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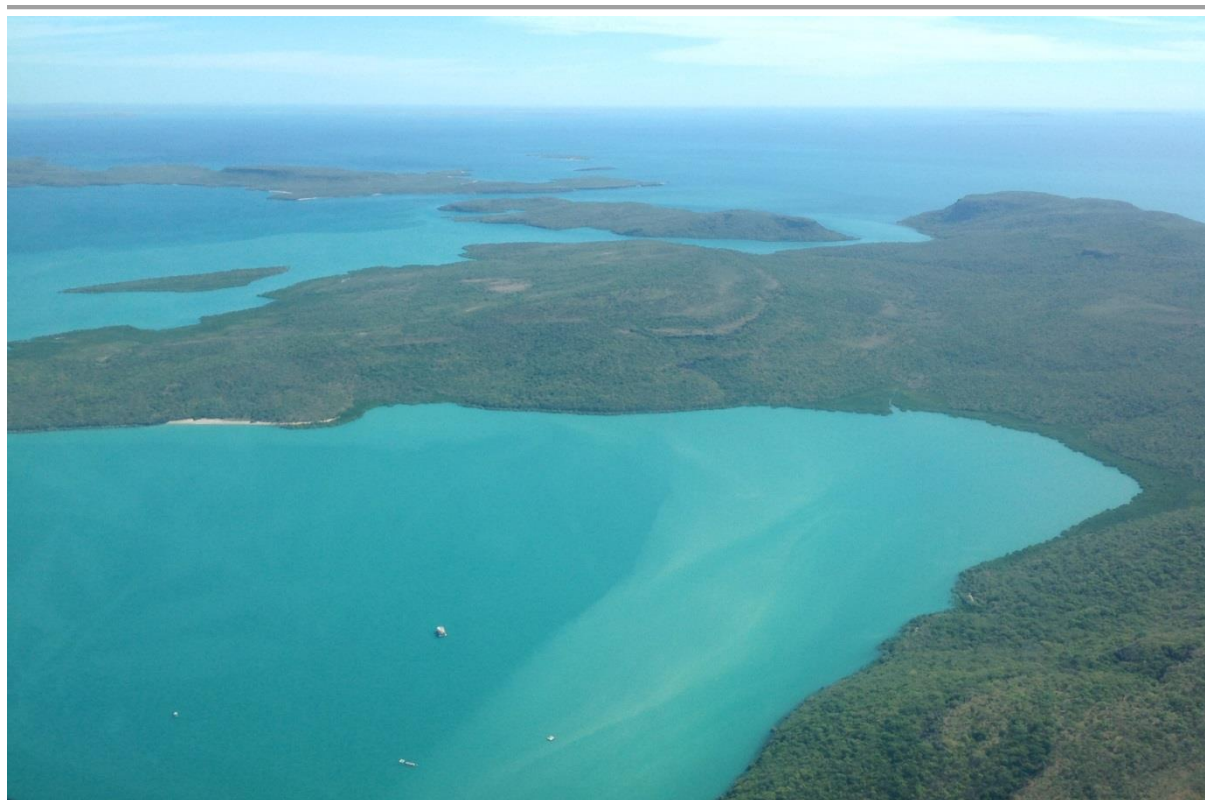
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April 2016



Vansittart Bay, north Kimberley coast (Source: J. Strickland-Munro)



Key words: PPGIS, social values, Kimberley coast, stakeholders, management preference, marine park, point density

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Author Contributions: SM, JSM, HK, GB designed the survey. JSM, GB, HK, SM collected the data. JSM, HK, GB analysed the data. JSM, HK, SM wrote the technical report, JP analysed stakeholder data.

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Corresponding author and Institution: Susan Moore (Murdoch University, Perth Western Australia, Australia).



Container ship being loaded with iron ore, Koolan Island, Buccaneer Archipelago (Source: J. Strickland-Munro)



Barn Hill coastline (Source: N. Cockram)



Campers preparing for fishing, Eighty Mile Beach Caravan Park (Source: J. Strickland-Munro)

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Human values and aspirations for coastal waters of the Kimberley

Extracted from Project Plan 2.1b (as updated August 2014)

Year	July 2014 – June 2015 (project suspended July 2014 – January 2014 inclusive: 6 mths)		Status
	1. Annual project planning completed		
3/2	Plan for assigned values (PP GIS) and management preferences combined online survey to be conducted over the period Apr-May 2015 (objective 2) (MU)	Feb 2015	Completed
3/3	Plan for social values mapping with up to two Traditional Owner groups to be conducted over the period May-June 2014 (objective 4) (MU)	Apr 2015	Completed
3/4	Plan for stated preference research as part of PP GIS online survey to be conducted over the period Apr-May 2015 (objective 3) (UWA)	Mar 2015	Completed
	2. Annual field program completed		
3/5	PP GIS and stated preferences online survey completed	May 2015	Completed
3/6	Social values mapping with up to two Traditional Owner groups completed	June 2015	Completed
	3. Annual data analysis completed		
3/7	PP GIS data analysed	June 2015	Completed
	4. Annual data management completed		
	GIS data (from interview-based mapping) provided to custodian (DPaW)	June 2015	Completed
	5. Annual reporting completed (outputs)		
	5.1 Science		
3/9	Annual fieldwork program and progress report completed	June 2015	Completed
3/10	PP GIS for Kimberley coast as technical report 2 (objective 2) (MU)	June 2015	Completed
3/11	Submit manuscripts: <ul style="list-style-type: none"> 1. • Mapping marine social values for Kimberley coast (MU) • Social values & tourism (MU) 2. • Tourism and awe: the Kimberley coast (MU) 	June 2015	In prep, ongoing
	5.2 Communication		
	5.3 Knowledge transfer		
3/14	Update WAMSI, DPaW, DPC, KLC & other key stakeholders on progress and proposed fieldwork for 2015	Mar 2015	Completed & ongoing
Year 4	July 2015 – December 2015 (project scheduled for completion December 2015)		
	1. Annual project planning completed		
4/1	Confirm completion schedule with Research Team members & WAMSI	July 2015	Completed
	2. Annual field program completed		
	Fieldwork completed in Year 3		Completed
	3. Annual data analysis completed		
4/2	Stated preference data analysed	July 2015	Completed
4/3	Traditional Owners' values information analysed	Dec 2015	Completed
	4. Annual data management completed		
4/4	GIS data provided to custodian	Aug 2014	
	5. Annual reporting completed (outputs)		
	5.1 Science		

4/5	Stated preferences – Kimberley coastline as <u>technical report 3</u> (objective 3) (UWA)	Sept 2015	Completed
4/6	Traditional Owner values for a selected marine park as <u>technical report 4</u> (objective 4) (MU)	Sept 2015	Completed
4/7	Complete final report (MU & UWA)	Dec 2015	Completed
4/8	Submit manuscripts: <ul style="list-style-type: none"> • Social mapping using PP GIS (MU) • Spatially locating human values for marine park planning & management (MU) • Stated preference research & marine parks (UWA) 	Dec 2015	In prep, ongoing
5.2 Communication			
4/9	Present final results at DPaW PVS Annual Conference (MU)	Oct 2015	Completed
4/10	Present findings at Resources Economics conference (if funding is sourced) (UWA) Present findings at European conference (MU)	Aug 2015	UWA conference completed MU conference May 2016
5.3 Knowledge transfer			
4/11	Provide briefing for DEC PVS, marine & planning staff on final results and how they can be presented and used in planning & management (MU & UWA)	Dec 2015	Completed

Personnel and staffing: Use this section to discuss staffing issues i.e. technicians hired, PhD or MSc or honours students working on the project (project completions etc). This section should be completed anew each 6-monthly reporting cycle. (Note: Do not delete this header text.)

No personnel or staffing issues.

Data/metadata reporting:

Data collection has been ongoing during this reporting period. PPGIS survey data will be collated and aggregated and will then become available to interested parties e.g. Dept of Parks and Wildlife. Mapping and values data from Year 1 of this project (spatial and supporting data from Kimberley interviews) was provided to Bardi Jawi Prescribed Body Corporate on their request.

Prior data reporting: The data from the Kimberley interviews (polygons and accompanying database assigning values to these polygons) were prepared and provided to the Management Planning Branch of the Department of Parks and Wildlife following an urgent request for this information in late May 2014. The Planning Branch intend to include these data in their spatial planning for the Kimberley marine parks. These data were provided at an aggregated level so individual respondents were unidentifiable (such aggregation is required by the Human Research Ethics Committee at Murdoch University). A MOU regarding use and reporting on use of these data has been finalised between the Department of Parks and Wildlife and Murdoch University.

Data collection has been ongoing during this reporting period. PPGIS survey data will be collated and aggregated and will then become available to interested parties e.g. Dept. of Parks and Wildlife. Mapping and values data from Year 1 of this project (Kimberley interviews) was provided to Bardi Jawi Prescribed Body Corporate on their request.

Links to other projects:

Other issues (including IP) and new or emerging risks:

A data sharing agreement with Department of Parks and Wildlife (Planning Branch) has been finalised.

Communication Activities – Publications, Presentations, Media releases:

Publications

- Brown, G, Strickland-Munro, J, Kobryn, H., Moore, SA (2016) Assessing stakeholder values and preferences for marine conservation using PPGIS. *Applied Geography* 67: 77-93.
- Strickland-Munro J, Moore SA, Kobryn H, Palmer D, (2016) How do people value the Kimberley coast? Research Bulletin 4.02, School of Veterinary and Life Sciences, Murdoch University, Perth, Western Australia
- 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)
- 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*.
- Pearce, J, Strickland-Munro, J, Moore, SA (under review) What contributes to awe-inspiring nature based tourism experiences? *Journal of Sustainable Tourism* (Nov 2015)
- Tonge J, Strickland-Munro 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, Strickland-Munro, J, Kobryn, H., Palmer, D, Brown, G (in prep) Identifying conflict potential in a coastal and marine environment using participatory mapping. *Ocean and Coastal Management* (March 2016)
- Strickland-Munro, J., Brown, G, Kobryn, H., Moore, SA (in prep) Marine conservation planning for the future: Using Public Participation GIS to inform the human dimension for large marine parks through understanding values and management preferences. *Marine Policy* (March 2016)
- Strickland-Munro J, Kobryn H, Moore SA, Brown G (2015) Human values and aspirations for coastal waters of the Kimberley: Port Smith (Purnturrpurnturr) visitor survey. Technical Report. Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia
- 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. Kimberley Marine Science Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia

Presentations and Meetings

- Strickland-Munro, J, Kobryn, H, Brown, G, Spencer-Cotton, A, Kragt, ME, Pearce J, Burton, M and 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 and 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 and 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, E M, 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, E M, 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
- 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, 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
- 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

Media and internet

- 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

Communication Activity	Total to date
Peer reviewed publication	7 (1 published, 1 in press, 3 under review, 2 in prep)
Technical report	4
Popular publication (ie Landscape, newsletter, etc)	2
Conference Presentation	9
Presentations/Meetings with Department of Parks and Wildlife managers & WAMSI	8
Presentations/Meetings with Traditional Owners	5
Presentations/Meetings with other stakeholders	17
Presentations to general public	2
Media releases	4
Radio interviews	6
Newspaper articles	7
Other	4
Total	75

Certification

I certify that the reporting is complete and accurate to the best of my knowledge, and I have reported any substantial deviation from the Project Plan and matters which I believe may affect the ability of the project to

meet its objectives. I certify that each Project Party has provided Contributions as required under the Project Agreement.

Project Leader: *S.A. Moore*

Date: 13 April 2016

This section needs to be signed for the Final Project Report only by the relevant Joint Venture Partner Executive.

Certification

I certify that this report has been reviewed by the agency and reflects the standards of this agency in reporting.

WAMSI JV Partner
Executive:

Date:

Human values and aspirations for coastal waters of the Kimberley: Social values and management preferences using Public Participation GIS

Executive summary

This is the second report from the “Values and aspirations for coastal waters of the Kimberley” research project funded by the Western Australian Government and administered by the Western Australian Marine Science Institution (Kimberley Research Node Project 2.1.2). The study area extends from the south western end of Eighty Mile Beach to the Northern Territory Border, a coastline 13,296 km in length at low water mark including the islands. The aim of this 3-year research project is to document and analyse the social values and aspirations of people associated with the existing and proposed marine parks at Eighty Mile Beach, Roebuck Bay, Lalang-garram (Camden Sound), Horizontal Falls and North Kimberley, and other coastal waters of the Kimberley.

This report provides results from a Public Participation GIS (PPGIS) survey undertaken to identify and describe stakeholders’ values and management preferences regarding the coastline and marine environment. PPGIS methodologies use spatially explicit mapping techniques to identify information on a range of planning concerns including ecosystem services, values and management preferences. Two discrete respondent groups participated in the survey: a ‘public’ sample who participated on the basis of personal interest and/or relevance, and an online panel sample who were paid to complete the survey. While the comparison of these two datasets is expected to provide interesting analytical opportunities, this report focuses on results from the ‘public’ respondent dataset, for two reasons. One, these respondents had an identifiable interest in the Kimberley coast and willingly volunteered spatially explicit information. Two, time constraints associated with project reporting requirements precluded the inclusion of online panel results at this stage.

Stakeholders involved in the PPGIS 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 (Traditional Owner status unknown); commercial fishing and aquaculture workers; and others. Almost two-thirds of respondents (64%) participated in the study following a direct email invitation. The survey asked respondents to place markers corresponding to pre-determined values and management preferences onto a high resolution, satellite imagery Google® maps interface of the Kimberley study area. A minimum mapping scale of 10 km was enforced, meaning that respondents could not place markers on the map until they had zoomed in to a sufficient scale. Once this minimum required scale for mapping was reached, a suite of identifying place names and markers became more obvious. The 10 km minimum mapping scale (where 1 cm on the map interface was equivalent to 10 km on the ground) was a compromise between the vast size of the Kimberley region and the need to ensure an acceptable level of accuracy in placing markers. A total of 19,157 value and management preference markers were placed during the survey.

Mapped social values for the Kimberley coastline and marine environment included indirect use values, direct use, non-consumptive values and direct use consumptive values. The main mapped values were: biological/conservation (indirect use value); scenic/aesthetic (direct use, non-consumptive); recreational fishing (direct use consumptive); and Aboriginal culture and heritage values (direct use non-consumptive) (listed here in descending order of prominence in mapping results). Non-use values comprised a very small proportion of the mapped values. In total, 13,756 value markers were placed in the survey, with each respondent placing an average of 29 markers (standard deviation = 40.8, max = 341).

Value and preference density was established by determining point density (for value and preference markers respectively). To do this, the spatial data were overlaid with 2 km grid cells and areas of greatest intensity of values and preferences were identified through three related processes: i) the definition of a 20 km search radius (‘the neighbourhood’); ii) counting the number of points within the neighbourhood for each value or preference, and dividing by the total neighbourhood area and iii) presenting as point density maps using a colour scale with a histogram stretch of 2.5 standard deviations from the mean. These densities were relative rather than absolute for each value and preference. Marker densities were differentiated into low, medium and high densities.

The results show the entire Kimberley coast as valued. Broome; Roebuck Bay; the southern, western and northern Dampier Peninsula; and the Buccaneer Archipelago were value hotspots (Table 1). Derby/southern King Sound and Kalumburu/Napier Broome Bay were also hotspots, although mainly of medium density (i.e. smaller number of markers) and for fewer values.

Direct use, non-consumptive values such as scenery, Aboriginal culture and wilderness, for example, had the greatest combined number of high density hotspots (Table 1). This group of values also included the greatest number of north Kimberley hotspots (e.g., Camden Sound, St. George Basin, Prince Frederick Harbour). Direct use, non-consumptive values relating to European heritage had the greatest number (11) of high density hotspots while therapeutic values had the lowest (2) (Table 1). Direct use, consumptive values on the other hand recorded eight discrete high density hotspots. These were focused on four areas: Broome and Roebuck Bay; southern, western and northern Dampier Peninsula; Buccaneer Archipelago and Derby/southern King Sound. Biodiversity (i.e., biological/conservation), the sole indirect use value, was valued along the entire coastline with two high density hotspots: Broome/Roebuck Bay; and the southern and western Dampier Peninsula. Non-use values such as intrinsic/existence value had three high density hotspots in the southern coastal region (Broome and Roebuck Bay; southern and western Dampier Peninsula; northern Dampier Peninsula).

Table 1. Key high and medium density hotspots according to value.

Value	Hotspot 80 Mile Beach region	Broome & Roebuck Bay	Southern & western Dampier Peninsula	Northern Dampier Peninsula	Buccaneer Archipelago	Derby/ southern Sound	King Bay	Camden & Brunswick Bay	Sound St. George Basin/Prince Regent River	Prince Frederick Harbour	Kalumburu/ Napier Broome Bay	King George Falls	Wyndham/ Cambridge Gulf
Biological/conservation ¹		X	X	x									
Scenic/aesthetic ²		X	X	x									
Recreational fishing ³		X	X			x					x		x
Aboriginal culture & heritage ²		x	x	X							x		
Wilderness ²		x			X			X	X		x		
Nature-based tourism ³		X	X	X									
Recreation (non-fishing) ²		X	X	x									
Learning & research ²		X	X	x	x	x							
European heritage ²	X	X	X	X	X	X		X	X		X	X	X
Special place		X	x	X									
Economic (non-tourism) ³		X	X		X	x							
Intrinsic/existence ⁴		X	X	X	x							x	
Spiritual ²		X		X							x		
Therapeutic ²		X		X									

X= high density of values (as determined by number of markers placed in the PPGIS survey)

x= medium density of values (as determined by number of markers placed in the PPGIS survey)

¹= Indirect use value

²= Direct use, non-consumptive value

³= Direct use, consumptive value

⁴= Non-use value

Chi-squared analyses of significance were performed to investigate the differences in values mapping between Kimberley residents and non-residents. A statistically significant difference in propensity to map (number of markers placed) was evident between Kimberley residents and non-residents for four value categories: recreation (non-fishing), recreational fishing, biological/conservation and wilderness/ pristine. Residents were more likely to map recreation and recreational fishing values while non-residents were more likely to map biological/conservation and wilderness/pristine values.

Respondents mapped a total of 5,401 management preference markers. An average of 19.5 preferences were placed per respondent (standard deviation = 24.9, max = 161). Two subsets of results were evident: 'pro-conservation' preferences and 'pro-development' preferences. 'Pro-conservation' preferences dominated (84.9% of all mapped preferences). Support for increasing conservation/protection; no oil/gas development; no commercial fishing/aquaculture; increasing Aboriginal management; no new port development and restricting or limiting access (listed here in descending order of prominence in mapping results) covered the entire study area coastline, with a lesser density of markers evident for the Eighty Mile Beach coastline. Hotspots were evident for all six 'pro-conservation' preferences. High density hotspots were: Broome and Roebuck Bay, the southern, western and northern areas of the Dampier Peninsula, and the Buccaneer Archipelago. Medium density hotspots were present at various coastal locations (Table 2). The preference to 'increase conservation/protection' had the most hotspots (6 including high and medium density) while Broome and Roebuck Bay, and the southern, western and northern Dampier Peninsula were hotspots for the preference to 'increase Aboriginal management'.

'Pro-development' management preferences, including add tourism services/development; improve or increase access; add recreational facilities; commercial fishing/aquaculture; oil/gas development; and new port development, listed in descending order of mapping prominence, received less mapping attention (15.1% of all mapped preferences). Hotspots included Broome and Roebuck Bay; the northern Dampier Peninsula; Derby/southern King Sound and Kalumburu/Napier Broome Bay (Table 2).

Broome and Roebuck Bay were loci for a number of potentially competing management preferences. For instance, respondents expressed a desire on the one hand to: increase conservation and protection, limit oil/gas and new port developments, no commercial fishing, and restrict or limit access. At the same time, the area was a hotspot for 'pro-development' preferences including the adding of tourism services and recreational facilities, increasing access, and new port development (Table 2). The southern, western and northern Dampier Peninsula were similar foci for potentially competing management preferences. While these areas were hotspots for 'pro-conservation' preferences, there was a concurrent call for improved access, recreation and tourism facilities. The western Dampier Peninsula (particularly the James Price Point/Walmadany region) was especially conflicted, being a hotspot for both opposition and support for oil/gas and new port development. The Kalumburu region also evidenced both 'pro-conservation' and 'pro-development' hotspots (Table 2). The Derby region in contrast was characterised by 'pro-development' hotspots.

Table 2. Key high and medium density hotspots according to management preference.

Hotspot M/ment preference	Broome & Roebuck Bay	Southern & western Dampier Peninsula	Northern Dampier Peninsula	Dampier Archipelago	Buccaneer King Sound	Derby/ southern St. George Basin/Prince Regent River	Prince Frederick Harbour	Kalumburu/Napier Broome Bay	Wyndham/ Cambridge Gulf
<i>Pro-conservation management preferences</i>									
Increase conservation/ protection	X	X	X	x		x		x	
No oil/gas development	X	X	x	x					
No commercial fishing/aquaculture	X			X				x	x
Increase Aboriginal management	X	X	X				x		
No new port development	X	X	x	x	x				
Restrict or limit access	X	x	x			x	x		
<i>Pro-development management preferences</i>									
Add tourism services/development	X		X	x	X			X	
Improve or increase access	X	X	X		X			X	
Add recreational facilities	X		x		X				x
Commercial fishing/aquaculture	x		X	X					
Oil/gas development		X				x			x
New port development	X				X				
Other	X	x		X					

X= high density of values (as determined by number of markers placed in the PPGIS survey)

x= medium density of values (as determined by number of markers placed in the PPGIS survey)

Chi-squared analyses of significance were performed to investigate the differences in preference mapping between Kimberley residents and non-residents. A statistically significant difference in propensity to map (in terms of number of markers placed) was evident between Kimberley residents and non-residents for three preference categories: add recreational facilities, new port development and 'other'. 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 one given preference more than another.

Policy and management Implications: Knowledge to action

The following policy and management implications derive from the research reported in this document.

- 1. The main values mapped were biological/conservation, scenic/aesthetic, recreational fishing, and Aboriginal culture and heritage. Collectively, these values were evident for the entire Kimberley coast. Thus, no part is 'value-free' and people must be consulted regarding its future, no matter if the location appears to be used (i.e. 'direct use, consumptive values') or not (i.e. 'direct use, non-consumptive values', 'indirect use values' and 'non-use values').*
- 2. These main values are all compatible with the purposes of marine parks and reserves. Protection of these values will, however, require careful zoning and consultation regarding the location of these zones. The PPGIS data collected in this study, where respondents mapped onto high resolution satellite imagery with a minimum mapping scale of 10 km, can contribute to MPA boundary designation as well as the general location of zones. More fine-grained planning requires a finer scale of data capture than undertaken here. PPGIS can be conducted at these finer scales.*
- 3. The coastline and associated marine environments of Broome, Roebuck Bay, and the southern, western and northern Dampier Peninsula are high density hotspots for many values including biological/conservation, scenery, nature-based tourism, European heritage and intrinsic/existence value. As such, they warrant careful planning and management, and widespread consultation when changes in land and sea use are being considered.*
- 4. Hotspots of medium density were also evident at the Buccaneer Archipelago, Derby and Kalumburu. This lesser density of markers may have been due to lower levels of familiarity and/or visitation to this largely inaccessible coastline (Derby excepted). Again, any proposed changes in land use must be accompanied by widespread consultation.*
- 5. Pro-conservation management preferences dominated the results (85% of all mapped preferences). This suggests the importance of the natural and cultural (Aboriginal) environment to most respondents. This is reflected in results from the environmental-economic priority scale question in this survey, which shows that 77.6% of respondents placed a greater priority on environmental than economic factors. This strength of attachment to the natural and cultural environment will underpin and emerge in any future planning, so being prepared to understand and plan for this set of management preferences (increase conservation/protection, no oil/gas development, no commercial fishing/aquaculture, increase Aboriginal management, no new port development, restrict or limit access) will underpin any successful policy development and implementation.*
- 6. Pro-development preferences, including add tourism services/development, improve or increase access, oil/gas development, and new port development, centre on Broome, Roebuck Bay, the northern Dampier Peninsula, Derby/southern King Sound and the Kalumburu region. This information on locations where development is regarded as desirable is vitally important as governments seek to develop the Kimberley, through ports and other infrastructure.*
- 7. Broome and Roebuck Bay are places where there are potentially competing management preferences. Both included, as well as pro-conservation preferences, desire for adding of tourism services and recreational facilities, increasing access, and new port development. This mixture of intentions makes the collection and use of social data in policy development and planning, and comprehensive, ongoing, meaningful engagement with stakeholders essential. Given the key role of local government in land use planning, this result suggests adequate resources and skills are essential for the Shire of Broome who will have carriage of much of this task.*
- 8. Largely pro-development views regarding the Derby region provide an opportunity to progress development in this lesser contested setting.*
- 9. Potential contestation between pro-conservation (increase conservation/protection and no commercial fishing/aquaculture) and pro-development (add tourism services/development and improve or increase access) management preferences at Kalumburu suggests early and ongoing attention to the collection of meaningful social data and to ongoing, targeted consultation with Traditional Owners as custodians and managers as well as other stakeholders.*

10. Monitoring, feedback, evaluation and changes in response to such processes are essential elements of good management. PPGIS provides a rapid, cost effective way of accessing social information for MPA spatial planning and coastal and marine spatial planning more generally. A lack of such social information and resultant problems for MPAs has been highlighted for other marine environments nationally and globally.¹ The scale of data capture should be determined by the project scope and the end uses to which the data will be put.

¹ Voyer M, Gladstone W, Goodall H (2012) Methods of social assessment in marine protected area planning: Is public participation enough? *Marine Policy* 36:432-439, and Gruby, RL, Gray, NJ, Campbell, LM, Acton, L (2015) Towards a social science agenda for large marine protected areas. *Conservation Letters* 2015 00(0) 1–11.

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I Introduction

I.1 Scope and purpose of research

This is the second technical report produced from the Western Australian Marine Science Institution Kimberley Research Node Project 2.1.2 *Values and aspirations for coastal waters of the Kimberley*. The study area encompasses all State coastal waters extending from the south western end of Eighty Mile Beach to the Northern Territory Border (Simpson 2011). A primary focus of the funding for this research, by the Western Australian Government, is to support the management of the proposed marine parks at Eighty Mile Beach, Roebuck Bay, Lalang-garram (Camden Sound), Horizontal Falls and North Kimberley (Figure 1). This research also encompasses the surrounding marine environment which includes Commonwealth marine parks as well as non-marine park waters.

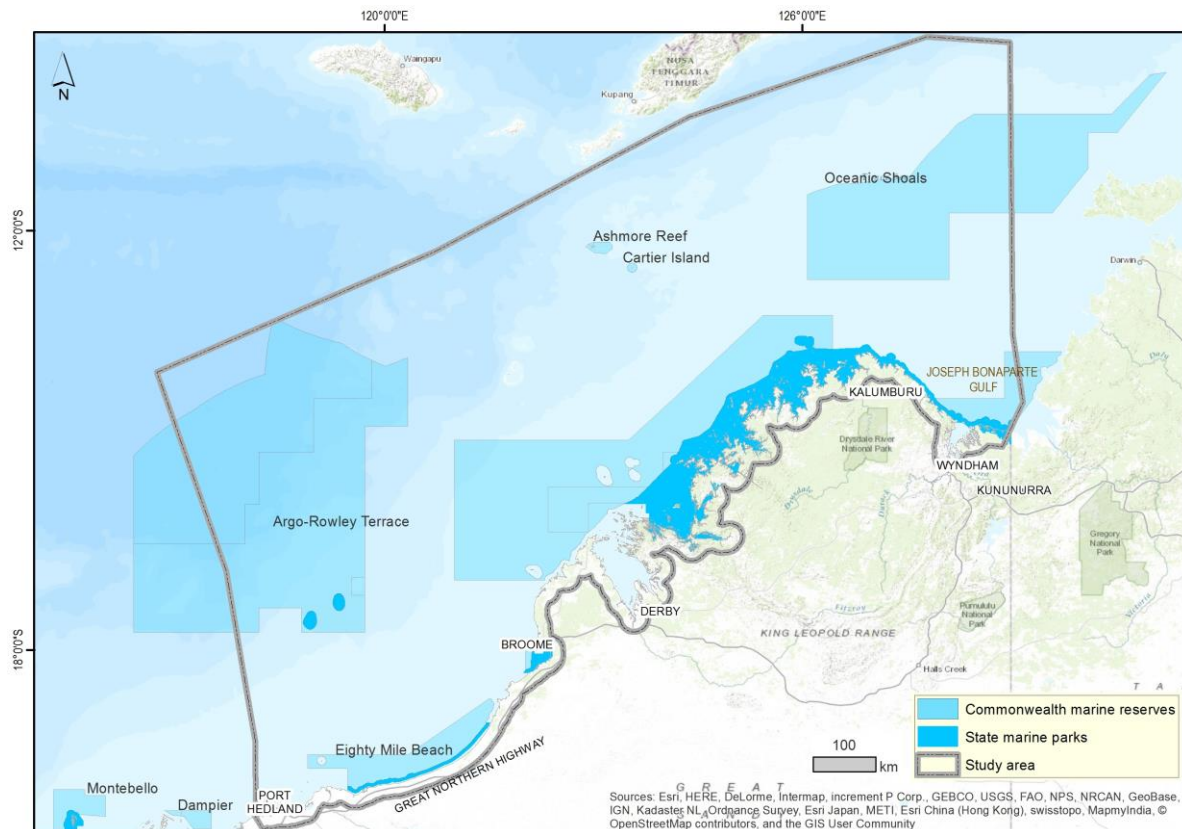


Figure 1. Kimberley marine parks (current and proposed) (Source: Geoscience Australia 2014, Department of Parks and Wildlife Sept 2015)

The Kimberley Marine Research Node Projects are guided by the Kimberley Marine Research Program (Simpson 2011), which focuses on two major areas of research: bio-physical and social characterisation (providing foundational data sets and better understanding impacts) and understanding key ecosystem processes. This technical report addresses the first major area by contributing to social characterisation of the Kimberley coastline and marine environment. It goes beyond a focus on people as 'impacts' to help understand peoples' needs and values. This second technical report draws heavily on material from Strickland-Munro et al. (2015) in its description and characterisation of research context and background.

Understanding peoples' needs and values is essential for effective planning and management, particularly when 'public' assets such as marine parks are involved. Voyer et al. (2012), in their review of Australian marine park planning, note that the social impacts and values associated with such areas have been inadequately considered to-date. These authors posit that failure to adequately consider social factors in planning and management may have implications for the long-term success of marine protected areas. They note that in two of their three cases studies social and economic arguments were used to delay and block future expansion of such areas. They conclude that where social values and impacts have been considered, they have relied on public participation and economic modeling as surrogates for comprehensive research and analysis of social values, perceptions and aspirations with respect to proposed (and existing) marine parks. Gruby et al. (2015) make a

similar call for greater research into the social dimensions of marine protected areas, as do Cornu et al. (2014) in relation to marine and coastal planning. As such, this research focused on researching social values as a contribution to enhanced decision-making and management.

1.2 Social values

No clear-cut and consistent definition of the term 'value' exists, with definitions varying according to the discipline of enquiry. For instance, anthropology, sociology, environment, philosophy and ecological economics all consider the term in different ways (Reser & Bentrupperbaümer 2005, Song et al. 2013). Despite this profusion of uses and lack of clarity, some commonalities are evident. In this research the scope is narrowed to 'values' as identified in the environmental field.

The environmental literature typically classifies human values as either held or assigned. The focus of this research is 'assigned values': "values that people attach to things, whether they are goods such as timber, activities such as recreation, or services such as education" (Lockwood 1999, 382). People also have 'held values', which are much more abstract – they are principles or ideas "that are important to people, such as notions of liberty, justice or responsibility" (Lockwood 1999, 382). Brown (1984) described held values as fundamental underlying ideals that prioritise modes of conduct or desirable qualities, e.g. bravery, loyalty, fairness, beauty. Held values are believed to influence assigned values through subjectively evaluating objects (Brown 1984, Lockwood 1999, Brown & Weber 2012).

While natural features such as waterfalls and turtles are often described as values, they are better understood as natural features that give rise to values (Lockwood 2011). These features are the source of values, rather than being values themselves. The same holds for cultural and historical sites, for example, Aboriginal art sites and shipwrecks. Features can also give rise to multiple values, a waterfall or bay may be aesthetically beautiful, it may have recreational opportunities, and it may have spiritual values for Aboriginal people (Lockwood 2011).

Assigned rather than held values have been argued as more useful for examining values in relation to specific sites (McIntyre et al. 2008). The idea of assigned values having a 'geography' (Davies 2001, 82 in McIntyre et al. 2008) recognises that they are place-based. The spatial nature of assigned values implies that value may be allocated at a range of scales from highly site specific to broader ecosystem, regional, national or global levels (McIntyre et al. 2008).

Knowing about assigned values is important for natural resource managers because these values influence how people behave at a place and the concerns and aspirations they have about it now and in the future. Assigned values also influence how people respond to proposed changes in policy and management. Brown and Weber (2012) suggest that mapping landscape values (they define these as a type of relationship value that bridges held and assigned values) can help managers: identify potential land-use conflict areas; assess the compatibility of land uses (e.g. zoning in marine parks) with landscape values; and provide public input to managing public lands (and waters). A number of other researchers (e.g. McLain et al. 2013) use the term 'landscape values', strongly influenced by the work of Greg Brown (see Brown & Reed 2000), who developed a list of landscape values for National Forests in the United States, with this list underpinning numerous studies over the intervening period.

In this research we adopt the term **social values** to broaden the suite of values beyond the 'landscape'. Although many landscape value typologies being applied are suitably broad, for example, including health and spiritual values (e.g. Besser et al. 2014), we take a more expansive perspective in this report to avoid such values being narrowly construed as restricted to the 'landscape'. We define social values as "*the importance of places, landscapes, and the resources or services they provide as defined by individual and/or group perceptions and attitudes towards a given place or landscape*".

1.2.1. Value typologies

Many typologies of values exist. Lockwood has written a handful of seminal papers on values, with the most recent (Lockwood 2011) organising values for protected areas into three primary categories: direct use, indirect use and non-use (existence) values, with economic value included as a fourth separate category. Direct use values include nature-based recreation, maintenance of public facilities, personal development (e.g. development of leadership skills), therapeutic and physical wellbeing values, education, research and some forms of resource extraction (e.g. honey production). Indirect use values (equated with ecosystem services) include 'the filtering of air and water, the assimilating of waste, the cycling of nutrients, and the regulation of climate' (Lockwood 2011, 4). Non-use (existence) values include appreciating a protected area just because it is there, as well as knowing it will be there for future generations (bequest value). Non-use values also include spiritual and cultural connections with nature, and personal identity. The latter can encompass elements of

personal, family and community histories. Economic values are not separate, with Lockwood (2011) noting they are merely another way of expressing values, especially use values. 'Biodiversity' is considered the source of many different values rather than being a 'value' in its own right.

The Millennium Ecosystem Assessment (2005), in their Total Economic Value Framework, present a similar values typology to Lockwood, discussing direct use, indirect use and option values with respect to ecosystem services. However, they take the typology one step further by dividing direct use values into consumptive (the taking of resources e.g. fishing) and non-consumptive (no reduction in resources, e.g. recreation, spiritual, social aspects) categories. Indirect use values similarly refer to values associated with water purification, waste assimilation and other regulating services. The final category of option values includes existence and bequest value as well as value attached to the potential to use a service in the future.

This research draws on both typologies. Lockwood's research has been specifically directed to protected areas and as such encompasses the complexity of values such areas hold. Such complexity is also likely to typify the Kimberley coast and marine environments. As such, his typology was one of the two frameworks to underpin this study. The second framework is the utilitarian approach taken by the Millennium Ecosystem Assessment (2005) with their Total Economic Value Framework. It was chosen because of the current interest in ecosystem services expressed by protected area managers and the hope that framing the research as such would enable a more rapid uptake of the findings.

We discuss social values (often referred to as landscape or place values in the literature) in four broad ways: (1) Direct use, non-consumptive values. This category of value implies that while the Kimberley coast was directly used in the attainment of value, the quantity of goods or value available was not diminished or reduced as a result. (2) Direct use, consumptive values. This category includes values accrued through direct use of the Kimberley coast and its waters, with a potential concomitant reduction in the quantity of goods and value available due to that use. (3) Indirect use values. Indirect use values are those associated with air and water purification, waste assimilation and other regulating services. Biodiversity is considered one of these 'services'. (4) Non-use values. This final category of value includes those unrelated to physical experience or use of the Kimberley coastline or marine environment.

1.3 Overview of research to-date on marine social values

The marine environment, and marine protected areas (MPAs) in particular, are receiving an increasing amount of attention in regards to biodiversity conservation (Pita et al. 2013). While MPA ecology and economics have been well studied in the past, the social aspects of marine conservation and MPAs have received much lesser consideration, although there is a growing recognition of their importance in terms of the ongoing success of marine conservation (e.g. Charles & Wilson 2008, Pollnac et al. 2010, Voyer et al. 2012). These 'social aspects' include the relationships that people have with the marine environment and may be reflected in the social values they express (people's preferences and opinions regarding management, benefits or ecosystem goods and services derived, attitudes and perceptions pose other elements of social interest). While understanding people's social values, perceptions and aspirations in relation to the marine environment is increasingly seen as critical for long term conservation, comprehensive investigation and analysis has been lacking to-date (Voyer et al. 2012, Cornu et al. 2014, Gruby et al. 2015).

A recent review of the scientific literature concerning social considerations relating to marine environments (Strickland-Munro et al. under review) supports the assertions of Voyer et al. (2012) and Gruby et al. (2015). Their review of articles variously exploring social values, perceptions, attitudes, preferences and benefits derived from marine and coastal landscapes highlights a lack of consistency and rigour characterising the investigation of social considerations. For instance, the particular variable(s) investigated in the articles (e.g. value, perceptions, attitudes) was typically undefined or used interchangeably with other related terms (e.g. concurrent use of the terms attitudes, perceptions, values and views). In addition, articles at times explored more than one (undefined) variable simultaneously. This use of multiple, undefined research variables contributes to confusion over the meaning of variables already present within and among different disciplines. It may also be indicative of language 'slippage' within the wider environmental values literature (Reser & Bentrupperbauer 2005). Strickland-Munro et al. (under review) conclude that failure of many reviewed articles to provide clear definitions of their social research variables impedes their ability to convey meaning across disciplinary divides and their usefulness for decision making.

Further, their review illustrates that while a range of stakeholder groups (e.g. tourists, recreational, subsistence and commercial fishers, conservation management agencies, government, conservation organisations, the tourism industry, divers, local community members, scientists) have been involved in social research, the majority of studies engaged with only two primary stakeholder groups, commercial fishers and local community

members. While these stakeholder groups clearly have a close involvement with the local marine environment and are likely to be impacted by management changes (Pita et al. 2013), future research would benefit from engaging with a greater number and more varied range of stakeholders to help provide a greater diversity of perspectives.

The review also highlights recreational values as the most frequently identified value evident in existing studies. Economic and biodiversity values were the next most commonly identified social value relating to marine and coastal environments. Over 20 other values were identified, in addition to a number of ecosystem goods and services. These included the notable presence of non-use or intrinsic values including existence, bequest, and option values (Strickland-Munro et al. under review).

1.4 The Kimberley coast and marine environment as valued places

1.4.1 *Aboriginal connection to country*

Aboriginal people have occupied the Kimberley region for an estimated 40-60,000 years and evidence an enduring relationship with the landscape. The physical landscape, or 'country', is more than a mere geographical space for Aboriginal people, it is a living entity, as active and responsive as people. As Rose (2002) explains, in Aboriginal English, the word 'country' is both a common noun and a proper noun. People talk about country in the same way that they would talk about a person: they speak to country, sing to country, visit country, worry about country, grieve for country and long for country. People say that country knows, hears, smells, takes notice, takes care, and feels sorry or happy. Country is a living entity with a yesterday, a today and tomorrow, with consciousness, action, and a will toward life. This contrasts to western ontology with its emphasis on geography, location, boundaries, utilitarian use, and topography with flora and fauna. Instead country is life affirming, active and the means through which people can work in conjunction with "the totality of beings that are ever-present in land, water and the heavens" (Doohan 2006, 117).

Long-established ontological traditions and practices connect the health of country to the health of people. Country, and one's relationship to it, entails a suite of personal, cultural and spiritual obligations and responsibilities. Country exceeds the biophysical: it also includes that which cannot be seen including spirits, the old people, the forces that shape behaviour, and laws and rules for conduct. This means that country has the capacity to instruct, direct and influence at the same time as offering people specific sites that allow them to hunt, conduct education, carry out law and ceremony and inspire song, language, story and law (YRNTBC 2011).

The centrality of country to Aboriginal culture means that great value is placed on keeping country healthy. This applies equally to land and sea (or saltwater) country, which are inseparable for coastal Aboriginal people (Smyth 2007). Vigilante et al. (2013, 146) describe saltwater country as a "complex enculturated place". Saltwater country activates all sorts of things for local Aboriginal people. It brings to life story, song and memory. It brings to life not just a landscape that is 'out there' or truncated from human subjectivity. It holds the imprints and life force of ancestral characters and spiritual activity. It can heal and it can punish. Thus saltwater country calls up and maintains "layer upon layer of relationships to land and ancestors" (Sharp 2002, 77).

