1. Introduction

Case One

An 81-year-old male with Alzheimer's disease was recently placed into a secure nursing facility. After a day of banging on the doors in an attempt to exit, the former police officer realized he could cut off his wrist alarm and the doors would open. He was last seen at the facility at 16:30 and reported missing at 17:19. The initial search consisted of a facility and grounds search. The following morning a scent-discriminating dog was brought in with no results. The next day the search with a scent-discriminating dog was repeated. On the third day a helicopter was used. On the fourth day ground teams and air-scent dog teams were deployed and the subject was found 0.4 miles/0.6 kilometers away in a shallow drainage in a direction in line with the door of exit. He was found deceased.

Case Two

A 60-year-old male recently moved into an assisted living facility along with his wife who has vascular dementia. During his first week at the facility the retired pastor was reported missing after going to feed the ducks at the nearby pond. He was last seen with a bag of broken bread in hand at 17:00. Additional investigation uncovered that he had received a diagnosis of mild Alzheimer's disease only two days before. Resources were dispatched that night and he was found across the road from the first pond, near a second pond, next to a drainage, in a briar patch. Found alive by a hasty team, he was 200 yards/meters from the point last seen. The search lasted slightly less than three hours.

Who lives? Who dies? What went wrong? What was done right? *Search and Rescue (SAR)* valiantly strives to locate the subject alive in the shortest possible amount of time. It begins with a call for help and ends with the lost person being found, hopefully alive but possibly dead. Between the initial report and the find is the search. Will the search planners know what they are doing? Are they aware of behavioral research, able to use modern tools, and knowledgeable about lost persons? Will they write the task that sends a team to the correct area? Can they write another (or a third) if the first task fails to detect the lost person? Are they ready and trained to accept the responsibility?

Both subjects displayed what could be called classic dementia behavior (Alzheimer's disease is the most common type of dementia). In the first case,

SAR resources were not sent to the correct location until the fourth day; in the second case, just a few hours. The different results are clear. In Case One, no one wanted to deploy any searching resources into the field to initiate a search. Instead, the search manager relied upon the hope the subject could be found by tracking instead of searching. The subject died; in part, due to a lack of understanding of search theory, but primarily because the search manager had little to no understanding of lost person behavior.

This book will better prepare both searchers and search planners to understand the *who*, *where*, and *why* of lost persons. **If you are in the middle of a SAR incident while reading this book, turn to Chapter 8 Subject Behavior to consider observations and statistics for the relevant lost subject category.** That chapter is a concise reference tool for search planning. Other chapters describe the *International Search & Rescue Incident Database* (ISRID), definitions, how statistics were derived, limitations and general findings. Insight into typical strategies that lost persons attempt is provided in Chapter 5. Since several misconceptions regarding lost persons exist, behavior myths and legends are examined in Chapter 6. Finally, in Chapter 9, a generic approach called "reflex tasking" appropriate for the initial stages of most searches is outlined, as well as methods to formally determine the likelihood of the subject being found in each search.

> ➢   **Send a resource to the correct location**
> ➢   **Team detects the missing subject**

Finding the missing subject requires two separate but equally important factors. First, a SAR resource must be sent into an area where the lost person is located. Second, the team in the correct area must actually detect the subject. *Operations research* provides a simple formula that expresses how these two factors contribute to the chances of finding the lost person.[1] It goes without saying that if a team is never dispatched to the correct area then the likelihood of the search effort finding the subject approaches zero (although attraction and containment often do work; search teams have gotten lost and found the subject by mistake; lost subjects have found search teams out of the search area; and the media has been used effectively to alert the public).

If we already know where the subject is located, then we have a rescue situation and not a search. However, in a more typical search scenario, we may

have some ideas where the subject might be, but we don't know for certain. Search planners will feel differently about the probability that the subject is in each segment of land or water. This segment has an "area" and the uncertainty can be called "probability."

Probability of Area (POA) describes the chance of the missing subject being in the segment of land or water under consideration. This term has been used by the ground SAR community since the earliest ground SAR textbooks were written.[2,3] In 1973, Dennis Kelley called it "Probability subject is actually in the area," denoted as P(A). However, the concept goes back even further to World War II operations research. Bernard Koopman described the probability of two areas and was the first to define *probability density* in the context of SAR.[4] He used an equation of p_1/A_1—or probability of area one divided by its size (area)—to illustrate probability density. The evolution of Koopman's work to Kelley's term and finally to POA is clear. Koopman's work initiated search theory as a field of study within the applied science known as operations research. Search theory has since been successfully applied to many search situations, including search and rescue.

B.O. Koopman

Prior to circa 1995–96, the US Coast Guard did not use probability of area terminology. Rather, it relied upon a pure mathematical approach to define the search area. (It took a simple estimate of the probable error (E) of the initial *datum* (think initial planning point) updated for drift caused by winds and currents, the probable error of that position (the radius of a circle centered on datum that has a 50% chance of containing the true position), multiplying the probable error by a safety factor, then circumscribing a square around the corresponding circle, and finally searching it.)

When the *International Aeronautical and Maritime SAR Manual* (IAMSAR) was being written, the need arose to better define "Probability of Area." Identifying probable areas on the ocean is different than on land, but the use of probabilities is the same. The term POA and *probability of containment* (POC) were in equal contention for use in the manual. According to Jack Frost, the maritime world, unaware of terminology already in use by the land SAR community (POA), decided on the term POC because to those developing the IAMSAR Manual, it seemed more descriptive of the concept they were trying to convey. The two terms are virtually identical in usage.[5] Since this book is more directed at a ground SAR audience, the term POA is used.

