

Ningaloo Collaboration Cluster: Ningaloo Client Outreach

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LIST OF ABBREVIATIONS

AIMS	Australian Institute of Marine Sciences
BAC	Bayaungu Aboriginal Corporation
BoM	Bureau of Meteorology
CCG	Cape Conservation Group
CCPAC	Coral Coasts Parks Advisory Committee
CFI	Commercial Fishing Industry
Comm	Community
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CU	Curtin University
DEC	Department of Environment and Conservation
DEWHA	Department of Environment Water Heritage and the Arts
DoFWA	Department of Fisheries Western Australia
DoIR	Department of Industry and Resources
DoW	Department of Water
DPI	Department of Planning and Infrastructure
ECU	Edith Cowan University
EPA	Environmental Protection Agency
ESU	Eastern States Universities
GBR	Great Barrier Reef
GDC	Gascoyne Development Commission
GSA	Geosciences Australia
IP	Intellectual Property
LI	Limestone Industry
LT	Local Tourism Operators
MU	Murdoch University
NCMC	Ningaloo Cluster Management Committee
NMP	Ningaloo Marine Park
NROCA	Ningaloo Reef Outback Coast Association
NSDC	Ningaloo Sustainable Development Commission
NSDO	Ningaloo Sustainable Development Office
OGI	Oil and Gas Industry
Pas	Pastoralists
RFW	RecFish West
SI	Salt Industry
SoE	Shire of Exmouth
TWA	Tourism Western Australia (Tourism WA)
UWA	University of Western Australia
WA	Western Australia
WAM	Western Australian Museum
WAMSI	Western Australian Marine Science Institute
WC	Water Corporation
WfO	Wealth from Oceans Flagship
WS	Wilderness Society
WWF	World Wildlife Fund

1. EXECUTIVE SUMMARY

The Ningaloo Collaboration Cluster, a partnership between Murdoch University, the University of Western Australia, Australian National University, University of Queensland, Edith Cowan University, Curtin University, the Collaborative Research Centre for Sustainable Tourism and CSIRO's Wealth from Oceans Flagship. The Cluster was established as a mechanism for ensuring targeted and coordinated research for the sustainable management of the Ningaloo Marine Park (NMP), namely through the delivery of systems which aid in the ecological, economic and social decision making in the region. Research varies from bathymetry through studies of fish species to the social science of visitor behaviour. One of the significant activities is the development of models of various types that will serve as a major integrating output. While there is an 'all encompassing' model there are also activities to incorporate qualitative modelling and 'user friendly' modelling of components. The intention is that these efforts will result in informed decision makers and managers who will have tools that they will regularly use to reach decisions enabling them to manage the uncertainties that are associated with what is a complex socio-ecological system. To help ensure that the research has impact, CSIRO's Wealth from Oceans Flagship (WfO) created a small "Ningaloo Client Outreach" project.

The research question was approached through the construction of sociograms as a means of exploring group roles and networks. This prompted us to consider critically who the 'client' is for the projects. There were many potential end users, particularly governance bodies whose policies could ultimately be informed by the science and research and the communities in the regions studied who may be ultimately impacted on by the science/research informed policy.

The results clearly show the need to consider the 'client' from outset. They also show that the motivation behind research questions, the mechanism people employ in their enquiry and the role of scientists and researcher are changing. This makes for an exciting future in how scientists and researchers engage with 'clients' and how science and research is communicated in the future. A Ningaloo Client Outreach Community Report is also available. The report is a concise version of this technical report and has been structured to tell the 'story' of the research while explaining the technical aspects of the project. As such, care has been given to ensure an appropriate level of technical information (e.g. methodological and interpretive) that remains comprehensible for the general community.

2. PROJECT BACKGROUND

The Ningaloo Coastline, located in Western Australia covers an expanse of 200km, stretching between the towns of Carnarvon to the south and Exmouth to the North and includes the Ningaloo Marine Park (NMP), 430,000ha in size. Recognised as a Marine Park since 1987, more recently there has been discussion of increasing the zone, and potential World Heritage listing. Natural assets are extensive, particularly the Park's marine life. Whale sharks, manta rays and whales serve as seasonal tourism draw cards, similarly, coral and fish species that prompt snorkelling and scuba diving. Of significance is the location of the reef. Unlike the Great Barrier Reef (GBR) that is accessible only via boat, the Ningaloo reef is accessible directly from shore. Fishing near to the reef outside of the marine park zoning is also seen as an important recreation and is attracting increasing numbers of fishers to the region. Development pressure is also emerging from the expanding gas industry active off the North West Cape. Natural assets are not limited to marine life; terrestrial assets are also valued (Wood & Glasson, 2005). Of particular significance is the Cape Range National Park, located on the outskirts of Exmouth which encompasses a land mass of 50,581ha. The National Park itself will require increasingly careful management with the rising population and increases in the numbers of visitors.

The multiple communities and associated values in the natural environment including but not limited to Indigenous, environmental, tourism, scientific, cultural and economic make for complex governance, planning and management. This becomes particularly pertinent where the values are in conflict. Overwhelmingly there has been consistent interest from a myriad of perspectives for a 'sustainable Ningaloo'. The indicators of what constitutes sustainability can be debated and are beyond the direct scope of this project; however, it became apparent that the social networks and roles of scientists and researchers in communities were worth investigating.

The complexity of this region has prompted environmental and social researchers to coordinate their efforts, as such, a large-scale research program has been developed for Ningaloo Reef and the terrestrial surrounds, including town settlements. There are at least fifty stand-alone research projects currently underway. Many of these have been organised under umbrella organisations such as the Western Australian Marine Science Institute (WAMSI), CSIRO's Wealth from Oceans Flagship and its associated Ningaloo Collaboration Cluster. The Ningaloo Collaboration Cluster, a partnership between Murdoch University, the University of Western Australia, Australian National University, University of Queensland, Edith Cowan University, Curtin University, the Collaborative Research Centre for Sustainable Tourism and CSIRO's Wealth from Oceans Flagship. The Cluster was established as a facilitative mechanism for targeting and coordinating research for the sustainable management of the Ningaloo Marine Park (NMP), through the delivery of systems which aid in the ecological, economic and social decision making in the region. Research varies from bathymetry through studies of fish species to the social science of visitor behaviour. One of the significant activities is the development of models of various types that will serve as a major integrating output. While there is an 'all encompassing' model there are also activities to incorporate qualitative modelling and 'user friendly' modelling of components.

The intention is that these efforts will result in informed decision makers and managers who will have tools that they will regularly use to reach decisions enabling them to manage the uncertainties that are associated with what is a complex socio-ecological system. To help ensure that adoption happens, CSIRO's Wealth from Oceans Flagship (WfO) created a small "Ningaloo Client Outreach" project.

Initially Ningaloo Client Outreach was developed with the intention of solely providing outreach or support to other scientists and researchers within the Cluster through monitoring the decision support needs of government and to help match these with the outcomes of the modelling. In part, this comes in response to previous challenges in large scale modelling projects where there have been difficulties during implementation phases. Initially this was considered to be a relatively simple process of maintaining and developing key links with decision makers and with the modellers and in a relatively straightforward way act as knowledge brokers. The project was to; support the use of outputs of the research; help inform the design and form of the research outputs; identify and implement the most effective strategies for providing support to operational management agencies. It was quickly recognised that in order to perform such a role, there is a fundamental need to develop an understanding of the broader system in which such engagement takes place and as such the opportunity was used to ask empirical questions regarding the way in which science and research is conducted and investigate pathways to impact. It was recognised that that there would be many challenges in demonstrating that the research activities and modelling did in fact have a positive impact for the reef. These challenges related among other things to:

- understanding the role of formal and informal networks in creating understanding and implementing decisions,
- the nature of knowledge requirements in decision making,
- the ability of individuals to think in dynamic systems terms, and
- the conceptual and methodological issues associated with evaluating how adoption of the models may have improved the decisions made and the implementation of these decisions.

A sociogram, or a map of actors and their connections, was constructed to identify the key researchers, their projects and proposed linkages within the Ningaloo Cluster. Sociograms are diagrams consisting of nodes with connecting lines. The lines, which may be directional, indicate a transactional relationship between the nodes. In this instance, the nodes consisted of research projects and the lines a desired relationship between the projects, for instance a collaborative relationship. The sociogram was constructed with the use of project proposals and other supporting documentation. The sociogram construction including all researchers became so complicated that it was decided that it would be constructed at the Project Leader Level which can be seen in Figure 1. In this instance, for simplification of the model, the lines are non-directional. Theoretically collaborative relationships could be bi-directional.

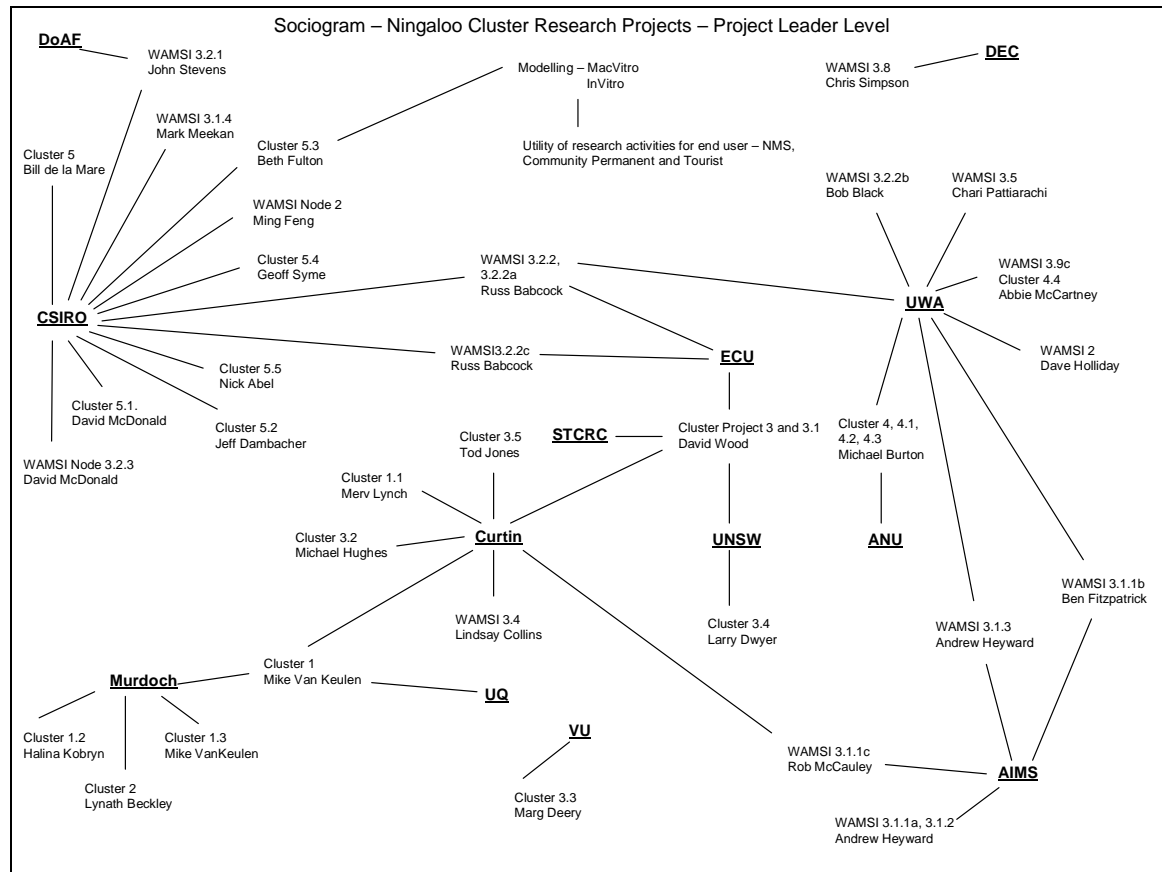


Figure 1 Sociogram of Ningaloo Cluster Research Projects

The sociogram highlighted the complexity of the proposed research network, and furthermore prompted us to consider critically who the ‘client’ is for the projects. There were many potential end users, particularly governance bodies whose policies could ultimately be informed by the science and research and the communities in the regions studied who may be ultimately impacted on by the science/research informed policy. Considerations were also made as to the role of regional communities within the Ningaloo Region, such groups were notably absent from the sociogram highlighting that at the project plan level there were no formal collaborative arrangements made between scientists/researchers and end users. This was despite there being a strong discourse within the scientific and research community to ensure pathways to impact. Realisation of the complexity of the system prompted us to apply systems theory to consider in more depth the way in which science currently has impact.

This report describes progress in defining and addressing these system-wide adoption issues which we believe to be common to all large scale multidisciplinary research programs. Nevertheless they are particularly relevant to modelling exercises that are conducted to integrate research and provide useful decision support tools for policy and management in the context of ecosystem management. The report begins with an overview of systems theory that has informed the direction of this research, followed by a description of the methods employed, findings and implications.

2.1 Systems Theory

Constructing the initial Sociogram of the Ningaloo Collaboration Cluster illustrated the many ‘clients’ in the project, and highlighted the absence of formalised structures connecting scientific and research agencies to local community members and decision makers. This absence highlighted the need to better understand how these different groups perceive their own role in the management of the NMP, and to develop an understanding of how such roles fit together. Underpinning the research and scientific investigations, and the regional governance is the motivation to ensure the long-term sustainability of the Ningaloo reef; it is evident that this aim in part rests on an assumption that there is the social capacity to implement research and scientific findings. In part, this project is considering the capacity for the Ningaloo Collaboration Cluster research findings to have regional impact. It addresses the social mechanisms and groupings that may house the knowledge and technologies that are the products of the science.

Systems theory presented one way of attempting to unravel the complexity of multi-group interactions and interdependencies. To understand the roles of the groups, different types of roles and connections were of interest to the Client Outreach project. Particular interactions that were of interest included; sub-group bonding ties, between group bridging ties, structural holes and bridging nodes.

Subgroup (within group) bonding ties

Bonding ties illustrate linkages at the subgroup level. Subgroups can be thought of as the groups that emerge based on interaction within a broader group and therefore illustrate the linkages that emerge at group level. As such these linkages can be thought of as the ‘within-group’ relationships. Investigating subgroups are important in that they provide an understanding of the way in which particular organisation or sectors of the community operate. Within these groups, there is often highly specialised knowledge. Such knowledge can be both a beneficial and limiting factor to the capacity and activity of the group. They are beneficial in that the interconnections tend to be domain or expertise specific, allowing the opportunity for further knowledge generation within the particular domain. Such interactions can also be limiting in that there is the risk for action and knowledge generation to be domain exclusive, which can potentially prevent the introduction of new ways of thinking and other cross-disciplinary opportunities. When subgroup networks are too cohesive, whereby the network consists of too many subgroups to be fully functional, it can equate to pressure and the “result of the inherent limitations of actors to uphold too many concurrent relationships” (Bodin & Crona, 2009, p.368). Bodin and Crona (2009) reflect, “isolated sets of specialised knowledge is of limited use in governing complex ecosystems since systematic and boundary spanning understanding and actions are often needed” (p.369). The potential issues that can arise at the sub-group network level can in part be remedied by the beneficial impacts of between group bridging ties in the network.