A consistent set of themes runs through various Aboriginal ideas about the coast. Most fundamental is the interconnected relationship between people, country and law. These first principles in Aboriginal ontology involve the interweaving of community (through old kin-based social structures and rules), country (through keeping places alive by visiting, walking, hunting and caring) and law (through transmission of song, culture, language, knowledge and story from generation to generation).

Significant archaeological evidence of Aboriginal occupation and use exists along the Kimberley coastline as well as on a number of offshore islands. This evidence includes rock art, stone arrangements, shell middens and other human artefacts (Zell 2007, Vigilante et al. 2013). Saltwater country also provides evidence of Dreamtime events in the form of rock art, stone arrangements, sacred sites, song lines and other in/tangible features of land and sea within which reside ancestral creator beings (Smyth 2007, Vigilante et al. 2013). Maintaining contemporary connections to these Dreaming events is paramount and achieved through complex religious narratives known as 'stories' (Vigilante et al. 2013). The transmission of knowledge via stories is the *raison d'être* for Aboriginal life, giving elders the chance to have their accounts listened to, young people the chance to learn and Aboriginal culture the chance to rejuvenate.

1.4.2 Overview of Aboriginal values

The enduring and all-encompassing role of country provides insight into a number of ways in which Aboriginal people value the Kimberley coastline and marine environment. The following section provides a brief overview of these values but is in no way a comprehensive representation of the special relationship between Aboriginal people and country. The centrality of subjective values and involvement of both physical and metaphysical realms contrasts with objective Western measures of 'health' (Scherrer et al. 2011), posing one difficulty in accurately portraying Aboriginal relationships to country. Reticence in sharing culturally sensitive information with outsiders presents another challenge, as found in other values mapping research (e.g. Klain & Chan 2012, Ramirez-Gomez et al. 2013).

Coastal (or saltwater) Aboriginal people continue to rely on coastal and marine environments and the resources therein for their cultural identity, health, wellbeing and domestic as well as commercial economies. Their connections to sea country have remained strong despite the impacts of dispossession (Smyth 2007) that saw traditional Aboriginal language groups decimated and Aboriginal people forcibly removed from their homelands. Beyond the metaphysical spiritual and cultural values associated with the need to care for country and maintain spiritual health, a number of more tangible values relating to the coastline and marine environment are evident. These include the provision of food resources from the sea and coastal area, with coastal Aboriginal groups noted for their heavy reliance on sea resources to comprise their traditional and preferred diet.

For Kimberley Aboriginal groups the connection between people and country is paramount. This is because in Aboriginal ontology and cosmology learning about traditional kinship obligations is incorporated into the business of looking after 'sea-country'. Indeed to think about people without reference to country is akin to talking about the future of a child without reference to its mother (Rose 2004). As Edwards (1988) further explains this is because in Indigenous cosmology country is the place where present living family, ancestors and as yet unborn children dwell. This means that as a member of one's family, country demands care. In turn, country offers care. To visit country, to travel through it, hunt on it, make fire on it and sing to it is much like visiting an older relative. In both acts one maintains relationships, obligations and 'keeps alive' one's family. In this way, keeping country healthy (by visiting it, dancing on it and warming its soul by fire) also involves the act of keeping community healthy (Collard & Palmer 2006).

1.4.3 European history and current land use

The Kimberley coast has a relatively long history, by Australian standards, of exploration. Makassan sea traders (from today's Indonesia) began visiting the Kimberley coast between 1669 and 1763 (Crawford 1969, 2001 in Vigilante et al. 2013). Early explorers from the 16th century onwards included the Portuguese, Dutch, French and British. French, Dutch and English names attached to this coast as a consequence of these early European explorers. Australian-born Phillip Parker King visited from 1817-1822 and provided excellent charts for the area. He also carved HMC Mermaid into a boab tree at Careening Bay where he hauled his boat up for repairs.

An early attempt at settlement, at Camden Harbour in 1864/5 for sheep grazing, failed within a year. A similar attempt by pastoralists at Roebuck Bay also failed. Pearling began in the Kimberley in the 1850s and was well established by 1870. A fleet of 400 luggers was in evidence at Broome by 1910, however, by 1950s few were left after plastic and Bakelite made pearl shell redundant. The late 1950s saw a resurgence in the pearl industry in the late 1950s as cultured pearls became popular. The Australian pearl industry is now a world leader owing to high water quality and a shallow continental shelf.

Broome was named in 1883 and became the main base for pearling. The majority of workers in the industry were Japanese and Malaysian, but there were also Chinese, Filipino, Amborese, Timorese and Makassan, as well as Aboriginal people and Europeans. Thus, the multicultural history of Broome was born. Derby was established at about the same time, as a port for shipping cattle. The Wyndham meatworks, also developed as part of the supporting infrastructure for the beef cattle industry, were established in 1919 and closed in 1985.

Commercial fishing and aquaculture in the Kimberley coastal waters includes prawns, barramundi, demersal scatefish, shark, mud crabs, mackerel, aquarium fish, specimen shells, beche de mer, trochus and pearls (DPW & DAC 2013). The Kimberley coastline and marine environment is highly prospective, with iron ore currently mined on Cockatoo and Koolan Islands. There are large reserves of petroleum and gas offshore in the Browse and Bonaparte basins. The Port of Broome is currently being used as a supply base for rig servicing and supply logistics.

An integral part of the history of the Kimberley has been the establishment of Christian missions for Aboriginal people. A Presbyterian mission was established at Port George IV in 1912 and then shifted to Kunmunya by

1916. By 1949, Worora, Wunambal & Ngarinyin people lived in two major mission settlements: Kunmunya and Munja due to pastoral stations occupying almost all Aboriginal land in the north Kimberley. Beagle Bay mission was established in 1890, Lombadina in 1892 and Sunday Island in 1898-9. Sunday Island mission closed 1957, with people moved to Derby until 1967. They then moved back to Sunday Island in 1967 and then to One Arm Point in 1972. In many cases different language groups were forced to live side by side in missions, further contributing to a sense of disconnect from country and kin.

Native title determinations are dramatically changing how lands and coastal waters in the Kimberley are delineated, valued and ultimately managed. Native title recognises under Australian law that some Indigenous people have rights and interests to their land associated with their traditional laws and practices. Native rights and interests may include: living on an area; access for traditional purposes such as camping or ceremonies; visiting and protecting important places; hunting and gathering food; and teaching law and custom on country (National Native Title Tribunal 2014). Almost all of the Kimberley coast is subject to native title applications and determinations (refer to http://www.nntt.gov.au/Mediation-and-agreement-making-services/Documents/Quarterly%20Maps/WA_Kimberley_NTDA_schedule.pdf for the most recent map).

The Kimberley provides a range of tourism activities, many of them with a coastal, nature-based focus. Activities include ecotourism, ground and fly-drive operations, four-wheel-drive opportunities, luxury coastal cruising with a tour company, independent cruising, coastal resorts, and Indigenous cultural tours. A comprehensive report on coastal tourism in the Kimberley published by Scherrer et al. (2008) placed tourism third in terms of economic contribution to the Kimberley, with minerals and petroleum (including diamonds, iron ore and crude oil) first, and retail second.

1.4.4 Current marine park activities

The global and national biological significance of the Kimberley is well recognised. The marine environment in particular is noted for its 'very good' ecological condition and inclusion in the 3.7% of global oceans considered to have had very low human impact (Halpern et al. 2008). While acknowledged as ecologically diverse and untouched, pressures on the marine environment are growing. Further, there is a recognised dearth of scientific knowledge regarding the marine environment (GoWA 2009), which has been described as "one of the great frontiers for science" (GoWA 2011, 28).

Seeking to remedy this lack of scientific knowledge and invest in long term conservation for the region, in 2011 the Western Australian Government introduced the Kimberley Science and Conservation Strategy (GoWA 2011). Part of the commitments enshrined in the Strategy was to introduce a system of marine reserves through the establishment of four new, multiple use marine parks. Located at Eighty Mile Beach, Roebuck Bay, Lalang-garram/Camden Sound and North Kimberley (proposed) (Figure 1), the marine parks were to cover 48% of the Kimberley's coastal waters, and increase the area of State marine parks and reserves from approximately 1.5 million hectares to 4.1 million hectares (Thomson-Dans et al. 2011). A fifth marine park for the iconic Horizontal Falls area was announced in 2013, as were plans to extend the North Kimberley Marine Park eastwards to the Northern Territory border. To-date three parks have been established, at Eighty Mile Beach, Horizontal Falls and Lalang-garram/Camden Sound, with the remaining two parks yet to be formalised. These existing and proposed State marine parks complement four existing Commonwealth marine reserves located at Eighty Mile Beach, Roebuck Bay, Argo-Rowley Terrace and 'Kimberley' (Figure 1). Commonwealth marine reserves are located beyond State boundaries in Commonwealth waters, which extend seawards from the limit of West Australian coastal waters.

Commonwealth marine reserves are managed primarily for biodiversity conservation outcomes but also allow for a range of activities including commercial and recreational fishing, tourism, mining operations, and pearling and aquaculture (CoA 2014). All existing and proposed State Kimberley marine parks are to be managed with Aboriginal Traditional Owners under formal joint management agreements.

2 Methods

2.1 Research approach

2.1.1 Research questions and objectives

This technical report contains the results from the second part of the 3¹/₂ year social research project (*Socio-cultural values of the Kimberley coastline and marine environment*), and reports on a web-based Public Participation GIS survey validating and extending the findings from the first part of this project research (see Strickland-Munro et al. 2015).

The overarching aim of this 3¹/₂ year social research project is to document and analyse the social values and aspirations of people associated with the existing and proposed marine parks at Eighty Mile Beach, Roebuck Bay, Lalang-garram (Camden Sound), Horizontal Falls and North Kimberley and other coastal waters of the Kimberley between Eighty Mile Beach and the Northern Territory border.

This research aim is being pursued through the following research objectives. This report addresses the second one.

1. Describing and analysing how people value the Kimberley coastline and marine environment and what places are important to them, especially for Aboriginal people, through 167 in-depth face-to-face interviews accompanied by participatory mapping in the Kimberley region, Perth and Darwin.
2. Undertaking a follow-up web-based Public Participation GIS (PPGIS) survey to extend and validate the results from Objective 1.
3. Undertaking comprehensive stated preference choice analyses. This was achieved by adding a series of questions designed to elicit respondents' preferences regarding future activities on the Kimberley coast and future management of this coastline and its waters in the web-based PPGIS survey detailed under Objective 2.
4. Undertaking a detailed analysis of the social values for up to two marine parks through extended consultation with Aboriginal Traditional Owners and others with a particular interest in the chosen marine park(s).

2.1.2 Research design

The study area for this research was the Kimberley coastline from the Western Australia – Northern Territory border to Cape Keraudren at the western end of Eighty Mile Beach (Figure 1). Respondents were sought from a range of geographical locations both within the Kimberley (focusing on the coastline) as well as locations remote from the Kimberley. All were asked to focus their responses on the coast and associated islands and waters. Much of the coast and its waters are either held under native title by Aboriginal Traditional Owners or are currently subject to native title negotiations. The WA Government is committed to jointly managing Eighty Mile Beach, Roebuck Bay, Lalang-garram (Camden Sound) and North Kimberley Marine Parks with Aboriginal Traditional Owners. All marine parks in WA are vested in the Marine Parks and Reserves Authority, with joint management possible under section 56A of the Conservation and Land Management Act 1984 (WA).

A variety of methods have been used to collect socio-spatial data, including open-ended personal interviews through to web-based tools (as per this study) (McLain et al. 2013). A public participation GIS (PPGIS) methodology was used in this study. A PPGIS methodology uses spatially explicit mapping techniques to identify spatial information on a range of planning concerns including ecosystem services, values and management preferences (Sieber 2006). Brown and Fagerholm (2015) describe PPGIS as a useful method for accessing place-based, local information held by stakeholders that offers an alternative to secondary data collection from the literature.

PPGIS has been used extensively by natural resource managers for a variety of purposes including local scale conservation and protected area planning (e.g. Green 2010, van Riper et al. 2012, Plieninger et al. 2013) and larger scale tourism and development planning (e.g. Brown & Weber 2012, Brown et al. 2014). PPGIS studies have been performed on all continents apart from Antarctica and Asia with the majority taking place in North America, Europe and Australia (Brown & Fagerholm 2015). A typical PPGIS study asks respondents to spatially locate landscape values, ecosystem services and/or management preferences by placing markers onto a map of a particular geographical area. Mapping may occur on an online mapping interface or on hard copy cartographical or aerial maps. This is often accompanied by the assignment of relative importance to mapped items. The data collected through PPGIS provides planners and managers with socio-spatial information that

can assist in the identification of potential land-use conflict; assess the compatibility of land uses (e.g. zoning in marine parks) with landscape values; and provide public input to managing public lands (and waters) (Brown & Weber 2012).

An online PPGIS approach was adopted in this research for three reasons. One, to validate and extend previous project findings on the values associated with the Kimberley coast and marine environment. Two, an online PPGIS survey facilitated the inclusion of a broader range and greater number of respondents than was possible in initial interview research. Many people who have visited or who have an interest in the Kimberley live remote from the region and an online survey made it possible to engage with these geographically distant stakeholders. A third reason lay in the methodological novelty of applying a PPGIS study to the coastal and marine environment. To-date, there is a paucity of PPGIS studies conducted in marine environments, with research by Ruiz-Frau et al. (2011) and Klain and Chan (2012) providing notable exceptions. None of these studies however have been undertaken in such a unique, vast environment characterised by very high 'wilderness' values and limited access.

Usually, both interview and web-based approaches have relied on pre-defined value categories, most often those developed by Brown and Reed (2000). The PPGIS survey reported on here applied pre-determined value categories generated through the earlier interview-based phase of research (see Strickland-Munro et al. 2015). These interviews used an interpretivist approach (Neuman 2009) to generate a set of emergent social values for the Kimberley coast and its waters. Table 3 presents the 17 mutually exclusive value categories obtained from these interviews.

Table 3. Social values derived from previous project research and their definitions (Strickland-Munro et al. 2015).

Value category	Definition
<i>1. Direct use, non-consumptive values</i>	
Physical landscape	Values derived from components of the physical landscape. Major elements: aesthetics, tidal phenomenon, coastal geology, unique nature experiences, the Kimberley's 'pristine untouched environment', and the coastline being 'wilderness' and a 'last frontier'.
Aboriginal culture	Values derived from the transmission of Aboriginal wisdom, knowledge, traditions, and way of life. Major elements: cultural sites, connection to country, evidence of historical use, and transmission of cultural knowledge. DOES NOT include SPIRITUAL values relating to profound or awe inspiring nature experiences as expressed by non-Aboriginal people.
Therapeutic	Values derived from places that make people feel mentally better, calm, or recharged. Major elements: escapism, relaxation, remoteness, and personal recharge.
Social interaction and memories	Social values derived from a place. Major elements: social experience and home/childhood memories.
Recreation–other	Values derived from places that provide opportunities for outdoor recreation unrelated to camping or fishing. Major theme: exploration.
Learning and research	Values derived from the ability to learn from a particular place. Typically expressed in terms of scientific research, but also monitoring, exploration, discovery and more generally the ability to learn about the environment (i.e. 'lay' learning). DOES NOT include transmission of cultural knowledge within Aboriginal society (included in ABORIGINAL CULTURE).
Experiential	Values derived from places offering a unique personal experience. Major elements: adventure, iconic destination, 'blown away' experience, private experience.
Historical	Values derived from places of natural and human history that matter to an individual, others, Australia or the world. Major elements: European and missionary history. DOES NOT include evidence of historical Aboriginal use (included in ABORIGINAL CULTURE).
Spiritual	Values derived from places that are sacred, religious, unique, or that provide deep and/or profound experiences of nature. Typically related to an expressed reverence/respect for nature by non-Aboriginal people. Major elements: nature as a spiritual landscape. DOES NOT include ABORIGINAL CULTURE e.g. those values related to the transmission of wisdom, knowledge, traditions and way of life.
<i>2. Direct use, consumptive values</i>	
Recreation–camping	Values derived from places that offer recreational activities centred on overnight or longer stays in transient and/or fixed accommodation in coastal areas.
Recreation–fishing	Values derived from places that offer recreational activities relating to the catching of fish species as well as gathering of other marine life e.g. mud crabs, cockles, oysters and stingrays. DOES NOT include fishing undertaken by Aboriginal people as this activity was more commonly referenced as subsistence rather than recreational pleasure.
Subsistence	Values derived from places that provide for basic human needs. Major elements: subsistence food collection and fresh water provision. DOES include Aboriginal hunting where specifically mentioned in the context of subsistence hunting.
Economic–tourism	Generic tourism values, or more specifically refers to eco or nature based tourism, or Aboriginal cultural tourism.
Economic–commercial fishing, pearling and aquaculture	Values derived from commercial fishing, aquaculture and pearling activities. DOES NOT include subsistence food collection (included in SUBSISTENCE).
<i>3. Indirect use values</i>	
Biodiversity	Values derived from the presence of flora, fauna and/or other living organisms. Major elements: marine fauna, reef biodiversity, migratory shorebirds and mangroves.
<i>4. Non-use values</i>	
Bequest	Values derived from places that offer future generations the ability to know and experience places, landscapes and habitats as they are now.
Existence	Values derived from knowing that a particular place, environmental resource and/or organism exists, regardless of having physically been to or directly used an area.

These values accord with the body of knowledge on landscape values developed and extensively used by Brown and colleagues in their PPGIS work (e.g. Brown & Reed 2000, Brown & Weber 2012, Brown 2014, Brown & Donovan 2014). Table 4 provides an example of the landscape values commonly applied by Brown and colleagues in their PPGIS studies. The 17 emergent value categories outlined above complement this established typology in broad terms while explicitly recognising the unique characteristics and nuances of human-environment interactions in the Kimberley region (for example, values relating to Aboriginal culture and subsistence).

Table 4. Landscape values used in Victorian public lands PPGIS survey (Brown et al. 2014).

Values	Operational definition
Scenic/aesthetic	These areas are valuable to me because they contain attractive scenery including sights, smells, and sounds
Recreation	These areas are valuable to me because they are where I enjoy spending my leisure time – with family, friends or by myself, participating in outdoor recreation activities (e.g., camping, walking or fishing)
Economic	These areas are valuable because they provide natural resources or tourism opportunities
Life Sustaining	These areas are valuable because they help produce, preserve, clean, and renew air, soil and water
Learning/education/research	These areas are valuable because they provide places where we can learn about the environment through observation or study
Biological/conservation	These areas are valuable because they provide a variety of plants, wildlife, and habitat
Heritage/cultural	These areas are valuable because they represent natural and human history or because they allow me or others to continue and pass down the wisdom and knowledge, traditions, and way of life of ancestors
Therapeutic/health	These areas are valuable because they make me feel better, physically and/or mentally
Spiritual	These areas are valuable because they are sacred, religious, or spiritually special places or because I feel reverence and respect for nature here
Intrinsic/existence	These areas are valuable in their own right, no matter what I or others think about them
Wilderness/pristine	These areas are valuable because they are wild, uninhabited, or relatively untouched by European activity

A condensed set of the social values as outlined in Table 3 was used in this PPGIS survey (see 2.4 *Data collection*). Inclusion was based on the relative importance of each value type as determined by its percentage representation in interview data as well as consideration of values unique to the Kimberley. For example, ‘recreation–fishing’ emerged as a critical value for the Kimberley coast in earlier project research (Strickland-Munro et al. 2015). However ‘recreation–camping’ and ‘recreation–other’ were condensed into one larger ‘recreation’ category, as they were less important as stand-alone value categories.

Earlier project interviews similarly generated a set of emergent management preferences for the Kimberley coast and marine environment. A subset of these preferences were included in the PPGIS survey, with refinement guided by a number of sources. First, the preferences were consolidated through analysis of perceived threat data contained in interview transcripts. Second, the preferences were designed to resonate with information contained in relevant policy documents (e.g. Draft Kimberley Regional Planning and Infrastructure Framework, Government of Western Australia 2014). Third, the preferences were aligned with those used in previous PPGIS research (e.g. Brown et al. 2014) to aid comparability of findings. The draft list of preferences was then finessed in consultation with key research partners including WAMSI and the Department of Parks and Wildlife. Further information on the refined value and management preference sets used in the PPGIS survey may be found in 2.4 *Data collection*.

Sampling design

Sampling design was informed by the objective of validating and extending previous research findings. Recruitment was thus driven by the need to engage with the greatest possible number of respondents; a challenge faced in earlier research given the Kimberley’s vastness, its small, dispersed population and limited accessibility. With an area of 423,500km² the Kimberley is almost twice the size of the state of Victoria and three times the size of England (Kimberley Society 2014). Its coastline extends 7,331 km at MHW excluding the islands and 13,296 km at LWM including the islands, with more than 1,200 islands in the Buccaneer Archipelago alone (Geoscience Australia 2015). With a population of 34,794 people this is a sparsely populated region. A total of 40% of this population is Aboriginal (Australian Bureau of Statistics 2011). Economic activities associated with the Kimberley coast (the focus on of this study) include commercial fishing, pearling and other aquaculture (e.g. barramundi farming), oil and gas extraction, iron ore mining, tourism, and pastoralism. The Kimberley towns of Broome, Derby, Wyndham and Kununurra are important service centres.

The population of interest included people living in or visiting the Kimberley as well as those who may be geographically remote yet hold an ongoing interest in the region. Stakeholder groups previously involved in this research included Aboriginal Traditional Owners; Aboriginal and non-Aboriginal residents; tourists and the tourism industry; commercial and recreational fishing, and aquaculture; federal, state and local government; industry (mining, oil, gas and tidal energy interests); marine transport and aviation; and environmental non-government organisations. The term stakeholder is used here to denote persons or groups having an interest

in the Kimberley coast or marine environment. The PPGIS survey purposely targeted these same stakeholders with a specific focus on people and organisations associated with the existing and proposed marine parks, given the Kimberley Marine Science Plan (Simpson 2011) identifies these as of particular interest for the overarching research program of which this project is part. This purposive sampling approach is particularly useful when stakeholder groups are known to the researchers (Neuman 2009).

Three additional groups were purposively targeted for the PPGIS survey: scientific researchers, particularly those involved in other WAMSI research projects in the Kimberley, and groups with an interest in the Kimberley who were located geographically remote from the region. Members of an online panel were a third group purposively recruited for the PPGIS survey. The recruitment of online panel members represents a divergence from the usual public sampling approach used in PPGIS, in that panel members i) are paid to complete research and ii) have no known or readily identifiable personal interest or stake in the research. Thus, the inclusion of online panel respondents was intended to provide the basis for comparisons between data generated by those with and without an identifiable interest in the Kimberley. Results from online panel respondents are not included in this report, which is focused on exploring the values of those respondents with an identifiable interest in the Kimberley.

In a recent review of empirical PPGIS studies, Brown and Fagerholm (2015) identify a range of sampling methods, with random household or landowner surveys being the most common. Surveys have also been used to target on-site visitors or tour operators. Typically, surveys are self-administered and include a mapping element. The purposive sampling of stakeholders or 'experts' using interviews or workshops have not been used as frequently as surveys (Brown & Fagerholm 2015). This research employed a number of direct and indirect sampling methods in an effort to recruit a diverse respondent cohort.

Previous values mapping research has relied on a wide range of respondent numbers, from 22 interviews in a recent interview-based study on the marine environment off Wales in the United Kingdom (Ruiz-Frau et al. 2011), through to 1,905 responses in an online study of values associated with public lands in Victoria, Australia (Brown et al. 2014). A minimum of 350 participants is recommended to identify areas of significance (i.e. hotspots) with a high degree of confidence in mapping research using markers or dots (Brown & Pullar 2012), as occurred in this research. Therefore, a target of 350 plus responses was set for this PPGIS survey, with representation sought from all stakeholder groups, with an added emphasis on gaining responses from local residents. A period of three months was envisaged as necessary to achieve this number of responses. Survey response was incentivised by offering a small reward of \$10 (redeemable as a donation to one of three selected charities or in the form of an Amazon voucher) linked to completion of the survey.

2.2 Recruitment approach

In total, 120² separate official and informal representative bodies were approached to participate in the PPGIS survey over the months of April-July 2015, the period that the survey was open for input. Each of the 120 discrete approaches was intended to result in the recruitment of multiple respondents via information being disseminated by a primary point of contact(s). Stakeholder group membership was not mutually exclusive; for instance, respondents targeted through Government or industry avenues would also have been subject to recruitment through local resident avenues.

The recruitment approach taken to engage with respondents (as indicated by stakeholder groups) is summarised in Table 5. Eight principal methods of recruitment were employed, with stakeholder groups targeted using a combination of these approaches. The first recruitment approach was direct personal contact by members of the research team. This involved project researchers directly inviting potential respondents to participate in the study and relied heavily on accessing established personal and professional networks. Direct contact was used for all stakeholder groups but was particularly important for engaging with Aboriginal people. A range of Prescribed Body Corporates, relevant Aboriginal organisations e.g. Kimberley Land Council, individual rangers and Traditional Owners were approached in this manner.

² Direct personal invitation from project researchers are not included in this tally.

Table 5. Recruitment approach for engaging with respondents.

Stakeholder group	Recruitment approach							
	1. Direct personal contact	2. Direct postal invitation	3. Email with sponsored survey link	4. Social media	5. Local media	6. Survey invitation cards	7. Newsletters	8. Incidental recruitment via postal invitation
Local residents ¹	X	X	X	X	X		X	
Aboriginal Traditional Owners and rangers	X				X			X
Tourists & tourism industry	X		X	X	X	X	X	X
Commercial fishing, including aquaculture & pearling	X		X		X		X	X
Recreational fishing	X				X		X	X
Industry (mining, oil & gas, tidal power, ports)	X		X		X		X	X
Marine transport and aviation	X		X		X			X
Environmental non-government organisations	X		X	X	X		X	X
Government ²	X		X		X			X
Remote interest groups ³	X		X	X			X	
Scientific research	X		X	X			X	

¹Includes recreational fishing and local media (print, online and radio) stakeholders.

² Federal, State and local.

³ Includes non-local media outlets.

Direct postal invitation to Kimberley residents inviting them to participate in the PPGIS survey formed a second recruitment approach. The postal letter was motivated by a desire to ensure sufficient responses were received from this important stakeholder group. Information purchased from online residential database supplier Yell123 (2014 data) was refined to exclude incomplete addresses and locations either away from the coast e.g. Halls Creek, or outside of major population centres, e.g. small Aboriginal communities. Aboriginal people may have been recruited via postal invitation if they lived in one of the main population centres, however,, the majority of addresses linked to Aboriginal communities were incomplete and hence excluded from the postal survey.

The third recruitment approach involved liaison with relevant formal stakeholder organisations both within and remote from the Kimberley to facilitate the sending of an endorsed email to staff and/or members. This method was used for all stakeholder groups with the exception of Aboriginal Traditional Owners and rangers, where direct contact was preferred. Advertisement via social media platforms, principally Facebook, formed the fourth recruitment method. Local residents, tourists and the tourism industry, environmental non-governmental organisations and remote interest groups were stakeholder groups targeted in this manner (Table 3). The use of Facebook to advertise the survey and invite participation was a deliberate attempt to tap into the distributive power of social media to reach a wide and geographically dispersed population of potential respondents.

Recruitment via a range of local print and radio media was a fifth method used. All stakeholder groups apart from remote interest groups were targeted in this manner, which used these platforms to raise awareness of the research and call for participation. A sixth approach involved the distribution of survey information cards to a variety of key tourist transit areas, for example local visitor centres, key accommodation providers and camping grounds, and selected luxury cruise operators. These cards invited potential respondents to participate by including a brief introduction to the survey and providing the survey web link. The use of these cards was intended to provide another avenue for tourist recruitment. A seventh recruitment method centred on using relevant newsletters to advertise the survey. Newsletter recruitment was adopted for all stakeholder groups with the exception of Traditional Owners and rangers, industry (mining, oil and gas, tidal energy interests) and Government (Table 5). Finally, incidental recruitment arising from the direct postal survey invitation was intended to recruit potential respondents who may not have been made aware of the survey through other more direct means. In addition to these eight avenues, previous research participants (representing all stakeholder groups) were also invited by direct email correspondence to complete the online survey.

2.2.1 Recruitment effort

Recruitment was restricted as much as practicable to Kimberley residents for the first three weeks of operation. This restriction was intended to ensure that locals as much as possible received the \$10 incentive associated with survey completion. Recruitment effort in the lead up and initial phase of survey operation was therefore restricted to direct researcher contact, Aboriginal Traditional Owners and rangers and local resident outlets. Eight discrete points of contact were made for Aboriginal Traditional Owners and rangers, including a number of saltwater Prescribed Body Corporates and ranger teams involved in previous project research.

Twenty-five local resident outlets were approached to assist with recruitment. These included (for example): local Chambers of Commerce, local libraries; and community groups such as recreational fishing clubs, sea rescue and sailing groups and museums. Each of these outlets was asked to advertise the PPGIS survey to their staff and/or members through i) word of mouth, ii) the sending of an endorsed email containing survey background and web link, and/or iii) inclusion of the survey/web link in their newsletters to members (Table 5). Media releases relating to the survey were distributed to local Kimberley newspapers (e.g. Broome Advertiser, Kimberley Echo, The Muddy Waters and The Bastion) just prior to the survey launch. Versions of this media release entered print over the following three weeks. Researchers also conducted pre-recorded interviews with local radio stations ABC Kimberley and Radio Goolari. These interviews were reproduced for several local radio segments and for ABC radio, played in both the Kimberley and Pilbara regions. A related online article was also produced for ABC online. In addition, the survey was posted on number of local community Facebook pages such as 'The Broome noticeboard', 'Derby Notice Board' and 'Kununurra community noticeboard'.

Tourists and the tourism industry were targeted through 20 discrete recruitment avenues. Organisations involved in email and/or newsletter recruitment included (among others) Australia's North-West Tourism, FACET- Forum Advocating Cultural and Ecotourism, the Campervan and Motorhome Association of Australia, Kimberley Coast Cruising Yacht Club, Fremantle Yacht Club, Tourism Council of Western Australia, and a range of local land and sea based tourism operators. Two local expedition cruise operators, The Great Escape and Ahoy Buccaneers, advertised the survey via direct email to a select group of previous clients as well as advertising more generally in their newsletters and company Facebook pages. Hard copy survey information postcards were also left at local visitor centres across the Kimberley and distributed to selected caravan parks, accommodation and tour operators (including luxury cruise operators) across the region (Table 5).

Four direct recruitment approaches were undertaken for commercial fishing interests, targeting aquaculture and pearling operations as well as offshore fishing. At the time of research there were eight commercial fisheries in the Kimberley region, with operators from some of these fisheries involved in earlier project research. It was envisaged that those operators not directly targeted for inclusion in the PPGIS survey would be incidentally recruited either via direct postal invitation, through local outlets, remote interest groups or in response to direct email contact made by researchers to previous (interview) research participants (Table 5).

Both industry (mining, oil and gas, tidal energy and ports) (nine discrete avenues) and marine transport and aviation stakeholders (nine discrete avenues) were recruited via the sending of endorsed emails to staff and/or members. Again, incidental recruitment via direct mail invitation, direct researcher request or exposure to local media was also anticipated to assist with response rates (Table 5). Relevant groups included key mining companies and representative bodies such as the Chamber of Minerals and Energy, Australian Petroleum Production & Exploration Association (APPEA), Pluton Resources, Mt. Gibson Iron, the Broome and Wyndham ports, local barge transport operations and aviation companies.

Ten environmental non-government organisations and groups were directly involved in advertising the survey to their members. Some of these were based in the Kimberley (e.g. Environs Kimberley, Rangelands WA, Australian Conservation Foundation, Roebuck Bay Working Group) and others were based remotely (e.g. The Wilderness Society) but with ongoing campaigns and interests in the region. For this reason, a staggered approach was used to ensure local group involvement only for the first few weeks of the survey. Environmental non-government organisations and groups made extensive use of endorsed emails to members, advertisement in relevant newsletters as well as extensive posting on social media sites, particularly Facebook (Table 5).

Eleven different local, State and Federal Government Departments contributed to survey recruitment through the sending of endorsed emails and direct researcher request, as well as incidental recruitment through local media and postal invitation (Table 5). These Departments spanned a range of stakeholder interests and included the Shires of Broome, Derby/West Kimberley and Wyndham/East Kimberley, the Department of Mines and Petroleum, Tourism WA, Customs, the Departments of Fisheries, Planning, Water, State Development and Transport. Eighteen remote interest groups were directly contacted. These groups, which again spanned a range of stakeholder interests, included Department of Parks and Wildlife volunteers, the

Professional Association for Environmental Consultants in WA, the Australian Marine Sciences Association and the Australian Marine Conservation Society. Significant exposure was also gained through a report on the research contained in the Weekend Travel section of the West Australian newspaper.

Scientific researchers working in the Kimberley were targeted through six discrete avenues. Members of other WAMSI research projects, the Kimberley Marine Research Station, the University of Western Australia Oceans Network and the National Environmental Research Program (Northern Hub), for example, were requested to participate in the survey through methods including the sending of endorsed emails, newsletter advertisement and direct researcher request (Table 5).

2.3 Conducting ethical research

The research was conducted in accordance with approvals gained from the Murdoch University Human Research Ethics Committee (Permit No. 2015/014). Transparent research processes, requirements for informed consent and the right to refuse or withdraw participation helped to ensure the project was conducted in an ethical manner. Participants were required to acknowledge, and indicate their consent to, research procedures and particulars including data confidentiality, anonymity and right to refuse or withdraw participation at any stage (Appendix 1). Participants were also asked to indicate if they wished to receive a copy of project reports when available. Access to raw survey data was restricted to members of the research team. Project partners and funders were provided with access to higher level, aggregated data only.

2.4 Data collection

Data collection relied on the online PPGIS survey method. Upon entering the survey web link into a web browser or clicking on the link (if supplied electronically), participants were greeted with an initial survey welcome screen that provided a brief overview of the survey requirements (Figure 2). Respondents were required to request a survey access code, with this unique code used in later analysis to link survey responses to individual respondents.



Figure 2 PPGIS survey welcome screen.

Participation was voluntary, and respondents were able to withdraw at any time or leave and return at a later stage using their unique survey access code. The survey itself consisted of three sections: i) a set of pre-mapping questions; ii) the mapping exercise and associated post-mapping questions; and iii) a choice-experiment component. This technical report presents to results from the first two sections only. The other results (choice experiment findings) are presented in an associated technical report.

Pre-mapping questions included socio-demographic information, how respondents learnt of the study and their knowledge of the Kimberley (Appendix 2). The mapping interface was carried out with Google® maps and images of the entire Kimberley region with the coastal and marine study area boundary clearly marked in contrasting colour (Figure 3, see also Appendix 3). Additional layers depicting marine and terrestrial protected

area boundaries were added to this base. Considerable effort was invested in further annotating the map interface with well-known place names to ensure adequate representation of key coastal access points and destinations, tourist nodes and Aboriginal communities. These protected area and place marker layers could be switched on and off. To aid navigation, 'quick zoom' functions were added to assist respondents in navigating to the key parts of the region such as Broome, Dampier Peninsula etc. Respondents had the choice of two base layers: satellite imagery or topographic map.

Superimposed over this mapping interface was a set of instructions as to how to complete mapping. The online interface allowed respondents to zoom in and out as desired, enabling people to place markers at a variety of scales. However, a minimum resolution of 10 km was enforced (where 1 cm on the map interface was equivalent to 10 km on the ground), meaning that respondents could not place markers on the map until they had zoomed in to a sufficient scale. Once this minimum required scale for mapping was reached, the suite of identifying place names and markers became more obvious. The 10 km minimum mapping scale was a compromise between the vast size of the Kimberley region and the need to ensure an acceptable level of accuracy in placing markers. At least one marker had to be placed on the map before respondents could move through to the post-mapping questions.

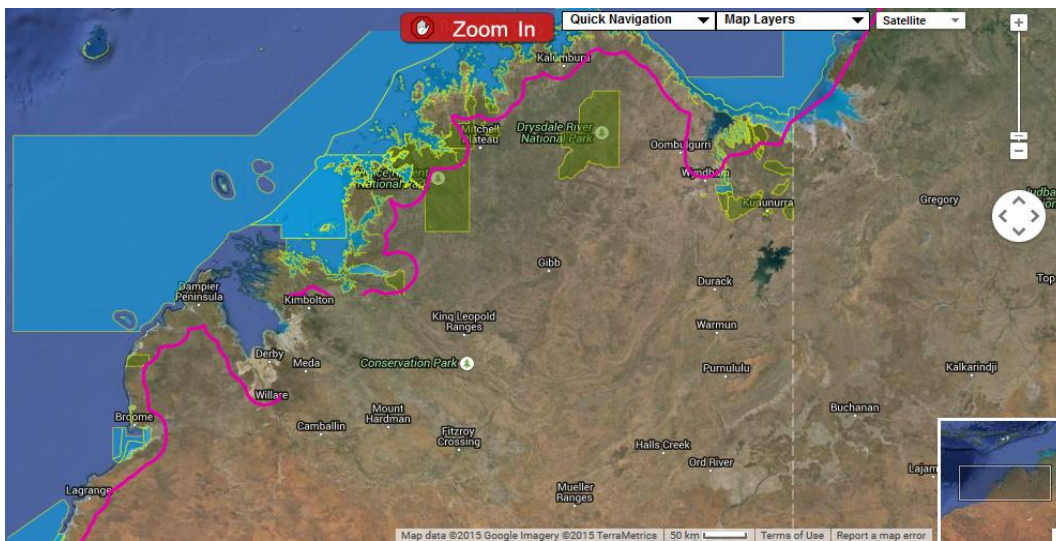


Figure 3. PPGIS survey mapping interface showing pink landward study area boundary.

Respondents were provided with a list of 14 pre-defined place values and 13 pre-defined management preferences to choose from (Figure 4). The mapping interface contained an 'Icon description' button that provided respondents with the definitions associated with each value and management preference (see Table 6 for an overview of value descriptions). Outlined in Figure 4, these pre-defined values and preferences were arrived at following the process of i) analytical refinement and ii) alignment with key literature as discussed previously (see Section 2.1.2 Research Design). In particular, initial project data sets on values and management preferences were refined to best represent those receiving the greatest mention in earlier interview data. Similar value categories were then combined. Management preferences were further refined to ensure accordance with the particular management concerns and development realities characterising the Kimberley. While marker options were pre-defined, respondents were provided with two options to express greater depth or nuance in their responses. Firstly, respondents were able to annotate their markers if desired to provide qualitative information associated with a particular marker. Secondly, a 'free' option was provided for both values and management preferences ('special place'/'other preference', Figure 4, Table 6). This latter free choice option allowed respondents to specify other values and/or management preferences not available to them in the pre-defined survey lists.



Figure 4. Place value and management preference choice sets contained within the PPGIS survey.

Table 6. Definitions of place values contained within the PPGIS survey.

Values	Operational definition
Scenic/aesthetic	These areas are valuable because they contain attractive scenery including sights, smells, and sounds
Recreation	These areas are valuable to me because they are where I enjoy spending my leisure time – with family, friends or by myself, participating in outdoor recreation activities (e.g., camping, walking or exploring)
Fishing (recreational)	These areas are valuable to me because they are where I can go fishing for fish and other marine life like crabs, cockles and oysters
Economic (non-tourism)	These areas are valuable because they provide natural resources that can be used by people (e.g. minerals, oil, gas, fish, pearls, pastoralism)
Nature-based tourism	These areas are valuable because they provide tourism opportunities, including Aboriginal cultural tourism, in a generally undisturbed environment
Biological/conservation	These areas are valuable due to the presence of plants, wildlife, and habitat including marine wildlife, reefs, migratory shorebirds and mangroves
Aboriginal culture/heritage	These areas are valuable because they allow Traditional Owners to maintain connection to their coastal and sea country through identity and place, family networks, spiritual practice and resource gathering
European heritage	These areas are valuable because they reflect European history associated with exploration, pastoralism, missions, commercial fishing and the Second World War
Learning/education/research	These areas are valuable because they enable us to learn about the environment through observation or study
Therapeutic/health	These areas are valuable because they make me feel better, mentally and/or physically
Spiritual	These areas are valuable because they are sacred, religious, or spiritually special places or because I feel reverence and respect for nature here
Intrinsic/existence	These areas are valuable in their own right, no matter what I or others think about them
Wilderness/pristine	These areas are valuable because they are wild, uninhabited, or relatively untouched by European activity
Special place	These places are special. Please indicate the reason why they are special to you

Post-mapping questions explored further socio-demographic data such as age, gender and education, as well as ease of access, visitation history, stakeholder group affiliation and a question relating to environmental and economic priorities trade-offs in coastal and marine management (Appendix 4). The latter question asked respondents to indicate their position along a 7-point Likert scale exploring attitudes towards the primacy of environmental or economic factors, using the Environmental-Economics Priority (EEP) scale. The EEP scale

provides a richer understanding of attitude distribution among respondents, rather than simply collecting information on whether people agree or disagree with environmental statements (Abrams et al. 2005).

