# Establishing the Search Area

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## Introduction

Search Management is not one single entity, but a whole series of interlocking components. The analogy which we use is that of a jigsaw puzzle - if the pieces are used correctly then the entire picture will emerge, and if not then it will be deficient in some way. Similarly, if we can improve the quality of one of the pieces then the overall picture will be enhanced. For this reason, we feel that it is important that each of the component pieces is reviewed at regular intervals in order to maintain a sharp focus.

One way in which we recognise that pieces of the jigsaw puzzle are due for review is from the feedback we get from teaching Search Management courses. From these, it appears to us that the process of establishing the Search Area, and in particular the way in which Lost Person Statistics for distances travelled are used for this, would possibly benefit from being looked at again.

## Current methodology

Current practice, as exemplified by the NASAR instruction text Managing the Lost Person Incident (ref. no.) and the ERI instruction text Search is an Emergency (ref. no.), is to give the following information for a number of different categories of lost person:

a. **the median distance**, and

b. **probability zones around the median** distance, commonly referred to as "donuts". These zones are ranges of distances which contain some stated percentage of the available data which lies around the median for that category. The NASAR text uses data from Nova Scotia collected by Hill and gives the 50% and maximum zones (Table 1), while the ERI text uses data collected by Syrotuck and gives the 25%, 50% and 75% zones as well as a zone of around 90%, called the maximum range, which presumably excludes extreme values (Table 2). In addition, the Syrotuck data distinguishes between hilly terrain and flat terrain - the data shown in Table 2 is for flat terrain only.

The NASAR text uses data from Nova Scotia collected by Hill and gives the 50% and maximum zones (Table 1), while the ERI text uses data collected by Syrotuck and gives the 25%, 50% and 75% zones as well as a zone of around 90%, called the maximum range, which presumably excludes extreme values (Table 2). In addition, the Syrotuck data distinguishes between hilly terrain and flat terrain – the data shown in Table 2 is for flat terrain only.

The distances used in these tables are the straight-line distances from some starting point (generally known as the Initial Planning Point IPP, which could be either a Point Last Seen PLS or a Last Known Point LKP) to the point at which the person was located. Throughout this paper all distances are given in miles.

**Table 1:** Median Distances Travelled and 50% Probability Zones for nine categories of Lost Person in Nova Scotia, Hill (1994)

| **Category** | **median** | **50% zone** | **max zone** | **no. of cases** |
|---|---|---|---|---|
| Hunters | 1.52 | 0.98 to 2.38 | 0.14 to 12.00 | 100 |
| Fishermen | 0.89 | 0.59 to 2.17 | 0.31 to 11.00 | 25 |
| Hikers | 1.63 | 0.89 to 2.88 | 0.37 to 14.91 | 24 |
| Misc. adults | 1.27 | 0.75 to 2.24 | 0.06 to 11.81 | 26 |
| Youth 13-15 | 1.12 | 0.62 to 1.78 | 0.25 to 4.35 | 20 |
| Child 7-12 | 1.30 | 0.99 to 1.70 | 0.59 to 4.97 | 8 |
| Child 1-6 | 0.50 | 0.42 to 0.75 | 0.25 to 1.65 | 11 |
| Despondents | 0.64 | 0.47 to 1.12 | 0.06 to 3.50 | 16 |
| Walkaways | 0.62 | 0.34 to 1.19 | 0.09 to 3.00 | 22 |

Reproduced from Managing the Lost Person Incident, by kind permission of Ken Hill.

