

8 EGO-NETWORKS

Ego-networks are networks that are defined by a single central individual, known as ego. Everyone in the network is connected to ego. The ego-network includes ties between these other actors, known as alters, and ego, as well as ties between the alters themselves. One of the main analytical advantages of ego-networks is being able to ask how many of the people whom ego knows also know each other, in the stated context. While it is possible to construct an ego-network specially 'from scratch', all of the ego-networks we examine here are sub-sets of 'whole networks'. Whole networks are defined by factors that are extraneous to ego; in our case, they are defined by bodies of historical documents. The examples which follow are ego-networks derived from the larger whole network of witnesses to documents in the PoMS database, 1093 to 1286, of the five specified document types: charters, charter/briefs, notifications, agreements and settlements. All of the people who have co-witnessed alongside the nominated 'ego' will appear in the ego-network; thus, the size of the ego-network is always the same as the degree centrality of ego in the whole network.

Ego-network size and density

One feature of the ego-network that is perhaps most commonly explored is density. The density of an ego-network is measured as the percentage of potential ties in a network which are actualised, or, in other words, the extent to which alters are connected. A network in which all of ego's friends also know each other, all of the potential ties are actualised, and consequently the density is 1 (or 100 percent).

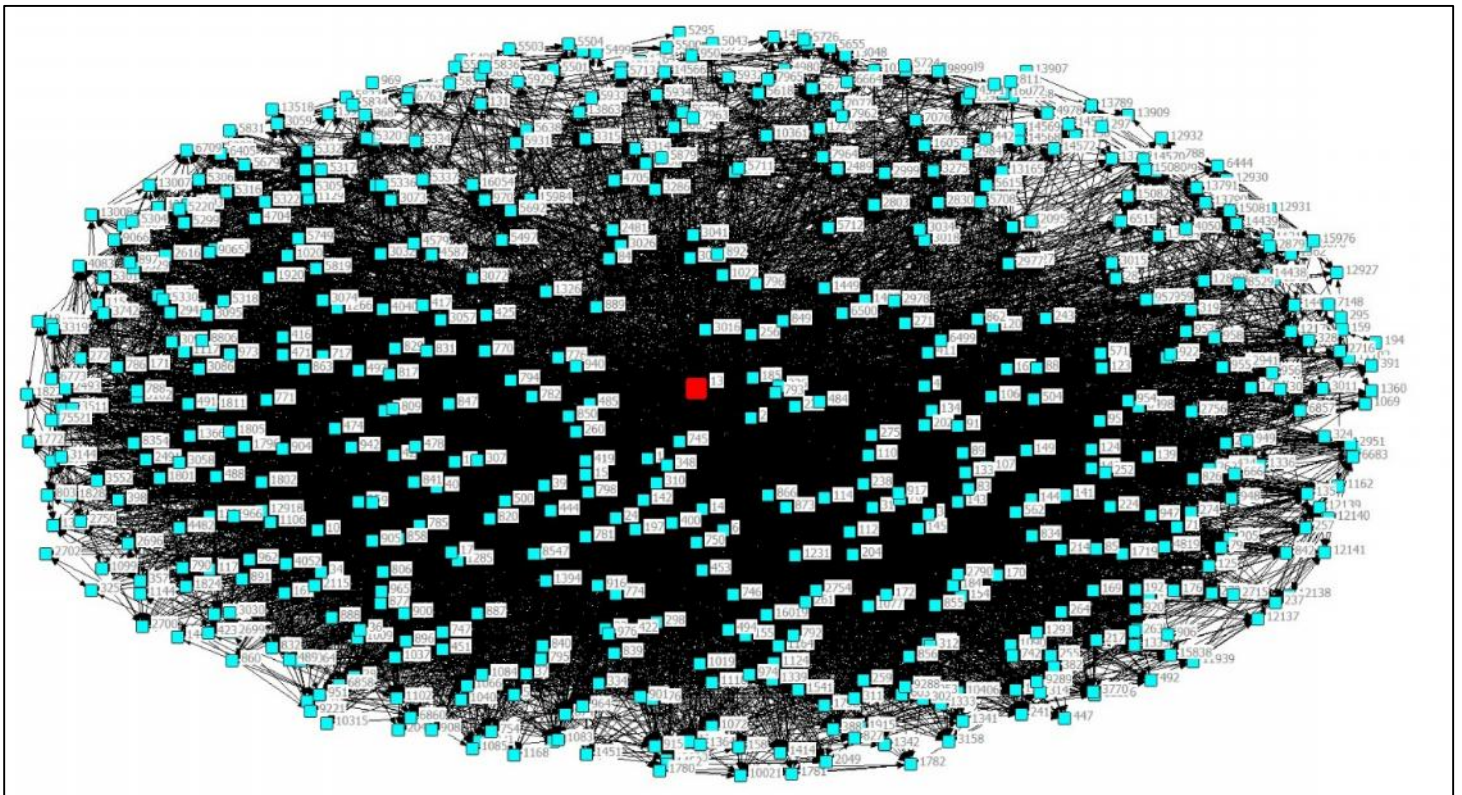
A useful place to start may be to examine the density of the ego-networks of PoMS actors who have been identified as important through high centrality. The following table examines the densities of the ego-networks of the fifteen individuals with the highest degree centrality in the whole network. In other words, it lists the top 15 by size of ego-network.

Table 8.1. Top fifteen players by size of ego-network, with densities

Poms ID	Name	Degree/ size	Egonet Density
13	Duncan (II), earl of Fife (d.1204)	585	8.4
42	William del Bois, chancellor (d.1232)	476	8.04
2	Matthew, bishop of Aberdeen (d.1199)	475	10.4
142	David, earl of Huntingdon (d.1219)	411	13.12
858	Walter of St Albans, bishop of Glasgow (d.1232)	380	10.58
40	William Malveisin, bishop of St Andrews (d.1238)	379	10.82
782	Malcolm (I), earl of Fife (d.1229)	377	11.54
15	Philip de Valognes, chamberlain (d.1215)	363	13.57
745	Jocelin, bishop of Glasgow (d.1199)	356	12.06
260	Gilbert or Gilla Brigte, earl of Strathearn (d.1223)	354	13.81
798	Richard de Prebenda, bishop of Dunkeld (d.1210)	347	15.39
444	Patrick (I), earl of Dunbar (d.1232)	343	12.56
850	John Scott, bishop of Dunkeld (d.1203)	337	13.34
1285	Walter Oliphant, justiciar of Lothian (son of Walter) (d.1242)	327	11.14
1	William I, king of Scots (d.1214)	321	16.56

All of the individuals listed in the above table have ego-networks of more than 320 people, and all have ego-network densities of less than 17 percent. This corresponds to a general principle that the larger the ego-network, the less likely that all of one's contacts will also be connected to each other. If charter witnessing were a proxy for knowing one's contemporaries, which of course is a complicated question, then only about 8% of Earl Duncan II of Fife's will have known each other, which would raise the likelihood that Earl Duncan acted as a bridge or conduit between those other actors. Of course, the charters witnessed by Earl Duncan were spread out across nearly fifty years, meaning that in reality, some of Earl Duncan's alters would not have even been alive at the same time.

Figure 8.1. Ego-network of Earl Duncan II of Fife



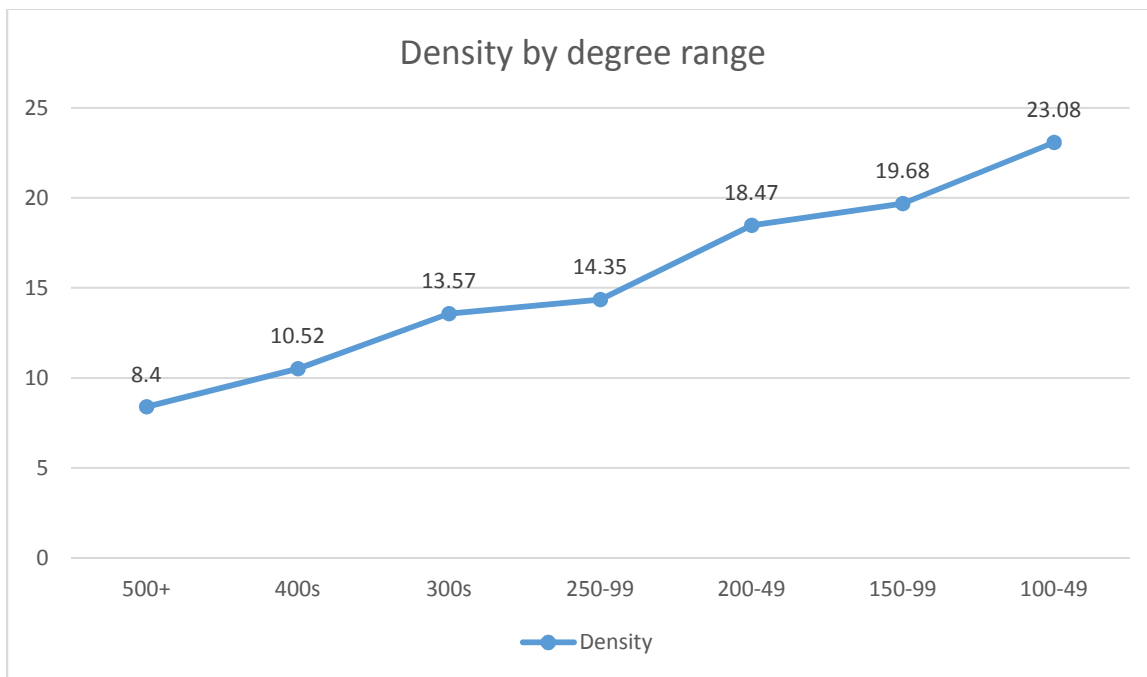
As we can see from Table 8.1, the fifteen largest ego-networks all have densities between about 8 and 17; indeed, most of them are below about 13. These are among the lowest-density ego-networks of PoMS actors, and this makes sense, because the larger number of contacts in their ego-networks are mathematically less likely to be connected to each other as compared to contacts in much smaller networks, where it is easier to come closer to 'completion' (100% density). How meaningful a measure can ego-network density be, though, if it is merely a reflection of how many people one with whom ego has co-witnessed, given the variations in documentary production discussed in previous chapters? How close is the correlation between degree or ego-network size and density? John Scott notes that 'the dependence of density on the size of a graph' does constitute a problem for comparing networks of different sizes, but mentions a countervailing trend to that already mentioned, whereby the number of contacts that ego can sustain tends to 'decline as the size of the network increases'. This is due to real constraints on time available for meaningful human interaction (Scott 2000, 74-5). We must remember, however, that our historical networks reflect chronological spans of time, which must be kept in mind during historical network analysis.

Table 8.2. Fifteen actors with lowest ego-network densities

Poms ID	Name	Egonet Density	Degree/ size
3350	Adam of Makerstoun, master, provost (d.1280×86)	7.99	155
42	William del Bois, chancellor (d.1232)	8.04	476
13	Duncan (II) earl of Fife (d. 1204)	8.4	585
2190	Robert Mowat, knight, justiciar, sheriff of Forfar	9.43	153
2762	Henry, archdeacon of Dunkeld (fl.1183×1203-1220×25)	9.69	175
5364	John Cameron, sheriff of Perth	9.76	136
43	John, abbot of Lindores (fl.1219-44)	10.05	159
788	Andrew Murray, bishop of Moray (d.1242)	10.17	273
4427	William, son of Earl Patrick (I) (d.1253)	10.29	140
1378	Walter Stewart (II), son of Alan (d.1241)	10.3	253
2	Matthew, bishop of Aberdeen (d.1199)	10.4	473
858	Walter of St Albans, bishop of Glasgow (d.1232)	10.58	380
2067	Gilbert Hay (I), lord of Errol (d.1263) (son of David)	10.7	137
3432	Thomas Crook, knight	10.79	110
40	William Malveisin, bishop of St Andrews (d.1238)	10.82	379

Table 8.2 shows the lowest ego-network densities when we analyse the ego-networks of the 315 individuals in the whole-network study of the PoMS database with degrees of 100 or above. Of the fifteen individuals with the lowest ego-net densities, ten actors had degrees/ ego-net sizes less than 320 (in boldface) and were thus not in the table of the fifteen players with the largest ego-networks. In other words, of the actors with 100 co-witnessing contacts or more, one third of the fifteen individuals with the lowest densities had more than 320 contacts, and two-thirds had between 100 and 320 contacts. Indeed, over half had ego-network sizes of between 100 and 200, and three of the “top five” had degrees below 200. Thus, it is clear that while many of the largest ego-networks were relatively less dense, at the same time, many of the least dense ego-networks were much smaller. Presumably, if we had the time to analyse all of the PoMS actors with fewer than 100 contacts, we would find some ego-networks with low densities. The significance of low-density networks will be explored below.

Figure 8.2. Average density by ego-network size ranges



As Figure 8.2 shows, there is still a general tendency for the smaller ego-networks to be denser. The average density of ego-networks where ego had between 400 and 500 co-witnessing contacts was only 10.52, while the average density of those networks with between 100 and 149 contacts was more than twice that, at 23.08. Nevertheless, as presence of low-density networks of that size reveal, this is only a general trend and not an exact correlation. Therefore, it is still meaningful to compare ego-network densities.

The following sociograms illustrate the ego-networks of various PoMS actors with a range of ego-network sizes and densities. Figure 8.3 is a sociogram of the ego-network of Henry, archdeacon of Dunkeld [PoMS, no. 2762]. This is an example of a small network – Henry witnessed alongside 175 other actors in a total of 26 documents included in the study. Nevertheless, he has a remarkably low ego-net density of 9.69. It is visible in the sociogram that many of the nodes appear in groups of higher density, but that these are not particularly well connected to each other. Figure 8.4, on the other hand, serves as an illustration of a small network with high density. King David I (1124-53) [130] only witnessed alongside 25 other actors in only four included documents, which is not surprising given the early date of his reign in terms of the chronology of charter production and the fact that kings tended not to witness documents as often as did their chief advisors. King David's charter witnessing ego-

network is highly connected: its density of 57.33 means that over 57 percent of David's contacts also witnessed alongside one another. Figure 8.5 shows a very small ego-network with a very high density, that of Gilchrist mac inien (son of the daughter of) Samuel [no. 920]. In this network of 28 alters, 85.45% of them were connected to each other. It could be said that Gilchrist is deeply embedded in this very dense network. A network with 100% density is said to have reached 'completion' and would comprise a large clique.

Figure 8.3. Low density, small size: Henry, archdeacon of Dunkeld (fl.1183×1203-1220×25)

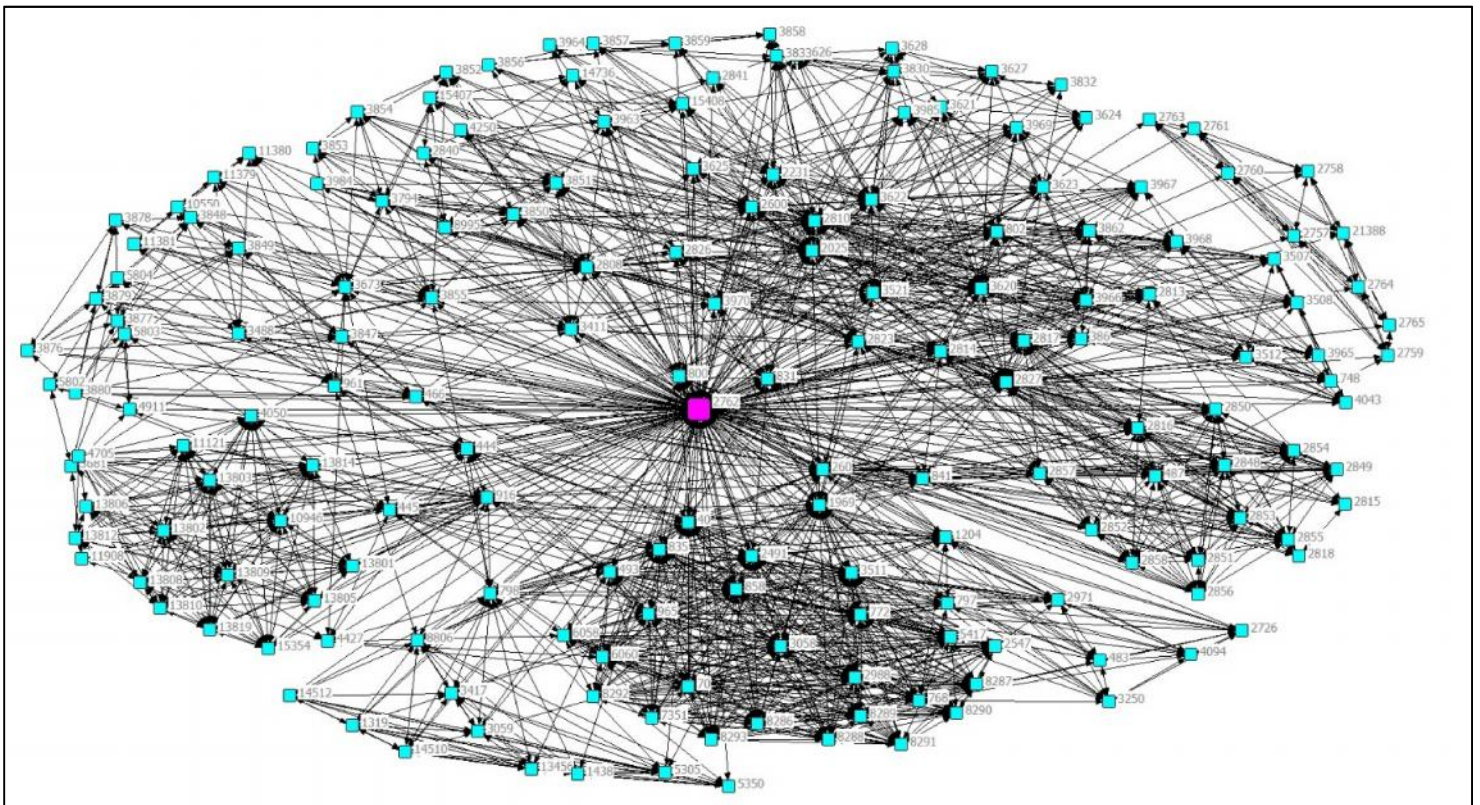


Figure 8.4. Very small, high density: King David I (d. 1153)