A prototype of the PPGIS survey was pilot tested in March 2015. Pilot testing involved three different but complementary approaches:

- 1) Asking respondents to complete the survey and then obtain detailed design feedback from them. This first approach involved three different user groups. The first group comprised four middle to senior level managers in the WA Department of Parks and Wildlife, the agency responsible for managing the State's marine parks. Second, two social science researchers in Environmental and Conservation Sciences, Murdoch University; and third, two recreational users of Kimberley coast, one with in-depth recent camping/tourism experience of the region and one with an extensive working knowledge of the offshore oil and gas industry. Pilot testing with Department of Parks and Wildlife also helped to ensure concordance between the PPGIS survey value set and those values used in Departmental marine park planning.
- 2) Demonstrating to key Broome-based stakeholder/respondent groups the survey and asking for their views regarding survey design and opinions on the ease or otherwise of completion. Groups consulted included the West Kimberley office of the Department of Parks and Wildlife, Shire of Broome, Department of Fisheries, Environs Kimberley and PMJ Tourism Solutions. These meetings took between 0.5-1.5 hrs.
- 3) Focus group. Six people from the School of Agricultural and Resource Economics at the University of Western Australia either self-nominated or were selected to participate in a focus group session. The session presented the survey in an open discussion format. Feedback was sought on the clarity of survey instructions and descriptions, layout and wording. The focus group session went for 2 hours.

Feedback from these three sources was used to: adjust the scale at which mapping occurred, increase the clarity of mapping instructions, and add extra place names and reference locations.

2.5 Data cleaning and analysis

2.5.1 Data cleaning

Data were downloaded from the PPGIS survey server as a text file. The data were first restructured in a MS Access database, dividing the information into three sections: pre-mapping socio-demographic data, spatial value and management preference mapping data, and post-mapping socio-demographic data. Survey data were then refined through a number of data cleaning mechanisms. First, 'gamers', individuals attracted to the survey site because of the incentive offered but who did not meaningfully contribute to the mapping activity, were removed from the sample. Gamers were identified on the basis of i) selection of the Amazon reward voucher as their incentive and ii) responses to text-based survey questions that were known to be false, for example the selection of response options that were not actually implemented in the PPGIS study (e.g., joining the survey following a notice on the Parks and Wildlife website, Appendix 2 – Q1). A third method for identifying gamers involved determining iii) the origin of their IP address, information which was captured in the course of respondents accessing the survey. International responses to the PPGIS survey were expected to be limited owing to the recruitment methods undertaken. Therefore, IP addresses originating from the United Kingdom, United States or China were flagged and monitored. Instances where user IP addresses changed during the survey (i.e. multiple IP addresses associated with a single user ID) were removed from the data set. The combination of these multiple criteria provided sufficient information to screen invalid responses.

Second, data were then cleaned to correct for spelling, inconsistencies and multiplicity of terms resulting from entries in open-ended survey questions (e.g., 'other – please specify' options, see e.g. Appendix 4). For example, responses pertaining to respondent country of origin were standardised, with 'U.S', 'USA' and 'United States' being standardised into 'United States of America'. Third, open-ended data were aggregated into groups for summary purposes. For instance, responses indicating the website or social media platform from which respondents learnt about the PPGIS survey were grouped to account for varying levels of specificity. Some respondents specified the generic 'Facebook', for example, while others specified a particular Facebook page. Responses pertaining to 'Facebook' were thus grouped into an overarching 'Facebook' category and a number of associated sub-categories specifying the particular Facebook page identified by respondents. The aggregation of open-ended data included grouping of time periods (e.g. frequency of visitation to the Kimberley, Appendix 4 – Q7) into logical and coherent categories.

A fourth layer of data cleaning involved mediating the input from a 'super mapper'. One survey respondent was identified as having placed a very large number of value/preference markers (2,080) in the mapping component of the survey. This represents a new record for number of markers placed during a PPGIS survey (G. Brown,

pers. comm. 2015). The next largest mapping contribution from respondents was ~400 markers. Markers placed by the 'super mapper' were analysed and it was ascertained that i) the markers were placed in one session over a three hour period, ii) the majority were placed within the study area and iii) the markers coincided with various geographic features, indicating that their placement was deliberate and not random. A random selection of 500 markers was chosen and retained within the dataset to avoid introducing spatial and preference/value bias. The remaining 1,580 markers were removed from the dataset. The fifth and final layer of data cleaning involved the extension of study area boundaries seaward to include significant clusters of value/preference markers located far into Commonwealth waters. All other markers located outside of study boundaries (e.g. outside of the Kimberley coastal/marine region) were removed from the dataset.

2.5.2 Data analysis

Analysis involved two distinct phases. One, markers representing the individual values and management preferences were plotted on separate maps to provide an overview of their respective geographic extents. Two, this information was used to create point density maps. In this participatory mapping the rationale for point density maps derives from Brown and Reed's (2009) understanding that aggregations of special place maps (i.e. the hotspot maps generated in this study) exhibit a degree of collective, spatial consistency. These authors draw on Surowiecki's 'wisdom of the crowd' saying that a diverse collection of individually determined value maps brought together on a GIS platform can produce collective spatial information that is better than that of individuals and even experts (Surowiecki 2004, in Brown & Reed 2009).

The point density analysis conducted in this study was used to identify areas of greatest intensity of values and preferences. To achieve this, the spatial data were overlaid with 2 km grid cells; this resolution matched the extent of geographic features on the ground, for example Broome's Gantheaume Point. Calculating point density involved i) defining a 20 km search radius ('the neighbourhood'), with this choice of radius based on the rationale that it was twice the minimum scale at which mapping was able to be undertaken; ii) counting the number of points within the neighbourhood for each value or preference, and dividing by the total neighbourhood area; and iii) presenting as point density maps with high and low densities being relative rather than absolute for each value/preference. Point density maps are displayed in this report using a colour scale with a histogram stretch of 2.5 standard deviations from the mean as this suited all values and preferences and illustrating a range from low to high.

3 Results

3.1 Response and respondent details

A total of 763 respondents participated in the PPGIS survey. Of these, 108 of these respondents were determined to be 'gamers' and were removed from the sample as they were deemed to provide ineligible data (see 2.5.1 above), as were 77 invalid responses. Of the remaining 578, 372 respondents were from the 'public' responding to the PPGIS and 206 were online panel respondents. The results from the panel have not been considered further here for two reasons. First, the public PPGIS provides a strong focus on responses by stakeholders with an identifiable interest in the Kimberley. The panel PPGIS respondents have no such identification, being drawn to be representative of WA residents but may not have a close personal connection with the Kimberley (Spencer-Cotton et al. 2016). Second, while the comparison of the public and panel PPGIS results could provide interesting analytical opportunities, timing constraints associated with this reporting period precluded the inclusion of results from the latter cohort. As such, this report is based on findings from the publically available, online PPGIS responses only (N = 372).

3.1.1 Recruitment method

Figure 5 illustrates the relative success of each recruitment method employed. Direct email invitation to complete the PPGIS survey was the most effective method of recruiting respondents (63.7% of all responses; N=372). The success of this method may have reflected ease of accessing the survey, with respondents able to quickly and easily participate in the survey by clicking on the survey link including within the email text. Social media proved a reliable means of attracting respondents (13.3% of responses) (Figure 5). Facebook was the primary social media platform cited by respondents, accounting for 75% of all 'social media' responses.

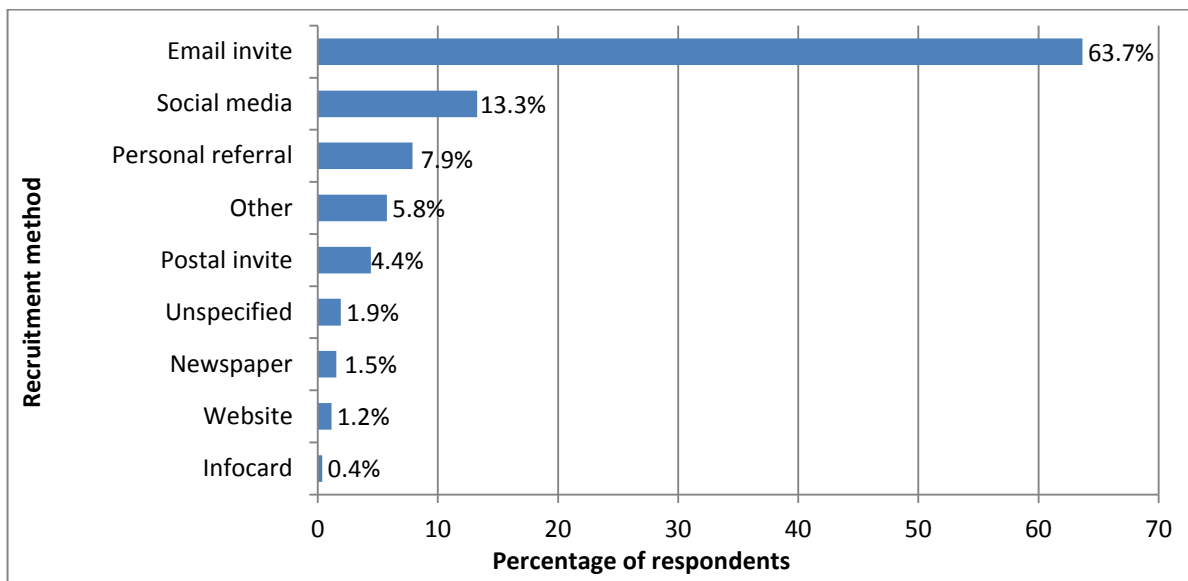


Figure 5. Effectiveness of recruitment methods in attracting respondents.

Personal referral and 'other' accounted for 7.9% and 5.8% of all respondents respectively. 'Other' included recruitment resulting from survey information disseminated through relevant newsletters, direct contact with researchers (e.g. via presentations or other meetings) and further forms of recruitment. The direct postal invitation letter was successful in recruiting just over four percent of respondents (Figure 5). The utility of a postal recruitment method was impacted by the quality of residential data available. Of the 2,915 letters sent, 1,435 were returned. The majority were returned owing to 'unclaimed mail' and/or 'owner left address', indicating that available residential information was outdated. A very small number (<5) included further information such as 'deceased' and 'no computer'. Newspaper stories, the PPGIS survey website itself and hard copy info cards proved ineffective in recruiting participants, attracting a combined total of just over 3% of respondents (Figure 5).

3.1.2 Respondent socio-demographics

Age, gender, education and household income

Survey respondents spanned a range of age groups (Table 7; N=372). Respondents aged 55-64 (23.4% of all respondents) were the largest age group, followed by those aged 45-54 (22%) and 35-44 (19.3%). Ten respondents did not specify their age. PPGIS response rates align with the population age profile of Kimberley residents aged 18-24, 25-34, 65-74 and 75-84 (Table 7). However, greater proportional representation was gained in the PPGIS survey by respondents aged 35-64. This is to be expected as the Kimberley region is characterised by a more youthful population (Australian Bureau of Statistics 2011).

A relatively even split of male (52.9%) and female (45.9%) survey respondents was achieved. This compares to the Kimberley average of 53.2% male / 46.8% females (Table 7), and the Western Australian (WA) average of 50.3% males / 49.7% females (Australian Bureau of Statistics 2011). Four respondents did not indicate their gender. There were approximately twice the number of female PPGIS respondents than males for those aged 18-34, while females were completely absent from respondents aged 74-84. Approximately equal numbers of male and female respondents were recorded for ages 35-74..

Table 7. Respondent characteristics with comparison to Kimberley and WA 2011 census data (Australian Bureau of Statistics 2011).

Socio-demographic characteristic	PPGIS respondents	Kimberley 2011 Census	WA 2011 census
<i>Age (%)</i>			
18-24	5.1	5.4	9.7
25-34	15.6	18.6	14.9
35-44	19.3	15.9	14.5
45-54	22.0	13.3	13.8
55-64	23.4	9.0	11.3
65-74	9.1	9.1	6.8
75-84	2.7	1.2	3.9
Unspecified	2.7	-	-
<i>Gender (%)</i>			
Male	52.9	53.2	50.3
Female	45.9	46.8	49.7
Unspecified	1.2	-	-
<i>Indigenous (%)</i>	4.3	43.5	3.4
<i>Highest level of education completed (%)</i>			
Primary	1.3	5.6	4.0
Secondary	8.3	*	*
Some tertiary	12.9	*	*
Undergraduate/Bachelor degree	29	9.1	15.2
Vocational/technical training	15.3	23.5	28.6
Postgraduate degree	31.7	2.9	2.9
Unspecified	1.3	21.1	20.4
<i>Household income (annual, median) (\$)</i>	91,000 [^]	68,976	73,580

* Unable to ascertain accurate data.

[^] N=289.

Indigenous respondents are underrepresented in the PPGIS survey. Only 4.3% of respondents identified as Indigenous, whereas 43.5% of the Kimberley population is Indigenous. Earlier interview-based project research partly addresses this underrepresentation, providing greater insight into the views of Indigenous people (including Traditional Owners) (Strickland-Munro et al. 2015). This earlier research interviewed 50 Traditional Owners, Aboriginal rangers and residents to gain an understanding of Indigenous values for the coastline.

Respondents reported educational attainment ranging from primary schooling (1.3% of respondents) through to undergraduate/Bachelor (29%), vocational (15.3%) and postgraduate qualifications (31.7% of all survey responses, N=594). Males and females were represented equally in all educational levels. These educational attainment levels are at odds with Kimberley and WA ABS data, which indicates 5.6% and 4% of the population respectively completed primary schooling only, and less than 10% of Kimberley residents and just over 15% of WA residents hold an Undergraduate/Bachelor degree. A larger proportion of the Kimberley and WA population holds vocational qualifications while the proportion of residents with postgraduate qualifications is far smaller than PPGIS respondents (Table 7).

PPGIS respondents reported a higher median annual household income than both Kimberley and West Australian ABS data (Table 7). Caution is warranted in interpreting this finding however as the sample size for this question is far lower (N=289) than that of other socio-demographic questions (N=372). The PPGIS

respondents are roughly representative of the broader Kimberley population in terms of age and gender (Table 7). As noted, the PPGIS respondent, Kimberley and WA populations are approximately proportional for ages 18-34 and 65-84, while the PPGIS survey recorded greater representation of people aged 35-64. Overall numbers of males and females are approximately equal while the PPGIS survey recorded a greater proportion of females in the 18-34 grouping, and proportionally more males for ages 75-84. Gender representation is proportional for all other age groupings. Survey respondents in general are more highly educated (tertiary qualifications) and less likely to hold a vocational qualification than are Kimberley or WA residents.

Residency

Australian residents overwhelmingly dominated survey responses (87.9% of all respondents; N=372). Nine responses (2.4%) were recorded from respondents residing in Europe/United Kingdom, the United States of America, Asia and the Indian Subcontinent. A further 9.7% of respondents did not specify their country of residence.

Kimberley residents accounted for 33.3% of survey responses. Most responses however originated from non-Kimberley residents (64.8% of survey respondents) while 1.9% of respondents did not specify their residential status. Sixteen respondents identified as being of Aboriginal heritage. Ten of these respondents identified as belonging to Kimberley Aboriginal groups while the remainder indicated affiliation with Indigenous groups remote from the Kimberley.

3.1.3 Stakeholder group affiliation

Respondents were 'allocated' to a stakeholder group based on their responses to the survey question 'How would you describe yourself in relation to the Kimberley?' (Appendix 9, Q9). Figure 6 summarises response numbers according to stakeholder group (N=372). Respondents were able to indicate affiliation with more than one stakeholder group if desired, leading some to identify with more than one stakeholder group on the basis of residence and current and previous activities in the Kimberley. Thus the figures provided here sum to greater than 100% even though some respondents chose not to enter a response. Almost half of the survey respondents identified as past or current visitors to the Kimberley (47.6% of all responses). People identifying as Kimberley residents comprised the next largest grouping (31.4% of responses), followed by Government employees (19.5%) and researchers (16.4%). The slight discrepancy between respondents identified as Kimberley residents by researchers on the basis of postcode (33.3%) and those self-identifying as residents (31.4%) may be explained by respondents choosing to participate/answer survey questions in an official rather than personal capacity, e.g. participating as a Government employee rather than resident.

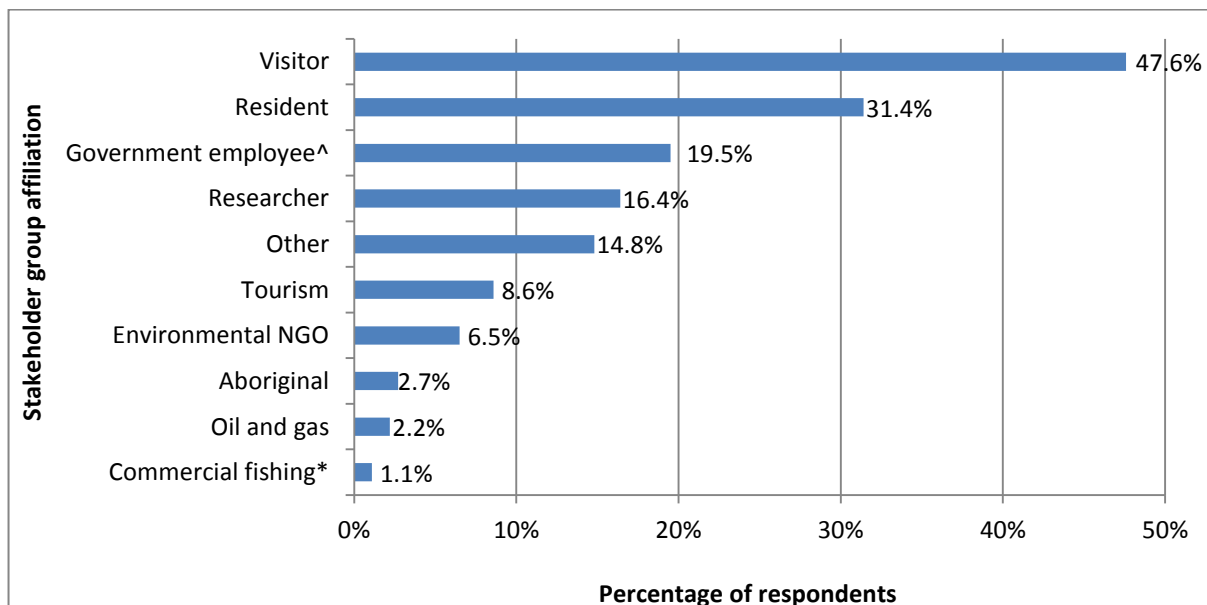


Figure 6. Respondent self-identification with stakeholder group.

[^] Includes local, State and Federal Government

^{*} Includes pearling and aquaculture

'Other' (14.8% of all responses) was a free expression category that allowed respondents to enter an affiliation with the Kimberley not covered by the listed options. Responses were diverse, and included stated affiliations such as photographer, observer, no relationship, community development, West Australian or Australian citizen, biology teacher, site of personal importance, aspiring visitor, and mining. The tourism industry accounted for 8.6% of all responses and environmental non-government organisation members 6.5% (Figure 6). Aboriginal, oil and gas industry employee and commercial fishing all recorded 20 or fewer individual responses.

3.1.4 Visitation and knowledge of the Kimberley coast

Aside from Kimberley residents, one quarter of respondents indicated that they had visited the Kimberley coast between 2-5 times (24% of responses) (Figure 7; N=372). Respondents who indicated they had visited the region once (11.5% of responses) or between 11-30 times (10.4%) followed. Eight percent of respondents had never visited the Kimberley coast, while almost eight percent had visited in excess of 31 times. It is unclear whether respondents indicating a large number of visits (i.e. 51+) to the coast and marine environment were in fact visitors to the region or whether this figure included Kimberley residents who answered the question despite being requested to choose 'resident' as their answer option. Respondents recording a large number of visits may also have been researchers working in the region over a number of years.

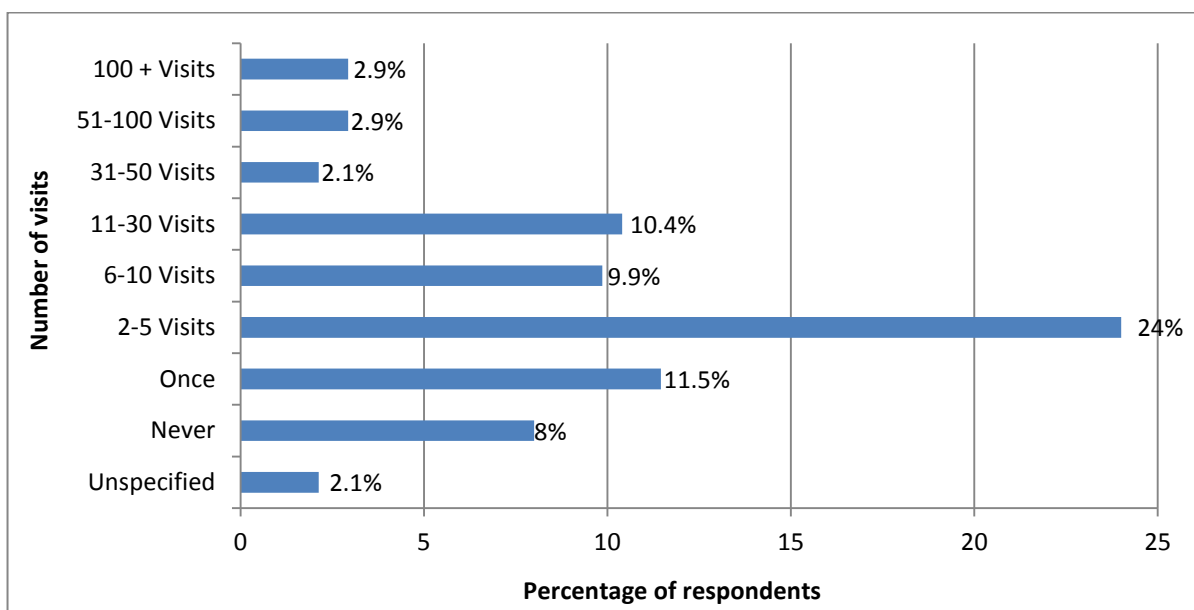


Figure 7. Number of visits to the Kimberley coast region.

Most respondents assessed their knowledge of the Kimberley coast as 'average' or 'good' (38.2% and 41.1% of respondents, respectively) (Table 8; N=372). Smaller proportions indicated having an 'excellent' or 'below average' knowledge of the coast (10.2% and 8.6%). A very small number of respondents either did not specify their level of knowledge (0.5%) or rated it as 'poor' (1.9%).

Table 8. Self-assessed knowledge of the Kimberley coast.

Knowledge of the Kimberley coast	Percentage of respondents
Unspecified	0.5
Poor	1.3
Below average	8.6
Average	38.2
Good	41.1
Excellent	10.2

3.2 Values and management preference mapping

A total of 23,752 value and management preference markers were placed during the mapping exercise. A total of 4,595 markers were placed outside of the study area and were excluded from further analysis. The geographic spread of these markers can be found in Appendix 5. As a preface to further exploration of the mapped values and management preferences, Figure 8 highlights a number of locations relevant to the mapping results presented below. This Figure provides spatial context to the discussion of value and preference hotspots outlined in the following sections.

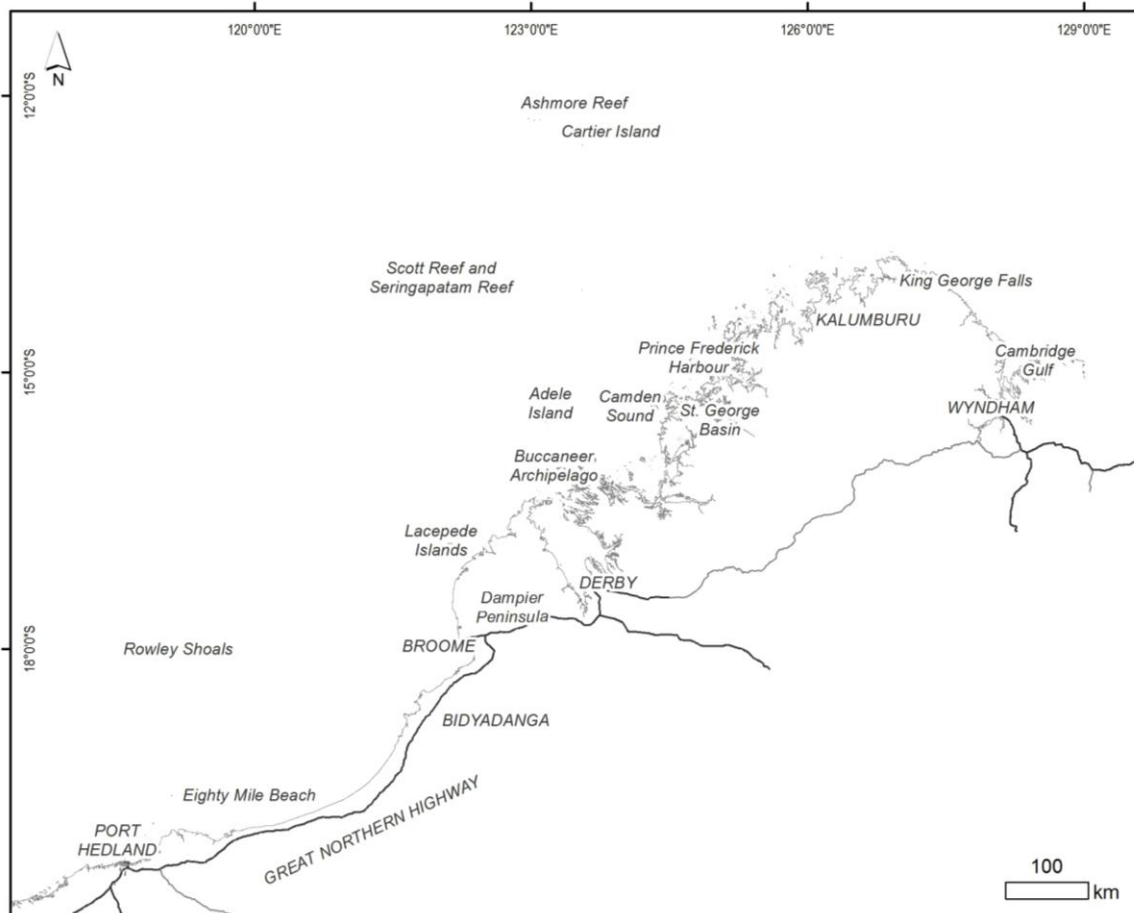


Figure 8. Location of key mapped areas for values and management preferences.

3.2.1 Values mapping

The number of value markers mapped by a single respondent ranged between 1 and 2,080 (the 'super mapper'). As noted, values mapped by the 'super mapper' were mediated to reduce undue bias, reducing the number of their markers used in this analysis to 500 (random selection). It is worth noting that the 'super mapper' was very meticulous and precise in their marker placement; that is, not random, with the majority of the markers being within the study area. An average of 29 values were placed per respondent (standard deviation = 40.8, max = 341). A total of 13,756 value markers were mapped during the survey by 466 unique respondents. Figure 9 depicts this composite mapping output, showing the entire Kimberley coastline as valued. A number of distinct offshore clusters corresponding to recognised islands/landmarks are also evident. The larger of these clusters correspond to locations including Rowley Shoals, Scott and Seringapatam Reef, the Lacepede Islands, Ashmore and Cartier Reef, and Adele Island (see also Figure 8).

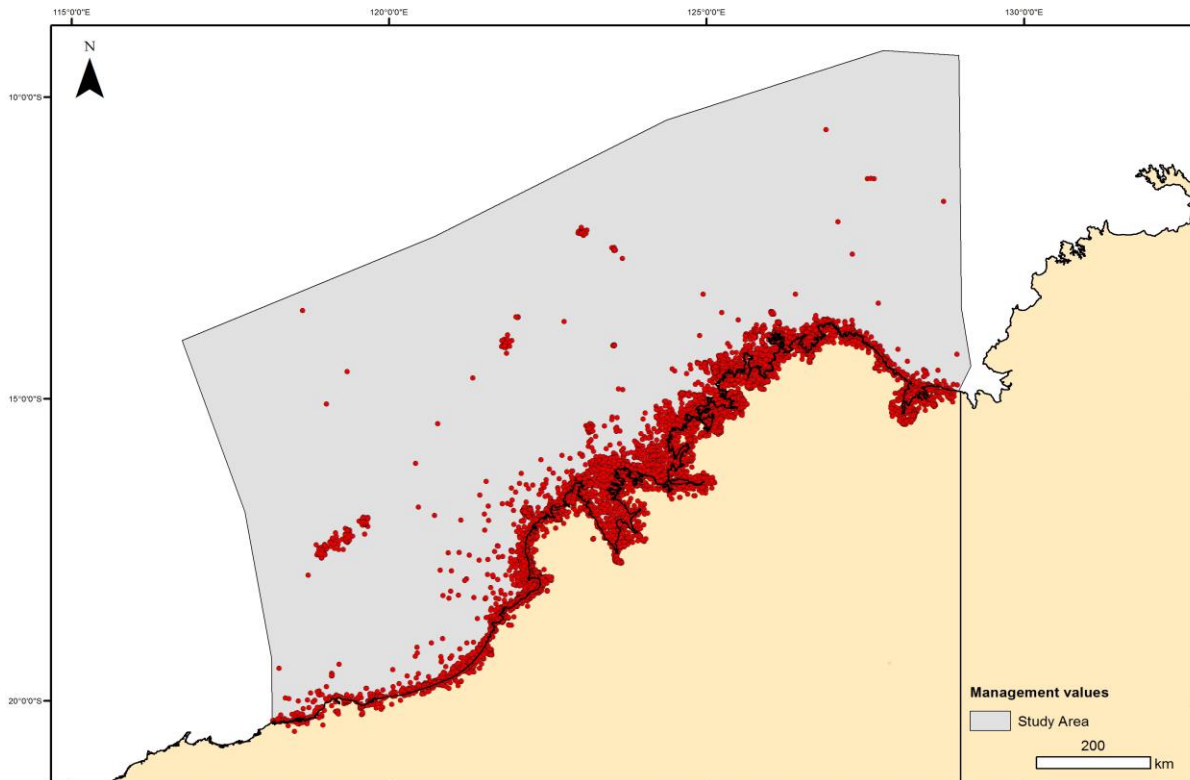


Figure 9. All value markers mapped within the study area (N=13,756).

Figure 10 depicts the relative count of value markers mapped for each value category. The largest number of markers mapped related to biological/conservation values (2,259 markers, 16.4% of all value markers mapped). Points relating to scenic or aesthetic values (2,129 markers, 15.4%), recreational fishing (1,849 markers, 13.4%) and Aboriginal culture and heritage (1,608 markers, 11.7% of all value markers mapped) followed. Therapeutic and spiritual values received the least number of markers (<2% of all value markers mapped).

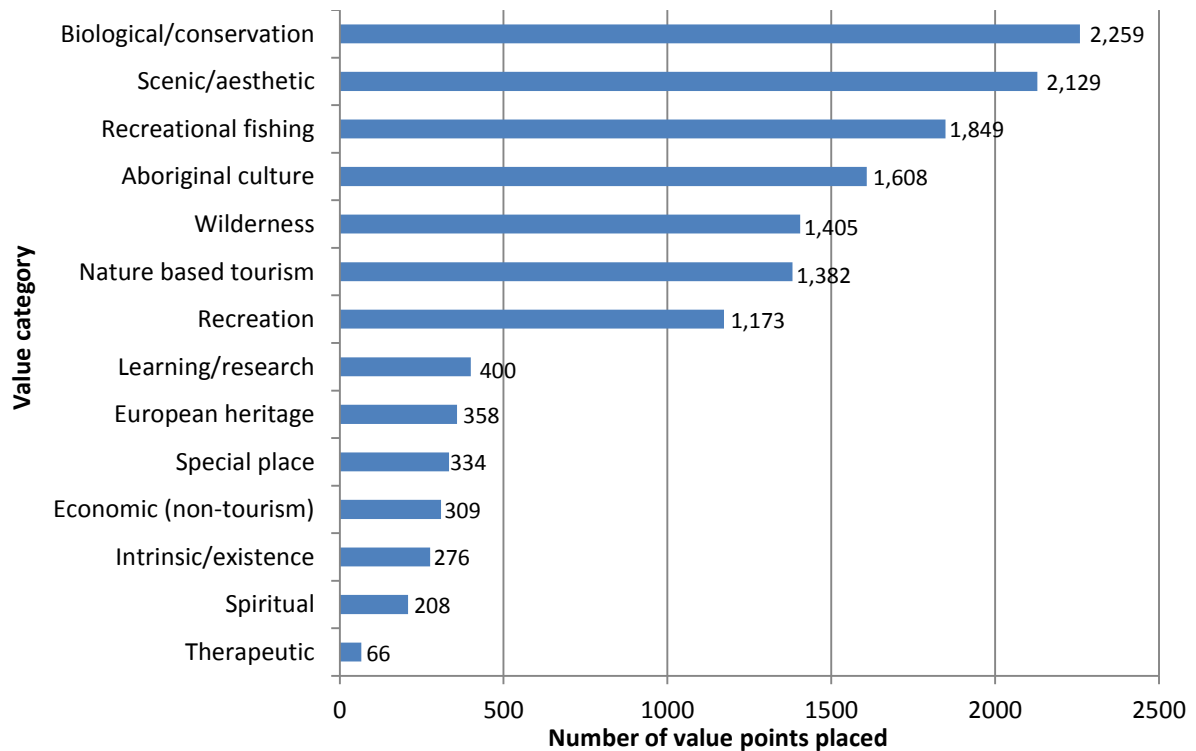


Figure 10. Count of value markers mapped in the PPGIS survey (N=13, 756).

Values relating to biological/conservation, scenery/aesthetics, recreational fishing, Aboriginal culture and heritage, wilderness and nature based tourism accounted for over 70% of all value markers placed in the survey. The remaining value categories of recreation, learning and research, 'special places', European heritage, intrinsic/existence values, economic (non-tourism), spiritual and therapeutic values collectively accounted for 22.9% of total value markers placed. Each of these latter value categories accounted for less than 10% of total markers placed. Individual maps showing value markers placed are given in Appendix 6.

3.2.2 *Value point density maps*

In this section the point density maps are presented according to number of markers placed, moving from the value with the most markers placed to the value with the fewest markers placed (reverse order to Figure 10). As noted above, the most important result – illustrated in Figures 11 - 24 – is that no part of the Kimberley coast is free of value, with all of the coast and associated marine environments represented by the value markers included in one or more of these Figures.

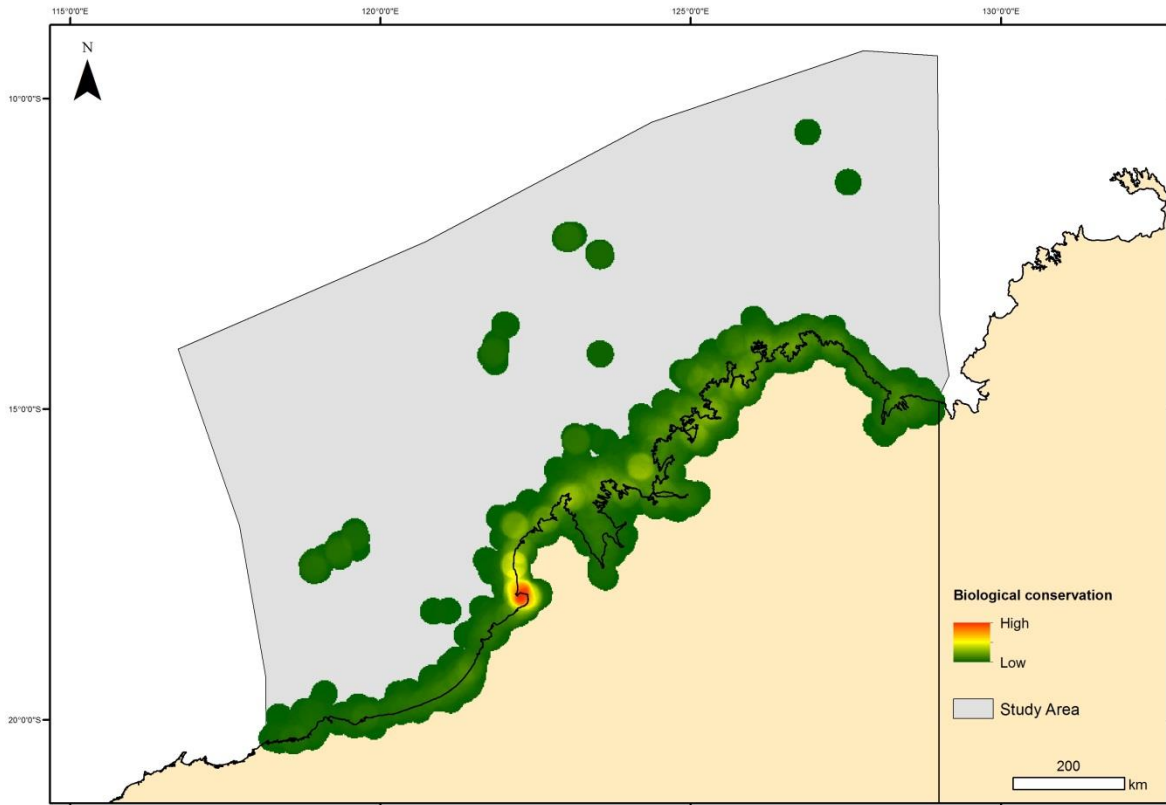


Figure 11. Point density map for biological/conservation values (N=2,259).

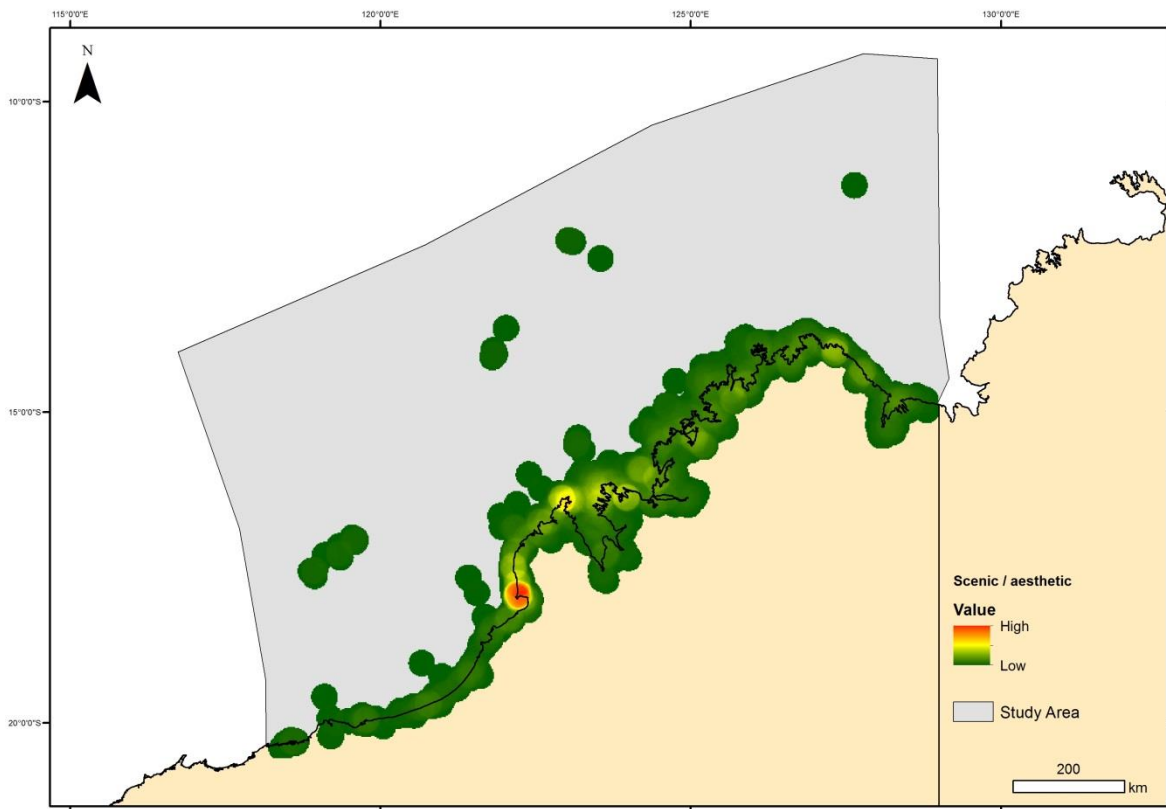


Figure 12. Point density map for scenic/aesthetic values (N=2,129).

