CHAPTER EIGHT

STRUCTURE AND FUNCTION OF MACKAY WHITSUNDAY SAFE COMMUNITIES: A SOCIAL NETWORK ANALYSIS

8.1 INTRODUCTION

In 1986, the First International Conference on Health Promotion held in Ottawa re-emphasised the environmental and social determinants of health, redefining health promotion as the process of enabling people to increase control over, and improve, their health. It was recognised that could not be achieved by the health sector alone but required the co-operative action of "individuals, community groups, health professionals, health service institutions and governments" (WHO, 1986). The Ottawa Charter highlighted the importance *of strengthening community action*, one of its five domains of health promotion action:

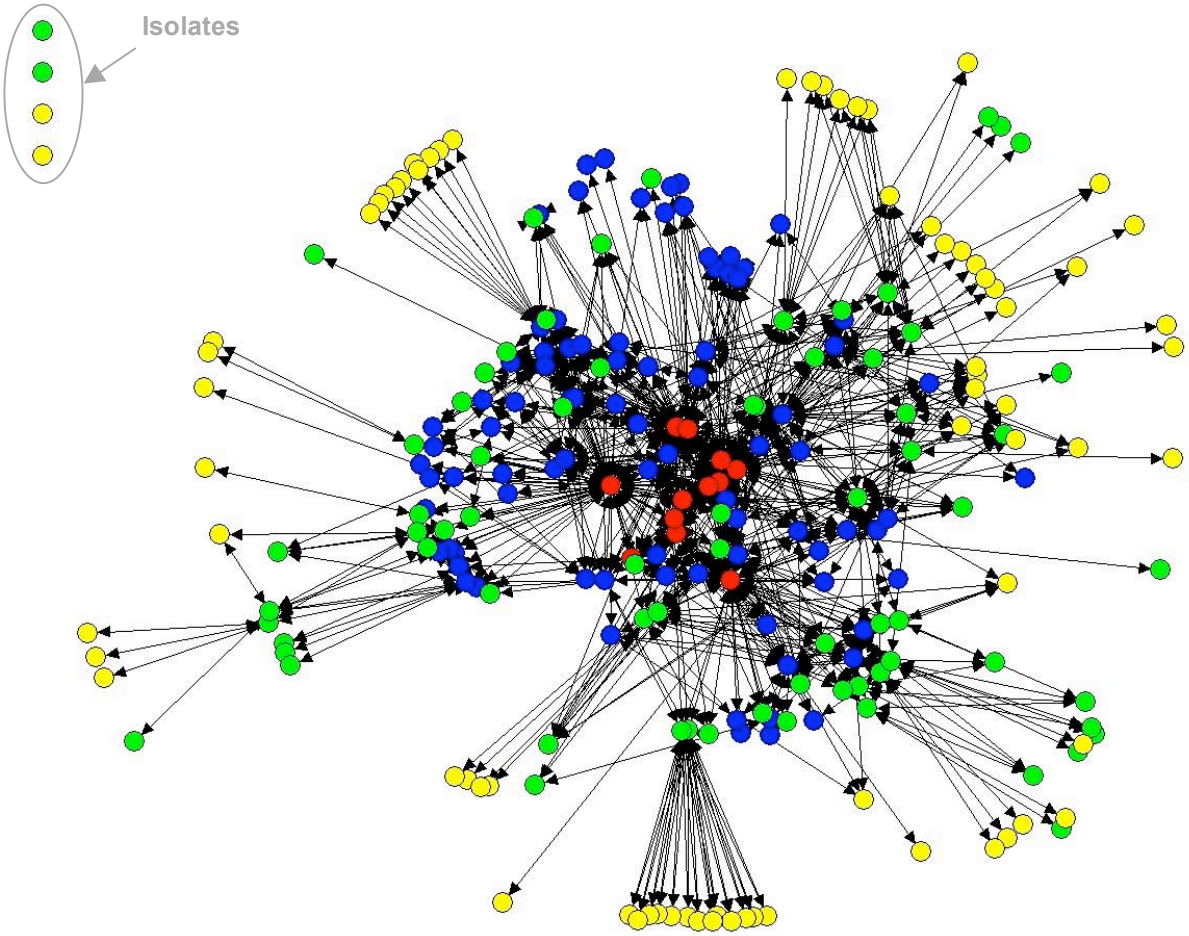
> "Health Promotion works through concrete and effective community action in setting priorities, making decisions, planning strategies and implementing them to achieve better health. At the heart of this process is the empowerment of communities. ... Community development draws on existing human and material resources in the community to enhance self help and social support, and to develop flexible systems for strengthening public participation in and direction of health matters (WHO, 1986)."

The Mackay Whitsunday Safe Communities (MWSC) was implemented under this community development health promotion model. Evaluation of the network therefore required a research tool capable of describing, analysing and assessing the effectiveness of this community development process.

Social Network Analysis (SNA) was applied as an evaluation tool. Although Sefton and Hawe (2002) undertook a simple SNA as one strategy in an suite of evaluation tools used to assess three pilot Safe Community programs, the present study is the first to conduct a comprehensive SNA of a safety promotion coalition.

This study seeks to assess the utility and validity of SNA as a tool to describe and analyse the function of MWSC and its external Support Network (SN).

8.2 Mackay Whitsunday Safe Communities and Support Network



Initial Sample
Members of the NSG (Dec 03)

Wave One
Network members identified by NSG (Mar to May 04)

Wave Two
Network members identified during Wave One and MWSC members (Sep to Dec 04)

Wave Three
Network members identified during Wave Two but not surveyed

Figure 8.1 Sociogram MWSC and SN 2004 – four study phases

The twelve members of the NSG identified 85 additional network members who were surveyed in *wave one*. The 52 network members identified by wave one respondents were surveyed in wave two (Figure 8.1). Minutes of MWSC action groups were reviewed to identify any MWSC members not yet nominated. An additional 21 MWSC members were identified. Seven could not be contacted while three refused the opportunity to participate. Two of these non-participants did not receive any subsequent nominations during wave two of the study. As the study was unable to identify any evidence of relationships involving these two actors, or "isolates", they were excluded from further analysis. The remaining 19 actors joined the *Wave Two Network* to form the study population, the *MWSC and SN*. This provided a network of 168 members. One hundred and twelve (67%) were members of the MWSC while 56 (33%) were external actors. One hundred and forty-eight individuals agreed to participate, giving an overall response rate of 87%. Notably, one half of non participants were network members included in the study as a result of reviewing the project minutes. In this group the participation rate was only 52%.

Wave two respondents identified a further 74 additional actors, who were not surveyed (in accordance with study protocol). Ten (14%) of these were members of the MWSC but had joined the network after the completion of wave one (July 2004). The remaining 64 (86% of new actors identified during wave two) were not members of the MWSC. Forty-seven (64%) of these individuals were identified by actors who were themselves external to the project. Indeed, 23 (31%) were identified by 3 actors who were not members of the MWSC. Two actors, non members of the MWSC, were identified as part of the network in 2000 but were no longer involved in 2004. They therefore appear as isolates in Figure 8.1.

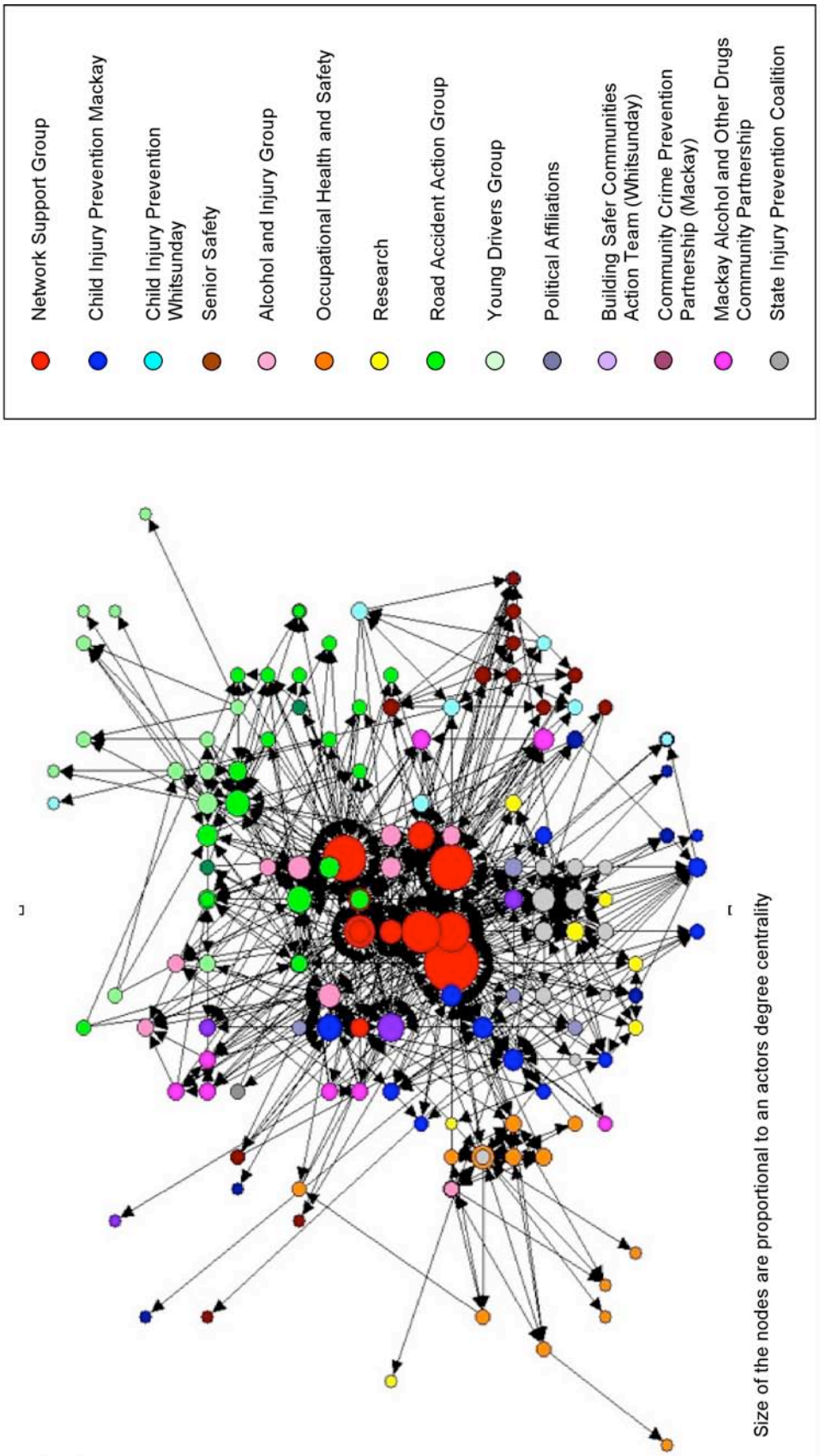


Figure 8.2 Sociogram Mackay Whitsunday Safe Communities and Support Network, 2004

The sociogram of MWSC and its SN is shown in Figure 8.2. Actors were categorised according to the action groups they were affiliated with. Actors who were members of more than one action group were assigned to the group with which they maintained the most relationships. Members of the NSG who were also members of an action group were assigned to the NSG.

At the time of the study MWSC consisted of eight action groups:

- Network Support Group (NSG),
- Child Injury Prevention Mackay (ChIPP),
- Child Injury Prevention Whitsunday,
- Alcohol and Injury Group,
- Occupational Health and Safety Group,
- Road Accident Action Group (RAAG),
- Young Drivers Group.

MWSC also maintained relationships with a number of local, state, national and international organisations and groups, including:

- The Building Safer Communities Action Team (BSCAT) Whitsunday,
- Community Crime Prevention Partnership (CCPAT) Mackay,
- Mackay Alcohol and Other Drugs Community Partnership,
- Queensland Injury Surveillance Network (QISU),
- Queensland Child Injury Prevention Project (ChIPP) in association with Injury Prevention and Control Australia (IPCA),
- School of Public Health, Tropical Medicine and Rehabilitation Science (SPHTMRS), James Cook University,
- Tropical Population Health Unit (TPHU), Queensland Health,
- Walking Bus Program, Queensland University of Technology,
- Australian Injury Prevention Network (AIPN),
- World Health Organisation Collaborating Centre on Community Safety Promotion (Karolinska Institute, Stockholm, Sweden).

The observed structure of the MWSC and its SN is shown in Figure 8.2.

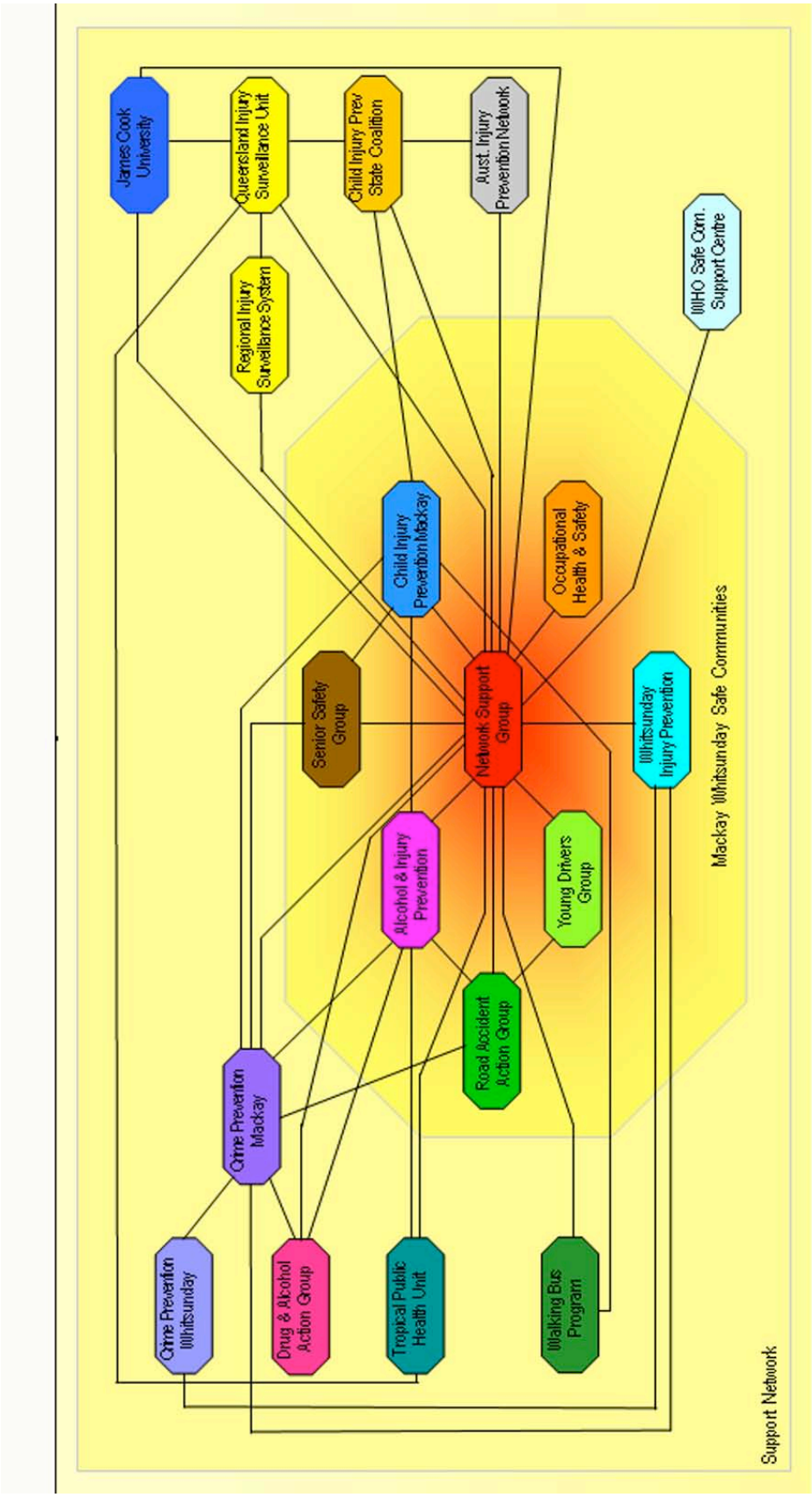


Figure 8.3 Observed Structure Mackay Whitsunday Safe Communities and Support Network, 2004

8.3 TRIAD CENSUS

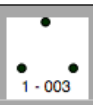
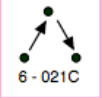
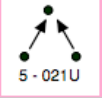
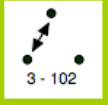
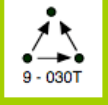
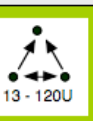
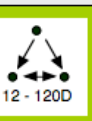
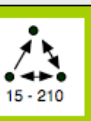
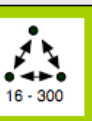
Triad number	Description	Observed frequency	Expected frequency	Ratio Obs / Exp
Triad 1 003*	Empty Triad	663,086	624,046	1.06
Triad 2 012*	Unreciprocated relationship	71,658	138,677	0.52
Triad 3 102*	Reciprocated relationship	28,284	2,569	11.01
Triad 4 021D*	Heirachy "out star"	752	2568	0.29
Triad 5 021U*	Heirachy "in star"	2314	2568	0.90
Triad 6 021C*	2 path "mixed star"	1898	5136	0.40
Triad 7 111D*	Reciprocated relationship & incoming tie	3504	190	18,44
Triad 8 111U*	Reciprocated relationship & outgoing tie	1697	190	8.93
Triad 9 030T*	Transitive triad	287	190	1.51
Triad 10 030C*	Cycle	19	63.41	0.30
Triad 11 201*	Reciprocated heirachy	1521	3.52	432.10
Triad 12 120D*	Triangle	338	3.52	96.03
Triad 13 120U*	Triangle	139	3.52	39.49
Triad 14 120C*	Triangle	153	7.05	21.70
Triad 15 210*	Triangle	343	-.26	1319
Triad 16 300*	Triangle	223	0.002	138,441

* for description of triad classification system, please see entry entitled "triad census" in Glossary

Table 8.1 Triad census

Triads describe relationships within a group of three actors (deNooy et al., 2005). Whereas dyadic forces concern interpersonal forces acting between a pair of actors, triadic forces are the first manifestations of social interaction, where interpersonal relationships are modulated by the presence of the third party.

The *Triad Census* is the frequency distribution of the triads observed in a network. There are sixteen possible permutations of relationships connecting any group of three actors (de Nooy et al, 2005). Table 8.1 compares the observed frequency of each triad in the MWSC and SN with the expected frequency if relationships in the network were randomly distributed. It is clear that the relationships within MWSC and SN are not randomly distributed. Triads 2, 4 and 10 occur less frequently than would be expected by chance, whereas triads 3, 7, 8, 9 and 11 through 16 occur more frequently than would be expected by chance.

Empty triad	 1 - 003 obs/exp = 1.1				
Paths	 6 - 021C obs/exp = 0.4	 10 - 030C obs/exp = 0.3			
Unreciprocated ties	 2 - 012 obs/exp = 0.5	 6 - 021C obs/exp = 0.4	 10 - 030C obs/exp = 0.3		
Hierarchies	 5 - 021U obs/exp = 0.9	 4 - 021D obs/exp = 0.3			
Reciprocated ties	 3 - 102 obs/exp = 11	 8 - 111U obs/exp = 8.9	 7 - 111D obs/exp = 18	 11 - 201 obs/exp = 432	
Transitivity (triangles)	 9 - 030T obs/exp = 1.5				
Triangles with reciprocated ties	 14 - 120C obs/exp = 22	 13 - 120U obs/exp = 40	 12 - 120D obs/exp= 96	 15 - 210 obs/exp = 1319	 16 - 300 obs/exp =138,441

obs/exp = the ratio of the observed frequency of triads in the MWSC and SN to the expected frequency if relationship were randomly distributed.

Table 8.2 Classification of triads in terms of Interpersonal forces

Table 8.2 classifies triads in terms of the local social forces acting within them. It is important to note that more than one interpersonal force may be acting in each triad. Accordingly triads may be listed more than once in Table 8.2. Three local triad configurations were observed less frequently than would be expected by chance:

1. Paths - a path is a sequence of ties joining two actors in a network. Actors generally prefer to interact directly with other actors if possible, as intermediaries may on occasion, by omission or commission, fail to transmit information accurately. The longer a path, the more inefficient this channel of communication becomes.
2. Unreciprocated relationships - only one member of a dyad nominates the relationship. Unreciprocated relationships (triads two, four, six and ten) occurred at less than half the rate expected by chance.
3. Hierarchies - either one actor reports relationship with two other actors (triad 4, the “out star”) or the two other actors report to this actor (triad 5, the “in star”). Bevelas (1950) empirically confirmed the theoretical suspicion these “central” actors gain social leverage from this structural opportunity. If possible, other actors prefer to relate directly to other members of network, thereby circumventing the social leverage gained by these central actors.

Contrastingly, two types of local forces occur more frequently than expected by chance:

1. Reciprocity - the tendency for social actors to share two way relationships is the most important dyadic force. Reciprocated relationships (triads 3, 7, 8 and 11) occurred at least nine times more frequently than would be expected by chance. Note there are other dyadic forces. For example, homophily - the tendency of similar actors to form relationships, or heterophily - the tendency for opposites to attract (e.g. gender based relationships). These types of dyadic forces were not studied in this analysis.

2. Triangles – the tendency of actors to cluster in small groups. The transitive triad (Triad 9) describes the introductory social force. If actor a knows actor b, and actor b knows actor c, then it is likely that actor b might introduce actor a to actor c who may subsequently form a relationship. A number of other triangle configurations are possible with varying degrees of reciprocation (triads 12, through 16) and were observed far more frequently than would be expected if relationships in MWSC and SN were randomly distributed.

8.4 NETWORK ATTRIBUTES

Key attributes of the networks under study in 2004, Mackay Whitsunday Safe Communities (MWSC), its Support Network (SN) and the combined network (MWSC and SN) are listed in Table 8.3.

	MWSC	SN	MWSC and SN
Network Members	112	56	168
Reciprocity	33%	29%	30%
Transitivity	33%	44%	26%
Density - directed matrix - symmetrised matrix	 0.048 0.069	 0.043 0.067	0.036
Average Degree - directed matrix - symmetrised matrix	 5.5 8.3	 2.2 3.4	5.9
Average Distance	2.7	2.5	2.8
Distance based cohesion	0.29	0.10	0.34
Centralisation	40%	18%	43%
Clustering co-efficient	0.50	0.44	0.50

Table 8.3 Network attributes of the MWSC and SN, 2004

The density of the MWSC and SN networks are similar. However, members of the SN identified fewer relationships among themselves (average degree = 2.2) than members of the MWSC (average degree = 5.5). Relationships within the MWSC are more centralised through a core group of actors (centralisation = 40% for the MWSC compared with 18% for the SN).

8.5 VERIFICATION OF NETWORK ATTRIBUTE ESTIMATES

Table 8.3 compares network attributes estimated by data collected during each stage of the study. In the *Initial Sample* the 12 members of the NSG were surveyed and asked to nominate network members they knew. They nominated 85 additional network members who were then surveyed in wave one of the study. Together with the 12 members of the NSG already surveyed, they formed the *Wave One Network*. In wave two 52 additional actors nominated during wave one were surveyed. Together with the initial sample and wave one respondents, they formed the *Wave Two Network*.

	Initial Sample	Wave One Network	Wave Two Network	MWSC and SN
Number of network members	12	97	149	168
Reciprocity	76.6	42.1%	33.1%	30 %
Transitivity	90.1%	28.8%	26.2%	26 %
Density	0.86	0.066	0.042	0.036
Average Degree	9.4	6.4	6.3	5.9
Average Distance	1.1	2.3	2.7	2.8
Distance based cohesion	0.93	0.42	0.36	0.34
Centralisation	3.6%	53%	47%	43 %
Clustering co-efficient	0.86	0.60	0.53	0.50

Table 8.4 Network attribute estimates compared for the four study stages

Table 8.4 and Figure 8.4 compare the network attributes of the four snowballing study networks. These network attributes are all measures of group cohesion. Network analysts (Wasserman and Faust, 1994; Scott, 2000) propose that the cohesion of a social group is reflected by:

- the mutuality of relationships (i.e., reciprocity, transitivity, centralisation and clustering coefficient),
- the closeness of relationships (i.e., distance based cohesion), and
- the frequency of relationships (i.e., density and average degree).

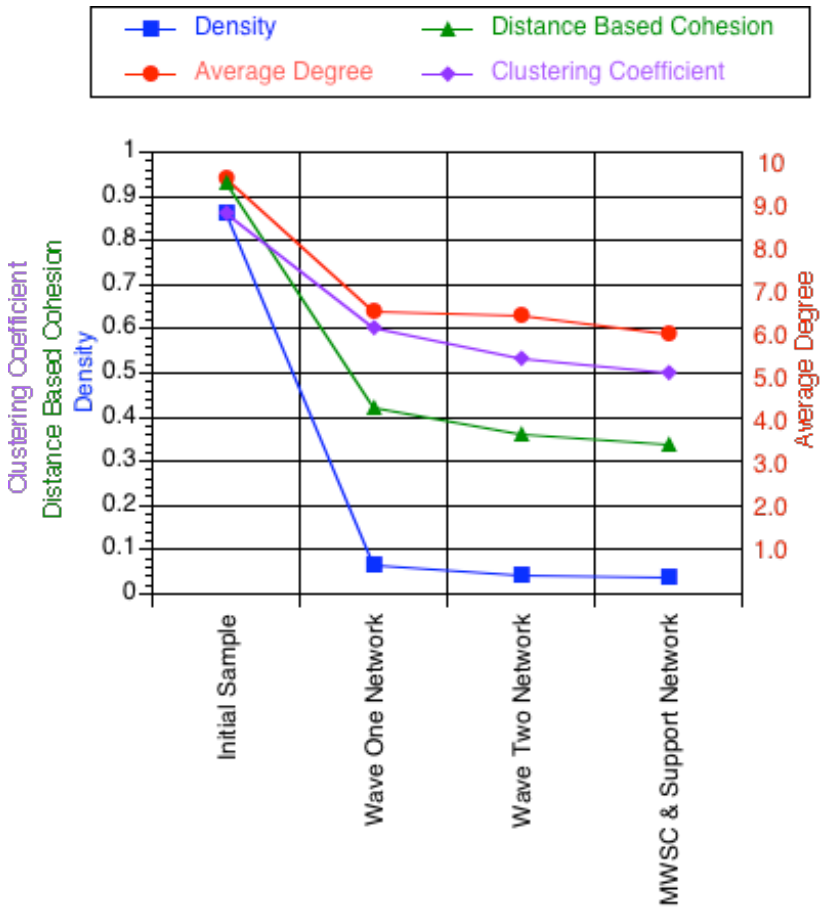


Figure 8.4 Estimates of network cohesion compared for the four study stages

The 19 actors entered in the study after review of group minutes (rather than by nomination during wave one), were less active network members. While constituting 11.3% of the total network they only accounted for 2.3% of the relationships. Eight were not recalled by any other actors during wave two. Eleven who were subsequently nominated had an average in-degree of 1.7 compared with 6.4 in the *Wave Two Network*. Consequently, networks created solely using the snowballing methodology overestimated cohesion of the MWSC and SN (Table 8.3 and Figure 8.4). The density of the combined MWSC and SN was estimated to be 0.042 using the wave two snowballing network, 16% higher than the observed density of the MWSC and SN (0.036). Similarly, the estimated average degree of the wave two network was 6.3 or 7% higher than that observed in the MWSC and SN (5.9). Each wave of the study more closely approximated the final network parameters.