Between group bridging ties

Between group bridging ties are connections that link the bonding subgroups (within group) with other subgroups within the network. Linking multiple subgroups can prove to be useful, providing the potential enhancement of knowledge, for instance through introducing diversity of in collaborative or interdisciplinary arrangement. Further, developing overall cohesion through linking of subgroups can energise the governance system by providing the opportunity for each subgroup to provide their own

group-level perspective. Hence, these forms of ties can be particularly important when considering coastal zone management which require coordinated effort on part of a myriad of often diverse interest groups.

The presence of current or potential structural holes

The absence of between group bridging ties to link subgroups result in structural holes. Structural holes within a network can lead to a collapse in the way that people communicate, integrate or influence each other. The importance of identifying current structural holes in between group relationships is that it provides opportunities in which new or sounder bridging relationships can be introduced. Attempting to anticipate future structural holes enables pre-emptive mechanisms to be introduced as a means of preventing a potential risks associated with a poorly connected network. A poorly connected network can result on some nodes being overly burdened in their role as a connecting unit within the subgroup network which can result in burn-out. Such roles are also pivotal in the sense that the removal of the particular role can result in vast changes to the way in which the network structure operates. For instance, the removal of the actor performing the “broker node”, if not replaced can lead to isolation between sub-groups.

Frequently, structural holes require institution of particular roles or nodes as a means to bridge the subgroups. Such nodes typically act as brokers that shape interaction and provide a valuable brokerage often acting as translators or interpreters between groups. The Ningaloo Client Outreach Project has specific interest in the types of brokerage roles present within the network. Understanding the type, presence or absence of brokerage relationships within the network is highly valuable, for instance for planning.

3. METHODS

The following is an overview of the methods employed. The research used a mixed methods design consisting of two research phases both based on interpersonal interviews. Phase 1 entailed Scoping Interviews and Phase 2 Formal Interviews. Participants were sourced via snowballing methods, whereby initial interviews (based on a desk top analysis of grey and white literature) and consecutive interview rounds were based in participant referral. This means of recruitment also makes intuitive sense given our interest in the networks that the participants belong to as part of their role. Participants were invited to contribute to the research via phone call or face to face; the latter a common occurrence while in the field locations. The applicability of participant background was loosely defined for the study. This was because a broad range of perspectives were vital so to ensure a myriad of backgrounds, experiences and needs (both within the scientific/research and regional communities) were captured. Participant background included; pastoralists, station workers, local government, community groups, local business owners, government and non-government associations, horticulturalists, tourism operators, recreational fishers, accommodation providers, research directors, communication experts, scientific support staff, researchers, and scientists.

3.1 Phase 1 – Scoping Interviews

At the scoping phase of the research, scientists were identified as being the primary ‘client’ of the project, and their needs as researchers within the broader Collaboration Cluster were explored. Semi-structured interviews were conducted with the intention being to initiate a dialogue with the scientists within the Ningaloo Collaboration Cluster. Interviews were conducted either face to face or over the phone and ranged from 30 minutes to 90 minutes in duration.

Notes were taken during interviews and were analysed thematically. Findings from Phase 1 contributed to the overall design of the project. What became apparent during scoping interviews were several interrelated themes, including; pressure associated with timelines and coordinating research, concerns regarding current or potential collaborative relationships, concerns regarding Indigenous engagement in science, concerns over the uptake of science by regional communities, and, a passion for their project¹. Overwhelmingly, it was apparent that concerns associated with projects related to processes – either engaging with other scientists and researchers, or community members. There was also recognition of a link between science/research and the community, where the community was identified as ultimately the ‘end users’ of science and research. Recognising the importance of social processes greatly influenced the shape of the Client Outreach Project. It became apparent that one of the key indicators of achieving the aim of a ‘sustainable Ningaloo’ was the effectiveness of the network in which science and research is conducted and the effectiveness of the engagement with the perceived beneficiaries of the research findings, most typically identified as agency staff and the regional community members.

¹ A comprehensive interpretation of interview content from scoping and formal interviews with scientists and researchers is captured in the Findings section of this report.

3.2 Formal Interviews – Considering Networks

Formal data collection was based around the interpersonal interview. In all but two cases, two researchers were present for all of the 34 interviews undertaken. Interviews ranged from between approximately 45 minutes to just over two hours in duration. The range in interview time was a function of the conversational nature of the interviews. Interviews were conducted in locations negotiated between the participant and the researchers, occurring in the following locations; the participants' workplace, the offices of the CSIRO, participants' homes or neutral locations such as local eateries or cafes. Generally, one interviewer acted as the facilitator of the interview with hand written notes taken by both interviewers present, notes included observations, verbatim extracts of conversation and commentary regarding the content of the interview. Discussions between researchers regarding their interpretation of the interviews were held frequently which acted as a data validation mechanism. Data validation also took the form of feedback at symposiums and during interviews. Participants were aware that the content of the interviews were anonymous although not necessarily in confidence with the themes of interviews serving to inform subsequent interviews. Interviews commenced with verbal consent from the participant/s.

Interviews consisted of two components. The first was a general conversation regarding community needs, values and aspirations. The second was two formalised exercises which explicitly aimed to consider the participants role, relationships and interactions that characterise the role. The first exercise was the construction of a sociogram. The second exercise elicited the perceived utility of the groups in which they are engaged through a card sorting exercise. Interviews were informed by an interview guide. The content of the guides differed slightly, depending on whether the interview was with a community member or from scientific/research or governance settings. This was a consequence of the individual context of the participant, and thus altered to ensure relevance of the interview.

3.3 Sociogram Exercise

Respondents were asked to draw an "ego network" diagram (Everett and Borgatti 2005) of all those with whom they had to interact in order to fulfil their role. In constructing an ego network, individuals were required to use directional arrows to depict the relationship between themselves and the organisations and groups which they identified as important to fulfilling their role. Arrows were used to indicate both who is assisted by the individual, and who is of assistance to them. Interdependencies between the various groups and the individual were illustrated through the use of directional arrows. The end products are hand drawn networks that describe social interactions. A whole network was created by the superposition of all of the ego networks. As with the sociometric analyses, gaps in transmission lines between roles could also be identified from the whole network. From the participative planning viewpoint, the analysis highlights key community and government roles as well as their interactions. Research and model building, including pathways to adoption can then be built around these role nodes.

Though not strictly a Social Network Analysis, the sociogram approach draws on the underpinnings of social network theory. Hence, statistical significance in the social models has not been a consideration; the emphasis of the analysis has been to draw on elements of network theory as a mechanism for grounding, theorising and interpreting the data from the exercises conducted with participants.

Using a relatively abstract means of understanding community interaction has introduced a unique way of exposing community and stakeholder tacit knowledge, a localised and complex knowledge

system that has the capacity to be overlooked in research settings. Tacit knowledge of how complex systems operate and further how participants perceive and illustrate them operating has been highly valuable to this study and recognised more broadly as an important and somewhat neglected area of exploration (Crona & Bodin, 2006; Hamel, 1991). This appears particularly important in the interview discussions held with local community members. They engage most closely with the local, physical and social environment which has been under investigation by the scientific and research agencies, and it is their knowledge as *local experts*, which presents a highly valuable data source and offers a unique interpretation of the broader social, economic and environmental system of Ningaloo.

During interviews, a demonstration of how to construct a sociogram was given by one of the interviewers using a real-world example of the network they employed to ensure the success of their role as a scientist at the CSIRO. After the example was given, participants were invited to draw their sociogram in response to the question, “who do you depend on and who depends on you to ensure your role in contributing to the sustainable management of Ningaloo?”. The question was purposively broad to encompass the myriad of roles that we engaged in the research. The emphasis was on developing an understanding of individuals' roles and how roles interact within the network.

3.4 Card Sort Exercise

A list of 44 groups and organisations was identified in the original interviews as having a distinctive role in the welfare of the Ningaloo reef. These included, but were not limited to, scientific and research organisations, local community groups, advocate groups, private enterprise, regional business, industry and universities. Participants were asked to distinguish between the organisations and groups that were ‘Helpful’ in them fulfilling their role in Ningaloo, others who were ‘Less Helpful’ in fulfilling their role and those organisations and groups they had not interacted (‘No Interaction’) with as part of their role. It was emphasised that the ‘Less Helpful’ did not necessarily imply individual lack of responsiveness but may reflect a variety of issues such as lack of resources or information, or, that the group or organisation served no purpose in the participant fulfilling their role. We stressed that this need not be a criticism of the group or organisation, merely that in some instances this reflects diversity of roles and needs.

During interviews, participants were presented with 44 cards each featuring a unique group or organisation, of which they sorted according to the above stated headings (‘Helpful’, ‘Not So helpful’ or, ‘No Interaction’). Their responses were recorded and participants were then asked about the nature of their groupings, for instance, are there any particular qualities or trends that make a group ‘helpful’ or ‘not so helpful’?, or why haven’t you interacted with these groups, for instance is that because it is not part of your role? Over the course of the research the categories were extended to include the category, ‘Interested in Future Interaction’ for the purposes of gauging anticipated interests. This was later abandoned as the same information was more efficiently captured in discussion during sociogram construction². Participants were also asked if there were any groups/organisations that they feel were not captured in the original list of 44.

² For analytical purposes the variable was collapsed with ‘No Interaction’.

3.5 Network Analysis

Several analyses were conducted using Ucinet (Borgatti *et al.*, 1999) to interpret the sociogram data. Specifically, Regular Role Equivalences, Brokerage and Key Player Analysis were conducted. Analysis using Ucinet provided a mechanism for understanding participants' perceived networks. Exploring these networks provided an analytical basis for making inferences regarding group level interactions and the potential implications of these interactions. The particulars of each of these investigations are discussed as follows.

3.5.1 Regular Role Equivalences

Two nodes or actors are completely equivalent if they interact with the same kind of nodes or actors, but not necessarily the exact same nodes or actors in a network. Regular Role Equivalences compute a measure of regular equivalence using the standard REGE algorithm (White, 1984).

REGE is an iterative algorithm and within each iteration a search is implemented to optimize a matching function. Refer to Appendix 1 for details of the technical parameters used in the analysis of the network for regular role equivalences. The matching function between vertices i and j is based upon the following. For each k in i 's neighbourhood search for an m in j 's neighbourhood of similar value. A measure of similar values is based upon the absolute difference of magnitudes of ties. This measure is then weighted by the degree of equivalence between k and m at the previous iteration. It is this match that is optimized. This is summed for all members of its neighbourhood over all relations and normalized to provide the current iteration's measure of equivalence between i and j . The procedure is repeated for all pairs of vertices for a fixed number of iterations. The result of this iterative procedure is a symmetric similarity matrix which provides a measure of regular equivalence.

3.5.2 Considering Brokerage

Brokerage concerns transactions between actors, whereby a 'broker' is the individual who facilitates the transaction between two actors. The broker themselves can either benefit (e.g. through obtaining power, see Marsden, 1982) or, benefit can be marginal or non-existent (Gould & Fernandez, 1989). Gould and Fernandez (1989) contribute to the conceptualisation of brokerage by arguing that "actors in a social structure are differentiated with regard to activities or interests, so that exchanges between some actors differ in meaning from exchanges between other actors" (p. 91). It is this differentiation of exchanges that is of value to this study.

Brokerage occurs when, in a triad of nodes a , b and c , a has a tie to b , and b has a tie to c , but a has no tie to c . That is, a needs b to reach c , and b is therefore a broker. When there are three or more kinds of groups (represented here by differences in shading) in a network, then five kinds of brokerage are possible (Gould & Fernandez, 1989), namely, the Coordinator, Gatekeeper, Representative, Consultant and Liaison (Figure 3).

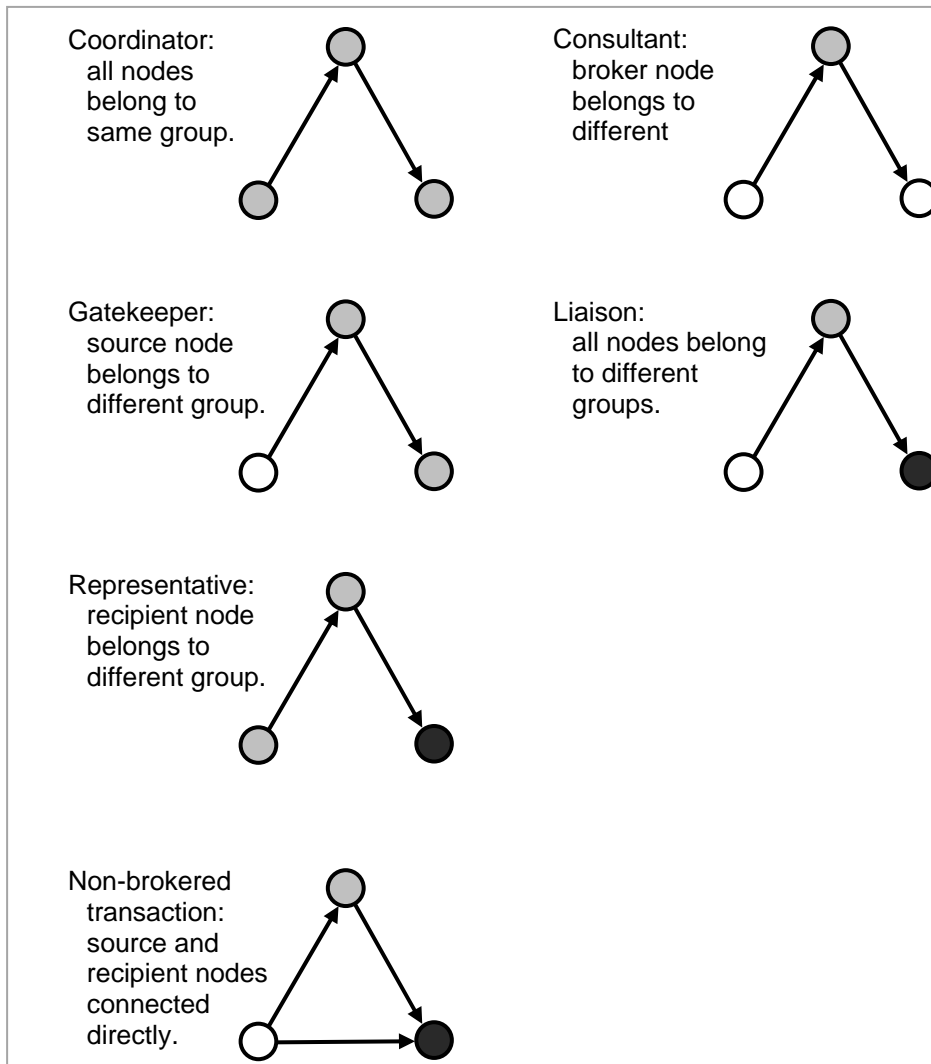


Figure 2 adapted from Gould & Fernandez (1989).

Table 1 Description of Brokerage Relationships

Brokerage	Description
Coordinator	Counts the number of times b is a broker and $G(a) = G(b) = G(c)$, that is, all three nodes belong to the same group.
Consultant	Counts the number of times b is a broker and $G(a) = G(c)$, but $G(b) \neq G(a)$; that is, the broker belongs to one group, and the other two belong to a different group.
Gatekeeper.	Counts the number of times b is a broker and $G(a) \neq G(b)$ and $G(b) = G(c)$, that is, the source node belongs to a different group.
Representative.	Counts the number of times b is a broker and $G(a) = G(b)$ and $G(c) \neq G(b)$. That is, the destination node belongs to a different group.
Liaison.	Counts the number of times b is a broker and $G(a) \neq G(b) \neq G(c)$. That is, each node belongs to a different group.