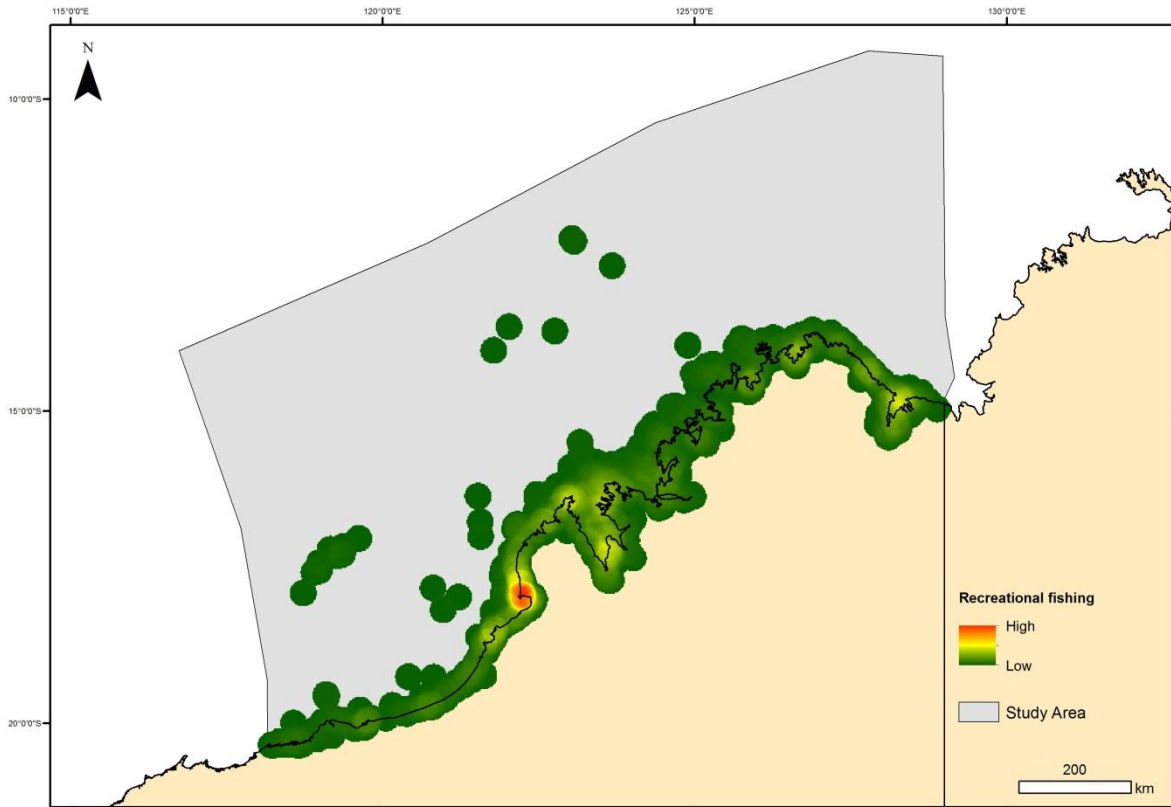


Figure 13. Point density map for recreational fishing values (N=1,849).

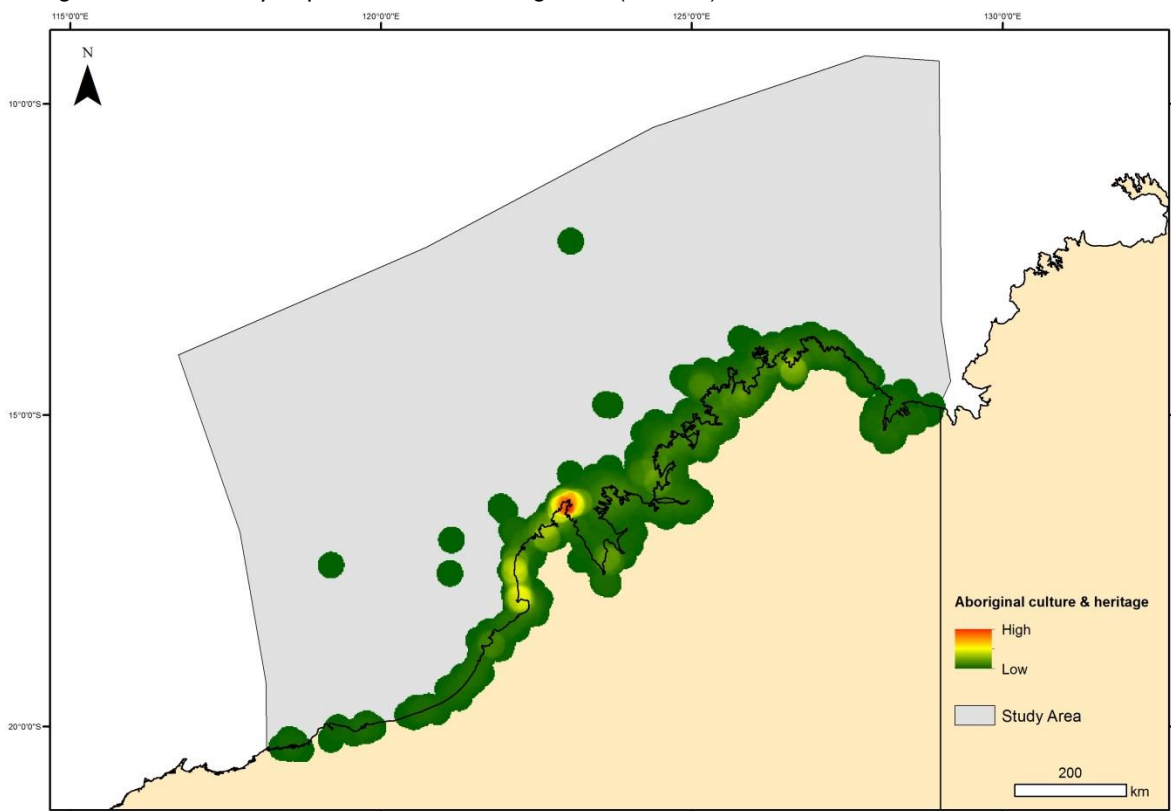


Figure 14. Point density map for Aboriginal culture and heritage values (N=1,608).

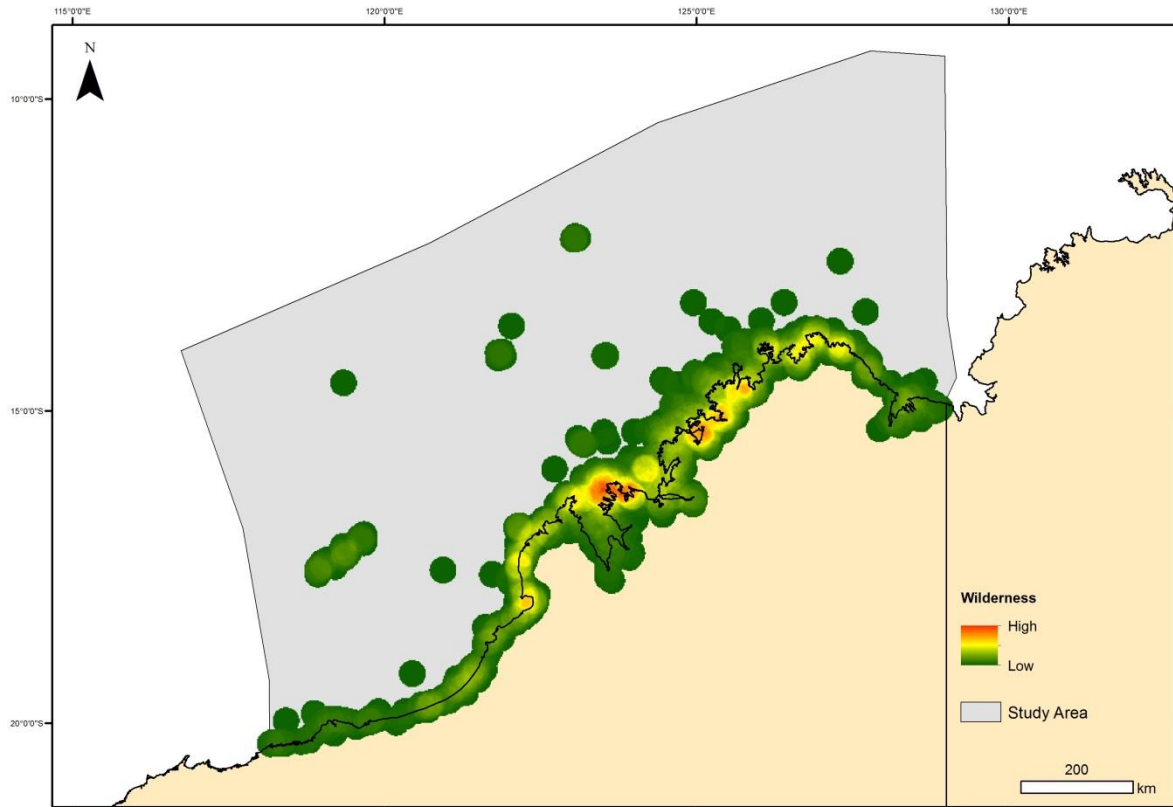


Figure 15. Point density map for wilderness values (N=1,405).

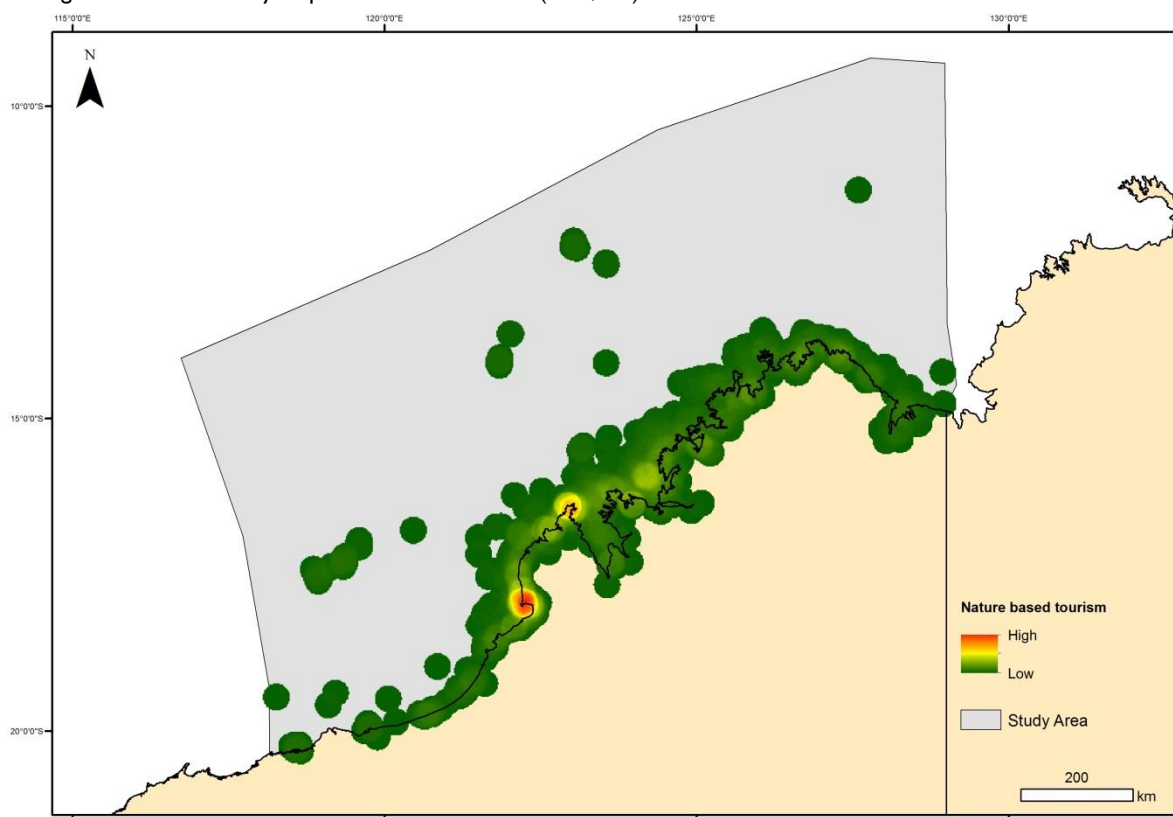


Figure 16. Point density map for nature based tourism values (N=1,382).

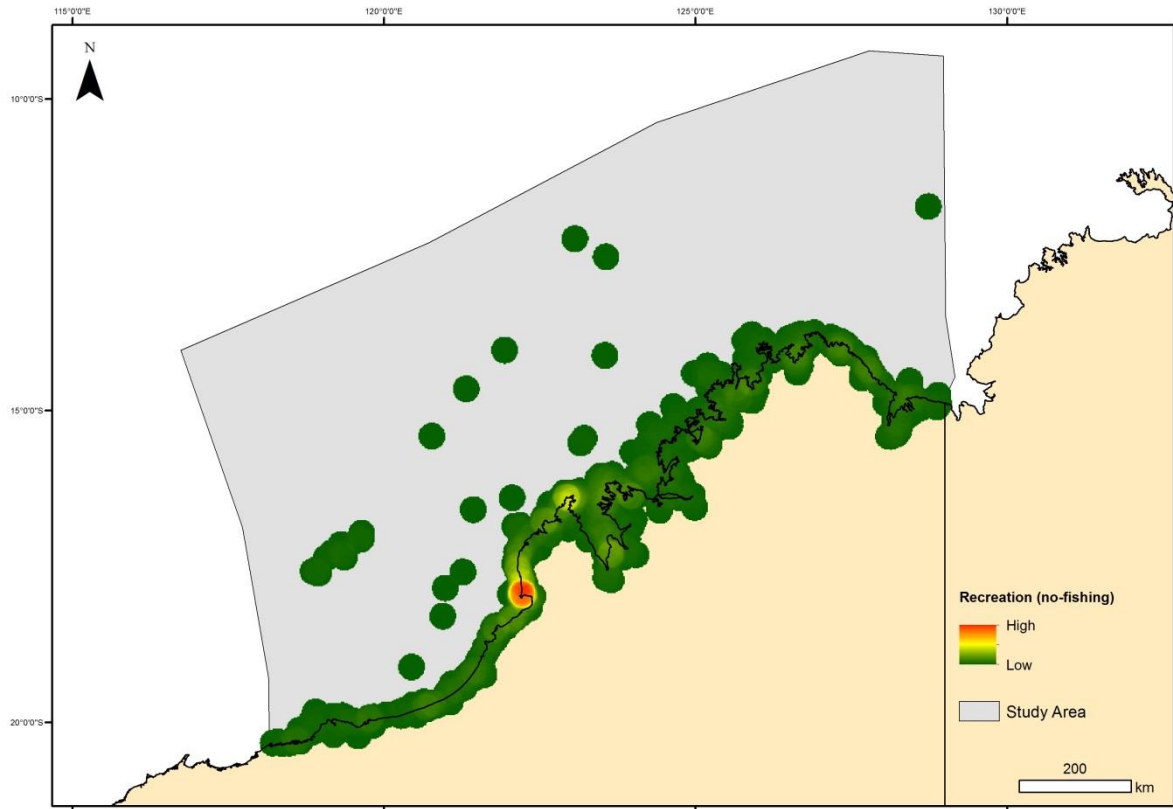


Figure 17. Point density map for recreation (non-fishing) values (N=1,173).

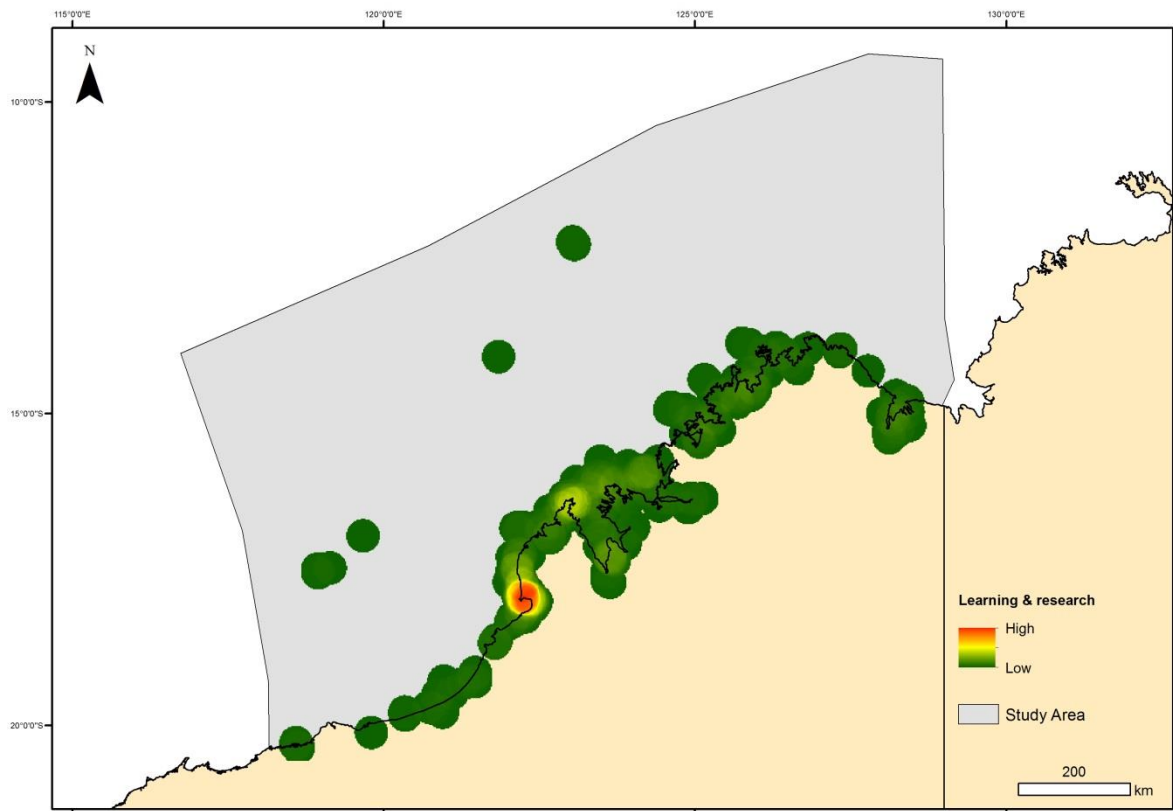


Figure 18. Point density map for learning and research values (N=400).

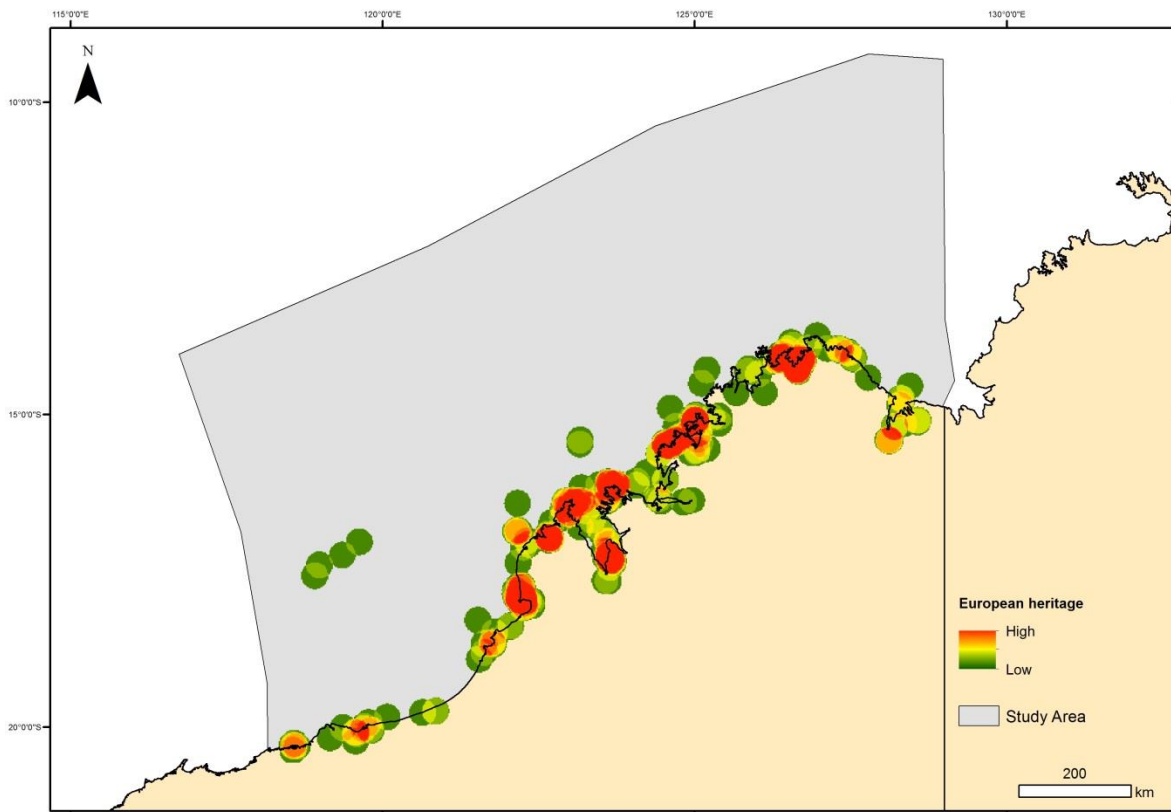


Figure 19. Point density map for European heritage values (N=358).

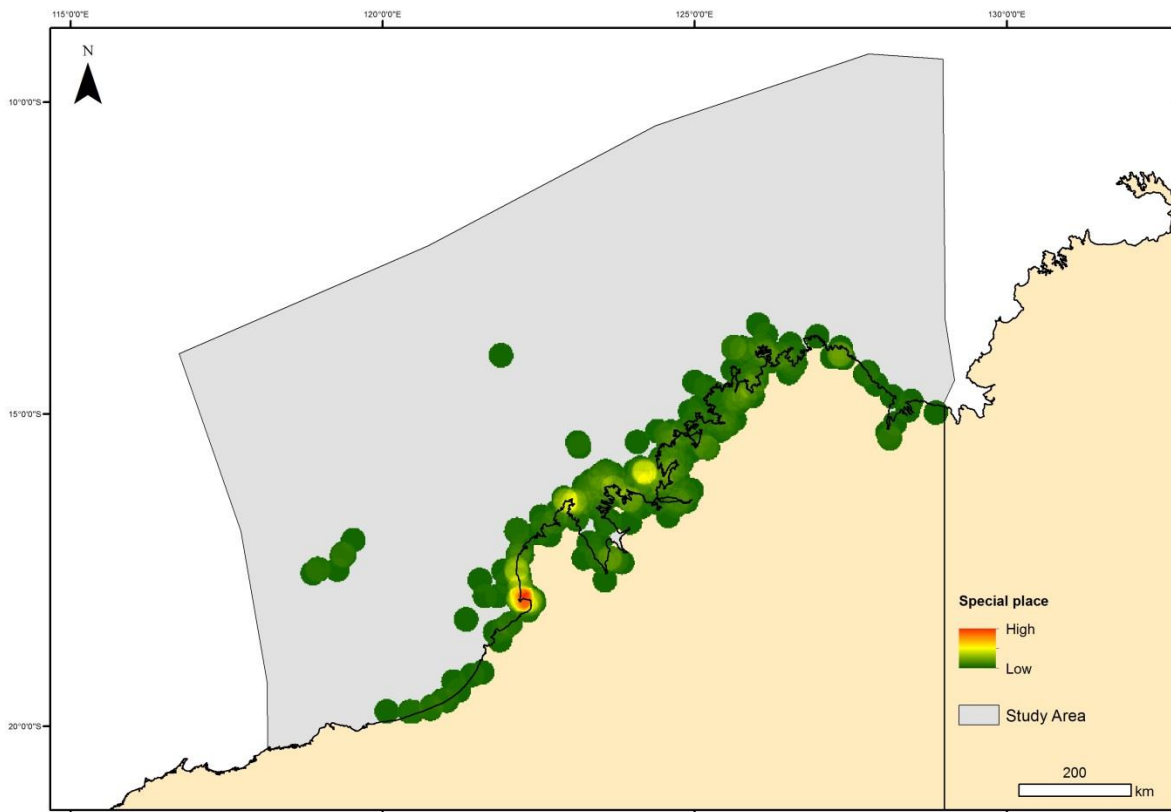


Figure 20. Point density map for 'special place' values (N=334).

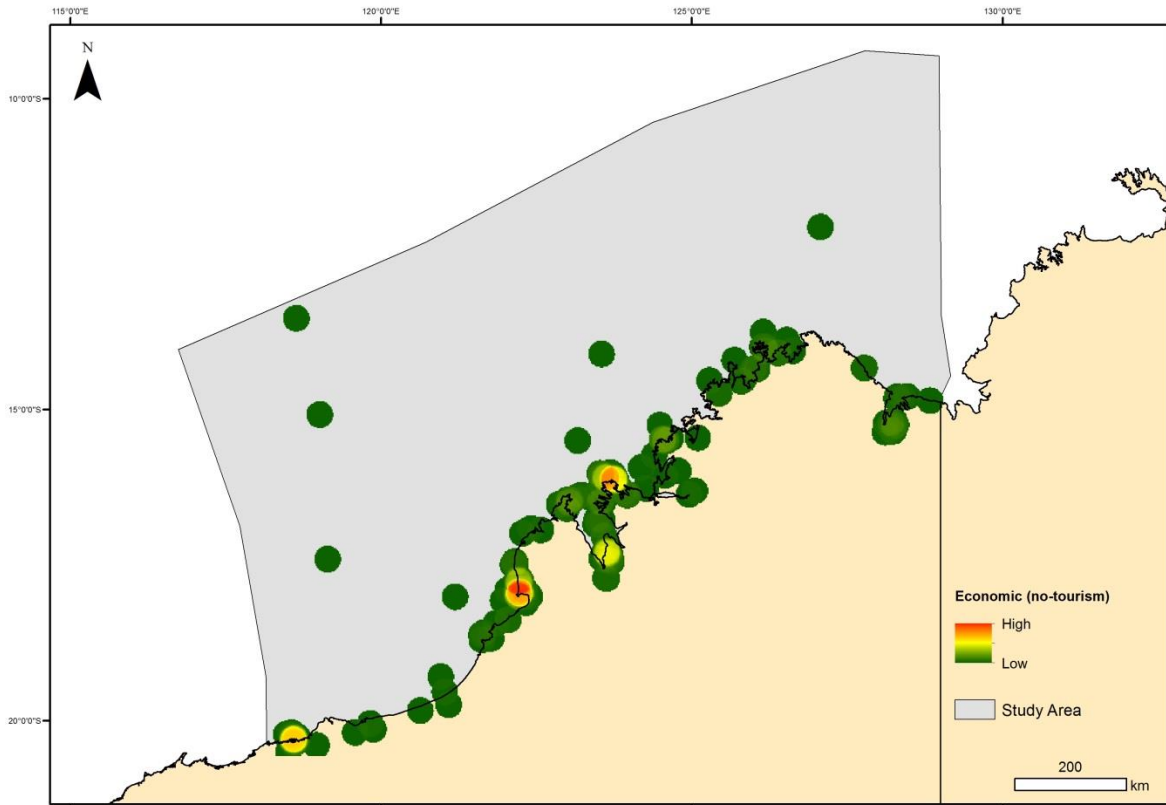


Figure 21. Point density map for economic (non-tourism) values (N=309).

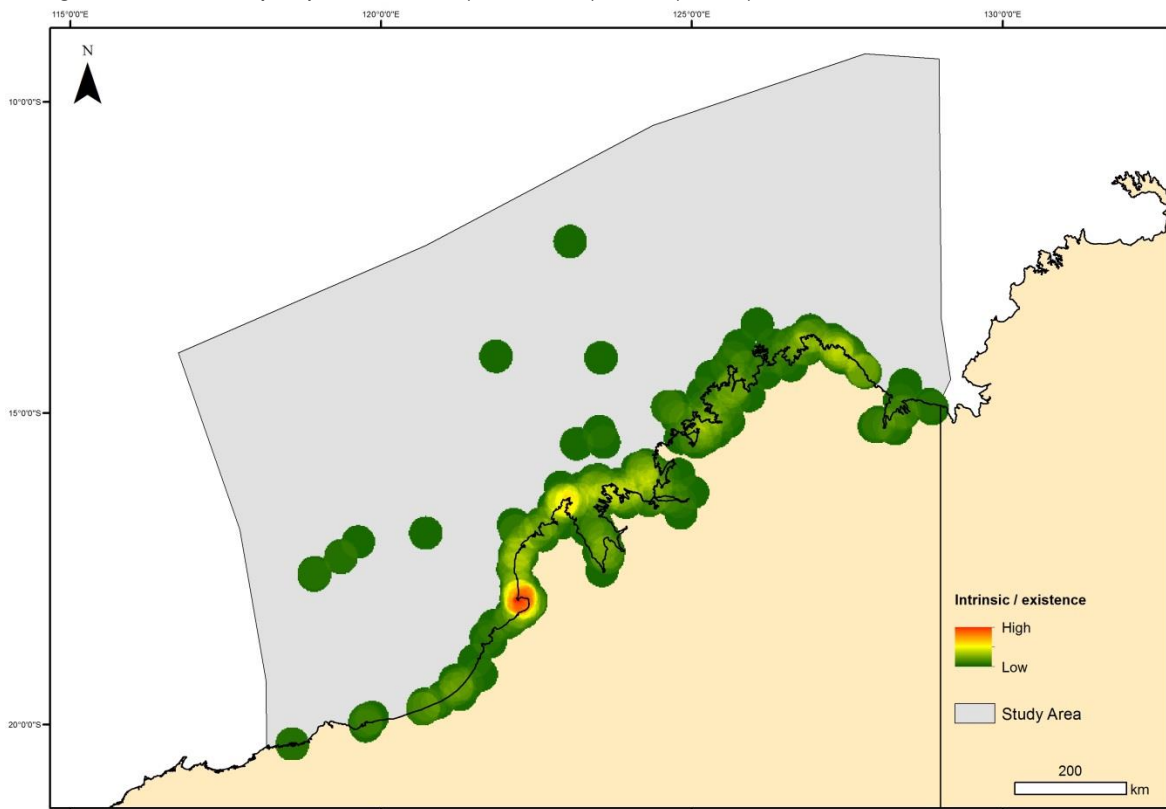


Figure 22. Point density map for intrinsic/existence values (N=276).

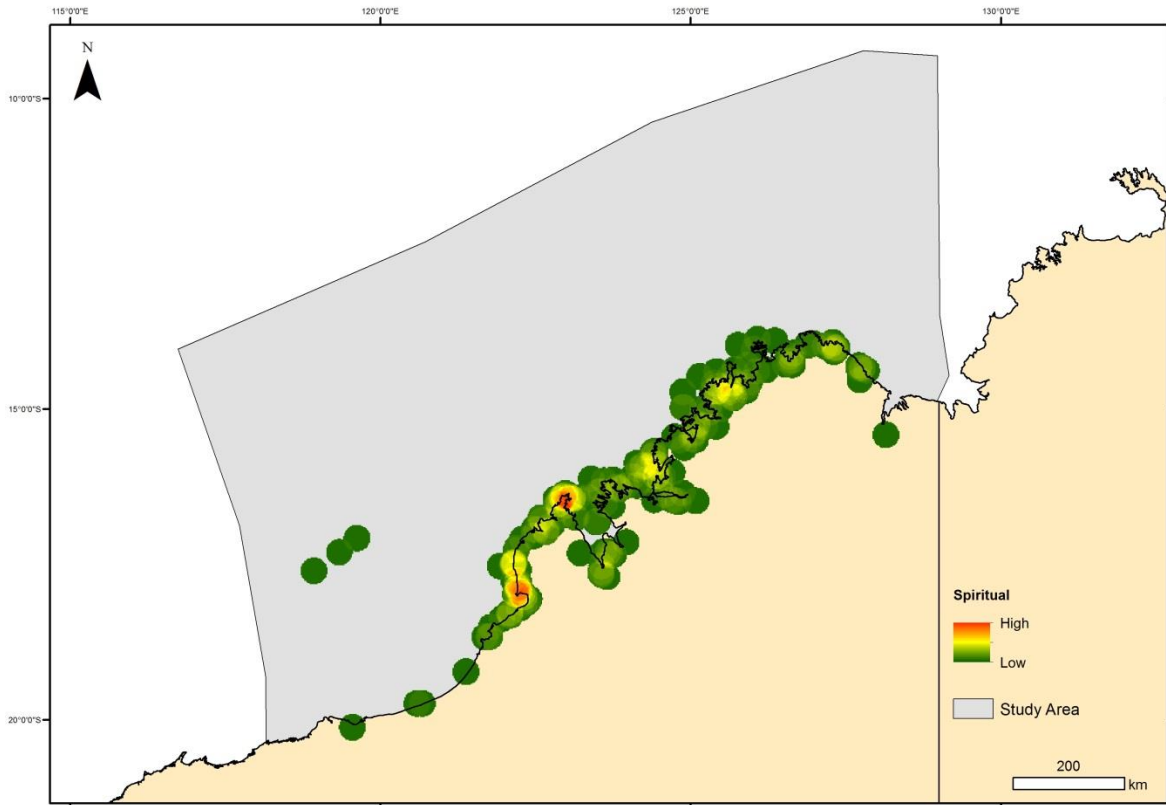


Figure 23. Point density map for spiritual values (N=208).

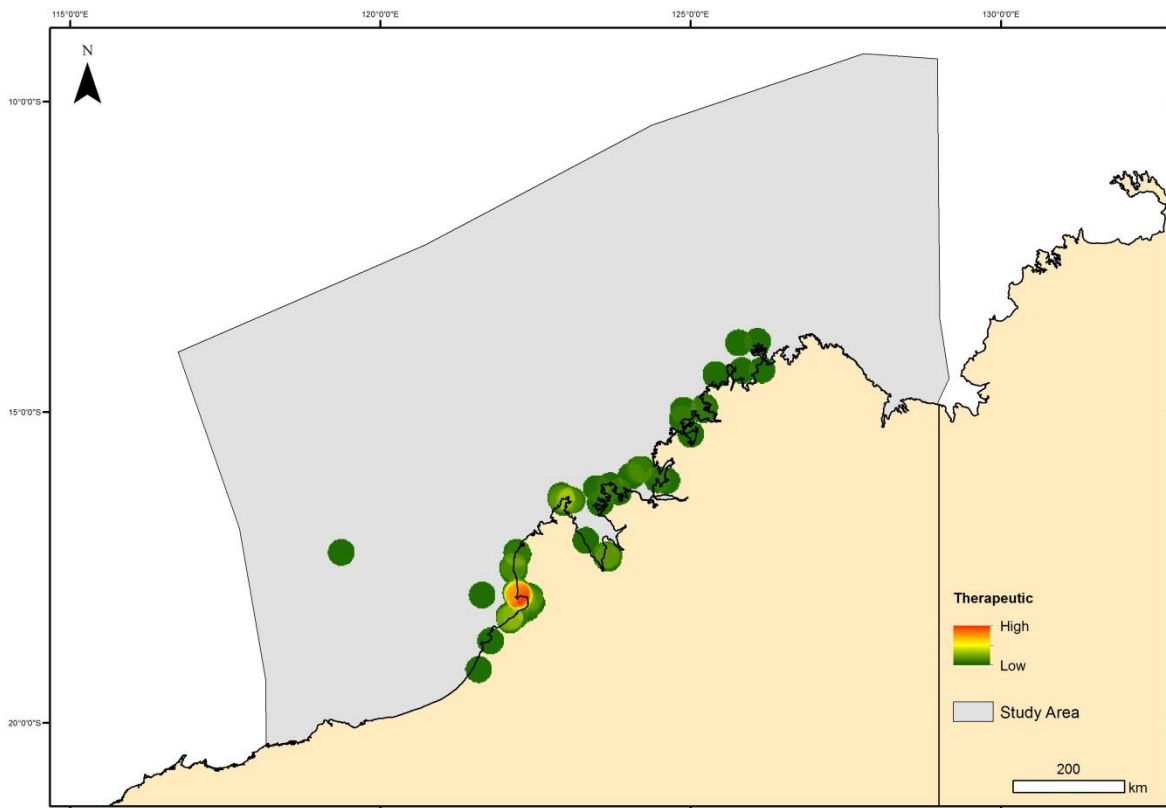


Figure 24. Point density map for therapeutic values (N=66).

Table 9 summarises the value hotspots evident from the point density maps (Figures 11 – 24). Three areas of recurrent high values are evident: Broome and Roebuck Bay, the southern and western Dampier Peninsula, and northern Dampier Peninsula. The Buccaneer Archipelago and Kalumburu/Napier Broome Bay region are also areas of value concentration, although for a lesser number of markers.

Table 9. High and medium density hotspots according to value type.

Value	Hotspot 80 Mile Beach region	Broome & Roebuck Bay	Southern & western Dampier Peninsula	Northern Dampier Peninsula	Buccaneer Archipelago	Derby/southern King Sound	Camden & Brunswick Bay	Sound St. George Basin/Prince Regent River	Prince Frederick Harbour	Kalumburu/ Napier Broome Bay	King George Falls	Wyndham/ Cambridge Gulf
Biological/conservation ¹		X	X	x								
Scenic/aesthetic ²		X	X	x								
Recreational fishing ³		X	X			x				x		x
Aboriginal culture & heritage ²		x	x	X						x		
Wilderness ²		x			X			X	X	x		
Nature-based tourism ³		X	X	X								
Recreation (non-fishing) ²		X	X	x								
Learning & research ²		X	X	x	x	x						
European heritage ²	X	X	X	X	X	X	X	X		X	X	X
Special place		X	x	X								
Economic (non-tourism) ³		X	X		X	x						
Intrinsic/existence ⁴		X	X	X	x						x	
Spiritual ²		X		X						x		
Therapeutic ²		X		X								

X= high density of values (as determined by number of markers placed in the PPGIS survey)

x= medium density of values (as determined by number of markers placed in the PPGIS survey)

¹= Indirect use value

²= Direct use, non-consumptive value

³= Direct use, consumptive value

⁴= Non-use value

The following section provides further detail regarding the hotspots evident for each value type. The values are discussed according to the typology established in 1.2.1 *Value typologies*, being (1) direct use, non-consumptive values; (2) direct use, consumptive values; (3) indirect use values; and (4) Non-use values. 'Special place' values are a final category of value discussed. As highlighted previously, Figure 8 depicts the location of hotspots outlined in Table 9. This Figure provides an important spatial reference to the following discussion of hotspots.

Direct use, non-consumptive values of the Kimberley coast

This value set was dominated by scenic/aesthetic values, which comprised the second most commonly mapped value category following biological/conservation value (covered below under 'Indirect use value') (see Figure 10). Scenic/aesthetic value was ascribed to the entire coastline with the exception of some small areas in the southern reach of Eighty Mile Beach. Scenic value hotspots were evident along the southern, western and northern Dampier Peninsula as well as the Buccaneer Archipelago (Figure 12, Table 9, see also Figure 8). These findings are not surprising given that the Kimberley is a beautiful region renowned for exceptional scenery, with the Dampier Peninsula and Buccaneer Archipelago in particular embodying the striking contrasts that the area is famous for.

Values relating to Aboriginal culture and heritage were the fourth most numerous value mapped (Figure 10), with value markers covering a large swathe of the coastline in keeping with the region's diverse historic and living Aboriginal culture (Thomson-Dans et al. 2011). Hotspots were located along the southern, western and northern Dampier Peninsula (Figure 14, Table 9). These hotspots may reflect a heightened public awareness of Aboriginal culture and heritage stemming from the Dampier Peninsula's position as a pre-eminent location for Aboriginal cultural tourism as well as recent public debate regarding the cultural and other values of the James Price Point area. Wilderness/pristine areas were more heavily concentrated in areas north of the Buccaneer Archipelago although also valued in areas further south (Figure 15). Four hotspots are apparent: the Buccaneer Archipelago; the St. George Basin/Prince Regent River area (location of the iconic Kings Cascade waterfall); Prince Frederick Harbour; and near Mitchell Falls (Table 9, see also Figure 8). This greater northern density of wilderness/pristine values could be linked to the fact the northern coastline is much less accessible than areas to the south.

Non-fishing recreational value was ascribed to a large proportion of the coastline with foci again being some of the most accessible parts of the Kimberley coast: Broome and Roebuck Bay; the southern, western and northern Dampier Peninsula; and the Buccaneer Archipelago (Figure 17, Table 9, see also Figure 8). The areas provide ample opportunities for recreation activities such as swimming, diving, exploring and walking (Beckley 2015, Strickland-Munro et al. 2015). Learning and research values were clustered around Broome and Roebuck Bay and the southern, western and northern Dampier Peninsula (Table 9). Hotspots of medium density were located in the Derby/southern King Sound region, Buccaneer Archipelago and Montgomery Reef (Figure 18, see also Figure 8).

European heritage value was less widespread along the coastline but evidenced a large number of distinct hotspots. These were: Eighty Mile Beach (Port Hedland, Cape Keraudren and Lagrange Bay/Bidyadanga); Broome/Roebuck Bay; the southern, western and northern Dampier Peninsula (with Beagle Bay and the Lacepede Islands as separate hotspots within this northern region); the Buccaneer Archipelago, Derby/southern King Sound region; Camden Sound/Brunswick Bay; Kalumburu/Vansittart Bay; King George Falls area; and Wyndham (Figure 19, Table 9, see also Figure 8). These areas boast significant heritage values relating to i) the Second World War (e.g., flying boat wrecks in Roebuck Bay, Truscott airfield near Kalumburu); ii) pearling history (Broome, northern Dampier Peninsula, Kuri Bay); and iii) missionary/exploration history (e.g., Sunday Island Mission off the northern Dampier Peninsula; Brecknock Harbour (Camden Sound), the site of failed settlement in 1864; Phillip Parker-King's carved boab tree at Careening Bay; ruins of Kunmunya Mission; and Wyndham, the Kimberley's oldest town and once-lively port).

Spiritual and therapeutic values were the two least-mentioned values. Spiritual values were concentrated around the western and northern Dampier Peninsula, Broome/Roebuck Bay, Raft Point/Doubtful Bay and Swift Bay (Admiralty Gulf) (Figures 23, Table 9, see also Figure 8). Therapeutic values were centred on Broome and Roebuck Bay, with a slight concentration on the northern Dampier Peninsula (Figure 24, Table 9).

Direct use, consumptive values of the Kimberley coast

The direct use, non-consumptive value set was dominated by recreational fishing, the third most common value mapped in the survey (Figure 10). Value markers covered virtually the entire coastline with a clear hotspot surrounding Broome and Roebuck Bay. Other discernible areas of value concentration were the southern,

western and northern Dampier Peninsula, Buccaneer Archipelago, Derby/southern King Sound region and Cambridge Gulf (Figure 13, Table 9, see also Figure 8). These areas are i) easily accessible for both tourists and residents and ii) renowned for fishing opportunities. Nature-based tourism values were similarly widespread along the coast and evidenced comparable loci (Broome; the southern, western and northern Dampier Peninsula) (Figure 16, Table 9). Again, these concentrations of nature-based tourism value are located in more accessible areas providing a range of tourism offerings. Non-tourism economic values were concentrated around similar hotspots, with the addition of the Buccaneer Archipelago (particularly Yampi Sound, where the iron ore mining islands of Koolan and Cockatoo are located) and the Derby/southern King Sound region (Figure 21, Table 9, see also Figure 8).