8.6 DEPTH OF RELATIONSHIP

Network members were asked to nominate the context of the relationships they shared as a proxy measure of the degree of collaboration (Table 8.4):

1. *In depth relationships* were defined as those in which network members "collaborate to develop joint funding proposals, plans or projects, sharing time and resources to actively work together". Twenty-four percent of relationships were described as *in depth*, involving 126 actors. This in-depth network reported an average of 1.4 relationships.
2. *Working groups* were defined as groups who "collaborate at committee level to meet shared objectives". Forty-two percent of relationships were in the context of *working groups*. Sixty-six percent of relationships were at least at working group level, creating a network of 153 members. This "working group network" had an average degree of 3.9 relationships.
3. An *interagency meeting* was defined as that in which members "meet to share information and discuss mutual goals, but work independently". Eleven percent of relationships were in the context of *interagency meetings*. Seventy-seven percent of relationships were at least at interagency group level, creating a network of 155 members. "Interagency network" members averaged 4.6 relationships.
4. *Some contact* was defined as relationships in which network members "share flyers and advertising material, ask questions or refer clients to each other". Twenty-three percent of relationships were described as *some contact*. This created a total network of 168 actors who reported at least some contact with other network members. The MWSC and SN members averaged 5.9 relationships with other network members.
5. *No contact.* Respondents reported no contact in two circumstances. Firstly, the actor was known to them in 2000, but they had no contact in 2004. Alternately, some respondents nominated actors who might potentially be know to them (perhaps using action group minutes) but record that they had no contact with this actor in either 2000 or 2004.

	In Depth Relationship (23%)	Working Group (42%)	Interagency Meeting (11%)	Some Contact (22%)	No Contact (2%)
Cumulative actors	126	153	155	168	
Density	0.008	0.024	0.028	0.036	
Average Degree	1.4	3.9	4.6	5.9	
Centralisation	10%	22%	25%	43%	
Clustering Coefficient	0.28	0.46	0.45	0.50	

Table 8.5 Depth of relationships 2004

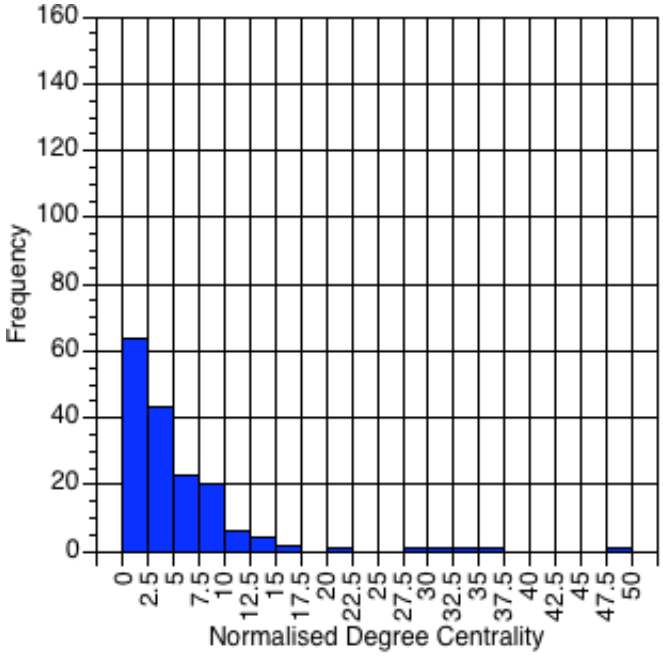
The number of network members, the number of relationships, network density and average degree all increased as the definition of a relationship became less stringent (Table 8.5), ranging from the most stringent definition "in depth relationship", to the least stringent definition "some contact". Centralisation of the network decreased as more stringent definitions of network relationships were applied.

	Unreciprocated Relationships	Reciprocated Relationships: Some Contact	Interagency	Working Group	In Depth	Reciprocity
Some Contact	134	44 (46%)	8	33	11	26%
Interagency	75		10 (36%)	14	4	19%
Working Group	212			126 (76%)	40	33%
In-Depth	117				64 (54%)	36%

Table 8.6 Concordance for depth of relationships

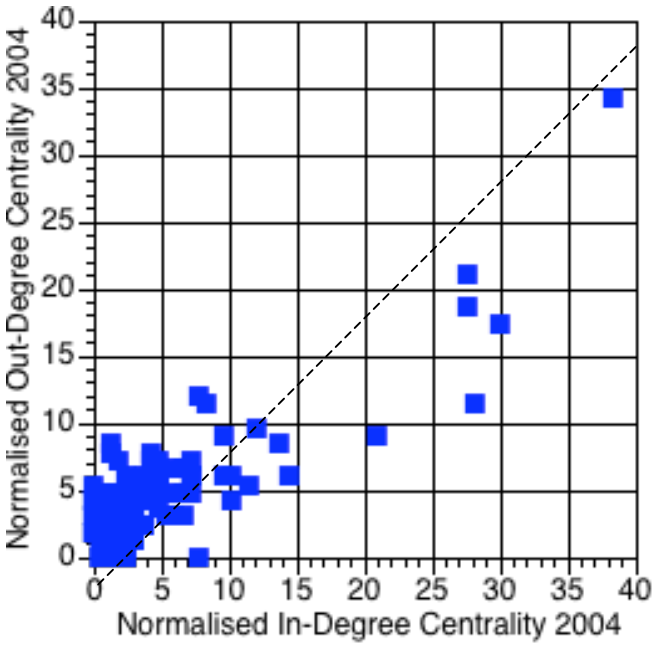
Table 8.6 reports the concordance observed at each relational depth. With the exception of interagency relationships, the degree of concordance, when both actors report a relationship, is 46% or more. However, even relationships reported by one respondent to be "in depth" were not reciprocated more than 36% of the time. With the exception of interagency relationships, stronger relationships were more likely to be reciprocated.

8.7 ACTOR CENTRALITY



	2004
Minimum	0.6%
10th Percentile	0.6%
25th Percentile	1.8%
Median	3.6%
Mean	5.5%
75th Percentile	6.6%
90th Percentile	10.8%
Maximum	47.9%

Figure 8.5 Histogram of normalised degree centrality, 2004



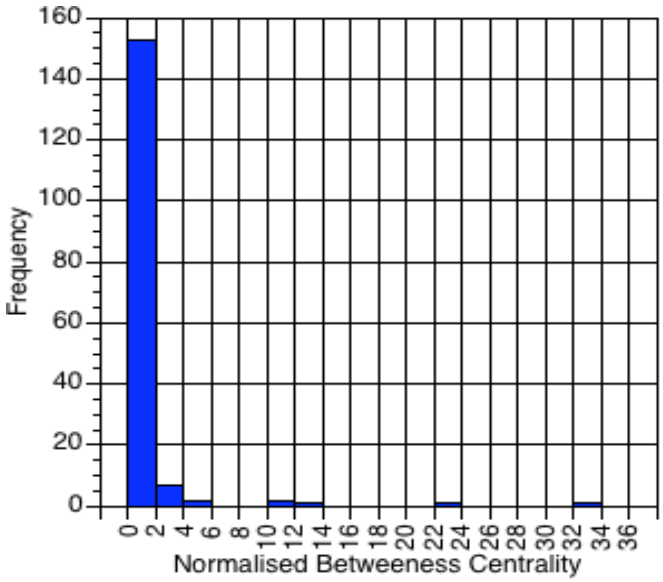
	In-Degree	Out Degree
Min	0%	0%
10th %ile	0.6%	0%
25th %ile	0.6%	1.2%
Median	1.8%	2.4%
Mean	3.6%	3.6%
75th %ile	3.6%	4.8%
90th %ile	7.8%	7.2%
Max	38%	34%
Std. Dev.	5.7%	4.1%
Correlation with proportion of ties reciprocated[1]	0.248 ($p < 0.01$)	0.145 not sig.

Figure 8.6 Normalised in-degree centrality vs out-degree centrality, 2004

[1] Correlation of Normalised Degree with the proportion of ties that were reciprocated. A measure of expansiveness and attractiveness bias (see discussion).

Figure 8.5 is a frequency histogram of normalised degree centrality in the MWSC and SN in 2000 (Note, to allow comparison of different measures of network centrality and networks of different size, centrality was normalised). This is a skewed distribution biased towards a small number of network members with very high degree centrality. Sixty-four actors (38%) had a normalised degree centrality of 2.5% or less and together accounted for 11% of relationships observed in the network, whereas the six most connected actors (3% of the network) had a normalised degree centrality of 20% or above, together accounting for 44% of all relationships observed in the network. Actors with higher degree generally gave more time to network activities (Pearson Correlation Coefficient = 0.72, $p < 0.01$) and were more likely to maintain stronger relationships (Pearson Correlation Coefficient = 0.17, $p < 0.05$).

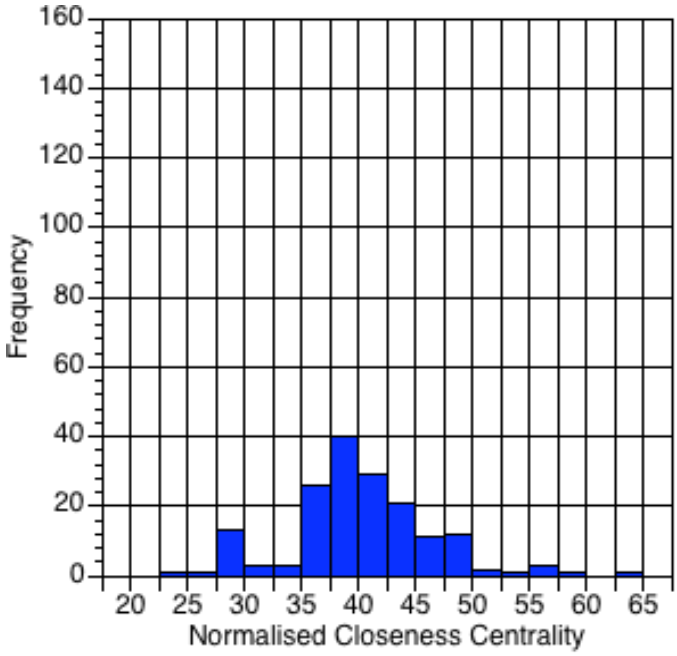
Figure 8.6 compares the number of nominations an actor received (in-degree) with the number of nominations they made (out-degree). Actors below the equivalence line have underestimated the number of relationships they maintain relative to their peers (in-degree > out-degree). The more connected actors underestimated their relationships, while the less connected actors tended to overestimate their relationships. The standard deviation of in-degree is greater than out-degree, indicating greater variability in incoming nominations.



	2004
Minimum	0%
10th Percentile	0%
25th Percentile	0%
Median	0.04%
Mean	0.9%
75th Percentile	1.4%
90th Percentile	1.6%
Maximum	33.0%

Figure 8.7 Histogram of normalised betweeness centrality, 2004

Figure 8.7 indicates that betweeness centrality was more skewed than degree centrality. One hundred and eleven actors (66%) had a normalised betweenness centrality of 2% or less, together accounting for only 2.3% of the total brokerage potential observed in the network. The six most connected actors had a normalised betweenness centrality of 5% or higher, together accounting for 60% of the brokerage potential observed in the network.



	2004
Minimum	23%
10th Percentile	30%
25th Percentile	37%
Median	40%
Mean	40%
75th Percentile	44%
90th Percentile	49%
Maximum	63%

Figure 8.8 Histogram of normalised closeness centrality, 2004

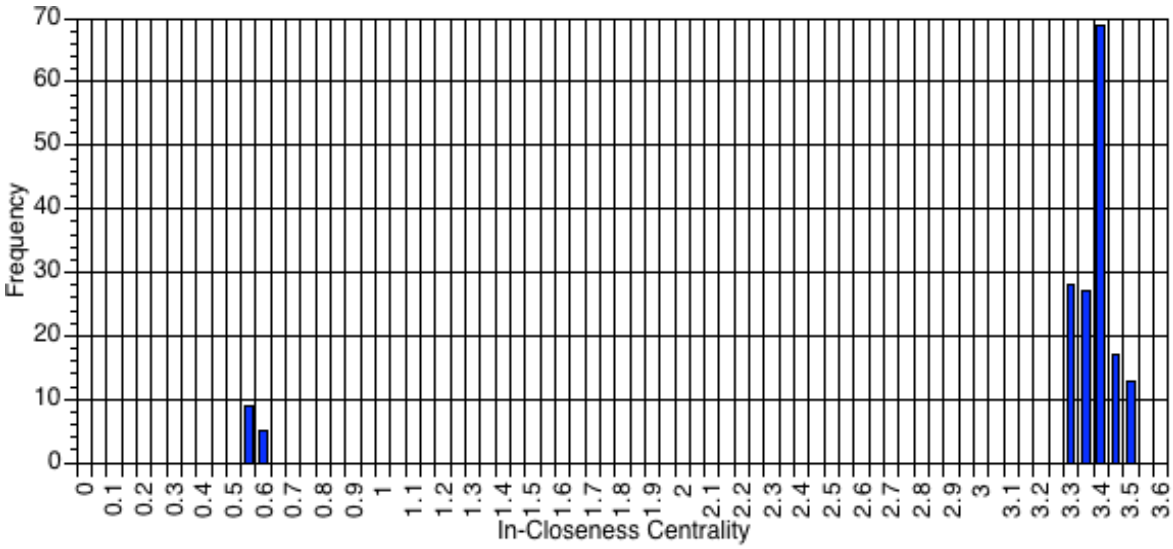


Figure 8.9 Histogram of in-closeness centrality, 2004

Figure 8.8 shows the distribution of normalised closeness centrality. While superficially this may appear a normal distribution, the UCINET algorithm for calculating normalised centrality symmetrises matrix data and in the case of closeness centrality this masks the underlying morphology. In-Closeness centrality is a biphasic distribution[2] (Figure 8.9) consisting of a small group of 14 relatively poorly connected actors with an in-closeness centrality ranging between 0.5 and 0.6 and second larger group of relatively well connected actors with a in-closeness centrality ranging between 3.3 and 3.6 with a mode of 3.4.

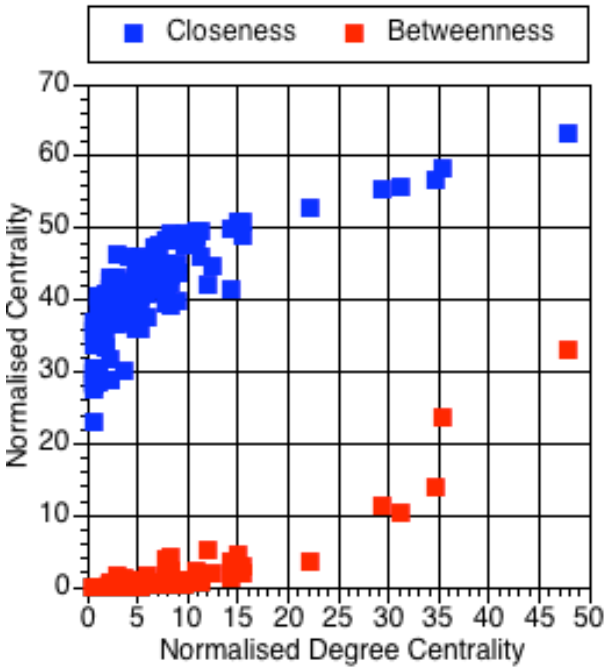


Figure 8.10 Multidimensional scaling diagram of normalised degree centrality and normalised betweeness and closeness centrality

Figure 8.10 is a multidimensional scaling diagram comparing normalised degree centrality with normalised closeness and betweenness centrality. Six actors, all members of the NSG, had high scores in all measures of centrality.

[2] Out-closeness centrality is also a biphasic distribution.

8.8 VERIFICATION OF ACTOR CENTRALITY ESTIMATES

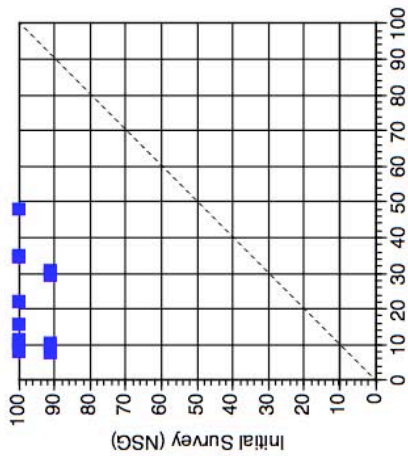


Figure 8.11 Normalised degree centrality
MWSC & SN vs initial sample network

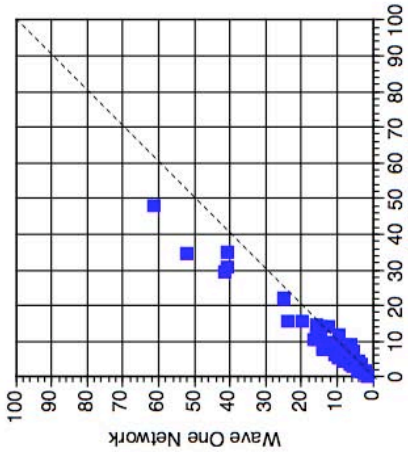


Figure 8.12 Normalised degree centrality
MWSC & SN vs wave one network

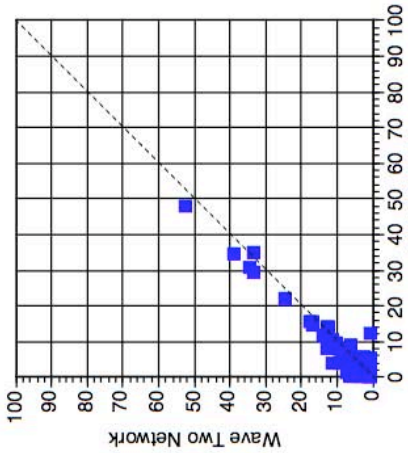


Figure 8.13 Normalised degree centrality
MWSC & SN vs wave two network

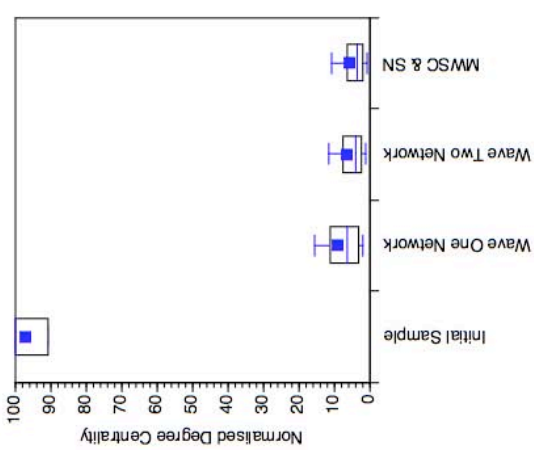


Figure 8.14 Box and whisker plot
normalised degree vs study phase
(10th, 25th, median, mean, 75th & 90th percentiles)

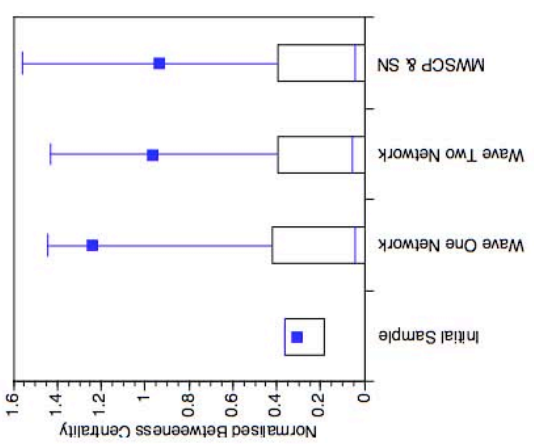


Figure 8.15 Box and whisker plot
normalised betweenness vs study phase
(10th, 25th, median, mean, 75th & 90th percentiles)

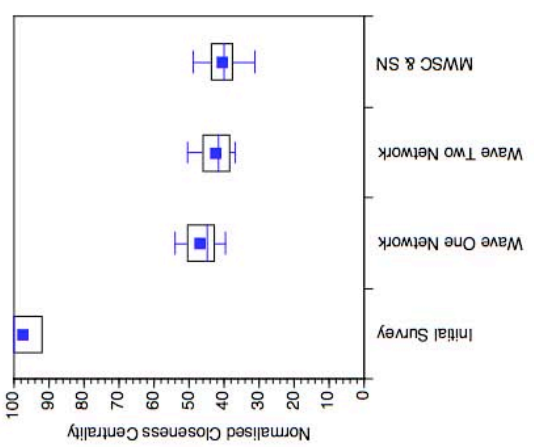


Figure 8.16 Box and whisker plot
normalised closeness vs study phase
(10th, 25th, median, mean, 75th & 90th percentiles)

Snowballing methodology may induce sampling bias by following the chain of connected actors emanating from the initial study sample, in this case the NSG. It is evident from this analysis that the most connected members of the network are also members of the NSG. Thus it is important to assess whether the snowballing methodology resulted in undue prominence of members of the NSG.

Figures 8.11, 8.12 and 8.13 are multi-dimensional scaling (MDS) diagrams comparing degree centrality of actors observed in the MWSC and SN during each stage of the study. Networks created solely using the snowballing methodology overestimated the prominence of the most central actors. However, each phase of the study more closely approximated the final degree distribution and waves one and two successfully identified the six most prominent actors. The observed prominence of these actors therefore appears to reflect their network activity rather than being an artefact of the study design. Estimates of normalised centrality from wave two of the study were within 15% of the final degree centrality calculated for the most prominent members of the MWSC and SN.

Figures 8.14, 8.15 and 8.16 are box and whisker diagrams comparing degree, betweenness and closeness centrality distributions from the snowball waves with the final MWSC and SN network. As with degree centrality, the snowballing methodology tended to overestimate closeness and betweenness centrality. However, wave two of the study provided reasonable estimates of all forms of centrality and successfully identified the most prominent actors.

8.9 MAIL AND TELEPHONE RESPONDENTS

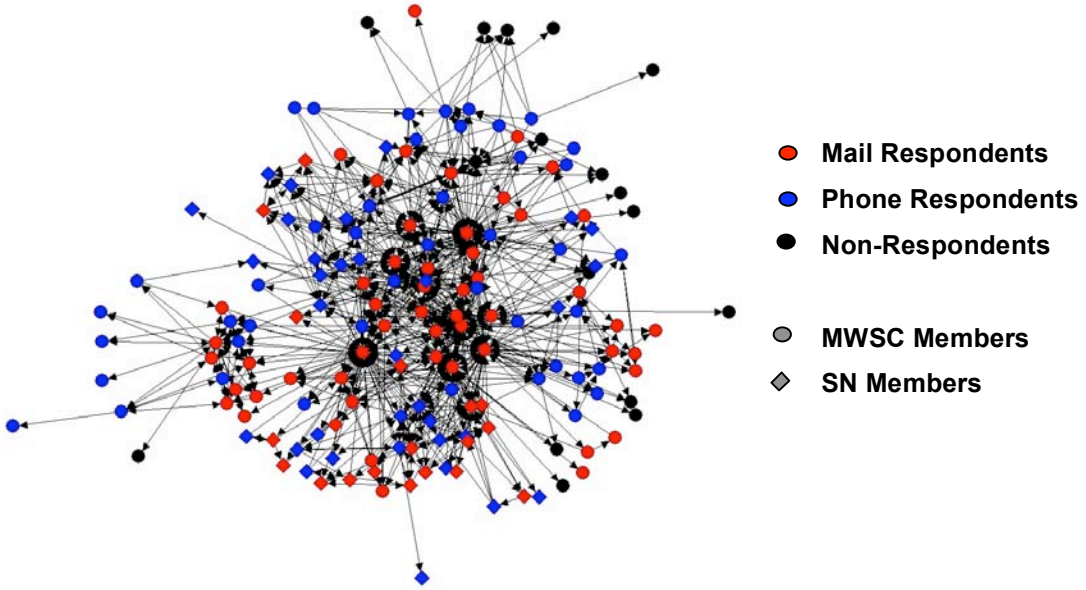


Figure 8.17 MWSC and SN comparing mail and telephone respondents

One hundred and forty-eight actors agreed to participate in the study, giving an overall response rate of 87%. Seventy (47%) responded to the original mail out, while the remaining 78 (53%) agreed to participate during telephone follow up. Mail respondents were more likely to be a member of the MWSC (73%) than telephone respondents (58%). In general telephone respondents occupied more peripheral positions in the network (Figure 8.17).

	Mail Respondent Network	Phone Follow Up Network
Density +	0.031	0.028
Average Degree ++	5.2	4.7
Network Centralisation	36%	13%

+ Difference = 0.003 (p = 0.50, not sig)

++ Difference = 0.5 (p = 0.79, not sig, Wilcoxon 2 tailed)

Table 8.7 Mail and telephone respondents selected network attributes, 2004

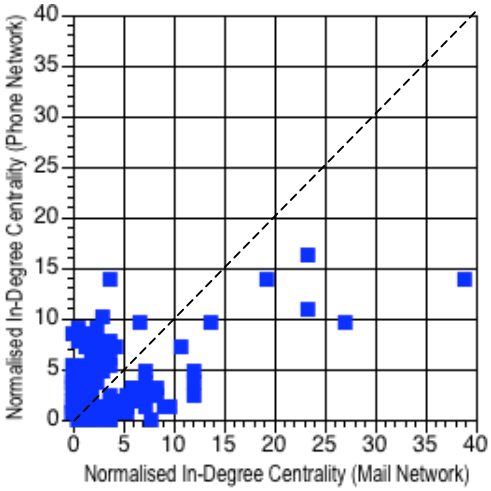


Figure 8.18 Normalised in-degree centrality mail and telephone networks, 2004

Figure 8.18 shows that telephone respondents were less likely to report relationships with the most central actors in the network. Similarly, Table 8.7 demonstrates a one third reduction in network centralisation when 'telephone respondents' are included in the analysis. However, there was not a statistically significant difference in either density or average degree. Thus, telephone respondents were less likely to be a member of a MWSC and less likely to report relationships with the most active network members.