When b is not the only intermediary between a and c, it is possible to give b only partial credit. That is, if there are two paths of length two between a and c, one of which involves b, we can choose to give b only 1/2 point instead of a full point. This is an option in the computer program (Borgatti, *et al.*, 1999). The program calculates these measures for each node in the network, and also the total of the five. The program also computes the expected values of each brokerage measure given the number of groups and the size of each group. That is, the expected values under the assumption that brokerage is independent of the group status of nodes. The final output divides the observed brokerage values by these expected scores.

3.5.3 Key Player Analysis (Finding Optimal Sets of Key Nodes)

Key Player analyses (Borgatti, *et al.*, 1999) are conducted to identify nodes within a network that due to their level of connectedness either, due to their presence have the capacity to be influential to the remainder of the network, or through their absence have the capacity to be crippling to the network. There are specific functions within the UciNET program that can be used to calculate the key players within a network. There are two choices designated as, the Remove function or the Observe function. The output of all the analysis is a list of nodes that belong in the optimal set, along with a measure of fit - the extent to which they satisfy the objective. For this reason, the output of all analyses is a list of nodes that belong in the optimal configuration. The program does not actually delete nodes; just identify which nodes are key. Desirable networks would represent versatile roles for each organisation, with some redundancy in role to ensure the minimisation of isolates. A further consideration is that this be achieved with minimal transaction costs.

Remove Function

The Remove function considers how a network can be crippled by the removal of a key player node. There are two ways in which the network can be crippled, either by fragmenting the network, or by lengthening the distance³ between all pairs of nodes. Each option aids in deciding which nodes to remove. In instances when the network has many links or, is dense, fragmentation may be difficult; therefore it is easier to consider distance. Networks with long paths transmit information more slowly and less securely, and when the information eventually arrives, it may be distorted.

Fragment

When you choose this procedure, the program requires you to specify how many nodes to remove, how many “starts” you want, and the maximum number of iterations. A “start” is one run of the combinatorial optimisation algorithm. The more starts you pick, the greater the likelihood of finding the combination of nodes that divides the network into the most fragments. The measure of fragmentation optimized by the program is based on the heterogeneity coefficient used in statistics (Borgatti, *et al.*, 1999). Basically, the program counts up the number of separate components in the network after deleting the key nodes, and counts the proportion of all nodes that are contained in each component. The sum of the squares of these proportions gives a measure of the extent that people are bunched into just a few components, and one minus this sum gives the degree of fragmentation, where a value toward 1 indicates fragmentations (lots of small clusters) and a value toward 0 represents redundancy or resistance to fragmentation (most people still connected).

³ Distance in this instance refers to the least number of links between one node to another.

Distance

Here the analysis is to lengthen the average distance between pairs of nodes by judiciously deleting key nodes. Often, deleting a node will not only increase distance between some pairs of nodes, it will completely disconnect them. The distance between pairs of nodes that are completely disconnected is technically undefined, although you could think of it as infinite. The practical issue is how to treat these infinite distances when computing the average distance among all pairs. An obvious approach is to assign a value that is greater than any possible distance. The smallest such value is n , the number of nodes in the network. However, because disconnecting nodes seems considerably more informative than increasing their distance by one, we might want to consider larger values, such as $2n$ or $5n$. By default, the program uses $2n$, but you can enter any multiplier of n that you like for this parameter (called Weight in the program).

Observe

Version 1.0 of KeyPlayer only has one option under Observe, which is called Reach. The idea of reach is to find a set of nodes who are linked to as many distinct others as possible. Note the word “distinct”. If you just took the 10 people with the most ties as your set of key players, you might find that they don't reach very many different people because they are all tied to each other. Thus, this program is designed to find nodes are well-connected but also non-redundant. The key option in this program is the number of steps to allow. If the number of steps is 1, the measure of reach is the number of distinct persons (including the key players) that have a direct link (a tie) with any member of the set of key players. Thus, the 1 indicates a distance of 1. If the number of steps is set to 2, the measure of reach becomes the number of distinct persons who are within two links (i.e., separated by one intermediary) of any member of the set of key players.

4. FINDINGS

For some of the participants, the Card Sorting Exercise and/or the Sociogram Exercise were omitted from the analyses. Generally this was either due to the nature of their role or the interview location (difficult or challenging settings such as in businesses). Gauging suitability was based on initial discussions with the participants with a decision to proceed with the intended activity made at the time. The following is a discussion of the findings, the above issue of suitability explains variations in the number of participants reported.

4.1 Qualitative Findings

The Ningaloo Coastline includes the towns of Carnarvon, Exmouth and the non-gazetted community of Coral Bay. These have been the key research bases for all (social, economic and biophysical) Ningaloo Cluster research. (see Figure 3). The Carnarvon coastline while not under the zoning of the Ningaloo Management Plan is featured in this research due to its proximity to the region and the colloquial identification of the town as being the ‘gateway’ to Ningaloo.



Figure 3 Map of Ningaloo Coastline and Ningaloo Marine Park

The following is a discussion of some of the regional issues raised by community members during interviews over the course of the research project. These are discussed as themes and assigned to town/community so to flag site specific needs or aspirations.

4.1.1 Carnarvon

Carnarvon is located approximately 904km North from Perth. The total population stands at 5,682 with a relatively even distribution of men ($N = 2,914$) and women ($N = 2,768$) (ABS, 2006). Of the total population, 1,084 residents are Indigenous Australians. The median age of the town is increasing, from 38 years in 1996, to 44 years in 2006. According to 2006 census data, the total workforce stands at 3,284 with the majority employed in Agriculture, Forestry and Fishing ($N = 548$) a number which since the 1996 census has fallen by just over 100. The demographic of Carnarvon is particularly interesting when considered in light of its positioning as a historically significant town known for marking the entrance into the Ningaloo Marine Park. Unlike Exmouth and Coral Bay, that tend to be tourism based, Carnarvon's economic base is in horticulture and fisheries. None of Carnarvon's Coastline is within the Ningaloo Marine Park, making it a prime fishing destination. Additionally, the town serves an important role in the region in terms of economic contribution and tourism patterns. Hence, effort was made to ensure that the thoughts, experiences and reflections of the Carnarvon community have been captured in this research.

Carnarvon as the southern 'Gateway to Ningaloo'

Much of the discussion centred on the town's identity and relationship with Coral Bay, Exmouth and to a lesser extent Shark Bay. A common theme related to the town of Carnarvon being promoted as the 'gateway' to Ningaloo, and the strengths and limitations associated with this means of identification. Carnarvon has historically served as a service centre for road travellers heading north, particularly to Coral Bay or Exmouth and the term 'Gateway' has been used to describe the way in which the town has acted as an entry to the Ningaloo coastline.

It was also noted that the reef rarely comes up as a focal point or issue within Carnarvon, rather the reef serves as a focal point for Coral Bay and Exmouth which serves to emphasise the 'gateway' term. One participant stated:

Carnarvon has always had an image problem. Powers that be at the tourism side decided that gateway is the best way. This began six to eight years ago. At that time a starting point, town has progressed a bit since then.

The consequence of this term has meant that there has been limited opportunity for development of the tourism industry, which to some has been seen as an area requiring investment. Instead, despite the efforts of the town's people, there remains a broader perception that Carnarvon is an access way to bigger and better things North, which is met with frustration by townspeople. For instance, a participant reflected

we are on the end of it (NMP), we don't get as much profile or access as the Coral Bays or Exmouths.

Typically, tourism activities are concentrated within the Marine Park and the key accommodation precincts that are adjacent to the reef, namely Coral Bay and Exmouth. This marks a distinct

difference in the way in which the Carnarvon is conceptualised by both visitors and the community itself. One participant stated “great place to live, wouldn’t want to visit”, a reflection that tends to summarise the general orientation of town.

Community members expressed concern that there have been social issues, particularly violence, within the town that has acted as a deterrent for visitors. Over time such issues have been seen to be improving particularly in regards to relationships between Indigenous and non-Indigenous community members.

Regional Future

Consistently there was an overwhelming perception within the Carnarvon community that the town holds a great deal of potential. Historically it was reflected that the town has tended to be resistant to change and has therefore not endeavoured to improve itself – a tendency which has been met with frustration within the community. Many of the frustrations related to a perceived resistance to improve the towns’ streetscape, issues associated with the limited opening hours of local businesses, and occurrences of violence within the town. Some residents expressed concern about the lost opportunities due to the way in which some of the current businesses operated, for instance, “I have been all around the world and this is the only place that has told me that the kitchen is not open to make me a sandwich”.

Over time, there has been growing resentment within the community of the lack of enthusiasm within some sectors of the community. In response there has been demand for attitudinal change geared towards increasing the sense of pride that people have in their town and ultimately making it more attractive to visitors. Currently there is a degree of optimism within the community as there have been signs of social change; this has been seen in the efforts of newer, younger and enthusiastic caravan park operators, the introduction of suitable town signage (encouraging visitors on the road to explore the main street), and efforts at street-scaping. A participant reflected on the way in which it takes only one person to have pride in their front garden before others begin to also take pride.

While discussion regarding the towns’ potential was often raised, generally tourism was not flagged as being the current or intended major industry for the town, rather fishing and horticulture were the dominant industries. The strength of these industries were perceived as an asset, with particular reflection made to the vulnerability of towns such as Exmouth and Coral Bay who rely on tourism as their main or sole industry. Similarly, there was a strong sense of ownership of these industries and a sense that horticulture and fishing enabled the town to be self sufficient consequently providing them with a sense of security. The current fishing industry was also seen as having the propensity to be developed further, with, scallops, prawns, crabs and snapper flagged as having the potential for becoming large scale independent industries.

Tourism at times emerged as a contentious topic whereby a degree of competition between towns along the coast was evident. This makes intuitive sense given that Carnarvon is part of a region that is dependent on tourism as their primary industry. Comparatively, Carnarvon’s assets are primarily based in fishing and horticulture and this presents as a vastly different experience, both in terms of the economic base of the town but also how it is utilised recreationally. The contrasting identities make for a complex set of expectations, and introduce varying community needs. These differences however have been reported by some community members as meaning that Carnarvon is anti-tourism. Others

had the view that the tourism potential is different from Exmouth and Coral Bay and is in addition to other industries present in the town.

Some participants averred that the tourism focus of the region “doesn’t have to be coral” therefore providing a rationale for tourism development in Carnarvon that does not necessarily draw on the traditional assets of the Coral Coast. This marks a key difference concerning the way in which the towns along the coastline are identified. There is an appreciation within the community that while the town does not have the white sandy beaches characteristic of communities further north, it does present itself as an attractive destination for recreational fishing, and for long term visitors who can benefit from the slightly cooler conditions than those further north, the favourable conditions for recreational fishing and access to affordable produce from the horticultural sector. There were aspirations for tourism development of the horticultural industry and recognition of the different tourism needs and possibilities in Carnarvon. Another participant reflected, “16 years ago I thought this town had something, I still don’t know what it is!”

Restrictions to Carnarvon’s development potential were raised by participants. It was expressed that there is interest in expanding the town; however, some participants reported conflict between interested development companies and the Shire. Development potential was also limited by the positioning of the river, tidal flats and issues related to the provision for deep sewerage (this particular issue has prevented the capacity for subdivision of larger blocks).

Demographic Issues

There was some discussion regarding the way in which census data for the town fails to capture the impacts and needs of some of the long term temporary visitors, namely ‘the grey nomads’. It was noted that within the caravan parks the majority of the residents are retirees who live there for extended periods, generally up to six months of the year. It was reflected that the Carnarvon lifestyle is ideal for these visitors, with the mild climate, and affordable food due to the local horticulture and fishing industries. Anecdotally it was reported that the census data indicated that the Carnarvon population was decreasing. Locals had difficulty in believing this. This perception is significant in that the locals reported concerns regarding water availability and the risk that the perception of a decreasing population has for the towns’ access to opportunities and likelihood of investment by government.

4.1.2 Exmouth

Exmouth, located approximately 1270km north of Perth, is most recognised for its tourism assets; Ningaloo Marine Park and Cape Range National Park. The town was established in 1964 in association with a base for United States submarine communications. US military personnel were largely withdrawn 1993, resulting in a major drop in population numbers. Population numbers have since recovered, and the total population is now 2172, with a relatively even distribution of males (N=1181) and females (N=991). (ABS, 2006) The Indigenous population makes up 1.4% of this total population. (ABS, 2006) A significant amount of internal migration occurs in Exmouth, with 50.5% of people living at a different address 5 years prior to the ABS 2006 census, with over one quarter (25.8%) of these people having moved in the previous 12 months.

Participants in Exmouth reflected on demographic changes in the town which were seen to be as result of the natural gas industry. The wealth within that sector and of the employees themselves has been

linked to an increase in living expenses and housing and accommodation shortages that were seen to be squeezing people out of the real estate market – both those intending to buy and those seeking rental accommodation. Consequently, this was seen to be impacting on local businesses' capacity to source employees that are paid at rates below those found in the natural gas industry. Some participants noted during interviews that the demography of recreational fishers has changed; they are now notably wealthier and own larger fishing vessels that can access different waters and fish species. This was also observed in part to be related to the presence of gas industry employees who live in the area and have the time and money to support their hobby.

The industry focus within the town has also changed. The downscaling of the marine communications base lead to a dramatic and sudden drop in population numbers; consequently there was the need to identify an alternative industry in the town in order to support the remaining community. Due to the range of natural assets in the region, tourism emerged as an alternative. Interestingly there remains what participants described as 'old locals' versus 'locals'. 'Old locals' are construed by the participants as being community members who have lived their entire life in and around Exmouth and their family has been there for at least one generation. With this label comes a sense of social hierarchy, whereby they are perceived as being more 'legitimate' community members. Comparatively, 'locals' have not been in the region for an extended period of time and are yet to hold any of the social esteem that comes with time and experience in the region.

Attitudinal Change

Over time there have been observed attitudinal changes within the community regarding the way in which the local community and visitors consider the reef and the region. Major local conservation campaigns have been embraced, for instance peoples' opinions regarding turtle populations, "turtles are not an attractive thing" and, "definitely a change in mentality - seen the pay off... turtles now draw people". Similarly bids at ceasing retail plastic bag use have proven effective with the majority of Exmouth businesses participating in 'No Plastic, Fantastic'; a campaign sponsored through the Cape Conservation Group.

4.1.3 Coral Bay

Coral Bay is located 155km south of Exmouth. While it is not gazetted as a town, settlement as a tourism node began in an *ad hoc* manner in 1968. Coral Bay is the closest and most heavily developed access point to Ningaloo Reef, and the town is adjacent to the Maud's Sanctuary Zone. The Shire of Carnarvon has planning control over Coral Bay, but the area is colloquially known to be more readily serviced by the Shire of Exmouth. The 2001 ABS census recorded 247 permanent residents in Coral Bay, but a more recent informal survey completed by business operators estimate the figure at roughly 150 people. (Ningaloo Coast Regional Strategy Carnarvon to Exmouth, 2003). There is limited accommodation and services and this creates problems for residents, detailed in section 2.3.1 Housing and Accommodation. Tourist numbers are increasing in the area, while there are 1848 approved overnight visitor beds under the town planning scheme, estimates in peak periods indicate up to 6000 visitors seeking accommodation. (Ningaloo Coast Regional Strategy Carnarvon to Exmouth, 2003).