Indirect use values of the Kimberley coast

Biological/conservation was the most prominent value associated with the Kimberley coast; accounting for 16.4% of all value markers mapped (Figure 10). The value markers were widely distributed along the entire coastline, in keeping with the Kimberley's reputation for unique terrestrial and marine ecosystems with high biodiversity (GoWA 2014). Hotspots were evident around Broome and Roebuck Bay (both easily accessible areas, with the latter renowned as a Ramsar site for migratory waterbirds). Further hotspots are apparent along the southern, western and northern Dampier Peninsula (Figure 11, Table 9).

Non-use values of the Kimberley coast

Intrinsic/existence values were the sole non-use value category included in the PPGIS survey and recorded the third least numerous number of value markers (Figure 10). These value markers were scattered along the majority of the coastline. Hotspots centred on Broome and Roebuck Bay; the southern, western and northern Dampier Peninsula; and the Buccaneer Archipelago (particularly the Yampi Sound area) (Figure 22, Table 9, see also Figure 8). Hotspots of medium density exist within the Collier Bay/Montgomery Reef region as well as along the northern Kimberley coastline from Cape Londonderry to King George Falls.

Special places

Analysis of comments associated with 'special place' values identified a number of common themes corresponding to existing categories of value (cf. Figure 10). These themes were: biodiversity/conservation, natural and European heritage, Aboriginal culture and heritage, nature based and cultural tourism, and personal significance. As with the point density maps relating to these value types, the Broome/Roebuck Bay area, the southern, western and northern Dampier Peninsula were highly valued (Figure 20, Table 9, see also Figure 8). The Montgomery Islands was another area of high value as a 'special place'.

Comments relating to biodiversity typically referenced key species such as whales (particularly migration routes), snubfin dolphins, crocodiles and migratory shorebirds. The diversity and health of offshore coral reefs and location of threatened ecological communities (coastal vine thickets) also featured. Natural and European heritage was predominantly recognised in relation to dinosaur footprints, war history and pearling operations.

Comments relating to Aboriginal culture and heritage emphasised the presence of internationally significant rock art, burial sites and other cultural areas. A number of areas were singled out for their existing and/or potential for nature based or Aboriginal tourism ventures. Special places of personal significance included i) those where important life events (e.g. marriage), memories or social bonding took place, ii) places of logistical importance e.g. freshwater source or communications point, and iii) places offering unique and/or unmatched experiences of nature. This latter category encompassed reference to superlative natural phenomena (e.g., Horizontal Falls, the Montgomery Islands, the 'Staircase to the Moon', the scale and grandeur of scenery) and the transcendent or profound experience associated with it (Pearce et al. under review).

3.2.3 Management preference mapping

A total of 275 respondents placed markers to indicate their management preferences. The number of management preference markers mapped by a single respondent ranged between 1 and 161. An average of 19.5 preferences were placed per respondent (standard deviation = 24.9, median = 10). Figure 25 depicts the total of 5,401 management preference markers that were mapped during the survey. Management preferences were allocated to the vast majority of the coastline and near shore environment. Again, a number of discrete offshore locations are evident, corresponding to Rowley Shoals, Scott, Seringapatam, Ashmore and Cartier Reefs, Browse Island and Adele Island (see also Figure 8).

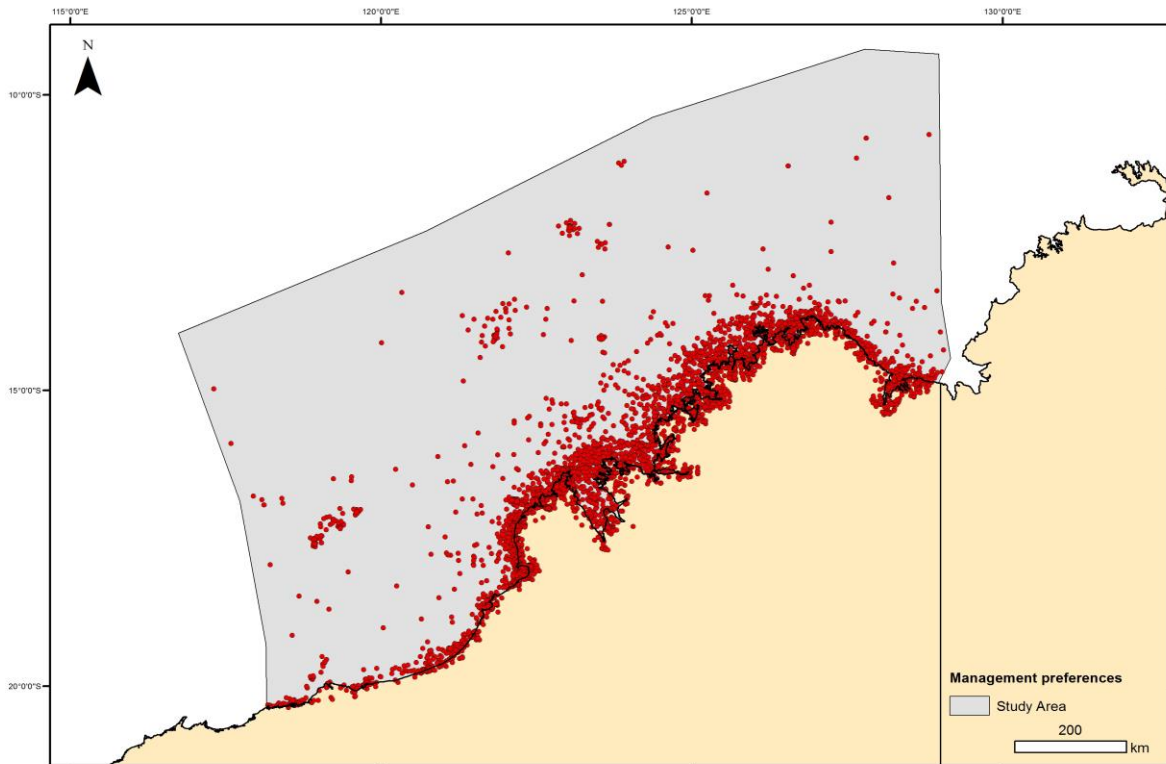


Figure 25. All management preference markers mapped within the study area (N= 5,401).

Figure 26 depicts the relative count of markers mapped for each management preference category. The majority of markers mapped related to 'pro-conservation' preferences (84.9% of all markers placed). Of these preferences, 'increase conservation/protection' (1,474 markers) and 'no oil/gas development' (1,273 markers) most prevalent, accounting for over 50% of all preference markers placed (27.4% and 23.7% of markers placed, respectively). This was followed by 'no commercial fishing/aquaculture' (680 markers, 12.6%), 'increase Aboriginal management' (528 markers, 9.3%), 'no new port development' (398 markers, 7.4%) and 'restrict or limit access' (231 markers, 4.3%). 'Pro-development' preferences (792 markers) accounted for 14.7% of all markers placed. Of this, resource-related management preferences supporting commercial fishing/aquaculture, new port and oil/gas developments received the least number of markers (300, 5.5% of all preference markers placed). 'Other' preferences accounted for 0.5% of all markers placed (N=25).

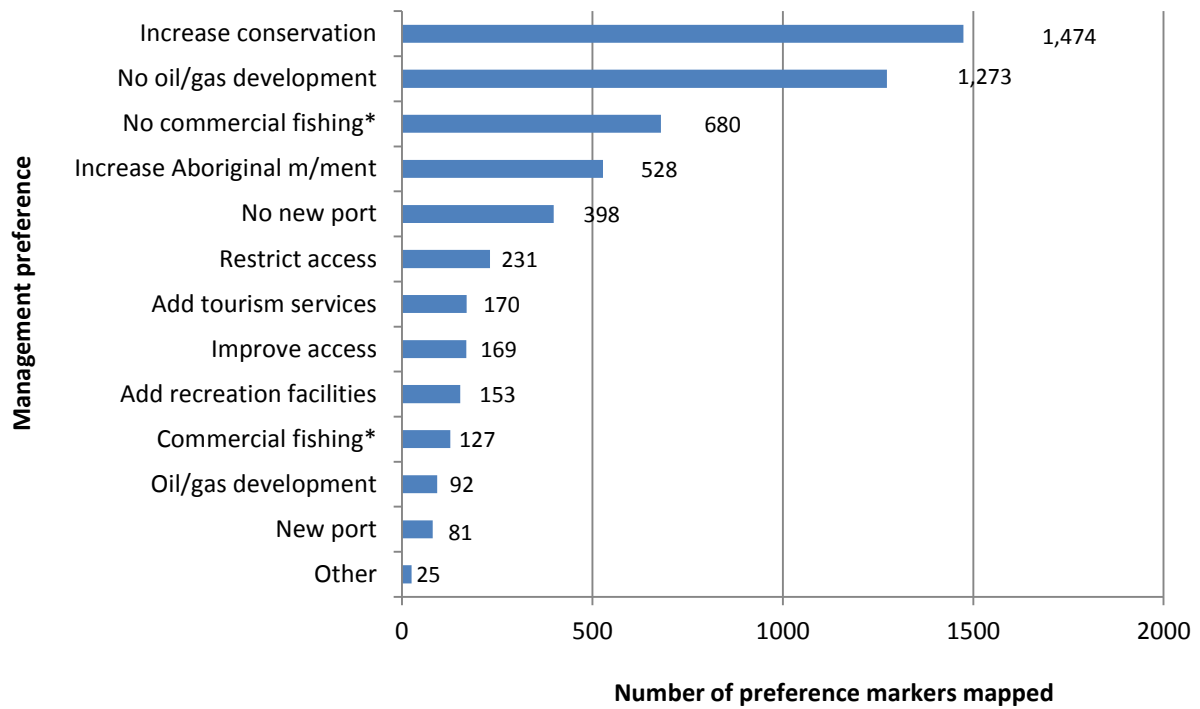


Figure 26. Count of management preferences mapped in the PPGIS survey (N=5,401).

* Includes aquaculture.

3.2.4 Management preference point density maps

In this section, the point density maps are presented according to the number of markers placed, moving from the preference with the most markers placed to the preference with the fewest markers placed (reverse order to Figure 26). As noted above for values, the most important result – illustrated in Figures 27 – 39 below – is that some form of management preference is specified for the entire coastline included in this study.

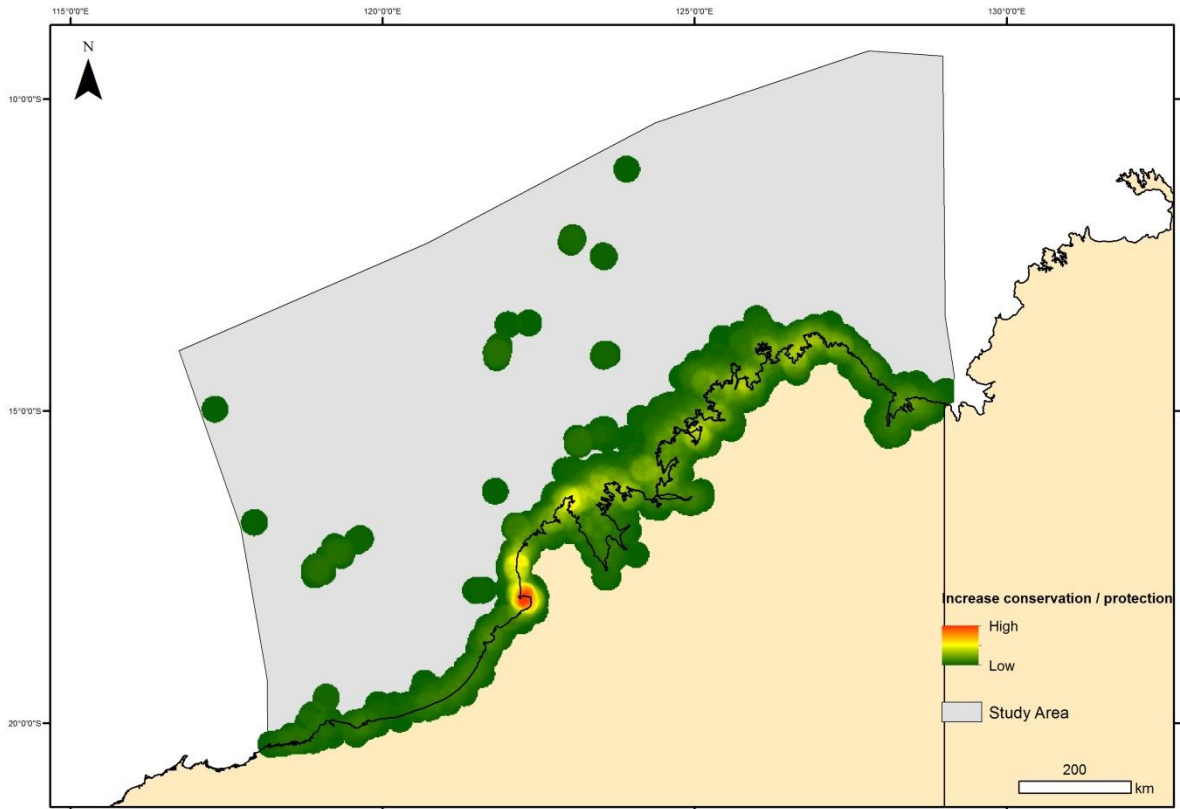


Figure 27. Point density map for 'Increase conservation/protection' management preference (N=1,474).

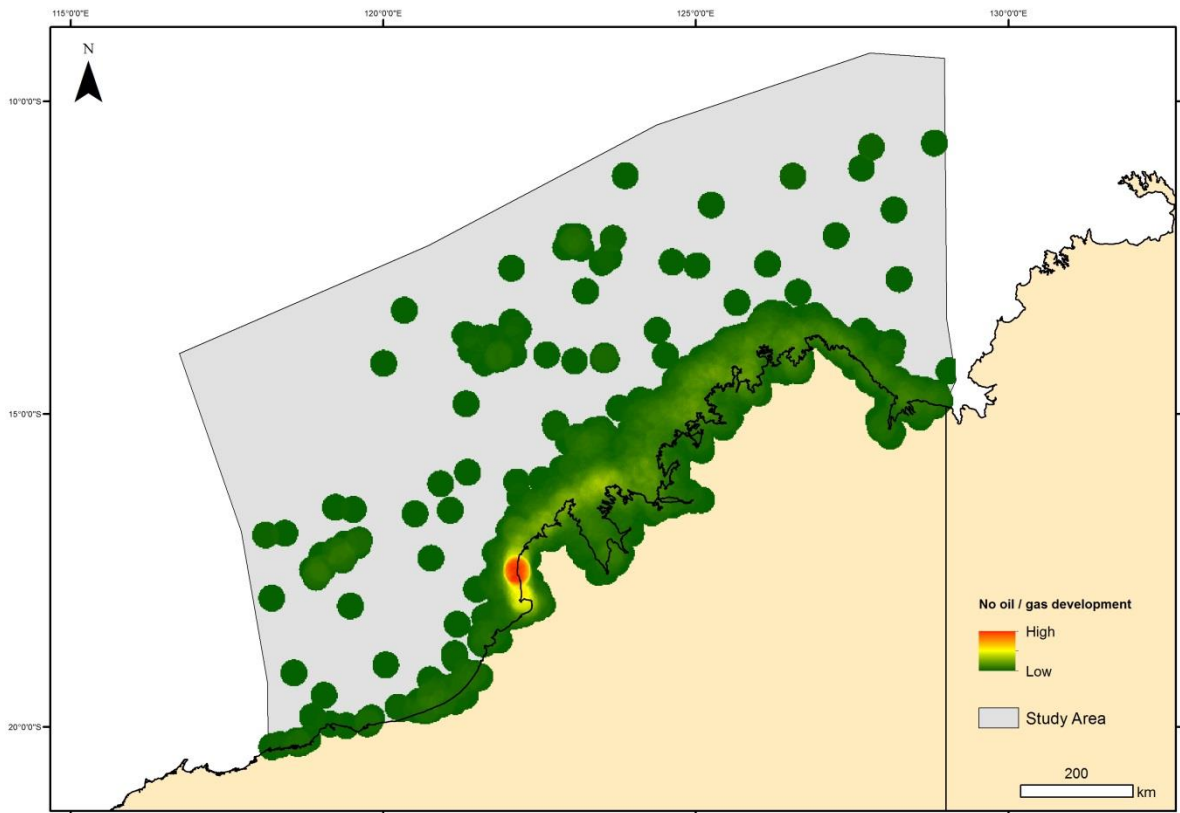


Figure 28. Point density map for 'No oil/gas development' management preference (N=1,273).

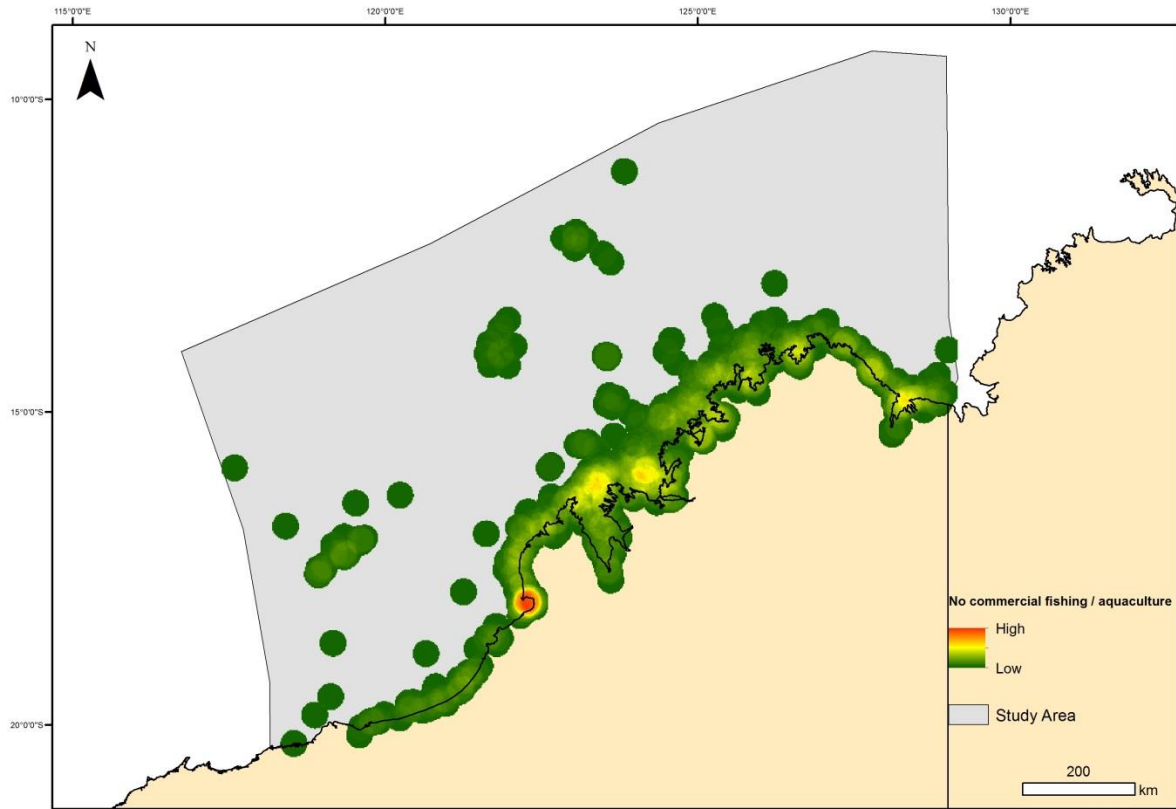


Figure 29. Point density map for 'No commercial fishing/aquaculture' management preference (N=680).

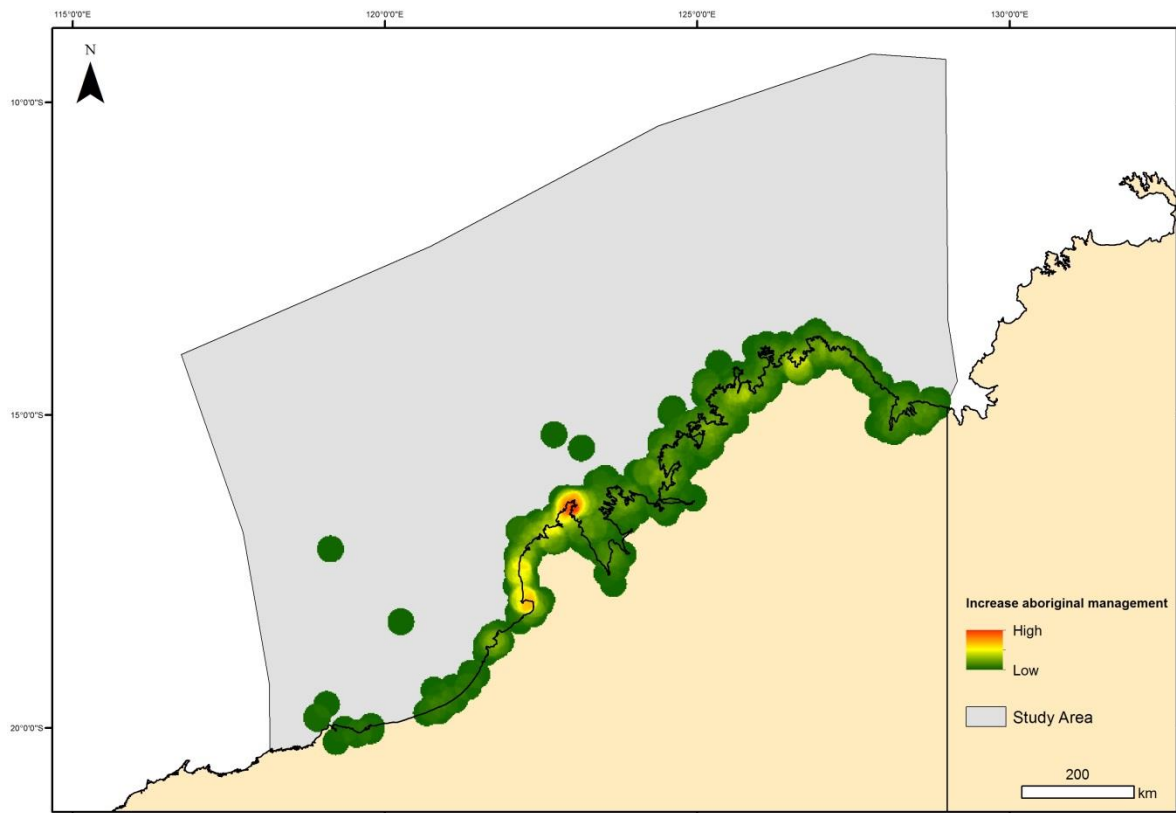


Figure 30. Point density map for 'Increase Aboriginal management' management preference (N=528).

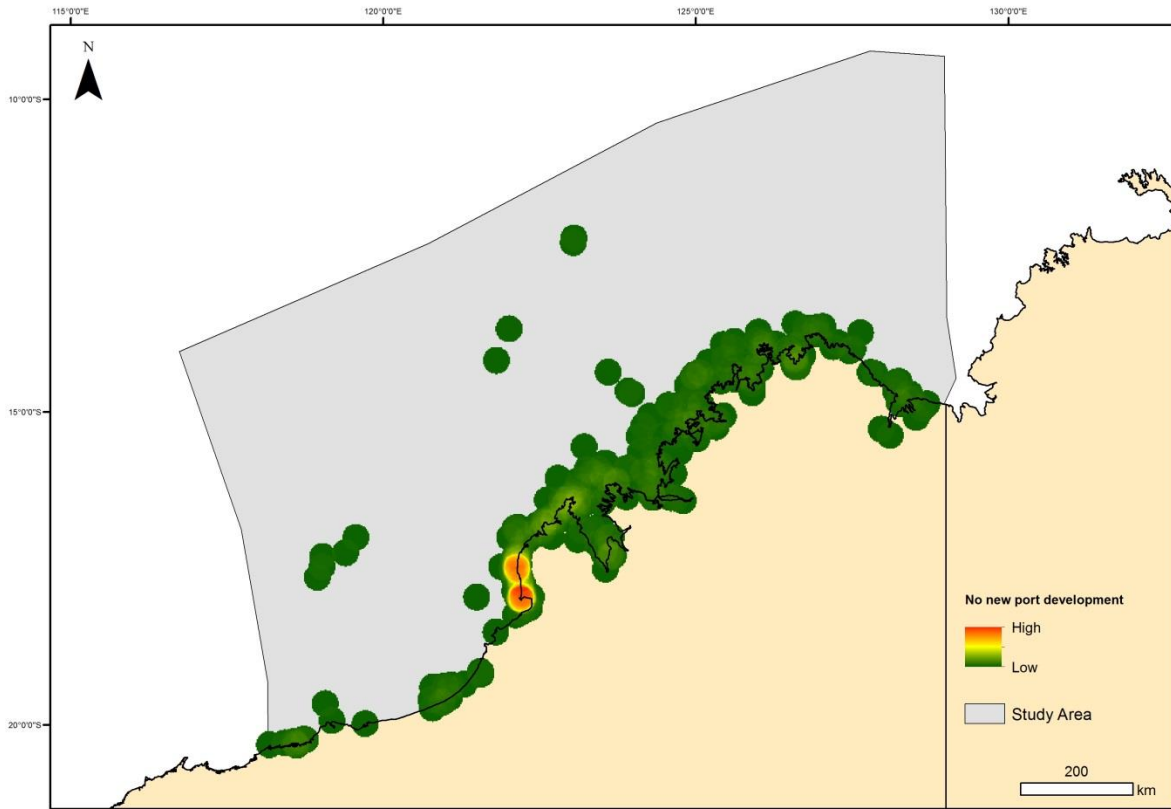


Figure 31. Point density map for 'No new port development' management preference (N=398).

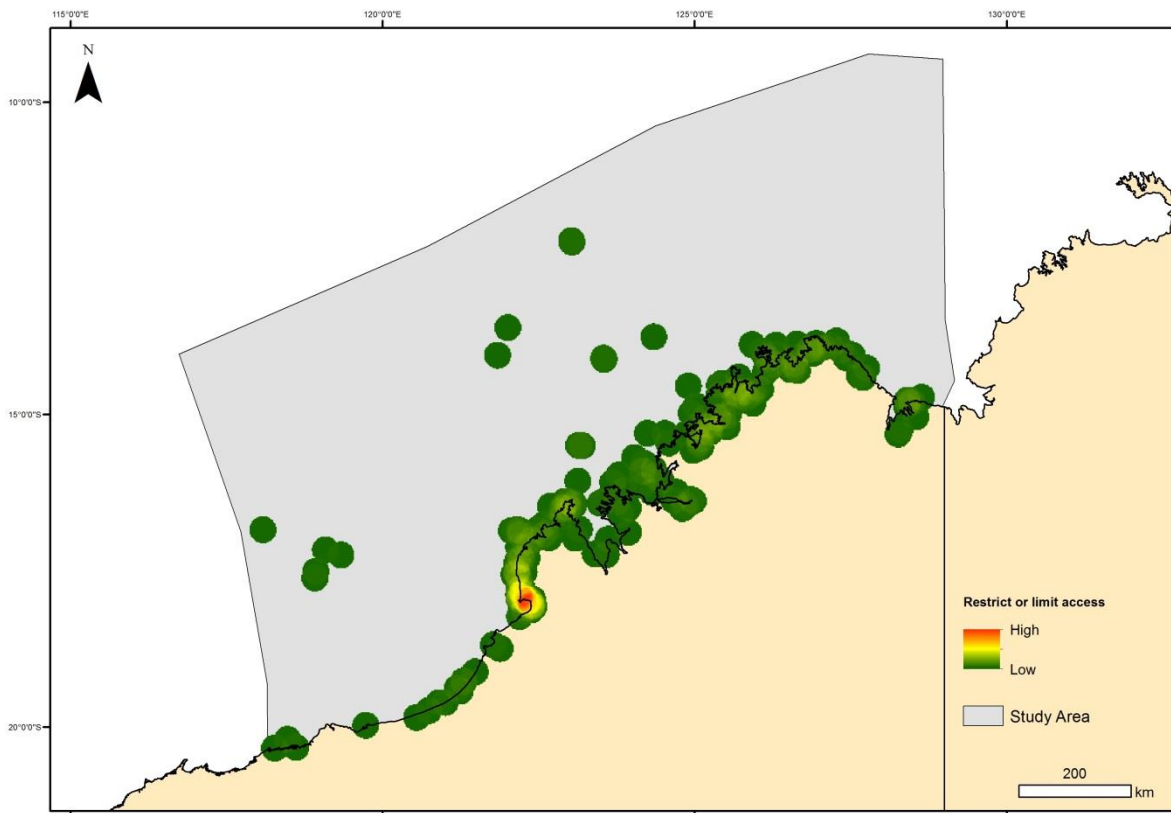


Figure 32. Point density map for 'Restrict or limit access' management preference (N=231).

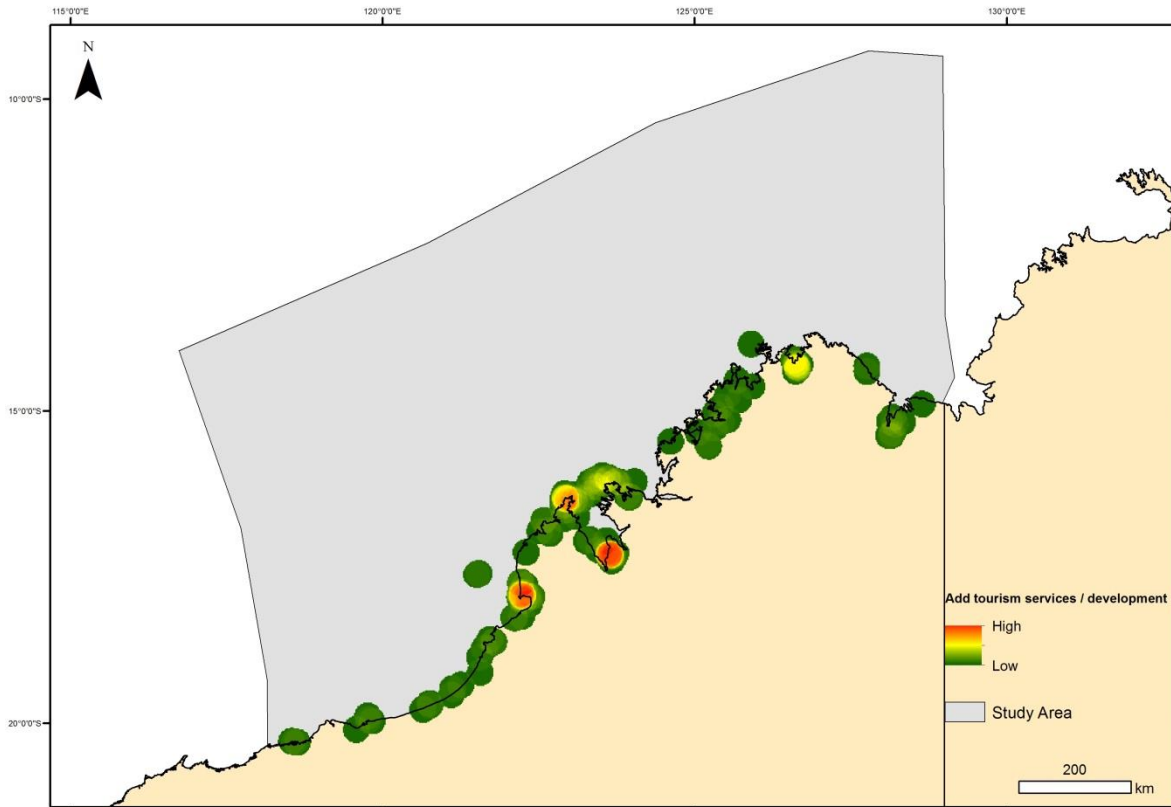


Figure 33. Point density map for 'Add tourism services/development' management preference (N=170).

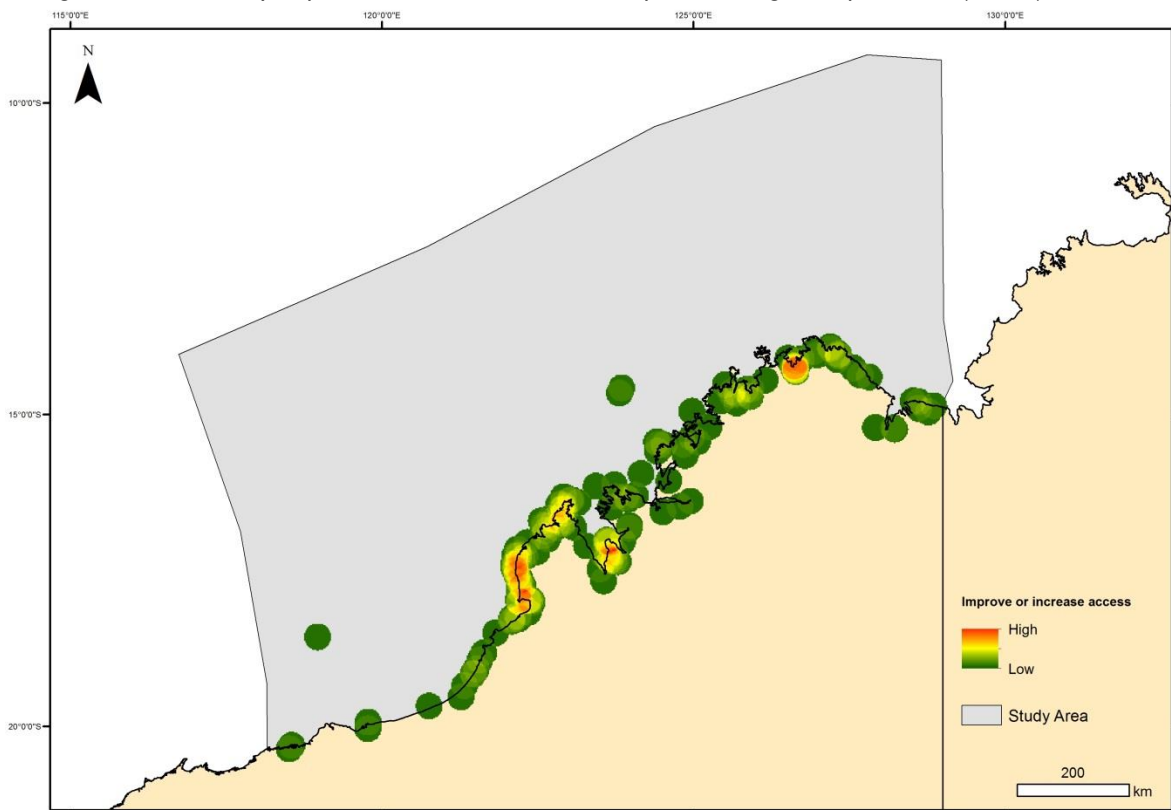


Figure 34. Point density map for 'Improve or increase access' management preference (N=169).

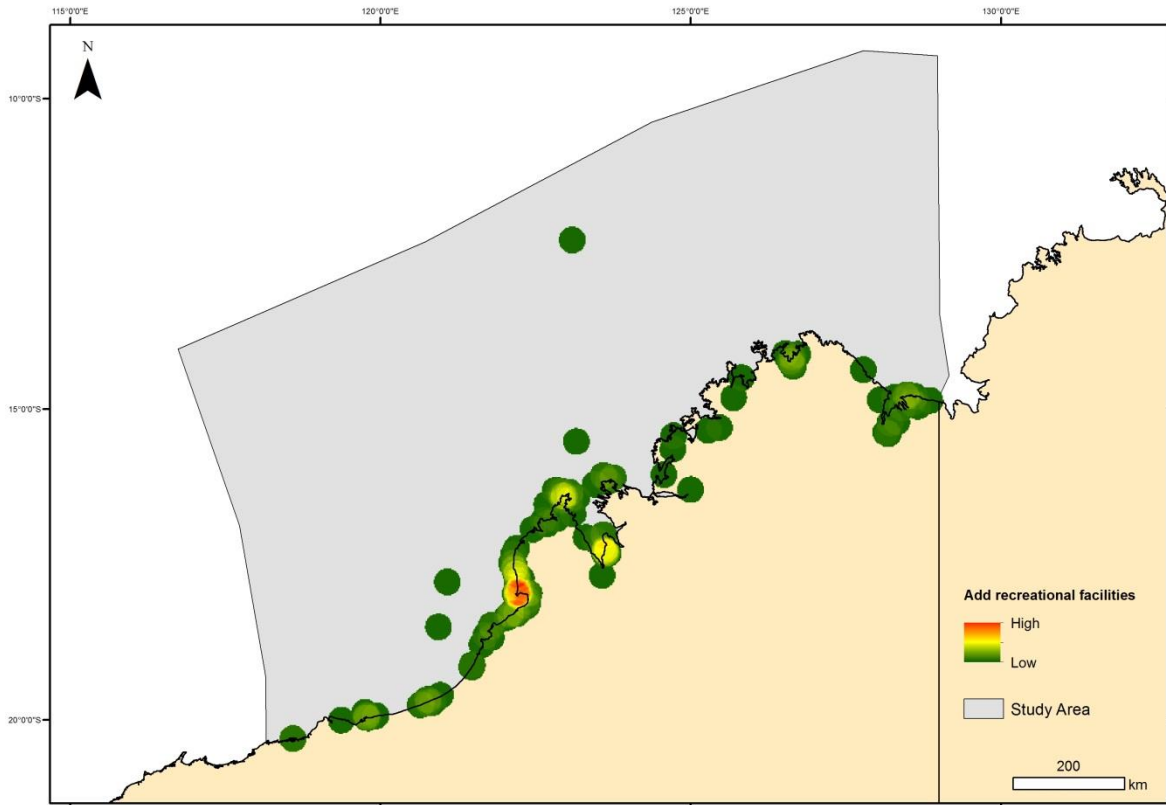


Figure 35. Point density map for 'Add recreation facilities' management preference (N=153).

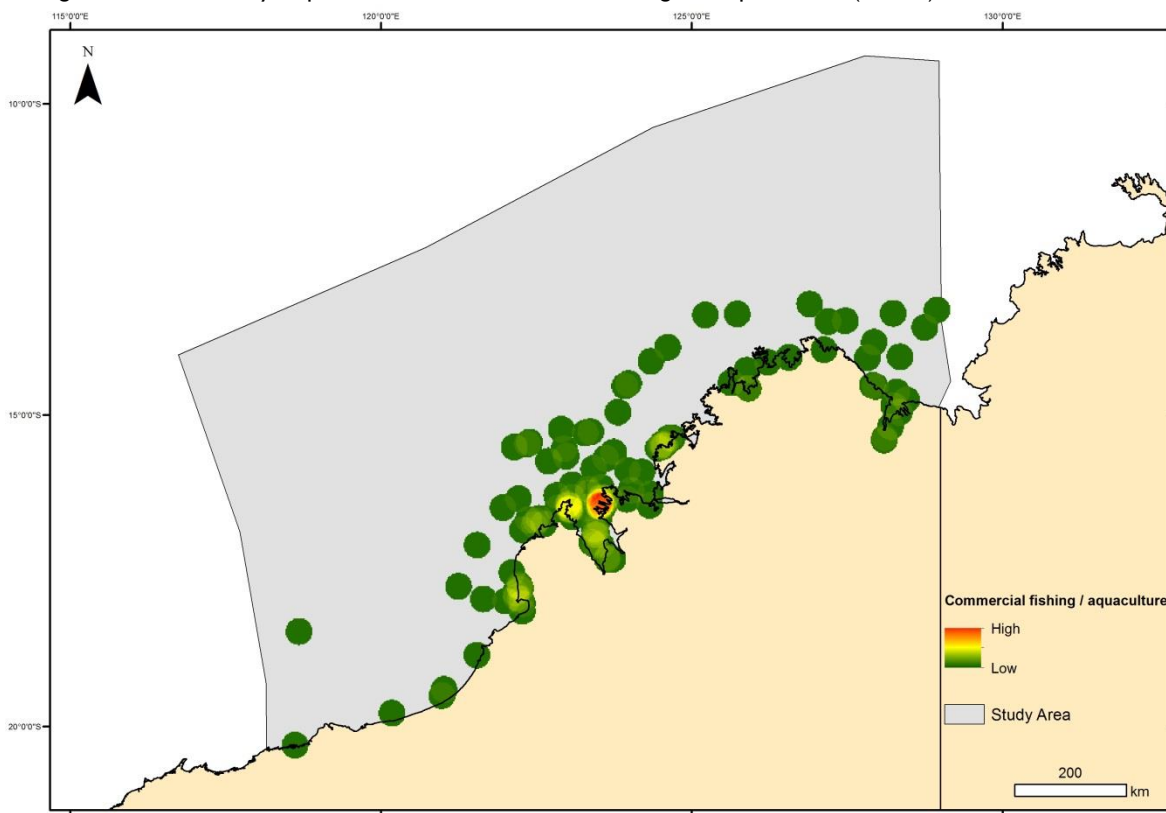


Figure 36. Point density map for 'Commercial fishing/aquaculture' management preference (N=127).