**Table 2:** Probability Zones (miles from IPP), flat terrain, Syrotuck (1977)

| Category | median | 25% zone | 50% zone | 75% zone | max zone |
|---|---|---|---|---|---|
| Child 1-6 | 1.2 | 1.0 to 1.6 | 0.6 to 1.7 | 0.5 to 2.1 | 0 to 2.2 (92%) |
| Children | 1.2 | 0.8 to 1.2 | 0.7 to 2.0 | 0.2 to 2.2 | 0 to 3.0 (92%) |
| Elderly | 1.0 | 0.8 to 1.0 | 0.7 to 1.2 | 0.1 to 1.3 | 0 to 3.0 (93%) |
| Hikers | 2.0 | 1.4 to 2.4 | 1.0 to 3.2 | 0.2 to 3.3 | 0 to 4.0 (94%) |
| hunters | 1.6 | 1.0 to 1.6 | 0.9 to 2.2 | 0.1 to 2.3 | 0 to 3.0 (89%) |
| misc, | 1.6 | 1.1 to 1.6 | 0.5 to 1.8 | 0.1 to 2.8 4 | 0 to .0 (89%) |

Reproduced from Search is an Emergency, by kind permission of ERI.

How similar are these tables? A full comparison is not possible because of category differences, but both tables have the categories children 1-6, hikers and hunters in common so some comparison is possible. Of these, the data for hunters is remarkably similar, that for hikers is less so and that for children 1-6 shows little in common at all.

It is interesting to note that this reflects exactly the number of cases which were analysed by Hill, with by far and away the greatest number of these three being for hunters (the number of cases in each category of the Syrotuck data is not known), with fewer observations in the hikers category and far fewer in the category children 1-6. This leads to the interesting and quite separate question, which is not addressed here, as to whether or not we would expect there to be any similarities between two sets of data collected in different places at different times.

**Practical problems**

If you do not have access to data like this which has been collected and analysed for your own area then the first problem to be overcome is that of which of the two tables you should use. Syrotuck's table has data for three zones whereas Hill's has one, and gives data for two types of terrain but without any clear indication as to what constitutes hilly terrain as opposed to flat terrain.

Hill's table, on the other hand, is for one specified terrain type ("generally level, with occasional low hills, dense forest, and numerous streams and rivers") and has more tightly specified categories. For our purposes we use flat terrain data, and opt for Hill's table because the categories are more watertight.

The generally held belief is the idea that the median is the important statistic in all this because "missing persons tend to cluster round the median", as though it was some kind of beacon which attracted them like moths.

> *"According to the laws of probability, more lost subjects will be found closer to the median distance than any other point."*
>
> LaValla, Stoffel and Jones (1995), page 121

We would question this for two reasons:

1. We have not seen any real hard evidence to suggest that missing persons are in fact found at distances which tend to cluster round the median. The typical shape of the graph of the distribution of distances from IPP at which persons are located will show that a large proportion are found within a relatively short distance but that there are some who are found at distances much greater than that - the distribution is positively skewed, in other words. The median value is likely to occur in the lump of values relatively close to IPP, but that is not the same as saying that the distances cluster around it.

2. There is a danger that if you are really convinced that that is the case then the median circle will drive everything from then on once you have drawn it on the map. This means that the area around the IPP will tend to be forgotten about, and scenarios which are perfectly sensible either ignored or adjusted to land the missing person conveniently on the median circle somewhere. This can also happen if donuts are drawn on the map.

**Clustering about the median**

A formal test for clustering would necessitate looking at the actual data items; these are not available to us. A simple test would involve taking a slice of some particular width through the distribution so that it straddles the median and counting how many data points it contains. If we were to take other slices of the same width from any other place in the distribution then if there is clustering taking place they should contain fewer data items.

Another way of expressing that is to say that if we take a slice corresponding to the 25% zone around the median, slices of similar width from anywhere else would contain less than 25% of the data items if there was clustering. An extension of that idea would be to say that if you double the width of the 25% zone then that should be significantly narrower than the width of the 50% zone around the median, and three times the 25% zonewidth should be a lot less than the 75% zonewidth.

We can test that hypothesis with Syrotuck's data because his table gives us 25%, 50% and 75% zones; the results of this are shown in Table 3. In Table 3, 'zonewidth' means the width of a probability zone in miles from Table 2, '2x25%' and '3x'25% mean two times and three times the width of Syrotuck's 25% zone respectively. If clustering towards the middle is taking place then we would expect the column headed '3x25%' to be a lot less than the 75% zonewidth, and we would expect the column headed '2x25%' to be quite a bit less than the 50% zonewidth.