Housing and Accommodation

Housing and accommodation concerns were a prevalent issue during discussions. The shortage of suitable and safe workers accommodation was commonly raised. Colloquially known as 'Little Kenya' workers accommodation consists mostly of makeshift houses derived from shipping containers and caravans. The safe provision of electricity was an issue raised by many during discussion. There were also issues of equity regarding land and resource ownership in Coral Bay with tensions associated with much of the land under a single family's ownership.

Planning and Development

Planning and development in Coral Bay has been a highly debated issue with a broad range of opinions regarding the settlement's potential future. The proposed development at Mauds' Landing continues to be an issue of discussion, not only to the current proprietors in Coral Bay, but similarly in Carnarvon and Exmouth. Both towns have vested interests in the development capacity of the settlement. Although under the Carnarvon local government area, it was noted throughout interviews that there is a greater physical, social and recreational connection between Coral Bay and Exmouth. Participants also noted that, despite the formal governance arrangements, it is Exmouth that provides Coral Bay with essential services such as fire, ambulance, policing and emergency services. This blurring of traditional linkages introduces complexities regarding governance and planning arrangements, and further, how participants relate to the region and develop a sense of place.

The boat ramp development located at Monck Head was a frequent discussion point. The development located 1.5km out of Coral Bay centre includes parking for between 100 and 200 vehicles, a service jetty and a sealed road joining the development to the main access route. The intended purpose of the ramp was so to manage the launching of boats in a bid to regulate launching access points and limit potential detrimental impacts on the near shore areas of Coral Bay. Support for the ramp varied widely from extremely negative to highly positive. Specific concerns related to the positioning of the ramp, with criticism directed at the way in which the ramp was constructed as some participants reflecting on the consequential environmental impacts to the shoreline. The ramp to some was also perceived as a risk whereby it has enabled larger more powerful boats to enter. Some participants reflected that the introduction of the ramp had lead to detrimental impacts on fish stocks. Comparatively, other participants perceived the ramp to be of benefit to the community and the environment, whereby the ramp was seen to be a wise environmental management strategy. More specifically the development meant that with the sealed road and specified area structured boat launching could be monitored placing pressure on only one section of the coastline.

Maud's Landing was a highly contested discussion point. Maud's Landing was a proposed marina development on the northern outskirts of Coral Bay during 2002. The proposed development plan resulted in high degree of public scrutiny and the launch of the 'Save Ningaloo' campaign, in which the Maud's Landing proposal received a wide ranging negative criticism ranging from locals to Australian celebrities and consequently received adverse international attention. Individuals were impassioned by the proposal with parallels made to the perceived damaging impacts of coastal developments on the east coast of Australia. An outcome of the publicity was the introduction of the Ningaloo Sustainability Office and the Ningaloo Sustainability Committee, the latter formed as a means to ensure that there was sufficient community consultation for future development plans in the region. Participants' opinions regarding the history of the development were strong and were either in strong opposition to the proposal (including larger developments for the region more generally) or the

perception that the rejection of the proposal was to the detriment of the region. Detriment was seen in the loss of tourism potential, and, lost opportunity for more sufficient housing and capital works to support the existing community. Some participants, reflecting on their local knowledge of the area and the coastline, saw the proposed development site as the best location due to tides, currents and depth of the marina.

4.1.4 Common themes

Across the interview settings, there were a series of common themes that emerged. These are summaries and discussed in the following section.

Governance

Issues associated with governance were consistent across all three communities. The major concern related to a sense of powerlessness associated with regional planning – both in terms of the governance and planning of the Marine Park, and community development. Concerns about current governance structures were directed at all tiers of government, (local, state and federal decision making process) and also in relation to scientific and research practices that occur in the region.

Governance comments tended to be related to issues associated with how community members in the region noticed a differentiation between themselves and people in city areas. For instance, in relation to how people think about time (slower pace and more relaxed in the regions), and the relative lack of a range of opportunities in comparison with the city.

Consistently, there was the expressed desire for a change to occur in the current local government approaches, for instance, “[we] would like to work with the Shire but tend to work against the Shire” and the reflection that within the region it is, “a battle to implement change”. The desire for change was a commonly discussed theme within all of the communities. Potential changes to Shire boundaries were discussed with concerns relating to property rights.

Local Ownership

Local ownership was a common theme across the towns visited and again related to criticisms to current governance structures (local, state and federal levels). Town assets, particularly in relation to industries (e.g. fishing, horticulture, tourism), or natural assets (e.g. reef, fish stocks) are perceived as being locally owned and accordingly there is the desire for the management and planning of these resources to be based locally. There was a degree of resentment associated with external control, including governmental and scientific control of local resources. In instances where their control is not locally based there is the expectation that there should be processes in place to ensure that local needs are heard and that there is the opportunity for local opinion to be voiced. Criticism was directed towards processes that claim to employ a consultative framework but in reality resemble a tokenistic approach to genuine engagement. In Exmouth there is a sense within the community that tourists are “coming into my backyard”, and while there is an appreciation that tourism is an important industry there was often resentment directed towards tourists, for instance one resident commented “Exmouth people hate terrorists, not tourists, terrorists”.

Changing Fishing Patterns

Changes in fishing patterns were a concern to both government departments and the broader community particularly as it was reported that it was “getting harder and harder to catch a fish”. Locals, particularly in Carnarvon and Exmouth reported on changes in visitor fishing behaviour thought to be due to modified fishing zones and falling fish stocks as far south as Bunbury and Busselton. Subsequently, locals reported that in recent years there has been targeted and high intensity fishing from private non-commercial vessels. One participant reflected that “(it is) now a case of six guys on a boat - dedicated fishermen”. This practice was criticised, not only for the detrimental impact it was seen to be having on fish stocks but also in regard to the way in which the practice was perceived as skirting around regulatory requirements. This type of fishing practice was also seen to damage the image of recreational fishing, particularly in Carnarvon. Recreational fishers there appeared to pride themselves on their efforts in promoting and policing sustainable fishing, both commercial and recreational, and also their extensive local knowledge regarding fish habitats, stocks and behaviours. The perceived problematic recreational fishing patterns that have been emerging were seen to threaten this image and similarly enjoyable and equitable fishing behaviours for both visitors and locals. Fish tended to be recognised as a highly valuable asset – either for commercial or recreational consumptive purposes, their aesthetic qualities particularly in relation to tourism and how each species has a role within the broader ecosystem. These complex and often competing values provide a critical link between the three communities surveyed.

World Heritage Listings

There was extensive discussion associated with community perceptions of the costs and benefits of World Heritage Listings. Generally there was the sense that World Heritage listings restrict growth and development opportunities for the towns. There were also concerns associated with flow on effects of the listing, particularly in relation to increases in tourism numbers on the already stressed accommodation and housing provision, particularly in Coral Bay and Exmouth.

Within the business community there were concerns regarding implications associated with Heritage Listing and restrictions to potential future business development. Myths within the community were present regarding the World Heritage Listing process with claims that additional restrictions, such as buffer zones are often introduced. Particular anxieties related to restrictions to town and residential development as a consequence of World Heritage listing.

Other community members felt that there was mythology associated with the impacts of World Heritage, particularly in reference to concerns associated with restrictions to town or regional development. There were local efforts made to dispel mythology that surrounds the proposal and the feared impacts.

Reported negativity towards science and research in the region

Participants expressed concerns regarding the on ground applicability of science that had been conducted in their community and more generally along the Ningaloo coastline “no practical application on the ground. Purely scientific, although valuable data, the fundamental question is where does that value help the people on the ground”. Furthermore there were concerns as to who had responsibility in the implementation of research findings, with particular reference to the modelling

work and “no group’s going to drive and hold hands with the community...no drive and it is like the North West Shelf, what is the point of it?”

The scientific process was discussed as something that the local community runs the risk of being detached from, for example it was stated, “have to have community buy in – not the seagull mentality”. In this instance, the participant compares scientists and researchers to seagulls, drawing parallels between the way in which scientists and research ‘swoop’ into communities, scavenge for information and data they require and then leave again. This approach was heavily criticised across all communities and consequently there was an expectation of the researcher or scientist to appropriately engage the local community. The issue of engagement was also considered in depth by some participants, whereby the integrity of the participatory process by some parties in the past was described as “tick box consultation”. In such instances, this form of participation was equal to or more damaging to the community than had no consultation occurred at all.

There was a general perception that the science that has been conducted in the region, particularly in relation to the Marine Park is marred with negativity in that the threats to the area or potential restrictions to behaviour seem to be more prevalent for Ningaloo rather than collaborative solutions in communications. Furthermore there was some concern that science tends to pose problems but fails to suggest solutions. There was also a sense that there is an “assumption that people (scientists and researchers) are expecting the worst of people”. In part, this appeared to be related to the way in which community members articulated a power differentiation between themselves and the scientific and research community, for instance, one participant reflected, the feeling that “he’s the scientist, I am just a yobbo”.

4.1.5 Issues expressed within the Scientific, Research and Governance Settings

This research also engaged participants from scientific, research and governance settings. This process provided valuable insight into the challenges and opportunities that these individuals felt in relation to not only their engagement within the Ningaloo Cluster, but also in terms of how they conceptualised their roles in science or governance more generally. Several issues emerged that were pertinent across groups and are discussed as follows. Significantly, while separate issues emerged, they appear to be intrinsically linked and suggest the need to introduce new ways of thinking about and conducting science.

Post –Project Life

In part, this project emerged in response to experience from the North West Shelf modelling exercise whereby there were limited mechanisms to support or house research findings post research program. The life of a research project emerged as a serious issue for the Ningaloo Collaboration Cluster work, which has largely been supported by the findings of this project. Notably, there are limited resources available within the community – both social and in terms of infrastructure within the towns. It was recognised by the scientific and research community that there are limited mechanisms written into projects to mark a transition between data collection and interpretation and then into the phase whereby findings are implemented. Some researchers/scientists did not deem this to be an important part of their role, or their role at all. For others, it was recognised as being a critical flaw in the way in which research is conducted and perceived as detrimental to their own cause by not being able to ensure that their work has utility in ‘the real world’. Participants with governance roles also

recognised this limitation within the prevailing scientific paradigm and appeared challenged as to the viable ways in which this could be resolved. This was particularly the case for regional settings where there was a pre-existing sense of being physically and socially removed from the city where the vast majority of researchers are based. The tyranny of distance in this sense also contributes to a sense of disempowerment.

Collaboration and Data Sharing

Within the broader Ningaloo Cluster, at times tensions emerged regarding intellectual property (IP). The tensions typically were across institutions where there was reluctance to provide data for the broader modelling project. In some instances, the apprehension to provide data was in a bid to protect the IP interests of PhD Students. Clear parameters and agreements regarding IP need to be considered to the commencement of projects to ensure that expectations regarding data sharing are defined and any limiting factors (such as time lines) are pre-empted. This is particularly important in instances where collaborative research arrangements are cross-disciplinary and extend across institutions that may have their own IP policy.

4.1.6 Community Engagement

The engagement process was raised by some participants as being a complex component of their research, this was particularly the case for researchers/scientists who were not from a social science background and yet found themselves acting in roles that would traditionally constitute social research. Given the scale and multitude of the research projects within the region, appropriate engagement is particularly critical. The number of researchers in the region at any one time and the expectations regarding community involvement varied widely.

Engagement also emerged as an issue when more traditional science was being conducted, for instance scientific activities that occurred on the reef, or terrestrial projects that did not explicitly entail social engagement with community members. Some community members and regional based government or community groups, lamented over some of the scientific conduct observed by research institutions that visited the region for research purposes. Particular concern related to inappropriate use of anchors, poor sharing of the waterways or general inappropriate interaction with the reef. Some participants were particularly perturbed by the non-compliance of scientific researchers and expressed concern that bad behaviour is particularly detrimental given the status associated with science. The concerns expressed by locals related to both violations of laws such as those pertaining to appropriate conduct within the Marine Park, and also social customs and rules. Such customs and rules, although not necessarily explicit in the form of publicised laws were related to expectations of visitors based on mutual respect. For instance, it was reported that at times, there was an air of arrogance amongst the scientists and researchers who visited the town. This arrogance was seen in instances of impatience or criticisms over service or facilities within the town.

As part of the sociogram exercise, one participant reflected directly on the relationship between the scientific, research and bureaucratic community and the regional communities and is illustrated in Figure 4 Participant sociogram.

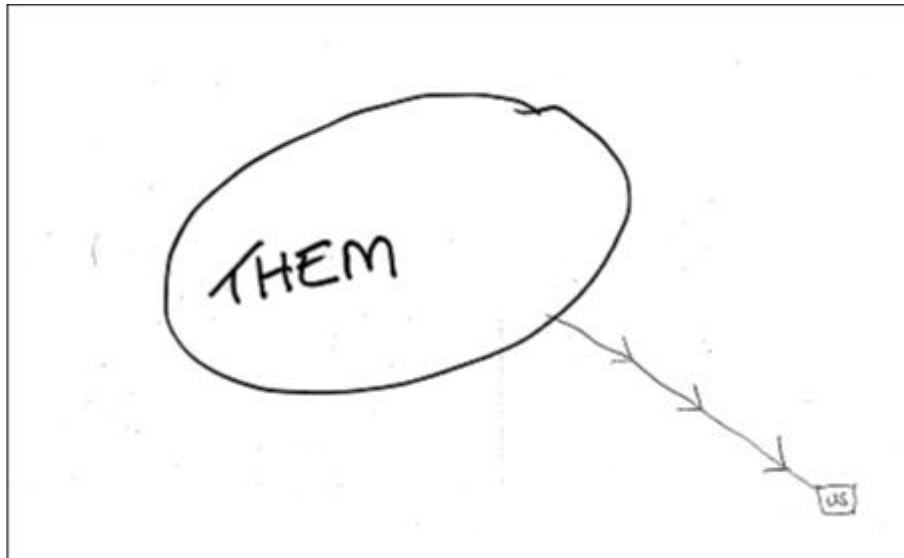


Figure 4 Participant sociogram

The term “**THEM**” is used to describe the roles of scientists, researchers and bureaucrats, whereas the term “us” is used to describe the role of the communities. There is a lot of symbolism used in the sociogram. Firstly, ‘**THEM**’ is written in a dark, bold pen; the symbolism associated with the scale of the term is important. “**THEM**” has a foreboding presence over “us” and further contributes to the sense of domination over the community, as does its positioning above the term “us”. Comparatively “us” is written in finer and smaller print, contributing to the symbolic sense of being small, or lacking in power. The direction of the arrow is also indicative of the direction of influence and power over the community by governance, scientific and researcher agencies. The multiple arrow heads further suggests that there are multiple pressures that are imposing on the community. Further interpretation of the associated symbolism of the diagram is in the way in which “us” has been enclosed in a square box suggesting that the community is confined and boxed in. “them” while still enclosed is circular and as a shape suggests freedom.

The image was drawn by the participant as a means of depicting the social and institutional pressures that are experienced within his community, much of which emerged about of the relationship between “us” and “them”. This sociogram illustrates an important point, namely that despite all parties perceiving they have a common objective or outcome e.g. working towards a sustainable Ningaloo, there are procedural issues that have lead to the communities experiencing a sense of disempowerment. The dynamic of such relationships between community and research raises an interesting paradox. The functional role of researchers/scientists has the capacity to both enhance or assist a community, but the processes in which this engagement process occurs also has the propensity to disempower the community. This sociogram serves as a critical reminder of the implications of poor engagement with local communities.