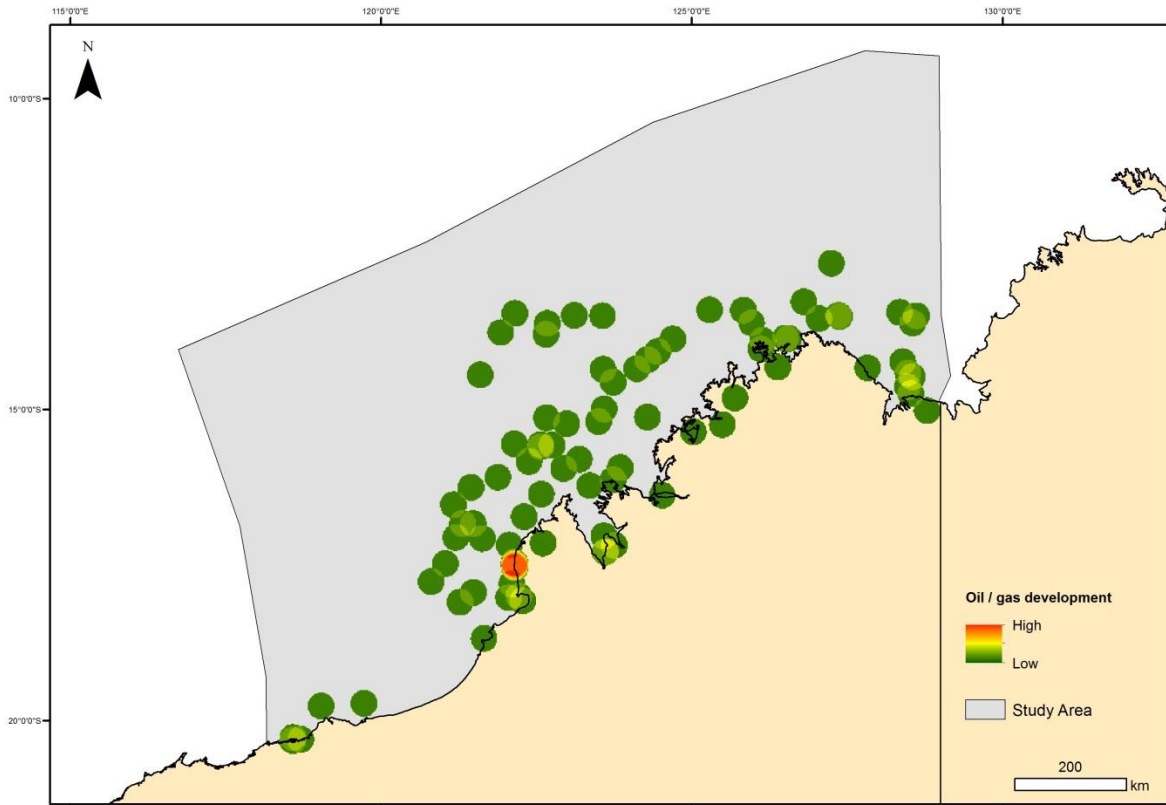


Figure 37. Point density map for 'Oil/gas development' management preference (N=127).

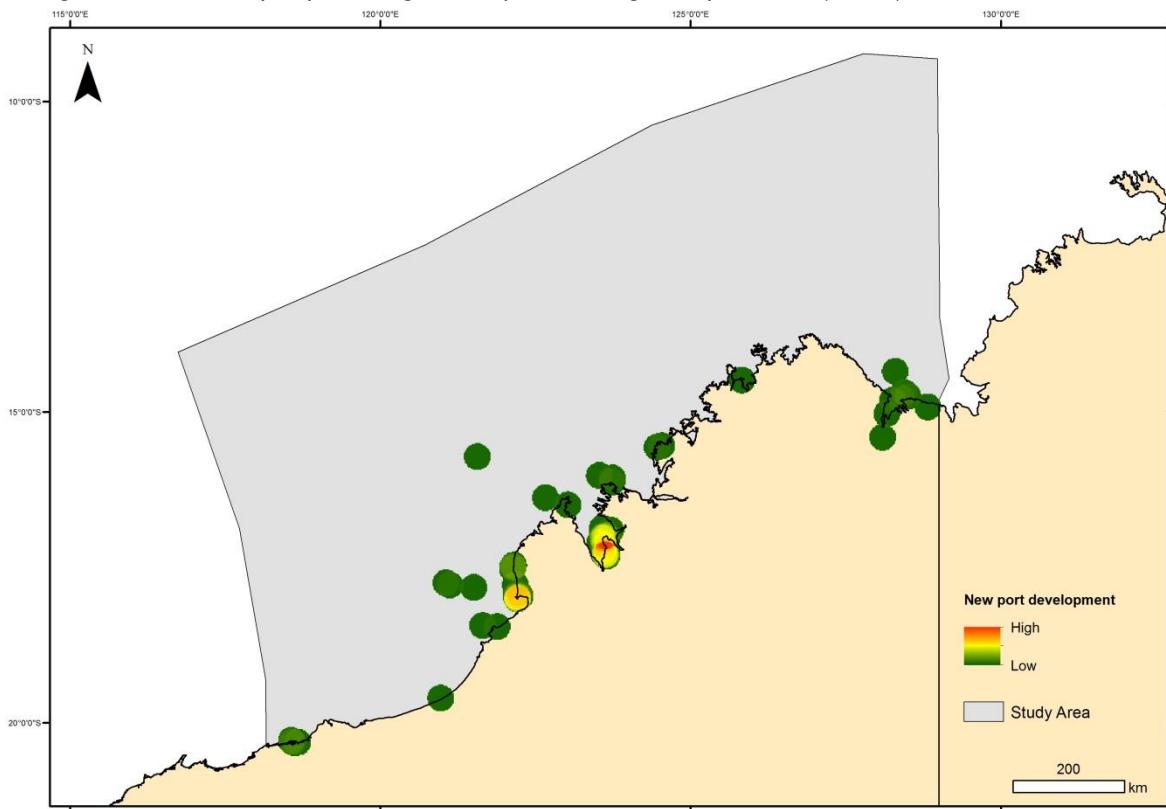


Figure 38. Point density map for 'New port development' management preference (N=92).

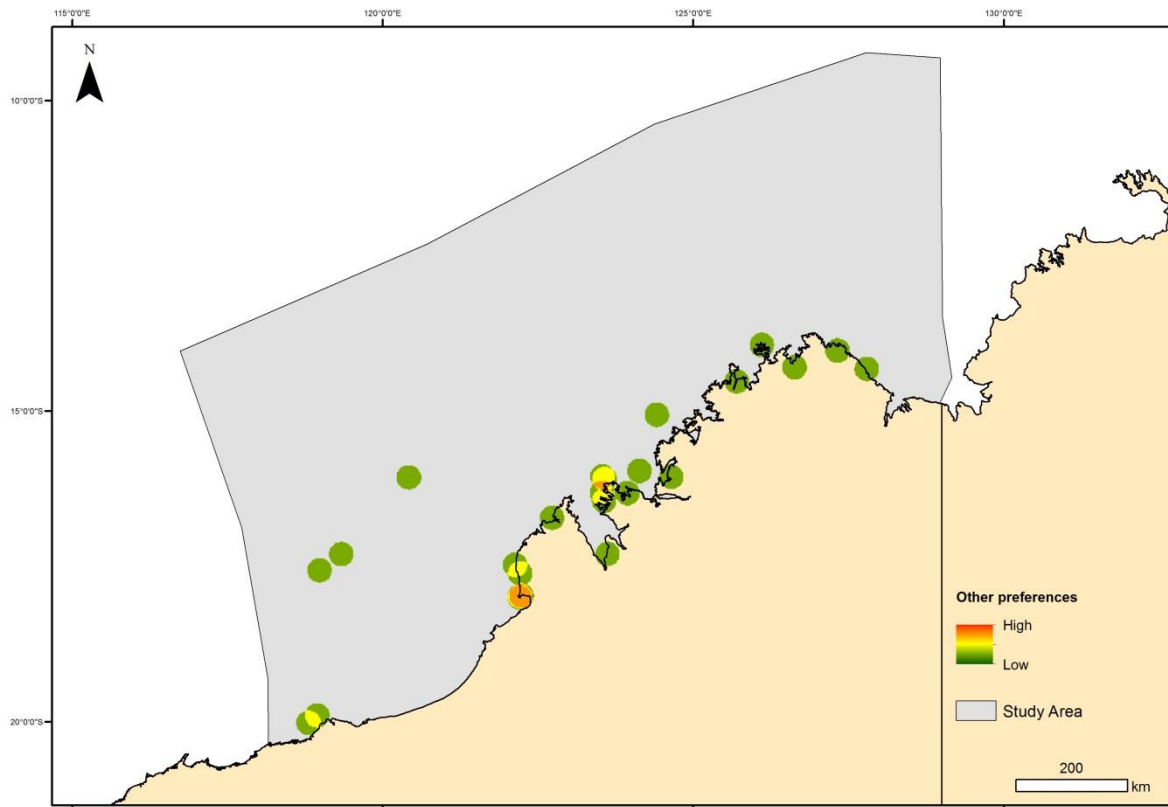


Figure 39. Point density map for 'Other' management preference (N=25).

Table 10 summarises the preference hotspots evident from the point density maps (Figures 27 – 39). Six hotspot areas are evident: Broome and Roebuck Bay; southern and western Dampier Peninsula; northern Dampier Peninsula; the Buccaneer Archipelago; Derby/southern King Sound region and Kalumburu.

Table 10. High and medium density hotspots according to management preference.

M/ment preference	Hotspot	80 Mile Beach region	Broome & Roebuck Bay	Southern & western Dampier Peninsula	Northern Dampier Peninsula	Buccaneer Archipelago	Derby/southern King Sound	Montgomery Islands	Camden Sound & Brunswick Bay	St. George Basin/Prince Regent River	Prince Frederick Harbour	Kalumburu/ Napier Broome Bay	Wyndham/ Cambridge Gulf
<i>Pro-development management preferences</i>													
Increase conservation/ protection			X	X	X	x				x		x	
No oil/gas development			X	X	x	x							
No commercial fishing/ aquaculture			X			X		X				x	x
Increase Aboriginal management	x	X	X	X							x		
No new port development			X	X	x	x	x						
Restrict or limit access			X	x	x					x	x		
<i>Pro-development management preferences</i>													
Add tourism services/ development			X		X	x	X					X	
Improve or increase access			X	X	X		X					X	
Add recreational facilities			X		x		X						x
Commercial fishing/ aquaculture			x		X	X			x				
Oil/gas development				X			x						x
New port development			X				X						
Other			X	x		X							

X= high density of preferences (as determined by number of markers placed in the PPGIS survey)

x= medium density of preferences (as determined by number of markers placed in the PPGIS survey)

The mapped management preferences can be divided into three categories: 'pro-conservation' (no development), 'pro-development' and 'other'. These categories aggregate a number of aligned preferences in a manner that assists in the geographic analysis of respondent preferences. The following section provides further detail regarding the hotspots evident for each management preference. The location of hotspots is depicted in Figure 8.

Pro-conservation management preferences

Six management preferences were grouped under the 'pro-conservation' (no development) banner: increase conservation/protection, no oil/gas development, no commercial fishing/aquaculture, increase Aboriginal management, no new port development, and restrict or limit access (Figures 27 – 32). These six management preferences were also the most popular (number of markers mapped) preferences in the PPGIS survey and together covered the entire study area coastline, with a lesser density of markers evident for the Eighty Mile Beach coastline. Distinct areas of greater preference density were evident along Broome and Roebuck Bay, the southern, western and northern Dampier Peninsula, and Buccaneer Archipelago (Table 10, see also Figure 8).

A desire to increase conservation and protection was the most common overall management preference; accounting for over 27% of all management preference markers mapped (Figure 26). Such preference markers were located along the entire coastline with a number of hotspots evident as outlined above. The main hotspots of Broome, Roebuck Bay, and western and northern Dampier Peninsula (Figure 27, Table 10) are i) easily accessible, with a corresponding high rate of visitation (WAPC 2015), ii) offer scope for a wide range of competing land uses and iii) have been the subject of/proposed sites for infrastructure developments that have the potential to impact on environmental quality. Hotspots of medium density were also present along much of the coastline to the north, being particularly evident around Talbot Bay (Buccaneer Archipelago), St. George Basin, and Kalumburu regions (Figures 8 & 27, Table 10).

Preference markers relating to 'no oil/gas development' were similarly spread along the study area coastline with concentrations evident near Broome and southern and western Dampier Peninsula (Figure 28, Table 10). The location of the western Dampier Peninsula hotspot likely reflects the considerable recent controversy regarding resource extraction in the area following the nomination and subsequent dismissal of James Price Point (Walmadany) as a processing site for liquefied natural gas (WAPC 2015). Medium density hotspots were scattered along the coastline in areas such as the northern Dampier Peninsula and the Buccaneer Archipelago (Table 10). A number of preference markers were placed in offshore areas although the overall density of these was low.

Preferences relating to 'no commercial fishing/aquaculture' were scattered along the coastline. Broome and the Roebuck Bay area was the main hotspot for this preference (Figure 29), perhaps reflecting the active local environmental movement as well as recent public interest and debate concerning commercial fishing operations in the Bay. Other hotspots were evident in the Buccaneer Archipelago, Montgomery Islands, Kalumburu/Napier Broome Bay and Cambridge Gulf (Figure 29, Table 10, see also Figure 8). Comments relating to 'no commercial fishing/aquaculture' emphasised a desire to limit commercial enterprises so that locals retained the opportunity to fish. For example "commercial fishing should be restricted in the [King] Sound to allow local residents the opportunity to catch a fish or crab".

Support for increased Aboriginal management was widespread across the coastline with hotspots present in the Lagrange Bay/Bidyadanga/Port Smith area; Broome and Roebuck Bay; the southern, western and northern Dampier Peninsula, Admiralty Gulf/Mitchell Falls area; and Kalumburu/Napier Broome Bay area (Figure 30, Table 10, see also Figure 8). The northern tip of the Dampier Peninsula was the most pronounced hotspot for increased Aboriginal management. This may reflect the presence of successful, long term Aboriginal tourism offerings present in the area (e.g. Kooljaman at Cape Leveque, award-winning Brian Lee Tagalong tours) as well as the presence of a well-functioning and visible Aboriginal ranger group (the Bardi Jawi rangers).

Preferences for 'no new port development' were concentrated around Broome and Roebuck Bay as well as the western Dampier Peninsula (James Price Point/Walmadany area) (Figure 31, Table 10). Other hotspots were evident for the northern Dampier Peninsula (particularly around Beagle Bay and One Arm Point), as well as the Buccaneer Archipelago (near the iron ore mining islands of Koolan and Cockatoo) and Derby/southern King Sound area. The latter has long been proposed as a potential new port development site (GoWA 2014).

The preference to 'restrict or limit access' centred on Broome, Roebuck Bay and the southern Dampier Peninsula (Figure 32, Table 10, see also Figure 8). Medium density hotspots were evident near the northern Dampier Peninsula, St. George Basin/Prince Regent River, Prince Frederick Harbour and Admiralty Gulf/Mitchell Falls areas. Comments associated with this preference suggest that some people chose to restrict

access for cultural reasons, e.g. “Law ground, no access to unwanted visitors” and “protected area sacred site”. The presence of a ‘restrict access’ hotspot in the Broome and southern Dampier Peninsula area contrasts with official planning strategies outlined in the Kimberley Regional Planning and Infrastructure Framework (GoWA 2014), which seek to limit visitor access to nominated tourism nodes and corridors (of which Broome is one).

Pro-development management preferences

The remaining six management preferences broadly correspond to a ‘pro-development’ outlook (Figures 33 – 38). These were: add tourism services/development, improve or increase access, add recreational facilities, commercial fishing/aquaculture, oil/gas development, and new port development. These six management preferences received the least number of mapped markers (in decreasing order) in the survey (Figure 26). However, a number of preference hotspots were evident including Broome, Roebuck Bay, the northern Dampier Peninsula, Buccaneer Archipelago, Derby/southern King Sound area and Kalumburu region.

The desire to add tourism services or development displayed a number of distinct hotspots. Key areas of concentration included Broome and Roebuck Bay, the northern Dampier Peninsula, the Buccaneer Archipelago, Derby/southern King Sound and Kalumburu (Figure 33, Table 10, see also Figure 8). These areas are key tourism destinations offering varying levels of tourism infrastructure. The preference to ‘improve or increase access’ evidenced five hotspots, centring on Broome and Roebuck Bay, the southern and western Dampier Peninsula, and northern Dampier Peninsula, Derby/southern King Sound and Kalumburu (Figure 34, Table 10). Again, all of these locations are key tourism destinations, offering varying levels of access. The roads to Kalumburu and the northern Dampier Peninsula are notoriously damaging to vehicles and/or difficult to navigate, as expanded on by one respondent: “80 kilometres of the [Dampier Peninsula] road is gravel and subject to flooding. Improve access to the Cape [Leveque] and [for] the communities situated along [the Peninsula]”. The desire to increase access to Derby is less clear however as the town is serviced by a national Highway. This particular hotspot may instead reflect a desire to increase marine access (i.e. port/shipping access) in the area, as the Derby/Point Torment region has long been proposed as a potential site for a new Kimberley port (GoWA 2014).

Support for increased recreational facilities was particularly evident for Broome and Roebuck Bay, key tourism destinations, as well as the Derby/southern King Sound region (Figure 35, Table 10, see also Figure 8). Other hotspots focused on the northern Dampier Peninsula and the Wyndham/Cambridge Gulf area. Preferences for commercial fishing and aquaculture were centred on the Cone Bay area within the Buccaneer Archipelago, site of the existing Cone Bay barramundi aquaculture operation. The northern tip of the Dampier Peninsula was a second hotspot, likely reflecting again the presence of established aquaculture operations in the area (Cygnet Bay Pearls and the Aardyaloon trochus hatchery at One Arm Point) (WAPC 2015). A hotspot of medium density was evident in the Camden Sound region (site of Kuri Bay pearl farm) (Figure 36, Table 10, see also Figure 8).

‘Oil/gas development’ preferences were scattered throughout the study area, with most preference markers located offshore rather than on the coast. The James Price Point (Walmadany) region on the western Dampier Peninsula was a focus. As previously noted, this area has been subject to considerable controversy regarding resource extraction following its nomination and subsequent dismissal as a LNG processing site. A hotspot for oil and gas development also exists near the Cambridge Gulf and the Derby/Point Torment region (Figure 37, Table 10). Finally, preferences supporting new port development concentrated on the Derby/southern King Sound region and the Broome, Roebuck Bay and southern Dampier Peninsula (James Price Point) regions (Figure 38, Table 10). These areas correspond to either existing ports (Derby and Broome) or proposed new port locations (Point Torment and James Price Point) (GoWA 2014).

Potentially conflicting preferences

Broome and Roebuck Bay were loci for a number of potentially conflicting management preferences. For instance, respondents expressed a desire on the one hand to: increase conservation and protection, limit oil/gas and new port developments, no commercial fishing, and restrict or limit access. At the same time, the area was a hotspot for ‘pro-development’ preferences including the adding of tourism services and recreational facilities, increasing of access, and new port development (Table 10). The southern, western and northern Dampier Peninsula were similar foci for potentially competing management preferences. While these areas were hotspots for ‘pro-conservation’ preferences, there was a concurrent call for improved access, recreation and tourism facilities. The western Dampier Peninsula (particularly the James Price Point/Walmadany region) was especially conflicted, being a hotspot for both opposition and support for oil/gas and new port

development. The Derby region in contrast was characterised by 'pro-development' hotspots, while the Kalumburu area evidenced a mix of 'pro-conservation' and 'pro-development' hotspots (Table 10). Further north, the Cambridge Gulf/Wyndham region was a hotspot for 'no commercial fishing/aquaculture', 'add recreational facilities' and 'oil/gas development'.

'Other' preferences

Only 25 markers were placed denoting 'other' management preferences (Figure 26). Discernible areas of greater density are evident around Broome and Roebuck Bay as well as the Buccaneer Archipelago near Yampi Sound (Figure 39, Table 10, see also Figure 8). Comments associated with 'other' preferences were diverse. A number of comments/preferences were more closely aligned with existing preference categories available within the survey, for example "better boat launching facilities", "maintain management - limit additional development", "regulate camping better", "no new iron ore mine on Bathurst and Irvine islands", "improve road access so that Aboriginal tourism ventures can do better", "boat wash down bay", "developments as identified by the community", "more research" and "needs boat launching facilities and marina".

4 Stakeholder 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.

4.1 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 1 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 (Table 1), 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 11. 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%

4.2 Stakeholder analysis: Kimberley resident versus non-resident mapping

4.2.1 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 Appendix 8 for further details of statistical analyses). Table 12 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 12. 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.

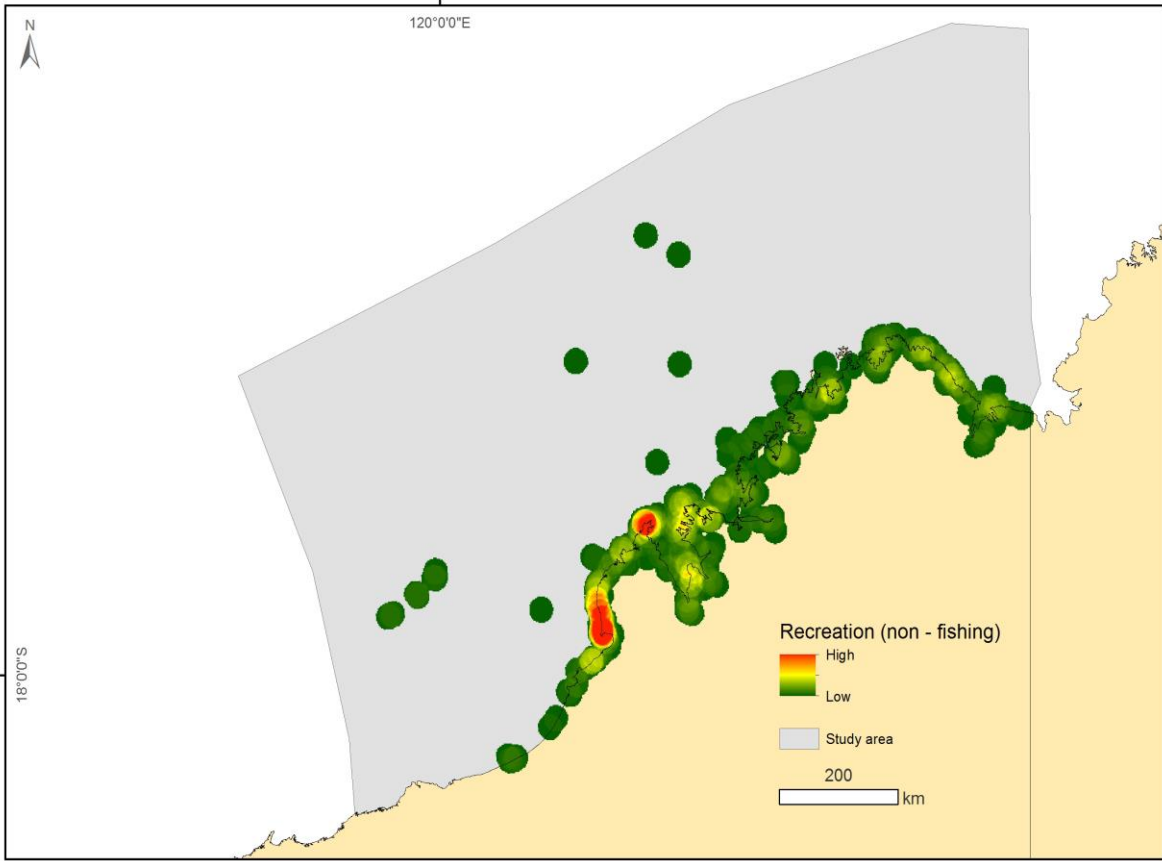


Figure 40. Resident mapping for recreation value (N=89)

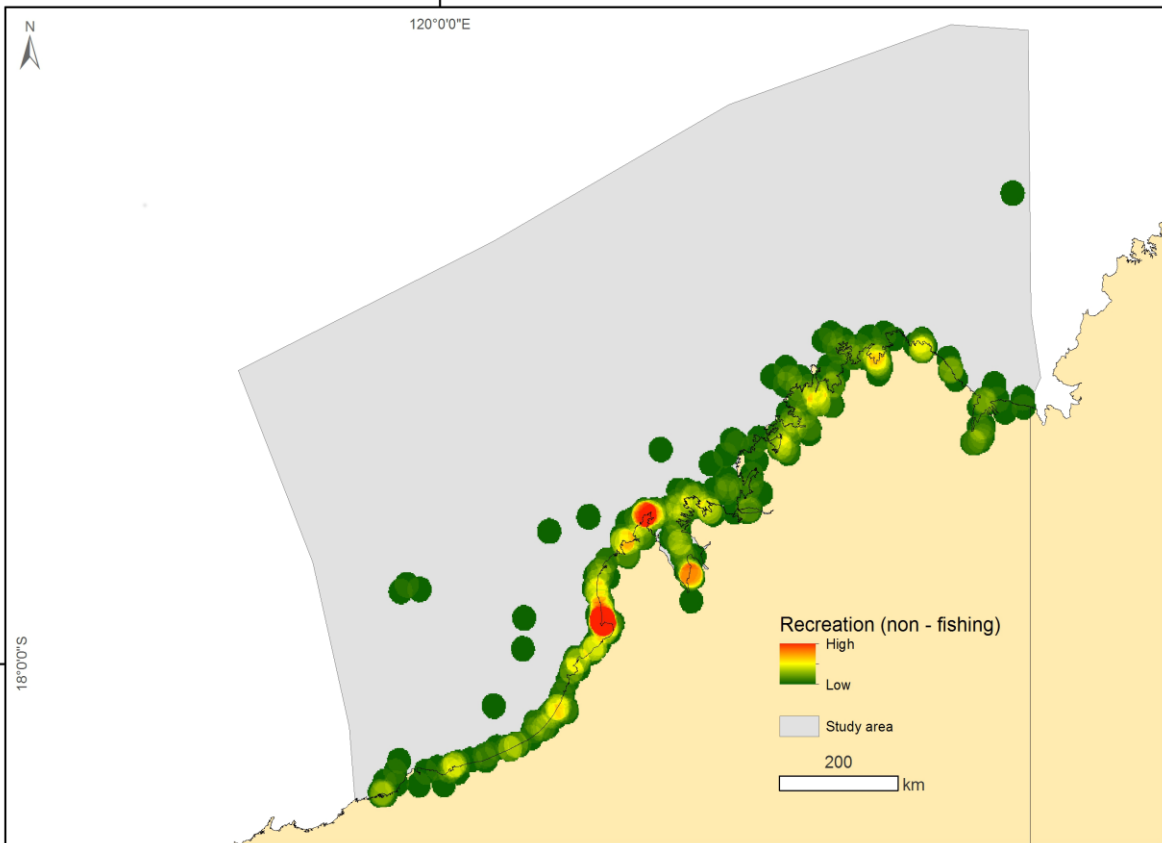


Figure 41. Non-resident mapping for recreation value (N=145)

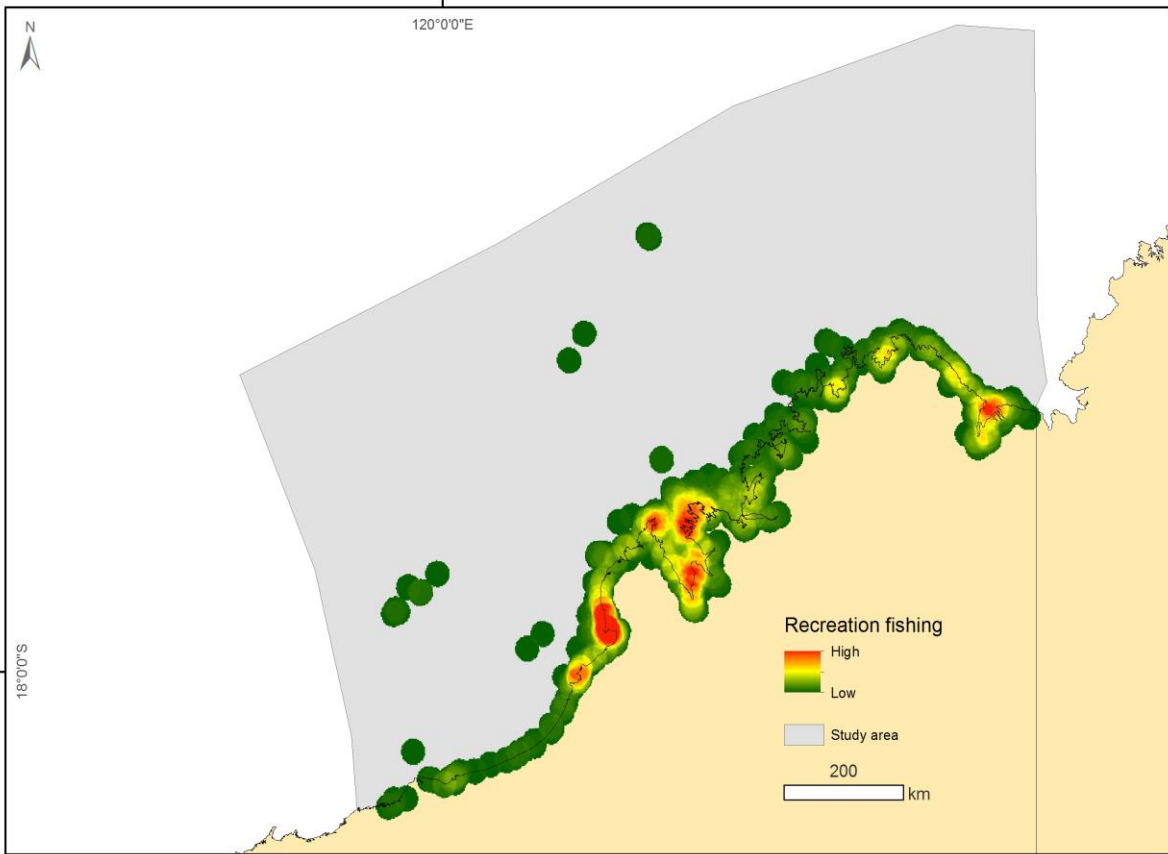


Figure 42. Resident mapping for recreational fishing value (N=99)

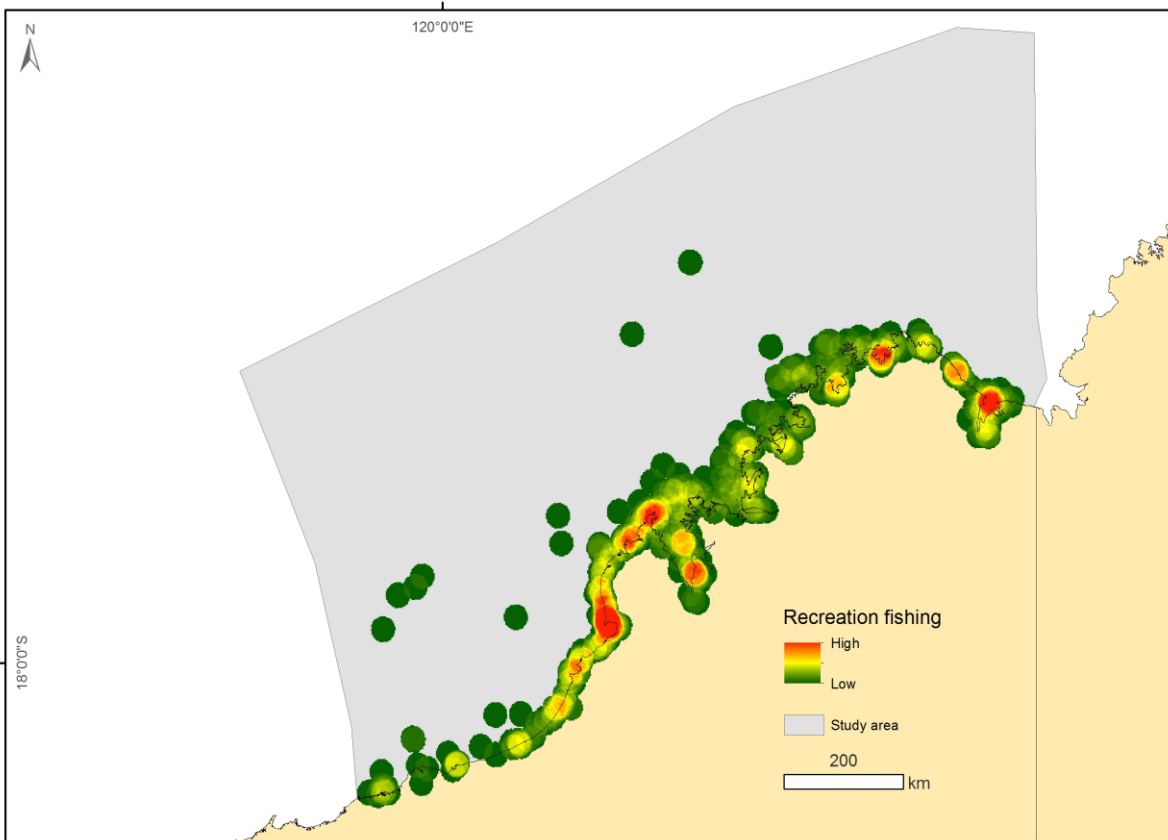


Figure 43. Non-resident mapping for recreational fishing value (N=126)

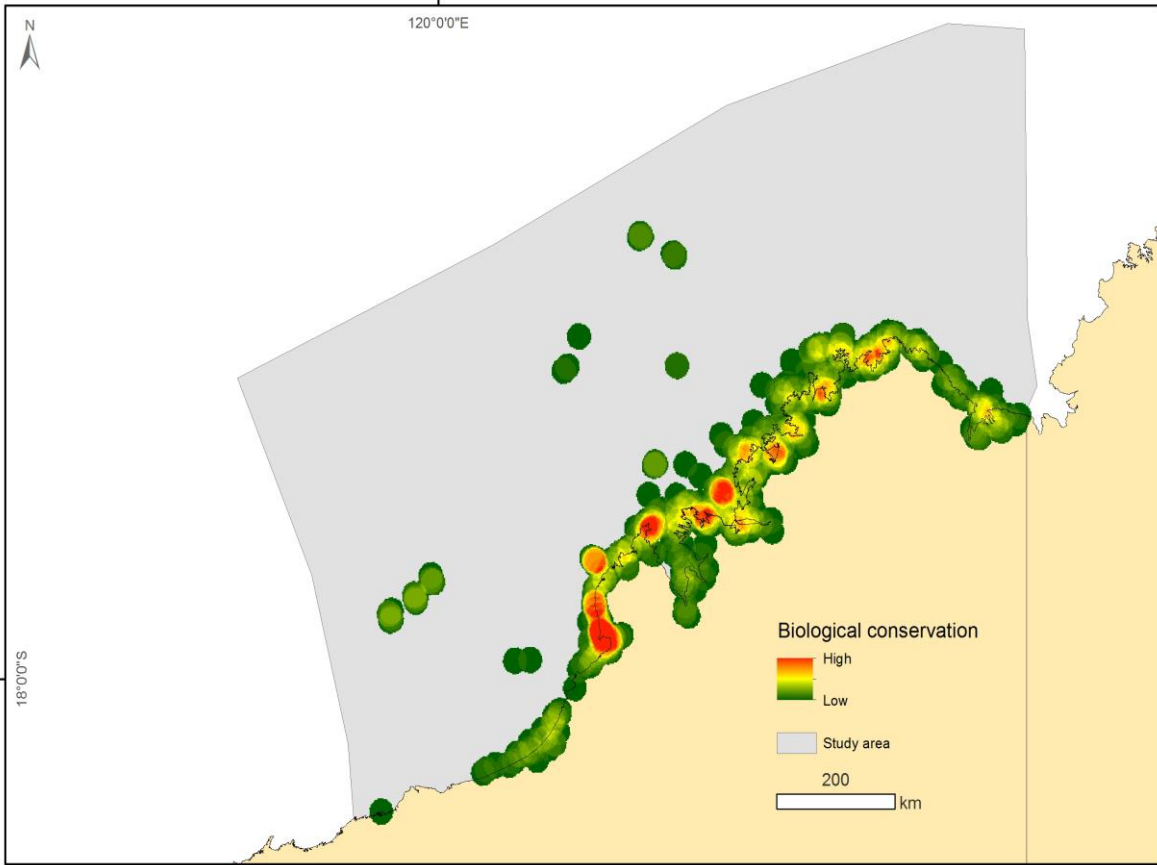


Figure 44. Resident mapping for biological/conservation value (N=60)

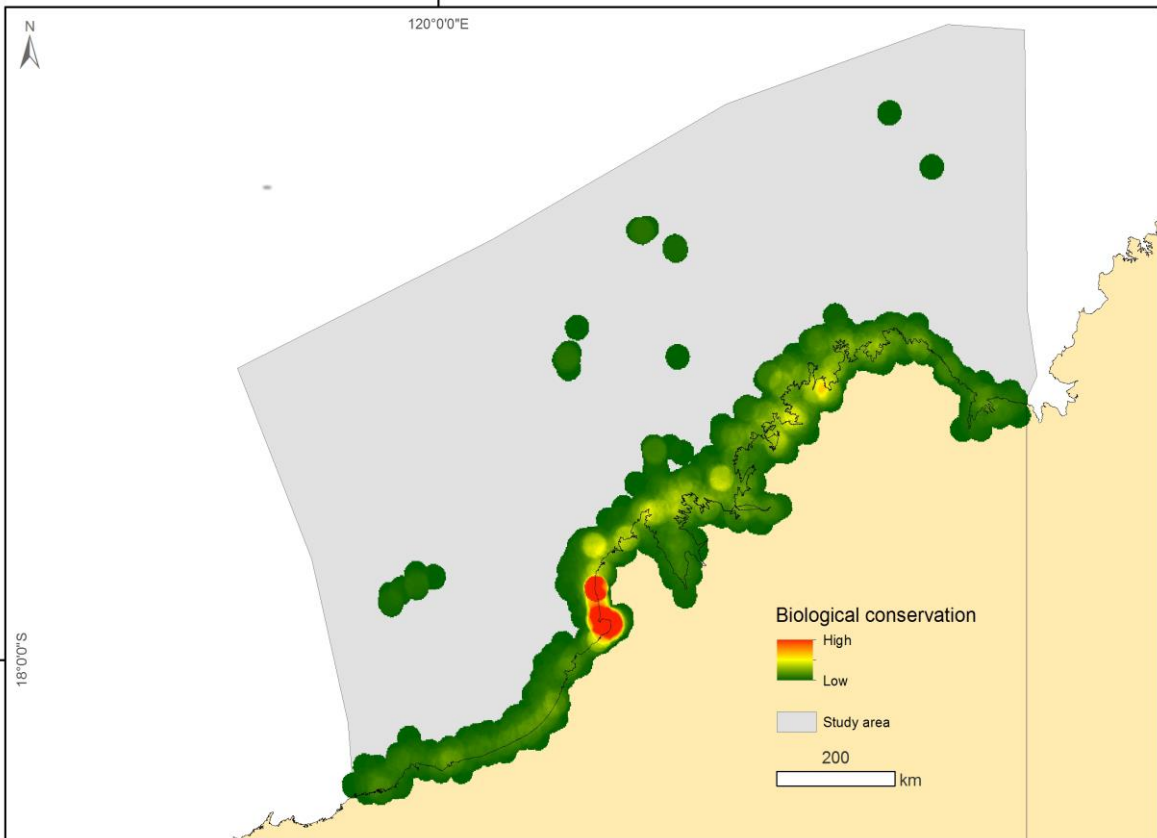


Figure 45. Non-resident mapping for biological/conservation value (N=169)

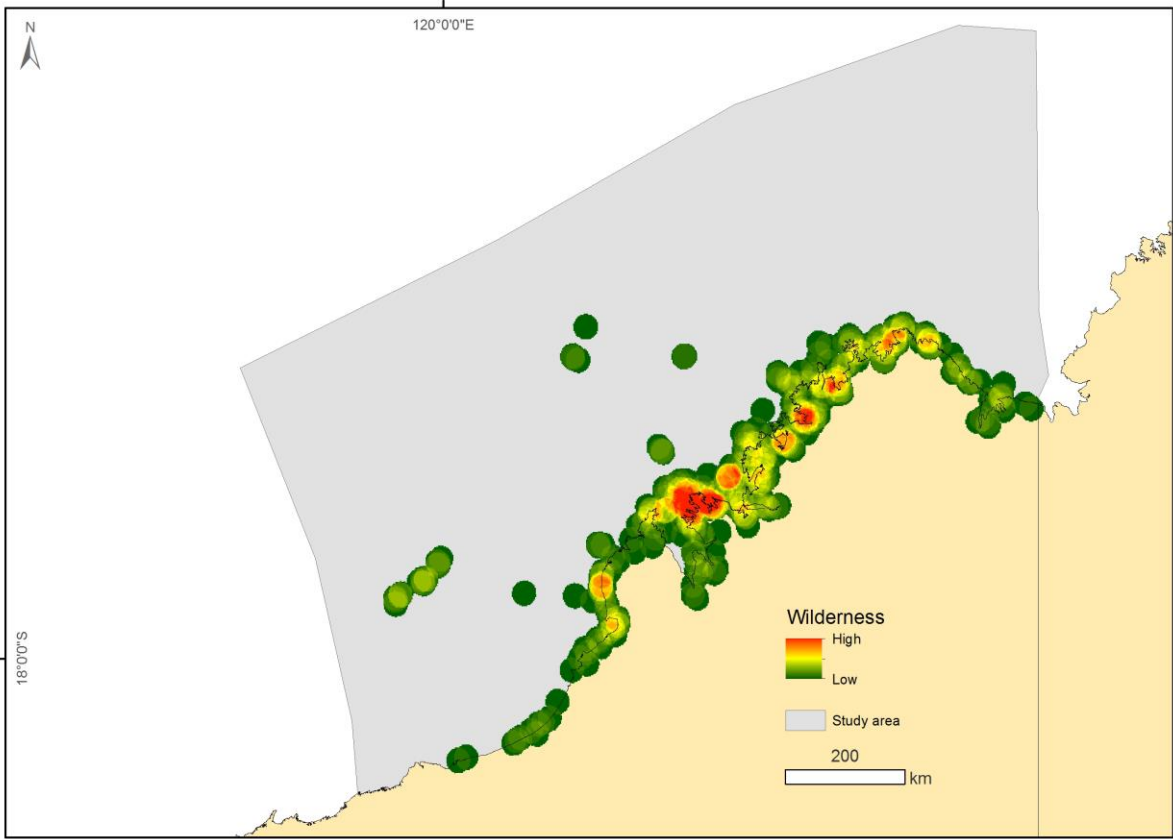


Figure 46. Resident mapping for wilderness/pristine value (N=65)

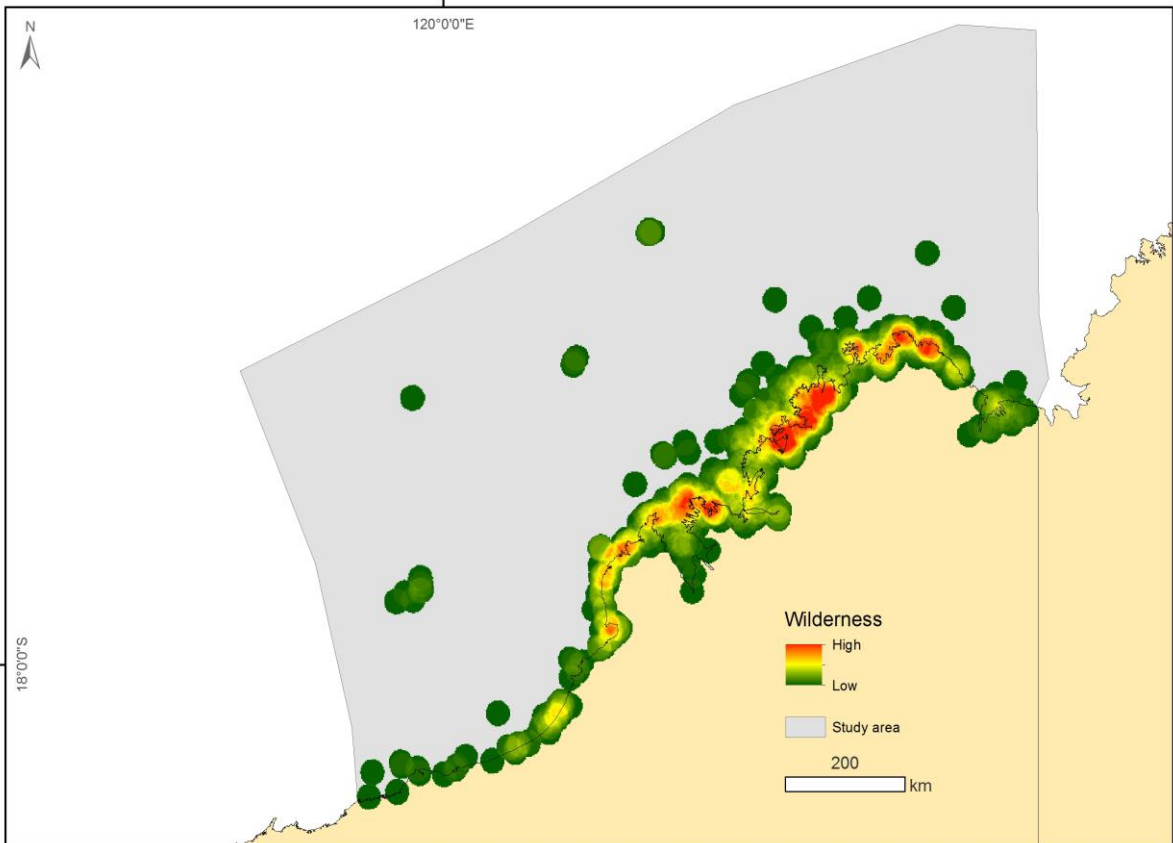


Figure 47. Non-resident mapping for wilderness/pristine value (N=169)

These comparative Figures illustrate point density results for those values for which a statistically significant difference in mapping exists (Figures 40-47). 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 40 & 41).