**Table 3:** Simple clustering test for Syrotuck's zones

| **Category** | **25%** | **2x25% zonewidth** | **50% zonewidth** | **3x25% zonewidth** | **75%** |
|---|---|---|---|---|---|
| child 1-6 | 0.6 | 1.2 | 1 | 1.8 | 1.6 |
| child | 0.4 | 0.8 | 1.3 | 1.2 | 2.0 |
| elderly | 0.2 | 0.4 | 0.5 | 0.6 | 1.2 |
| hikers | 1.0 | 2.0 | 2.2 | 3.0 | 3.1 |
| hunters | 0.6 | 1.2 | 1.3 | 1.8 | 2.2 |
| misc | 0.5 | 1.0 | 1.3 | 1.5 | 2.7 |

Comparing the 75% zonewidth with the '3x25%' value shows that the categories child, elderly, miscellaneous and to a lesser degree hunters show some kind of clustering towards the centre of the distribution. A comparison of the 50% zonewidth with the '2x25%' value shows that of these the category child appears to have significant clustering towards the centre, miscellaneous less so, while the categories elderly and hunters are not very convincing at all.

Of the other categories, hikers seems to show a fairly uniform spread of values, while child 1-6 exhibits some other form of behaviour altogether. Based on this admittedly non-thorough analysis it would seem to us that, based on Syrotuck's data, for categories other than 'child' the assumption that missing persons are found at distances from IPP which cluster about the median is a dangerous one to make.

Ken Hill has kindly made some of his raw data available to us, and a similar analysis of that gives the following results (Table 4); the distances are again in miles.

**Table 4:** Simple clustering test for Hill's data

| Category | 25% | 2x25% zonewidth | 50% zonewidth | 3x25% zonewidth | 75% |
|---|---|---|---|---|---|
| Hunters | 0.8 | 1.70 | 1.40 | 2.55 | 3.94 |

Table 4 shows that for the category hunters, for which Hill has analysed a large amount of data, there is some kind of clustering towards the middle of the distribution based on a comparison of the 3x25% value and the 75% zonewidth - as you would expect since the upper end of the 75% zonewidth takes you out into the tail of the distribution - but a comparison of the 50% zonewidth and the 2x25% value implies that although there is a concentration of values over a relatively short distance we would not use the expression "clustering about the median" to describe what appears to be going on.

**It would seem to us that the expression "clustering about the median" is being used in a way which is misleading to describe what is happening with lost person distance travelled data.**

Its use makes it sound as though something which is highly significant is going on which in fact is not, apart from in possibly one of Syrotuck's categories. What is happening is that distance travelled data tends to be positively skewed and therefore there appears to be some kind of collecting towards the middle.

This also raises the question as to exactly what do we mean when we talk about the 25%, 50% and 75% probability zones. Some people understand them to be in percentiles, so that for example the 50% zone is from the $26^{th}$ to the $75^{th}$ percentile. The alternative meaning, which makes more sense, is that the 25% zone consisted of that 25% of the distances which were closest to the median.

It is not difficult to visualise an example in which, because of the skewed nature of the distribution, values from the $70^{th}$ to the $75^{th}$ percentile are further from the median than are values from the $21^{st}$ to $26^{th}$, and so the latter would be included in the zone containing the 50% of terms closest to the median rather than the former. The resulting 50% zone would be considerably narrower, and would be of greater significance for people who want to draw it on a map.

**Probability Density and Probability Zones**

As was mentioned in the previous section, drawing the median circle and probability donuts on the map can lead to the assumption that that is where you go and search. But what about the area between the IPP and the inner circle of the donut?