Issues and anxieties regarding the engagement of traditional owner’s in research were raised by both researchers and community members. Here researchers expressed frustration in not being able to engage with aboriginal community members, with many researchers expressing concerns that they felt

ill-equipped to engage effectively and sensitively with the local Aboriginal community⁴. As a consequence, engagement with Indigenous community members across research projects has been limited. This poses a concerning implications regarding the application of research findings within an Indigenous context. Instances where engagement has been successful provide the opportunity for learning about engagement processes in the future. Such success stories have pointed to specific social processes as being important, for instance, a prolonged and genuine presence within the community, efforts at minimising Indigenous community fatigue and burnout in multiple research processes, evidence of cultural competence, researchers of both genders available for contact, understanding of Indigenous knowledge as expert knowledge, appropriate use of Indigenous expert knowledge, appropriate processes such as payment for learning from and engagement with Indigenous experts, and appreciation of non-Western based conceptualisations of time. Time was often a particular frustration within the scientific and research community, whereby timelines and deliverables for scientific or research purposes would not necessarily coincide with the time required to be invested within Indigenous communities that is suitable engagement.

4.2 Card Sort Exercise

Results from the card sort exercise illustrate that the level of interaction with the 44 organisations listed differed significantly from participant to participant. Table 2 Card Sort Exercise shows the breakdown of interactions across different organisations reported by the participants. Taking into account only the valid responses from participants, we calculate that the average participant can be expected to interact with just under half (47.6%) of the organisations. Although the numerical values appear similar for interactions and non interactions, it is essential to recognise the difference that some interactions are 'helpful' and others are 'not so helpful'. While interactions that were described as 'helpful' were ones which enabled participants to perform their role in the Ningaloo, interactions that were 'not so helpful' were not necessarily interactions which hindered the ability to fulfil a participant's role in the area. These responses also indicated that the interaction was not of primary importance to fulfilling their role.

Participants rated only 17.3% of the interactions as 'helpful', but most (79.2%) had at least one helpful interaction. Participants who had found one organisation helpful were highly likely to have found multiple organisations helpful; occurring in 80% of cases. Some organisations were not considered 'helpful' by any participants. These were largely research organisations and universities, such as CSIRO, Curtin University, Edith Cowan University, Murdoch University and the University of Western Australia. Overall, CSIRO was the organisation with fewest interactions, either helpful or not so helpful.

Organisations where few participants had given a rating 'not so helpful' generally had a higher rating of no interaction as well. This could be due to a lack of information and knowledge about the organisation. Organisations which scored higher for 'not so helpful' generally had less non-interaction. This indicates that it was being utilised more frequently but yielded less helpful interactions.

⁴ Unfortunately a project to engage with aboriginal communities collapsed after the researcher involved resigned from CSIRO.

Table 2 Card Sort Exercise

Organisation	Helpful	Not so helpful	No interaction	Missing data
Australian Institute of Marine Science	0	7	16	9
Baiyngu Aboriginal Corporation	2	10	10	10
Bureau of Meteorology	2	8	9	13
Camping Accommodation Providers	2	10	10	10
Cape Conservation Group	1	13	10	8
Commercial Fishing Industry	2	12	8	10
Coral Coast Parks Advisory Committee	0	13	9	10
CRC for Sustainable Tourism	0	7	15	10
CSIRO	0	5	18	9
Curtin University	0	4	15	13
Department of Planning and Infrastructure	3	2	16	11
Department of Environment and Conservation	4	2	15	11
Department of Environment, Water, Heritage and the Arts	1	11	10	10
Department of Fisheries	3	6	13	10
Department of Industry and Resources	2	12	8	10
Department of Water	2	6	14	10
Eastern States Universities	3	11	7	11
Edith Cowan University	0	7	13	12
Environmental Protection Agency	0	10	10	12
Existing Community	3	2	15	12
Gascoyne Development Commission	2	5	16	9
Geosciences Australia	0	12	10	10
Limestone Industry	4	14	6	8
Local Recreational Fishing Groups	1	11	11	9
Local Tourism Operators	3	2	7	20
Murdoch University	0	4	16	12
Ningaloo Cluster Management Committee	0	8	12	12
Ningaloo Reef Outback Coast Association	3	14	3	12
Ningaloo Sustainable Development Commission	1	5	16	10
Ningaloo Sustainable Development Office	0	3	11	18
Oil and Gas Industry	2	10	11	9
Pastoralists	5	8	10	9
Recfish WA	3	14	6	9
Resort and Hotel Accommodation Providers	2	8	11	11
Salt Industry	3	13	4	12
Shire of Carnarvon	1	6	15	10
Shire of Exmouth	4	6	12	10
The Wilderness Society	3	16	4	9
Tourism WA	1	6	16	9
University of Western Australia	0	5	15	12
WA Museum	2	12	7	11
Water Corporation	1	8	11	12
Western Australian Marine Science Institution	2	7	13	10
World Wildlife Fund	4	13	6	9
Total	77	368	490	473

Participants were prompted to comment on any themes or linkages that characterised how they sorted their cards. ‘Helpful’ groups or organisation tended to reflect the key points of interaction for the participant. Typically, helpful groups or organisations were those that had a direct functional or pragmatic utility (e.g. a collaborative arrangement) but in addition possessed a style that made interaction favourable (e.g. the personalities of those employed, professionalism, knowledgeable and hard working).

4.3 Regular Role Equivalences

Group clusters for regular role equivalences were determined and are illustrated in Figure 5 Group Clusters for Regular Role Equivalence in the Ningaloo Network.

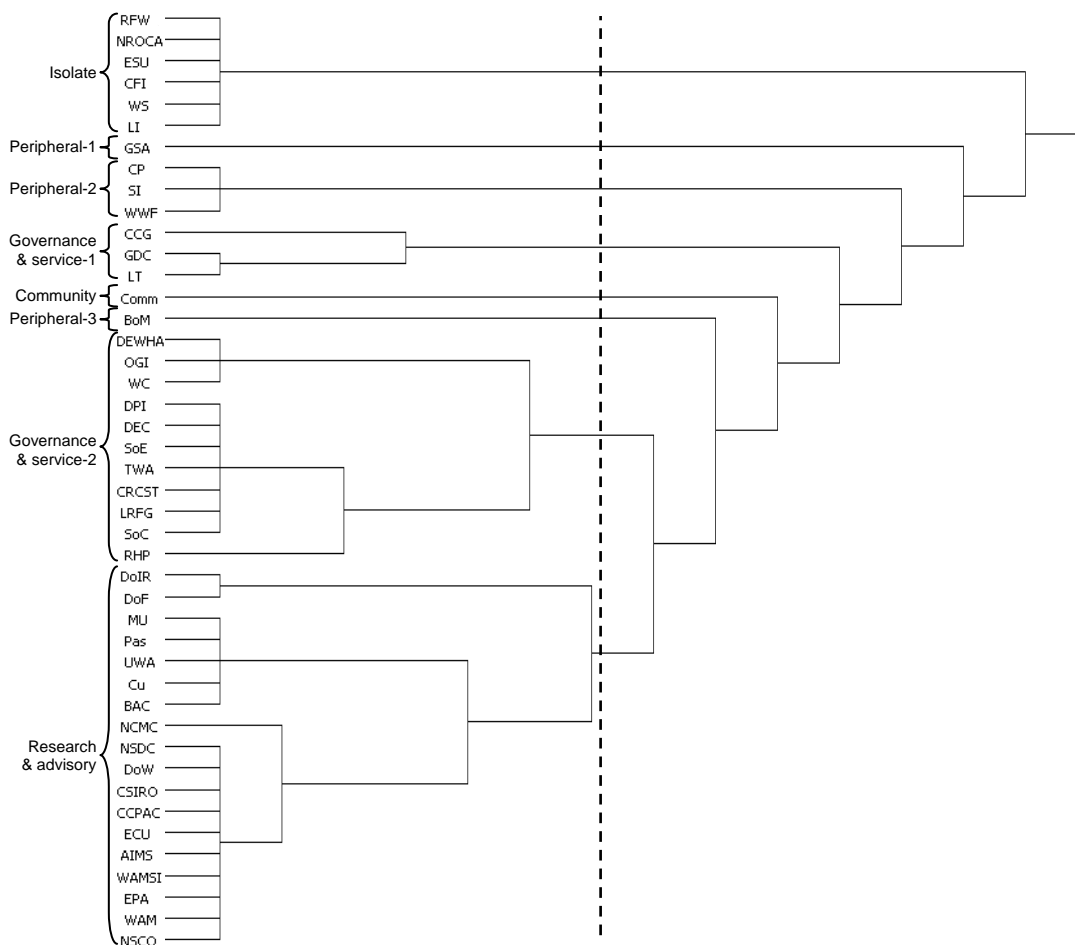


Figure 5 Group Clusters for Regular Role Equivalence in the Ningaloo Network

Based on knowledge obtained from interviews, desktop enquiry, and through other forms of interaction with the groups (such as symposiums and workshops) a thorough understanding of the dynamic, roles and responsibilities of these groups has been developed. Based on such findings, we were able to appraise the group clusters which emerged through the Regular Role Equivalences analysis. The emergent clusters made intuitive sense, further; we were able to name each of the

clusters with a title that appropriately captured the role that they serve within the Ningaloo network. The titles include:

Isolate: a node that is not connected to the network. In part this may be due to sampling measures.

Governance, Industry and Service: nodes that whose role is characterised by service delivery duties. This particular group consists of groups that have more of a regional focus, for instance, may have an office that works out of the towns sampled or provide local services or industry (e.g. Limestone Industry).

Community: a single node consisting of community members from Carnarvon, Coral Bay or Exmouth.

Peripheral: nodes that are connected to the network on a peripheral basis connected by only one unidirectional or bidirectional link.

Research and Advisory: nodes that are affiliated with research institutions and Government Departments who engage in research, and, the key advisory groups that they engage.

4.4 Sociogram Analysis

As discussed earlier in the methods section, analysis of sociograms was conducted using UCINET. Doing so allowed for the construction of individual ego networks and the whole Ningaloo network. For both sets of data, nodes are colour coordinated so to capture the groupings that emerged through the analysis of Regular Role Equivalence. Figure 5

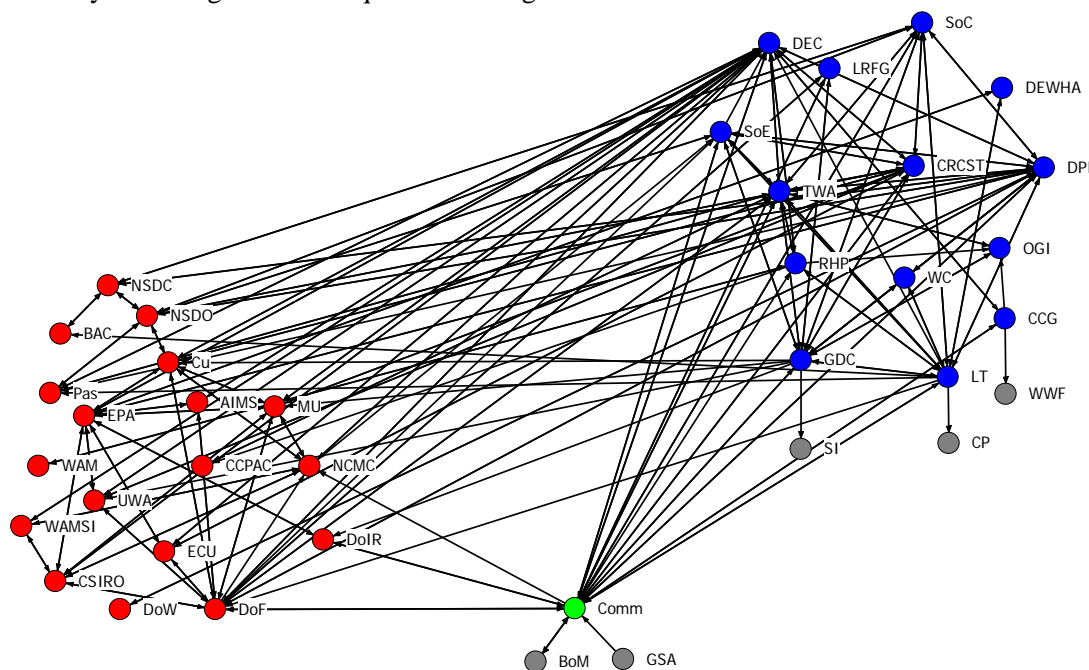


Figure 6 Whole Ningaloo network with group clusters for research and advisory (red), governance and service (blue), community (green), and peripheral (gray) nodes; six isolate nodes are excluded. Further, due to the similarity in role evidenced in Governance and Service 1 and Governance and Service 2 both of the group cluster nodes are presented in blue.

Combined with the groupings obtained through the analysis of Regular Role Equivalence as illustrated through the colour coding, the figure conveys some interesting findings.

Peripheral (Grey Nodes)

Peripheral nodes consisted of the Bureau of Meteorology (BoM), Geosciences Australia (GSA), Salt Industry (SI), Camping Accommodation Providers (CP), World Wildlife Fund (WWF), Cape Conservation Group (CCG), Oil and Gas Industry (OGI) and the Department of Primary Industries (DPI). These groups may be presented as peripheral in this particular network as a consequence of the sampling.

Community (Green Node)

Notably, there are few direct links between the community and the Research and Advisory Group Cluster. Further the only bidirectional link is between the community and the Department of Fisheries. The community is more readily linked with the Governance and Service Cluster (Blue Nodes), which consists of groups which tend to have a regional base and presumably greater opportunity to be engaged with the regional community.

Governance and Service Agencies (Blue Nodes)

Consists of all of the key regional players within the Ningaloo Cluster, namely, the Shire of Exmouth (SoE), Shire of Carnarvon (SoC), the Gascoyne Development Commission (GDC), Local Tourism operators (LT), (CCG), Tourism WA (TWA) service agencies including Water Corporation (WC), Hotel and Resort Accommodation Providers (RHP). Government departments include the Department of Environment and Conservation (DEC), Department of Primary Industry (DPI), Department of Environment Water, Heritage and the Arts (DEWHA). Local groups were also clustered, including Local Recreational Fishing Groups (LRFG), as were the Oil and Gas Industry (OGI). The presence of the LRFG and OGI, make sense to be included in this cluster given their regional focus.

Research and Advisory (Red Nodes)

Majority of Government agencies engaged in research and management of the NMP together with Universities and major research organisations cluster together. This makes intuitive sense given the level of interagency collaboration that had been invested in the project, particularly through the Ningaloo Cluster and WAMSI. Government Departments that were not clustered under the Governance and Service Agencies Cluster were notably departments that have a greater regional presence, such as DEC for their management and enforcement of sanctuary zones within the Reef.

4.4.1 Ego networks

Ego networks were collected to consider networks at the independent group level. Particular groups were chosen from our snowballing sampling technique. This means that they were gathered by reference from others. While this can be regarded as legitimate in that we were collecting interactions between organisations who clearly recognised by several others as having an actual or potential role in the management of Ningaloo it must be recognised that some agencies may have been missed because of the purposive nature of the sampling. This is unlikely to be a significant failing as new

relevant agencies have not appeared over the year since out data collection has been completed. The value of the independent group level ego networks are in observing overarching trends in the types of links present as opposed to making explicit claims regarding the content of the ego networks.