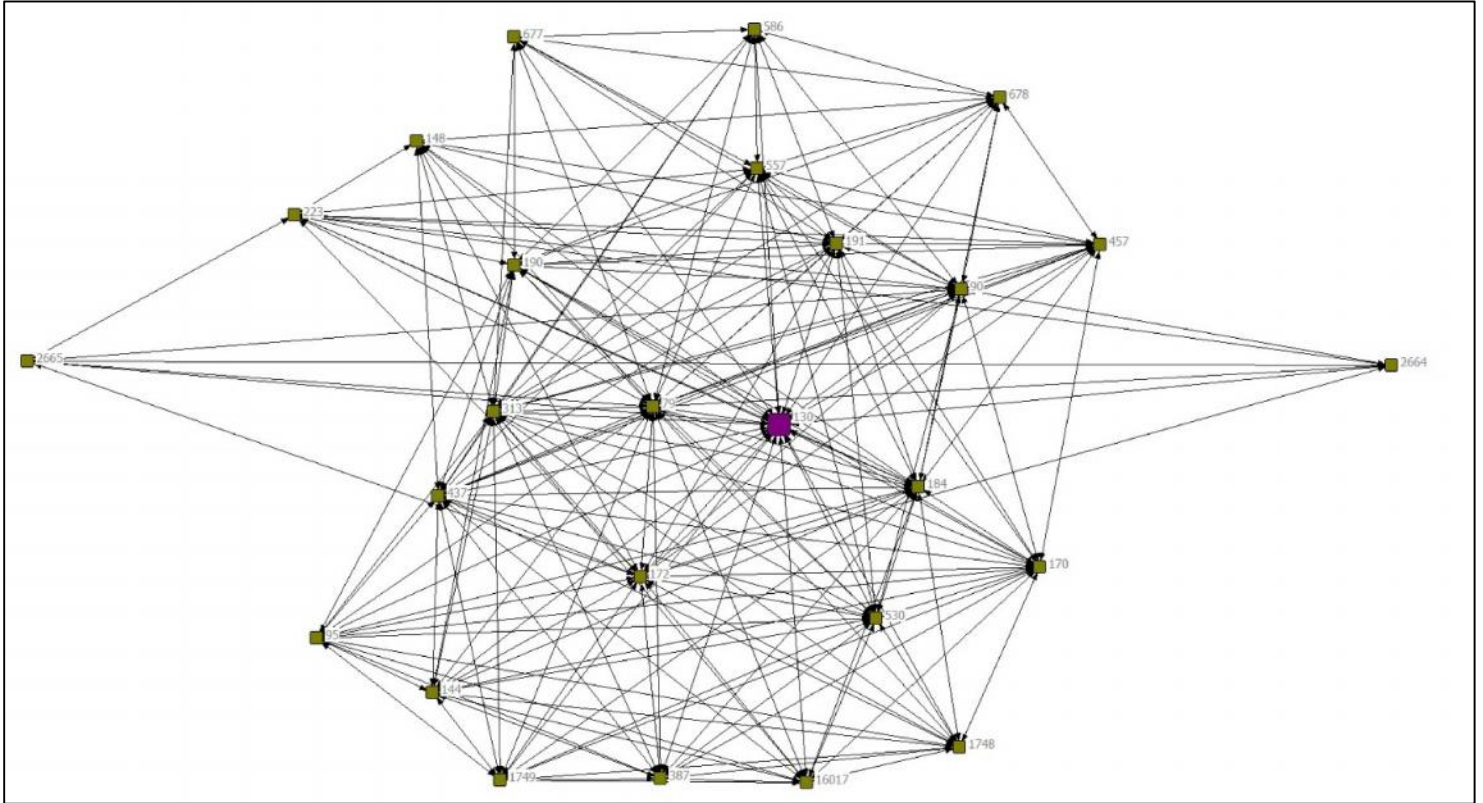
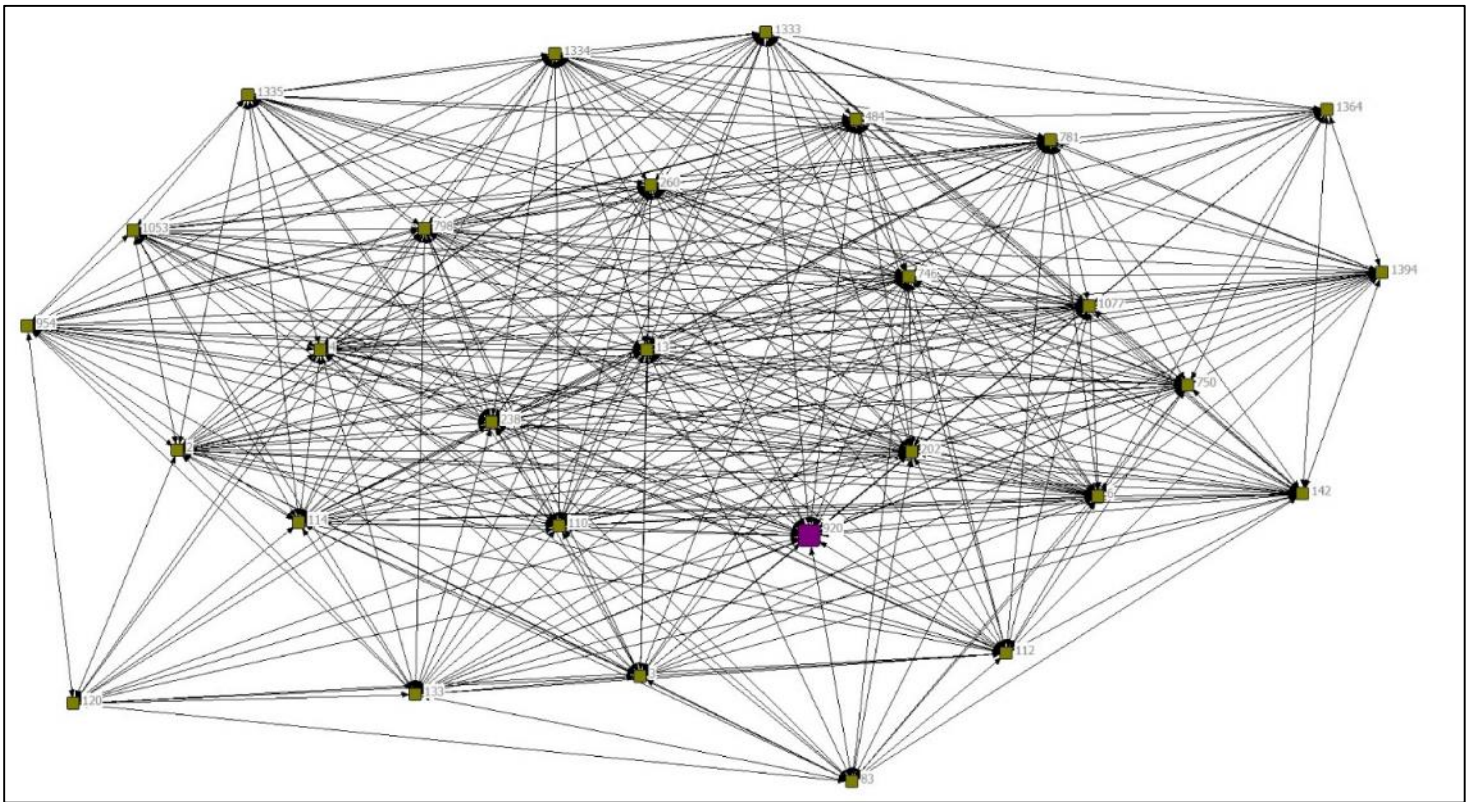


Figure 8.5 Very small, very high density: Gilchrist mac inien Samuel



Betweenness and Density

There is a certain parallel between betweenness centrality and density, given that both concepts focus on the position of an actor within the network structure and the relative advantages this position affords him or her. We may remember that William del Bois, chancellor (d. 1232) [42] had the highest betweenness centrality in the whole graph; thus, it should not be surprising that he also has the second-lowest ego-net density yet found in the PoMS database, at 8.04. For reasons explained by Christina Prell, however, the betweenness centrality of an actor in a whole network bears a complicated relationship to that actor's position in his/her ego-network (Prell 2012, p. 124-5). However, ego will have a different betweenness centrality score in the ego-network than in the whole network, and that score is more straightforwardly related to the ego-net density.

Table 8.3: Betweenness Centrality – actors with 20 lowest ego-net densities

Person Name	ID	Ego-betweenness	Degree/ ego-net size	Ego-net density
Adam of Makerstoun, master, provost (d.1280×86)	3350	18747.30	155	7.99
William del Bois, chancellor (d.1232)	42	107525.03	476	8.04
Duncan (II) earl of Fife (d. 1204)	13	137516.64	585	8.4
Robert Mowat, knight, justiciar, sheriff of Forfar	2190	15641.31	153	9.43
Henry, adcn. Dunkeld (fl.1183×1203-1220×25)	2762	21763.12	175	9.69
John Cameron, sheriff of Perth	5364	12630.01	136	9.76
John, abbot of Lindores (fl.1219-44)	43	16310.76	159	10.05
Andrew Murray, bishop of Moray (d.1242)	788	40847.69	273	10.17
William, son of Earl Patrick (I) (d.1253)	4427	12743.03	140	10.29
Walter Stewart (II), son of Alan (d.1241)	1378	33797.48	253	10.3
Matthew, bishop of Aberdeen (d.1199)	2	76630.54	473	10.4
Walter of St Albans, bishop of Glasgow (d.1232)	858	60825.98	380	10.58
Gilbert Hay (I), lord of Errol (d.1263) (son of David)	2067	10410.55	137	10.7
Thomas Crook, knight	3432	8278.65	110	10.79
William Malveisin, bishop of St Andrews (d.1238)	40	60948.97	379	10.82
Bernard of Hadden, sheriff of Roxburgh	880	25268.25	226	10.88
John Maxwell, chamberlain, sh. Roxburgh (d.1241)	1281	33509.98	277	10.89
Laurence of Thornton, adcn. St Andrews (d.1238×40)	835	26403.11	233	10.99
Alan of Harcarse, knight	5954	10189.57	121	11.05
Walter Oliphant, justiciar of Lothian (d.1242)	1285	47075.48	327	11.14

Table 8.4: Betweenness Centrality – actors with 15 highest ego-net sizes (degree)

Person Name	ID	Ego-betweenness	Degree/ ego-net size	Ego-net density
Duncan (II) earl of Fife (d. 1204)	13	137516.64	585	8.4
William del Bois, chancellor (d.1232)	42	107525.03	476	8.04
Matthew, bishop of Aberdeen (d.1199)	2	76630.54	473	10.4
David, earl of Huntingdon (d. 1219)	142	47409.30	409	13.12
Walter of St Albans, bishop of Glasgow (d.1232)	858	60825.98	380	10.58
William Malveisin, bishop of St Andrews (d.1238)	40	60948.97	379	10.82
Malcolm (I), earl of Fife (d.1229)	782	54044.90	377	11.54
Philip de Valognes, chamberlain (d.1215)	15	37298.79	363	13.57
Jocelin, bishop of Glasgow (d.1199)	745	49181.71	356	12.06
Gilbert, earl of Strathearn (d. 1223)	260	39261.70	354	13.81
Richard de Prebenda, bishop of Dunkeld (d.1210)	798	30088.01	347	15.39
Patrick (I), earl of Dunbar (d.1232)	444	46258.25	343	12.56
John Scott, bishop of Dunkeld (d.1203)	850	40658.70	337	13.34
Walter Oliphant, justiciar of Lothian (d.1242)	1285	47075.48	327	11.14
William I, king of Scots (d.1214)	1	26471.33	321	16.56

The above tables show that ego-betweenness is related to both size of the network and density. In general, the larger the network size, the higher betweenness number. This is also offset by the density of the actor, so that Walter Oliphant [1285], who has a degree of 327 and a density of 11.14, has a betweenness of about 47K. Meanwhile, David earl of Huntingdon [142] also has a betweenness score of about 47K, despite having a much higher degree of 409. This is because his density, at 13.12, is also considerably higher.

The conceptual world of high-density networks

As Charles Kadushin writes, 'in network terms, safety or supportive systems are usually equivalent to density in networks, a condition that has been generally associated with "social support", "cohesion" and "embeddedness".' (Kadushin, 60). Dense networks are often considered to engender situations of 'trust, cooperation, mutual support,' and a 'sense of solidarity and belonging' (Crossley, 31). These are underpinned by important work on social theory by sociologists like Robert Putnam, who elaborated the concept of 'bonding capital' as a kind of social capital, and of James Coleman, who explored the inherent incentives towards trust and support in dense networks (Crossley, 31). Importantly in our

case, however, networks in one specific social context may be dense, while the same actors may be involved in different, much less dense networks in other social contexts. One could enjoy a dense network of friends, but much looser networks at work or school. In doing our analysis of dense networks, we need to consider to what extent the actors were likely to have belonged to other important social groups, as well as to consider whether the survival pattern of documents was a major factor. It should be possible to speculate fruitfully whether what appears to be a very dense network of charter witnesses is likely to reflect a pattern of cohesion and embeddedness by weighing various factors.

The concept of homophily is typically used to characterise networks that have high densities. Homophily is sometimes described with the old adage 'birds of a feather flock together'. Sociologists have long recognised a tendency in humans to group together according to similar traits and tastes. It is harder to determine whether the groups form because of the actors' similarities, or instead whether actors who are already tied become more similar due to the effect of the ongoing social relationships. Sticking with the avian metaphor, this is considered the 'chicken and egg' problem of homophily. It is possible to study homophilous ties in social networks in a quantitative way, but this necessitates one's network having attributes which are measurable and relevant (Prell, 129-30). For medieval Scotland, it is hard to come up with such quantifiable attributes, but it is still worth asking whether homophily is relevant. Obviously, charter witnessing is a very particular kind of social relationship. In many cases, the witness himself will have little-to-no agency in the matter, particularly where charters were produced at large political assemblies. At the same time, there is a certain homophily involved in such cases, as witnesses will all be those deemed important or prestigious enough to witness a major royal charter, for example. In other cases, typically more local in nature, another kind of homophily might exist, one based on personal relationship, geography, and local community. As far as ego-networks go, it might be worth considering whether networks of greater density are characterised by a more homogenous group of documents and social contexts, and, by contrast, if the less dense networks involve more heterogeneous collections of documents. For example, an actor who has witnessed documents only having to do with episcopal properties in east Fife is more likely to have a network of homophilous co-witnesses, than would an actor who has witnessed royal charters, as well as those of an earl, a bishop, and an abbot.

We can test this by comparing the ego-networks of roughly equal size but with divergent ego-net densities. Walter Stewart (II), son of Alan (d. 1241) [1378] has a degree of 253, while Hugh of

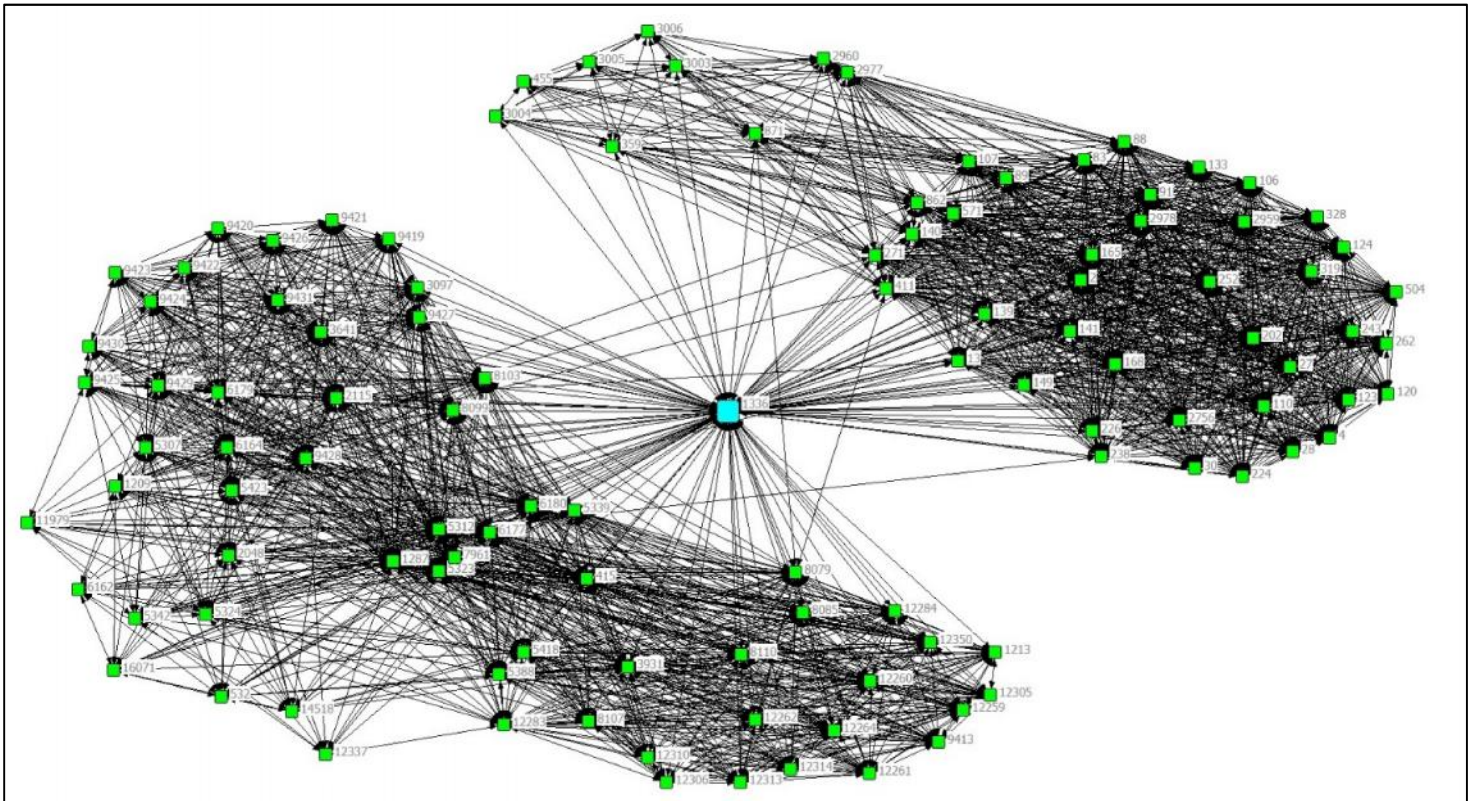
Roxburgh, bishop-elect of Glasgow (d. 1199) [820] has a degree of 255. They also witnessed almost the exact same number of documents, 101 for Walter and 99 for Hugh. Walter had a much lower density, at 10.3, compared to Hugh, at 19.94. So what is different about the two networks? 81 of the 99 documents (81.8%) witnessed by Hugh were charters of King William (a further three were charters of the king's brother and son); this is not surprising given that Hugh was the king's chancellor. While Walter also witnessed a number of royal charters (71 out of 101), he also witnessed the charters of a number of different lay magnates and lords in the kingdom's southwest, especially the earls of Lennox. This explains a good deal of why a much larger number of co-witnesses from quite different social contexts appear in Walter's network. Another way of looking at it is to ask how many roles/ positions each person held, and how distinct they were from each other. Walter witnessed charters in his position as the king's steward, both in the king's household and in terms of being a major landholder in the Firth of Clyde region, but also as justiciar of Scotia in the 1230s. While Hugh of Roxburgh was briefly archdeacon of St Andrews, and achieved the rank of bishop-elect of Glasgow before his death, most of his career was spent as the king's clerk and chancellor. It is likely that even many of the non-royal charters that he witnessed were in his capacity as king's chancellor. He would have been surrounded by many of the same actors in these settings. In another example, Gregory, bishop of Dunkeld (d. 1169) [149] had a similarly sized ego-network to Henry, archdeacon of Dunkeld (fl.1183×1203-1220×25) [2762], 174 and 175 respectively. Archdeacon Henry's ego-net density (9.69) is dramatically lower, however, compared to that of Bishop Gregory (30.32). Sixty percent of Gregory's attestations were of royal documents, and a further 29 percent were documents of the bishops of St Andrews. While these appear to be two distinct categories, which we would normally associate with a more diverse body of witnesses and thus a lower density, at the time when Gregory was active, both royal and episcopal charters were often produced at large political assemblies attended by the same core group of actors. Indeed, players who were active in the middle of the twelfth century often have higher than usual densities. [124] Cospatrick, earl of Dunbar (d.1166)'s density was 32.78, [172] Ranulf Soulis, king's butler (d.1165×72)'s was 28.72, and [88] William, abbot of Holyrood (I) (d.1172)'s was 40.32, to give but a few examples. So Archdeacon Henry's lower density is partly a result of the fact that he was active in the late twelfth and early thirteenth centuries, when the social contexts around document production were more manifold. Indeed, none of Henry's attestations were of royal charters. Despite the fact that 73 percent of his attestations were of ecclesiastical (H2) documents, most of which were based in his own home institution of Dunkeld, Henry witnessed in enough other social contexts to have a remarkably low-density network. This includes involvement in private transactions in central Scotland

and even Berwickshire, an area where the diocese of Dunkeld had far-flung possessions. The job of archdeacons, which involved representing the diocese's interests out in the world, on the ground, is a big part of why archdeacons often have ego-net densities on the lower end of the spectrum. [835] Laurence of Thornton, archdeacon of St Andrews (d. 1238×40), for example, had a density of 10.99. Members of the episcopal household whose job did not involve leaving the 'bubble' of the home institution, on the other hand, tend to have much higher densities. An example is [3057] Ralph, clerk of Bishop Roger of St Andrews, whose density of 34.09 belies the fact that he only witnessed documents of his employer or of St Andrews priory. Ralph's colleague [3072] Richard, chaplain of Bishop Roger, had an ego-net density of 33.3. Similarly, [167] William, chaplain (II) of King William (c.1196-1214) had a relatively high density of 25.57. Even though only 69% of the documents he witnessed were royal documents, most of the remainder of his attestations were private charters produced at the royal court or otherwise in a royal context where the king was present. While there is no shortcut to this kind of analysis, we can at least ask whether alters witnessed royal or other types of documents and display this in the sociogram (more on this below).