Much of what we will be touching on here has been discussed elsewhere (Managing the Lost Person Incident, page 174). We would agree with the sentiments expressed there, in particular the notion that " *… the task (of deciding where to allocate search resources) is not as simple as putting circles on maps".*

Having said that though we feel that there is some mileage in exploring the possibilities offered to us by these circles; they may add to our overall understanding of the problem and hopefully help us to see what might be the best way forward. In particular, we feel that it will add to the notion that *"… search planners should use all of the information available to them in order to increase the efficiency of search efforts …"* (page 175).

The use of probability donuts in establishing the search area has become a well established practice and the concept is used in teaching courses for Search Managers. The text 'Search is an Emergency', LaValla, Stoffel and Jones (1995) explains their use:-

> *"Wartes (1983) uses the term "probability density" to describe the probability that the lost person is in a defined area divided by the size of that area. As search mangers, we are looking for the area with the greatest probability density to use as a tool in establishing our search area.*
>
> *If the distribution of finds from our case histories was uniform we would have just as much chance of finding the subject inside the circle bounded by the median distance as we would of finding the subject in the 50% annular ring (band) within which 25% of the finds were just inside the median distance and the other 25% of the finds were just outside it.*
>
> *If we calculated the areas of these two segments, we'd find that the circle has a smaller area than the annular ring. Therefore,* ***the probability density of the circle is higher than that of the annular ring.***
>
> ***However, if the frequency distribution of finds is not uniform (a more likely occurrence) and there tends to be clustering about the median distance, then the width of the 50% band becomes narrower. Therefore, the area typically may be smaller than that of a circle whose radius is equal to the median. Therefore, it will have a correspondingly higher probability density."*** Page 121 – our emphasis

**Let us put this to the test!** - we will look at the 50% probability zone, and see how it compares with the circle centred on the IPP with its radius equal to the median (referred to here as the median circle). In each case the PoA is 50% - the notion that Lost Person Behaviour Statistics for distances travelled are effectively providing us with PoA values is an important concept and we will return to it later in the paper.

Tables 5 and 6 give the Pden values for each of these regions for each category.

**Table 5:** Pden for the 50% Probability Zone and the median circle, based on Syrotuck's data

| **Category** | **Pden for 50% zone** | **Pden for median circle** |
|---|---|---|
| child 1-6 | 6.29 | 11.05 |
| child | 4.53 | 11.05 |
| elderly | 16.75 | 15.91 |
| hikers | 1.72 | 3.98 |
| hunters | 3.95 | 6.22 |
| miscellaneous | 5.32 | 6.22 |

In all cases but one the Pden value for the median circle is higher than the Pden of the 50% zone.

**Table 6:** Pden for the 50% Probability Zone and the median circle, based on Hill's data

| **Category** | **Pden for 50% zone** | **Pden for median circle** |
|---|---|---|
| hunters | 3.38 | 6.89 |
| fishermen | 3.65 | 20.09 |
| hikers | 2.12 | 5.99 |
| misc. adults | 3.57 | 9.87 |
| youth 13-15 | 5.72 | 12.69 |
| child 7-12 | 8.33 | 9.42 |
| child 1-6 | 41.22 | 63.65 |
| despondents | 15.40 | 38.85 |
| walkaways | 12.24 | 41.40 |

Here the Pden values are greater in every category for the median circle than for the 50% donut.

What are these two sets of results telling us?

**The implication is that in all cases but one it would be a better proposition to search the circle from IPP out to the median than it would to search the 50% zone.**

**We suggest that that is a useful piece of information for Search Planners.**

The analysis we have just done dealt with circles, and therefore assumed that the lost person could have headed off in any direction from IPP. The comparison still holds even if this is not the case. Suppose that the IPP is up against some kind of natural barrier; we could then think in terms of semicircles rather than circles for our Pden calculations. The numbers would be different, but the overall comparisons would be the same. Similarly if the Search Area is constrained by natural barriers into a cone shape with the IPP at the apex our calculations would involve the same fraction of a circle throughout, and therefore the overall comparisons would be the same.