It is important to note that while the researcher (who conducted the telephone interviews) is a member of the MWSC, telephone respondents were less likely than mail respondents to report a relationship with the researcher. The researcher's degree centrality in the telephone network was only 35% of that reported in the mail network.

8.10 NON-PARTICIPANTS

Most research tools record and report little information about non-participants. This is not the case in SNA where a network member may be nominated by other study participants regardless of whether or not they agree to participate in the study.

	Non Participants	Participants
Minimum	0%	0%
10th Percentile	0.4%	0.6%
25th Percentile	0.6%	1.3%
Median *	0.6%	1.8%
Mean	1.3%	3.8%
75th Percentile	1.8%	4.2%
90th Percentile	2.4%	8.2%
Maximum	7.8%	38.3%

* Difference = 3 ($p < 0.002$, Wilcoxon 2 tailed)

Table 8.8 Normalised in-degree dentrality of participants and non-participants

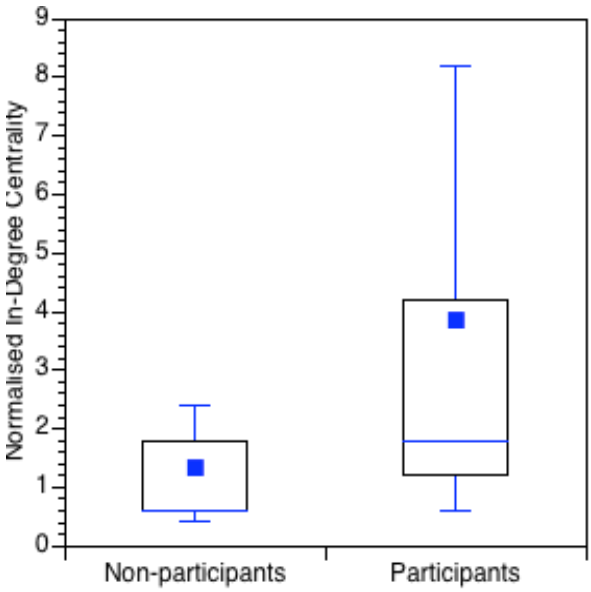


Figure 8.19 Normalised in-degree centrality participants compared with non-participants
Bow and Whisker Plot (10th,25th, 50th, Mean, 75th, 90th Percentiles)

There were 20 non-participants in this study, constituting 12% of the network. Nine (5%) declined the opportunity to participate. A further eleven (7%) could not be contacted despite two mail-outs and at least two telephone calls.

Table 8.7 and Figure 8.19 compare the In-Degree Distribution of non-participants and participants. Non participants were significantly less connected ($p < 0.002$, Wilcoxon 2-tailed) with a mean normalized In-Degree of 1.8%, compared with a mean in degree of 4.2% for participants.

	MWSC and SN	Respondent Network
Number	168	148
Density	0.036	0.044
Average Degree	5.9	6.4
Average Distance	2.8	2.7
Distance based cohesion	0.34	0.37
Clustering co-efficient	0.50	0.51

Table 8.9 Network attributes MWSC and SN, respondents and non-respondents, 2004

Table 8.9 compares the respondent network with the MWSC and SN network (including non-participants). As non-participants were less connected than participants, their exclusion from the network would have resulted in overestimation of network cohesion.

The respondent network overestimated the observed density of the MWSC and SN by 22%. The density in the respondent network was 0.044 whereas the density of the full MWSC and SN was 0.036. Similarly, the respondent network overestimated average degree by 8%. Average degree in the respondent network was 6.4 compared with 5.9 in the full MWSC and SN, including non-respondents.

8.11 QUALITY OF RELATIONSHIPS

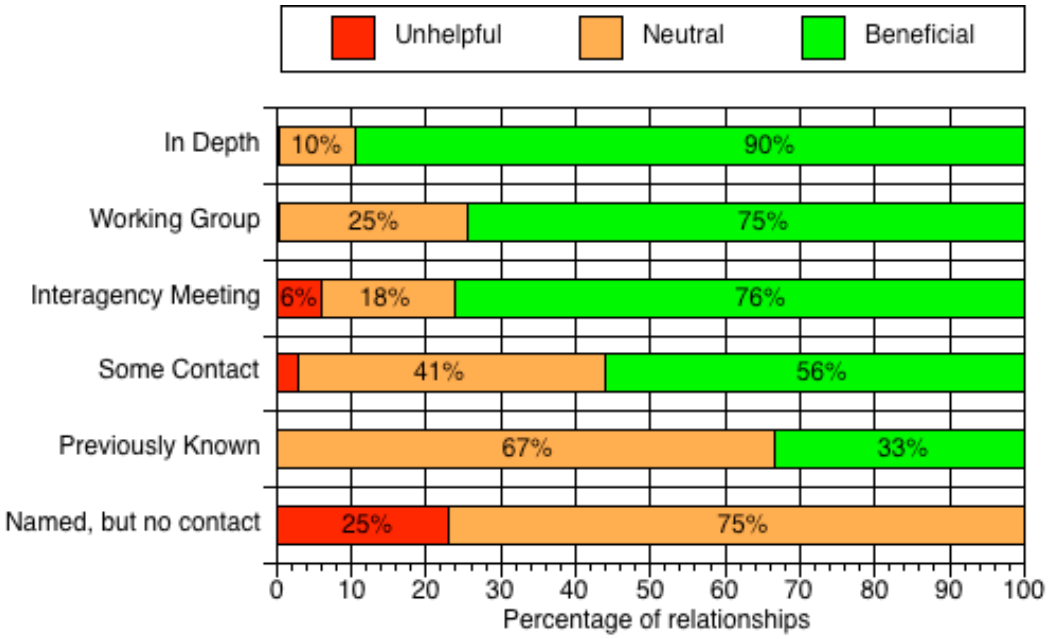


Figure 8.20 Depth of relationship in relation to reported perceived benefit

	Number of relationships	Number of "Unhelpful" Relationships	Percentage "Neutral" Relationships	Number of "Beneficial" Relationships
No Contact	22	3 (13%)	16 (74%)	3 (13%)
- Previously known	9	0	6 (66%)	3 (33%)
- Named, but no contact	13	3 (23%)	10 (77%)	0
Some Contact	230	6 (3%)	95 (41%)	129 (56%)
Interagency Meeting	111	7 (6%)	20 (18%)	84 (76%)
Working Group	425	2 (0.5%)	106 (25%)	317 (75%)
In Depth	236	1 (0.5%)	23 (10%)	212 (90%)

Table 8.10 Depth of relationship compared with perceived benefit

Respondents were asked to assess the net benefit of relationships they maintain. Relationships could be reported as:

1. *Unhelpful*. The benefits obtained by working together did not justify the extra effort and resources required to maintain the relationship,
2. *Neutral*. The extra effort and resources required to maintain the relationship was balanced by the benefits of working together, or
3. *Beneficial*. The benefits of working together outweigh any extra effort and resources required to maintain the relationship.

Two percent of relationships were reported to be unhelpful, 25% neutral and 73% beneficial. Closer relationships were more likely to be reported as beneficial (Table 8.10 and Figure 8.20) with 90% of *in-depth* relationships described as beneficial and 10% neutral.

8.12 RECIPROCITY

Thirty percent of relationships were reciprocated (i.e. both network members identified the same relationship), while 70% were not reciprocated. Five scenarios are worthy of special mention, together accounting for one third (36%) of the non-reciprocated relationships:

1. There were 20 non-participants. However, non-participants could still be nominated by other actors, resulting in a non-reciprocated relationship. Non-participants accounted for 4% of non-reciprocated relationships.
2. Six respondents agreed to participate in the study but did not identify any outgoing relationships. However, other actors in the network still identified an average of 1.5 incoming relationships with these network members, accounting for 1% of the non-reciprocated relationships.

3. Nineteen people had not been nominated during wave one of the study but were surveyed during wave two because they were identified as a MWSC member. Eleven were subsequently nominated during wave two. However, eight did not receive a nomination. They had an average out-degree of 5.0 compared with 5.9 for the rest of the network. They accounted for 3% of the non-reciprocated relationships observed.
4. Actors with high in-degree centrality underestimated the number of relationships they maintained compared to their peers (Figure 8.6). The 14 highest ranking actors had an average in-degree of 31 compared with an out-degree of 20. They under-estimated the number of relationships they maintained by 37%, accounting for 15% of the non-reciprocated relationships.
5. Actors with low in-degree centrality tended to overestimate the number of relationships they maintained compared to their peers (Figure 8.7). Seventy-seven actors had an in-degree of 2 or less. Their mean out-degree was 3.3 compared with an in-degree of 1.3, thus overestimating the number of relationships they maintained by 150%. This accounted for 13% of the non-reciprocated relationships.

	In-Degree	Av. Depth of Relationships (In-Degree)	Beneficial Relationships (In-Degree)	Proportion of Reciprocated Relationships
In-Degree	1	0.171 *	0.981 **	0.248 **
Average Depth of Relationships (In-Degree)		1	0.178 *	0.282 **
Beneficial Relationships (In-Degree)			1	0.242 **
Proportion of Reciprocated Relationships				1

* Pearson Correlation p < 0.05 ** Pearson Correlation p < 0.01

Table 8.11 Correlations between in-degree, relationship depth, relationship benefit and reciprocated relationships

Table 8.11 reviews the correlation between the proportion of reciprocated relationships maintained by each network member and three other attributes, in-degree, the average depth of incoming nominations, and the number of beneficial nominations they received. It is evident that:

1. The network members who on average had the strongest relationships maintained a greater proportion of reciprocated relationships (Pearson Correlation Coefficient = 0.28, $p < 0.01$).
2. The most connected network members (high in-degree) on average maintained stronger relationships (Pearson Correlation Coefficient = 0.17, $p < 0.05$) and a greater proportion of reciprocated relationships (Pearson Correlation Coefficient = 0.25, p , 0.01).
3. The network members who received more frequent nominations classified as beneficial relationships maintained a greater proportion of reciprocated relationships (Pearson Correlation Coefficient = 0.24, $p < 0.01$).

Interestingly, an actor's own perception of the number of the relationships they maintained (out-degree) correlated with nomination of a beneficial relationship by other network members (Pearson Correlation Coefficient = 0.20 $p < 0.01$) and an increased proportion of reciprocated relationships (Pearson Correlation Coefficient = 0.34, $p < 0.01$).

8.13 DISCUSSION

Human relationships in the MWSC and SN were not randomly distributed. The triad census for MWSC and SN listed sixteen possible triad configurations (de Nooy, 2005) (Tables 8.1 and 8.2). Reciprocated relationships and the tendency towards triad triangulation (small group formation), occurred far more frequently than would be expected by chance. Similarly, relationships were not randomly directed among actors in the network. Degree, betweenness and closeness distributions were all highly skewed (Figures 8.5 to 8.10). Thirty-eight percent of actors had a normalised degree centrality of 2.4% or less, accounting for 11% of relationships observed in the network, while six actors (3% of the network) had a normalised degree centrality of 20% or more accounting for 44% of relationships

observed in the network. These same six actors accounted for 60% of the brokerage potential existing in the network. As relationships in social systems, such as MWSC and SN, are not randomly distributed, it is meaningful to study the pattern of distribution of these relationships and how this contributes to the overall structure and function of the network.

SNA proved a powerful tool for measuring, describing and analysing relationships within the MWSC and SN and the social structure they created. It was possible to quantify important global network attributes (for example, cohesiveness), as well as the contribution of individual actors to the network (for example, social influence as measured by degree centrality, brokerage as measured by betweenness centrality, and efficiency of communication as measured by closeness centrality) and to describe some of the interpersonal forces acting within MWSC and SN (for example, reciprocity, transitivity and social closure).

SNA was able to provide diagrammatic representation of the social structure observed in the MWSC and SN (Figures 8.2 and 8.3). Criteria One of the WHO Designation Guidelines states that WHO Safe Communities must have, “an infrastructure based on partnership and collaborations, governed by a cross sectional group that is responsible for safety promotion in their community” (Coggan, 2004, p 351). It is clear from Figure 8.3, that the MWSC and SN is built on a network of relationships clustered into shared domains of activity facilitated by members of a cross sectoral group, in this instance the NSG.

SNA demonstrated a core periphery structure (Borgatti and Everett, 1999; Scott 2000) in which a core group of highly connected actors appeared to play a central role in MWSC and SN relationships. More connected network members generally gave more time to network activities (Pearson Correlation Coefficient = 0.72, $p < 0.01$), maintained stronger relationships (Pearson Correlation Coefficient = 0.17, $p < 0.05$), more beneficial relationships (Pearson Correlation Coefficient = 0.20, $p < 0.01$) and more reciprocated relationships (Pearson Correlation Coefficient = 0.34, $p < 0.01$). Six actors appeared to play a

particularly prominent role. They maintained 44% of all relationships observed in the network and 60% of its brokerage potential. It is important to note that these actors did not have any innate administrative authority when they joined the network. Rather, their combined role of action group and NSG members offered them an important structural opportunity to act as intermediaries and facilitators. The prominence of these six core actors may in part be related to the time they invested in the network, with four working a minimum of half time on network activities. It is perhaps concerning that such a small group of leaders are disproportionately influential. While hopefully these actors use their influence for the benefit of the network, it is also possible they could exploit it for personal gain at the expense of network activities. However, it is evident that their contribution is valued by other members of the network. On average, 85% of the relationships they maintain were reported by peers to be beneficial, compared with 62% for other network members.

While this study highlights the importance of the relational contribution of network members, it should not be assumed that more relationships are necessarily better. In this study, respondents were asked to describe the strength of relationships they maintain. Twenty-four percent of relationships were described as “in depth”, 42% “working group”, 11% “interagency” and 22% “some contact”. Network members who maintain stronger relationships were more likely to be perceived as making a beneficial contribution (Pearson Correlation Coefficient = 0.20, $p < 0.01$) and their relationships were more likely to be reciprocated (Pearson Correlation Coefficient = 0.34, $p < 0.01$). Ninety percent of “in depth” relationships were reported as beneficial, compared with 75% of “working group” and “interagency” relationships, and 56% of “some contact” relationships.

Similarly, it should not assumed that only relational contributions to the network are valuable. A community harbours many different types of resources, including financial capital, physical capital and human capital, which are exchanged across the network. It is conceivable that the actors active in the exchange of these non-relational resources may not be the same actors responsible for facilitating

social interaction. SNA was also used to describe and analyse the exchange of these important resources (Chapter 10).

The importance of adequate delineation of the network boundary is demonstrated in this study.

At the completion of wave two, the study had identified a network of 168 members. Wave two respondents identified a further 74 actors who were not surveyed in accordance with study protocol. However, this arbitrary cut off point proved reasonable. While 10 new members of MWSC were nominated during phase three, they had all joined the coalition after the study was commenced in 2004. The remaining 64 actors (86%) were not members of MWSC. Forty-seven (64%) of these were nominated by external actors. As the purpose of including actors external to the MWSC was to identify in-kind, human and financial resources mobilised on behalf of MWSC there seemed little point in following up external agents who did not have a direct relationship to the MWSC. Thus the three phase snowball study design did appear to identify external agents who made a direct contribution to the project.

Nineteen MWSC members were not identified by the snowball design. They were included in the study after review of action group minutes indicated that they had attended one or more meetings under the auspices of MWSC. While constituting 11.3% of the total network they only accounted for 2.3% of relationships. The snowball sampling technique had overlooked less connected members of the MWSC and as a result overestimated cohesion (Table 8.3 and Figure 8.4), confirming Kossinets (2006) observation that network cohesion will be overestimated when peripheral members of a social network are not identified. However, each wave of the study more closely approximated final network parameters (Figure 8.4). Density showed the greatest variation over the three study phases. While density is the most commonly cited measure of social cohesion it has significant disadvantages (Friedkin, 1981; Marsden, 1990). Density is inversely proportional to the logarithm of the number of actors in the network (see glossary for the mathematic definition of density). As a result, large

networks will have substantially lower density even though network members maintain the same number of relationships (Friedkin, 1981). While density may be useful for comparing networks of similar size, or the same network over time (see Chapter Ten), it is not useful for comparing cohesion in networks of different size. In this instance average degree is a more useful measure of cohesion. Average degree has the added advantage of a more intuitive definition, “the average number of relationships maintained by each member of the network”.

Conscientious follow up of all potential participants in a SNA is a prerequisite for ensuring a representative SNA. Borgatti (2004, personal communication) suggested that participation rates of at least 80% are necessary for calculations of network attributes to be truly representative. Only 70 actors (41%) agreed to participate in the original mail survey despite a second reminder letter. Seventy-eight (46%) actors subsequently agreed to participate during telephone follow up, providing a total response rate of 87%. Mail respondents were more engaged members of the network, reporting more relationships and in particular more relationship with the most central actors. The most engaged members of the network were more likely to agree to participate in the study, firstly by mail and secondly by telephone. The omission of telephone respondents would have significantly confounded results (the density of the mail network was 0.031 compared with 0.036 in the MWSC, average degree 5.2 compared with 5.9 and centralisation 36% compared with 43%). Thus network studies should ensure participation of as many network members as possible. Informal feedback during the telephone interviews indicated that many respondents were unfamiliar with the methodology and unsure of how to complete the survey without assistance. Many commented that the survey was easier to complete when telephone assistance was available. The attempt to use a mail survey may have been naive given the unfamiliar nature of the research technique. The initial use of either a personal or telephone interview may have been helpful to expedite early participation of the maximum number of respondents and ensure consistency of survey technique.

As the researcher is a member of the MWSC, it was concievable that telephone follow up may have resulted in excessive nominations of the researcher. These concerns were not realised. The researcher's degree centrality in the telephone network was only 35% of that observed in the mail network.

SNA reports relationships involving a *pair of actors*. This raises an important ethical issue unique to network analysis. Non-participants can still be nominated by other study participants. As a result, network studies gather data about relationships involving non-participants. It might be argued that it is unethical to report data concerning non-participants as they have not given their permission to be involved in the study. However, many researchers argue participants are doing no more than offering their personal perception of their relationships (Borgatti and Molina, 2003). This perception is meaningful and valid even when it concerns non-participants. It can therefore be argued that it is unethical to allow non-participants to effectively veto other participants' right to accurately report their perceptions of the network by excluding relationships involving non-participants (Borgatti and Molina, 2003). Given the particular sensitivity of SNA to missing data, exclusion of non-participants poses a further ethical issue for investigators. While data collected in any research sample is ultimately an imperfect representation of the true population, the impact of any missing data is usually unknown. In SNA, researchers actually know something about this missing data. If this data is excluded, researchers may end up reporting results they *know* to be inaccurate or misleading.

In this study relationships involving non-participants have been reported and clearly illustrate the effect of withholding this information. Active members of the network were more likely to agree to participate than less active members (Figure 8.19). The mean normalised in-degree of non-participants was 1.3% compared with 3.8% for participants ($p < 0.002$, Wilcoxon 2 tailed). As a result the exclusion of relationships involving non-participants would significantly bias calculation of network parameters and interpretation. Average degree in the respondent network was 6.4 an 8% increase over that observed in the MWSC

and SN (5.9). Similarly, the density of the MWSC and SN was estimated at 0.44 in the respondent network, 22% higher than observed in the MWSC and SN network (0.036).

In this study, the six most prominent MWSC and SN actors (see figures 8.2 and 8.10) were all members of the NSG and therefore participants in the initial survey sample. This raises the important question of whether their prominence was an artefact of the snowball design. The snowball samples did overestimate the prominence of the six lead actors (Figures 8.11 to 8.13). However, it is evident from Figures 8.13 and 8.14 that the wave two snowballing network provided a reasonable estimate of the distribution of actor degree centrality in the complete MWSC and SN. Both wave one and wave two networks successfully identified the six lead actors. With the exception of betweenness centrality in the initial sample, all measures of actor centrality were overestimated by the snowballing networks. However, wave two estimates did provide a reasonable approximation of the final distributions observed in the MWSC and SN network. Estimates of actor centrality using the wave one network (i.e. actors identified by the NSG) provided a credible thumb-nail sketch of the MWSC and SN. The most prominent actors tended to underestimate their personal influence (Figure 8.6). It therefore seems reasonable to conclude the observed prominence of the six lead actors is a true reflection of their network activity rather than an artefact of the snowballing design.

Two types of recall bias may impact on the analysis of relationships observed within a social network. Respondents may either under report or over report relationships. A number of researchers have observed that respondents commonly under-report their personal networks (Bernard and Killworth, 1977; Bernard et al., 1980, 1982 and 1984; Hammer, 1984; Sudman, 1985 and 1988; Marsden, 1990). Network data that concern relationships that are more frequent, closer or stronger are more likely to be reported accurately than relationships that are infrequent, distant or weak (Hammer, 1984, Marsden, 1990). In this study, actors that on average maintained stronger relationships, or more beneficial

relationships, had a greater proportion of their relationships reciprocated (Pearson Correlation Coefficient = 0.28, $p < 0.01$ and 0.24, $p < 0.01$, respectively).

The snowball design meant that MWSC and its SN was "discovered" by asking participants to recall "people they knew or work with that are part of the Mackay Whitsunday Safe Communities Project" but also a second recall opportunity by asking them to nominate those people "who had an impact (either negative of positive) on their contribution to the project". That is, the study used an active recall technique. This is not typical of most network studies, where the network under study is usually identified prior to commencement of the study either by using a formal list of network members (if available) or key informant interviews (Scott, 2000). Participants are prompted with this list to assist them to identify all members of their personal ego network. An active recall strategy may result in respondents underreporting relationships (Hammer, 1984; Sudman, 1985; Sudman, 1988; Marden, 1990). Sudman (1985, 1988) demonstrated that the number of nominations offered using a recall strategy were generally lower than nominations using a recognition method, particularly for networks of more than 50 members.

Only 30% of relationships were reciprocated (i.e. nominated by both members of the dyad) raising suspicion that there may be significant under-reporting of relationships in this study. A minimum of 20% of non-reciprocated relationships can be clearly attributed to under-reporting of relationships.

1. Four percent can be accounted for by the 20 non-participants (who were not surveyed and therefore offered no nominations, yet could still be nominated by other participants).
2. A further six actors agreed to participate but did not offer any nominations. However, they still received an average of 1.5 incoming nominations, accounting for 1% of non-reciprocated relationships.
3. In Figure 8.6 it is evident that the most connected members of the MWSC and SN underestimated the number of relationships they maintain relative to their peers (out-degree < in-degree). For example the 14 highest

ranking actors had an average out-degree of 20 compared with in-degree of 31. They underestimated the number of relationships they maintained by 37%, accounting for 15% of non-reciprocated relationships observed in the network. It is worth noting that the six most prominent actors received between 34 and 64 nominations. For these actors, remembering and documenting all the relationships they maintained within the network would have been a daunting task. It is not surprising that they may have overlooked significant relationships or tired of completing the survey.

Relationships may also have been over-reported. Feld and Carter (2002) suggest two types of systematic bias are associated with over-reporting of relationships. Expansiveness bias refers to the tendency of some actors to systematically over report their relationships with others (out-degree). Attractiveness bias refers to the tendency of some actors to be systematically over reported by others (in-degree). They suggest that expansiveness bias is particularly common in social networks. However, in this study more connected actors tended to under report their relationships compared with their peers, while less connected actors tended to over-report relative to their peers, raising a suspicion of attractiveness bias. Sixteen percent of non-reciprocated relationships were clearly related to relative over-reporting of relationships by poorly connected network members:

1. Seventy-seven poorly connected MWSC and SN members had an in-degree of two or less. They had a mean out degree of 3.3 compared with a mean in-degree of 1.3, overestimating their influence by 150%, accounting for 13% of the non-reciprocated relationships observed in the network.
2. Eight network members identified using action group minutes nominated relationships (average out degree = 5.0) but did not themselves receive any nominations. They accounted for 3% of non-reciprocated relationships.

The suspicion of attractiveness bias is heightened by the relatively high variability of in-degree centrality (standard deviation = 5.7%) compared with out-degree centrality (standard deviation = 4.1%) (Feld and Carter, 2002). Feld and Carter hypothesise that if a network is subject to attractiveness bias, then actors who receive a lot of nominations (because they are particularly noticeable or popular) would be less likely to reciprocate these nominations. Actor in-degree would therefore be inversely correlated to the proportion of reciprocated relationships (Feld and Carter, 2002). We have already seen in this study that the more prominent actors were more likely to have high reciprocation rates. That is, in-degree was positively correlated with the proportion of reciprocated relationships (see Figure 8.6, Pearson Correlation Coefficient = 0.25, $p < 0.01$). Thus, the evidence of attractiveness bias is inconsistent in this dataset. There is no evidence of expansiveness bias in this study.

Kossinets (2006) suggests on the basis of his sensitivity studies that the inadequate enumeration of all relationships will result in measures of network cohesion being underestimated. Accordingly, some network analysts symmetrise relational matrices, arguing that if either member of a dyad recalls the relationship then some form of relationship must exist (Scott, 2000; Kossinets, 2006). In this study, symmetrising the MWSC and SN matrices resulted in a 50% increase in estimates of network cohesion (density increased from 0.036 to 0.054 and average degree increased from 5.9 to 9.1). Other analysts argue that the observation of a non-reciprocated relationship gives an important indication of the asymmetric quality of the social interaction. As one of the key objectives of this analysis was to report changes in the MWSC and SN network over time (Chapter Nine), it was decided that it was most appropriate to report network attributes using the observed directional matrices rather than symmetrised results. This ensured direct comparison of network attributes over time. There are currently no comparable published network studies of health or safety promotion networks. However, future researchers seeking to compare their networks with MWSC and SN should give serious consideration to whether comparison of symmetrised measures of cohesion would be appropriate.

8.14 CONCLUSION

The Ottawa Charter for Health Promotion emphasised the importance of community collaboration, suggesting that *strengthening community action* was one of five key health promotion strategies. To develop the theory and practice of safety promotion, it is critical to gather a comprehensive understanding of how social systems work and the social forces they access and mobilise. Social Network Analysis proved a useful tool to evaluate the structure and function of Mackay Whitsunday Safe Communities and its Support Network. It provided a graphic representation of social structure and quantified important aspects of network function, interpersonal interaction and individual actor contributions.