Ningaloo Cluster Management Committee (NCMC) Ego Network

Specific analysis was undertaken to consider the ego network of the Ningaloo Cluster Management Committee (NCMC) as in part the aim Ningaloo Client Outreach project was interested in the gauging avenues for the adoption of science generated within the Ningaloo Cluster as illustrated in Figure 7 Ningaloo Cluster Management Committee.

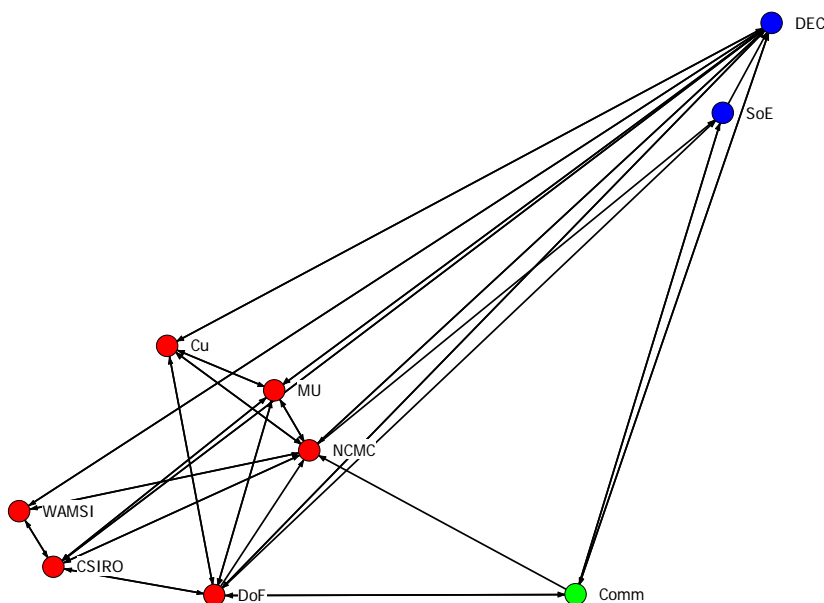


Figure 7 Ningaloo Cluster Management Committee

Most obvious are the links present between the major collaborative partners (CSIRO, WAMS, Curtin University, Murdoch University, Ningaloo Cluster Management Committee). These links make intuitive sense given the intention of the Ningaloo Collaboration Cluster as to facilitate coordinated science across discipline and organisation. Absent however are the University of Western Australia, DEC and AIMS (all positioned within the Governance and Service Cluster).

The Shire of Exmouth is captured in the ego network, however, Shire of Carnarvon is absent. This is congruent with Carnarvon community reflection that they felt less engaged in research that was conducted in Ningaloo. This may be a consequence of Carnarvon’s coastline not being part of NMP and fewer research projects focussing on this geographical region.

The Shire of Exmouth, and DEC are the only nodes captured in the ego network from the Governance and Service Cluster, notably the cluster that has been associated with having a regional presence.

The community is captured in the ego network, however, the direction of the arrows connecting the Community node directly to the NCMC node is of interest. The uni-directional arrow points from the Community node to the NCMC node, which indicates that the community helps the NCMC with their

role in the management of Ningaloo, however, this is not reciprocated. The DoFWA acts as a gatekeeper between the Community and the NCMC, whereby the source node (the community) belongs to a different group to the DoF and NCMC.

Shire of Exmouth (SoE) EgoNetwork

An EgoNetwork of the Shire of Exmouth (SoE) was conducted due to the importance of their governance role; see Figure 8 Shire of Exmouth. The EgoNetwork of the SoE includes several other groups as part of the Governance and Service Network Cluster (Blue Nodes).

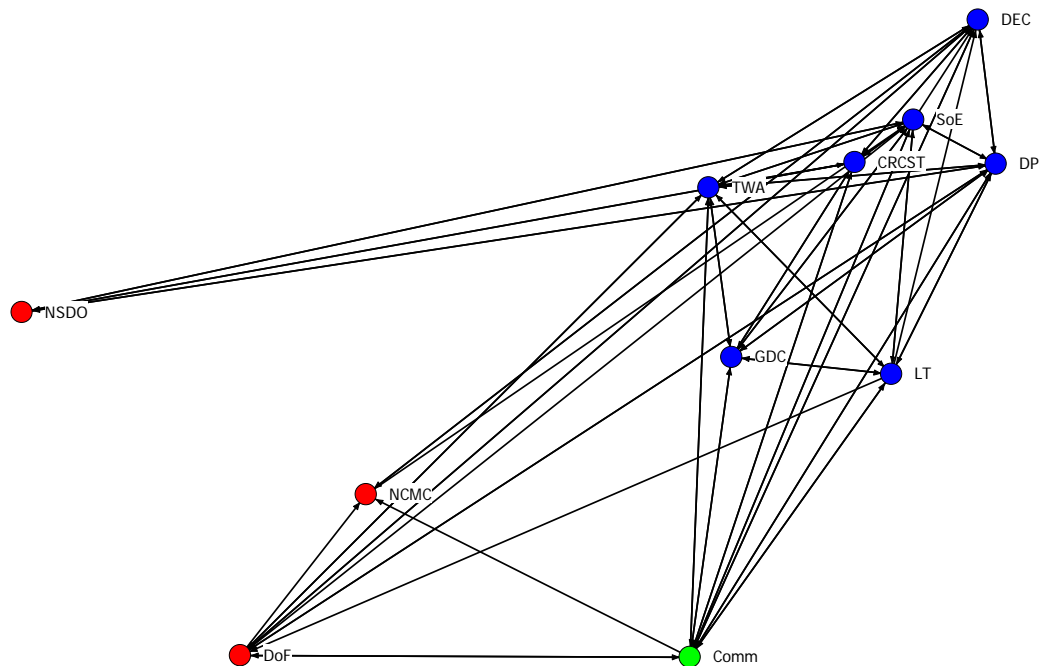


Figure 8 Shire of Exmouth

Noteworthy however is the absence of the Shire of Carnarvon as captured in this sample. There are bi-directional links to the community. Links to NSDO, NCMC and DoF are the sole groups from the Research and Advisory Network Cluster (Red Nodes). The significance of the NSDO was raised by Shire participants during interviews and explicit concerns expressed regarding the implications regarding the closure of the office. Interestingly, the Ningaloo Sustainable Development Committee (NSDC) was not captured in the SoE ego network, despite discussion of the perceived importance of the role of the committee in connecting science, governance and the general community.

Shire of Carnarvon (SoC) EgoNetwork

An Ego Network of the Shire of Carnarvon (SoC) was conducted due to the importance of their governance role, as seen in Figure 9 Shire of Carnarvon.

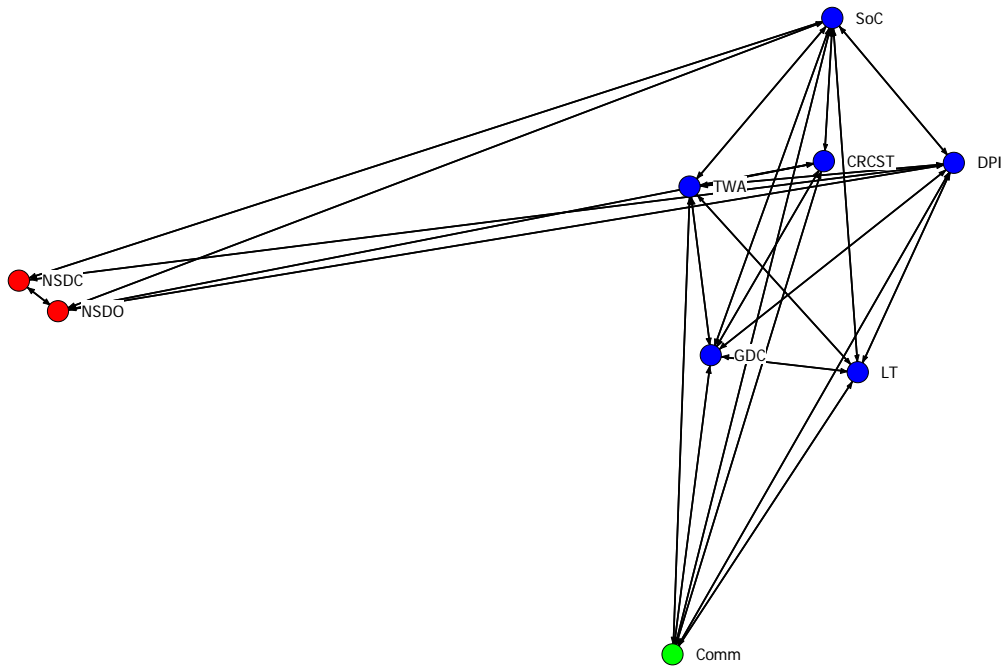


Figure 9 Shire of Carnarvon

Noteworthy is the absence of the Shire of Exmouth in this ego network which supports discussion by participants regarding the lack of integration across the Shires. The ego network appears comparatively less dense than the SoE.

Gascoyne Development Commission (GDC) EgoNetwork

An ego network was constructed for the Gascoyne Development Commission out of interest in its governance role and to explore its reach, for instance, industry or research links as seen in Figure 10 Gascoyne Development Commission.

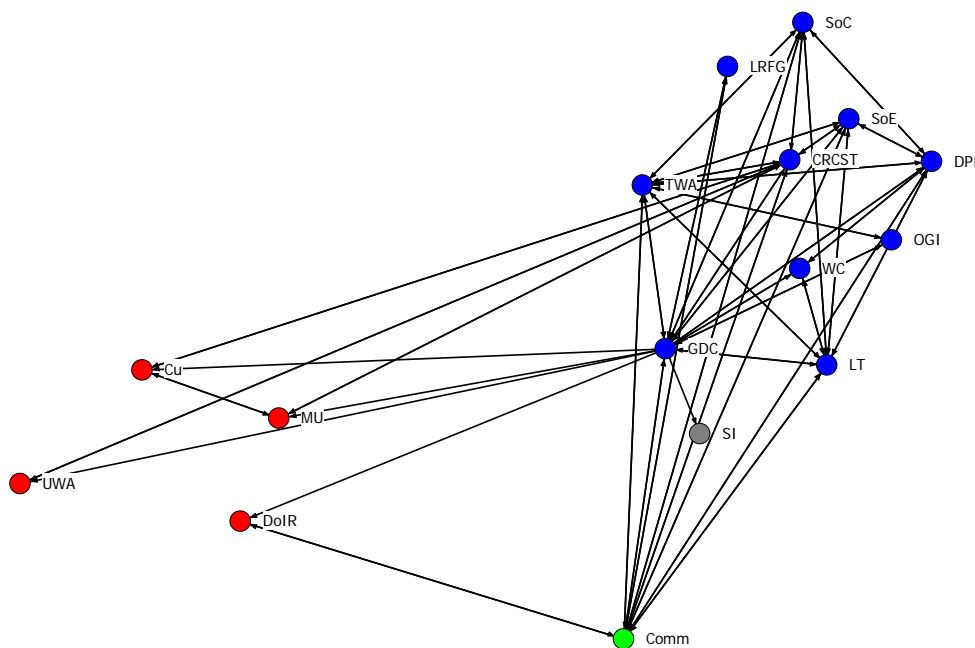


Figure 10 Gascoyne Development Commission

The GDC was the sole link to an Isolate Cluster node including the Salt Industry (SI). Oil and Gas Industry (OGI) which makes intuitive sense given the role of the GDC and their likely clients being industry based. Both Shire of Carnarvon (SoC) and Shire of Exmouth (SoE) are included. Notably, the CSIRO and Ningaloo Cluster Management Committee (NCMC) are absent; one could have anticipated that link would have been present.

Department of Environment and Conservation (DEC) EgoNetwork

An ego network for the Department of Environment and Conservation (DEC) was conducted given that the Department was a key driver within the Ningaloo Collaboration Cluster, see Figure 11 Department of Environment and Conservation. There was also interest to further explore its network given that in the analysis of Regular Role Equivalences, it was grouped in the Governance and Service Cluster as opposed to the Research and Advisory Cluster.

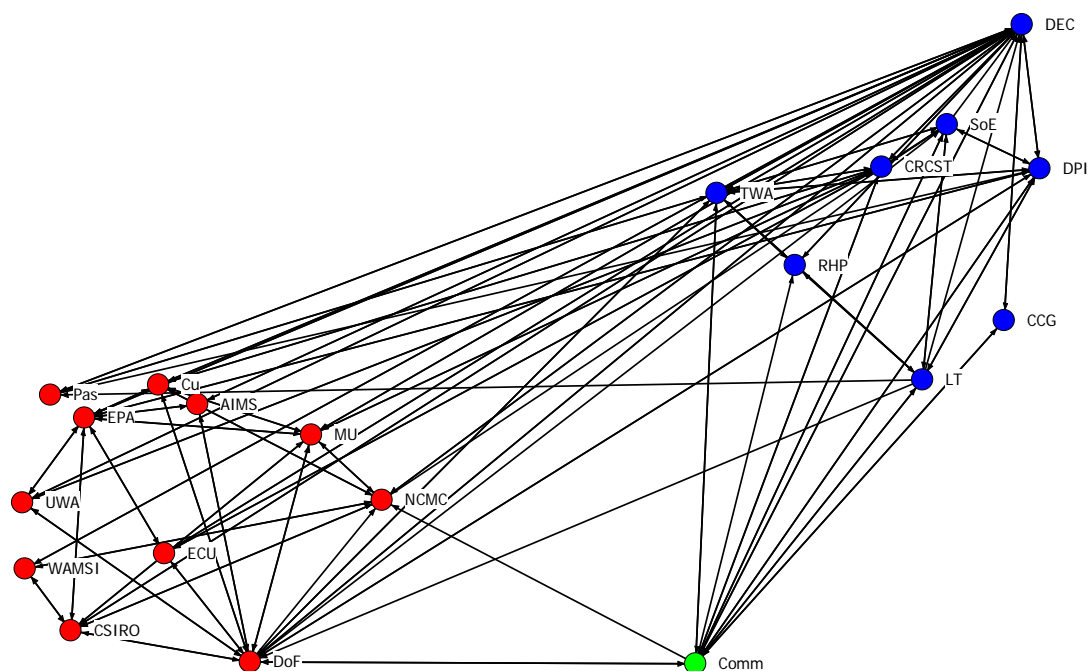


Figure 11 Department of Environment and Conservation

The ego network is quite dense, with a large contingent of the Ningaloo Cluster captured in their sociogram. Notable however is the absence of the Shire of Carnarvon from the ego network.

Department of Fisheries (DoF) EgoNetwork

An ego network of the Department of Fisheries (DoFWA) was developed to explore any nuances as illustrated in Figure 12 Department of Fisheries.