The conceptual world of low-density networks

Ron Burt's concepts of brokerage and structural holes are very important for our understanding of low-density ego-networks. Burt argues that some individuals act as 'brokers', holding a high level of influence or power due to their position in the network structure. In particular, they are well-placed to fill what Burt calls 'structural holes', or empty spaces between actors where the potential for meaningful connections exist (Prell, 122-24). This is based in part on Granovetter's notion of 'transitivity', whereby 'two nodes are more likely to have a tie when they each have a tie to a common third party' (Crossley, 15-16; 35). The broker would be the common third party, and might be in a position to benefit from bringing together the other two nodes in the triad. The sociological and psychological foundations for the role of the broker exist outwith Burt's SNA theories. Brokers are rich in what Robert Putnam calls 'bridging capital': by acting as bridges between different communities, brokers can facilitate the flow of ideas, resources, innovations, but also sometimes negative things like pathogens (Crossley, 31). In social network terms, brokers fill structural holes, acting as conduits between two otherwise distinct components, clusters or cliques. The particular structure of the network and position of the broker can also be important, and scholars have identified various types of brokers, including representative brokers, gatekeeper brokers, and liaison brokers, reflecting various arrangements of personal agency (Prell, 127).

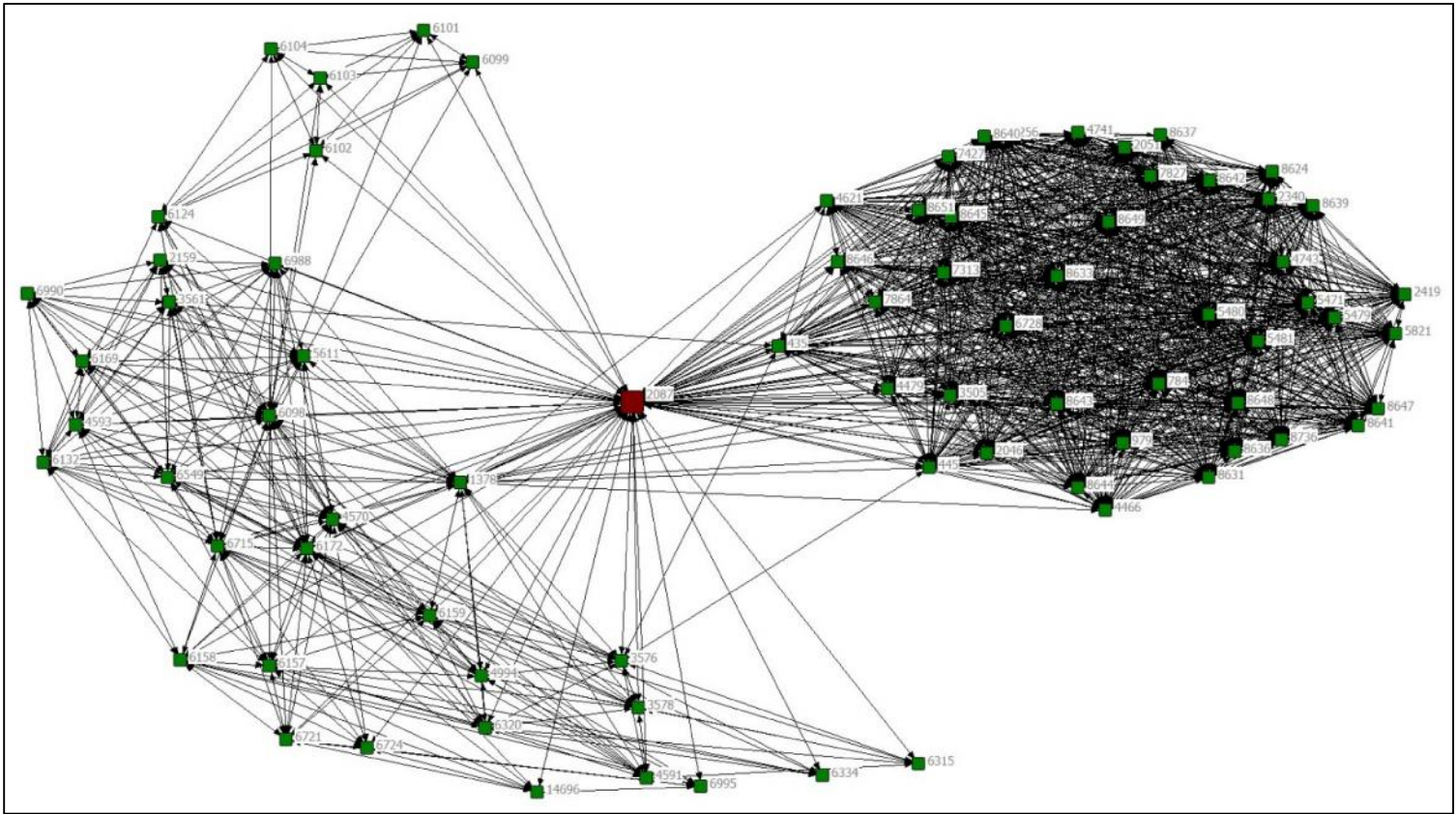
Figure 8.6. Ego-network of [1336] Master Merlin (fl.1161x62-1189x1203)



This sociogram of the ego-network of Master Merlin, who flourished from the early 1160s until around the turn of the century, is illustrative of the bridging position of a broker in an ego-network. As we can see, Merlin acts as the main point of contact between two otherwise very dense components. Some of the actors in the segment on the right were [13] Earl Duncan II of Fife (d. 1204); [2] Matthew, bishop of Aberdeen (d. 1199); [202] Andrew, bishop of Caithness (d.1184); [139] William, bishop of Moray (d.1162); [141] William, abbot of Melrose (fl.1159-70); [149] Gregory, bishop of Dunkeld (d.1169); [226] Merleswain, son of Colban, lord of Kennoway (fl.1150s-90s); and [238] Malcolm, earl of Atholl (d.c.1197). Some of the actors in the segment on the left were [2115] Walter Lindsay (III), son of William (II) (d.c.1222); [3097] Richard Niger/Brun (12/13C); [5339] Reginald of Little Reston (brother of Aldan); [6180] Maurice, son of Master Merlin; [8099] Richard, forester (BWK); [8103] Constantine (at Ayton); and [9427] Philip, porter (BWK). It is clear that the actors on the right were powerful figures on the 'national stage', while those on the left were active in the local world of eastern Berwickshire. Master Merlin had ties with the episcopacy of Arnold, bishop of St Andrews, but was also likely a landholder in Berwickshire, where he witnessed a number of charters, and where his sons held land (PoMS, no. 1336). Indeed, there was a place called Merlington in the area which is now lost. So Master

Merlin was an individual with dense ties in the community of Berwickshire who also had connections to the more powerful in the kingdom, likely due to his higher education and ecclesiastical acumen.

Figure 8.7. Ego-network of [2087] Mael Domnaig, earl of Lennox (d. ×1265)



Another example of an actor who is filling a structural hole in an ego-network is [2087] Mael Domnaig, earl of Lennox. As is obvious from his sociogram, the earl acts as the main connector between a very dense segment of actors on the right and a less dense segment on the left. The dense group on the right, however, is the result of a single document, the 1237 Treaty of York, witnessed by a large number of magnates and prelates, while the group on the left are witnesses to various charters dealing with local Lennox issues. While this serves as a salutary reminder that we must always follow up the documents underlying the SNA patterns, this sociogram does still represent the very real situation that earls could serve as bridges between the kingdom's 'national' politics and the locality of his own province.

Table 8.5. Fifteen actors with lowest ego-network densities

Poms ID	Name	Egonet Density	Degree/ size
3350	Adam of Makerstoun, master, provost (d.1280×86)	7.99	155
42	William del Bois, chancellor (d.1232)	8.04	476
13	Duncan (II) earl of Fife (d. 1204)	8.4	585
2190	Robert Mowat, knight, justiciar, sheriff of Forfar	9.43	153
2762	Henry, archdeacon of Dunkeld (fl.1183×1203-1220×25)	9.69	175
5364	John Cameron, sheriff of Perth	9.76	136
43	John, abbot of Lindores (fl.1219-44)	10.05	159
788	Andrew Murray, bishop of Moray (d.1242)	10.17	273
4427	William, son of Earl Patrick (I) (d.1253)	10.29	140
1378	Walter Stewart (II), son of Alan (d.1241)	10.3	253
2	Matthew, bishop of Aberdeen (d.1199)	10.4	473
858	Walter of St Albans, bishop of Glasgow (d.1232)	10.58	380
2067	Gilbert Hay (I), lord of Errol (d.1263) (son of David)	10.7	137
3432	Thomas Crook, knight	10.79	110
40	William Malveisin, bishop of St Andrews (d.1238)	10.82	379

A better way of considering possible brokers is to examine actors with low ego-net densities. While their brokerage opportunities may not be as visible in sociograms as the above examples due to the large size of many of their networks, the low density itself is a very important indicator. If denser networks are associated with social cohesion, support, and security, less dense networks are associated with competition and effectiveness. 'Relationships with insiders are more dense, supportive, and trusting, while relationships with outsiders are less dense and therefore open to manipulation afforded by "structural holes".' (Kadushin, 62). Individuals with the lower ego-net densities (Table 8.5) should be further investigated for potential broker status. This is because very few of the contacts with whom they have co-witnessed have also co-witnessed with each other. In other words, if charter witnessing were a proxy for knowing someone, only about 8-10% of the 'friends' of the people listed in Table 8.5 'know each other'. These actors are the common thread tying together various divergent groups of actors. That would present a great number of opportunities for these potential brokers to bridge those structural holes in meaningful ways.

The method of comparison might be useful for us here. Comparing a person with a lower-than-usual density with a person with higher-than-average density in the context of potential cohesion and safety

versus brokerage and effectiveness might be illuminating. While [202] Andrew, bishop of Caithness (d. 1184) had a large ego-network of 260 actors drawn from 88 documents, his density of 19.98 is 5.5 above the average for his degree range. 78 percent of the documents he witnessed were royal, and 16% were documents of the bishops of St Andrews. So despite his clearly very important position, he seems to circulate in a fairly homophilous environment. As we shall see, this could mean that a person like Andrew was able to draw safety, security, and strength from his highly embedded position in the tight-knit networks of the king's court and ecclesiastical capital, but he may not have been in a position to act as an opinion leader, or to introduce new ideas or energy into the dense network. His younger contemporary [2] Matthew, bishop of Aberdeen (d. 1199), who was also archdeacon of St Andrews from around 1150 to 1172, serves as a good counterpoint. Matthew witnessed 152 documents, and had a very large ego-network size of 473 and a very low density of 10.4. Some of Matthew's low density as compared to Andrew can be explained by his living at a slightly later date, when there were both more charters produced and more different types of social context producing them, tying into the fact that Matthew witnessed many more documents than did Andrew. Nevertheless, only 54% of Matthew's witnessing acts were royal charters, while another 30% were ecclesiastical grantors, most but not all of which related to St Andrews. But 14% of his co-witnessing was of private charters. A few of these would have been produced in a royal setting, but many were not. They included charters of many of the top landholders in Scotland proper at that time, including the earls of Atholl, Fife, Mar, and Buchan, the lords of Leuchars, and members of the Valognes, Maule, Avenel, Uviet, and de Fréville families. Remarkably, these activities were not a result of his position as archdeacon of St Andrews, but date to his time as bishop of Aberdeen, despite the fact that most of them relate to lands outwith the diocese of Aberdeen. What Matthew's low density is pointing to here is that he had an importance which is not fully captured by simply his titles and positions. Matthew was the leader of an important network which carried on the legacy of Bishop Robert of St Andrews, and it was likely this role combined with presumably effective personal abilities which made him a person for whom the whole is greater than the sum of its parts. Bishop Matthew should be seen as a very good contender for a broker in Scottish society. What this approach can give historians more broadly is the method of thinking about important actors according to the social groups they represented and various roles they filled, and how they may have acted as brokers or mediators between different interest bases in society. These interest bases could be particular provincial communities, religious houses or orders, international or more local kin-based networks, the royal house, burghs and trading networks, and so forth.

It is worthwhile pausing to consider the variations in network size between Bishop Matthew (473) and Bishop Andrew (260) and to question how much this affected the above analysis. This is particularly relevant in the context of how many documents were witnessed. Did the fact that Bishop Matthew witnessed more documents (152) than Andrew (88) determine his network size and thus the overall analysis? Clearly, the more documents one witnesses, the more opportunities there are to co-witness with new actors. First, Bishop Matthew's degree is 1.82 times that of Andrew, and Matthew witnessed 1.72 times as many documents, so there is a fairly close correlation there. Second, if we divide the degree (ego-net size) by the number of documents witnessed, we get an indicator of repetition of actors among the body of witnesses. This gives us a number of 3.11 for Bishop Matthew and 2.95 for Bishop Andrew. These indicators are broadly comparable, which suggests that the number of documents has not been the determinative factor in this case.

Table 8.6. Lowest degree/ documents witnessed ratios

Person name	ID	Degree/documents	Degree	Documents
<i>William of Mordington</i>	3673	1.943661972	138	71
Henry Balliol (d. 1246) [chamberlain]	1420	2.068965517	120	58
Richard de Moreville, constable (d. 1189 or 90)	112	2.094017094	245	117
Nicholas of Roxburgh, chancellor (d. 1171?)	133	2.123966942	257	121
Walter Barclay, chamberlain (d.c.1193)	6	2.172413793	189	87
<i>Gilbert of Lumsdaine</i>	3660	2.177419355	135	62
Philip de Valognes, chamberlain (d.1215)	15	2.186746988	363	166
William Comyn, earl of Buchan (d.1233)	16	2.193103448	318	145
Walter Comyn, earl of Menteith (d.1258)	1357	2.223404255	209	94
<i>Robert, son of Gregory steward of Coldingham</i>	7960	2.225806452	138	62
Hugh de Moreville (I) (d.1162) [constable]	79	2.305882353	196	85
William del Bois, chancellor (d.1232)	42	2.356435644	476	202
<i>Adam of Prenderquest</i>	6190	2.433333333	146	60
Walter Stewart (II), son of Alan (d.1241)	1378	2.504950495	253	101
Walter de Bidun, chancellor (d. 1178)	78	2.506024096	208	83
Walter son of Alan, steward (d. 1177)	3	2.532258065	314	124

First, there are a number of individuals on this list who are part of the Coldingham group, a corpus of critical mass which tends to feature the same actors with great regularity. These have been put in italics. When we remove these actors, there are clear patterns to the rest of the list. Nearly all of the players with very low degree/document ratios were royal household members, especially constables,

stewards, chancellors, and chamberlains. The only remaining two in the 'top 16' presented here were William Comyn and Walter Comyn, men who had similarly central positions at the royal court. This means that there were only about 2 unique individuals in their networks for each document they witnessed. Even though 7 individuals here witnessed more than 100 documents, their low ratios mean that they witnessed alongside the same people again and again, rather than encountering more new people. It makes a great deal of sense that people who witnessed mostly royal charters would have such low ratios. [13] Duncan (II), earl of Fife (d. 1204), despite witnessing 202 documents and having the largest ego-network size of 585, has a slightly higher ratio of 2.9. The people on the higher end of the spectrum tend to have witnessed much smaller numbers of documents, but the middle range is quite interesting. For example, [40] William Malveisin, bishop of St Andrews (d. 1238) witnessed 67 documents and had a ratio of 5.7, while [850] John Scot, bishop of Dunkeld (d. 1203) also witnessed 67 documents but had a lower ratio of 5.03. So even though they witnessed the same number of documents, Bishop William had more contacts (379) than Bishop John (337). Interestingly, Bishop William has a lower ego-net density (10.82) than Bishop John (13.34).

Not all structural holes are equally important, however. The two components must have something meaningful to offer: creating a bridge between two actors who are already very similar may ultimately be of little value (Crossley, 36). Burt developed a number of statistical measures to help fine-tune our analysis. Two of these are effective size and efficiency. Burt and Granovetter both accept that some ties are 'redundant' because they fail to bridge any meaningful gap. Nodes in a dense network which do not allow any new information to reach ego are redundant (Crossley, 36). Effective size is a modification of the measure of the ego-network size, the degree centrality or number of ego's contacts, which is calculated as ego's degree minus the average degree of the alters, not including ties to ego (Crossley, 83; Borgatti, 274-5). Another measure is efficiency, which is effective size divided by degree. The term 'efficient' here should be thought of in terms of broker expending time and resources on alters who themselves are unconnected. High efficiency means avoiding redundancy (Crossley, 91). Table 8.7, below, gives the effective size and efficiency calculations for the fifteen largest ego-networks, and table 8.8 gives the measures for the twenty lowest-density ego-nets. As we see, there is a general trend, but not an exact correlation, for the larger networks to be more efficient. While Duncan (II), earl of Fife has 585 contacts, the effective size of his ego-network is 536, giving him an efficiency of almost 92%. This is the inverse of his density, at 8.4%. Theoretically, about 536 of his 585 alters are unconnected, giving him ample opportunities for brokerage.