CHAPTER NINE

DOCUMENTING THE DEVELOPMENT OF SOCIAL CAPITAL IN A COMMUNITY SAFETY PROMOTION NETWORK USING SOCIAL NETWORK ANALYSIS

A formative version of this paper was presented at the "International Conference on Engaging Communities", an initiative of the United Nations and the Queensland Government, which was held in Brisbane from the 14th to the 17th of August, 2005. A written version of that presentation was peer reviewed and is available at: http://www.engagingcommunities2005.org/ab-theme-6.html

Aspects of this research which emphasised the relevance and application of social capital to the practice of Injury Prevention and Safety Promotion were presented at the 8th World Conference on Injury Prevention and Safety Promotion held in Durban, South Africa from the 2nd to the 5th of April, 2006, and at the 15th International Safe Communities Conference held in Cape Town, South Africa from the 10th to the 11th of April 2006.

Over 2,000 abstracts were submitted for consideration by the Scientific Committee of the 8th World Conference on Injury Prevention and Safety Promotion Conference. Three hundred and fifty of these were offered an oral presentation. Authors of abstracts considered to be of particular merit were approached and asked to submit a written version of their paper for consideration for the award of best paper presented at the conference. The International Scientific Committee reviewed this manuscript and assessed the oral presentation delivered at the conference, awarding it the prize for best oral presentation delivered during the 8th World Conference on Injury Prevention and Safety Promotion (Appendix 25).

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9.2 ABSTRACT

Problem under study

The transition from researching "what works" (efficacy) to researching "how to make it work" (effectiveness) in a complex social setting is not straightforward. Efficacy trials test whether an intervention does more good than harm when administered under optimum conditions. By isolating the experimental variable from the influence of contextual factors a clear relationship between the control and experimental variable can be elucidated. On the other hand, effectiveness trials test whether an intervention does more harm than good in real world conditions. Here the outcome of the trial may be influenced by extraneous contextual factors. Efficacy research may offer little insight into the practical challenges of implementation in a community social system if it has conceptually avoided the impact of contextual factors on outcome. If injury prevention is the science of controlling context, safety promotion is the art of managing context.

To successfully promote safety in a community context a sophisticated understanding of these social forces is necessary. "Social Capital" is one concept proposed in an effort to describe and understand these social forces.

Objectives

Mackay Whitsunday Safe Communities (MWSC) was established in February 2000 to address high levels of non-intentional injury documented in the region. By involving the community in finding its own solutions, the MWSC aims to be a catalyst for structural, social and political change that empowers the community and ultimately individuals within the community to change their

environment and behaviours to reduce the risk of injury. This study uses Social Network Analysis (SNA) to document and analyse the social forces harnessed by the network.

Method

A questionnaire exploring the nature and quality of network relationships was distributed throughout the network and analysed using UCINET software. Respondents were asked to name individuals with whom they interacted in their work of promoting safety in the community. Using a snowballing methodology the chain of social relationships was documented moving outwards from the network support group (NSG) of the MWSC.

Results

In February 2000, the seven founding members of the NSG had a direct sphere of influence on 78 actors. By 2004 this had increased to include a network of 152 members, who in turn had contact with a further 16 actors, creating a total network of 168 members. The network had become more cohesive, with the average number of relationships between network members increasing from 3.3 to 5.9 ($p<0.000$) and a significant increase in the density of relationships [0.022 in Feb 2000 cf 0.036 in Aug 2004 ($p < 0.0002$)]. However, relationships were not evenly distributed. In 2004, 44% of all relationships observed in the network involved the six most influential actors, compared with 32% in 2000. More strikingly, in 2004 these same six actors maintained 60% of the brokerage potential observed in the network, compared with 39% in 2000.

Conclusion

SNA proved a useful tool for documenting the growth of social capital within a community safety promotion coalition. Two distinct forms of social capital were documented: firstly, the growth of network cohesion and secondly, the critical role played by a small number of key actors who performed an important brokerage function in the network.

9.3 ACCIDENT PREVENTION AND INJURY PREVENTION

The pre-modern era viewed disease and injury from a fatalistic ecological perspective. Helpless against the ravages of war, plague, pestilence, famine and disaster, man was at the mercy of the forces of nature, and subject to the whims of "the gods" (McMichael, 2001). Injury, in particular, was perceived to be the result of an accident, "an unfortunate event that is without apparent cause" (Moore, 1997).

The enlightenment brought the advent of empiricist science and a shift away from ecological dependency towards a reductionist approach to disease (Schneiderman and Speers, 2001). In particular, René Descartes advocated a reductionist approach to science, with humans considered as machines that could be understood by systematically investigating the function of their component parts.

> *"And so that the reader will have from the beginning a general notion of the whole machine which I have to describe. I shall say here that it is the heat of the heart which is … the mainspring and origin of all the movements of the body; and that the veins are the pipes which carry the blood from all parts of the body towards the heart, where it serves as nourishment"* (Descartes, 1640, p226-7).

Importantly, Descartes also argued the separation of mind and body, thought and matter:

> *"The knowledge that I think therefore I am is the first and most certain of all items of knowledge which anyone will arrive at if they philosophise in the right order. This is also the best approach for understanding the nature of mind, and its distinction from body" (Descartes, 1644, Principles 1.7 and 1.8).*

Descartes' philosophical thinking laid the conceptual foundations of the modern biomedical paradigm (Engel, 1977) in which thought, emotions and social interaction are separate from bodily processes. Disease could be explained in terms of physical processes that could be understood and manipulated by modern scientific investigation (Schneiderman and Speers, 2000).

In the 20th century the science of injury prevention displayed this shift away from resigned fatalism towards biomechanical determinism. In 1942 De Haven (2000) published his classic case series of eight survivors from high

falls (50-150 feet), concluding that energy from high force impacts could be dissipated, thereby preventing serious injury. This key observation precipitated the birth of the bioengineering paradigm of injury prevention.

Gordon (1949) hypothesised that the epidemiological concepts of infectious disease could be generalised to an injury event, which resulted from the interaction between host (human), agent (hazard) and the environment. Gibson (1961) refined the concept, proposing that the agent of injury was energy. Haddon (1963, 1980) further developed this idea, postulating that the injury vector (for example a motor car) was the carrier of the agent (energy). Haddon demonstrated the application of this epidemiological framework, developing Haddon's Matrix (Haddon, 1972 & 1980). This epidemiological framework with its emphasis on the interaction between host, agent, vector and environment has since dominated thinking in injury prevention. Haddon particularly highlighted opportunities for harm reduction through redesign of the physical environment arguing that by preventing or dissipating the adverse release of energy, it was possible to minimize the chance of injury without necessarily preventing the accident. Haddon precipitated a major paradigm shift from accident prevention to injury prevention. Much has been achieved on the strength of this fundamental change in thinking.

In keeping with this bioengineering paradigm, injury has been defined as:

> *"Any unintentional or intentional damage to the body resulting from acute exposure to thermal, mechanical, electrical or chemical energy or from the absence of such essentials as heat or oxygen" (National Committee for Injury Prevention and Control, 1989, p4).*

Descartes' separation of the physical from the psychosocial is striking in this definition. The possibility that an individual's thinking, behaviour or social situation may place them in an environment where energy may be released is neither acknowledged nor addressed. Practice reflected the epistemology:

> *"On the whole, effective countermeasures are those that do not require any action by individuals intended to be protected by them. This principle, first articulated in the 1960s but recognised to have particular resonance for the practice of injury prevention, focuses on the extent to which an intervention is built into the environment, having an effect regardless of human activation" (Stevenson et a., 2004, p37).*

"Passive" interventions - those that require no action by the individual being protected (for example, occupant protection zones used in modern automotive engineering) were preferred over "active" interventions - those that required an active behavioural response (for example, buckling a seatbelt) (Haddon, 1974). However, this epistemological blind spot to the psychological and social determinants of injury is increasingly being challenged.

There is overwhelming evidence that behavioural, social and economic factors have a profound impact on the occurrence of injury. (Bonnie et al., 1999; Laflamme, 2001; Petridou and Tursz, 2001; Stokes et al., 2002; Gielen and Sleet, 2006). Even archetypal "passive" interventions must be reinforced by an "active" behavioural response if they are to achieve their full safety potential. Child resistant caps on medication must be replaced after use. Smoke alarm batteries must be changed. Swimming pool fences must be maintained (Gielen and Sleet 2006; Cunningham, 2002). Finally and most importantly, implementation of so called "passive" solutions requires a behavioural response from politicians, bureaucrats and manufacturers, who must be motivated to support these innovations. Sleet (1984) asserts the need for an "active approach to passive protection".

9.4 INJURY PREVENTION AND SAFETY PROMOTION

To focus solely on the biomedical concept of *"injury prevention"* is to underestimate the wholistic nature of human experience, and consequently how the positive state of *"safety"* is achieved. Maurice et al. (2001) defined safety as:

> *"a state in which hazards and conditions leading to physical, psychological, or material harm are controlled in order to preserve the health and well-being of individuals and the community" (p. 237).*

It is as much concerned with the subjective dimension – the perception of safety, as it is with the objective dimension – the absence of injury; as much concerned with the community in which individuals reside, as it is with the individuals that make up the community. Safety is a psychological, sociological and environmental phenomenon, rather than just physiological. It is inherently an ecological concept (Hanson et al., 2005).

The transition from researching "what works" (efficacy) to researching "how to make it work" (effectiveness) is not straightforward (Howat et al., 2004). Efficacy trials assess "*the extent to which a specific intervention, procedure, regimen, or service produces a beneficial result under ideal conditions*" (Last, 1995, p 52). To ensure internal validity, contextual factors are carefully controlled. By isolating the experimental variable from the influence of contextual variables a clear relationship between the control and experimental variable can be determined (Flay, 1986; Glasgow et al., 2003; Allegrante et al., 2006). In contrast, effectiveness trials assess *"the extent to which a specific intervention, procedure, regimen or service, when deployed in the field in routine circumstances, does what it is intended to do for a specified population"* (Last 1995, p 52). Here the focus is on external validity and whether the intervention is effective when tested in real world conditions where contextual variables (that may have been excluded from analysis in efficacy trials) may impact on outcome (Cochrane, 1972; Flay, 1986; Glasgow et al., 2003). Efficacy research may offer little insight into the practical challenges of implementation in a community social system if it has conceptually avoided the impact of contextual factors (Allegrante et al., 2006).

If injury prevention is the science of controlling context, safety promotion is the art of managing context. This should not be taken to imply that safety promotion is "unscientific". On the contrary, good safety promotion practice is built on a foundation of good science. However, the safety promotion practitioner must be able to integrate this evidence with the specific contextual needs of the target community if they are to transform efficacious science into effective safety promotion practice.

9.5 THE "GREAT SYMPHONY" PARADOX

> *"Here is the paradox: you need a great team of people with diverse skills to perform a symphony well, but no team has ever written a great symphony."* (Leifer et al, 2000).

The "Great Symphony" paradox succinctly articulates the challenge facing theoreticians, researchers and practitioners studying and working with communities to promote health, safety and welfare. The interface between the individual and their social environment appears to be a critical quality of

productive social systems. A social system appears to be much more than the sum of the individual human resources it contains.

9.6 SOCIAL CAPITAL

Social Capital is one concept proposed to describe this interface between the individual and society. Robert Putnam (1995) defines social capital as *"the features of social organisation, such as networks, norms and trust that facilitate co-ordination and co-operation for mutual benefit" (p 67).*

"Social Capital" has been associated with numerous desirable social outcomes including:

- lower crime rates (Halpern cited in National Statistics 2001),
- improved health (Wilkinson, 1996; Kawachi, 1999; Szreter and Woolcock, 2004),
- longevity (Putnam, 2000),
- improved educational achievement (Coleman, 1988; Halpern, 2005),
- improved child welfare and decreased child abuse (Cote and Healy, 2001),
- effective governance (Putnam, 1995), and
- enhanced economic achievement (Fukuyama, 1995).

Social capital is a metaphor regarding the importance of social resources framed in the language of capitalism to capture the attention of political bureaucratic systems that weigh social good in financial terms (Hanifan, 1920; Jacobs, 1961; Putnam, 1993; Cox, 1995; Stevenson cited in Borgatti, 1998, Putnam, 2000). There is opportunity, but also risk, in using this metaphor. While the concept may promote useful dialogue between different professional groups, different frames of reference can confuse the issue. Ronald Labonte (1999) comments:

> *"The present popularity of social capital rests in its combining the gluey stuff of social cohesion with the economic stuff of capital. It can easily be occupied by either side of the ideological divide" (p432).*

Public health and community development researchers view social capital through a lens that seeks to promote community wellbeing, health and safety

through more equitable distribution of financial and physical resources. In this frame of reference, "social capital" is a stabilising social force that counters the excesses of the capitalist market, which can produce environmental, structural and social inequalities that are associated with poor health and reduced community wellbeing (Lomas, 1998; Kawachi, 1999; Labonte,1999; Baum, 2000; Lynch, 2000). A cohesive social network creates an environment in which social norms facilitate a pattern of reliable social interchange by restraining the fragmenting forces of social difference (different values, different ideas, and differential distribution of resources). Network members are constrained to behave in a predictable and socially acceptable way, enhancing trust between group members and thereby reducing the emotional, social and monetary cost of co-operating with other group members. This cohesive type of social capital is associated with social systems that have a network of strong, dense relationships that link members (Scott, 2000; Lin, 1999).

Others view social capital through an entirely different lens, where social capital is understood as a manifestation of the competitive advantage enjoyed by certain groups or individuals within a specific group (Granovetter, 1973; Lin, 1999; Burt, 2001). Burt (2000) argues:

> *"Society can be viewed as a market in which people exchange all variety of goods and ideas in pursuit of their interests. Certain people, or certain groups of people do better in the sense of receiving higher returns for their efforts" (p2).*

Mark Grannovetter (1973) in his noteworthy paper "The Strength of Weak Ties" argued that some relationships are more strategic than others. Relationships that span the boundaries between social groups offer unique information and are an important source of innovation. Paradoxically, these bridging relationships are usually "weak ties". Burt (1992) developed the idea further, arguing that Granovetter's "weak ties" are a manifestation of the "structural holes" in a social network. Rather like an insulator in an electrical circuit, "structural holes" are areas of sparse relationships separating different subgroups contained within the network. Each social "sub-circuit" carries its own "current" (different flows of information). Individuals that reside on the bridges that connect the different social sub-circuits assume importance

because, like an electronic switch, they can control how the social system works by switching on or off interactions between different sub-groups. As a consequence, they assume a central role in any social interaction that depends on the productive exchange of information or expertise between sub-groups.

Despite the intuitive appeal of a concept that has successfully transcended the boundaries of politics, economics and sociology, it is evident there has been controversy regarding its definition and application. Two very different constructs of social capital have been promulgated. The "communitarian" construct is a quality of social systems. Communities with stronger, denser relationships are more cohesive, promoting equity and minimising difference. The "entrepreneurial" construct is a quality of individuals, or special sub-groups within a social system, who are able to extract additional social benefit by forming strategic bridges across areas of reduced relational density. Thus, a key theoretical and empirical issue is whether these two apparently contradictory constructs of social capital are mutually exclusive or complimentary. Woolcock (2001) voices these concerns:

> *"Conceptualising social capital across units of analysis ranging from individuals to institutions and nations … renders it susceptible to the criticism that it is all things to all people (and hence nothing to anyone)" (p12).*

9.7 MACKAY WHITSUNDAY SAFE COMMUNITIES

The Mackay Whitsunday Safe Communities (MWSC) was launched in February 2000 in response to the excessive rates of injury observed in the region (Vardon et al., 2000). The project consists of a number of action teams (Child Safety, Senior Safety, Road Safety, Occupational Health and Safety, Safe Alcohol Use) overseen by the Network Support Group (NSG). It seeks to understand the causes of injury from a socio-ecological perspective (Hanson et al., 2005) and thereby co-ordinate a systematic, inter-sectorial response to injury within the region. The MWSC aims to achieve this by mobilising safety promoting forces contained within the community social system. By involving the community in finding its own solutions, the MWSC attempts to catalyse structural, social and political change that empowers the

community and ultimately, individuals within the community, to change their environment and their behaviours to reduce the risk of injury. It is therefore vitally important to understand these social phenomena. The MWSC has used Social Network Analysis (SNA) as a tool to describe the growth of this community safety promotion network.

9.8 METHOD

In the initial survey sample a questionnaire was distributed to all members of the NSG. Respondents were asked to actively recall other individuals with whom they interacted in their work of promoting safety in the community. They were also asked to retrospectively identify if they had a relationship with this person prior to their involvement in MWSC. These people did not necessarily need to be members of the MWSC. This allowed all contacts within the sphere of influence of the MWSC to participate in the survey. Group members identified by the NSG were then followed up in wave one of the study. Using a snowballing technique (Scott, 2000) the chain of contacts was followed up through two survey waves, at which point recruitment was terminated. During wave two, members of the MWSC not already identified by wave one respondents were also included in the survey. A MWSC member was defined as anyone recorded as having attended one or more meetings of one of the MWSC's action groups.

Participation in the survey was voluntary and any personal identifying information was kept confidential. Participants who had not returned their survey forms were initially followed up in writing and subsequently by telephone to ensure an optimum response rate. The three stages of the survey were conducted over a period from December 2003 (initial sample) until December 2004 (wave two completed).

Adjacency matrices and sociograms were constructed for both the 2000 and 2004 networks (Scott, 2000).

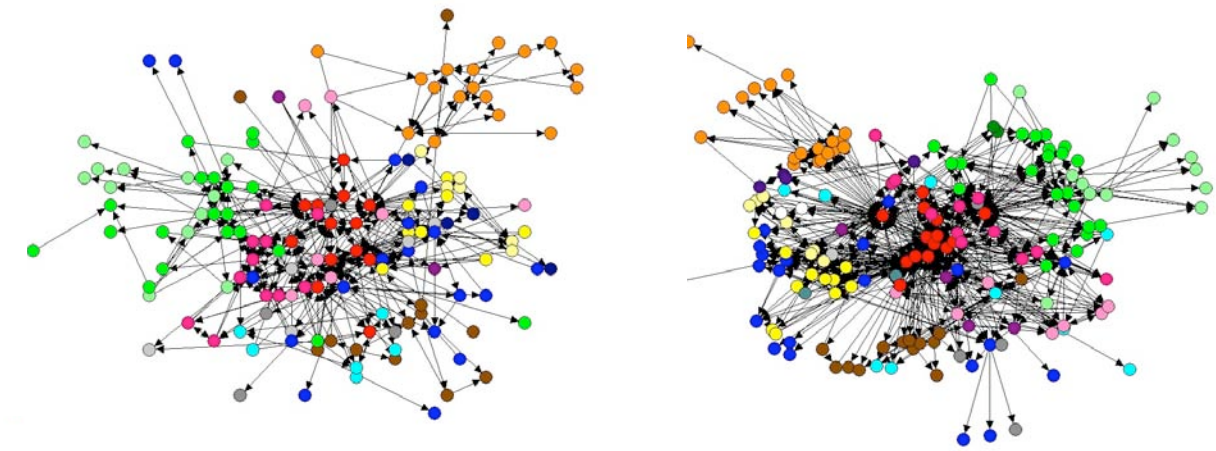
Network and actor attributes were calculated using UCINET 6.74 and NetDraw1.45 software (Borgatti et al, 2002). These included:

1. Measures of network cohesion, in particular network density and average degree, calculated for the 2000 and 2004 relational matrices. (Hanneman and Riddle, 2005).
2. Comparing the density of the 2000 and 2004 relational matrices using the algorithms described by Snidjers and Borgatti (1999).
3. Calculation of sphere of influence and leadership potential of individual actors including degree centrality and betweeness centrality (Freeman, 1979) using the 2001 and 2004 relational matrices.
4. Construction of a block-model of the 2000 and 2004 relational matricies to model relationships involving key facilitators from the NSG, MWSC and its external support network (SN).

9.9 RESULTS

At the time of the project launch in February 2000, the seven founding members of the NSG had a direct sphere of influence of 78 actors. These actors in turn identified relationships with a further 67 actors, creating a network of 152 members. Thus, at the time of project launch, the founding NSG had a direct relationship with only 56% of the network. By 2004 the direct sphere of influence of the NSG had nearly doubled to include 152 network members who in turn had access to a further 16 actors, creating a total network of 168, 90% of whom maintained a direct relationship with a member of the NSG. See Figures 8.1, 8.3 and 8.4.

Figure 9.1 compares the sociograms of the network at the time of project launch in 2000 with the network at the time of the study in 2004. The network had grown, but largely through increasing the number of relationships maintained by pre-existing members of the network. While the number of active network members increased from 152 in February 2000 to 168 by December 2004, the number of relationships doubled from 500 to 1002.



February 2000 (Project Launch) 2004

Figure 9.1 Sociogram of the MWSC in 2000 compared with 2004

	2000	*2004*
Active members	*152*	*168*
Relationships	*500*	*1002*
Reciprocity	*20%*	*30%*
Transitivity	*20%*	*26%*
Cohesion *- Density* *- Average degree* *- Distance based cohesion*	 *0.022* *3.3* *0.18*	 *0.036 (p < 0.0002)* *5.9 (p < 0.000)* *0.34*
Average distance	*3.9*	*2.8*
Core / periphery *- Density of core block* *- Density of periphery* *- Final model fitness*	 *0.14* *0.01* *0.25*	 *0.59* *0.02* *0.40*
Centralisation	*18%*	*43%*
Clustering co-efficient	*0.30*	*0.50*

Table 9.1 Network cohesion: 2000 compared with 2004

Cohesion within the network had increased substantially between 2000 and 2004 (Table 9.1). Density increased from 0.022 at the time of project launch to 0.036 at the time of the study, a statistically significant difference (p=0.0002) using the algorithms described by Sneijder and Borgatti (1999). The average number of relationships maintained by each actor (average degree) increased from 3.3 to 5.9 ($p < 0.000$, Wilcoxon 2 tailed). The average distance separating actors reduced from 3.9 to 2.8. The project had a strong core periphery structure centred on the NSG in 2004, with the core group

density increasing from 0.14 to 0.59. Similarly the centralisation index increased from 18% to 43%. Members of the network were much more likely to be clustered in groups (clustering coefficient 0.30 in 2000 compared with 0.50 in December 2004).

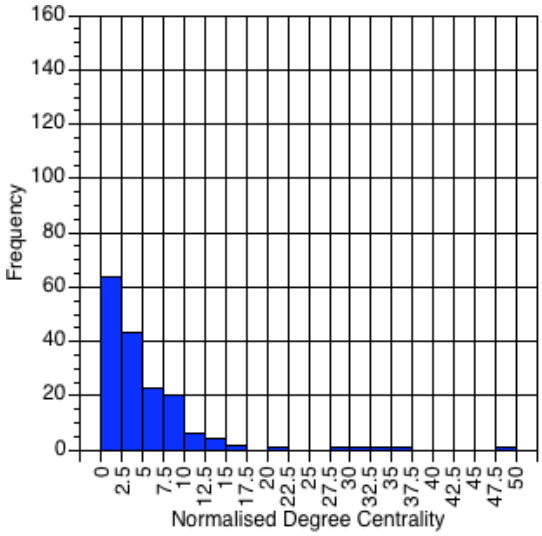


Figure 9.2 Normalised degree centrality, 2004

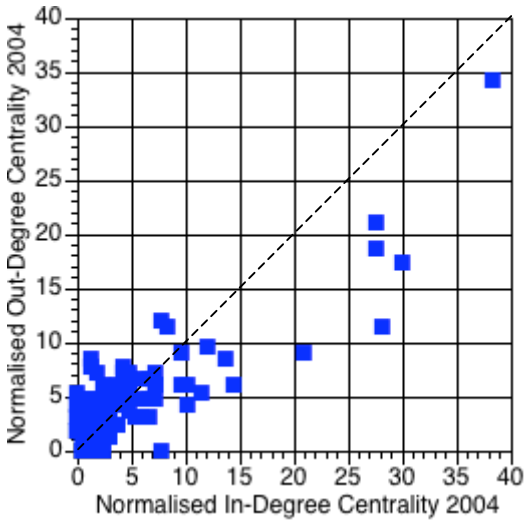


Figure 9.3 In-degree centrality[1] vs out-degree centrality, 2004

Figure 9.2 indicates that degree centrality is a skewed distribution biased towards a small number of actors with very high degree. Sixty-four actors (38% of the network) had a normalised degree centrality of 2.5% or less, together accounting for 11% of relationships observed in the network, whereas the six most connected actors (3% of the network) had a normalised degree centrality of 20% or above, together accounting for 44% of all relationships observed in the network.

Figure 9.3 compares in-degree centrality with out-degree centrality. Actors below the equivalence line have underestimated the number of relationships they maintain compared with nominations by their peers (in-degree > out-degree). Importantly, the more connected actors tended to underestimate the number of relationships they maintained.

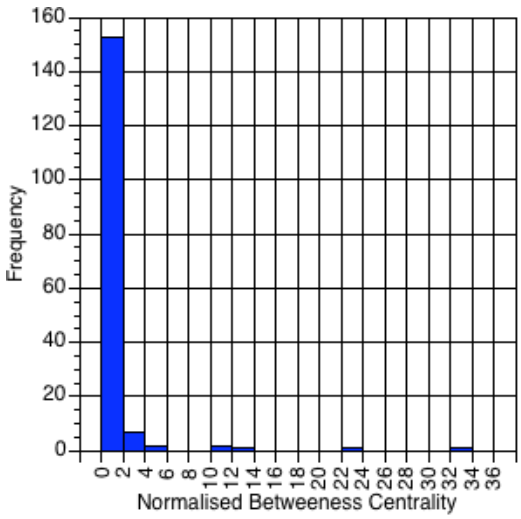


Figure 9.4 Normalised betweeness centrality, 2004

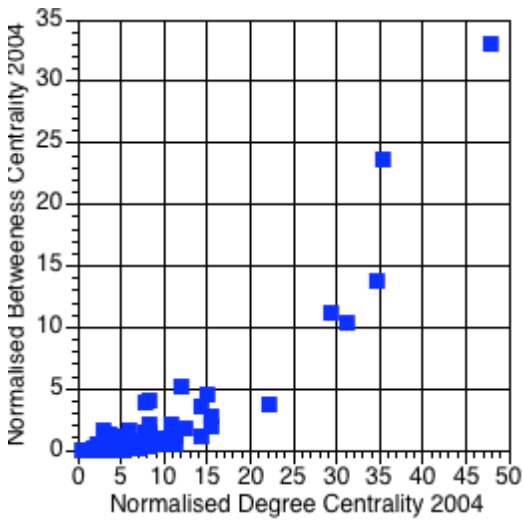


Figure 9.5 Degree centrality compared with betweeness centrality, 2004

Figure 9.4 indicates that betweeness centrality was even more skewed than degree centrality. One hundred and fifty-six actors (93%) had a normalised betweeness centrality of 2% or less, together accounting for 26% of the brokerage potential observed in the network. In contrast, the six most connected actors accounted for 60% of the brokerage potential observed in the network.