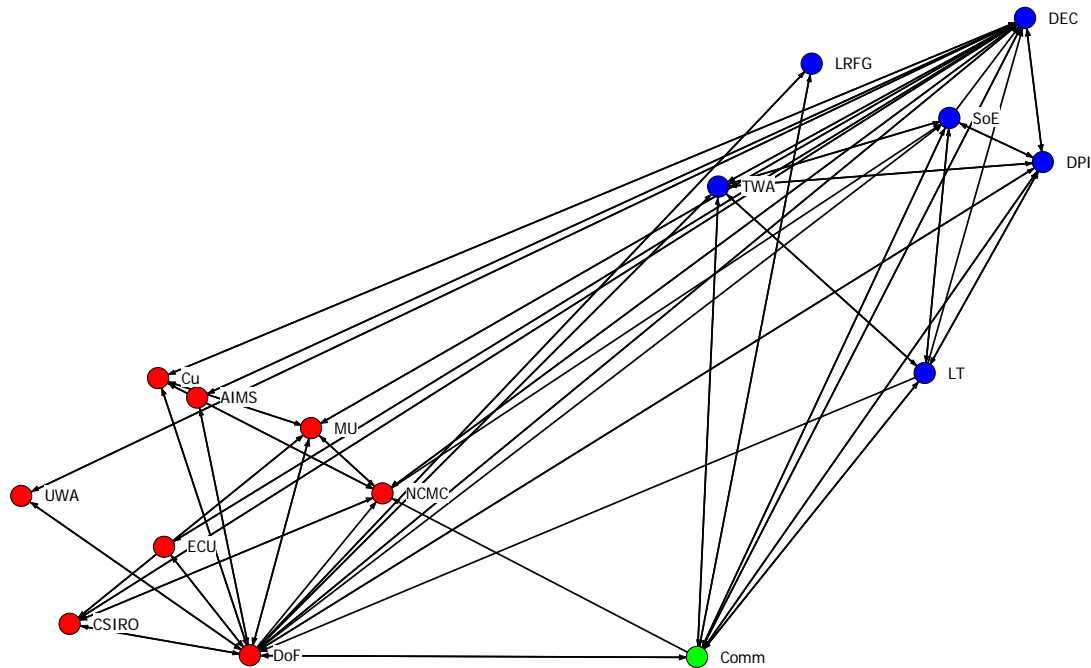


Figure 12 Department of Fisheries

DoFWA serves multiple roles within the region. Not only does the Department have a research focus, they also have a policing and enforcement role. This makes for an interesting if not complex series of relationships; they actively engage with other research agencies, while also having a physical presence within the region. The multiples roles may account for the many linkages present in the Department's ego network. Most critical is the bi-directional link to the community.

Ningaloo Sustainable Development Office (NSDO) and Ningaloo Sustainable Development Committee (NSDC)

The cessation of funding to support the Ningaloo Sustainable Development Office (NSDO) and the Ningaloo Sustainable Development Committee (NSDC) was met with a high level of apprehension from its participants and from sectors within the community. The Office and the Committee were perceived as valuable links between the broader Ningaloo community and other agencies. As such, there was interest in considering the ego network for the NSDO was conducted to investigate the level of connectedness within the network.

An ego network of the Ningaloo Sustainable Development Office (NSDO) was derived based primarily on regional expressions of concern regarding its pending closure (Figure 13 Ningaloo Sustainable Development Office). Notably there was no community node, and links are exclusively from the Research and Advisory Cluster, and, the Governance and Service Cluster.

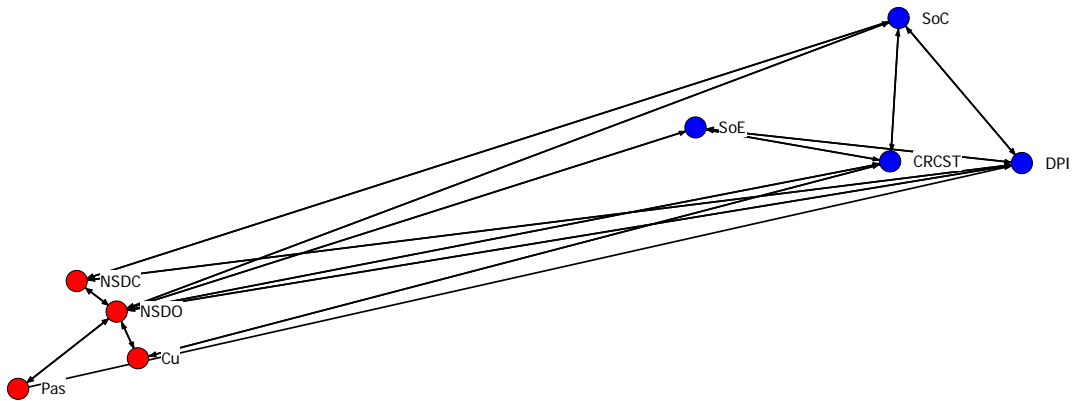


Figure 13 Ningaloo Sustainable Development Office

An ego network of the Ningaloo Sustainable Development Committee (NSDC) was developed based primarily on regional expressions of concern regarding its pending closure. Figure 14 Ningaloo Sustainable Development

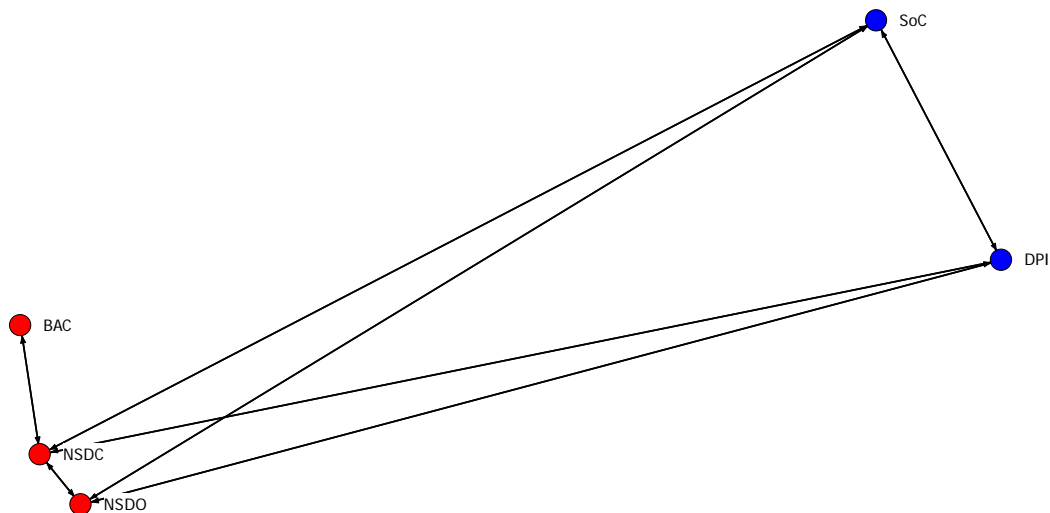


Figure 14 Ningaloo Sustainable Development Committee

Notably there is no Community node and links are exclusively from the Research and Advisory Cluster, and, the Governance and Service Cluster. A vital link is present between the NSDC to the Baiyungu Aboriginal Corporation (BAC).

4.4.2 Brokerage

As discussed in section 3.4.2 Considering Brokerage, an analysis of brokerage was conducted. See Table 1. Table 3 below, summarises the types of brokerage according to the Cluster Groups whereby scores of 0.7 and greater are of interest statistically. Each Cluster Group is discussed in turn as the group relates to each of the brokerage roles.

Table 3 Composite brokerage measures for three groups of nodes in the Ningaloo coastal tourism network (Table 1); brokerage definitions follow Gould and Fernandez (1989), Figure 11)

<i>Brokerage values</i>					
Groups	Coordinator	Gatekeeper	Representative	Consultant	Liaison
<i>Observed</i>					
Community	---1	---1	---1	53	80
Governance & service ²	170	153	230	118	59
Research & advisory	119	92	74	21	0
<i>Expected</i>					
Community	---1	---1	---1	70	63
Governance & service ²	103	161	161	161	145
Research & advisory	43	67	67	67	61
<i>Observed divided by expected</i>					
Community	---1	---1	---1	0.76	1.27
Governance & service²	1.65	0.95	1.43	0.73	0.41
Research & advisory	2.76	1.37	1.10	0.31	0.00

¹Community is represented by a single node in the Ningaloo network, thus it cannot exhibit this type of brokerage.

²Governance & service-1 & -2 combined.

Community Cluster Group (represented as a single node)

As the Community Cluster Group is represented by a single node, it is not possible for it to illustrate the Coordinator, Gatekeeper and Representative brokerage role (brokerage roles which consist of two or more nodes belonging to the same group). The community rated highly in the Liaison category (1.27). This may be due to the nature of rural communities whereby there is a greater proportion of champions and a higher level of volunteerism as compared to urban settings. Due to smaller population numbers proportionately there is a greater number of roles per person. The same needs and requirements are present as for urban communities; however there are less people within the communities to perform these roles. Consequently there is greater pressure on people to adopt these roles. The Community Cluster Groups high score on the Liaison category is particularly important given the comparatively low scores by Governance and Service (0.41) and particularly Research and Advisory at 0.00. As the Liaison consist of nodes belonging to different groups, The Community Cluster group, therefore appear the most active in engaging with other groups outside of their own. The Community Cluster Group scored 0.76 on the Consultant brokerage. In this brokerage relationship, the broker belongs to a different group and therefore serves an important role in communicating back to the group that consults them.

Governance and Service Cluster Group

The Governance and Service Cluster Group conveyed brokerage according to all of the five typologies, scoring the highest on the Coordinator Role (1.65) followed by the Representative (1.43). Of note is that the Coordinator category consists of nodes that belong to the same group, with only the recipient node of the Representative brokerage group consisting of a group outside of its own. High evidence of brokerage as Coordinators and Representatives makes intuitive sense given the sorts of duties and responsibilities that could be assumed of groups who perform governance roles – a high level of within group engagement (e.g. deliberation on decision making processes) with engagement with a recipient (e.g. a local community). Interestingly, a low Gatekeeper role score was reported (0.95). The Gatekeeper role is characterised by a source node being from a different group.

Research and Advisory Cluster Group

Research and Advisory Cluster Group scored highly on the Coordinator Role (2.76). This is of particular interest given the interactions of the Coordinator are limited to engaging with members of their own group (Research and Advisory Cluster Group interact with other members of the Research and Advisory Cluster Group). Research and Advisory have comparatively low scores for roles which entail engagement with other groups, particularly the Liaison Role with a score of 0.00 and the Consultant Role (0.31). The group's second highest score is on the Gatekeeper Role (1.37) this makes intuitive sense given that the source node is from a different group. In this instance, the different group may have a role in informing research endeavours. Brokerage which appears to be lacking within the Research and Advisory Cluster group is related to engagement with other groups. For instance, feedback of research activities to groups outside of the Research and Advisory Cluster Group may require development, with a comparatively low score of 1.10 for the Representative and a score of 0.00 for the Liaison – both brokerage roles characterised by recipient nodes belonging to another group.

Implications for Scientific Engagement

The Research and Advisory Cluster Group did not illustrate any liaison role within the network (the relationship between three nodes that are all from different groups). From our professional opinion, the absence of this form of interaction within the Ningaloo Network poses an interesting quandary. The absence of this brokerage role suggests that perhaps there is the need to consider the sorts of relationships and interactions which scientists and researchers are performing. For instance, if one argues that there is a need for a balance in brokerage types per group, it could be said that the Research and Advisory Cluster Group is severely underperforming in the liaison brokerage role. Alternatively, it could be argued that certain types of brokerage best suit particular roles. Given the comparatively high brokerage value of 2.76 for the Coordinator Brokerage role it could be interpreted that this form of interaction is what tends to characterise the interactions by scientists and researchers (i.e. they tend to interact with other scientists and researchers). As to whether this is the most appropriate dominant means of brokerage in the scientific and research domain can be debated. Interviews with researchers and scientists did point to changes in the way that scientists and researchers conceptualise their roles and more broadly their disciplinary paradigms. It appeared that some scientists and researchers are critically considering their roles, particularly in relation to

engagement with the general public and reflected that there is a growing need within the scientific and research community to be more active within the communities in which their research has impact. This was seen as achievable either through direct engagement with communities, or, through engagement with Government agencies that would essentially perform a liaison role for scientists and researchers. Currently however, Governance and Science Cluster Group have a relatively low Liaison score (0.41). The Community Cluster Group scored 0.76 on the Consultant brokerage (the highest for that brokerage), which suggests that the Community Cluster Group themselves may be active in facilitating their own feedback processes.

4.5 Key Player Analysis

Key Player Analysis was conducted with the intention of identifying within the Ningaloo Network the key player according to the most nodes that they reach within one, two or three links. Table 4 Key players in the Ningaloo network by the criteria of most nodes reached summarises the findings.

Table 4 Key players in the Ningaloo network by the criteria of most nodes reached

No. links	Key player	Nodes reached
1	Department of Environment (DEC)	53%
2	Community (COM)	100%
3	Ningaloo Cluster Management Committee (NCMC)	100%

DEC emerged as the most substantial key player, reaching 53% of the Ningaloo Network in one link. The community reached 100% of the Ningaloo Network in 2 links and the Ningaloo Cluster Management Committee (NCMC) reached 100% of the Ningaloo Network in 3 links. This is a pleasing finding in relation to the NCMC, indicating that the Cluster has the capacity to reach the entire network in a relatively few links, as would be expected as part of their role.

4.6 Conceptual Sociogram

As discussed, a list of stakeholders was devised at the onset of the project and utilised for the card sort exercise and also served as a reference list for coding the sociogram data. The formulation of this list was informed by analyses of white and grey papers and discussion and deliberation with key scientists in a bid to devise a holistic list of anticipated key stakeholders. As participants constructed their sociograms it was natural that we could not predict or anticipate all of the nodes included in their diagram, hence in addition to the initial list of stakeholders there is an array of additional nodes provided. It was decided that an additional sociogram analysis would be conducted to address these additional roles/stakeholders.

This conceptual sociogram, also captures the bonding ties articulated in individuals' sociograms. Again, bonding ties refer to within-group relationships, whereas the intention of the sociogram exercise was to develop an understanding of the bridging or between group ties – from this there is the capacity to begin to identify or hypothesis potential structural holes between organisational and group level nodes.

The conceptual sociogram was constructed by layering the participant drawn sociograms, including noteworthy, pre-existing linkages already captured from previous sociograms. The direction of the linkages are not included in this diagram, rather the emphasis is on capturing the additional nodes articulated by participants and develop an understanding of what organisations or groups expressed the importance of bonding ties, see Figure 15. New nodes are yellow, where as bonding ties are indicated through the use of red dots. Multiple dots in this instance refer to the number of within group ties that were identified in participants' sociograms.

Bonding ties presented as particularly important with Local Government, Government and scientific agencies appear to reflect relative introversion by scientific and research settings. In the general sociogram also showed that these groups were found to be relatively removed from the rest of the community.

Participant introduced nodes ranged from Federal Government agencies through to experiences as opposed to groups or organisations that were deemed important to the individuals' roles. Experiences such as private time with nature and the reef were an unexpected addition to the list of nodes, but highlight the diversity of needs within the population. Some new additions provided a vast range of additional node linkages. In particular the Chambers of Commerce for both Exmouth and Carnarvon both introduced a number of additional groups as necessary bridging for the participants role within the Chamber. The bridging ties present amongst nodes introduced by participants are particularly interesting as they appear to illustrate a context specific network as was the case with the horticulturalist and their linkages.

5. RECOMMENDATIONS FOR EFFECTIVE SCIENCE UPTAKE

The Ningaloo Client Outreach project was conceived in a bid to consider systematic client uptake of science. Ningaloo Client Outreach has in part tended to consider the entire life cycle of a research program in order to understand objectively the emergent relationships between the science and wider network of government and community stakeholders. As a project, Client Outreach recognised very early on that these relationships were central to understanding the capacity in which science can have impact, and, the avenues in which this can occur. It became increasingly evident over the course of interviews that the main key consideration for the project was the role of interpersonal interactions. The key indicator of science uptake success was identified as the effectiveness of the communication within and between the scientific/research/government community and the regional community. As such, this section considers the implications of the findings as they relate to the Ningaloo Research Cluster, followed with a broader theoretical implications relating to broader findings that can be utilised for research programs in the future.