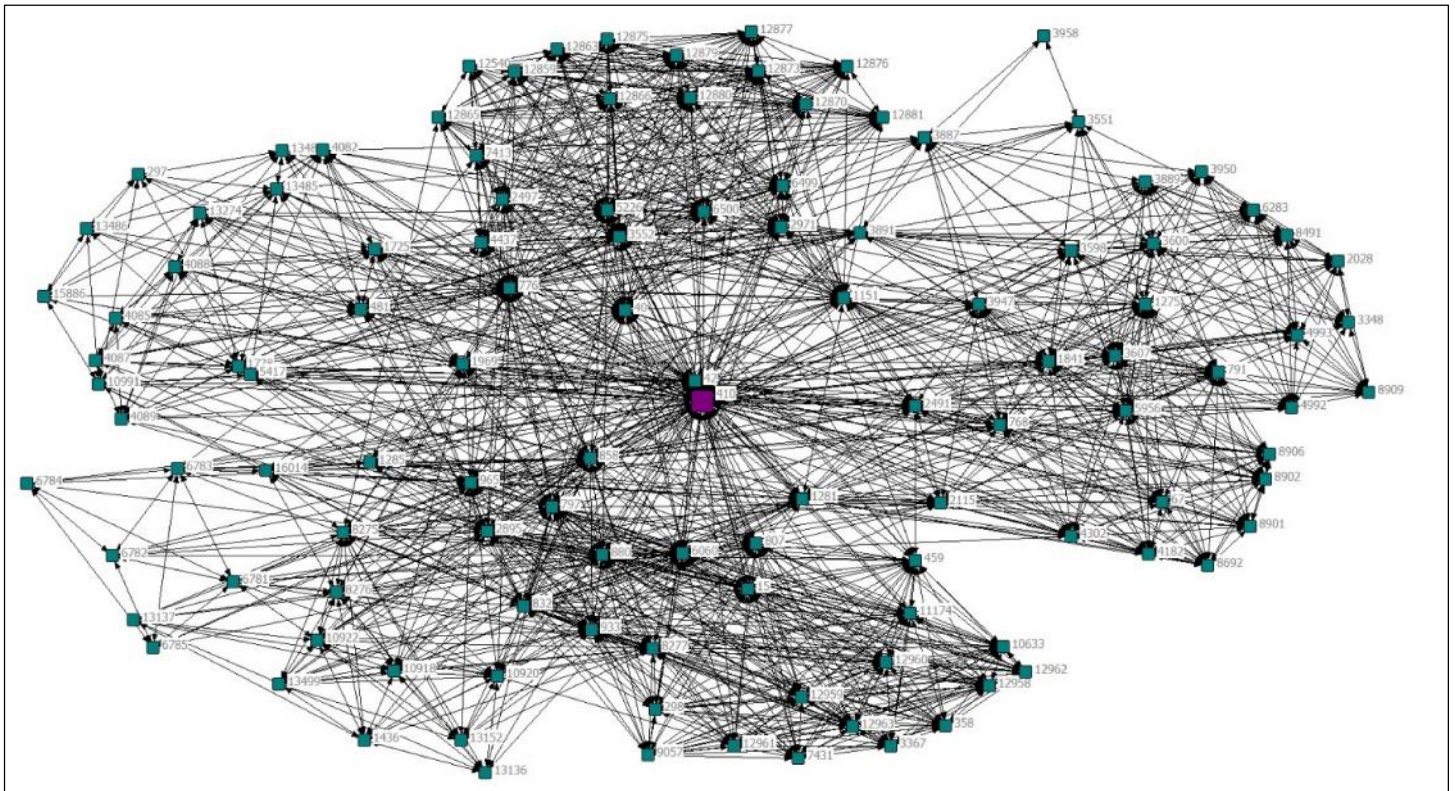
Table 8.7. Effective size and efficiency, 15 largest ego-nets

Person	ID	Density	Size	Effective size	Efficiency
Duncan (II) earl of Fife (d. 1204)	13	8.4	585	536	0.916
William del Bois, chancellor (d.1232)	42	8.04	476	437.8	0.92
Matthew, bishop of Aberdeen (d.1199)	2	10.4	473	423.9	0.896
David, earl of Huntingdon (d. 1219)	142	13.12	409	355	0.87
Walter of St Albans, bishop of Glasgow (d.1232)	858	10.58	380	339.9	0.894
William Malveisin, bishop of St Andrews (d.1238)	40	10.82	379	338.1	0.892
Malcolm (I), earl of Fife (d.1229)	782	11.54	377	333.6	0.885
Philip de Valognes, chamberlain (d.1215)	15	13.57	363	313.9	0.865
Jocelin, bishop of Glasgow (d.1199)	745	12.06	356	313.2	0.88
Gilbert, earl of Strathearn (d. 1223)	260	13.81	354	305.3	0.862
Richard de Prebenda, bishop of Dunkeld (d.1210)	798	15.39	347	293.8	0.847
Patrick (I), earl of Dunbar (d.1232)	444	12.56	343	300.1	0.875
John Scott, bishop of Dunkeld (d.1203)	850	13.34	337	292.2	0.867
Walter Oliphant, justiciar of Lothian (son of Walter) (d.1242)	1285	11.14	327	290.6	0.889
William I, king of Scots (d.1214)	1	16.56	321	268	0.835

Table 8.8. Effective size and efficiency, 20 lowest density ego-nets

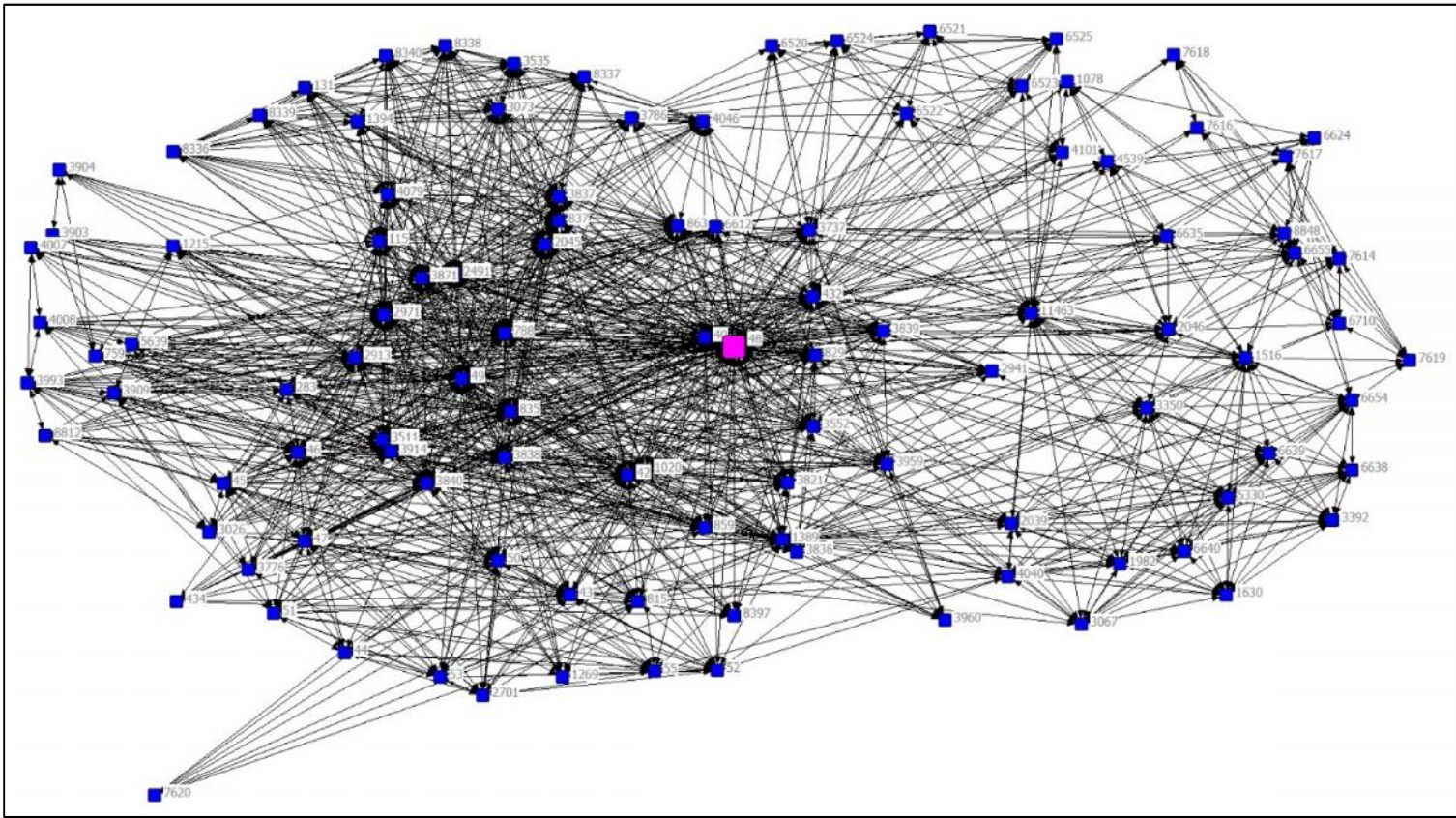
Person	ID	Density	Size	Effective size	Efficiency
Adam of Makerstoun, master, provost (d.1280×86)	3350	7.99	155	142.7	0.921
William del Bois, chancellor (d.1232)	42	8.04	476	437.8	0.92
Donnchad (II) earl of Fife (d. 1204)	13	8.4	585	536	0.916
Robert Mowat, knight, justiciar, sheriff of Forfar	2190	9.43	153	138.7	0.906
Henry, archdeacon of Dunkeld (fl.1183×1203-1220×25)	2762	9.69	175	158.1	0.904
John Cameron, sheriff of Perth	5364	9.76	136	122.8	0.903
John, abbot of Lindores (fl.1219-44)	43	10.05	159	143.1	0.9
Andrew Murray, bishop of Moray (d.1242)	788	10.17	273	245.3	0.899
William, son of Earl Patrick (I) (d.1253)	4427	10.29	140	125.7	0.898
Walter Stewart (II), son of Alan (d.1241)	1378	10.3	253	227	0.897
Matthew, bishop of Aberdeen (d.1199)	2	10.4	473	423.9	0.896
Walter of St Albans, bishop of Glasgow (d.1232)	858	10.58	380	339.9	0.894
Gilbert Hay (I), lord of Errol (d.1263) (son of David)	2067	10.7	137	122.4	0.894
Thomas Crook, knight	3432	10.79	110	98.2	0.893
William Malveisin, bishop of St Andrews (d.1238)	40	10.82	379	338.1	0.892
Bernard of Hadden, sheriff of Roxburgh	880	10.88	226	201.5	0.892
John Maxwell, chamberlain, sh. Roxburgh (d.1241)	1281	10.89	277	247	0.892
Laurence of Thornton, adcn. St Andrews (d.1238×40)	835	10.99	233	207.5	0.891
Alan of Harscarse, knight	5954	11.05	121	107.7	0.89
Walter Oliphant, justiciar of Lothian (son of Walter) (d.1242)	1285	11.14	327	290.6	0.889

Figure 8.8. Ego-network of [410] Richard of Ancrum, dean, official, persona (fl.1202-26)



Before moving on, it might be worthwhile to glance at a couple of examples of actors whose structural position in the network gives them a distinct lack of influence. These are individuals who, through their position, have very low opportunity to fill structural holes, and who could be very easily replaced were they to disappear suddenly from the network. As is evident from the sociogram above, [42] William del Bois, chancellor (d. 1232) occupies a nearly identical position in the network structure to Richard of Ancrum himself. It is likely that William del Bois could subvert any brokerage opportunities of Richard of Ancrum if he wanted. A similar situation is shown in Figure 8.9, below, where [48] Simon de Noisy, clerk of Bishop William of St Andrews, is very closely situated to [49] William of Gullane, rector of Gullane. These are individuals who are on the opposite end of the spectrum to people with very efficient ego-networks. Instead, they are at high risk of redundancy.

Figure 8.9 Ego-network of [48] Simon de Noisy, clerk of Bishop William of St Andrews



The strength of weak ties

Ron Burt's work on structural holes and brokerage was preceded by, and informed by, that of sociologist Mark Granovetter, on 'the strength of weak ties'. Granovetter's very influential work adds more nuance to our understanding of ego-networks by exploring the ways in which some contacts are different than others. Close friends, usually expressed in a dense network or network component, are described as strong ties, while mere acquaintances or people one only encounters infrequently are described as weak ties. While ego and his strong ties interact closely and are likely to possess a lot of the same information, have the same tastes, and so forth, ego's weak ties will themselves have strong ties with other actors who are not even part of ego's network at all. In this way, Granovetter's weak ties have a bridging function not unlike Burt's brokers. Weak ties move in different circles. New information is likely to enter a dense network through these weak ties (Kadushin, 30-1; Granovetter 1973 and 1983, Crossley, 35). In Granovetter's words, 'the fewer indirect contacts one has the more encapsulated he will be in terms of knowledge of the world beyond his own friendship circle' (Granovetter 1973, 1371.) Furthermore, weak ties are very important role in the integration of broader social systems; they are

the glue that bonds together various more isolated and fragmented groups (Kadushin, 31). Without them, according to Granovetter, 'subgroups separated by race, ethnicity, geography, or other characteristics will have difficulty reaching a modus vivendi' (Granovetter 1983, ??). Given the multi-ethnic and multilingual nature of society in central medieval Scotland, this concept could be invaluable to historians.

In our analysis of ego-networks, the work of Mark Granovetter has given us two key ideas which add nuance to our study. The first is that some parts of a network are more dense than other parts. There are areas of high and low density within the same sociogram. As one author puts it, 'the straightforward ego-net density measure is a relatively blunt structural instrument which fails to explore differentiation within the ego-net and which can disguise the fact that some parts of it are, in some cases, denser than others' (Crossley, 83). One method historians should consider is the identification of distinct components within the ego-network and asking whether they were likely to represent meaningful groups on the ground (Borgatti, 274). In small networks, such components may represent simply the witnesses of a single document. The following sociograms illustrate variations in density in ego-networks.