Figure 9.5 is a multi-dimensional scaling diagram comparing normalised degree centrality with normalised closeness and betweeness centrality. It is evident that the same six actors (all members of the NSG) had high scores on all measures of centrality and appear to play an important facilitative role in network activities.

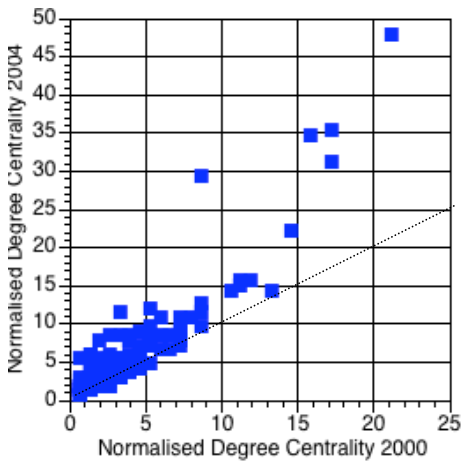


Figure 9.6 Normalised degree centrality 2000 compared with 2004

	2000	2004
Minimum	0.7%	0.6%
10th Percentile	0.7%	0.6%
25th Percentile	1.3%	1.8%
Median	2.6%	3.6%
Mean	3.6%	5.5%
75th Percentile	4.6%	6.6%
90th Percentile	7.7%	10.8%
Maximum	21.2%	47.9%

Table 9.2 Normalised degree centrality 2000 compared with 2004

Figure 9.6 and Table 9.2 compare normalised degree centrality for all actors at the time of project launch (2000), with that at the time of the study (2004). The number of relationships in the network had doubled from 500 to 1002 and the median normalised degree centrality increased from 2.6% in February 2000 to 3.6% by December 2004 ($p < 0.000$. Wilcoxon 2-tailed).

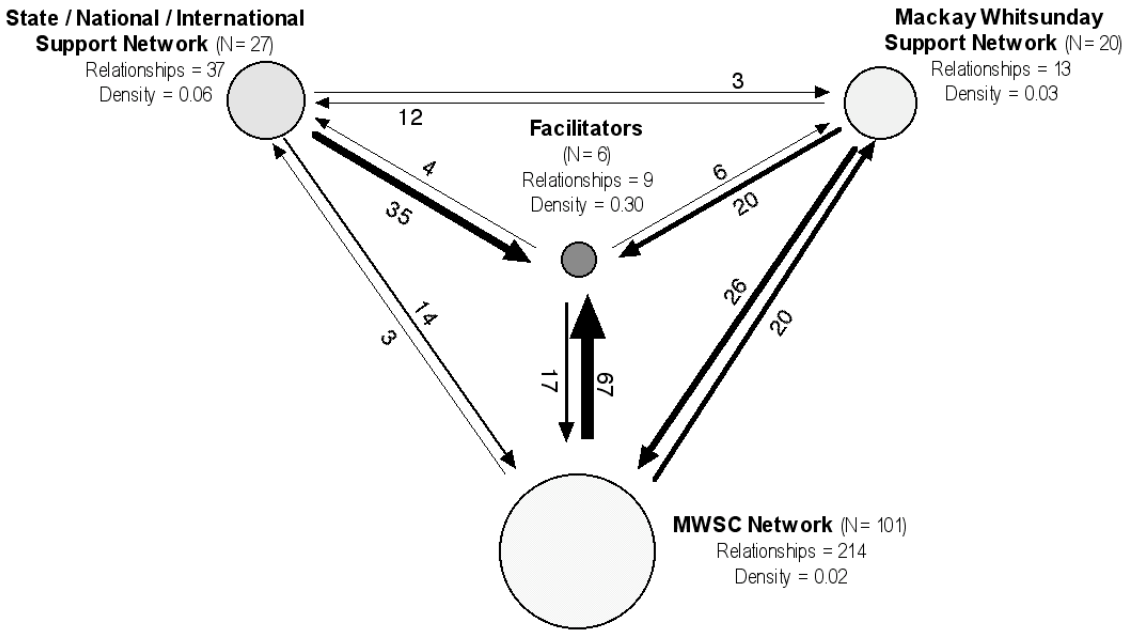


Figure 9.7 Block diagram of MWSC and SN in 2000: Number of relationships facilitators, MWSC, Mackay Whitsunday support network and State / National / International support network

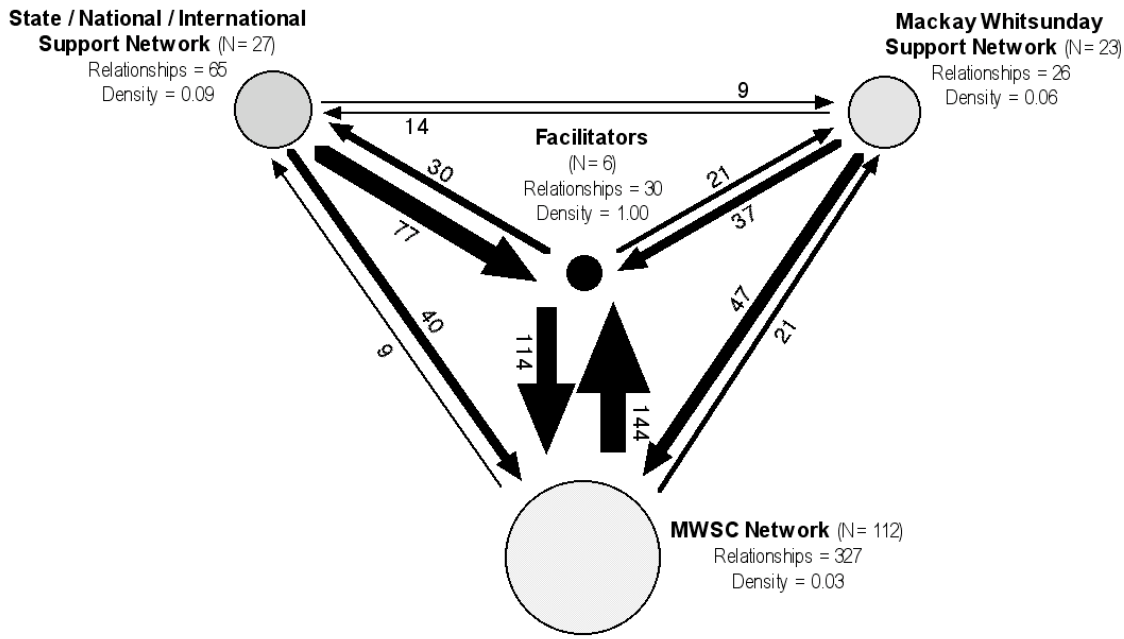
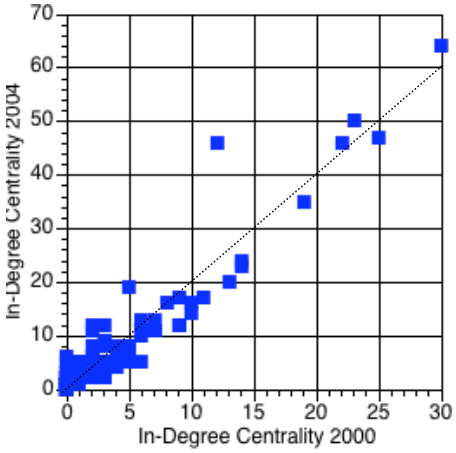


Figure 9.8 Block diagram of MWSC and SN in 2004: Number of relationships facilitators, MWSC, Mackay Whitsunday support network and State / National International support network



Regression:

In-Degree 2004 = 1.9 x In-Degree 2000 + 0.1

Pearson Correlation Coefficient = 0.84
$p < 0.000$, $R^2 = 0.90$

N.B. In-degree (Figure 9.7) is a directional measure of centrality which documents the number of times an actor is nominated by other members of the network. Normalised degree centrality (Figure 9.6) is non directional – a relationship is deemed to exist if either the actor or other members of the network nominate the relationship.

Figure 9.9 In–degree centrality 2000 compared with 2004

The doubling of relationships in the overall network was in large part related to the doubling of personal networks (Figure 9.9). Accordingly, actors who were already well connected developed more new relationships than other network members. Of the 502 new relationships formed by 2004, 157 (31%) were by the 6 network facilitators (Figures 9.8 and 9.9). As a result they increased the proportion of relationships they maintain from 32% of the network in 2000 to 44% in 2004. However, for every new relationship formed by the network facilitators, two new relationships were formed by other members. The cohesive social capital of the network increased as a consequence.

There is clearly a strong tendency for members of the MWSC, and the external support networks to direct relationships via the network facilitators (Figures 9.8 and 9.9). Figure 9.9 provides compelling evidence of the relational burden this imposed on the 6 network facilitators. As a group they received 258 incoming relationships (43 relationships per facilitator). Contrastingly MWSC members received 201 incoming relationships, shared between 112 actors (1.8 per actor). Members of the Mackay Whitsunday local support network received 42 incoming relationships shared between 23 members (1.8 per actor) and members of the state / national support network received 53 incoming relationships shared between 27 actors (2.0 per actor) . Thus for every relationship received by a member of the MWSC, network facilitators received twenty-four.

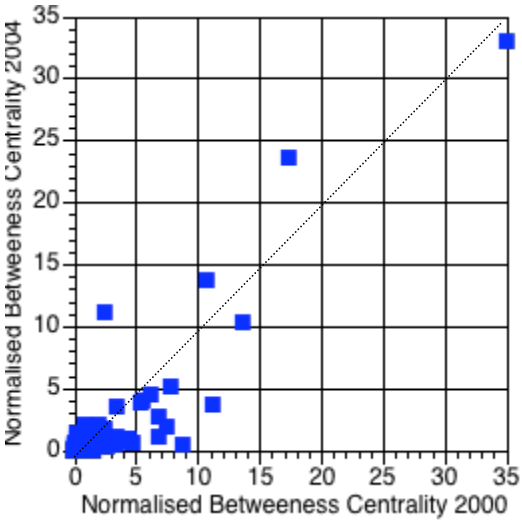


Figure 9.10 Normalised betweeness centrality 2000 compared with 2004

	2000	2004
Minimum	0%	0%
10th Percentile	0%	0%
25th Percentile	0%	0%
Median	0.15%	0.04%
Mean	1.5%	0.9%
75th Percentile	1.3%	1.4%
90th Percentile	4.4%	1.6%
Maximum	34.9%	33.0%

Table 9.3. Normalised betweeness centrality 2000 compared with 2004

As the network became more connected, the opportunity for the majority of actors to act as intermediaries decreased (Figure 9.10 and Table 9.3). Accordingly the median betweeness centrality decreased from 0.15 in February 2000 to 0.04 by December 2004 ($p<0.000$, Wilcoxon 2 tailed). However, against this trend, three actors had increased their intermediary role. In February 2000 the six most connected actors possessed 39% of the brokerage potential observed in the network. By December 2004 this had increased to 60%.

	Number	Percent
Worse	6	0.6%
Unchanged	433	43%
Better	563	56%

Table 9.4: Changed relationships

Actors were asked if the relationships they identified had changed since the coalition was launched in February 2000 (Table 9.4). Fifty-six percent of relationships were said to have improved, whereas 0.6% were said to be worse.

Network members were asked to nominate the context of the relationships they shared as a proxy measure of the degree of collaboration:

1. *In depth relationships* were defined as those in which network members "collaborate to develop joint funding proposals, plans or projects, sharing time and resources to actively work together".
2. *Working groups* were defined as groups who "collaborate at committee level to meet shared objectives".
3. An *interagency meeting* was defined as that in which members "meet to share information and discuss mutual goals, but work independently".
4. *Some contact* was defined as relationships in which network members "share flyers and advertising material, ask questions or refer clients to each other".

	2000	2004		
	all relationships	all relationships	new relationships	pre-existing relationships
No Contact	520 (51%)	22 (2%) *		12 (2%)
Some contact	235 (23%)	230 (22%)	99 (20%)	131 (25%)
Interagency	53 (5%)	111 (11%)	48 (10%)	63 (12%)
Working Group	72 (7%)	425 (42%)	184 (38%)	241 (46%)
In Depth	140 (14%)	236 (23%)	159 (32%)	77 (15%)

* 22 (2%) actors reported no relationships in 2004, 10 (1%) reported a relationship in 2000, 12 (2%) reported no relationships in 2004 or 2000

Table 9.5 Type of collaboration in February 2000 compared with 2004

Table 9.5 documents the degree of collaboration in February 2000 compared with 2004. In 2004 network members were six times more likely to be collaborating at the level of a working group (7% in 2000 compared with 42% in 2004), and almost twice as likely to report an in depth relationship (14% in 2000 compared with 23% in 2004). In depth relationship were twice as likely to develop as new relationships (32% of new relationships were described as in depth in 2004 compared with 16% of pre-existing relationships).

		Collaboration in 2004				Increased Collaboration	Decreased Collaboration
		Some contact	Interagency	Working Group	In Depth		
Collaboration in 2000	Some Contact	91 (40%)	18 (8%)	77 (33%)	44 (9%)	139 (60%)	n/a
	Interagency	2 (4%)	23 (45%)	25 (49%)	1 (2%)	26 (51%)	2 (4%)
	Working Group	2 (3%)	2 (3%)	61 (86%)	6 (8%)	6 (8%)	4 (6%)
	In depth	4 (3%)	5 (4%)	21 (15%)	108 (78%)	n/a	30 (22%)

Table 9.6 Change in collaboration for pre-existing relationships

Thirty-six percent of pre-existing relationships increased the degree of collaboration in 2004. Fifty-five percent remained unchanged while 9% reported a reduction in their degree of collaboration. Table 9.6 compares the degree of collaboration in February 2000 with that observed in 2004. Sixty percent of relationships reported as “some contact” in 2000 are now interacting at group or in depth level in 2004. Forty-nine percent of relationships reported as “interagency” had increased to “working group” indicating there is increased preparedness to work together collaboratively on joint projects. Interestingly, “in depth” relationships were more likely to develop in the context of relationships previously described as “some contact” than “working group” relationships, while pre-existing “in depth” relationships showed the greatest propensity to show decreased collaboration.

9.10 DISCUSSION

A key initial objective of MWSC was to consolidate and better coordinate a network of community groups already working in the domain of community safety promotion. This network analysis provides quantitative evidence that the coalition has been successful in engaging further partners and building social cohesion. While the number of actors involved in the network increased from 152 in February 2000 to 168 by December 2004, the number of relationships maintained by members of the network had doubled from 500 to 1002. More importantly, 56% of relationships were said to have improved as a consequence of MWSC. Aside from the 502 new relationships, 36% of pre-existing relationships increased their level of collaboration. In particular,

60% of relationships described as “some contact” in 2000 cooperated at group level[1] by 2004. As a result the proportion of relationships collaborating at group level increased from 26% in 2000 to 76% by 2004.

At an interpersonal level the average number of relationships maintained by network members (average degree) increased from 3.3 to 5.9. Reciprocity[2] increased from 20% to 30% and transitivity[3] from 20% to 26%. Network members demonstrated a stronger tendency to group formation (clustering coefficient increasing from 30% to 50%) and the network displayed increased potential for coordination by a central group of actors (centralisation index increased from 20% to 43%). All measures of network cohesion had increased. In particular, density increased from 0.022 to 0.036 ($p < 0.0002$) and median normalised degree from 2.6% to 3.6% ($p < 0.003$, Wilcoxon 2 tailed). The coalition had succeeded in building cohesive social capital.

SNA also provided evidence that a small number of well connected actors have disproportionate social influence within the network (entrepreneurial social capital). Figure 9.2 (degree centrality) and Figure 9.4 (betweeness centrality) indicate that social relationships within the network were not randomly or equitably distributed. Whether measured in terms of direct social influence (degree centrality) or brokerage potential (betweeness centrality), a small group of six actors, all members of the NSG, demonstrated disproportionate social influence (Figure 9.7). Furthermore their social influence had increased over the course of the study. By 2004, they maintained 44% of all relationships observed in the network compared with 32% in 2000. They also possessed 60% of the brokerage potential of the network compared with 39% in 2000. These network members linked the NSG to action groups and the action groups to each other. They were also distinguishable by the number of relationships they maintained external to the MWSC, linking the project to the outside world (Figures 9.7 and 9.8). They were therefore an important point of access to external information and resources. Thus, in keeping with Granovetter (1973) and Burt’s (2000)

[1] Interagency meeting, working group or in-depth collaboration.
[2] Both actors nominate each other.
[3] A measure of introduction: if A knew B and B knew C, then transitivity measures the likelihood A will know C

construct of social capital, entrepreneurial social capital was not evenly distributed across the network. Indeed, this social asymmetry became more marked over time.

It is perhaps concerning that a small group of actors were disproportionately influential within the MWSC as there is a potential for them to abuse this power. Even if their motivation was altruistic, in their efforts to get things done, they may steal initiative from other network members.

It should not be naively assumed that social capital is innately moral. Many authors emphasise the “dark side” of social capital (Putnam, 2000; Hawe and Shiell, 2000; Woolcock, 2001). The same cohesive forces that maintain desirable behaviours within a community can also maintain undesirable behaviours. The Mafia and the Ku Klux Klan are examples of cohesive social networks with strong internal “standards” of behaviour.

The competitive advantage certain individuals or groups enjoy within social systems may be used to promote the common good or exploited to acheve personal gain.

Health advocates and political champions may use their political leverage (social capital) to promulgate health promoting public policy (Carlisle, 2000). Social marketing programs frequently use the public profile (social capital) of prominent media or sporting personalities to promote safe or healthy behaviours in the community (Donovan & Henley, 2003).

Both Granovetter and Burt hypothesise that the strategic position enjoyed by specific actors offers them special opportunities to control the flow of information and resources. This not only makes them more influential, but more effective in completing their work. Granovetter’s (1973) original paper documented the link between weak ties and success in finding employment. Burt (2000) and colleagues have conducted a number of studies that demonstrated the link between entrepreneurial social capital and peer recognition, cost efficient management, successful job seeking, personal promotion, salary and bonus payments. This social leverage may either be used to enhance the efficiency and effectiveness of the coalition they lead or

be exploited by individuals seeking to advance their own political, bureaucratic, organisational or financial power.

It is reassuring to note that in MWSC the contribution of the six most connected network members appeared to be valued by other network members. On average 85% of the relationships they maintained were reported "beneficial" compared with 62% for other network members. As a result, relationships were strongly focused towards the network facilitators. However, the relational pressure this placed on the network facilitators was evident. As a group they process 258 incoming relationships (43 relationships per facilitator). Contrastingly, other members only process an average of 1.8 incoming relationships. Thus, for every incoming relationship maintained by other members of the network, the facilitators maintain 24. It is questionable if this facilitator role is sustainable in its present form if they continue to acquire new relationships at the same rate (that is, doubling every four years).

This study has clearly demonstrated the presence of both forms of social capital: cohesive social capital and entrepreneurial social capital. Based on the findings of this study, the polarisation of theoretical discourse regarding social capital into "cohesive social capital" and "entrepreneurial social capital" is misleading and unhelpful. Both forms of social capital were present and appeared important in this social system. Perhaps we are observing opposite sides of the same coin. On the one hand cohesive social capital is produced within regions of a network that are characterised by groups of actors that maintain frequent, strong and dense relational ties. On the other hand, entrepreneurial social capital is produced by relationships that bridge the regions of reduced relational density that separate different groups within a social network. Van der Gaag and Snidjers (2005) argue "the strength of strong ties" as well as the "strength of weak ties". The issue is not one of resolving which is correct, but rather understanding how each is generated, their key social features and how they can be most effectively used.

A synthesis is possible between these apparently contradictory constructions of social capital (Lin, 1999; Putnam, 2000; Burt, 2000). Putnam (2000) distinguished between bonding, bridging and linking social capital. *Bonding social capital* (cohesive social capital), refers to the cohesive bonds (strong

ties) that facilitate social relations within relatively homogenous social groups (for example, families, ethnic groups, religious cliques). *Bridging social capital* (a form or entrepeneurial social capital) refers to the weaker horizontal ties that exist between distant friends, associates or colleagues (for example civil rights movements and religious organisations). Bonding social capital is good for "getting by", whereas bridging social capital is good for "getting ahead". *Linking social capital* (another form of entrepreneurial social capital) refers to vertical relationships bridging social strata within a hierarchy where power, social status and wealth are differentially accessed (for example health advocates and project champions use linking social capital).

High Entrepreneurial Social Capital	**Disintegrated group** characterised by diverse perspectives, skills and resources	**Maximum performance** i.e. high cohesive social capital & high entrepreneurial social capital
Low Entrepreneurial Social Capital	**Minimum performance** low cohesive and low brokering social capital	**"Group Think"** Cohesive group containing only one perspective, skill or resource
	Low Cohesive Social Capital	High Cohesive Social Capital

Table 9.7 Synthesis of the relationship between cohesive and brokering social capital (Burt, 2000)

Burt (2000) has developed three-dimensional models of social capital demonstrating that cohesive social capital is complimentary to entrepreneurial social capital. Combining these two social forces strategically optimises output (Table 9.7). Lin (1999) proposes that cohesive social capital is a force of social stability that maintains group standards, whereas entrepreneurial social capital is an important force of innovation and creativity and thereby social change. This is a tantalising theory for those planning safety promotion interventions. Perhaps the social forces required to induce change (entrepreneurial social capital) are different from the social forces required to

maintain desirable social behaviours (cohesive social capital). This theory, if confirmed, has profound implications for the practice of safety promotion which must seek to use both forms of social capital. A key objective of community safety interventions is to enhance safe community standards of personal and group conduct (a manifestation of cohesive social capital), while the means to achieve this positive change is through the use of entrepreneurial social capital. For example, the United States and Australia have achieved dramatic reductions in road trauma mortality (Isaacs and Schroeder, 2001; ATSB, 2004) and while this improvement is multifactorial, and bioengineering innovations (including vehicle and road design) have unarguably made an important contribution to this reduction, it is also clear that changes in community standards have been important. These standards are both formal (legislative) and informal (social expectation). Since seat belt use became compulsory in Victoria in 1970, compliance increased from 25% to 97% in 2004 (ATSB, 2004). Compulsory seat belt legislation was introduced throughout Australia in 1972. Nationwide, 90% of Australians now wear seat belts (ATSB, 2004). In the USA, seat belt use increased from 11% in 1981 to 68% in 1997 (Centers for Disease Control and Prevention, 1999). Drink driving is increasingly perceived to be socially unacceptable (Isaacs and Schroeder, 2001). In Australia, Random Breath Testing (RBT) legislation was introduced in Victoria in 1976 and was progressively introduced in all states by 1988. RBT is well accepted in Australia and enjoys a 97% approval rate (ATSB, 2004). While formal social standards (legislation and enforcement) have undoubtedly contributed to changes in informal social standards (community expectation), these changes in community social expectations have meant that aggressive legislation and enforcement of seat belt and drink driving legislation have become socially acceptable. It is evident that community standards (cohesive social capital), both formal (legislation, manufacturing and infrastructure standards) and informal (social expectation), are an important amplifying force for interventions that seek to change behaviour. However, it is also illustrative to consider the contribution of key individuals in achieving these changes in community standards. Political champions (for example William Haddon as director of the U.S. National Highway Safety Bureau), consumer advocates (for example Ralph Nader in

his “Unsafe at Any Speed” campaign) and community activists (for example Doris Aitken, founder of Remove Intoxicated Drivers – “RID”, and Candy Lightner, founder of Mothers Against Drink Driving – “MADD”), made a critical contribution to changes in community standards and ultimately road trauma mortality (Isaacs and Schroeder, 2001; Allegrante et al. 2006).

This study confirms it is possible to measure cohesive social capital and entrepreneurial social capital within a community safety promotion coalition. With the recent innovations in stochastic and temporal modelling of social networks (Robins et al., 2006a, 2006b; Snijders, 2005; Snijders et al., 2006) it will soon be possible to test if cohesive social capital is a force that maintains social standards, thereby ensuring social stability and whether entrepreneurial social capital is a source of innovation and change in social systems.

9.11 CONCLUSION

A “great symphony” is a creative synthesis of many different social resources: composer, conductor, musicians and audience. It is a combination of excellence in composition, technical excellence in interpreting and performing the music, and talented leadership that can draw out the best in the musicians. But ultimately a great symphony is a social event in which all these components are combined to create a performance. Excellence in human endeavour is no different in other domains. It is a critical mix of financial, physical and human capital in which social capital, the ability of individuals to work creatively with groups, and of groups to draw out the best in individuals, is the crucial success factor.

The definition of social capital has been controversial. Two seemingly contradictory constructs of social capital have been promulgated. The “communitarian” construct championed by Cox (1995) and Putnam (1995) is a quality of social systems. Communities with stronger, denser relationships are more cohesive and better positioned to co-operate for mutual benefit. The “entrepreneurial” construct of social capital championed by Lin (1999) and Burt (2000) is a quality of individuals or special sub-groups, who are able to extract extra social benefit by forming strategic bridges across areas of

reduced relational density and thereby mobilise useful resources, access novel information and develop innovative solutions.

Our study identified both forms of social capital, cohesive social capital and entrepreneurial social capital. Like a great symphony, a great community coalition is a creative synthesis of two complimentary social resources: the collaborative power of a diverse, talented, committed and co-ordinated team of individuals and organisations, combined with innovative entrepreneurial energy of individuals, political and administrative champions, health advocates and community activists.

While a robust theoretical definition of social capital is undoubtedly important, the best way to understand social capital is to observe it in action. Empirical research combined with an informed theoretical discourse is the most productive way to develop a meaningful definition of social capital. Perhaps the “great symphony paradox” can offer us one more important insight. While there is value in the careful academic study of the music, to really understand what turns great music into a great symphony, the easiest way is still the best. Sit back, relax and enjoy the music.

CHAPTER TEN

MEASURING THE SUSTAINABILITY OF MACKAY WHITSUNDAY SAFE COMMUNITIES USING SOCIAL NETWORK ANALYSIS

10.1. SUSTAINABLE SAFETY PROMOTION

Sustainable safety promotion programs deliver lasting improvements in the health status of individuals or the communities they target (Olsen, 1998; Sheddiac–Rizkallah, 1998). Sustainability is an attractive concept to political and administrative systems that are anxious to achieve long-term outcomes from their social investments. While "sustainability" is common rhetoric, it is less often achieved. Approximately half of all community initiatives are not sustained beyond the initial development phase (Hanson et al., 2005).

Failure to sustain desirable project outcomes is counterproductive. It wastes the human and financial resources invested in the project and erodes community trust in the responsible organisations (Goodman and Steckler, 1989; O'Loughlin et al., 1998; Sheddiac–Rizkallah, 1998).