**Some observations about probability zones**

We did not set out with the express purpose of doing down probability zones. We were responding to what we perceive to be problems with their use. These are the conclusions which we have arrived at so far:

1. There are two sets of probability zone data in the public domain which are available for general use. We think that the data by Hill is to be preferred because its categories are more watertight.

2. We think that there is no evidence to support the commonly expressed belief that "missing persons cluster around the median". We acknowledge the fact that the median is the best single statistic to represent these sorts of distributions but suggest that to reduce all of the information in a category to a single number means that you will miss out on the bulk of the information which it contains. In fact we feel that it could be dangerously misleading to rely on the median to the exclusion of all else.

3. We think that the notion of probability zones is potentially misleading unless the user knows whether the published tables are based on percentiles or the "closest to" values.

4. We think that there is a danger that once probability zone data has been put on the map that it then drives the search plan rather than the search plan being driven by data about the incident …

5. … and as a consequence search resources may be deployed in a less efficient manner than they might otherwise have been, based on considerations of probability density.

6. We acknowledge that Lost Person Distance Travelled data can be of tremendous value to the Search Planner, but we think that there is an alternative a way a making use of it which overcomes the problems which we have identified.

In the remainder of this paper we will try to trace the history and development of probability zones, and from that show how we think they can be used in alternative and preferable manner.

**Historical perspective**

In "An Introduction to Land Search Probabilities", (ref. no.) Syrotuck explores the idea of search planning systems:

> *"Searching a very small area very thoroughly will yield a low probability of success as the chances of the victim being there are low. Conversely, searching a very large area with few searchers will also yield a low probability of success as the chances of spotting the victim are low. Somewhere in between is the most effective use of a given number of searchers in the most productive area. The search planning systems are methods of determining the effective use of resources and the most productive area……(This) takes into consideration: the probability of detection, the probability of the victim being in the area, the number of searchers available, the size of the area to be searched, the spacing between the searchers and the most productive areas to search in order to yield the highest probability of success." (page 21)*

His first step in solving this problem is to express, in graphical form, the relationships between PoD and searcher spacing, and between PoA and distance from PLS. *"By placing the PoD graph on top of the PoA graph, we have the two graphs' intersection …. The point of intersection is considered the maximum probability of success based on the probability of detection (spacing between searchers) and the probability of area* ***(depending on how far away from the point last seen)"*** (our emphasis) Syrotuck (1975) page 22.

Notice this version of PoA has nothing to do with scenarios, consensuses or any of the usual things we associate PoA with. It is based entirely on an analysis of lost person statistics and the notion of how far they were from PLS when they were found.

These are **archival PoA's** and are profoundly different from the normal idea of PoA - the scenario-related PoA . It seems small wonder then that problems can arise when we confuse the two.

Syrotuck then does a series of calculations based on his two graphs to illustrate the point. We note in passing that the linear PoD model based on the three spacings from Wartes (1974) which he uses has been superseded by the PoD graph (Perkins and Roberts (1989)), and therefore his calculations for spacings greater than 100 feet are based on incorrect assumptions.

Of more immediate interest is the fact that the values that he is using for PoA are archival PoA's - they are based on an analysis of lost person statistics, and depend only on how far missing persons are from PLS when they are found. He gives these values in tables (page 21 and Appendix 11) which show the cumulative percentage of people found against increasing distance from PLS. Table 7 shows the archival PoA data he uses for the calculations he is doing at this point:

**Table 7:** PoA table for all persons lost on level terrain

| Miles from PLS | %found | Miles from PLS | %found | Miles from PLS | %found |
|---|---|---|---|---|---|
| 0.2 | 5.2 | 1.2 | 47.36 | 2.2 | 84.21 |
| 0.4 | 10.5 | 1.4 | 57.89 | 2.4 | 86.84 |
| 0.6 | 18.42 | 1.6 | 60.52 | 2.6 | 89.47 |
| 0.8 | 28.94 | 1.8 | 71.05 | 2.8 | 92.10 |
| 1.0 | 44.73 | 2.0 | 81.57 | 3.0 | 94.73 |

> *"Reading the table indicates that 5.26% of the victims are found (within) .2 miles from where they were last seen, 10.52% were found (within) .4 miles away, 60.52% were found (within) 1.6 miles away. It also appears that 95% are usually within 3 miles, and 5% are exceptions to this rule. The 5% are beyond and no set distance is implied. However, it is important to realize that only 5% are the exception and then we can plan around the 95%."*

The Appendix gives similar tables for children, hikers, hunters, elderly plus the 'overall' category shown above.