Figure 8.10 Ego-network of [947] Patrick, son of Cospatric, earl of Dunbar

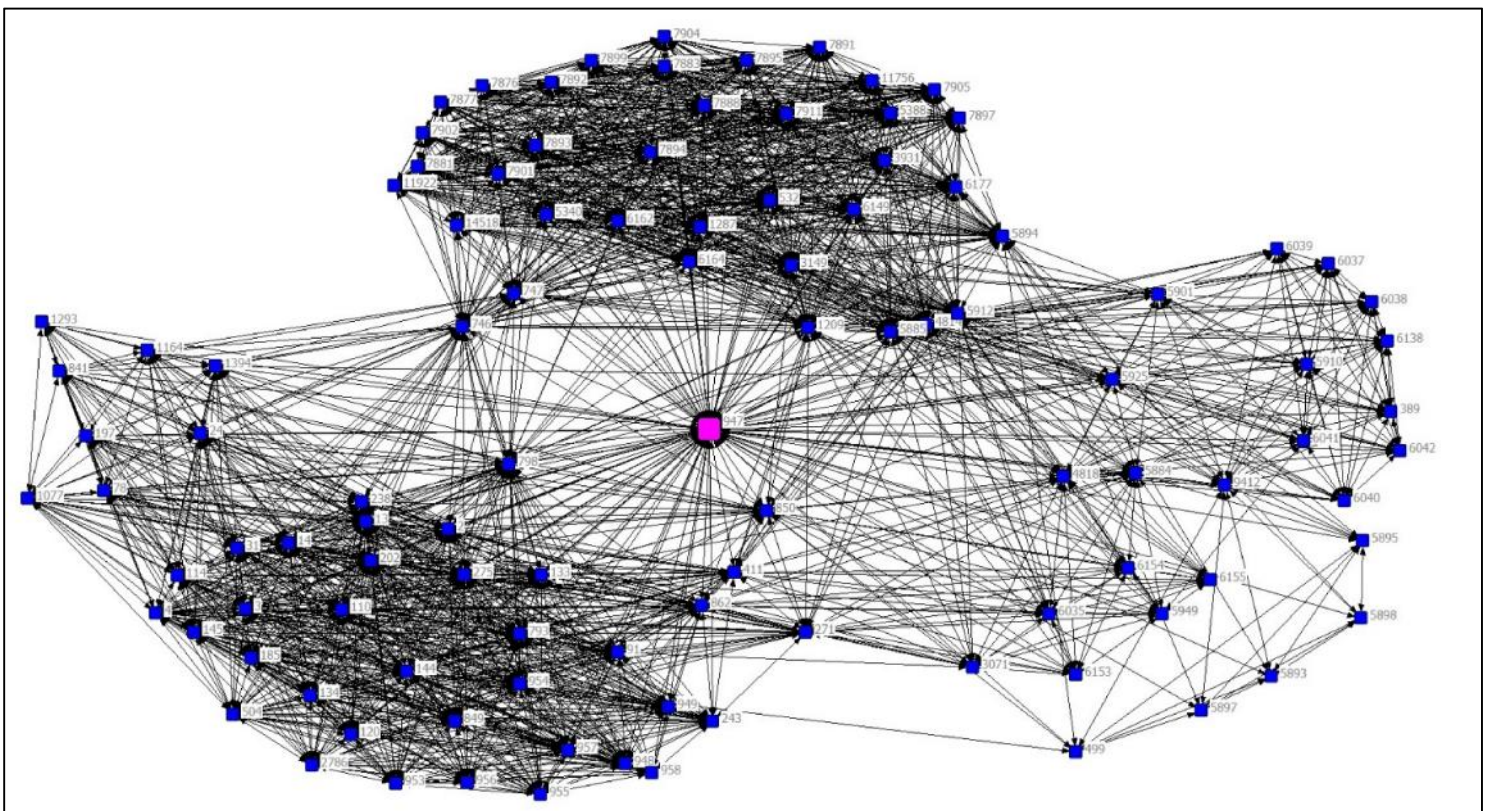


Figure 8.11 Ego-network of [37] Walter Murdoch

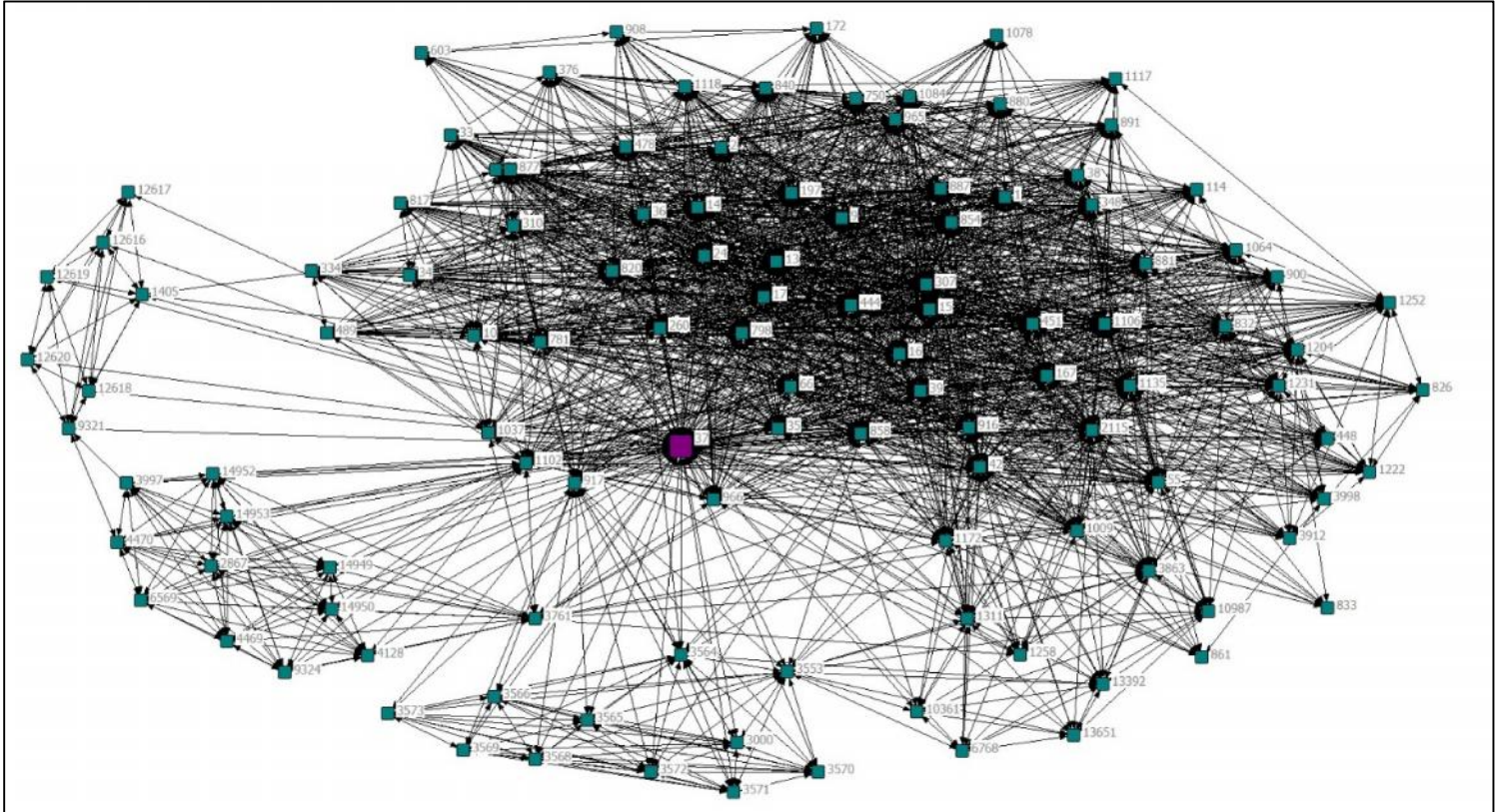


Figure 8.12 Ego-network of [562] William son of Thor, sheriff of Stirling

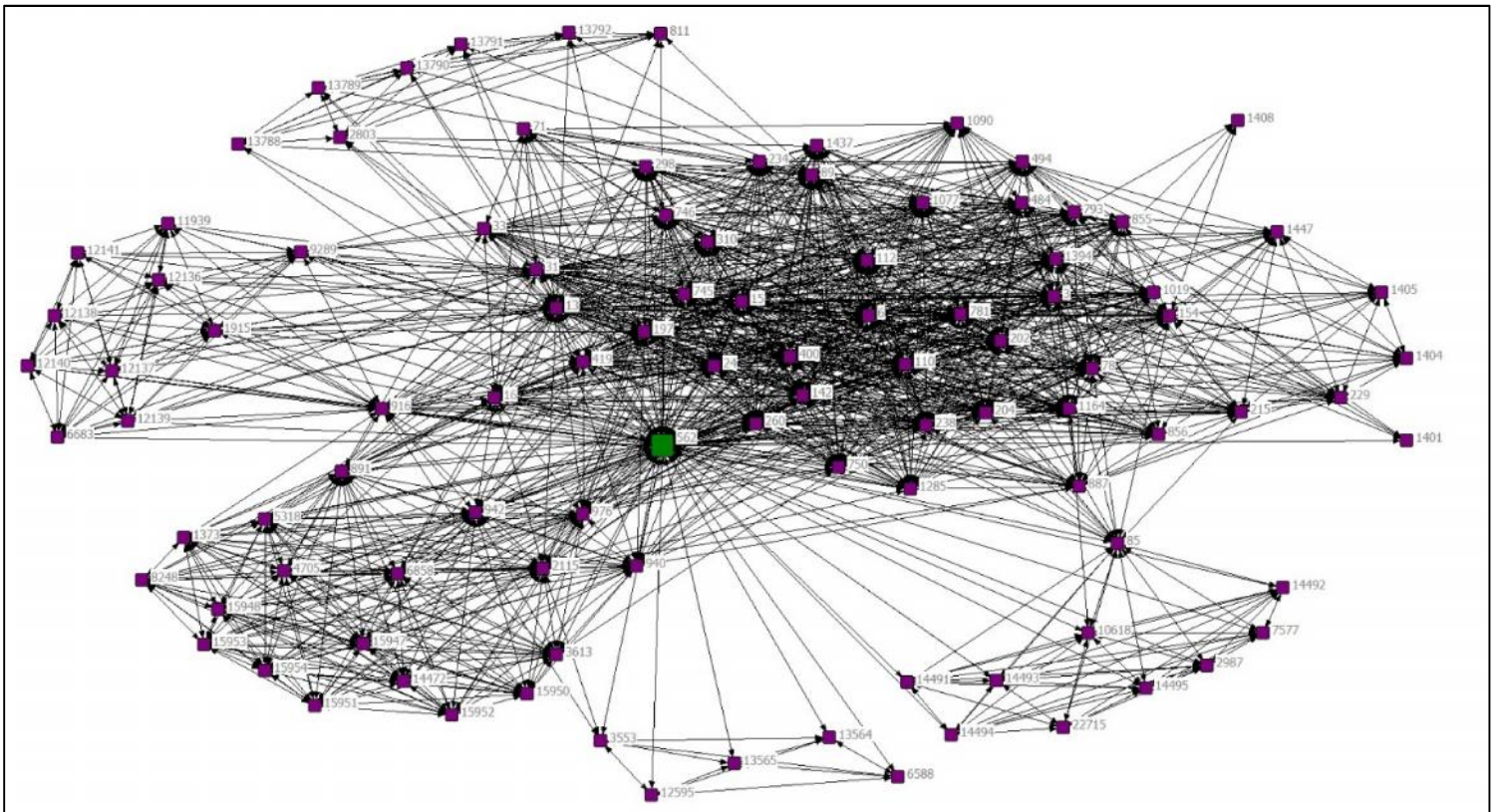


Figure 8.13 Ego-network of [831] Walter, abbot of Holyrood (d.1217 or 1218)

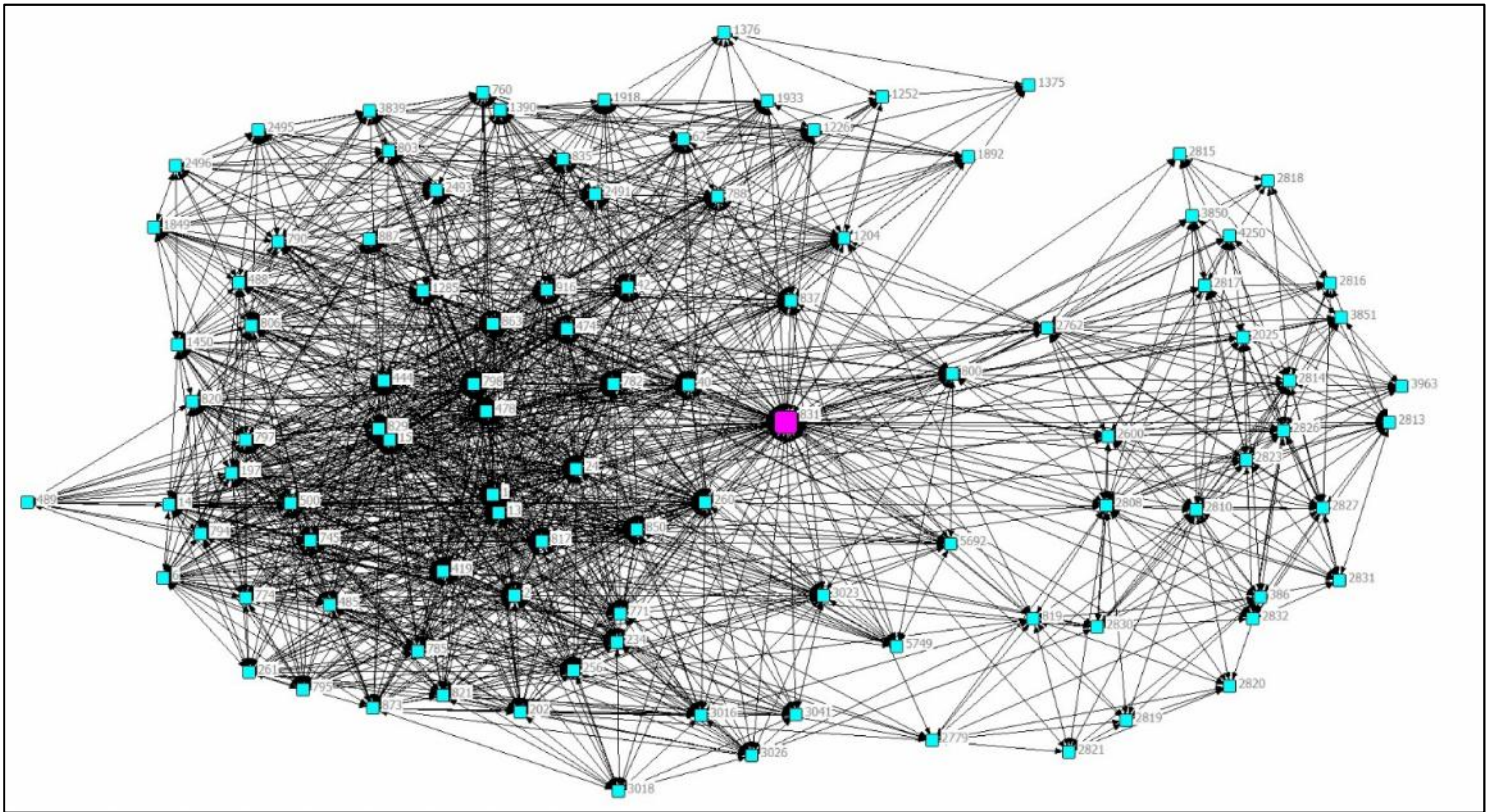
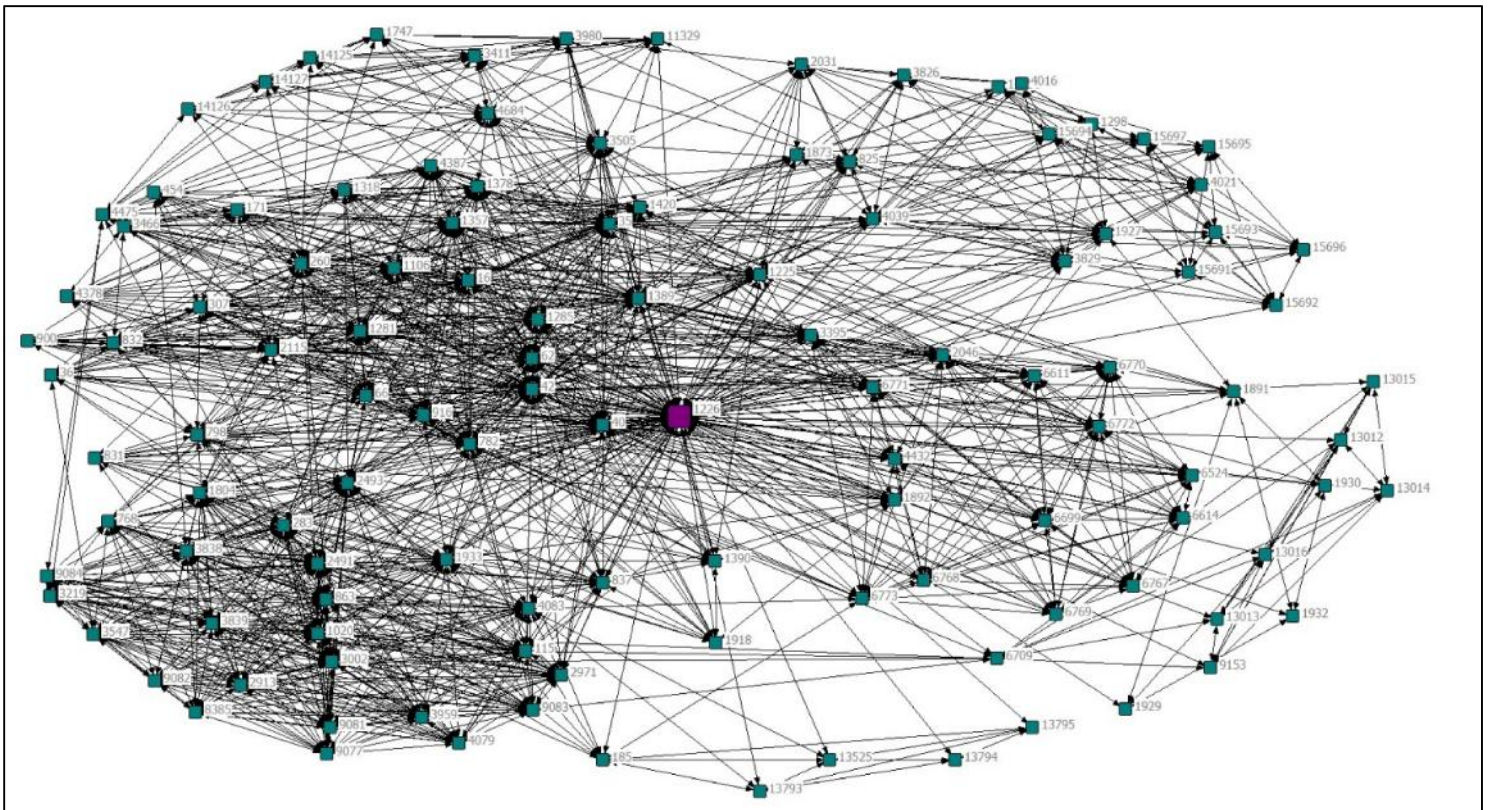


Figure 8.14 Ego-network of [1226] Geoffrey, son of Richard, of Inverkunglas, sheriff



The second idea that Granovetter gives us is that while all alters appear the same in our binary ego-networks, we need to add attributes and make them valued networks to give us a sense that some alters are strong ties and others are weak ties. The easiest way of doing this is to ask simply who witnesses many times with ego, and who witnesses only once or twice. The following series of sociograms show the ego-network of [13] Earl Duncan (II) of Fife (d. 1204), at various threshold levels of co-witnessing.

Figure 8.15. Ego-network of [13] Earl Duncan II of Fife (d. 1204)