5.1 Ningaloo Cluster Management Committee (NCMC) Implications

The emergent group clusters provide some insight as to the different types of overarching roles present within the Ningaloo network. These roles have thematic similarities related to the types of activities that they engage in.

The Research and Advisory Cluster consisted primarily of research institutions including all of the Western Australian based universities, several government departments (DoW, DoF, DOIR), research organisations (CSIRO, WAMSI, AIMS) and advisory groups (NCMC, Pastoralists, CCPAC, NSDO, NSDC, BAC). The clustering of these groups make intuitive sense given their interests and in part mutual dependencies. Regarding interests, there are a dominating research focus. This is particularly evident for the universities and research organisations where their research interests are made explicit. For groups whose activities are geared towards advising other groups, their role tends to be characterised as providing opinion or direction which are explicit to the interests of their group, herein illustrating their mutual dependencies.

The Governance and Service cluster has a distinct regional theme, with many of the groups having a strong regional focus, or presence (e.g. operating out of a regional office). Interestingly DEC is not clustered with Research and Advisory despite having a strong research focus. Rather DEC's role within the Ningaloo Network appears to be constructed in terms of the Department's regional governance role, a characteristic that is supported by discussion during the qualitative interviews. Similarly the CRC-ST is also positioned within the Governance and Service Cluster, despite their strong research focus which could have positioned them within the Research and Advisory cluster. In both instances, it is the strong regional focus which has positioned DEC and the CRC-ST along side other groups that operate out of the region.

The value of the group equivalences analysis is that it provided the opportunity to refer back to qualitative interviews and deduce particular trends in the way that particular groups operate and interact. Overwhelmingly the clustering of two main groups, namely Governance and Service and the Research and Advisory provide valuable insights into the types of interactions that occur between scientists, government body's and the communities. If the intention is to encourage use by both clusters of the Ningaloo research outputs then coherent, fit for purpose, communications plans need to be derived to ensure that the functional of the roles of each cluster is enhanced by better information and planning tools and scenarios.

As evidenced in the Ego Networks and supported by the content of qualitative analysis of interviews, there is a disproportionate level of engagement between the science and research agencies and the Shire of Exmouth and Carnarvon. This is an issue not only related to engagement with the Shire offices themselves but also in relation to their governing communities. Participants who reside in Carnarvon expressed a strong interest in more sound interaction with scientific and research agencies, and felt that they were less engaged with any of the research being conducted within the Ningaloo Collaboration Cluster than the communities of Coral Bay and Exmouth.

In part, some of the apparent disproportion of research/scientific investment and engagement with the community Carnarvon may be by the fact that Carnarvon does not have any coastline within the NMP. The administrative structure of the Shire is such that Coral Bay is within the Shire of Carnarvon, however due to its closer proximity to Exmouth, Coral Bay depends on Exmouth for some services, such as emergency services and schooling, the Exmouth (Learmonth) airport is also of closer. Consequently, Carnarvon is only marginally connected to the rest of the Ningaloo coast. Despite this, participants from Carnarvon expressed a strong desire to be more actively engaged in research that was conducted in the Region. Community members recognised the intrinsic connection between the three communities

Findings from the research suggest that the Ningaloo Research Cluster presents as a sound model when considering integrated science. What requires development is the presence of end users in the scientific process. Such interactions have been modelled nicely with the interaction of CRC-ST and CSIRO MSE efforts. The Ningaloo Cluster Management Committee has links to reach 100% of the network within 3 connections. Communications planning needs to ensure that information and interaction maximises the efficient bi-directional flow of information across these links. Related to between group bridging ties, the NCMC appears important in ensuring connections. This raises potential implications for future communication of Ningaloo Cluster research after the cessation of the research program, at which point effort should be made to consider mechanisms to prevent holes in the current network structure widening because the functioning of the current node effectively ceases. It is recognised that efforts are occurring in the short term through the formation of a local advisory group to avoid such a hole. Nevertheless, long term funding plans for such a group will be needed to create an opportunity for their involvement in adaptive learning being facilitated via science.

Over the course of the interviews, there was recognition of part of the researchers and community members alike that efforts was required to ensure the years of research have on ground applicability. Interestingly, the concern associated with science uptake intensified over time, peaking as projects neared their end and researchers and community members appraised the life of projects and the utility of findings. This observation emphasises the importance of

consistently maintaining and improving current networks to prevent holes which will diminish trust by the general community in the role of science and the conduct of scientists. At the very minimum the links between science and community interests should be fostered by strategic planning of a science outreach program with appropriate resources to implement it. The potential of reinforcing links between the Governance and Service Cluster and the Ningaloo Research Cluster with specific responsibilities assigned to achieve this aim for both rural and urban communities.

A specific means to gain and maintain community support and involvement is through engaging with the intended beneficiaries of the science at the onset of the research project. There are several ways in which this can occur. An outcomes focussed option is to negotiate potential avenues for the adoption of the outcomes, tending to possible training and support mechanisms once the project life has ceased. Alternatively there are process focussed options in which communities move from 'beneficiaries' to 'co-researchers'. Under this framework, science and research becomes a part of the culture of the community in which it is conducted and the research need not end at the cessation of a funding round, for instance, a community can continue to monitor a fish species through a local schools' science program or develop research partnerships with tourism operators. While the process focus option entails greater investment on part of the research team, it is likely to have greater traction on ground resulting in greater scientific impact.

Investigation Networks illustrated the absence of sound formal or informal networks between research agencies, and government with Indigenous community members in the region. This was supported with findings from interviews where concurrent themes regarding Indigenous engagement, particularly within research institutions occurred. The themes included lamentations regarding failed attempts at engagement with Indigenous communities, reflection on the degree of investment required (e.g. time and monetary) and a lack of knowledge regarding how to engage. These findings indicate some of the perceived barriers that appear to be leading to an unwillingness, or inability to conduct research with a sound level of Indigenous involvement. It should also be noted that there are resources within CSIRO and WA Universities that could be utilised to aid scientists with appropriate engagement, namely through the CSIRO Office of Indigenous Engagement⁵.

5.2 Future Program Implications

A concurrent message related to the role and capacity of science to have impact. There was recognition that perhaps the more traditional role of scientists and researchers is changing and diversifying to include additional responsibilities. This was most pertinent in instances where scientists and researchers were beginning to notice their role in science communication as being critical to their research process. Interestingly, for some researchers there was a degree of anxiety associated with effective communication. There were several aspects to this; fears that communication was/is too late in the project; that they did not have the necessary skills in which to perform this role, and, confusion as to whether this is actually a part of their role as a scientist or a researcher. The first two issues can be relatively easily mitigated through effective planning prior to project commencement and secondly through training. The third matter relating to role

⁵ Bearing in mind that a specific project on this aspect of the cluster collapsed with the resignation of the CSIRO researcher on the project and capacity limitations prevented its continuation.

definition will be considered more thoroughly in this section, particularly given the theoretical and practical implications it poses in respect to how science and research is conducted in the future.

Research findings specific to the Ningaloo Research Cluster have indicated the value in investing in a collaborative research environment. The success of the Ningaloo Research Cluster is seen as the cross- disciplinary and research integration, both in terms of disciplinary contribution of data to the collective good and in institutional support (e.g. Universities working closely with Government Departments). The analysis of Regular Role Equivalences produced a cluster of research and advisory groups which consisted of many of the research group's part of the Ningaloo Collaboration Cluster. Participants' part of the NCC identified that their roles in contributing to the sustainability of the NMP involved linkages with other agencies as part of the NCC. This is a positive finding as it indicated that the endeavour of integrating and coordinating Ningaloo research was relatively successful as scientists and researchers themselves flagged links with other agencies part of the NCC.

While there appears to be a high level of interaction between the research and scientific groups, there is less interaction between these groups and the regional communities. This is nicely evidenced in Figure 6 where the nodes coded according to Regular Role Equivalences sees only three links between the Community node and the Research and Advisory nodes. This is an important finding given the qualitative evidence which posited a strong interest within the Research and Advisory Cluster nodes to engage effectively with the community. Much of the discussion related to ways in which science and research conducted could have most beneficial impact and there tended to be widespread interest in seeing this impact at the local community level. Promisingly, there were connecting links between the Research and Advisory Cluster and the Governance and Service Cluster which were identified as consisting of many regionally based groups. This indicates there are avenues for impact present within the small purposive sample, particularly as many links were present between the Community Cluster and the Governance and Service Cluster.

The strong interest in ensuring beneficial social and local impact of research coming out of the NCC is an important finding in itself. Evident during interview discussion was how the scientific and research community were critically conscious of the strengths and shortcomings of their research. Part of this was recognition of a need to better ensure that the findings of research are of practical utility. Further, practical utility was perceived as something that occurs at the local community level. Some scientists and researchers were confused as to whether and if so how to include as part of their role a responsibility of ensuring that science had impact. Some recognised that scientific impact was not something that was traditionally considered a part of a scientist's role. The traditional role of science tends to be one that is characterised by handing over the results and leaving it for others to make use of them as they see fit. What was apparent was that the traditional role was changing

Broadly, it can be argued that science/research is moving towards a transdisciplinary orientation. This is evidenced in efforts such as the Ningaloo Collaboration Cluster where concerted effort was made at developing integrated research which is not disciplinary specific.

Participatory methods, feedback (from consultation to engagement) are often flawed in that many researchers are still more confident in thinking of themselves as experts who solve

problems on behalf of people. While much of science still has to be conducted by scientists as they have the appropriate resources there is much potential in involvement of the community as co-researchers. In working with the community scientists can have much greater confidence that they are asking the relevant questions for the community, gain access to local knowledge and often gain invaluable participation in data collection and interpretation. Pragmatic ways of using the findings can also be identified; often this is where the community are experts.

6. CONCLUSIONS

This project has emphasised the need for a systems approach to the development of large research programs. It also emphasises that it is essential to understand the network of decision makers, institutions, stakeholders and the community within which the science has been delivered.

Network analysis can ensure from the beginning that there are no key gaps in the information sought by biological science, social science and modelling during the planning stage of a program. Such analysis can also ensure that extension efforts can be efficiently targeted in terms of creating information exchange across the entire network by understanding functional overlap and the brokerage characteristics of nodes and the potential for functional holes in the network which if not recognised will defy the best attempts for getting science and modelling used for information based decision making and adaptive learning.

There were a number of clear findings from this research that will assist in the delivery of findings of this cluster's research. These include the need for science to create liaising links in the network from the beginnings of research programs, the importance of maintaining and supporting ongoing regional links to ensure that communication holes do not appear between the functional networks and the community, the need to ensure adequate planning so that each link is covered to enable potentially entire coverage by bodies such as the Ningaloo Coordinating Committee. By defining the network, and the relationships between key groups from the beginning the early questions for the research can be modified to meet the demands of the eventual recipients on an ongoing basis. The science network needed to deliver such knowledge can then be planned in a systematic way. As such, key drivers for positive research outcomes include:

- Genuine and coordinated engagement with local communities.
- Ensuring that tangible outcomes from research are valued within local communities, and, communities want to learn about what scientist and researchers have learnt.
- Genuine and coordinated engagement with traditional landholders, in a culturally sensitive manner which sees Aboriginal knowledge as expert knowledge in its own right.
- Awareness that scientists and researchers are beginning to think differently about their research and are considering the implications of their research beyond the lifetime of the project.

- That different stakeholder groups perform different roles and engage in different ways. Understanding that groups engage differently can help manage some of the expectations that people have of others.
- An understanding that sometimes scientists and researchers are confused about how to engage with communities. This is understandable, particularly in instances when processes such as engagement and participation are not part of their expertise. In such instances, it is highly valuable for scientists and researchers to ask for help. Times when this has occurred has resulted in some really pleasing outcomes within the Ningaloo Collaboration Cluster.

This project was instigated approximately half way through the Ningaloo cluster research. Nevertheless it has been able to demonstrate a new methodology for integrating client outreach within research planning and its delivery and identified some key concerns for the future as outlined in the recommendations. Perhaps most interestingly as it progressed the project started to develop its own informal networks from interested parties who greatly assisted in shaping our thoughts. These included CSIRO members where the project was housed, members of all participant universities (one of whom volunteered to conduct a systems thinking experiment on our behalf). This indicates that the measurement of information networks should not be viewed in a static sense, they provide a description of the here and now in terms of systems functioning but they also provide hypotheses about how such networks can be improved. Most importantly they can give an early warning of the likelihood of the science outputs be left "on the shelf".

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APPENDIX 1

Regular Role Equivalence Parameters

Parameter	Detail
Input dataset:	Name of file containing data to be analyzed Data type: Valued graph. Multirelational. Undirected data will give a trivial result with all non-isolate vertices being equivalent.
Maximum number of iterations: (Default = 3).	Number of iterations to be performed. Larger values increase the differentiation between vertices. A value of 3 has often been used and is now customary.
Convert data to geodesic distances: (Default = NO).	YES performs the analysis on the valued distance matrix. If symmetric data is to be analyzed then this option will provide a non-trivial analysis of the data.
Diagram Type: (Default = 'Dendrogram')	The clustering diagram can either be a Tree Diagram or a Dendrogram.
(Output) similarity matrix:	(Default = 'Rege'). Name of file which contains REGE measure of regular equivalence described in LOG FILE.
(Output) Partition Matrix: (Default = 'Regepart').	Name of file which contains a partition indicator matrix corresponding to the single link hierarchical clustering displayed in the LOG FILE. A value of k in a row labeled i and column j means that vertex j is in partition k at level i. Vertex k is always a member of partition k and is a representative label for the group. This matrix is not displayed in the LOG FILE.
LOG FILE	Single link hierarchical clustering dendrogram (or tree diagram) of the regular similarity measure. The level at which any pair of actors are aggregated is the point at which both can be reached by tracing from the start to the actors from right to left. The diagram can be printed or saved. Parts of the diagram can be viewed by moving the mouse to the split point in a tree diagram or the beginning of a line in the dendrogram and clicking. The first click will highlight a portion of the diagram and the second click will display just the highlighted portion. To return to the original right click on the mouse. There is also a simple zoom

	<p>facility simply change the values and then press enter. If the labels need to be edited (particularly the scale labels) then you should take the partition indicator matrix into the spreadsheet editor remove or reduce the labels and then submit the edited data to Tools>Dendrogram>Draw.</p> <p>Behind the dendrogram is an alternative cluster diagram. The columns have been rearranged and labeled. A '•' in row labeled i column label j indicates that vertex j is in a singleton cluster at level i. An 'X' indicates that vertex j is in a non-trivial cluster at level i, all other members of j's cluster are found by tracing along the row labeled i in both directions from column j until a space is encountered in each direction. The column labels corresponding to an 'X' which are connected to j's X are all members of j's cluster at level i.</p> <p>An actor by actor REGE similarity matrix. Values vary between 0 and 100. A value of 100 indicates strict regular equivalence.</p>
TIMING	O(N ⁵).
COMMENTS	<p>The values obtained for non-equivalent vertices are not robust measures of equivalence. The number of iterations affects these values there is little correlation between the values from one iteration to the next, even at the rank order level. This situation is improved if the number of iterations are increased.</p> <p>For these reasons users with binary or nominal data are advised to use CATEGORICAL REGE</p>



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