So Syrotuck expressed data about how far missing persons had travelled from PLS as a cumulative percentage, and at this stage appeared to be quite happy to use it as a method for providing PoA values for his calculations.

This likewise seems to us to be a perfectly good way of representing this data, so why then did he appear to abandon it in favour of expressing the same ideas in the form of zones around the median? We think that the answer soon becomes clear.

He now compares two of his search planning systems, namely Point Last Seen Search Planning and Predicted Position Search Planning. This is what he writes about Point Last Seen Search Planning (page 23):

> *"Traditionally, the centre of the search plan has emphasised the point last seen. We have inferred that the subject has gone some distance and direction from … PLS. Searches are centred at this point and move outwards. In some cases the search extends outwards in all directions while in others a specific direction is indicated. … The flat land PoA tables reflect this and are to be interpreted as in all directions."*

He then works through an example but is clearly not impressed by the resulting values for Probability of Success.

> *"To increase the Probability of Success we must either increase the PoD or the PoA. Predicted victim position is an attempt to increase the PoA."* (pg 24)

He now turns his attention to the Predicted Position Planning System:

> *"It would be most desirable to be able to exactly predict where the victim is. We would not need grid teams, dogs, helicopters, nor planning systems. It would only require this magical person to tell us where the victim is and then to go there. This, of course, is not possible. The next (best) alternative is to predict with some degree of probability where the victim 'should' be, and realise that we could be in error … readers therefore should not view the predicted position as being absolute.* ***It is only the most strategic place to centre the search."*** (our emphasis) (page 24)

He continues:

> *"(Predicted position is) a point which represents where most victims are found. From this point, tables (Appendix 13) were formed that represent distances (from that point) and the percentage of victims that were located."*

Table 8 is the one of the tables referred to, and is a general table covering all categories. It gives the cumulative percentage of lost persons found at increasing distances from the predicted position (PPos).

**Table 8:** PoA table for all persons lost on level terrain

| Miles from PPos | %found | Miles from PPos | %found | Miles from PPos | %found |
|---|---|---|---|---|---|
| 0.1 | 2.63 | 0.8 | 71.05 | 1.5 | 88.15 |
| 0.2 | 5.26 | 0.9 | 76.31 | 1.6 | 89.47 |
| 0.3 | 21.05 | 1.0 | 81.57 | 1.7 | 90.78 |
| 0.4 | 36.84 | 1.1 | 82.89 | 1.8 | 92.10 |
| 0.5 | 46.05 | 1.2 | 84.21 | 1.9 | 93.41 |
| 0.6 | 55.26 | 1.3 | 85.52 | 2.0 | 94.73 |
| 0.7 | 63.15 | 1.4 | 86.84 | | |

The point that Syrotuck is making is that more lost persons are likely to be found within a given radius of the Predicted Position than are found within the same radius of the PLS. This will become apparent if we compare the values in Tables 7 and 8, Here, he seems to be convinced that Predicted Position Search Planning represents a far more efficient use of search manpower, and is therefore the way to go. Table 9 shows his version of the comparison we referred to a moment ago.

As he puts it, “notice the sharp contrast”. The percentage of lost person found within a given radius of the Predicted Position greatly exceeds those found within the same radius of PLS. But the Predicted Position is a single point, and now has a circle drawn around it.