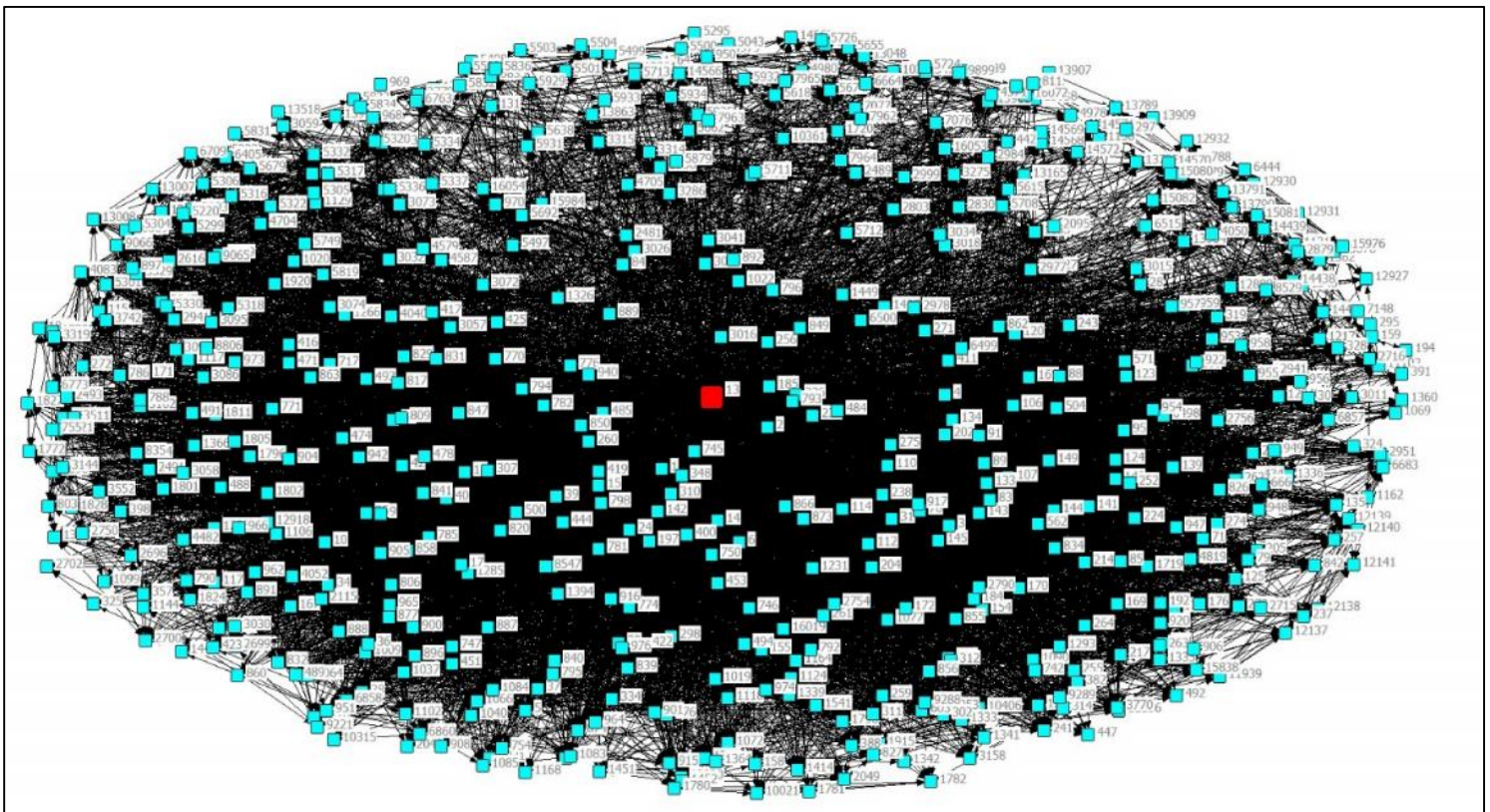


Figure 8.16. Ego-network of [13] Earl Duncan II of Fife (d. 1204), more than 5

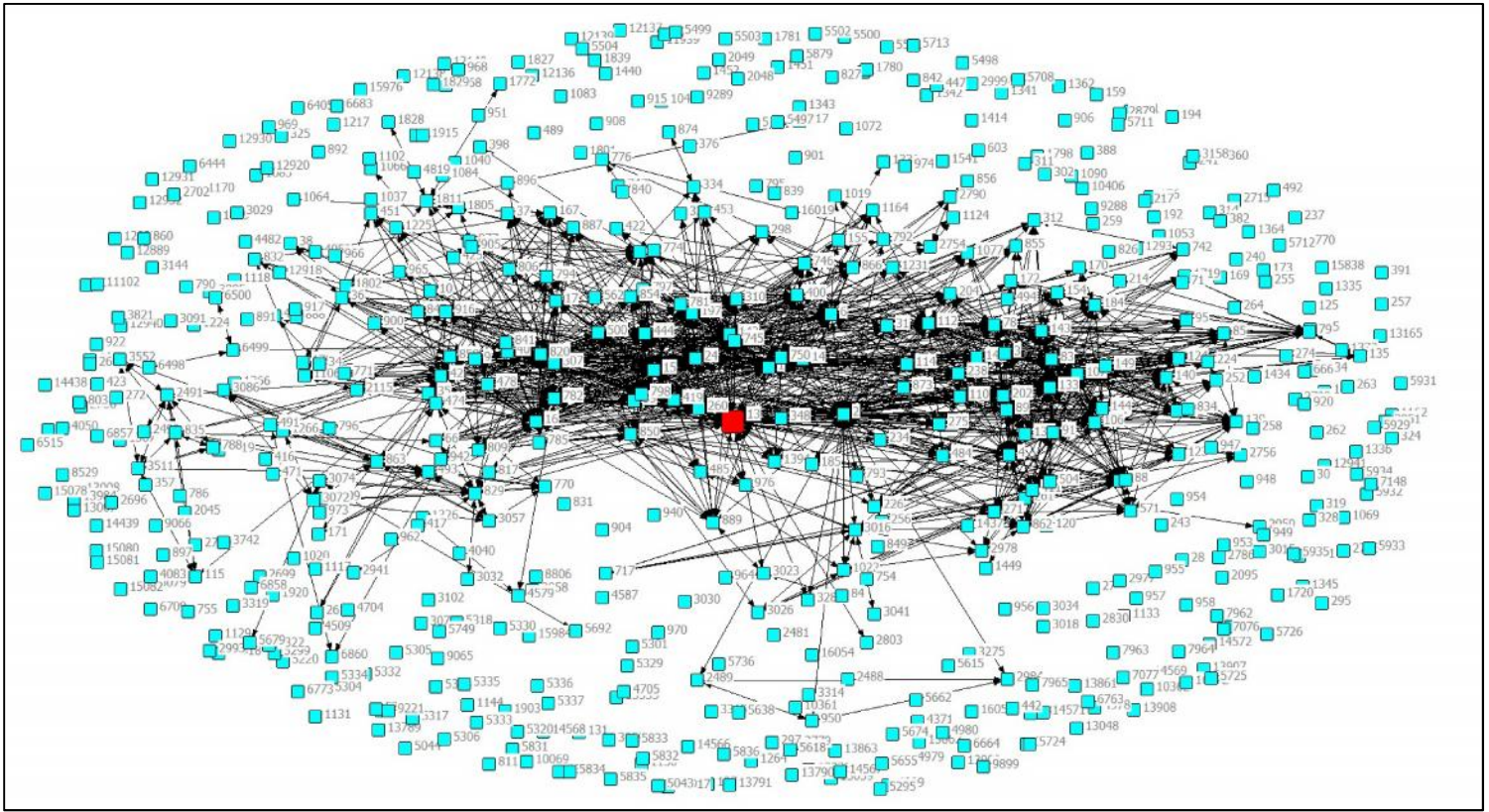


Figure 8.17. Ego-network of [13] Earl Duncan II of Fife (d. 1204), more than 10

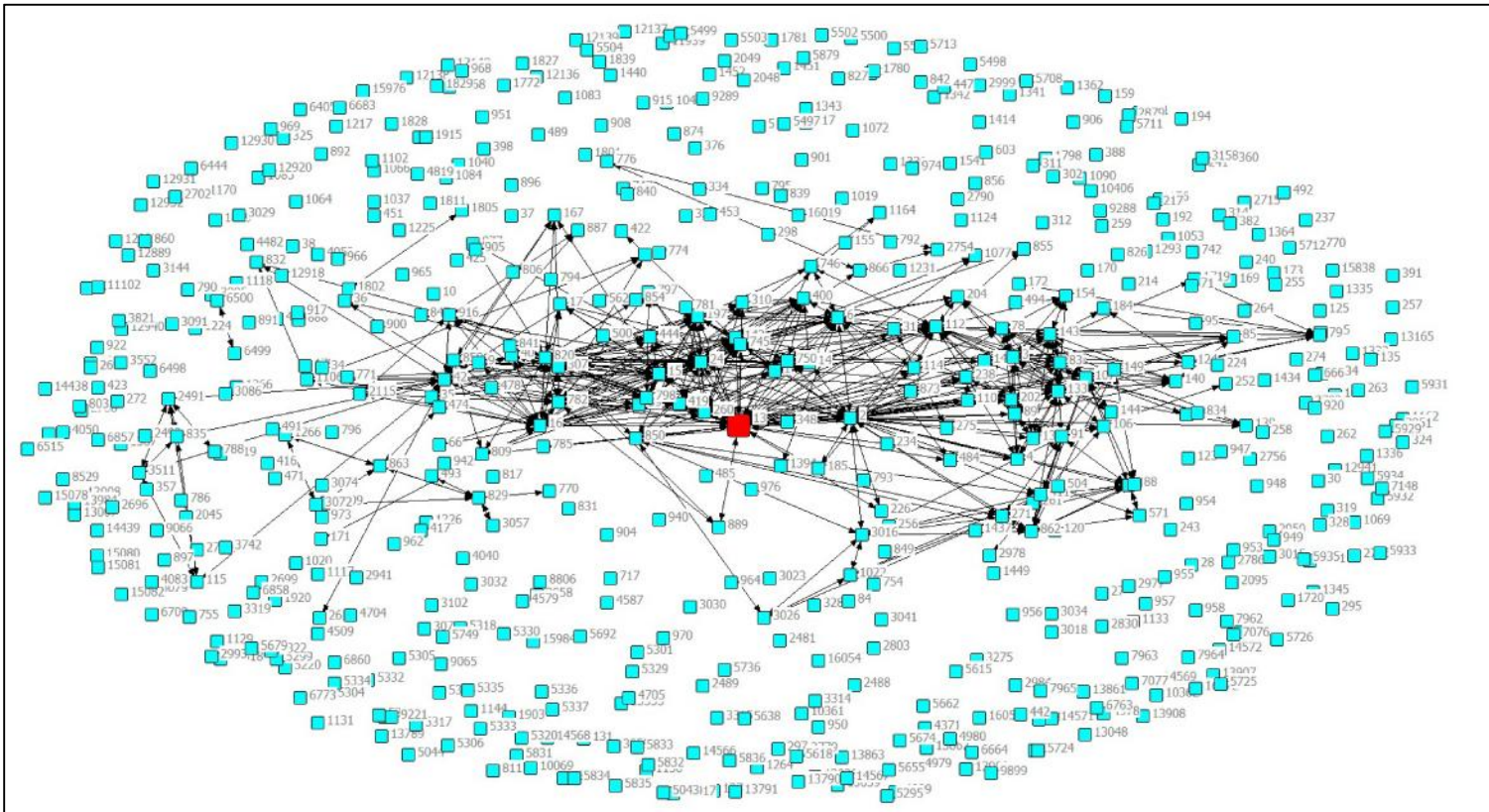


Figure 8.18. Ego-network of [13] Earl Duncan II of Fife (d. 1204), more than 20

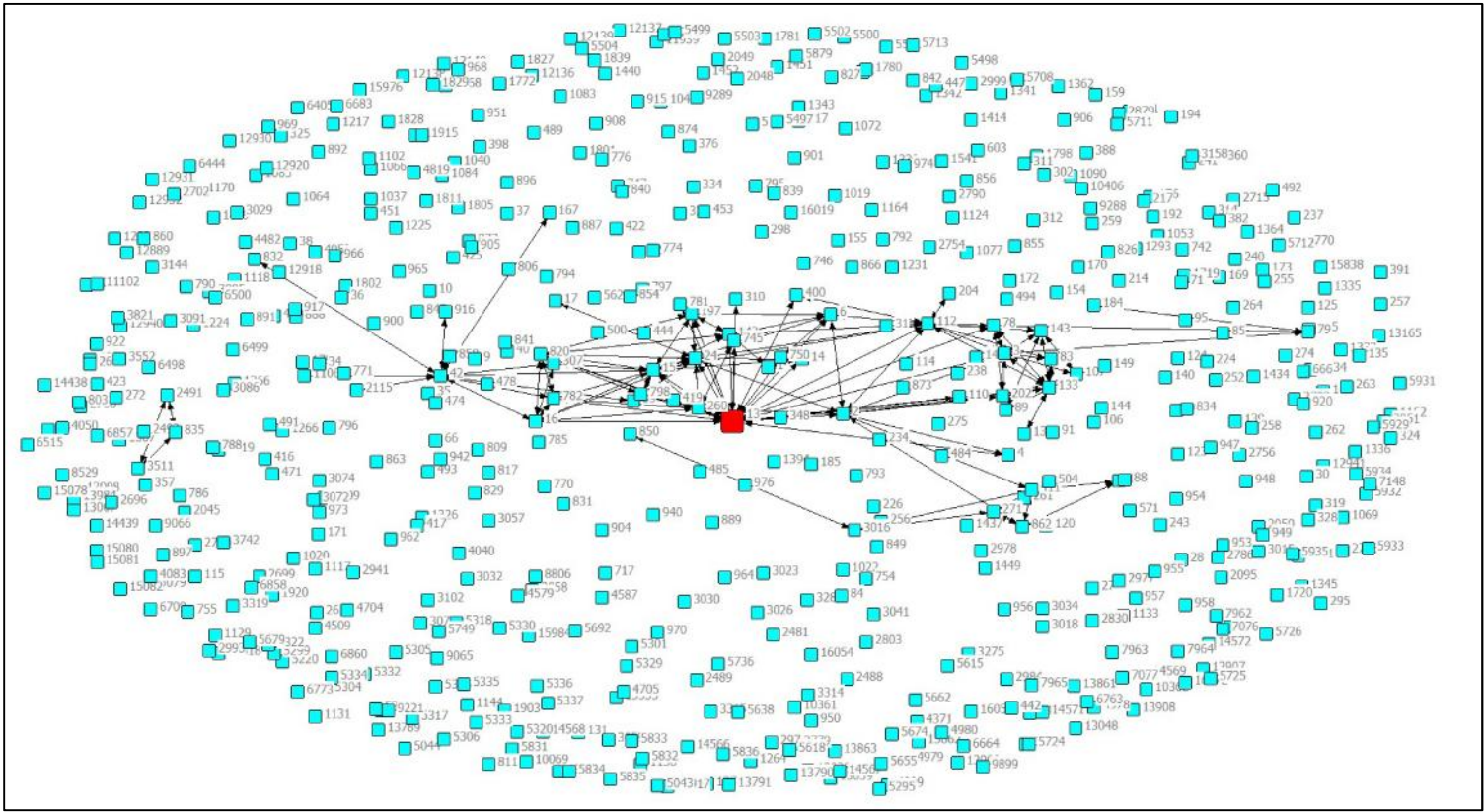


Figure 8.19. Ego-network of [13] Earl Duncan II of Fife (d. 1204), more than 30

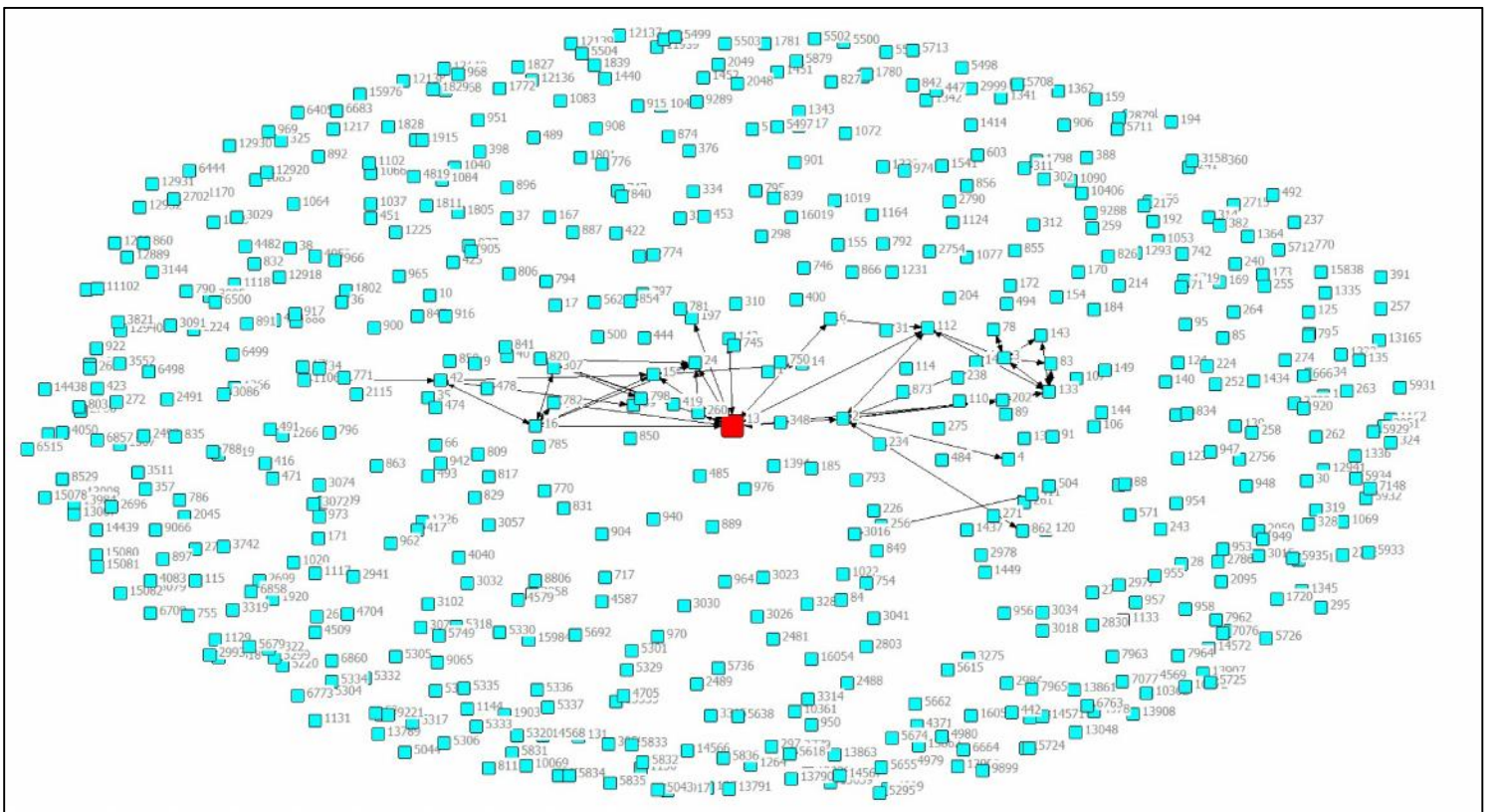
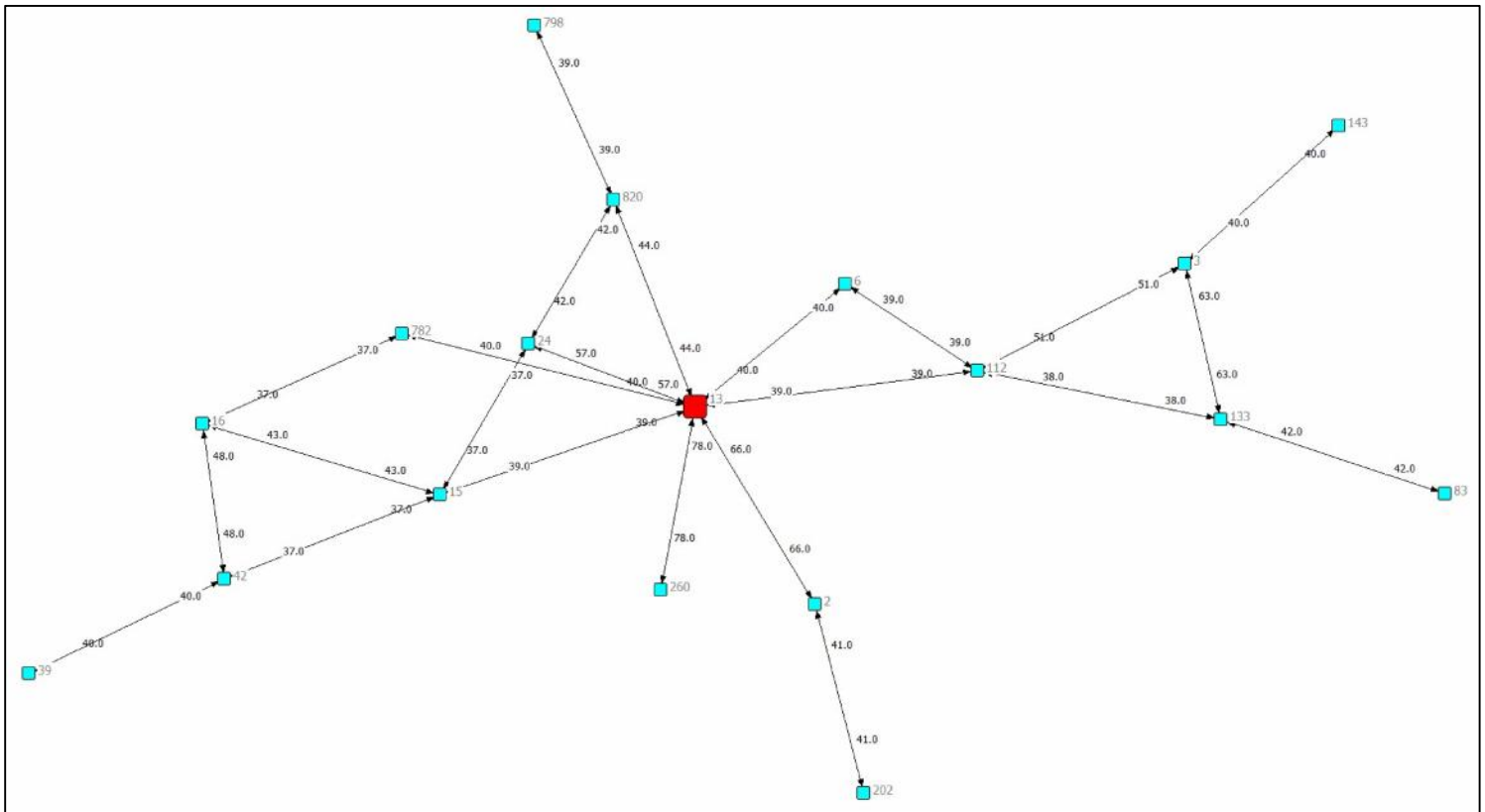


Figure 8.20. Ego-network of [13] Earl Duncan II of Fife, more than 35, with ties labelled