Mapping by residents provided a smaller number of hotspots than evidenced for non-residents. For residents, six distinct hotspots were evident along the coast: Broome, Roebuck Bay, northern Dampier Peninsula, Buccaneer Archipelago, and Derby/King Sound, with one in the northern Kimberley (Figure 42). Non-resident mapping in contrast displayed nine hotspots, with three located in the northern Kimberley (Figure 43). Figures 44 and 45 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 the southern Dampier Peninsula. Wilderness values were widespread along the coastline (Figures 46 & 47), 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.

4.2.2 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 Appendix 8 for further details of statistical analyses). Table 13 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 13. 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.

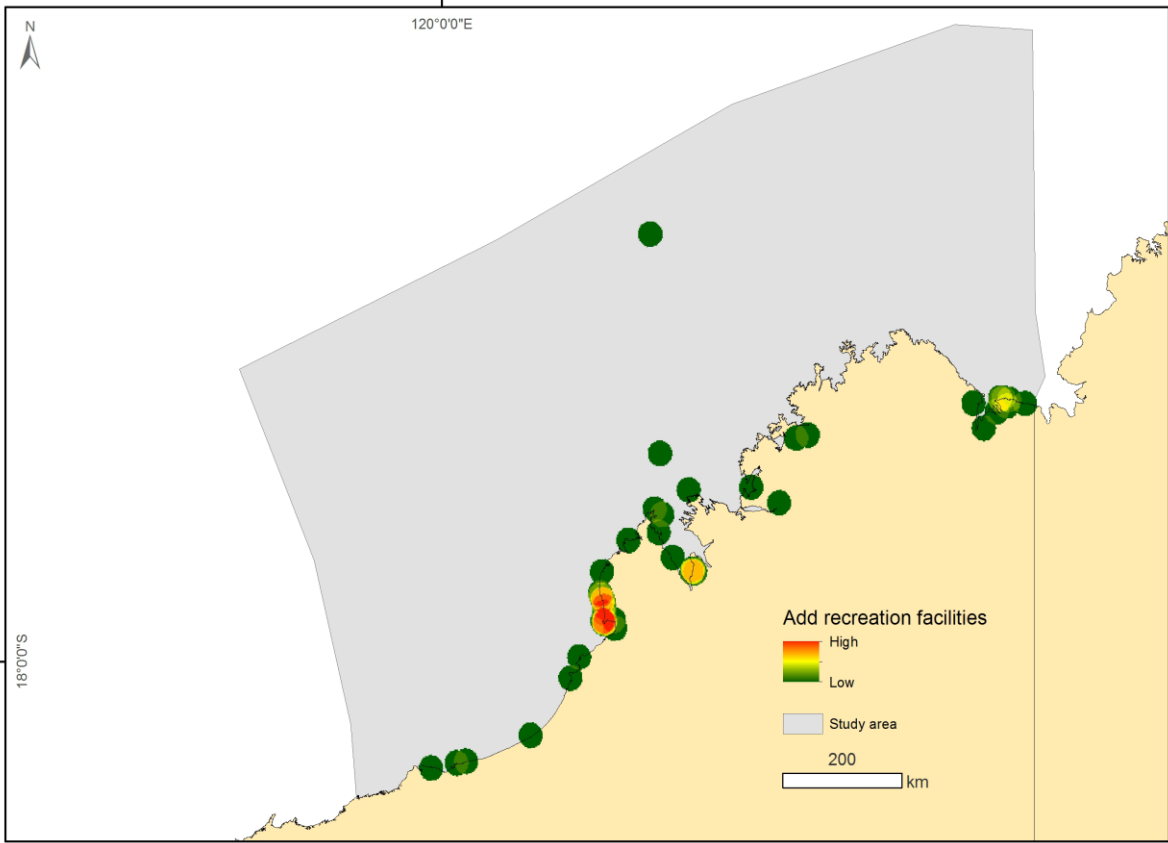


Figure 48. Resident mapping for 'add recreation facilities' preference (N=31)

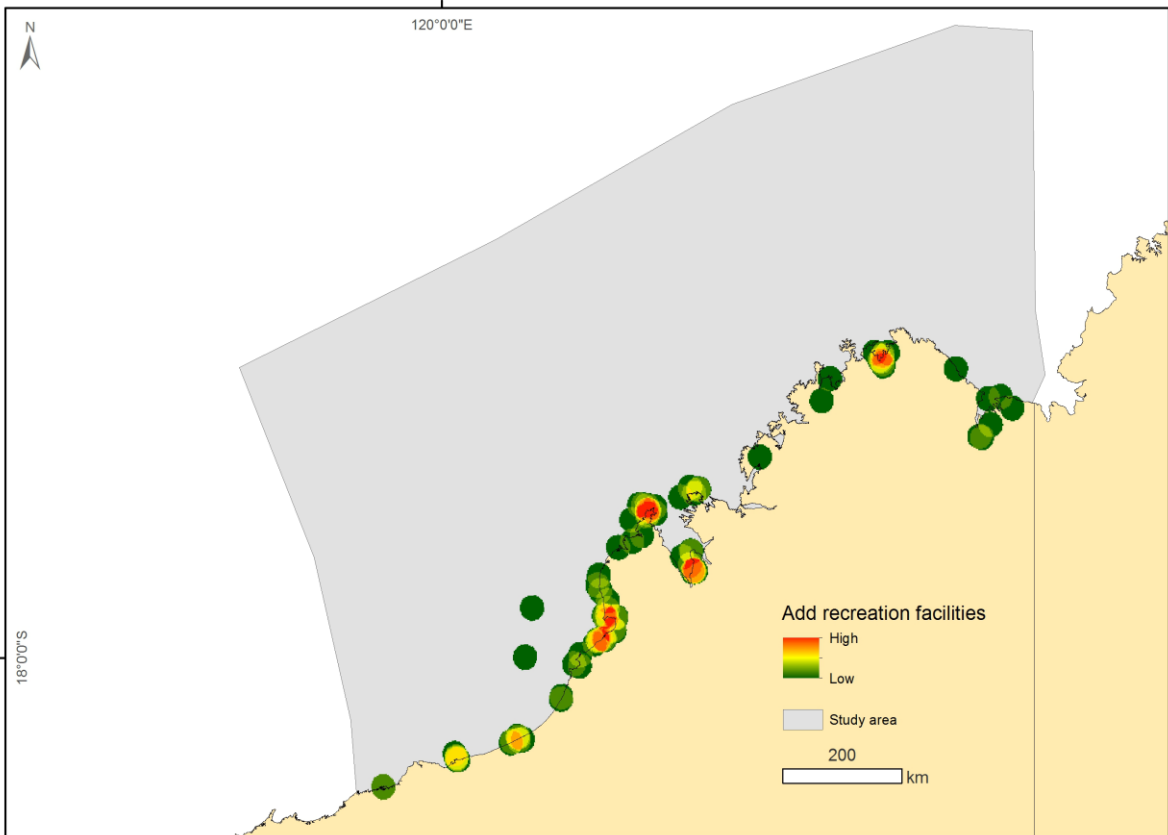


Figure 49. Non-resident mapping for 'add recreation facilities' preference (N=39)

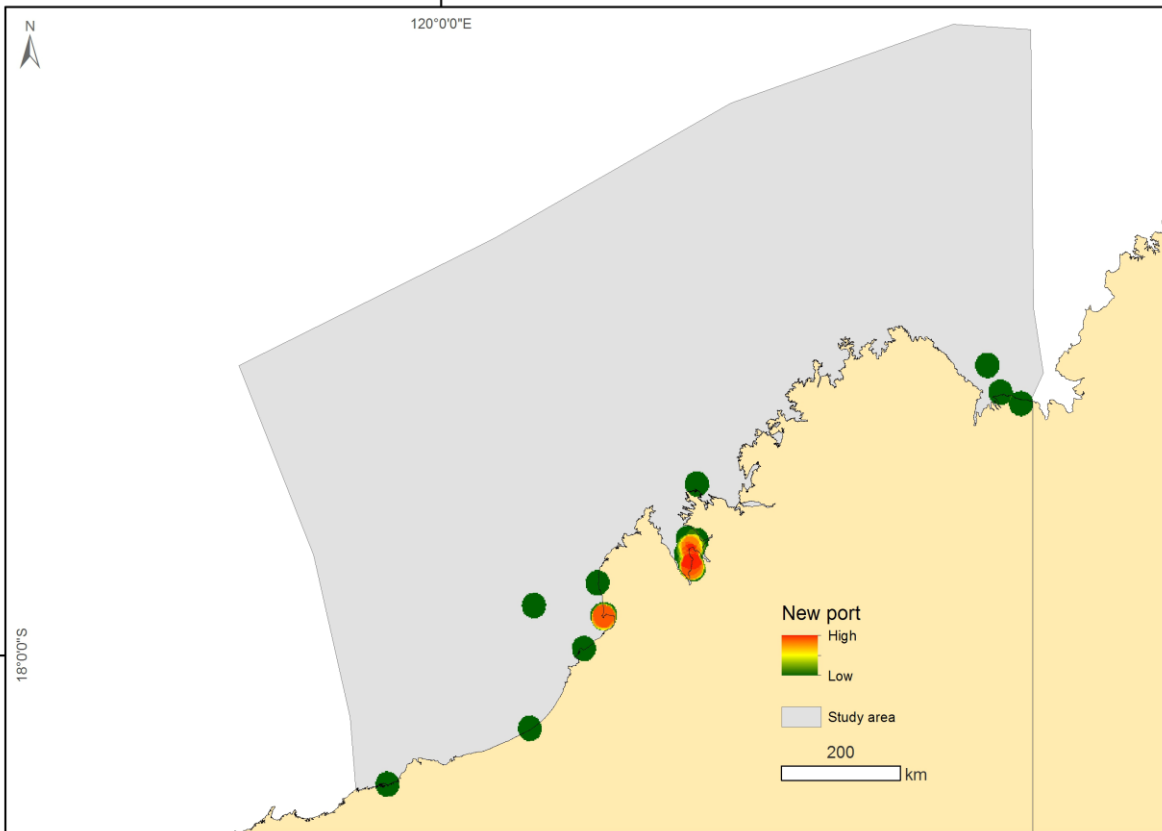


Figure 50. Resident mapping for 'new port development' preference (N=30)

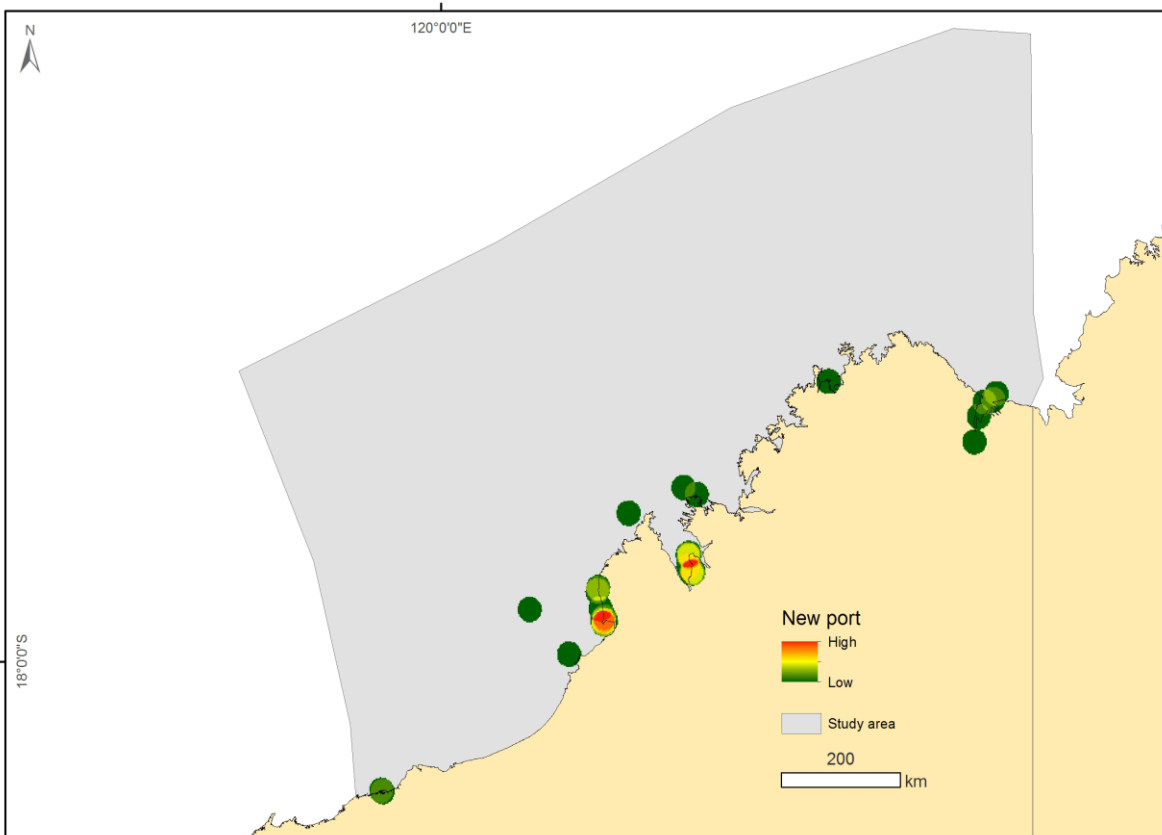


Figure 51. Non-resident mapping for 'new port development' preference (N=23)

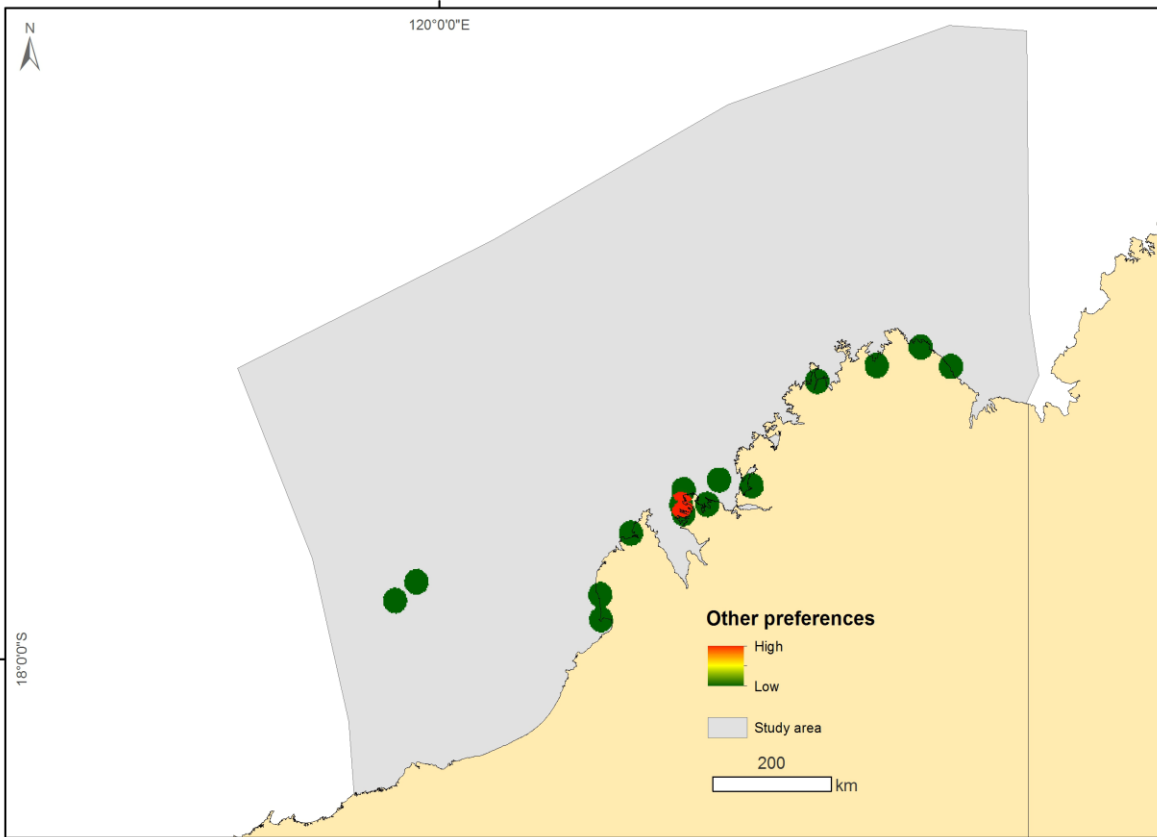


Figure 52. Resident mapping for 'other' preference (N=9)

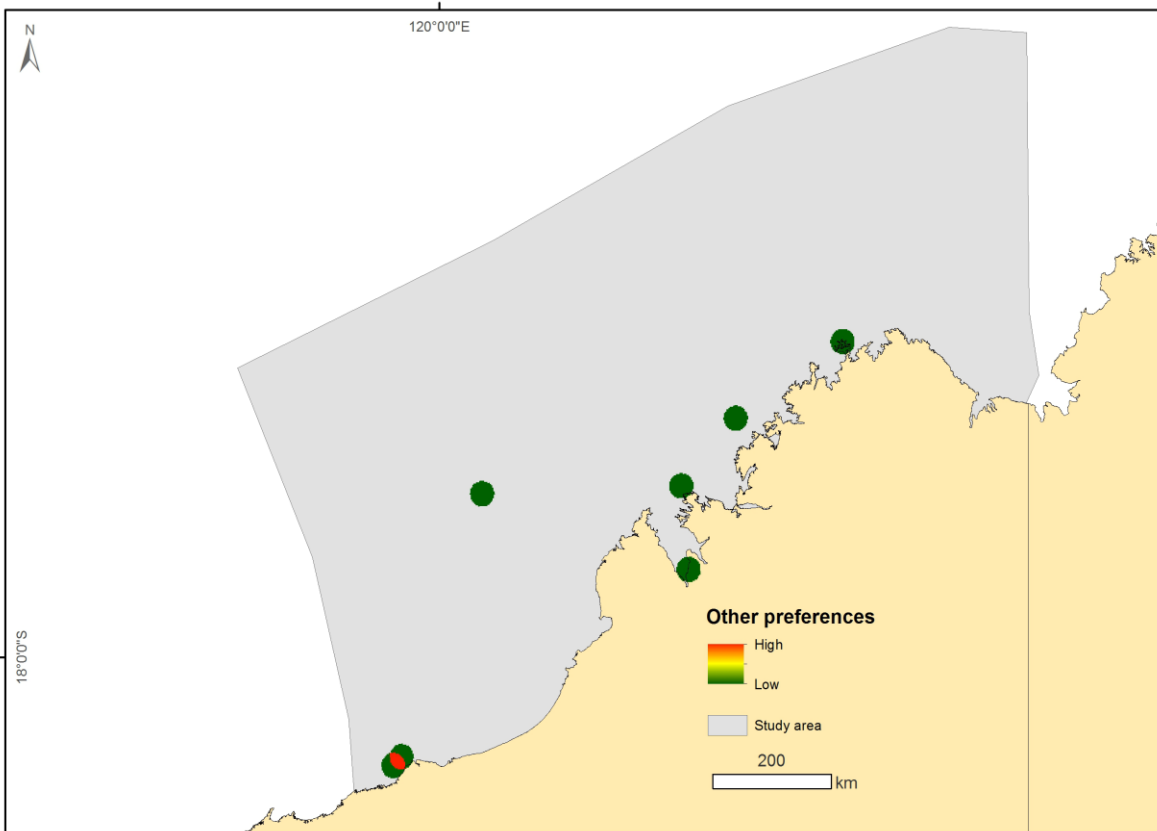


Figure 53. Non-resident mapping for 'other' preference (N=5)

Residents were more likely to map preferences relating to add recreation facilities, new port development and 'other' than were non-residents (Figures 48-53). Residents mapped two 'add recreation facilities' hotspots (Broome and southern Dampier Peninsula) while non-residents mapped five (Cape Keraudren, Eighty Mile Beach, northern Dampier Peninsula, Derby and Kalumburu) (Figures 48 & 49). Broome and the Derby/Point Torment region are hotspots for preferences by both residents and non-residents for new port development (Figures 50 & 51). '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 52 & 53).

4.3 Study limitations

The PPGIS survey did not record proportional representation from Aboriginal people, who account for 43.5% of the Kimberley population (Australian Bureau of Statistics 2011). This is a limitation of the research, given the preeminent role of Aboriginal people as custodians of country both culturally and legally through Native Title determinations. However, this research represents one of the few efforts to actively engage with Aboriginal people in an applied manner that has direct links to, and implications for, coastal management. The survey was not envisaged as a preferable means of engaging with Aboriginal people in a discussion around relationships to country; with researchers clearly acknowledging the suitability of other, more intensive engagement methods for this purpose. Previous interview-based project research engaged with a much higher proportion of Aboriginal respondents (50 people, 21.5% of all respondents) (see Strickland-Munro et al. 2015). In the absence of greater Aboriginal representation, information available in the documented literature such as Healthy Country Plans produced by Yawuru and Karajarri Native Title Bodies (e.g. YRNTBC 2011, Karajarri Traditional Lands Association 2013) may be used to source data on values and management preferences.

This analysis represents a snapshot of the social values of the Kimberley at a given place in time. Marine and coastal systems, and their provision of ecosystem services (often equated with values) and benefits derived, are highly variable in both space and time (Koch et al. 2009). Socio-cultural values and management preferences captured in this phase of research are by necessity contingent in nature and reflective of the particular people who participated in the PPGIS survey. Further, they are likely to be influenced by the respondent's social and cultural experience, habits and belief systems, traditions of behaviour, judgement, and styles of living (Kumar & Kumar 2008). Most importantly, these documented values and management preferences provide a basis for ongoing dialogue about what is important to people in the Kimberley. They provide an input to policy and planning, but ultimately, such values, and the management preferences associated with those values, must be co-produced through meaningful discussions among all those interested in the future of the Kimberley.

Another point to note is that the mapping component of this research is perhaps better classed as a voluntary geographic information (VGI) rather than PPGIS approach, an arguably subjective distinction. While both approaches seek to gather spatial information, participant sampling provides a point of difference. PPGIS typically focuses on engaging with specific local or under-represented populations, often using random household sampling, whereas VGI accesses a more widespread general (volunteer) population who participate on the basis on an active interest in the subject (Brown in press). This research used a variety of recruitment approaches to target diverse stakeholder groups, with local Kimberley residents being of primary interest. Despite these efforts, the number of residents engaged in the research was low (20.5% of all respondents). While greater resident input is always desirable, the research was highly successful in engaging respondents from across a broad range of stakeholder groups and evidenced a combination of targeted local resident, purposive and general volunteer recruitment to achieve this.

5 Policy and management implications

5.1 Policy and management implications

1. The main values mapped were biological/conservation, scenic/aesthetic, recreational fishing, and Aboriginal culture and heritage. Collectively, these values were evident for the entire Kimberley coast. Thus, no part is 'value-free' and people must be consulted regarding its future, no matter if the location appears to be used (i.e. 'direct use, consumptive values') or not (i.e. 'direct use, non-consumptive values', 'indirect use values' and 'non-use values').
2. These main values are all compatible with the purposes of marine parks and reserves. Protection of these values will, however, require careful zoning and consultation regarding the location of these zones. The PPGIS data collected in this study, where respondents mapped onto high resolution satellite imagery with a minimum mapping scale of 10 km, can contribute to MPA boundary designation as well as the general location of zones. More fine-grained planning requires a finer scale of data capture than undertaken here. PPGIS can be conducted at these finer scales.
3. The coastline and associated marine environments of Broome, Roebuck Bay, and the southern, western and northern Dampier Peninsula are high density hotspots for many values including biological/conservation, scenery, nature-based tourism, European heritage and intrinsic/existence value. As such, they warrant careful planning and management, and widespread consultation when changes in land and sea use are being considered.
4. Hotspots of medium density were also evident at the Buccaneer Archipelago, Derby and Kalumburu. This lesser density of markers may have been due to lower levels of familiarity and/or visitation to this largely inaccessible coastline (Derby excepted). Again, any proposed changes in land use must be accompanied by widespread consultation.
5. Pro-conservation management preferences dominated the results (85% of all mapped preferences). This suggests the importance of the natural and cultural (Aboriginal) environment to most respondents. This is reflected in results from the environmental-economic priority scale question in this survey, which shows that 77.6% of respondents placed a greater priority on environmental than economic factors. This strength of attachment to the natural and cultural environment will underpin and emerge in any future planning, so being prepared to understand and plan for this set of management preferences (increase conservation/protection, no oil/gas development, no commercial fishing/aquaculture, increase Aboriginal management, no new port development, restrict or limit access) will underpin any successful policy development and implementation.
6. Pro-development preferences, including add tourism services/development, improve or increase access, oil/gas development, and new port development, centre on Broome, Roebuck Bay, the northern Dampier Peninsula, Derby/southern King Sound and the Kalumburu region. This information on locations where development is regarded as desirable is vitally important as governments seek to develop the Kimberley, through ports and other infrastructure.
7. Broome and Roebuck Bay are places where there are potentially competing management preferences. Both included, as well as pro-conservation preferences, desire for adding of tourism services and recreational facilities, increasing access, and new port development. This mixture of intentions makes the collection and use of social data in policy development and planning, and comprehensive, ongoing, meaningful engagement with stakeholders essential. Given the key role of local government in land use planning, this result suggests adequate resources and skills are essential for the Shire of Broome who will have carriage of much of this task.
8. Largely pro-development views regarding the Derby region provide an opportunity to progress development in this lesser contested setting.
9. Potential contestation between pro-conservation (increase conservation/protection and no commercial fishing/aquaculture) and pro-development (add tourism services/development and improve or increase access) management preferences at Kalumburu suggests early and ongoing attention to the collection of meaningful social data and to ongoing, targeted consultation with Traditional Owners as custodians and managers as well as other stakeholders.
10. Monitoring, feedback, evaluation and changes in response to such processes are essential elements of good management. PPGIS provides a rapid, cost effective way of accessing social information for MPA spatial planning and coastal and marine spatial planning more generally. A lack of such social information and resultant problems

for MPAs has been highlighted for other marine environments nationally and globally.³ The scale of data capture should be determined by the project scope and the end uses to which the data will be put.

5.2 Future research

The PPGIS mapping methodology used in this study provided detailed information on the values and management preferences held by a variety of stakeholders regarding the Kimberley coast and marine environment. Data on values and management preferences obtained from this research has provided information for the entire Kimberley coastline at a broader scale useful for high level marine and coastal planning, particularly at the scale of Commonwealth and State marine parks. However, more effort is now required to provide this information at finer scales more applicable for a range of other stakeholder groups and purposes, e.g. local Shires and Prescribed Body Corporates. Similarly, these data are not suitable for informing detailed site planning or zoning.

There are also opportunities, yet to be realised, to more comprehensively map the cultural and other values held for Kimberley land and sea country by Traditional Owners. A related opportunity is to use this participatory mapping approach to conduct research in partnership with Traditional Owners, to address particular concerns and interests as Aboriginal people progress their rights and interest in land and sea management.

As such, the next stages of this research project are to:

- 1) Conduct further detailed analysis, using participatory mapping methodologies, of the social values associated with Aboriginal land and sea country, with an emphasis on agreement-based research with the associated Aboriginal Traditional Owners. Resources are currently available for this research with Traditional Owners and stakeholders relating to one marine park. The choice of research location will depend on interest from Traditional Owner groups and the priorities of the Department of Parks and Wildlife.
- 2) Carry out an analysis of blogs posted on the internet to better understand how the Kimberley is valued by
 - i) those who visit and
 - ii) those who might never visit but appreciate it from afar.

³ Voyer M, Gladstone W, Goodall H (2012) Methods of social assessment in marine protected area planning: Is public participation enough? *Marine Policy* 36:432-439, and Gruby, RL, Gray, NJ, Campbell, LM, Acton, L (2015) Towards a social science agenda for large marine protected areas. *Conservation Letters* 2015 00(0) 1–11.

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7 Appendices

Appendix I- PPGIS survey consent

CONSENT TO PARTICIPATE

Please read the following information before deciding if you would like to take part in this study. You must be 18 years or older to participate.

Purpose of Research

The purpose of this research is to assist the West Australian Government to make informed decisions about coastal management, now and into the future.

Participation and withdrawal

Your participation in this study is entirely voluntary. You may withdraw at any point. Upon your request and provision of your access code (obtained on the previous page), we will remove your responses from the database.

Data Collection, Storage and Use

This survey is being administered on a secure computer server. The responses you submit will be stored in a secure database that contains every response we receive (located in the Environmental Sciences Building, South Street Campus of Murdoch University). Your responses will not be personally identifiable in this database. Non-identifiable data will be retained for seven years.

Reporting Findings

A summary of the research findings can be emailed to you at the completion of the study if you wish and choose to provide an email address for this purpose. A publicly accessible map summarising the results will be accessible via the West Australian Marine Science Institution website (<http://www.wamsi.org.au/>).

Contact Information

If you have any questions or concerns about the research, please contact:

Prof Sue Moore (S.Moore@murdoch.edu.au)
Murdoch University (Telephone 08 9360 6484)

Prof Michael Burton (Michael.burton@uwa.edu.au)
University of Western Australia (Telephone 08 6488 2531)

Consent Statement

I have read the preceding information about this research and any questions I had were answered to my satisfaction. I am 18 years of age or older and freely consent to participate. I am free to withdraw from participating in this research at any time. I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential, unless required by law.

The project has been approved by the Murdoch University Human Research Ethics Committee (2015/014). If you have any concerns about the project or questions about your rights as a participant please contact the Murdoch University Research Ethics office on (08) 9360 6677 or email ethics@murdoch.edu.au.

I understand that by proceeding I consent to this study.

Thanks! Before mapping, please answer a few questions about yourself and how you learned about the study.

1. How did you learn about this study? (Please check one.)

- I received a request by email.
- I received a request by conventional mail (post).
- I heard about the study from a relative, friend, or acquaintance.
- I learned about the study through a website → Which one?
- I learned about study through social media → Which one?
- I saw a notice in the newspaper.
- I picked up an information card with the weblink for this survey on it.
- I saw a notice on the Parks and Wildlife website or Facebook page.
- Other source. (What was it?) →

2. Where do you live? (Please check one.)

- Australia → What is your 4 digit Australia postcode?
- Overseas → What country?

3. Are you a resident of the Kimberley region? (Please check one.)

- NO
- YES → How long have you lived in the Kimberley region? → YEARS

4. Are you of Aboriginal heritage? (Please check one.)

- NO
- YES → Which group(s)?

5. How would you rate your knowledge of the Kimberley coast? (Please check one.)

- Excellent
- Good
- Average
- Below average
- Poor/little knowledge

Kimberley Coastal Values Study

Icon Descriptions | Instructions — (Click to show) Logged in as 454-2760

Place Values | **Mgmt. Preferences**

What places have these values to you?

- Scenic / aesthetic
- Recreation
- Fishing (recreational)
- Economic (non-tourism)
- Nature-based tourism
- Biological / conservation
- Aboriginal culture / heritage
- European heritage
- Learning / education / research
- Therapeutic / health
- Spiritual
- Intrinsic / existence
- Wilderness / pristine areas
- Special places

Done mapping—go to next part

Instructions

- The 2 tabs on the left **Place Values** **Mgmt. Preferences** contain the icons you will use. Hold the left mouse button down on an icon then drag and drop it where you would like on the map. • You can choose which icons you want to map. • The more icons you map, the better! • Most people map at least 20 icons.
- The Kimberley study area boundary is identified on the map. You can "pan" the map or zoom in (+ or -) using the Google Map controls. You can also reposition map by moving the box in the inset map in lower right corner. Use the "Quick Navigation" dropdown menu to easily move to different state locations.
- If **Zoom In** shows at the top of the screen, you need to zoom in more until **OK to Map** appears at the top of the screen. **Hint:** Double clicking left mouse button zooms in, double clicking right mouse button zooms out. Move your mouse over "+" symbols on map to see more place names.
- If you want to explain why you mapped a particular icon, click on the icon after placing it on the map and a pop-up box will allow you to explain.

Map data ©2015 Google Imagery ©2015 TerraMetrics 50 km Terms of Use Report a map error

Thanks for mapping! We now have a few more questions to better understand your preferences.

6. Personally, how difficult or easy is it for you to access the Kimberley coast? (Please check one response.)

- Very easy to access
- Easy to access
- Neither difficult nor easy to access
- Difficult to access
- Very difficult to access

7. About how many times have you visited the Kimberley coast in your lifetime? (Please type a number in the box. If you are a resident of the Kimberley region, just type "resident" in the box.)

Estimated Number of Visits (put "0" if never visited)

8. Coastal and marine management decisions often involve tradeoffs between environmental and economic factors. Thinking about your own personal values, where would you place yourself on the scale below? (Please check one response on the scale that ranges from 1 to 7)

Highest priority should be given to maintaining natural environmental conditions even if there are negative economic consequences.				Environmental and economic factors should be given equal priority				Highest priority should be given to economic considerations even if there are negative environmental consequences
	1	2	3	4	5	6	7	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

9. How would you describe yourself in relation to the Kimberley? (Please check all that apply)

- Kimberley resident
- Aboriginal
- Visitor
- Commercial fishing, pearling or aquaculture interest
- Commonwealth government employee
- State government employee
- Local government employee
- Non-government organisation member
- Work in tourism industry
- Work in oil and gas industry
- Researcher
- Other role → Describe →

10. When thinking about the future of the Kimberley, what are you most concerned about? (Please select one category that fits *best*).

Response options:

- No response
- Making sure there are recreation opportunities for local people
- Ensuring rights of Traditional Owners/Aboriginal people in the region are respected
- Protecting biological and ecological features found in the region
- Maintaining and developing tourism opportunities
- Ensuring the region supplies natural resources
- Ensuring marine/coastal plans are developed/implemented/supported
- I am not concerned about the future of the Kimberley

11. Are you?

- Male
- Female

12. In what year were you born?

None ▼

13. Which life stage category best describes you? *(Please select one response.)*

Response options:

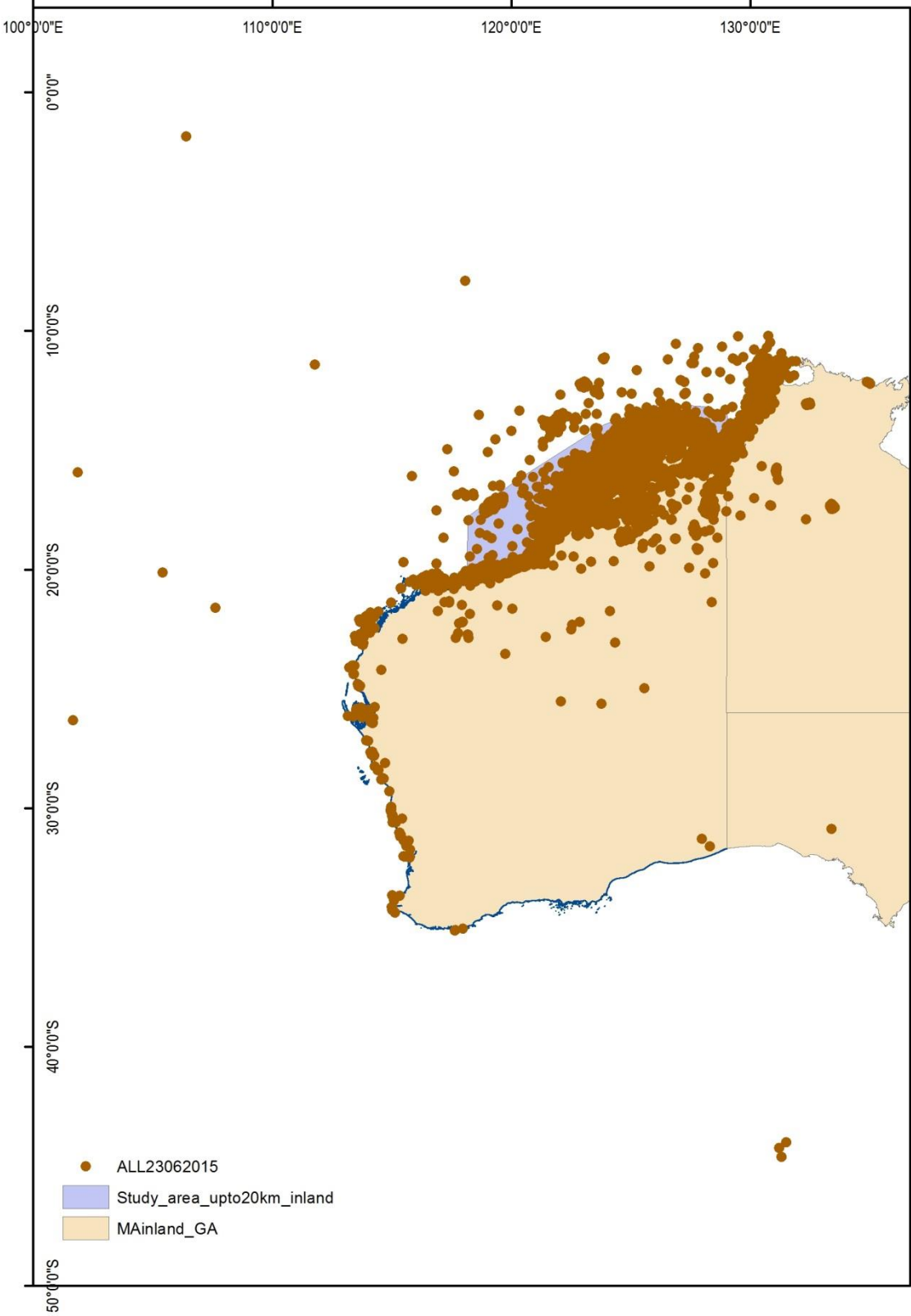
No response
Young single
Young couple/no children
Young family (oldest child less than 6 years)
Middle family (children 6-15 years)
Mature family (children older than 15 years at home)
Mature couple/no children at home
Mature single

14. Which of the following best describes the highest level of formal education you have completed? *(Please select one response.)*

Response options:

None selected
Primary/some secondary school
Secondary school
Vocational/technical training
Some undergraduate tertiary study
Bachelors degree or equivalent
Posgraduate degree

Appendix 5 – Total mapping data (values and management preferences), including points outside of study area (N=22,821)



Appendix 6 - Raw value point data

Figures 39-52 depict the raw place value mapping data (geographic location of points placed). Figures are presented in order of their prevalence in PPGIS results (cf. Figure 9).