10.2. ECOLOGICAL SUSTAINABILITY

Brinkerhoff and Goldsmith (1992, p 371) note that sustainability "is not an end state but an ongoing input-output process". It is an ecological concept (Hanson, 2005), concerning the flux of resources through an ecological system (von Bertalanffy, 1950; Brush, 1975; Lowe, 1994; Sciubba, 1995)

This concept has been adopted by public health practitioners. McMurray (1999, p56) suggests, "a community can be viewed as an ecosystem, with resources, opportunities and threats to health and healthy lifestyles." Interventions dependent on external resources are vulnerable, as they depend on the ability to secure ongoing funding. The solution is to maximise the ability of a community to maintain an outcome within its own "ecosystem".

10.3. SUSTAIN: A DEFINITION

The Oxford Dictionary (Moore, 1997) defines sustain as " (1) to maintain or keep going continuously, (2) to support or bear the weight of especially for a long period, or (3) to give strength to encourage or support." The concept is one of *assuming responsibility* to expend *sufficient resources* to *maintain* the *desired outcome*. Four questions are evident:

1. What is the desired outcome?
2. Are there sufficient resources to implement the outcome?
3. Are there sustainable resources to maintain the outcome?
4. Who is responsible?

10.4. DEFINING THE DESIRED OUTCOME

It is important to be clear about the ultimate objective (Swerissen, 2004). What is one seeking to sustain?

- The desired social outcome?
- The intervention used to achieve the outcome?
- The organisation or network used to implement the intervention?

In a particular situation, each of these objectives may be valid, but they require different approaches to sustainability. For example, if the objective was to improve public awareness of an injury risk and promote behaviours that reduce this risk, then an ongoing public education program by the organisation responsible for the program may be necessary to maintain the desired behaviour. On the other hand, if the objective was to implement an environmental modification that reliably reduces the risk of injury on an ongoing basis, it may not be necessary to maintain the advocacy program once the appropriate design standard had been enshrined in legislation or the appropriate infrastructure installed. Accordingly, injury prevention researchers have historically preferred "passive" environmental modifications that are not dependant on a behavioural response, over "active" behaviour modification programs (Haddon, 1974; Stevenson et al., 2004).

10.5. EMBEDDEDNESS

It may be possible for an intervention to embed safety-promoting characteristics in the physical and social environment in a way that means continuation of the program itself is no longer necessary.

The individual is, metaphorically speaking, the “tip of the iceberg”, just one part of a complex ecological system (Chapter Four). The most enduring way to reduce an individual’s risk of injury is to systematically address the environmental and social determinants of injury “hidden beneath the water line”.

10.6. SUFFICIENCY

A prerequisite for sustainability is sufficiency. Before an outcome can be sustained, it must be successfully implemented. This implies the investment of sufficient time and resources to induce the desired outcome. In the current climate of economic constraint, politicians and administrators are very aware of the dangers of extravagant waste – investing more resources than are necessary to implement the desired outcome. However, it is easy to underestimate the time, resources and resolve required to change the behavioural, environmental or social determinants of injury. It is important not to overlook the dangers of miserly waste – investing insufficient resources to achieve the desired change.

10.7. SUSTAINABILITY

The investment of sufficient resources to implement the desired outcome does not necessarily imply adequate operational resources to maintain the outcome (Stefanini and Ruck, 1992; La Fond, 1995; Olsen, 1998). Just as a new building requires ongoing maintenance to remain operational, social interventions require ongoing maintenance to remain functional (Thompson, 1993; Hill, 2002). Importantly, the resources required to maintain the outcome may be different in type and quality from the resources required to implement the outcome. These resources may even need to be accessed from a different source.

10.8. UNIVERSAL DOMESTIC POOL FENCING LEGISLATION: A CASE STUDY IN SUFFICIENCY AND SUSTAINABILITY

Australia is an affluent country with a warm climate. The introduction of prefabricated fibre-glass domestic pools in the early 1970's made domestic swimming pools affordable. Drowning in children under 5 years of age increased dramatically in the early 1970's from 7.30 per 100,000 in 1970 to 10.76 per 100,000 in 1973, with an average of 43 additional drowning deaths in this age group every year (Scott, 2003).

In Queensland, the problem was particularly concerning. Pern and Nixon (1977) calculated the drowning rate for children under 5 years as 15.69 per 100,000 in 1977. Half of these occurred in the family pool, and in three quarters of cases no barrier prevented toddlers from accessing the pool.

By the late 1970's the issue had achieved prominence in the media and strong advocacy efforts by public health physicians, the Consumer Association of Australia (1977), the Child Accident Prevention Foundation of Australia (Kidsafe) and the NSW Water Safety Council (Pearn cited Scott, 2003) were underway.

A viable environmental solution was rapidly identified. In the early 1970's, the South Australian and Australian Capital Territory governments introduced legislation requiring that pools be enclosed (Scott, 2003). The effectiveness of this intervention was quickly established (Pearn and Nixon, 1977; Ferguson and Harwood, 1984; Present, 1987). Development of a suitable Australian Standard for Domestic Pool Fencing and the passage and enforcement of universal four-sided isolation fencing had the potential to dramatically reduce the incidence of toddler drowning.

In 1979 Standards Australia published a design standard. These standards were drafted after negotiation between injury prevention researchers, child safety advocates, industry representatives and community representatives, which included members of the anti pool fencing lobby. Unfortunately, in spite of the advice of researchers and child safety advocates, a flawed standard was

published which failed to address an issue of critical importance – the position of the fence. Four-sided dedicated pool fencing that isolated the pool from the rest of the property and the house was necessary to ensure the safety of small children living in the house, but this was not specifically addressed in the original design standard. As a result, legislation and ordinances drafted on the basis of this standard in NSW (1992) and Victoria (1988) were flawed (Scott, 2003).

Amidst great controversy, Brisbane City Council passed a pool fencing ordinance in 1977 only to see the ordinance struck down by the conservative state government the following year. In NSW the Minister for Local Government (whose child had nearly drowned in a domestic pool) oversaw the passage of an act requiring all domestic pools be fenced in 1990. However, the government faced vocal opposition during an election campaign the next year. The Minister for Local Government lost his seat and the government majority was reduced to one. As a result NSW legislation was repealed even before it was enacted (Scott, 2003).

Sadly, it was 20 years after the identification of the problem and 15 years after the identification of the solution before best practice legislation was enacted in any jurisdiction (Scott, 2003). Best practice pool fencing standards were not published by Standards Australia until 1993.

After an intense period of public education and political advocacy, universal four-sided, isolation pool fencing legislation was eventually enacted by the Queensland Government in 1992. This was associated with a dramatic decline in toddler drowning. Only four children drowned in domestic pools in the 24 month period after the legislation was enacted, compared with an average of 15 per year prior to the legislation (Pitt and Balanda, 1991). Similar legislation was introduced in Western Australia in 2002.

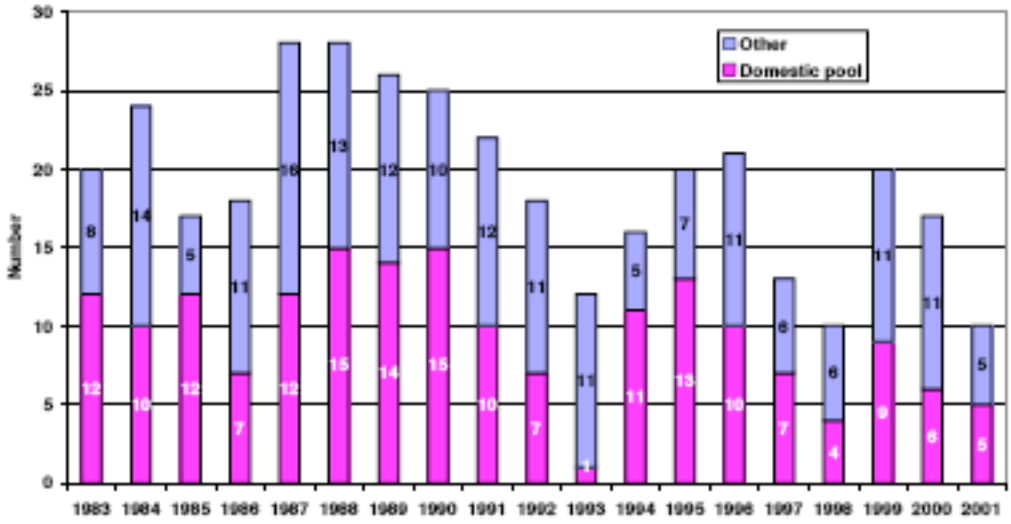


Figure 10.1 All Queensland drowning deaths, by year in children 0-4 years, 1983-2001 (Cunningham et al., 2002 – used with permission)

Cunningham et al. (2002) estimated that the legislation had saved an estimated 70 lives by 2001. However, the incidence was again rising (Figure 10.1). Over the ten year period since enactment of the legislation, 73 children under 5 years of age drowned, three quarters in in-ground pools. In 21% the pool was unfenced, in 46% the gate had been propped open or did not close automatically and in 13% the child had entered through the house door (three-sided fencing was permitted in pools approved prior to 1991).

Cunningham et al. (2002) concluded that pool fencing legislation had been effective, but compliance had faltered because of lack of maintenance of fences, deliberate propping open of gates and a lack of enforcement by local government. They pointed to the ongoing need for public health programs to maintain public awareness of toddler drowning in domestic pools, ensure adequate supervision of children in pool compounds, and maintain enforcement of existing legislation.

A number of important lessons can be learned from this case study:

- It may take a long time to generate sufficient administrative and political resolve to implement an effective intervention.
- Effective lobbying targeting those in responsibility may be circumvented by those opposing the intervention if there is not adequate consensus within the community that legislation is justified.
- Even an archetypal passive intervention (pool fencing) must be reinforced by ongoing public health campaigns to maintain community compliance and sufficient consensus to ensure enforcement of the legislation.

Injury is a complex problem. It has multiple inter-related causes that cut across policy and service areas and defy single strategy, single agency "silo" approaches (Keast et al., 2004). Sleet (1984) emphasised the importance of an "active approach to passive interventions". A suite of interventions simultaneously targeting behavioural, environmental and social determinants are more likely to be effective (Gielen and Sleet, 2006).

If comprehensive interventions that systematically address behavioural, environmental and social determinants of injury are to be designed, a new way of working is required that bridges traditional boundaries and unlocks expertise and resources already existing in communities (Ackoff, 1974; Rittel and Weber, 1973; Clarke and Stewart, 1997; Lasker et al., 2001; Keast et al., 2004).

In recent years, "settings based" approaches have been proposed as a way to embed comprehensive solutions to complex social problems within a target social system (Ashton, 1992; Whitelaw et al., 2001; Coggan and Bennett, 2004; Welander et al., 2004). If communities can be assisted to identify and address their own problems using their own resources, this may engender self sufficiency to sustain a safe environment (Hawe et al., 1997; Green and Kreuter, 1999; Hanson et al., 2002 and 2005; Coggan and Bennett, 2004; Welander et al., 2004).

10.9. COMMUNITY CAPACITY

Capacity building uses an intervention as a vehicle to identify, mobilise, co-ordinate and develop existing community resources to address local issues. This increases the community's capacity to mobilise sufficient resources to induce and ultimately sustain change (Hawe, 1997; Hawe et al., 1998; Coggan and Bennett 2004; Gielen et al., 2006). If this process can be adequately embedded within the community social system, the intervention itself may ultimately become superfluous (King, 1990; Labonte 1991a and 1991b; Swerissen, 2004).

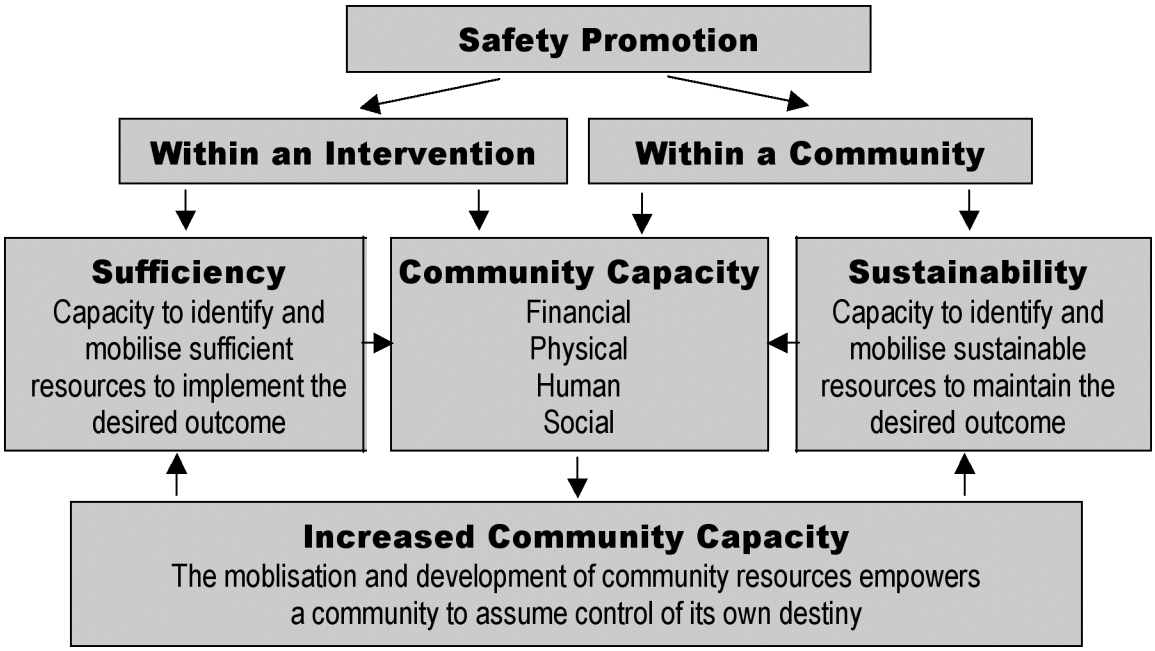


Figure 10.2 Community capacity building – magnifying the effect of a safety promotion intervention

There is more to a community than can be purely measured in dollar terms. Cox (1995) identified four types of community resources or "capital":

1. Financial Capital: the economic resources available to a community or program. While clearly important, it is frequently overemphasised at the expense of other forms of capital.
2. Physical Capital: the natural environment and man-made resources (including buildings and equipment) available to a community.

3. Human Capital: the skill and knowledge of the individuals contained within a community.
4. Social Capital: “the features of social organisation, such as networks, norms and trust, that facilitate co-ordination and co-operation for mutual benefit” (Putnam, 1993).

Communities have access to many different resources, all part of the mix necessary to implement and sustain safe communities.

Certain authors argue that social capital is a critical forgotten element of successful social interventions (Putnam, 1993; Cox, 1995). Two complimentary forms of social capital deliver different social outcomes (Lin, 1999; Burt, 2000; Putnam, 2000). Entrepreneurial social capacity is a source of innovation and advocacy. It is necessary to produce sufficient consensus to implement a desirable social outcome (Lin, 1999; Lasker et al., 2001). Cohesive social capital is a source of social stability and is necessary to maintain the consensus necessary to sustain a desirable outcome (Lin , 1999, Putnam, 2000). Entrepreneurial social capital is important to achieve sufficiency, while cohesive social capital is important to maintain sustainability.

10.10 RESPONSIBILITY

Multi-level, multi-sector, multi-agent collaborative networks have been proposed as vehicles for promoting social change. However, networks cannot be sustained unless all network members contribute. This principle applies equally to horizontal networks (within community systems) and vertical networks (between politico-administrative systems and communities).

In an age of financial accountability, economic rationalism and aggressive competition for funding, short term development funding is now the norm. Governments and organisations are reluctant to commit to ongoing operational investments, preferring to delegate this responsibility to local communities or non government agencies (NGOs). As a result, a paradigm has gained credence that explicitly or implicitly defines sustainability as, “the ability of a health project or

programme to deliver health services or sustain benefits after major technical, managerial and financial support has ceased" (United States Agency for International Development, cited La Fond, 1995). However, this paradigm is contingent on a critical assumption; the target community will, after a period of infrastructure and social development, have the authority and ability to mobilise enough resources to maintain the desired outcome. Many authors question if this assumption is realistic, given that administrative control over the necessary resources is often retained by agencies external to the target community (Stefanini, 1992; La Fond, 1995; Olsen, 1998; Swerissen and Crisp, 2004; Hanson et al., 2005).

All network members must seriously consider their responsibilities:

1. Community networks planning local interventions need to actively build self sufficiency into their processes using local resources as far as possible while developing the advocacy skills necessary to mobilise external resources when required.
2. External agents sponsoring community interventions need to seriously consider if it is realistic to delegate long term responsibility for intervention maintenance to a community network. If the community does not have the authority to access the resources necessary to maintain the desired outcome, the intervention is, by definition, unsustainable. In this circumstance, to delegate responsibility under the guise of capacity building without ensuring local self-sufficiency, is both ineffective and unethical.

10.11. MEASURING SUSTAINABILITY USING SOCIAL NETWORK ANALYSIS

Sustainability "is not an end state but an ongoing input-output process" (Brinkerhoff and Goldsmith,1992, p 371), contingent on the flux of resources though a social system (von Bertalanffy, 1950; Brush, 1975; Lowe, 1994; Sciubba, 1995).

Social Network Analysis (SNA) records and analyses interactions between members of a network. It may therefore be a useful tool to describe how this process of resource exchange occurs within a social system (Emerson, 1976; Cook and Whitmeyer, 1992) and thereby make some useful inferences about the sustainability of the process.

Cox identified four important community resources: financial, physical, human and social capital. In Chapter Nine, SNA was used to analyse the development of social capital in the Mackay Whitsunday Safe Communities (MWSC) and its Support Network (SN). This study seeks to analyse the exchange of in-kind (physical), human and financial resources within MWSC and its SN.

10.12. METHOD

The methodology used by this study was described in Chapter Seven. In addition to asking respondents to describe the relationships they maintained, respondents were asked to identify the resources they shared in the context of these relationships.

1. *In-kind resources* (including printed material, library access, desk space, office space, computer hardware or software).
2. *Human resources* to collaborate on joint projects. This did not include attendance at a meeting unless involvement in the group required the commitment of extra time to meet shared objectives set by the group.
3. *Financial resources* to collaborate on joint projects. Significant financial resources were defined as sums greater than $100.00 that once given were no longer under the direct control of the actor or their organisation.

They were also asked to describe the type and extent of resources they shared with the project as a whole (Chapter 7, Appendix 23).

As the financial resources identified by respondents may be transferred between actors, the financial network of each actor was reviewed by the three investigators[1] who by consensus decided on the original source of any funds contributed to the network. It was thereby possible to estimate the total value of financial contributions made to the network. An adjacency matrix documenting the sharing of financial resources was estimated by first assigning salaries to the appropriate employees and then by sharing any remaining financial resources given to the network by an individual actor equally among any other actors they identified they shared resources with.

Participation in the survey was voluntary and any personal identifying information was kept confidential.

Directional adjacency matrices were constructed for the following interactions:

1. Sharing of in-kind resources (2004) matrix and sociogram.
2. Sharing of human resources (2004) matrix and sociogram.
3. Sharing of financial resources (2004) matrix and sociogram.

Network and actor attributes were calculated using UCINET 6.74 and NetDraw1.45 software (Borgatti et al., 2002).

10.13. RESULTS

The study identified 168 members of MWSC and its SN. One hundred and fourteen (67%) were members of the MWSC, while 56 (33%) were external actors with whom project members maintained a relationship. One hundred and forty-eight agreed to participate in the study, a response rate of 87%.

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[1] Dale Hanson - School of Public Health and Tropical Medicine, James Cook University. Paul Vardon - Statewide Health Promotion Unit, Queensland Health. Kathryn McFarlane - Tropical Population Health Unit, Queensland Health.

10.14 SOCIAL CAPITAL

In Chapter Nine, SNA was used to quantify indicators of increased social capital in the MWSC &SN. Since the project was launched the project had developed:

1. More relationships. The number of relationships observed in the network doubled from 500 to 1002, largely by increasing the connectedness of existing network members. At an interpersonal level, the average number of relationships maintained by network members increased from 3.3 in February 2000 to 5.9 by December 2004.
2. Closer connections. The average distance (average number of intermediary relationships) separating network members decreased from 3.9 to 2.7.
3. Increased cohesion. The density of network relationships doubled from 0.022 in February 2000 to 0.036 by December 2004.
4. Better relationships. Fifty-six percent of relationships were said to have improved as a consequence of the project.
5. Increased reciprocity. In February 2000, 20% of relationships were reciprocated, increasing to 30% by December 2004.
6. Increased group formation. The clustering coefficient increased from 0.30 in February 2000 to 0.50 by December 2004.
7. More centralised structure. The centralisation index increased from 18% in 2000 to 43% in 2004. In February 2000 the founding members of the NSG had a direct relationship with 51% of the network. By December 2004 this had increased to 90% of the network.

MWSC had succeeded in developing cohesive social capital – the ability of a network to work collaboratively for mutual benefit.

While Chapter 9 demonstrated clear evidence of enhanced group function it also provided compelling evidence of the prominent role played by 6 network facilitators who support the MWSC and its SN. Figures 9.7 and 9.8 model the role these actors play in connecting local MWSC members to the external support networks (the Mackay Whitsunday Support Network, and the State/National and International Support Network). Figure 9.9 demonstrated that network relationships grew by most network members doubling their relationships. Accordingly, actors who already had a prominent role in 2000, developed more new relationships than other network members. Of the 502 new relationships formed by 2004, 157 (31%) were by the 6 network facilitators. Accordingly, their capacity to broker relationships increased from 39% in 2000 to 60% in 2004. However, this social influence came at a cost. As a group they received 258 incoming relationships (43 relationships per facilitator). Other network members only process an average of 1.8 incoming relationships.

10.15 RESOURCE SHARING

	Any Relationship	No sharing of resources	In-Kind Resources	Human Resources	Financial Resources
Actors	168	114	117	123	59
Relationships within MWSC &SN	1002	350 (35%)	467 (47%)	538 (54%)	151 (15%)
- Average Degree	5.9	2.1	2.7	3.2	0.9
- Reciprocity	30%	14%	14%	19%	10%
- Transitivity	26%	8%	18%	25%	2%
Relationships solely within MWSC	638	274 (43%)	232 (36%)	296 (46%)	70 (11%)
Relationships spanning between MWSC & SN	249	53 (21%)	159 (64%)	168 (68%)	49 (20%)
Relationships solely within the SN	115	23 (20%)	76 (66%)	74 (65%)	32 (29%)

Table 10.1: Network characteristics of resource sharing networks

Thirty-five percent of relationships did not share any resources, 47% shared in-kind resources, while 54% shared human resources. Only 15% of relationships resulted in the sharing of significant financial resources.

Table 10.1 details attributes of the three exchange networks. On average network members maintained 2.1 relationships that did not share resources, 2.7 that shared in-kind resources, 3.2 that shared human resources and 0.9 that shared financial resources. The sharing of financial resources was not associated with social forces such as reciprocity (10%) or transitivity (2%). In contrast, the sharing of human and in kind resources were more likely to be associated with reciprocity (19% and 14% respectively) and transitivity (25% and 18% respectively).

Relationships within MWSC were less likely to share resources than relationships involving external agents. Whereas 36% of internal relationships shared in-kind resources, 62% of bridging relationships (between the MWSC and its SN) and 67% of external relationships, shared in-kind resources. Forty-six percent of internal relationships reported sharing time outside of formal meetings, compared with 66% of bridging relationship and external relationships. While 10% of internal relationships shared financial resources, 20% of bridging relationships and 30% of external relationships shared financial resources.

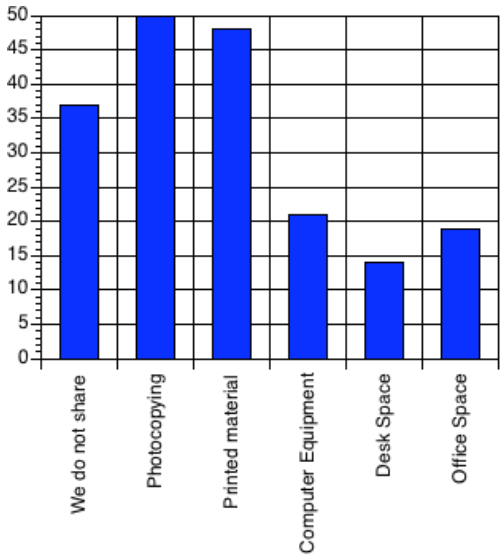


Figure 10.3 Sharing in-kind resources

Actors were asked to nominate what in-kind resources they shared with the network as a whole. Thirty-seven percent of actors indicated that they were not in a position to share in-kind resources. Approximately half indicated they shared printed materials or photocopies, while 20% shared computer equipment or office space (Figure 10.3).

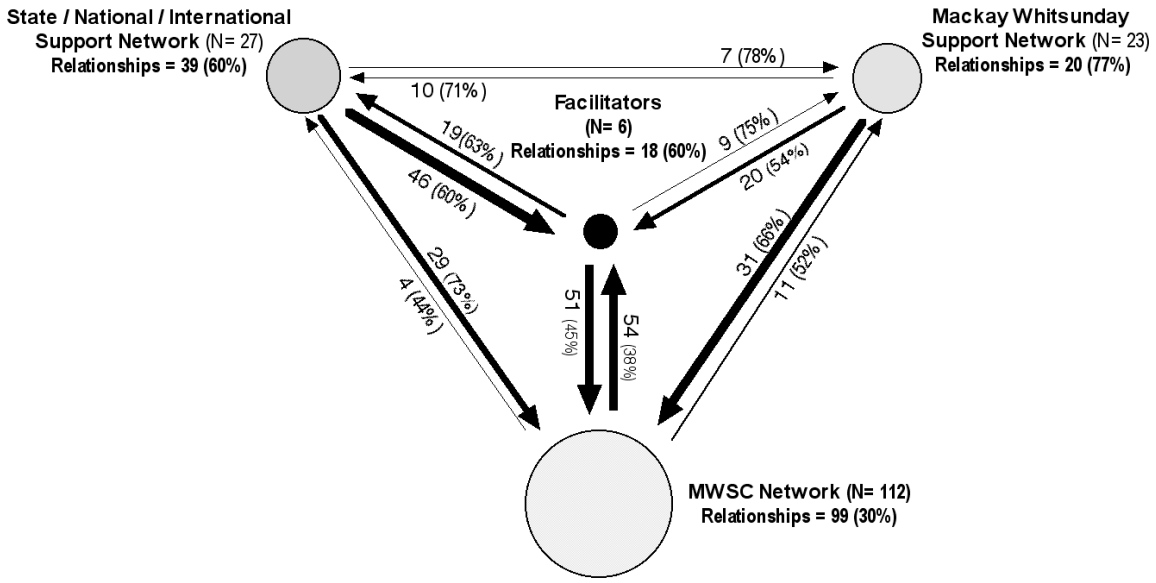


Figure 10.4 Block diagram of MWSC and SN in 2004: Sharing of in-kind resources facilitators, MWSC, Mackay Whitsunday Support Network and State / National International Support Network

Figure 10.4 documents the sharing of in-kind resources within MWSC and SN. There is a net movement of in-kind resources into the project. One hundred and twenty-six relationships deliver in-kind resources to MWSC, compared with 43 outgoing relationships. Of the in-kind resources entering the project, 48% were directly accessed by members of MWSC while 52% were accessed via the network facilitators. Within MWSC, 55% of in kind resource sharing was brokered by the network facilitators.