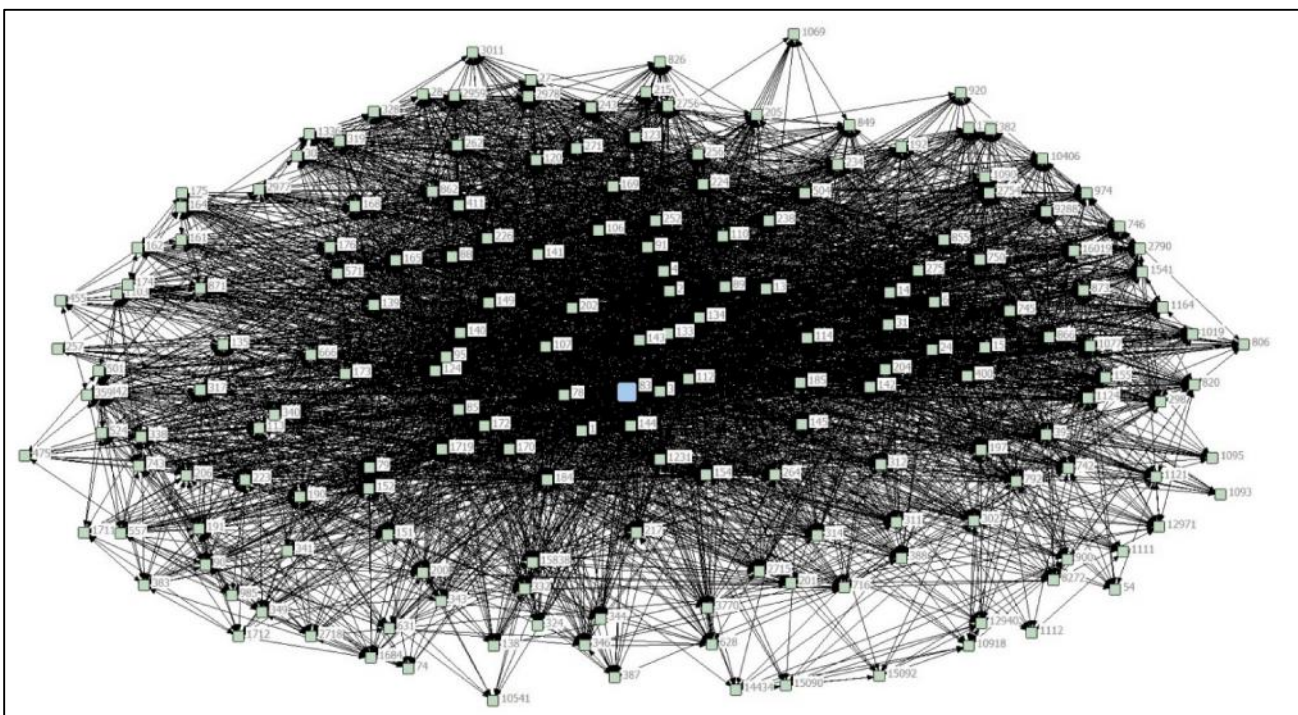
As the final sociogram in the series shows, Earl Duncan co-witnessed alongside eight people more than 35 times. The other people in the sociogram co-witnessed more than 35 times with each other but not as many times with Earl Duncan himself. The eight who witnessed the most with Earl Duncan were the following:

Table 8.9. Strongest ties of Earl Duncan (II) of Fife

Name	ID	# docs
Gilbert or Gilla Brigte, earl of Strathearn (d.1223)	260	78
Matthew, bishop of Aberdeen (d.1199)	2	66
William Hay (I), lord of Errol (d.c.1201)	24	57
Hugh of Roxburgh, bishop-elect of Glasgow (d.1199)	820	44
Walter Barclay, chamberlain (d.c.1193)	782	40
Malcolm (I), earl of Fife (d.1229)	6	40
Philip de Valognes, chamberlain (d.1215)	15	39
Richard de Moreville (d.1189 or 1190)	112	39

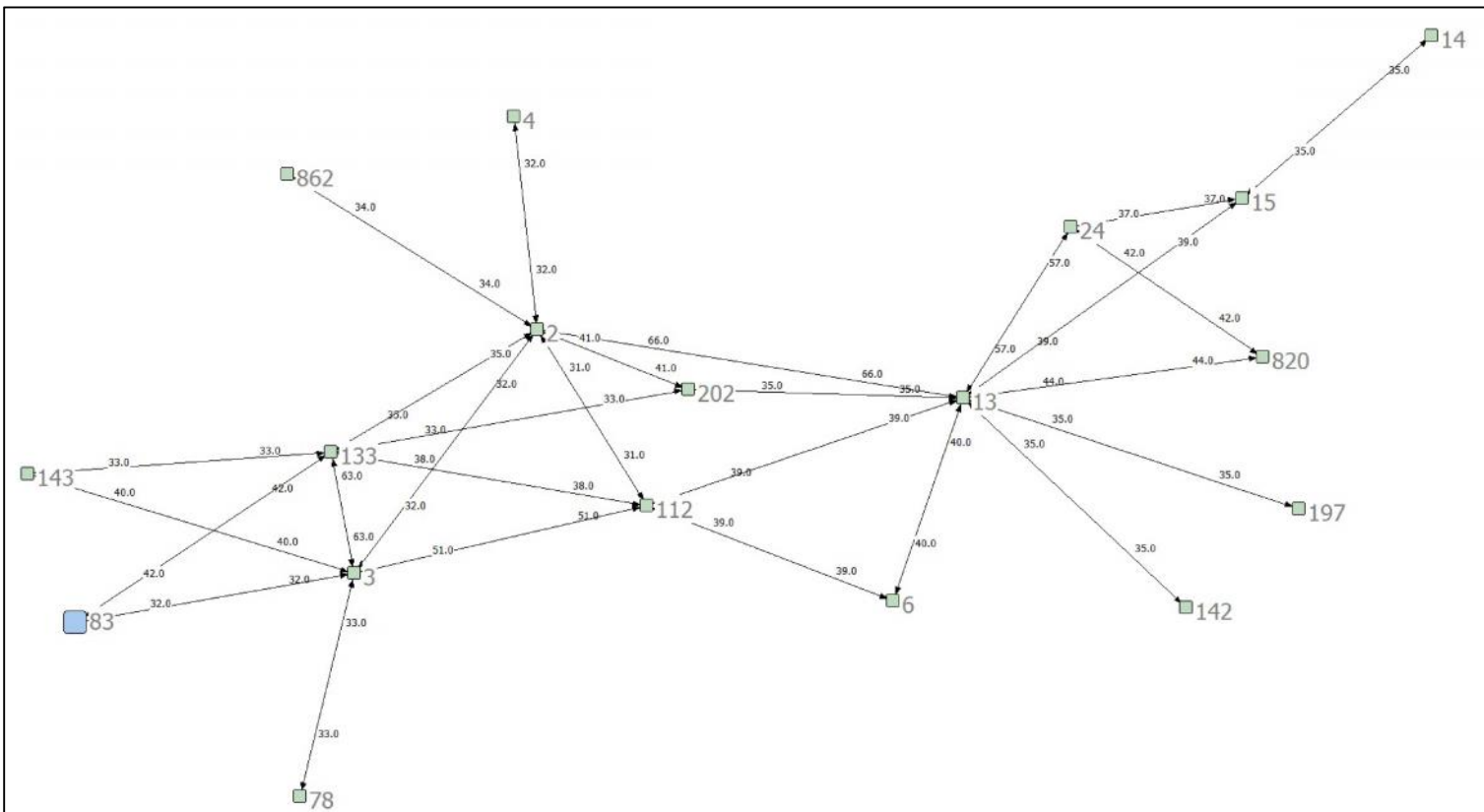
The above individuals are those with whom Earl Duncan had the strongest ties in the context of charter witnessing, and, given the high numbers of documents witnesses, most likely in life more generally. Of Earl Duncan's 585 contacts, 119 were people with whom he co-witnessed five or more times. These we might consider relatively strong ties. This means that 466 of Earl Duncan's contacts were people with whom he only co-witnessed four or fewer times. Indeed, he witnessed with 333 people only one time, and 82 people only two times. In theory, some of these weak tie co-witnesses could have acted as new sources of information and influence on Earl Duncan, while his closest contacts, like Earl Gilbert of Strathearn or William Hay of Errol, would have had less capacity for such influence. There is a paradox regarding the strength of weak ties, however, which is that research subsequent to Granovetter has shown that weak ties are much less important for actors who are already in a position of power, while weak ties provide opportunities for growth to those in a less advantageous position. Another somewhat paradoxical point is that Earl Duncan was himself in a position to be an 'opinion leader'. According to Kadushin, 'central individuals embedded in a system of strong ties not only have a high potential for transmitting ideas, but can also send messages to those who share those ideas or practices' (Kadushin, 145). So while the innovators who often introduce new ideas into a network are themselves less embedded, the influence makers and opinion leaders are, just like Earl Duncan, highly central (remembering Earl Duncan's paramount eigenvector centrality and very high betweenness in the whole graph) as well as deeply embedded.

Figure 8.21. Ego-network of [83] David Oliphant (12C)



[83] David Oliphant (12C) has a degree of 185, an ego-net density of 27.84, and witnessed 59 documents of the five specified types. As is visible in Figure 8.22, David's strongest ties, those he co-witnessed with the most, were the chancellor [133] Nicholas of Roxburgh (42 times) and the steward [3] Walter Stewart son of Alan (32 times). This is a reflection of the fact that David witnessed mostly royal charters, and these strong ties represent the security and trust involved in the dense world of the king's court. While David was part of this world, as the sociogram below shows, he was on its periphery. Moreover, 96 of David's contacts were people with whom he co-witnessed only once, and a further 24 were people with whom he witnessed only twice. While a detailed analysis of David's situation is beyond the remit of this book, it is among these weak ties that we would expect a man in David's situation to be able to make meaningful new contacts which might bring him new opportunities. In theory, weak tie alters should move in different circles. In David's case, the men at the royal court with whom he witnessed most often would be strong ties. Those who were less often at the king's court or were encountered in other social settings should be weak ties. These could be examined to identify the other circles in which they moved, by looking at who the strong ties were in their own ego-networks. This avenue of enquiry could be fruitful for the historian.

Figure 8.22. Ego-network of [83] David Oliphant (12C), more than 30, edges labelled



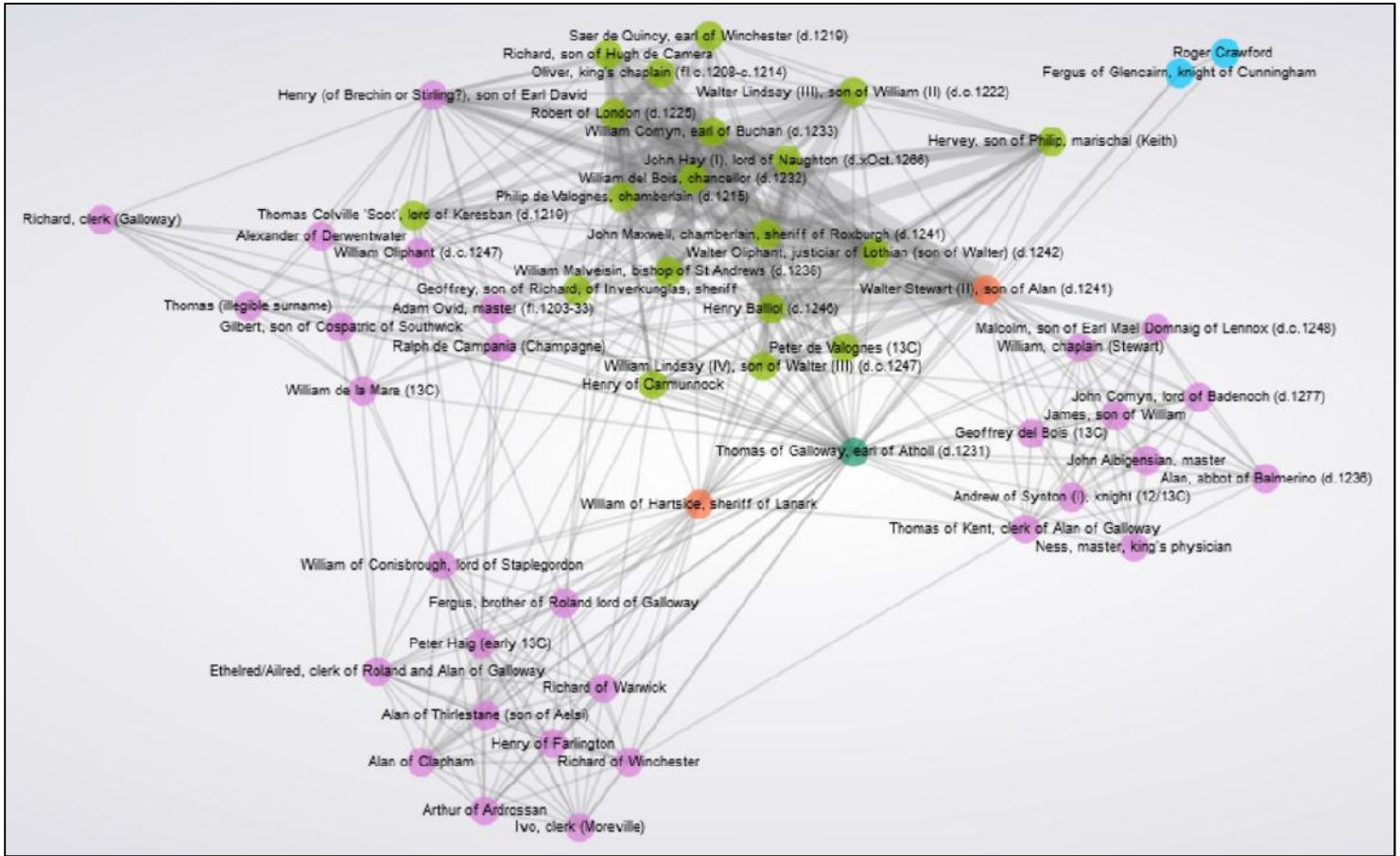
Finding the right mix

As should be clear from the above, there is no quick-and-easy shortcut for the historian wishing to find the most powerful or most influential actor in medieval society. Unfortunately, it is not as simple as asking who has the lowest density or highest efficiency. The social networks are never more than a reflection of the historical sources themselves, with all their inconsistencies in production, survival, and other factors. However, even with the best data possible, there is something of an art to analysing effectively ego-network data specifically and social network data more generally. As Brian Uzzi found in his study of New York City garment workers, embeddedness 'yields positive returns only up to a threshold point. Once the threshold is crossed, returns from embeddedness become negative... Optimal networks are not composed of either all embedded ties or all arms-length ties, but integrate the two'. (quoted in Kadushin, 68). Or, as Granovetter pointed out in 1973, a mixture of strong and weak ties can in some cases place ego in the best position (Crossley, 78).

One essential element to any analysis is that scholars always keep in mind the historical sources. The SNA data will largely reflect the variety and number of different social contexts reflected in the charters. While the situation is somewhat more nuanced than this, one relatively simple approach is to ask whether the actors appeared as witnesses in royal charters, or the charters of church prelates, lay magnates, or in the settlement of disputes. Because the H-number system used in the PoMS database employs these four basic categories, we can add as an attribute to the dataset whether witnesses appeared in only one of these contexts or in more than one. Witnesses who appeared in more than one context should be explored for potential as brokers or conduits.

Figures 8.23 through 8.26 show a Gephi sociogram of the ego-network of Thomas of Galloway, earl of Atholl (d. 1231), with his contacts colour-coded to reflect the document categories. It is also possible to highlight the nature of the links between actors with colour-coded edges or ties. Figure 8.24 shows how he co-witnessed in contexts which were royal, private, and settlement-related. Figures 8.25 and 8.26 show the connections of William of Hartside, sheriff of Lanark, and Walter Stewart (II), showing how they also witnessed across various contexts.

Figure 8.23. Ego-network of Thomas of Galloway, earl of Atholl (d. 1231)



Royal (H1) = green

Private (H3) = pink

Settlements (H4) = blue

Combination = peach

Figure 8.24. Ego-network of Thomas of Galloway, earl of Atholl (d. 1231)

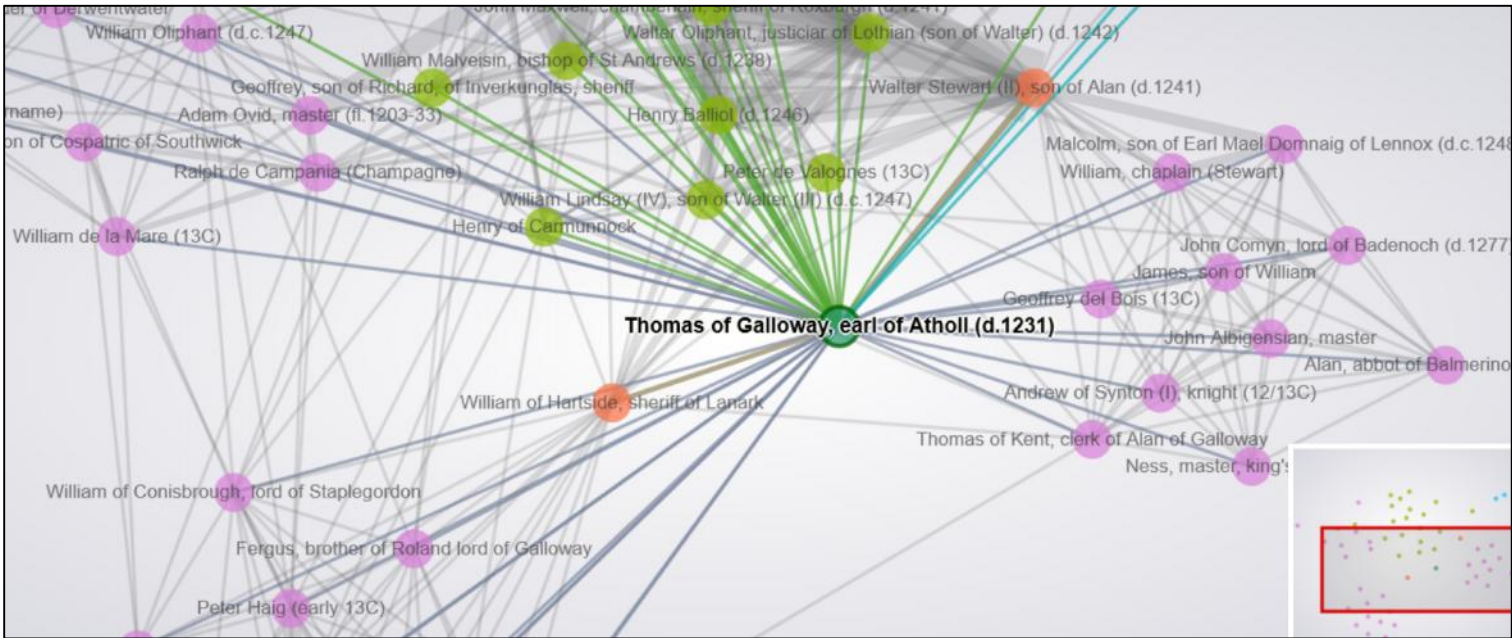


Figure 8.25. Ego-network of Thomas of Galloway, connections of William of Hartside