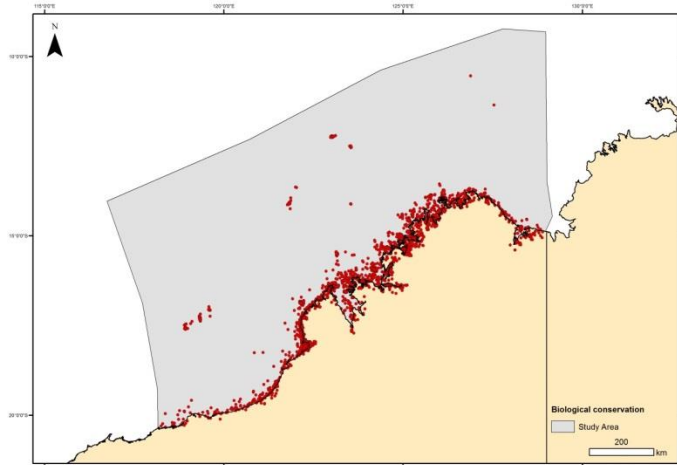


Figure 39. Value marker map for biological/conservation values (N=2,259).

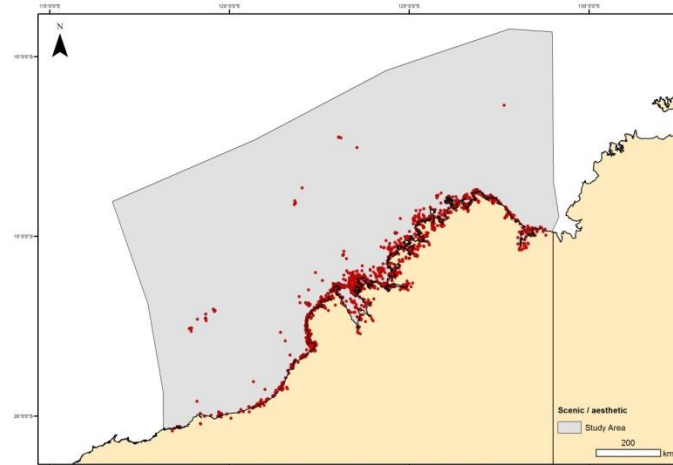


Figure 40. Value marker map for scenic/aesthetic values (N=2,129).

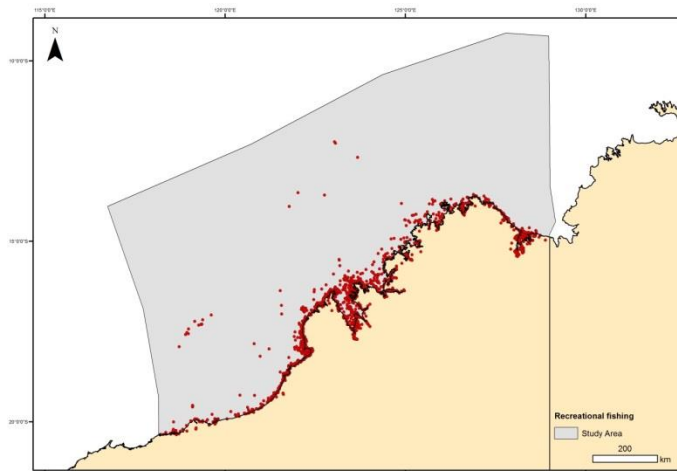


Figure 41. Value marker map for recreational fishing values (N=1,849).

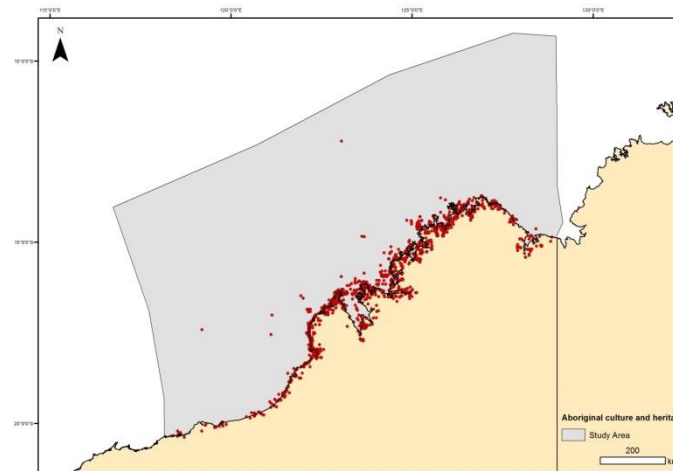


Figure 42. Value marker map for Aboriginal culture and heritage values (N=1,608).

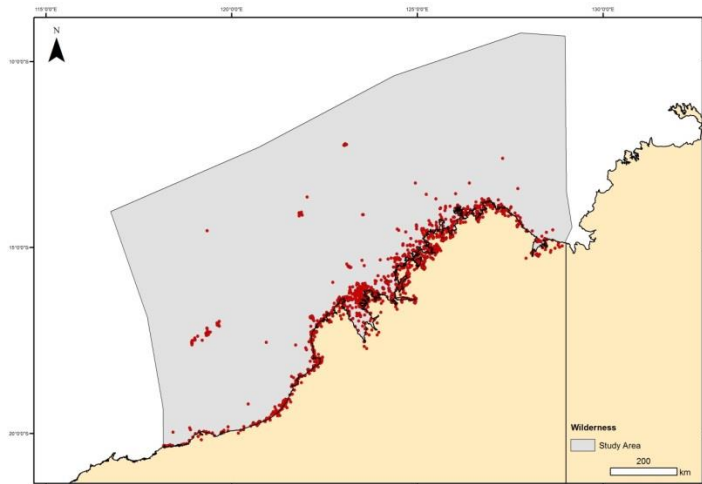


Figure 43. Value marker map for wilderness values (N=1,405).

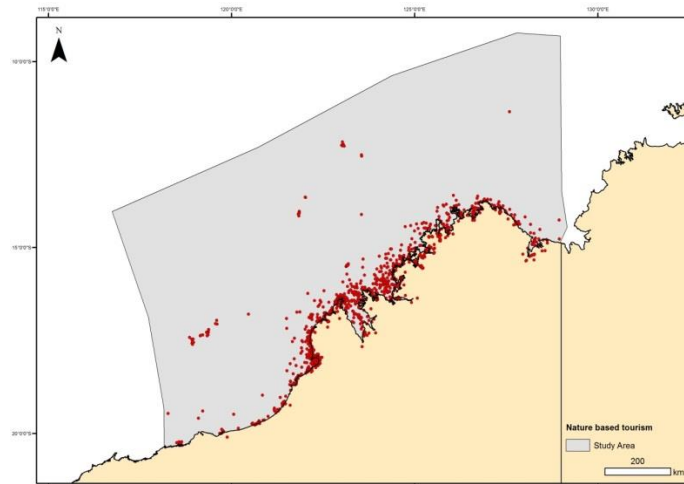


Figure 44. Value marker map for nature based tourism values (N=1,382).

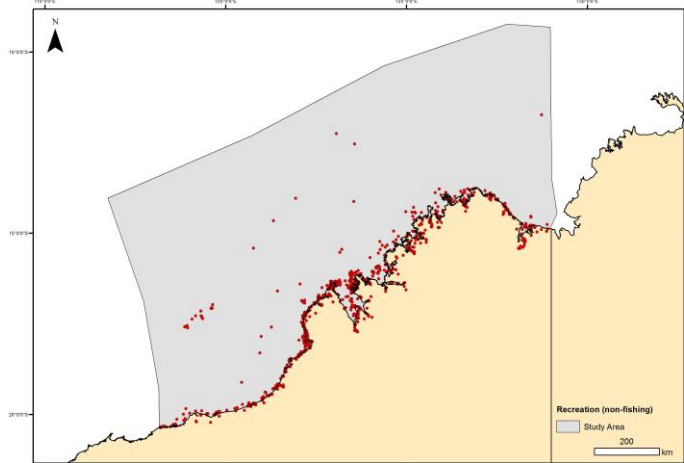


Figure 45. Value marker map for recreation (non-fishing) values (N=1,173).

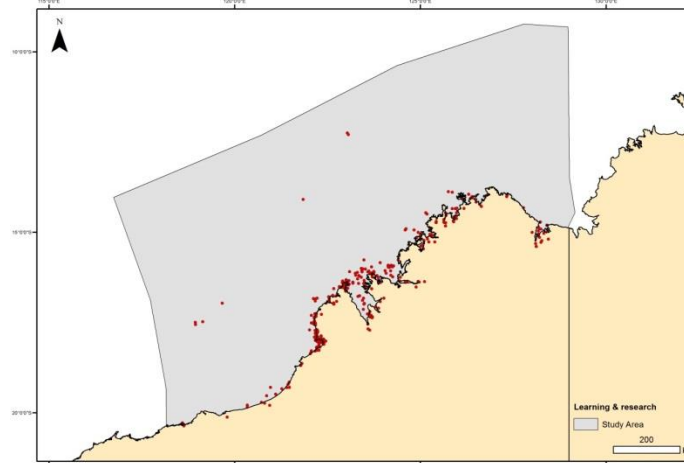


Figure 46. Value marker map for learning and research values (N=400).

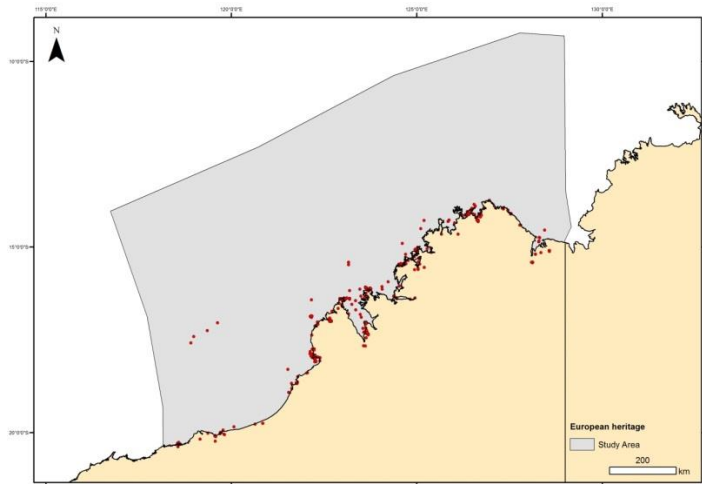


Figure 47. Value marker map for European heritage values (N=358).

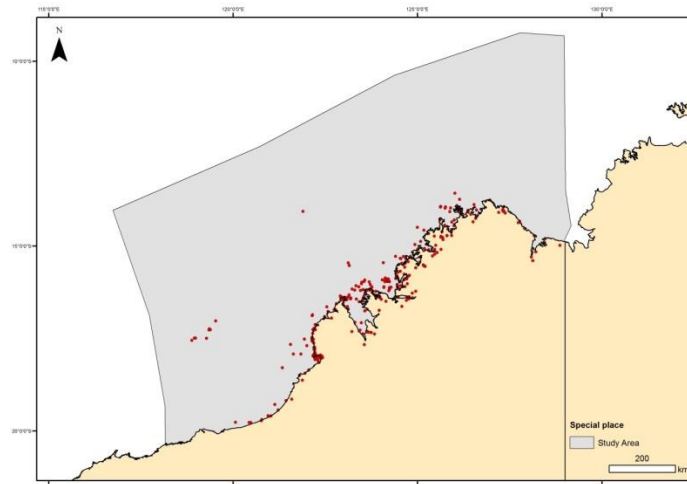


Figure 48. Value marker map for 'special place' values (N=334).

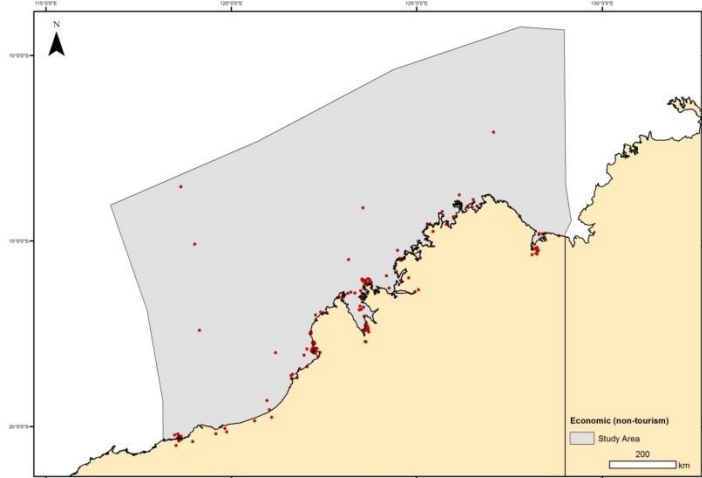


Figure 49. Value marker map for economic (non-tourism) values (N=309).

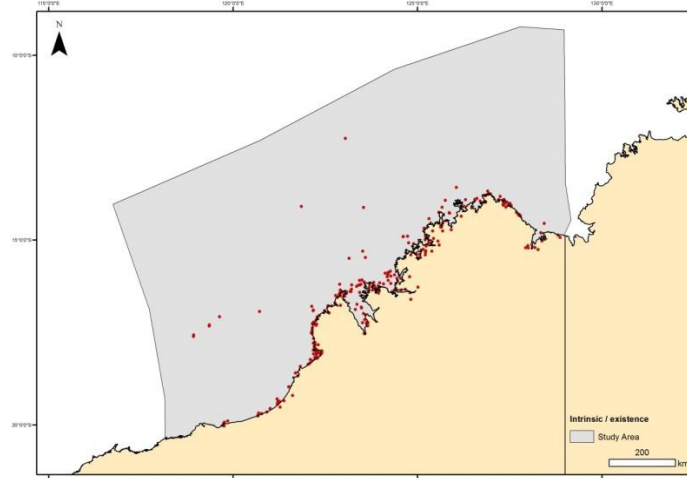


Figure 50. Value marker map for intrinsic/existence values (N=276).

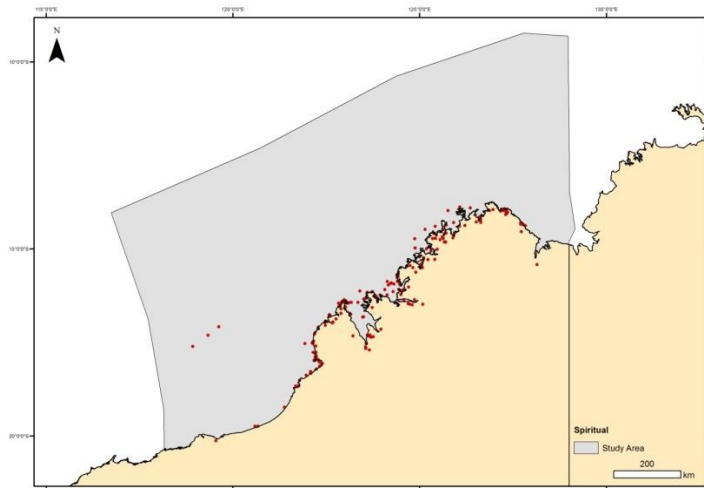


Figure 51. Value marker map for spiritual values (N=208).

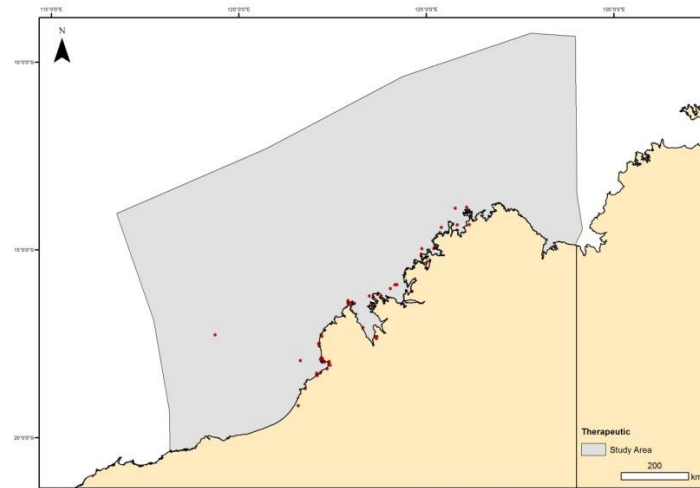


Figure 52. Value marker map for therapeutic values (N=66).

Appendix 7 – Raw management preference point data

Figures 53-65 depict the raw management preference mapping data (geographic location of points placed). Figures are presented in order of their prevalence in PPGIS results (cf. Figure 25).

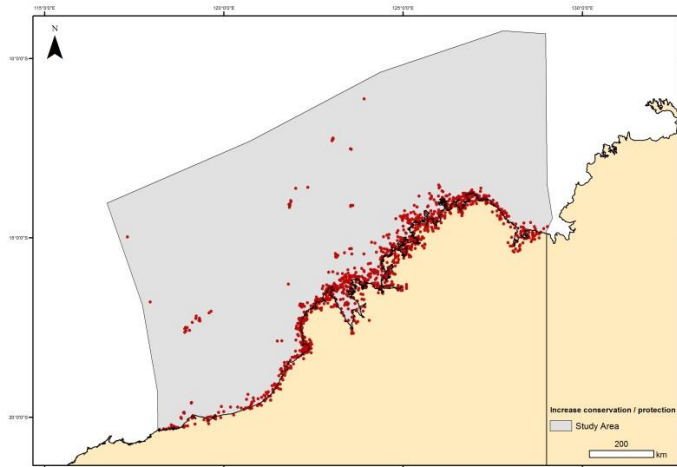


Figure 53. Preference marker map for 'Increase conservation/protection' (N=1,474).

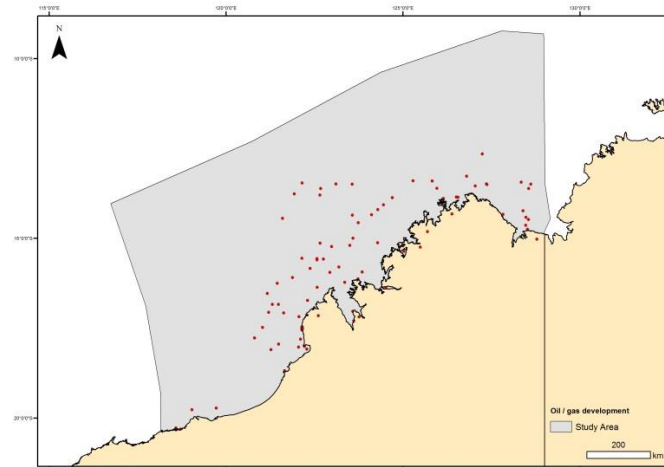


Figure 54. Preference marker map for 'No oil/gas development' (N=1,273).

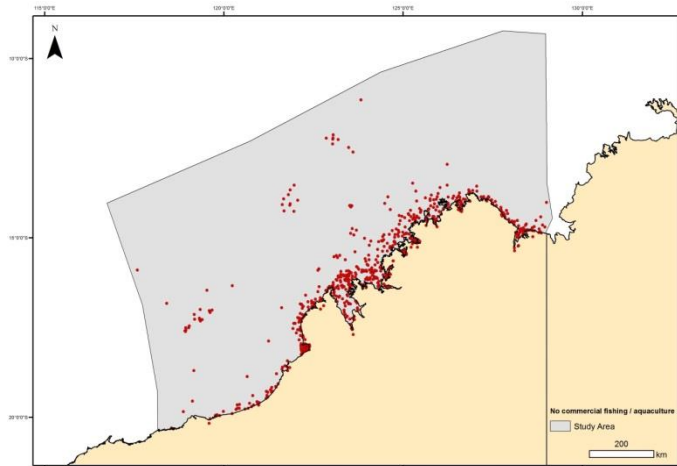


Figure 55. Preference marker map for 'No commercial fishing/aquaculture' (N=680).

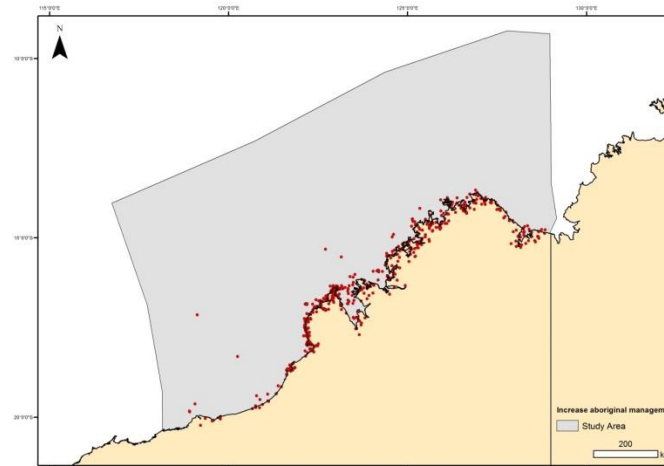


Figure 56. Preference marker map for 'Increase Aboriginal management' (N=528).

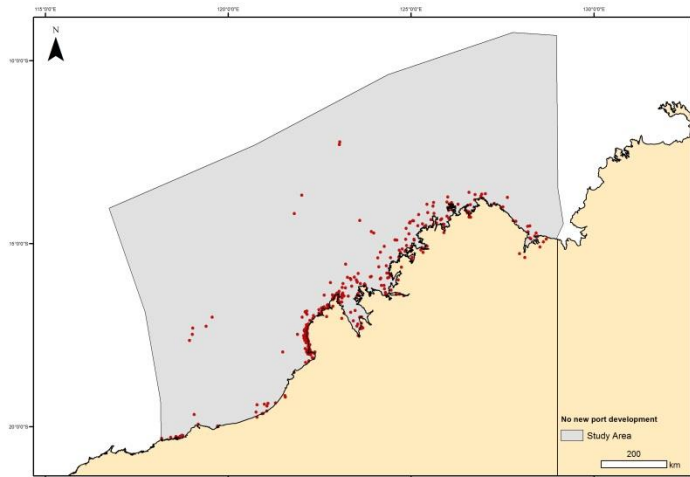


Figure 57. Preference marker map for 'No new port development' (N=398).

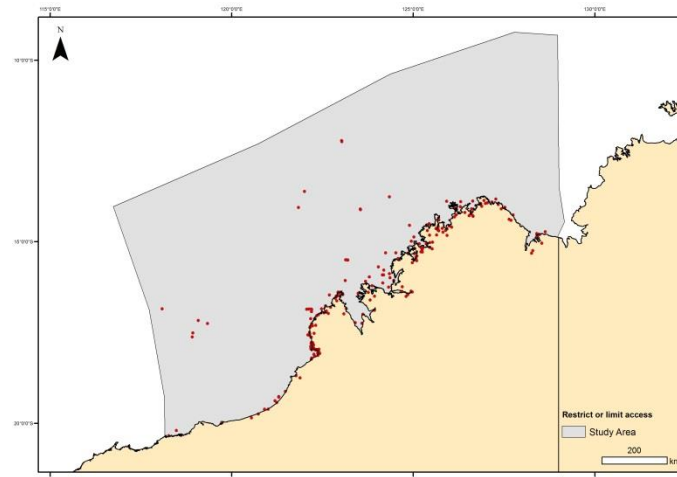


Figure 58. Preference marker map for 'Restrict or limit access' (N=231).

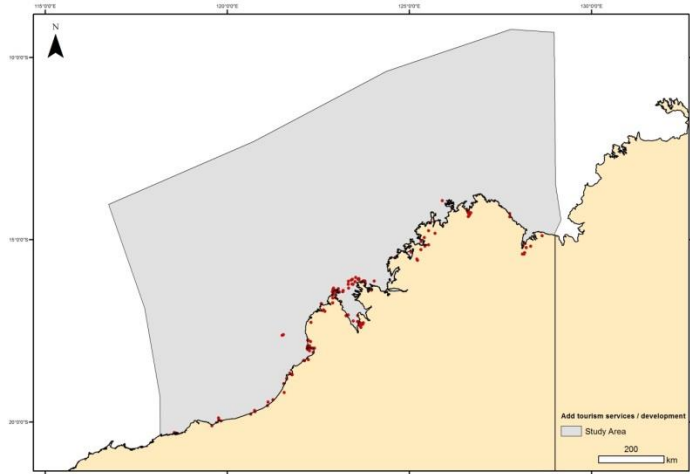


Figure 59. Preference marker map for 'Add tourism services/development' (N=170).

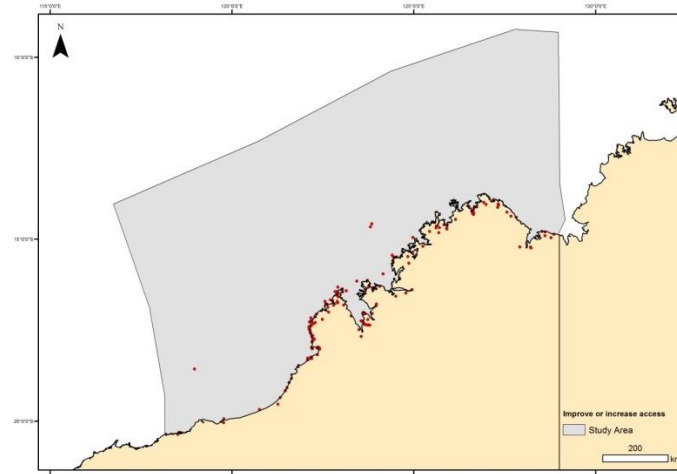


Figure 60. Preference marker map for 'Improve or increase access' (N=169).

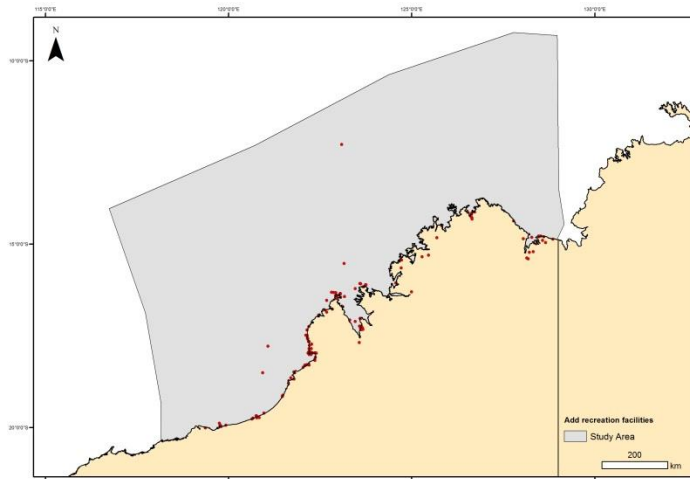


Figure 61. Preference marker map for 'Add recreation facilities' (N=153).

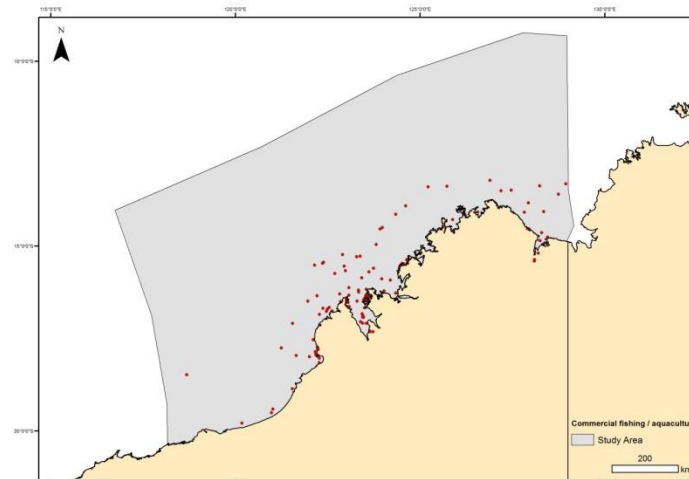


Figure 62. Preference marker map for 'Commercial fishing/aquaculture' (N=127).

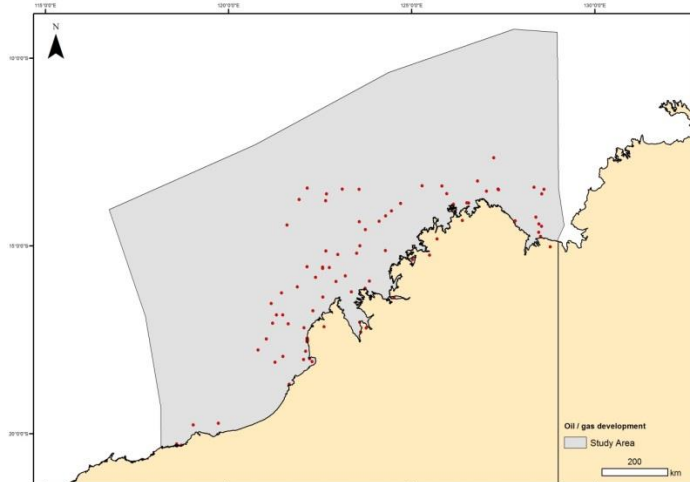


Figure 63. Preference marker map for 'Oil/gas development' (N=127).

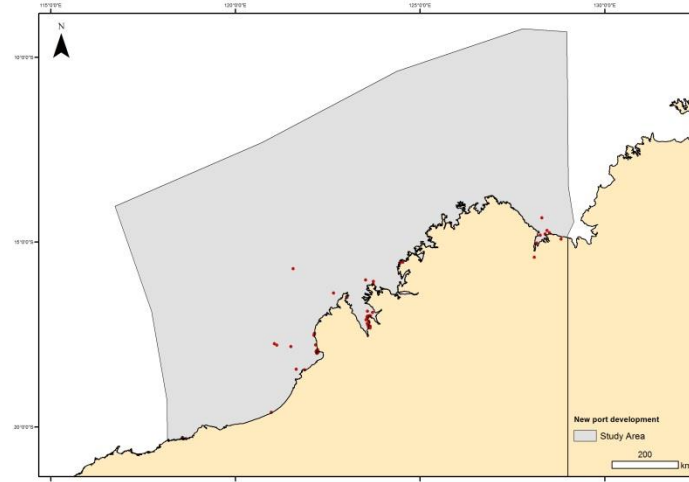


Figure 64. Preference marker map for 'New port development' (N=92).

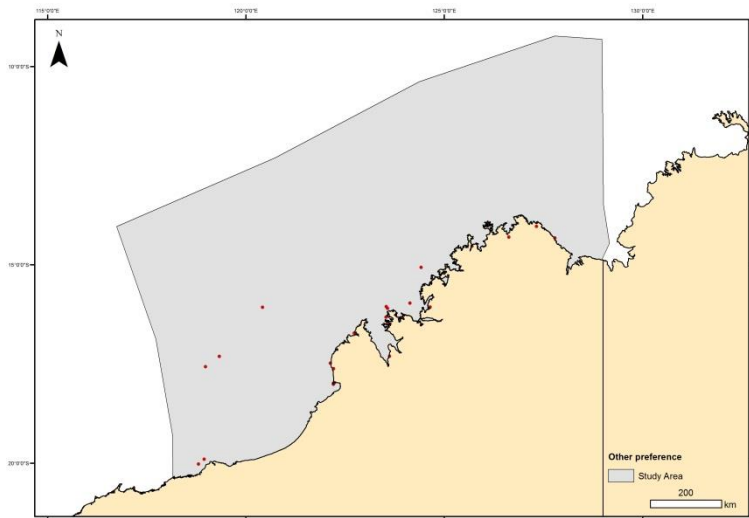


Figure 65. Preference marker map for 'Other' (N=25).

Appendix 8 – Stakeholder analysis raw data

Table. Comparison of the intensity (number) of markers between residents for each **value** using an independent 2-sample t-test (* = significant at 0.05). Significant values are highlighted in green.

Value		N	Mean	SD	T-stat
Scenic/aesthetic	Resident	95	9.37	9.82	2.77*
	Non-resident	198	6.20	7.61	
Recreation	Resident	89	6.11	6.29	2.53*
	Non-resident	145	4.18	5.25	
Fishing (recreational)	Resident	99	10.79	12.79	4.19*
	Non-resident	126	4.87	6.66	
Economic (non-tourism)	Resident	36	2.94	3.11	0.23
	Non-resident	77	2.81	2.88	
Nature-based tourism	Resident	77	6.65	8.62	1.45
	Non-resident	175	5.07	6.16	
Biological/conservation	Resident	60	10.93	20.85	0.25
	Non-resident	169	10.24	17.48	
Aboriginal culture/heritage	Resident	69	9.88	18.55	1.26
	Non-resident	154	6.90	9.36	
European heritage	Resident	39	2.36	2.23	-1.39
	Non-resident	76	3.51	4.92	
Learning/education/research	Resident	41	2.76	2.90	-0.54
	Non-resident	90	3.12	3.86	
Therapeutic/health	Resident	10	1.90	1.73	0.19
	Non-resident	24	1.79	1.41	
Spiritual	Resident	20	4.60	6.64	1.45
	Non-resident	60	2.32	2.59	
Intrinsic/existence	Resident	22	3.59	8.35	-0.23
	Non-resident	66	3.82	4.02	
Wilderness/pristine areas	Resident	65	7.17	8.35	1.35
	Non-resident	169	5.76	6.68	
Special places	Resident	33	4.61	11.46	1.17
	Non-resident	84	2.26	2.49	

Table. Comparison of the intensity (number) of markers between residents for each **management preference** using an independent 2-sample t-test (* = significant at 0.05). Significant values are highlighted in green.

Value		N	Mean	SD	T-stat
Increase conservation/protection	Resident	52	7.23	8.04	-0.84
	Non-resident	124	8.85	12.89	
Increase Aboriginal management	Resident	28	4.54	4.35	-0.97
	Non-resident	71	6.31	9.28	
Add recreational facilities	Resident	31	2.16	1.92	-1.02
	Non-resident	39	2.82	3.16	
Add tourism services/development	Resident	23	2.13	1.60	-0.67
	Non-resident	58	2.48	2.30	
Improve/increase access	Resident	26	4.04	4.03	1.99*
	Non-resident	42	2.31	2.33	
Restrict/limit access	Resident	20	2.55	2.33	-0.90
	Non-resident	54	3.31	3.51	
Commercial fishing/aquaculture	Resident	17	3.53	3.95	1.02
	Non-resident	30	2.43	3.31	
No commercial fishing/aquaculture	Resident	41	8.10	11.83	1.64
	Non-resident	67	4.87	5.56	
Oil/gas development	Resident	13	2.77	1.92	-0.6
	Non-resident	21	2.86	4.77	
No oil/gas development	Resident	45	7.47	10.42	-0.89
	Non-resident	103	10.29	20.13	
New port development	Resident	30	1.47	0.77	-0.38
	Non-resident	23	1.57	1.21	
No new port development	Resident	25	2.88	3.53	-0.98
	Non-resident	74	4.80	9.58	
Other preference	Resident	9	1.89	1.27	0.81
	Non-resident	5	1.40	0.55	

Table. Comparison of the propensity to map **values** and **preferences** between residents and non-residents.

Stakeholder	Value	Preference
Resident	Recreation ($X^2=11.61$, $df=1$, p value=0.001)	Add recreation facilities ($X^2=6.29$, $df=1$, p value=0.012)
	Fishing (recreation) ($X^2=39.64$, $df=1$, p value=0.000)	New port development ($X^2=17.67$, $df=1$, p value=0.000) Other ($X^2=7.12$, $df=1$, p value=0.008)
Non-resident	Biological/conservation ($X^2=8.38$, $df=1$, p value=0.004) Wilderness/pristine areas ($X^2=4.53$, $df=1$, p value=0.033)	

Research Type and Category

Record the type and category of research from the lists below

Type

Baseline – Quantifying the value, status, variability and trends

Category

Social

Objectives (What is the project doing?)

Research question and objectives

This technical report contains the second set of results from the 3-year social research project (*Socio-cultural values of the Kimberley coastline and marine environment*), reporting on the second part of the project: a web-based Public Participation GIS survey to validate and extend findings from previous project research.

The overarching aim of this 3-year research project is to document and analyse the social values and aspirations of people associated with the existing and proposed marine parks at Eighty Mile Beach, Roebuck Bay, Lalang-garram (Camden Sound) and North Kimberley and other coastal waters of the Kimberley between Eighty Mile Beach and the Northern Territory border.

This research aim is being pursued through the following research objectives. This report addresses the second one.

1. Describing and analysing how people value the Kimberley coastline and marine environment and what places are important to them, especially for Aboriginal people, through approximately 160 in-depth face-to-face interviews accompanied by participatory mapping in the Kimberley region, Perth and Darwin.
2. Undertaking a follow-up web-based Public Participation GIS (PPGIS) survey to extend and validate the results from Objective 1.
3. Undertaking comprehensive stated preference choice analyses. This will be achieved by including a series of questions designed to elicit respondents' preferences regarding future activities on the Kimberley coast and future management of this coastline and its waters in the web-based PPGIS survey detailed under Objective 2.
4. Undertaking a detailed analysis of the social values for up to two marine parks through extended consultation with Aboriginal Traditional Owners and others with a particular interest in the chosen marine park(s).

Management Questions (Why?)

List the management questions that were used to guide and frame the research question, It is expected that the final report will provide answers to these questions. Thus, note for each question where the research project will not fully answer the question, but will provide information towards answering it.

1. Stakeholder values research results will provide a baseline regarding values held today. They will help understand stakeholder responses to MPA proposals and inform how these responses are managed.
2. The value and management preference mapping will assist in the development of zoning plans and identify assets of high social value/management importance that may warrant special management and protection.

Extracted from Revised Project Plan 2.1b (as of June 2014)

Key Stakeholders/End-users (Who will use this?)

List the individuals in as much detail as possible who will have a use for this study and whether this is through a decision-making capacity or operational role.

Key stakeholders/End users	Use – decision making	Use – operational
WA Dept of Parks and Wildlife	X	X
WA Department of Fisheries	X	X
WA Department of Premier and Cabinet	X	
Aboriginal PBCs (inc Kimberley Land Council)	X	X

Extracted from Revised Project Plan 2.1b (as of June 2014)

Outputs (What do they want?)

List the outputs expected from the research, including the format in which these will be presented.

Year	Technical reports	Journal articles	Other
30 June 2014	Technical report (TR1): Social values and mapping – Kimberley coast	• Social values in marine environments	Information for Aboriginal PBCs, agency briefings
30 June 2015	Technical report (TR2) PP GIS for Kimberley coast	• Indigenous values of the Kimberley coast • Mapping social values for Kimberley coast • Tourism and awe: the Kimberley coast	Information for Aboriginal PBCs, agency briefings, conference papers
30 September 2015	Technical report (TR3): Stated preferences –Kimberley coast	• Social values & tourism • Social mapping using PP GIS	Information for Aboriginal PBCs, agency briefings
30 December 2015	Technical report (TR4): Traditional Owner values for a selected marine park	• Social values & tourism	Information for Aboriginal PBCs, agency briefings
31 December 2015	Final report (TR5)	• Spatially locating human values for MPAs • Stated preference research & MPAs	Information for Aboriginal PBCs, agency briefings, conference papers

Extracted from Revised Project Plan 2.1b (as of June 2014)

Links to other projects (How will the science be integrated?)

List the projects within the KMRP that will provide additional information in the reporting and interpretation of findings for this project. Also list projects that will be similarly informed by the outcomes of this project. Include information on how this project will interact with the linked projects to ensure information sharing.

Informed by outcomes	Approach to information sharing
1.2.2 Key biological indices required to understand and manage nesting sea turtles along the Kimberley coast	Invitations to key researchers to attend briefings (Tony Tucker, Scott Whiting)
1.5 Collating and integrating Indigenous coastal knowledge for marine conservation and management	Project has recently been refocused to centre around on-ground works with/for ranger groups
2.1.1 Human use patterns and impacts in the coastal waters of the western Kimberley	Regular exchange of information as CIs are co-located at Murdoch University (Moore & Beckley)
2.2.8 Knowledge integration and predicting biological and social response to climate change: MSE modelling	Regular (3-6 monthly) exchange of information with potential for use of our social values data in MSE modelling kept under review (contacts: Michael Hughes, Fabio Boschetti)

Synthesis reports that will require input from this project (How will the science be integrated?)

List the key KMRP synthesis reports that will require input from this project.

See row 5 above.