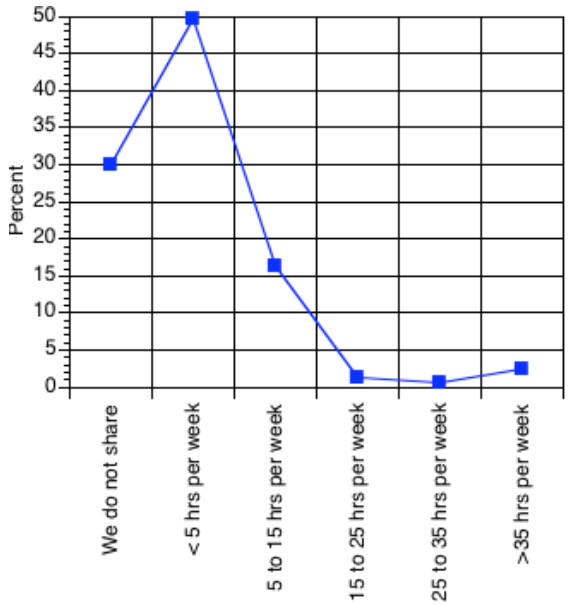
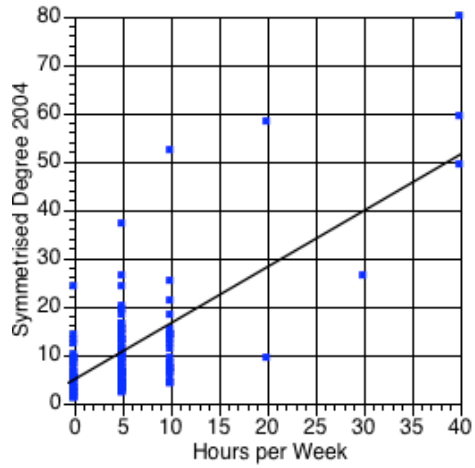


Figure 10.5 Human resources



Regression: degree = 1.2 x hrs + 4
P < 0.001, Rsq = 0.52

Figure 10.6 Scattergram of human resources by actor degree

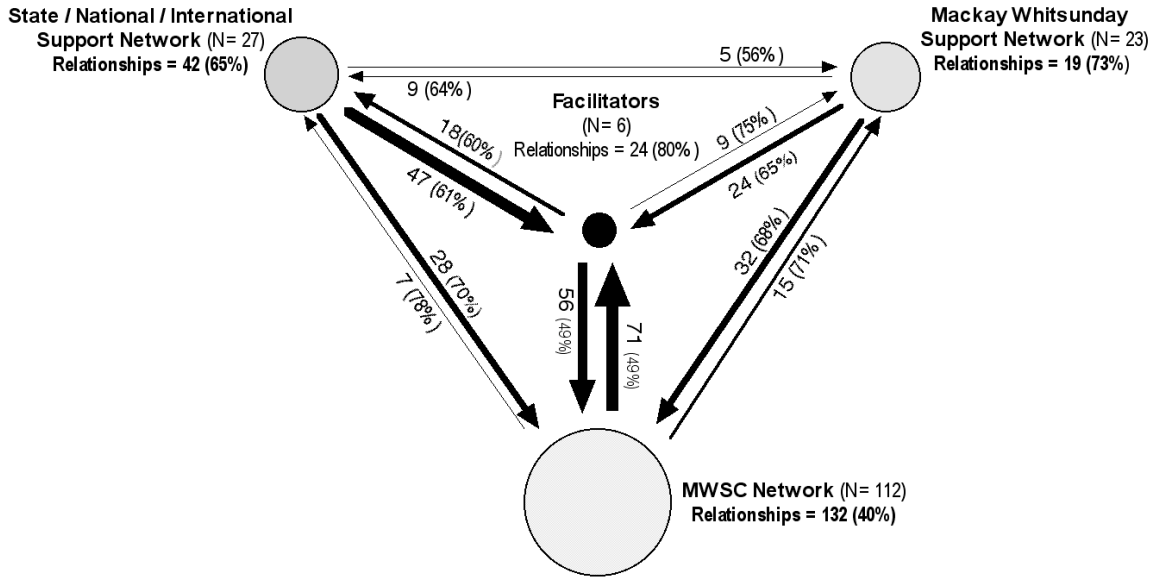


Figure 10.7 Block diagram of MWSC and SN in 2004: Sharing of human resources facilitators, MWSC, Mackay Whitsunday Support Network and State / National International Support Network

Fifty-four percent of relationships shared human resources, mobilising an estimated 10 full-time equivalents (FTE) across the whole network. 6.5 FTE were mobilised within MWSC. However, 30% of actors indicated that they did not share human resources, while half shared less than five hours per week. Only 6% were in a position to share more than 15 hours per week (Figure 10.5).

A significant correlation was observed between the time respondents invested in the network and degree centrality ($p < 0.000$, Pearson Correlation Coefficient = 0.72, $R^2 = 0.52$, Figure 10.6). 3.6 FTE were provided by six key leaders of MWSC accounting for 56% of time invested by members of MWSC.

Figure 10.7 documents the sharing of human resources within the MWSC and SN. The net human investment in the MWSC network is evident. One hundred and thirty-one incoming relationships were documented compared with 49 outgoing relationships. However, there is more intense sharing of human resources within MWSC. Forty-six percent of relationships shared human resources compared with 36% that shared in-kind resources and 10% that shared financial resources. Within MWSC, 55% of relationships sharing human resources involve the network facilitators.

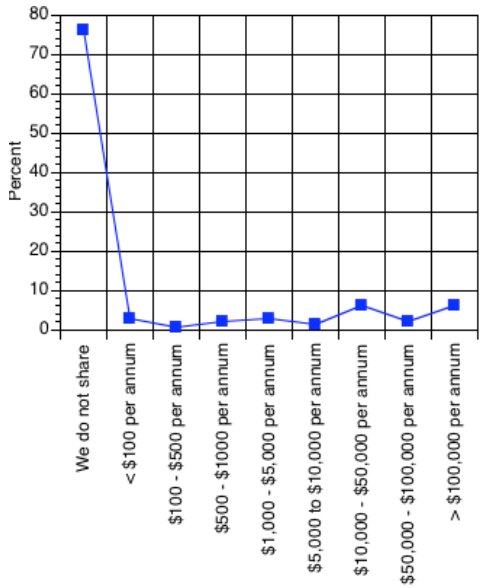


Figure 10.8 Sharing of financial resources

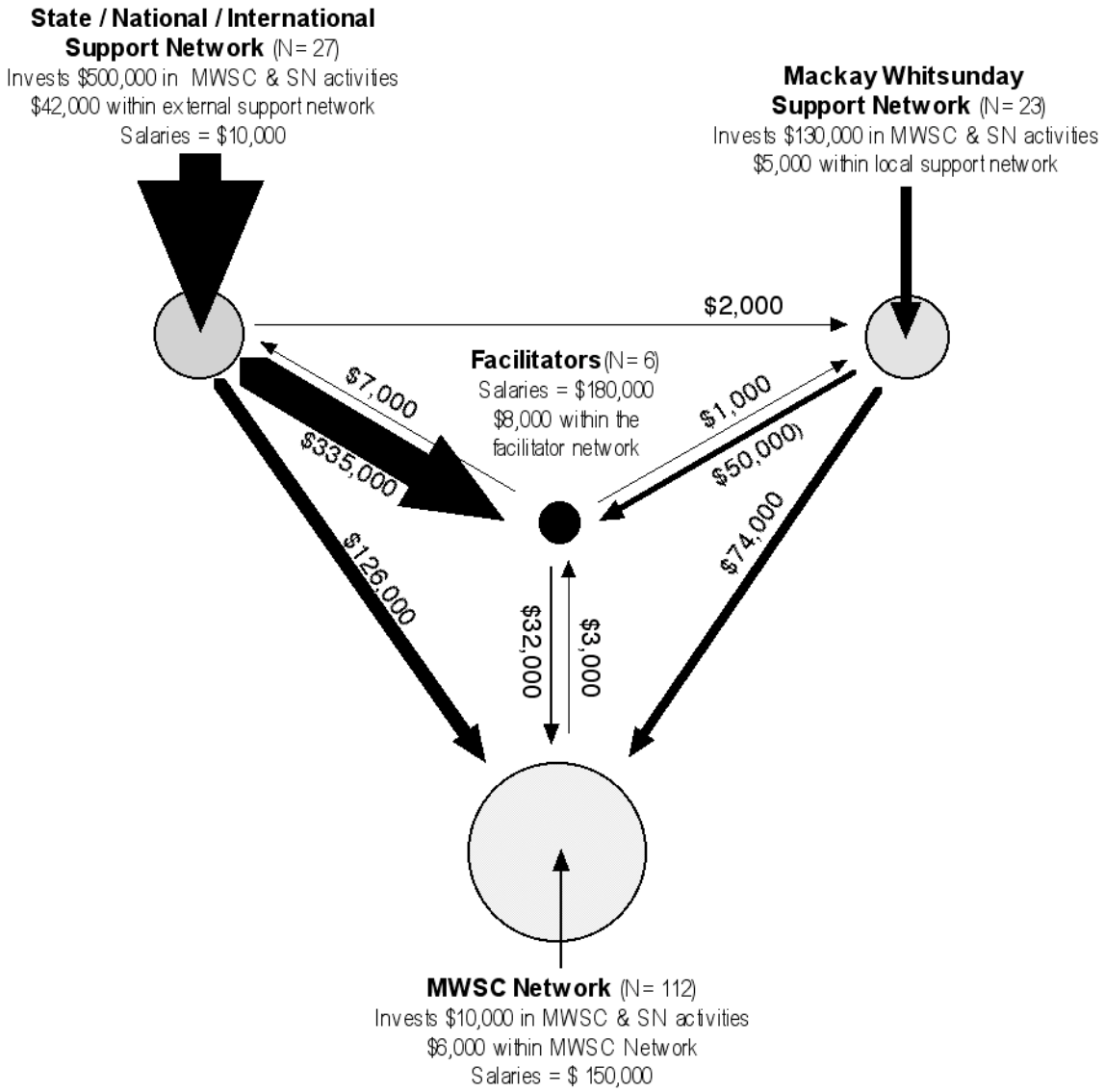


Figure 10.9 Block diagram of MWSC and SN in 2004: Sharing of financial resources facilitators, MWSC, Mackay Whitsunday Support Network and State / National International Support Network

The MWSC mobilised an estimated $910,000 dollars. $660,000 funded activities directly related to MWSC. $250,000 was invested in local infrastructure advocated by the MWSC to enhance community safety.

Seventy-six percent of respondents were not in a position to share financial resources (Figure 10.8). Eighteen percent shared sums greater than $1000 dollars, 8% shared between $10,000 and $100,000 while 6% shared greater than $100,000 per annum.

Figure 10.9 documents the sharing of financial resources within MWSC and SN. The net passage of financial resources into the MWSC is clear. $500,000 (78%) is accessed through the State / National / International Support Network, $130,000 (20%) from the Mackay Whitsunday Support Network and $10,000 (2%) from within MWSC itself. Of the financial resources entering the project, $200,000 (34%) was directly accessed by members of the MWSC while $390,000 (66%) was accessed via the network facilitators. Three quarters of the financial resources accessed for MWSC activities were used to fund salaries of MWSC members (an estimated 3.6 FTE for the network facilitators and 2.9 FTE for other MWSC members). Within MWSC, 70% of financial resource sharing involved the network facilitators.

	In-kind resources	Human resources	Financial resources
Some Contact	0.124 ***	0.097 ***	0.024 *
Interagency Meeting	0.105 ***	0.081 ***	0.069 ***
Working Group	0.248 ***	0.295 ***	0.087 ***
In-Depth	0.290 ***	0.358 ***	0.257 ***

Quadratic Assignment Procedure (QAP) Correlation (Jaccard Coefficient) * $p<0.05$, ** $p< 0.01$, *** $p < 0.001$

Table 10.2: Correlation matrix, resource sharing by depth of relationship

Table 10.2 is a correlation matrix identifying the association between the depth of collaboration and the sharing of resources. The Jaccard Coefficient was employed to estimate correlation using a Quadratic Assignment Procedure (Hanneman and Riddle, 2005). The sharing of resources, whether in-kind, human or financial was associated with closer collaboration. Interagency meetings were defined as those in which members “meet to share information and discuss mutual goals but work independently”, while members of working groups “collaborate at committee level to achieve shared objectives”. In keeping with this definition a stronger association was observed between working group relationships and resource sharing than relationships in the context of interagency meetings. Financial resources were most strongly associated with in-depth relationships.

10.16 RESOURCE SHARING AND BENEFICIAL RELATIONSHIPS

Respondents were asked to assess the net benefit of relationships they maintained. Relationships could be reported as:

1. *Unhelpful*. The benefits obtained by working together did not justify the extra effort and resources required to maintain the relationship,
2. *Neutral*. The extra effort and resources required to maintain the relationship were balanced by the benefits of working together,
3. *Beneficial*. The benefits of working together outweighed any extra effort and resources required to maintain the relationship.

Two percent of relationships were reported to be unhelpful, 25% neutral and 73% beneficial.

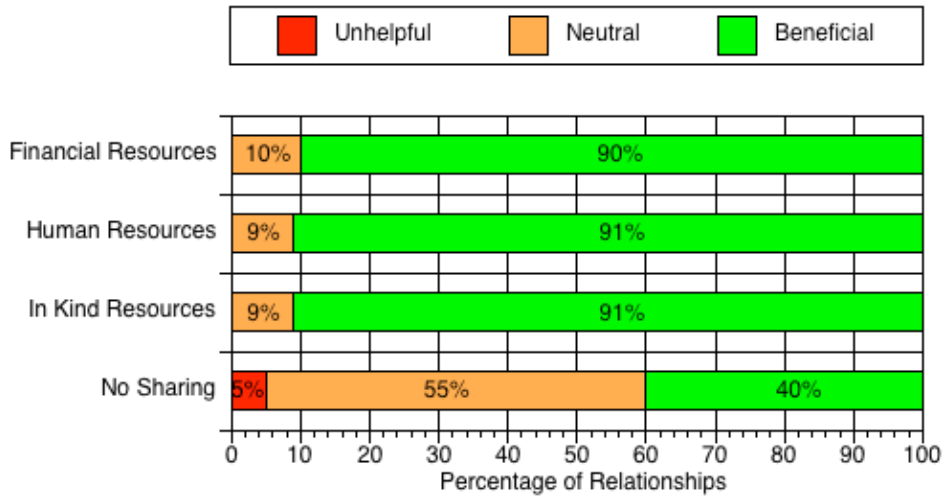


Figure 10.10 Resource sharing by perceived benefit

Relationships reported as beneficial were strongly associated with the sharing of resources. Ninety percent of relationships that shared resources, whether in-kind, human or financial, were reported as beneficial and 10% neutral. No relationships that shared resources were described as unhelpful. In contrast, 5% of relationships that did not share resources were reported as unhelpful, 54% as neutral, while only 42% were considered beneficial (Figure 10.10).

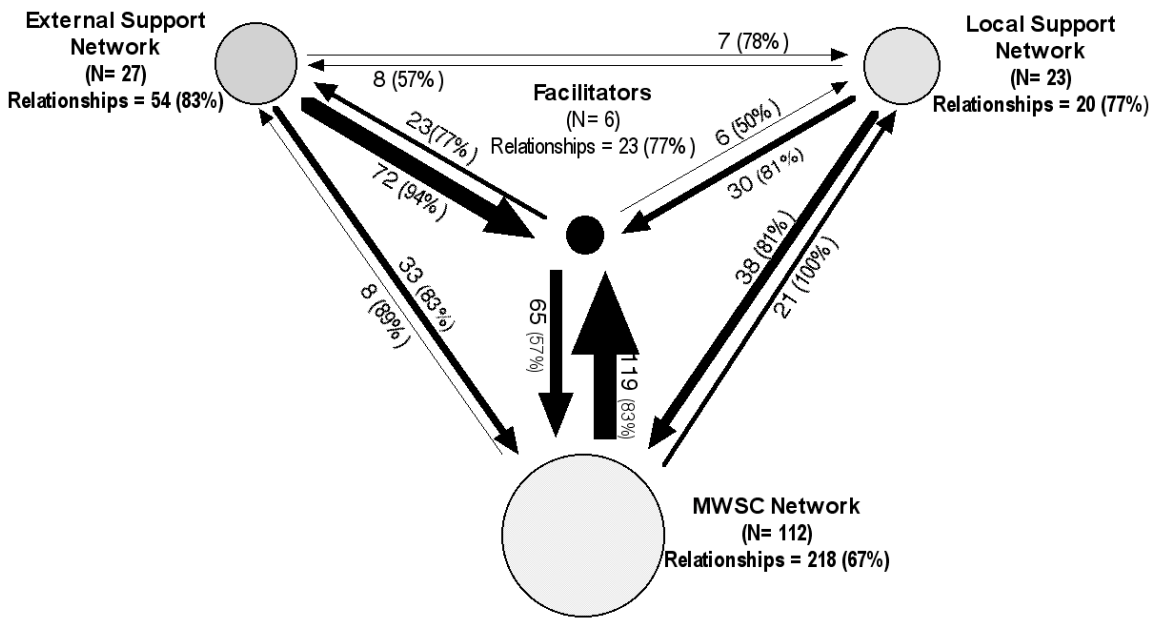


Figure 10.11 Block diagram of MWSC and SN in 2004: Beneficial relationships facilitators, MWSC, Mackay Whitsunday Support Network and State / National International Support Network

Figure 10.11 describes the distribution of beneficial relationships within MWSC and SN. The strong preference of network members for the six facilitators is evident. Eighty-six percent of relationships directed towards the network facilitators were perceived as beneficial. In contrast, only 62% of outgoing relationships were perceived as beneficial by the network facilitators. Similarly, 85% of direct relationships between MWSC and its SN were considered beneficial but only 67% of relationships within MWSC that did not involve network facilitators were considered beneficial. Seventy-eight percent of relationships among the support network were considered beneficial.

10.17 DISCUSSION

The MWSC was launched in February 2000 in response to perceived excess injury morbidity in the region. During the project planning stage a local needs analysis concluded that “Injury control activities in the Mackay and Moranbah Health District areas have been extensive but largely uncoordinated … A systematic and inter-sectorial approach would be more productive” (Repper and Vardon, 1999, p 3). Thus a key initial objective of MWSC was to better

coordinate relationships within a pre-existing network of community agents and in so doing, enhance the capacity of the community to collaborate effectively and thereby to sustain an ongoing safety promotion program in the Mackay Whitsunday Community.

In Chapter Nine, SNA was used to quantify indicators of social capital in the MWSC & SN. Since the network was established it has doubled the number of relationships (500 to 1002), decreased the relational distance separating network members (average distance reduced from 3.9 to 2.7) and as a result increased the cohesiveness of the network (density increased from 0.022 to 0.036, while average degree increased from 3.3 to 5.9). There was an increased tendency for group formation (clustering coefficient increased from 0.30 to 0.50) and a more centralised structure, allowing more opportunity for co-ordination of group activities (centralisation index increased from 18% to 43%). When the network was established, founding members of the NSG had a direct relationship with 51% of the network; by December 2004 this had increased to 90% of the network. MWSC had clearly succeeded in developing cohesive social capital – the ability to collaborate for mutual benefit.

Given that approximately half of all “community-based coalitions became inactive after they had performed initial simple tasks” (Yates,1973; World Bank, 1990; Rissel et al., 1995; Hanson et al., 2005), the fact that the network had persisted for four years and established an ethic of community collaboration in which 73% of all relationships were considered beneficial is a substantial achievement. As Hill (2002) notes, “In some ways, the literature implies that assembling or establishing a network is a huge success, in itself” (p43). However, if we are to invest the time and effort necessary to facilitate the development of a functional community network it is necessary to deliver something more substantial than a cohesive “beneficial” social system. Collaborative community networks have been proposed as vehicles to mobilise and develop community capacity that can be used to sustain public health outcomes.

SNA enabled quantification of the exchange of resources within the MWSC & SN. In 2004 the network mobilised an estimated 6.5 FTE within the MWSC and $910,000 dollars, $660,000 for direct network activities and $250,000 for safety infrastructure advocated by members of the MWSC. Given that MWSC is a collaborative network, not a financially incorporated body or a formal partnership bankrolled by government, this is a significant achievement.

Unfortunately this study did not measure the exchange of resources in 2000 and so it is impossible to determine whether sharing of resources was enhanced by the development of the network. However, it is worth noting that sharing of resources was associated with relationships at the level of working groups and in-depth collaborations (Table 10.2). The coalition converted 42% of relationships described as some contact to either working group (33%) or in-depth relationships (9%) during the period under review. Similarly 51% of interagency relationships were converted to either working group (49%) or in-depth relationships (2%).

While the network has mobilised sufficient human and financial resources to establish itself as a credible and productive community safety promotion coalition, if the MWSC is to be sustainable it is important to identify the origin of these resources and means by which MWSC has accessed them.

The majority of network members were not in a position to share large amounts of resources. Indeed, 35% of network members did not share any resources. Fifty-four percent shared human resources, 47% in-kind resources but only 15% shared financial resources. Relationships with external agents were more likely to involve resource sharing. While 36% of relationships within MWSC shared in-kind resources, 62% of bridging relationships between the MWSC and its SN shared in-kind resources, while 67% of relationships external to the MWSC shared in-kind resources. Similarly, 46% of internal MWSC relationships shared time, compared with 66% of bridging and external relationships. Importantly, five of the six most prominent actors (who together account for 56% of the time invested in the network) were externally funded. Finally, while 10% of internal

relationships shared finances, 20% of boundary spanning relationships and 30% of external relationships shared financial resources. Ultimately 98% of financial resources mobilised by MWSC were sourced externally, $500,000 (78%) from the State / National / International Support Network and $130,000 (20%) from the local Mackay Whitsunday Support Network.

These observations highlight an important sustainability principle:

> From the physical point of view, the characteristic state of the living organism is that of an open system. A system is closed if no material enters or leaves it; it is open if there is import and export ... Living systems are open systems, maintaining themselves in exchange of material with environment (von Bertalanaffy, 1950, p 23).

Communities are open systems; a community produces outputs (taxes, work, products and natural resources) and in return receives inputs (services, salaries and payment). Importantly, open systems never achieve equilibrium[2], a state in which the resources required to sustain a system equals the energy produced by the system itself. Natural systems only achieve equilibrium when there is no output; when they are dead (von Bertalanffy, 1950; Svirezhev, 2000). Living natural systems are stable when they are in steady state, when the net flux of resources into and out of the system are sufficient to sustain the function of the system. To define sustainability as "the ability of a health project or programme to deliver health services or sustain benefits after major technical, managerial and financial support has ceased" (United States Agency for International Development, cited La Fond, 1995) is an oxymoron. Closed system sustainability does not exist. Of course, energy efficient ecological systems, which require minimum inputs to maintain productive outputs, are more likely to be sustained. Wise communities aim to be as self-sufficient as possible.

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[2] A theoretical state of closed systems that in practice is never achieved. The first law of thermodynamics states that energy can neither be created or destroyed, or in colloquial terms, "you cannot get something for nothing". The second law of thermodynamics states that no process for converting energy is 100% efficient or "you cannot break even". The third law of thermodynamics states that absolute zero cannot be reached, that is equilibrium can never be achieved. Stated simply, physical and biological systems performing work require a constant input of energy.

Ultimately, all ecological systems require inputs to maintain their output. There are two important implications of this observation:

1. MWSC is an open social system. The sustainability of this network could only be understood by studying MWSC and its SN. To study MWSC in isolation would have been a partial system fallacy (Lauman et al., 1983). Relationships with external actors were clearly an important part of network function.
2. Sustainability is not just an issue of making the system self sufficient, but of also ensuring the community has the capacity to maintain an adequate flow of resources to sustain the desired outcome.

SNA provided one more interesting insight into the social process that mobilises resources on behalf of MWSC. The bridging relationships between MWSC and its SN (entrepreneurial social capital) were the conduit by which MWSC accessed the resources it required to maintain network activities. It was encouraging to note that members of MWSC had developed productive relationships with their SN, directly accessing 48% of in kind resources, 46% of the human resources, and 34% of the financial resources invested in the project. However, entrepreneurial social capital was not evenly distributed. Six network facilitators maintained 44% of all relationships, 57% of bridging relationships between MWSN and its SN, and as a result, 60% of the brokerage potential in the network (See Chapter 9). They used their entrepreneurial social capital to good effect, facilitating 52% of the in-kind investment, 54% of human investment and 66% of the financial investment in MWSC.

Many authors emphasise the voluntary horizontal nature of collaborative network relationships (Mitchell and Shortell, 2000; Gilchrist, 2000; Pedler, 2001; Hill, 2002; Mandell and Steelman, 2003; Keast et al., 2004). There is no innate vertical administrative hierarchy and nothing formally constraining network members to remain involved. For network members to remain engaged they must be motivated by the overall network objectives and find their involvement rewarding (Mitchell and Shortell, 2000; Pedler, 2001; Hill, 2002). Collaborative

partnerships therefore require boundary spanning leaders that facilitate the creation of a synergistic social space in which network members can work together to meet common goals yet at the same time fulfill their personal and organisational aspirations (Alter, 1993; Gilchrist, 2000; Lasker et al., 2001, Keast et al., 2004). In the MWSC & SN, 73% of relationships were described "beneficial", 25% "neutral" and 2% "unhelpful". Beneficial relationships were associated with sharing resources, closer collaboration and the facilitative role played by some members of the NSG.

Maintaining a functional social network has a cost. It takes time to develop and maintain relationships, a social investment known as "transaction costs" (Thompson, 1993; Hill, 2002; Mandell and Steelman, 2003). In this study the number of relationships maintained by network members (degree centrality) was strongly correlated with the amount of time members invested in network activities (Pearson Correlation Coefficient = 0.72, $R^2 = 0.52$, $p < 0.000$). However, the relational pressure this placed on the network facilitators was evident. Network relationships were strongly focused towards the facilitators (Figure 9.8). As a group they processed 258 incoming relationships (43 relationships per facilitator). Other members only process an average of 1.8 incoming relationships.