**Table 9:** comparison of Point Last Seen and Predicted Position Search Planning

| radius (miles) | Point Last Seen | Predicted Position |
|---|---|---|
| 0.2 | 5.26% | 18.75% |
| 0.4 | 10.52% | 37.50% |
| 0.6 | 18.42% | 62.50% |
| 0.8 | 28.94% | 81.25% |

If we consider the missing person who could have travelled in any direction from the PLS then the locus of these points will give us a circle centred on PLS, and the circles around the Predicted Positions will merge to give a donut.

To complete the picture which Syrotuck is building here, we can imagine how the Predicted Position distance from PLS became the median distance travelled - recall his comments about the Predicted position being *"the most strategic place to centre the search"* and *"where most victims are found", which is similar in sentiment to "… the median is a much more reliable predictive tool (than the mean) in estimating how far a lost person is likely to travel."* (MLPI, page 182),

**Comments on the historical perspective**

We think that there is a lot to be said in favour of the way in which Syrotuck was originally using archival PoAs as cumulative percentages from a PLS. We feel that it would overcome all of the difficulties which we enumerated earlier in the paper, namely the assumptions about clustering and how they can mislead the Search Planner, the confusion about whether the probability zones are the 'closest to the median' or are based on percentiles and the fact that they can override the scenario. In addition, as we will see, we think that they can offer a useful check on the size of the Search Area as well as a kind of yardstick check on the PoA for the Rest of the World.

**Establishing the Search Area**

We propose now an approach to establishing the Search Area which we think is systematic, as well as being sufficiently straightforward and robust. In the practical example which follows we will be making use of archival PoA data for lost hikers in Nova Scotia, kindly made available to us by Ken Hill. This is expressed in the same form (Table 10) as the data from Syrotuck shown in Table 7.

**Table 10**: Arcival PoA data for lost hikers, based on data from Nova Scotia

| Miles from PLS | %found | Miles from PLS | %found | Miles from PLS | %found |
|---|---|---|---|---|---|
| 0.5 | 8 | 5.5 | 88 | 10.5 | 96 |
| 1.0 | 32 | 6.0 | 88 | 11.0 | 96 |
| 1.5 | 52 | 6.5 | 88 | 11.5 | 96 |
| 2.0 | 72 | 7.0 | 92 | 12.0 | 96 |
| 2.5 | 72 | 7.5 | 96 | 12.5 | 96 |
| 3.0 | 76 | 8.0 | 96 | 13.0 | 96 |
| 3.5 | 80 | 8.5 | 96 | 13.5 | 96 |
| 4.0 | 80 | 9.0 | 96 | 14.0 | 96 |
| 4.5 | 84 | 9.5 | 96 | 14.5 | 96 |
| 5.0 | 88 | 10.0 | 96 | 15.0 | 100 |

In order to make use of this information we have reverted to the style of Syrotuck's concentric circles. For this we will use the data from Table 10 expressed in intervals of 10% rather than distances; we obtained these values (Table 11) by interpolation.

**Table 11:** Hill's archival PoA hikers data in intervals of 10%

| % found | miles from PLS | % found | miles from PLS |
|---|---|---|---|
| 10 | 0.54 | 60 | 1.70 |
| 20 | 0.75 | 70 | 1.95 |
| 30 | 0.96 | 80 | 3.50 |
| 40 | 1.20 | 90 | 6.75 |
| 50 | 1.45 | 100 | 15.00 |

We will be using these values, drawn to scale as concentric circles on a transparent overlay, so that they can be superimposed on the Search Area.

This is the approach that we will be using:

1. **Mark the IPP** on the map.

2. **Subjective Analysis:** look at the area from the point of view of the missing person - who they were and what they were doing - to mark any barriers (natural or otherwise) which may have constrained their direction of travel. In addition we will highlight any magnets, by which we mean any features which would have some kind of attraction for them. This could involve the use of Lost Person Behaviour information.

3. **Develop scenarios**: use our knowledge of the missing person and what they were doing, together with local knowledge of the area in order to come up with scenarios as to what might have happened which fit in with the outcomes of the Subjective Analysis.