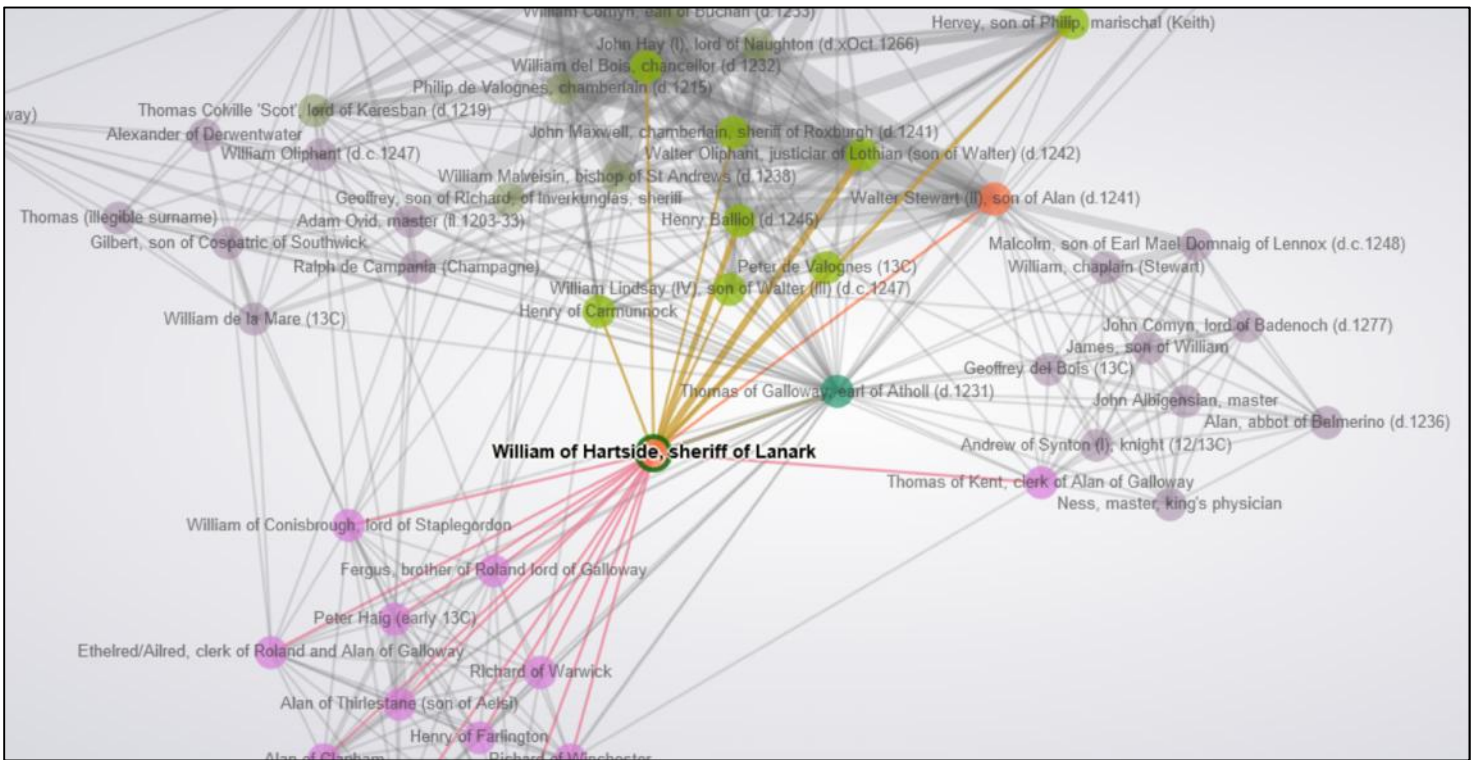


Figure 8.26. Ego-network of Thomas of Galloway, connections of Walter Stewart (II)

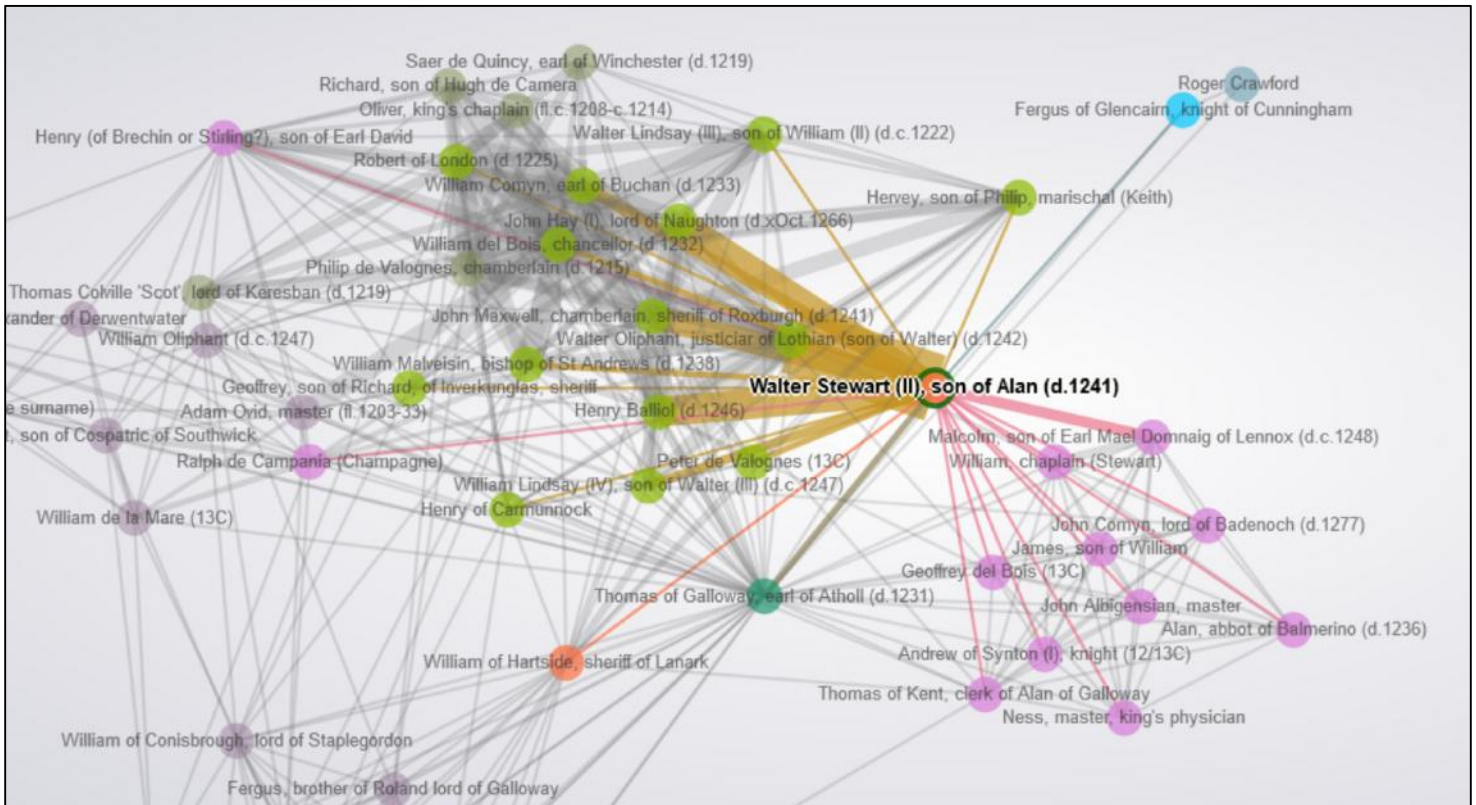


Table 8.10, which gives the 100 lowest density ego-networks of individuals with 100 contacts or more in the whole-network study of five specified document types in the PoMS database. The densities range from 7.99 up to 16.48, and there is a great variety of actors represented. In addition to the density and size, the table gives the number of documents (of the five specified types) witnessed by ego. This ranges from 202 on the upper end down to as low as 14. The final column tells us how many of these documents were non-royal. This is a quick shorthand to getting a feel for the social contexts in which the ego operated. Figures of 90% and above have been highlighted, but what we are really trying to separate out are the actors who operated in a very homogenous social context, versus those who operated in a range of social contexts. The same reservations could be made about those players who witnessed almost exclusively royal documents, such as Walter Stewart (9% non-royal), although more of these people have somewhat higher densities. Actors with very low densities with 90-100% non-royal witnessing probably offer historians less fruitful opportunities for further exploration. It is noteworthy that many of the actors identified elsewhere in this book as key figures tend to witness about 25-50% royal documents. The presence at the royal court suggests they were important on a 'national' level, but the critical mass of non-royal settings suggest they were not cocooned in the king's

presence. Some of these individuals included Duncan (II), earl of Fife (28% non-royal), Walter Stewart (II), son of Alan (d.1241) (30%), Walter Oliphant, justiciar of Lothian (son of Walter) (d.1242) (26%), and Alexander Comyn, earl of Buchan (d.1289), justiciar (31%). It is also worth noting that most prominent bishops operate in the 60-80% range; see for example William Malveisin, bishop of St Andrews (d.1238) (61%), Jocelin, bishop of Glasgow (d.1199) (65%), Andrew Murray, bishop of Moray (d.1242) (67%), Gamelin, bishop of St Andrews (d.1271) (67%), and David of Bernham, bishop of St Andrews (d.1253) (78%). While this table offers a good place to start, it is really necessary to consider the four categories of documents used in the Gephi sociograms above, and then to dig deeper within those categories to identify and define specific social contexts.

Table 8.10. The 100 lowest densities

Rank	Name	PoMS ID	Density	Size	# docs	% non-royal
1	Adam of Makerstoun, master, provost (d.1280×86)	3350	7.99	155	28	100%
2	William del Bois, chancellor (d.1232)	42	8.04	476	202	40%
3	Duncan (II) earl of Fife (d. 1204)	13	8.4	585	202	28%
4	Robert Mowat, knight, justiciar, sheriff of Forfar	2190	9.43	153	40	80%
5	Henry, archdeacon of Dunkeld (fl.1183×1203-1220×25)	2762	9.69	175	26	100%
6	John Cameron, sheriff of Perth	5364	9.76	136	21	90%
7	John, abbot of Lindores (fl.1219-44)	43	10.05	159	23	92%
8	Andrew Murray, bishop of Moray (d.1242)	788	10.17	273	46	67%
9	William, son of Earl Patrick (I) (d.1253)	4427	10.29	140	28	93%
10	Walter Stewart (II), son of Alan (d.1241)	1378	10.3	253	101	30%
11	Matthew, bishop of Aberdeen (d.1199)	2	10.4	473	152	45%
12	Walter of St Albans, bishop of Glasgow (d.1232)	858	10.58	380	66	53%
13	Gilbert Hay (I), lord of Errol (d.1263) (son of David)	2067	10.7	137	29	24%
14	Thomas Crook, knight	3432	10.79	110	18	100%
15	William Malveisin, bishop of St Andrews (d.1238)	40	10.82	379	67	61%
16	Bernard of Hadden, sheriff of Roxburgh	880	10.88	226	24	54%
17	John Maxwell, chamberlain, sheriff of Roxburgh (d.1241)	1281	10.89	277	98	32%
18	Laurence of Thornton, archdeacon of St Andrews (d.1238×40)	835	10.99	233	61	100%
19	Alan of Harcarse, knight	5954	11.05	121	17	100%
20	Walter Oliphant, justiciar of Lothian (son of Walter) (d.1242)	1285	11.14	327	123	26%
21	Walter de Mortimer, dean of Glasgow (d.1270×71)	2044	11.38	109	33	100%
22	Malcolm (I), earl of Fife (d.1229)	782	11.54	377	103	35%
23	John of Huntingdon, master, official of Glasgow (fl.1179×1208)	776	11.62	251	35	97%

24	Alexander Comyn, earl of Buchan (d.1289), justiciar	1981	11.71	170	45	31%
25	John Hay (I), lord of Naughton (d.×Oct.1266)	1389	11.83	234	66	39%
26	Gamelin, bishop of St Andrews (d.1271)	456	11.9	143	18	67%
27	William of Ednam, master, archdeacon of Dunkeld (d.1251×57)	1969	11.97	181	29	100%
28	Henry of Stirling, son of Earl David	64	11.98	191	49	49%
29	Jocelin, bishop of Glasgow (d.1199)	745	12.06	356	77	65%
30	Walter Lindsay (III), son of William (II) (d.c.1222)	2115	12.11	293	62	63%
31	Luke, chaplain of Paisley	5071	12.23	148	19	100%
32	William of Greenlaw, master (d.1247)	768	12.29	164	26	100%
33	Philip Melville, justiciar of Scotia	1233	12.33	150	24	75%
34	David of Lochore, knight	2225	12.34	128	23	83%
35	Hugh, king's chaplain and clerk (episcopal witness)	2497	12.5	132	26	100%
36	Patrick (I), earl of Dunbar (d.1232)	444	12.56	343	73	52%
37	Adam, steward of Arbroath (son of Aldan)	4757	12.58	133	22	100%
38	Thomas Randolph (d.c.1296)	2139	12.66	132	23	56%
39	Simon, archdeacon of Glasgow (fl.1165×74-1195×96)	866	12.69	286	55	89%
40	Ralph de Lascelles, knight	5808	12.74	106	17	100%
41	William Francis (the Frenchman)	5226	12.75	140	14	100%
42	Patrick (II), earl of Dunbar (d.1248)	445	12.76	260	63	59%
43	Roger de Merlay (II) (d.c.1239), steward of Earl Patrick	5781	12.81	166	31	100%
44	William of Brechin, knight	2110	12.92	138	27	56%
45	Edward Murray, master, canon, bishop's clerk	3871	12.93	161	42	100%
46	David, earl of Huntingdon (d. 1219)	142	13.12	409	100	23%
47	Gregory, bishop of Brechin (fl.1189×98-1242×46)	59	13.13	135	34	100%
48	Alan of Thirlestane (son of Aelsi)	6499	13.19	172	21	100%
49	John Scott, bishop of Dunkeld (d.1203)	850	13.34	337	67	84%
50	Philip de Valognes, chamberlain (d.1215)	15	13.57	363	166	13%
51	Simon Fraser (d.1291×92)	1810	13.71	102	32	50%
52	Gilbert, earl of Strathearn (d. 1223)	260	13.81	354	97	30%
53	Alan Durward (d.1275)	1971	13.95	145	43	30%
54	Bernard Fraser (in ELO and BWK) (brother of Ness and John of London)	11520	13.95	108	34	97%
55	John de Vaux, knight (fl.1213-55)	2081	14	147	40	43%
56	Peter Ramsay, bishop of Aberdeen (d.1256)	2047	14.15	110	18	89%
57	Robert Menzies (d.1267)	2065	14.19	151	44	32%
58	Patrick (III), earl of Dunbar (d.1289)	446	14.25	102	21	43%
59	Thomas de Normanville, knight	2328	14.55	113	19	74%
60	Andrew, archdeacon of Lothian (fl.1147×59-1178×84)	411	14.58	257	62	97%
61	David Graham, lord of Lovat (d.c.1272)	2005	14.71	133	23	87%
62	William Comyn, earl of Buchan (d.1233)	16	14.8	318	145	12%
63	Gilbert, archdeacon of Dunblane (fl.1203×10-1235×39)	466	14.83	115	28	100%
64	John of Stirling, knight, sheriff of Stirling	1228	14.95	118	25	64%
65	Walter son of Alan, steward (d. 1177)	3	14.96	314	124	9%
66	Elias of Partick, clerk, canon (son of Fulbert)	926	14.98	186	29	100%

67	Herbert, dean of Glasgow (fl.1179×89-1204×07)	481	15	207	32	100%
68	David Hay, lord of Errol (d.1237×41)	66	15.02	256	44	57%
69	William, earl of Mar (d.a.1281)	2041	15.06	130	38	29%
70	Peter Haig (early 13C)	6500	15.13	128	15	100%
71	Peter, chaplain and clerk of Bishop Malveisin	2971	15.16	178	40	100%
72	Ralph de Campania (Champagne)	3793	15.22	130	20	45%
73	Malcolm Lockhart (12C/13C)	4625	15.25	141	16	94%
74	Walter Stewart, earl of Menteith (d.c.1293)	2151	15.25	113	16	69%
75	Duncan, son of Earl Duncan (II) of Fife	1326	15.26	182	16	94%
76	Stephen of Lilliesleaf, master, clerk, persona	2491	15.3	179	40	100%
77	Geoffrey de Liberatione, bishop of Dunkeld (d.1249)	2039	15.3	156	34	38%
78	Richard Nanus (le Nain)	6060	15.32	165	26	100%
79	Richard de Prebenda, bishop of Dunkeld (d.1210)	798	15.39	347	82	29%
80	Freskin Douglas, dean of Moray (d.1226)	3761	15.45	106	21	100%
81	Alan, son of Cospatric of Swinton	1287	15.5	236	76	100%
82	Alexander, chaplain of bishops of St Andrews (12C)	3016	15.52	211	61	98%
83	Ranulf de Wat, archdeacon of St Andrews (d.1209)	829	15.55	277	45	100%
84	Walter Comyn, earl of Menteith (d.1258)	1357	15.55	209	94	13%
85	Aulay, brother of Earl Mael Domnaig of Lennox	4570	15.58	113	24	100%
86	Hugh de Sigillo, bishop of Dunkeld (d.1229 or 1230)	39	15.68	303	71	42%
87	William Lindsay (IV), son of Walter (III) (d.c.1247)	4425	15.68	167	51	51%
88	Ralph, king's chaplain (TRA2)	3576	15.74	124	31	55%
89	Reginald Crawford, sheriff of Ayr (early 13C)	1254	15.8	119	20	75%
90	Andrew, dean of Lothian/Tynninghame (fl.1194-1214)	414	15.89	182	19	100%
91	Hugh Barclay, justiciar of Lothian	2104	15.9	105	21	52%
92	Robert, archdeacon of Glasgow (d.1222)	797	15.97	233	52	44%
93	Robert Crook, knight (12C)	16019	16.03	187	20	95%
94	Malcolm Beg, son of Gillespie Galbraith	6172	16.21	121	21	100%
95	Aymer Maxwell (d.1266)	2091	16.28	117	23	39%
96	William of Hownam, son of John, son of Orm (d.1227)	933	16.4	137	20	95%
97	Henry, son of Geoffrey de Liberatione of Perth	5330	16.42	151	17	100%
98	John of Leicester, bishop of Dunkeld (d.1214)	493	16.43	241	30	100%
99	Aiulf, dean of Lothian (fl.1150/51-1186)	165	16.44	238	49	96%
100	David of Bernham, bishop of St Andrews (d.1253)	432	16.48	125	27	78%

References

- Borgatti Stephen P., Martin G. Everett, and Jeffrey C. Johnson (2013), *Analyzing Social Networks* London
- Burt, Ronald S. (2005), *Brokerage and Closure. An Introduction to Social Capital*. Oxford
- Crossley, Nick, et al. (2015), *Social Network Analysis for Ego-Nets*. London
- Granovetter, Mark S. (1973), 'The Strength of Weak Ties', *American Journal of Sociology*, 78, pp. 1360-1380.
- Granovetter, Mark S. (1983), 'The Strength of Weak Ties: A Network Theory Revisited', *Sociological Theory*, 1, pp. 201-233.
- Kadushin, Charles (2012), *Understanding Social Networks: Theories, Concepts, and Findings*. Oxford
- Pescosolido, Bernice (2007), 'The Sociology of Social Networks', in *21st Century Sociology: A Reference Handbook*, ed. C.D. Bryant and D.L. Peck. London.
- Prell, Christina (2012), *Social Network Analysis: history, theory and methodology*. London.
- Scott, John (2000), *Social Network Analysis: A Handbook*. Second edition. London.
- Small, Mario Luis (2013), 'Weak ties and the core discussion network: Why people regularly discuss important matters with unimportant alters', *Social Networks* 35, pp. 470-83.