It is questionable if the facilitator role is sustainable in its present form if they continue to acquire new relationships at the same rate (that is, doubling every four years). More importantly, network function would be highly compromised if their role were rationalised by the SN on the assumption that the network ought to be self sustaining after a four year period of capital investment. Given the Mackay Whitsunday communities limited financial capacity at this time (Figure 10.9) it is not credible to suggest that this level of relational output could be maintained by unfunded community agents. While the network may survive without its facilitators, its capacity would effectively be halved. They maintained 44% of all relationships in the MWSC & SN, 57% of bridging relationships between MWSC and its SN, and mobilised 52% of in-kind, 54% of human and 66% of financial investments in MWSC.

Collaborative networks are not necessary or expedient to solve all community problems. For any given problem, there will be a break point at which the transaction cost exceeds the value of the outcomes achieved. A network of collaborative relationships built on mutual trust and synergistic goals takes time to develop (Hill, 2002). Collaborative networks whose unique attribute is the ability to assimilate complex contextual determinants of social problems and produce innovative local solutions may have little to offer preconceived top down interventions that must be implemented in a short time frame.

MWSC was launched in February 2000 in response to perceived excess in injury morbidity and mortality in the region. It is a “bottom up” project initiated in response to a local problem. To achieve its objectives it needed to co-ordinate local agents already acting in the field of injury prevention and safety promotion, and build a common vision that the injury problem could be solved. This collaborative network was then used as a vehicle to get safety promotion on the agenda at a local and state level, and advocate for and co-ordinate the mobilisation of resources to address the issue. From this perspective the network has been successful as it has strengthened relationships, built cohesion, enhanced collaboration and used the coalition as a platform to attract resources to run safety promotion programs. It spearheaded the formation of the Safe Communities movement in Queensland, it successfully staged the 2nd Pacific Rim Safe Communities Conference and the 7th Australian Injury Prevention Conference, and after a process of external peer review achieved designation as a WHO Safe Community. However, in-kind rersources, salaries that fund human resources and financial resources are largely accessed outside the MWSC. From the perspective of external agencies seeking to tap into local community resources as a way to enhance their financial investments in community, this coalition may be disappointing. While a rich source of social capital, the discretionary in-kind, human and financial resources moblised within MWSC appear to be limited.

A number of important weaknesses of this study deserve comment:

1. This analysis documented the exchange of resources in MWSC and SN as a way of reviewing the sustainability of the network. However, sustaining MWSC & SN may not necessarily be an absolute requirement to maintain safety in the Mackay Whitsunday Region. Were the network able to adequately embed behavioural, environmental and social safety promotion characteristics in the community, MWSC may become superfluous. On the other hand, it cannot be assumed that sustaining MWSC & SN will necessarily ensure the safety of the community. Nevertheless by studying MWSC & SN it has been possible to identify general principles of how a social safety promotion process has been implemented and sustained over a period of four years.
2. The measures of physical, and human capital utilised were rather simplistic. There may be physical resources accessible to network members that need to be exchanged to support and promote safety in the region. A formal audit of physical capital accessible to the network would compliment a study that documents the exchange of these resourses. More importantly, humans bring much more to the network than just time, the attribute measured in this study. They contribute their previous experience, skills and training. The most commonly cited constructs of community capacity identify the importance of the exchange of information through social networks (Goodman et al., 1998; Hawe et al., 1997, Bush and Mutch, 1999). While the relational network by which innovations, knowledge and information are exchanged was mapped in this study, it must be stressed that this exchange of information was not formally assessed. Documenting the social capital the entrepreneurs have at their disposal to disperse information does not necessarily imply that they actually do this. It would be illustrative to formally measure the exchange of information in any future social network studies of a health coalition.

3. This paper has emphasised the dynamic quality of sustainability. Sustainability is an ongoing process, contingent on the ongoing exchange of enough resources to maintain the productivity of the network. It is not a stable quality of a social network that once achieved remains indefinitely. This study only measured the exchange of resources at one point in time and therefore offers little insight into the true dynamic quality of sustainability. While this once-off audit of resource exchange within MWSC and SN has offered useful observations regarding the social process by which resource exchange occurs, it would be far more useful to use tools able to analyse this exchange on an ongoing basis. Recent innovations in stochastic modeling of social networks using p*models (Robbins and Pattison, 2001; Snijders, 2005; Wasserman and Robbins, 2005) mean that it is now possible to create temporal stochastic models of social networks. This methodology therefore has potential to further elucidate how sustainability is achieved in social systems.

10.18 CONCLUSION

Project sustainability is not always achieved. Interventions dependent on external resources are vulnerable. In an age of financial accountability, economic rationalism and aggressive competition for funding, short-term capital development funding is the norm. Embedding behavioural, environmental and social safety promotion characteristics in a community maximises the potential of a community to sustain its own safety.

Ecological systems are open systems that achieve steady state when the flux of incoming and outgoing resources is adequate to maintain the function of the system. Sustainability is therefore a dynamic state contingent on the on-going supply of enough resources to sustain the productivity of the system.

Cohesive social capital may be an important social resource required to sustain safety promotion networks and maintain the safe community standards they promote. Entrepreneurial social capital may be the social resource required to generate sufficient community capacity to implement these standards and if necessary, maintain the community network that promotes them.

Social Network Analysis indicates that Mackay Whitsunday Safe Communities is rich in social resources, but in-kind, human and financial resources are largely accessed and controlled by its external support network. As six key broker leaders play a key facilitative role in mobilising these resources, the sustainability of the coalition is vulnerable to the changing priorities of its sponsoring agents and critically dependant on the advocacy skills of its leaders.

CHAPTER ELEVEN
CONCLUSION

11.1 COMING TO TERMS WITH THE CHALLENGE

In Australia, injury is the fourth leading cause of death and the leading cause of death in those under 45 years of age (Kreisfeld et al., 2004). Every year approximately 7,800 Australians die (Kreisfeld et al., 2004) and 330,000 are hospitalised (Berry and Harrison, 2006) due to injury. Injury rates in Queensland are higher than the Australian average, while in Australia, regional and rural communities experience greater morbidity and mortality due to injury than occurs in major cities (ABS, 2004; Berry and Harrison, 2006).

A community needs analysis conducted by the Mackay Division of General Practice in 1998 suggested that injury rates in the Mackay region were high (Azzopardi et al. 1998). Mackay Base Hospital reported an average 8,700 Emergency Department (ED) injury presentations per annum in 1998 and 1999, constituting 25% of the ED caseload. Age standardised ED presentation rates were double those observed in South Brisbane (Vardon et al., 2000). In response, Mackay Whitsunday Safe Communities (MWSC) was established in late 1999.

Injury has a complex aetiology that demands a multifaceted complex response (Baker, 1972; NCIPC, 1989; Bonnie et al., 1999). Complex problems are made up of a system of interrelated mutually interdependent problems (Buckley, 1998; Byrne, 1998, Lewis, 2005) and are resistant to investigation by reductionist scientific methods that seek to understand system function by disaggregating the system into its component parts (Ackoff, 1974; Rittal and Weber, 1973; Kickert et al., 1997; McMichael, 2001; Lasker and Weiss, 2003; Lewis 2005).

This thesis describes key learnings in coming to understand and address the complexity of Mackay's injury problem, its epidemiology and aetiology, the complexity of intervening at a community level and evaluation of this social process.

11.2 LOCAL INJURY SURVEILLANCE: NOT AS SIMPLE AS IT SEEMS

Initially the epidemiological evidence concerning injury in the Mackay Region seemed straightforward. A five year review of injury hospitalisations from July 1993 to June 1998 indicated that the age standardised hospital separation rates in the Mackay Region were double the Queensland average, as were ED injury presentation rates.

Subsequent review of injury hospitalisations in the Mackay Health Service District (THPU, 2006a) called into question the conclusion that the high injury separation rate at Mackay Base Hospital implied a high incidence of injury in the Region. A doubling of Injury Hospital Separation was observed in the 1992/93 financial year. The apparent excess in injury separations was attributed, at least in part, to better statistical capture of short stay ED admissions in the Mackay Health Service District[1].

The ability to generate robust statistics that allow comparison of injury incidence between communities is very useful as it allows monitoring of disease patterns and trends, and facilitates setting of public health priorities. However, from the perspective of the Mackay community, the key question was not one of comparison with other communities, but rather whether there was sufficient evidence to indicate that injury was an important local issue.

The average 8,700 ED injury presentations annually to Mackay Base Hospital, meant that Mackay ED injury presentation rates were higher than those observed in South Brisbane. This finding was consistent with the general observation that regional communities have higher injury morbidity rates than urban communities (ABS, 2004; Berry and Harrison, 2006). Thus there was evidence that injury was an important public health issue in Mackay.

[1] Short Stay ED admissions refer to episodes of care that require more intensive treatment or a period of extended observation in the ED. Typically they concern minor surgical procedures performed in the ED (e.g. fracture and dislocation reductions or suturing of deep wounds).

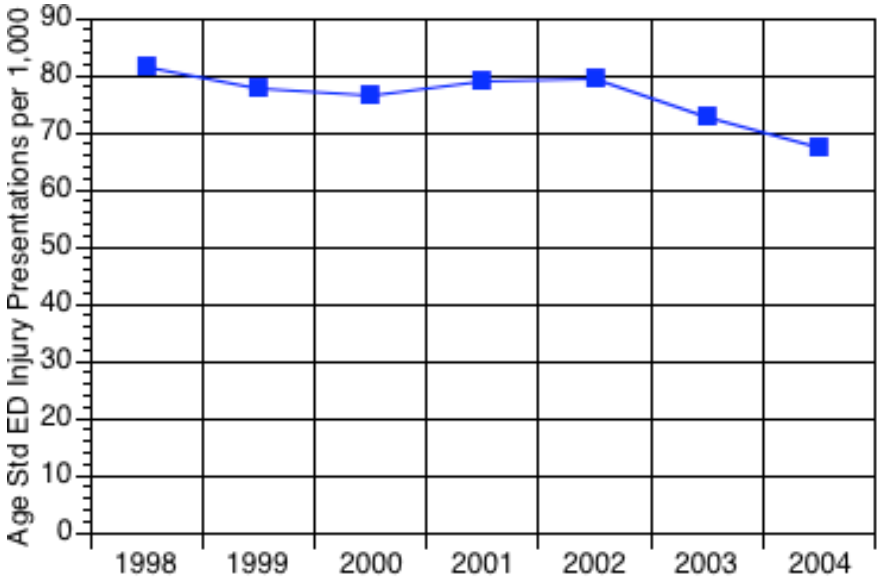

Figure 11.1 Age standardized emergency department injury presentation rates: Mackay Base Hospital, 1998 to 2004

It is encouraging to note that over the four year period since the launch of MWSC in February 2000 age standardised emergency department injury presentations to Mackay Base Hospital have reduced from 76.4 per 1,000 in 2000 to 67.5 per 1,000 in 2004 (Figure 11.1), a 12% reduction. Injury now constitutes 21% of ED caseload rather than 25%. Over the same period Mackay experienced a 5% reduction in age standardised injury separations relative to the Queensland (TPHU, 2006b). However because of the multi-causal nature of injury and local service utilization and data ascertainment issues it is not possible at this time to attribute this reduction to MWSC. Further research is required.

11.3 ECOLOGICAL SAFETY PROMOTION

The individualistic presuppositions of modern Western society (Lukes, 1971) and the reductionist epistemology of modern biomedicine (Engel, 1977; McMichael, 2001) resulted in early researchers attempting to understand injury causation by atomising the problem down to its most basic component – the individual. Rose (1985) argued that it was important to address the question, “Why does this population have a high incidence of disease at this time.”

A population based construct of injury causation was required. To focus solely on the biomedical concept of "injury prevention" underestimates the wholistic nature of human experience and how the positive state "safety" is achieved at a community level. Safety is a psychological, sociological and environmental phenomenon, as well as a biophysical one.

Communities can be viewed as an ecosystem, with resources, opportunities and threats to their safety (McMurray, 1999). While interventions targeting individual behaviour are undoubtedly important, these behaviours are unlikely to be sustained unless they are embedded in supportive physical and social environments. Syme and Balfour (1998) observed that "it is difficult to expect that people will change their behaviour easily when many forces in the social, cultural and physical environment conspire against it."

The individual is, metaphorically speaking, just the "tip of the iceberg," the pinnacle of a complex ecological system. While they may be the most visible component, important determinants of their behaviour and environmental risk are "hidden below the waterline." Attempts to modify the risk of injury at one level in isolation (for example individual behaviour) will be resisted by the rest of the ecological system, which will attempt to maintain its status quo. A comprehensive population based approach that simultaneously targets behavioural, environmental and social determinants of injury is necessary to promote and sustain the safety of the target community.

11.4 SAFETY PROMOTION NETWORKS

Contemporary literature on societal governance and public health argues that the complex nature of social problems, such as injury, has profound implications for the way they should be addressed (Rittel and Webber, 1973; Clarke and Stewart, 1997; Jones et al., 1997; O'Toole, 1997, Agranoff and McGuire, 2001; Hill, 2002; Mandell and Steelman, 2003; Keast et al., 2004). It has been proposed that networks are well suited to complex operational environments. They are more innovative, more responsive and better positioned to rapidly generate comprehensive solutions than individual organisational approaches (Lasker et al., 2001; Agranoff and McGuire, 2001; Keast et al., 2004). Network solutions to community problems have achieved

political favour because they align well with the contemporary ideology of "shared responsibility" and "community engagement". More importantly, they became an economic necessity as governments reduce long-term financial investment in communities (Gray and Lawrence, 2001). The convergence of academic theory, political philosophy, and economic reality, have created a social environment in which networks have become the signature organisational form of the post-modern era (Alter and Hage, 1993; Lipnack and Stamps, 1994; Castells, 1996; Agranoff and McGuire, 2001). Accordingly, MWSC responded to its perceived injury problem by forming a collaborative network.

A comprehensive understanding of how networks function and the social forces they access and mobilise requires scientific tools that facilitate description, analysis and evaluation of community based health promotion networks. This thesis sought to assess whether Social Network Analysis (SNA) could usefully describe and analyse the structure, function and development of MWSC and its Support Network (MWSC and SN).

11.5 SOCIAL NETWORK ANALYSIS OF MACKAY WHITSUNDAY SAFE COMMUNITIES AND ITS SUPPORT NETWORK

SNA proved a powerful tool for describing and analysing relationships within the MWSC and SN. It provided diagrammatic representation of the social structure (Figures 8.2 and 8.3) and quantified important changes in the structure and function of MWSC and SN. Since the network was established in February 2000, it had doubled the number of relationships (500 to 1002), decreased the relational distance separating network members (average distance reduced from 3.9 to 2.7) and as a result increased the cohesiveness of the network (density increased from 0.022 to 0.036). There was an increased tendency for group formation (clustering coefficient increased from 0.30 to 0.50) and a more centralised structure (centralisation index increased from 18% to 43%). MWSC had clearly succeeded in developing cohesive social capital – the ability to collaborate for mutual benefit.

However, the SNA also provided overwhelming evidence that a small number of well-connected social entrepreneurs played a prominent role in network activities (entrepreneurial social capital). Whether measured in terms of direct social influence (degree centrality), efficiency of communication (closeness centrality) or brokering potential (betweeness centrality), six actors, all members of the NSG, were disproportionately influential (Figure 9.7). Furthermore their social influence increased over the course of the study. By 2004, they maintained 24% of all relationships observed in the network compared with 17% in 2000 and they possessed 60% of the brokering potential of the network compared with 39% in 2000. These network members linked the NSG to action groups, the action groups to each other and the MWSC to its external Support Network. They were an important conduit for the exchange of information and resources.

SNA proved useful for quantifying the resources mobilised by the MWSC and SN. In 2004 the network accessed an estimated 6.5 FTE of staff time and $0.9 million dollars. However, these resources were largely accessed externally.

The entrepreneurial social capital of six MWSC leaders appeared to be important for facilitating access to resources. While accounting for 44% of network relationships, they accounted for 52% of relationships that shared in-kind resources, 54% of relationships that shared human resources and 66% of relationships that shared financial resources. Their role as brokers appeared critical to the function of MWSC.

These observations highlight an important sustainability principle. MWSC is an open system. Its ongoing function is critically dependent on the interface between MWSC and its external SN. Ecological systems never achieve equilibrium[2] except when they are dead (von Bertalanffy, 1950; Svirezhev, 2000). Rather, they are stable in steady state, a state in which the flux of resources in and out of the system are sufficient to maintain productivity. To

[2] a theoretic state of closed systems, when the outputs produced by a system are sufficient to sustain it.

define sustainability as “the ability of a health project or programme to deliver health services or sustain benefits after major technical, managerial and financial support has ceased” (United States Agency for International Development, cited La Fond, 1995) is an oxymoron. Closed system sustainability does not exist.

Many authors emphasise the voluntary horizontal nature of collaborative network relationships (Mitchell and Shortell, 2000; Gilchrist, 2000; Pedler, 2001; Hill, 2002; Mandell and Steelman, 2003; Keastet al., 2004). For network members to remain engaged they must be motivated by the network objectives and find their involvement rewarding (Mitchell and Shortell, 2000; Pedler, 2001; Hill, 2002). Collaborative partnerships therefore require leaders that provide a synergistic social space in which network members can work together to meet their common goals and organisational objectives (Alter and Hage, 1993; Lasker et al., 2001, Keast et al., 2004).

Maintaining a functional social network has a cost. Coalitions require social maintenance to ensure they remain operational. It takes time to develop and maintain relationships, a social investment known as “transaction costs” (Thompson, 1993; Hill, 2002; Mandell and Steelman, 2003). In this study the number of relationships maintained by network members (degree centrality) was strongly correlated with the amount of time key leaders invested in network activities (Pearson Correlation Coefficient = 0.72, $R^2 = 0.52$, $p < 0.001$). However, the relational pressure this placed on the network facilitators was evident. As a group they process 258 incoming relationships (43 relationships per facilitator), while other members only process an average of 1.8 incoming relationships. Maintaining a large community network is hard work.

Given the limited financial capacity of MWSC at this time it is not credible to suggest that this level of relational output could be maintained by unfunded community agents. While the network may survive without its facilitators, its capacity would effectively be halved. Network facilitators maintain 44% of all relationships, 57% of bridging relationships between MWSC and its SN, and broker 52% of in-kind, 54% of human and 66% of financial investments made in MWSC.

Sustainability is not just an issue of making the network self sufficient, but also ensuring that the network has the entrepreneurial social capital required to unite network members around a cause and to enable them to access the in-kind, human and financial resources necessary to maintain network productivity.

11.6 WHERE TO FROM HERE?

Designing stochastic models of social networks has been a longstanding aspiration of network analysts. However, managing the interdependence of human social interactions posed an important technical and cognitive challenge. Most statistical models are built on the assumption that observations are independent. However, in human systems, the interdependence of actors and their social environment (their capacity to influence each other, modify their environment and be influenced by their environment) is an essential characteristic of social interaction (Robins and Pattison, 2005b). These social interdependencies must become a core component of future public health research if we aspire to modify social environments as a vehicle for promoting health and safety.

By postulating different patterns of conditional dependence amongst network members a researcher can investigate the interpersonal processes that ultimately create social systems. Three characteristics of the current network configuration (Markov[3] properties) have been shown to be useful predictors of a network's future configuration (Robins and Pattison, 2005b).

1. Global network properties. These network characteristics equally affect all actors (Robins et al., 2006a). Size is particularly important. As a network becomes larger the number of possible relationships increases exponentially, as does the transaction cost of maintaining these relationships, with network members less likely to have the capacity or the inclination to maintain these relationships.

[3] In probability theory, a stochastic process has a Markov property if the conditional probability of the future state of a process only depends on its current state and is independent of any past state (the path of the process up until the present is not necessary to predict future outcomes). In the context of SNA, current network properties could be used to predict the future structure of the network.

2. Dyad properties (Dyadic or the p^1 and p^2 class of models). Patterns of relationships observed between a pair of actors that affect the likelihood they will form new relationships (Robins et al., 2006a). Important examples include reciprocity, exchange and homophily (the tendency of actors to form relationships with people of similar characteristics).
3. Local social properties (Exponential Random Graph or the p* class of models). The immediate social context of a pair of actors that affect the likelihood they will form new relationships; in particular, the star-like relational patterns associated with social entrepreneurs and the triangular patterns associated with cohesive social capital are perceived to be important (Snijders et al. 2006).

The Hammersley-Clifford theorem (Besag, 1974) provided a mathematical framework for developing stochastic models of social systems in which mutually dependent social attributes can be specified and their contribution to the structure and function of a social network estimated (Handcock, 2003; Wasserman and Robins, 2005; Robins and Pattison, 2005b).

$$\Pr(X = x) = \frac{1}{K} \exp\left(\sum_{T \subseteq C} \theta_T \prod_{st \in T} x_{st}\right)$$

Where:

- X is a network consisting of a set of relationships ($x_1, x_2, x_3, \ldots x_g$) joining a set of actors ($a_1, a_2, a_3, \ldots a_g$)
- x is a particular realization of this network
- x_{st} is a binary variable indicating the presence or absence of a relational tie joining a pair of actors (or couple) "s" & "t"
- C is the set of couples
- K is a normalizing constant
- T is a "clique" or a specific configuration of local relationships involving a pair of actors[13]
- θ_T the parameter, or the sufficient statistic, indicating the extent to which a specific clique configuration is actually observed in the network
- $\prod_{st \in T} x_{st}$ a specific clique configuration involving the pair of actors "s" & 't"

NB There is one, and only one, parameter for each clique.

This theorem allows factorisation of various social explanatory variables that may impact on overall social structure, including general network attributes, actor attributes, dyadic forces and local social forces. It thereby provided the mathematical platform for an important new innovation – exponential random

graph (p*) models for social networks (Frank and Strauss, 1986; Wasserman and Pattison, 1996; Pattison and Wasserman 1999; Robins et al., 1999; Robins et al., 2006a). This innovation, combined with the increased availability of powerful desktop computers, has meant that it is now possible to estimate the relative contribution of various interdependent explanatory social variables using Markov chain Monte Carlo[4] maximum likelihood estimation (Frank and Strauss, 1986; Handcock, 2003; Wasserman and Robins, 2005; Robins and Pattison, 2005b; Goodreau, 2006; Hunter, 2006; Robins et al. 2006a; Robins et al., 2006b, Snijders et al. 2006).

A striking characteristic of the MWSC and SN was the presence of two complimentary social forces, cohesive social capital and entrepreneurial social capital. This raises a number of interesting and important questions. How are these social forces produced? What is their effect on the structure and function of community safety promotion networks? How can these social forces be used to promote safety at a community level?

It has been hypothesised that cohesive social capital is produced by areas of dense cohesive relationships within a group, while entrepreneurial social capital is produced by relationships that cross boundaries between these groups (Lin, 1999; Burt, 2000; Putnam 2000). Lin (1999) hypothesised that cohesive social capital maintains the social status quo, while entrepreneurial social capital promotes change. Future research elucidating these hypotheses is critical to the future development of community safety promotion. If confirmed, safety promotion practitioners will attempt to develop cohesive social capital as a vehicle for maintaining desirable safety promoting behaviours (for example wearing seat belts and safety helmets) while simultaneously developing entrepreneurial social capital to promote the acquisition of these behaviours. Exponential Random Graph p* models may provide the scientific vehicle that empowers researchers to address these important questions.

[4] Monte Carlo method refers to a statistical sampling technique used to approximate solutions to quantitative problems that cannot be easily solved. A Monte Carlo simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distribution of an unknown variable until a stable model is created.

This thesis concludes that sustainability is a dynamic quality of social systems contingent upon the ongoing influx of sufficient resources to maintain network outputs. In this study, entrepreneurial social capital appeared to be an important social asset that facilitated the network's access to expertise and resources. This is in contrast to current literature on social capital that associates cohesive social capital with sustainable community social systems (Leonard and Onyx, 2004; Dale and Onyx, 2005) and raises an important question: is cohesive and/or entereneurial social capital necessary to sustain community social systems? Given that sustainability appears to be a dynamic rather than a static quality of social networks, temporal studies of community networks using p* stochastic models (Snidjers, 2005) may be useful to explore how different forms of social capital contribute to the sustainability of community networks.

11.7 SUMMARY

Injuries are preventable. However, discrepancy between academic, practitioner, community and political perceptions regarding injury causation remain an important barrier to mounting an effective response. Injury is a complex issue caused by multiple interrelated determinants. It demands a multifaceted comprehensive response. The dynamic, multi-causal, multi-level nature of injury means that it is resistant to interventions designed by any one profession or agency. In this regard, safety promotion can be characterised as a cooperative challenge. If key stakeholders can achieve consensus regarding the definition of a community's injury problem and negotiate a socially acceptable solution, the problem can be addressed.

Networks have been advocated as an effective response to the complex problems that plague modern society. They may be more innovative and responsive, and better able to generate comprehensive solutions. By pooling the expertise and resources of multiple local organizations it is possible to generate the critical mass of activity necessary to solve multifaceted complex problems such as injury.

The Mackay Whitsunday Safe Communities was launched in February 2000 in response to high non-intentional injury rates observed in the region. It responded to this perceived injury problem by forming a community network to enhance the capacity of the community to collaborate and sustain an ongoing safety promotion program in the Mackay Whitsunday Community.

This thesis evaluated Mackay Whitsunday Safe Communities and its Support Network using social network analysis, which proved useful for quantifying the growth of the network, describing the interpersonal and social forces acting within it, documenting important global attributes of the network and identifying the contribution of key network members.

Two complimentary types of social resource were identified, cohesive social capital and entrepreneurial social capital. Both are necessary to promote community safety. It is hypothesised that cohesive social capital is a force of social stability, produced in those parts of a social network that contain strong, dense, relational ties. It is useful to maintain safe standards of personal, environmental and social conduct. Entrepreneurial social capital is a force promoting change, produced by relationships that bridge the sparse social spaces that separate different groups within a social network. It is useful to propagate information and innovative ideas and thereby promote desirable changes in community safety standards.

Social network analysis also demonstrated that Mackay Whitsunday Safe Communities is an open system. Like all open systems it is not totally self sufficient, but rather, critically dependent on external support network from which it draws the in-kind, human and financial resources necessary to maintain the network's productivity. Entrepreneurial social capital was shown to be an important social conduit for the ongoing exchange of resources necessary to develop and sustain this community safety promotion network.