4. **Mark the Search Area,** based on the scenarios, on the map.

5. **Overlay the map** with the archival PoA data in the form of the concentric circles shown in fig. 2. Use this to determine the degree to which the initial

Search Area matches up with archival cumulative PoAs - this will give you a rough measure of PoA (RoW) - and if necessary be prepared to extend your Search Area for Phase 2.

6. **Segment** your Search Area.

7. **Assign priorities** to these segments - typically this will mean establishing the Initial Segment Ladder, Perkins and Roberts (1994) - and begin the Initial Phase of the search.

**Practical example**

A hiker left the campsite behind the pub at Butterburn (see map, fig. 3) at 10.00 a.m. today. His plan was to follow the footpath over the hills to Kirkholybottle, where he was to be met by a friend with transport at 4.00 p.m. It is now 8.00 p.m.

The friend is still there and the hiker has not yet arrived. The distance involved is about 10 miles with approximately 1200 feet of ascent and descent, which is well within his capability.

The terrain is covered largely with short grass which has been cropped by sheep, with a number of steep sided gullies which contain streams coming off the higher ground. The area is bordered by man-made coniferous forests in which the trees are planted so close together that they are effectively impenetrable.

There was a siting at the point marked X by a farm worker who was tending stock at the head of the track about a quarter of a mile to the west of X. The point X is taken to be the IPP. The time for this is given as " probably before 12 o'clock".

The weather was deteriorating at the time, and shortly after it began to rain heavily.

The roads, tracks and forest plantations are taken to be the boundaries on the west, south and east sides. To the north, a steam in a steep gully and the footpath are used as boundaries, although the Search Planner is less confident about these boundaries than the others.

It is thought that the hiker has either come down from the high ground to make his way by the road to the east or the lower ground to the west.

The map has been segmented for a previous incident and those segments which are outside the Search Area for this incident are to be ignored.

Fig 1 shows the map for this example, already segmented and Fig 2 shows the Search Area defined by a thick solid line.

The overlay shows that the boundaries to the north, about which the Search Planner was not too sure, are in fact extending the Search Area out to a distance which would include around 80% of missing persons in this category, which is reassuring.

The western boundary, which it was felt would be highly unlikely to be crossed by the hiker lies at around the distance from IPP corresponding to approximately 60% of missing persons in this category, which again the Planner finds reassuring.

To the east, the trees form a fairly impenetrable barrier and the Planner is confident that the hiker is unlikely to have tried to reach the road beyond by breaking through them; however, because this boundary is at a distance corresponding to only 20% of missing persons in this category the searchers are asked to look out for any signs of likely routes in and to report them to control.

The Initial Search Area contains only seven segments, which the Search Manager feels is within the capabilities of the searchers expected in the first hour. A figure of 20% for PoA (ROW) has been estimated, based on the northern boundary, which is at a distance corresponding to around 80% according to the archival PoA's, and based on the fact that this is the boundary about which there is some uncertainty.

The Search Manager feels that at this stage that value of PoA (ROW) is acceptable.

**Conclusions on the practical example**

We feel that the great advantage of this approach is that it makes the Search Planners focus on the incident, the subject and the scenarios and not allow their search strategy to be driven along by median distances or probability zones.

We feel that the method outlined gives a straightforward and systematic approach to establishing the search area which allows the archival PoA's to be used to assess its effective coverage.

We like the way in which it helps to identify possible 'leaky' boundaries that the Initial Search Area might have and enables the Search Manager to assess their robustness as a barrier against archival distances travelled.

## Summary

We have felt for some time that the traditional way of using Lost Person Distance Travelled statistics is potentially misleading. We note in addition that there is some confusion as to what these statistics are really telling us.

We were interested to find that the original way in which Syrotuck was using this information was similar to a way which we were trying to develop.

We feel that the notion of representing these archival PoA's by concentric circles in percentage intervals allows them to be used in a way which negates the objections without losing any of the information which they contain; in fact we think that in this form they provide more information in a way which is simpler to use.

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