Lost Person Behavior

Knowledge of lost person behavior is a powerful tool that helps to determine where to look for the lost person. A ground search area is typically decided by theoretical, statistical, subjective, and deductive steps. Summaries of typical lost person behavior can guide the search planner in determining the search area and where to send teams within that area. It can also help field personnel know the most likely areas within their particular search segment. This book is intended for both field and command personnel. Ultimately, it is only a tool based upon probability, statistics, and likely behavior. However, it is important to know how to interpret observations and statistics concerning lost person behavior.

The statistics used in this book are derived from case histories of lost persons, usually records kept by agencies and SAR groups. The first assumption is that the activities, competencies, and environments of different groups of individuals likely determine their patterns of behavior and extent of travel when lost. Thus, statistics for hunters are in a separate category than statistics for campers. Yet, even within a category, every lost person is unique, with a different set of circumstances—and behavior. Investigation is the tool that helps determine the specifics of an individual. However, good investigation takes time. Resources still need to be deployed. Well-organized summaries of lost person behavior and travel can get the search moving in a probable correct direction.

Lost person behavior contains two equally important elements:

> ➢ Statistics that give probabilities of where the subject might be located, and

> ➢ A general overview of the types of behaviors, likely actions, and goals or intent of the lost person.

From these two elements it is possible to make strategic and tactical recommendations. These recommendations can guide both the initial search effort and the extended effort. Failure to rapidly deploy resources results in wasted effort.

On one search, over 100 field resources were held up in the staging area for four hours until management completed its detailed investigation and determination of a formal search area. That wasted 400 person-hours of potential searching. The young subject was quickly located by a simple hasty task once teams were actually sent out into the field.

A search planner needs to be familiar with using behavioral and geographic data to address an immediate need for action.

Lost person behavior versus missing person behavior

The traditional term "lost person behavior" is widely used in ground SAR literature. In fact, some researchers have limited their research to only subjects who were actually lost.[6] Indeed, it is useful and important from an academic point of view to know how those who are truly lost behave. It appears that those who are truly lost do, in fact, behave differently than those who are missing.[7] However, search planners huddled over the hood of a car face the unknown. They don't know if the lost person is truly lost, simply overdue, stranded, trapped, or incapacitated by trauma or a medical problem.

Taking this uncertainty into consideration, this book employs a broader approach. The contents and statistics within the book are derived from subjects who are missing (which includes lost persons but excludes *investigative scenario* cases). Although the term missing person might also be considered to include the thousands of runaways and adults who purposely "disappear" each year, the results presented here are limited to actual search cases. Runaways and similar scenarios (previously called *bastard searches* in the ground literature) are now called investigative cases in this book. In these cases, the subject is found through law enforcement investigation and typically does not involve SAR field resources. It is felt that with this approach the statistics better reflect what the search planner actually faces.

This book is not intended to provide any assistance in "searching" for runaways, those who change identities, are starting a new life, or similar types of "searches" typically called investigative searches. For the purpose of this book, "lost" is defined more from the searcher's perspective than from the missing subject's point of view: The searcher is unable to find the subject, hence the subject is lost.

What is Lost?

Lost! A gripping sense of dread, fear, embarrassment washes over the missing subject. But what does it really mean to be "lost"?

> A two-year-old is *lost*! The tracker finds the teddy bear she *lost*. The IC was glad she had the tracker, whose skill was once considered a *lost art*. Unfortunately, a search team seemed *lost* to command, since the repeater appeared to be a *lost cause*. The Plans Chief was *lost in thought* attempting to figure out a probable success rate worksheet, but he quickly felt *lost*. Turns out the *lost* child was with the irresponsible and *morally lost* step-mother who had gone drinking.

Clearly, several different definitions exist. Consider the following scenarios:[8]

- A two-year-old follows the family pet into the woods behind the vacation cabin. She wonders: Where are Mommy and Daddy? Why aren't they coming? *Is she lost?*

- Out of shape hikers badly estimate the amount of time the hike would take. Now hours past the estimated time to arrive home they are caught by darkness while still on the trail. They are without a flashlight and faced with the difficult decision to keep going or wait until daylight. *Are they lost?*

- In Koopman's original book on search theory, there are pages upon pages of advanced calculus and formulas. *Would you be lost?*

The first two cases would qualify for the database used for this book, the last would not. However, the database goes further and classifies whether the subject was actually "lost." Then only the first case would be classified as lost using Ken Hill's definition, which involves two components:[9]

- ➢ confusion with current location in respect to finding other locations, and

- ➢ inability to reorient.

The emphasis on "being oriented" is perhaps related to observations of hunters, who typically navigate by a representation of themselves contained within the environmental layout. Lost hunters often report that they "got turned around" when cloud cover obscured the environmental layout to which they

were orienting. However, people also feel lost when they are oriented, such as when they report that they "followed Ram River to the north," but could not find the most direct route to a familiar place. Conversely, it is possible to have no clue where you are as long as you can get somewhere you want to go. Many a searcher only knows he is following the drainage up or down. Without an altimeter and no view of the surrounding terrain, he cannot precisely plot the current location. However, he would not describe himself as lost. (Most searchers would never describe themselves as lost, at least not in public.)

Ultimately, in SAR, what may matter most is the fact a reporting party has reported the subject as missing. In the end, our job is the same: Find the lost person before time runs out.

History of Lost Person Behavior Research

The first recorded collection of SAR statistics dates back to 1783 and Father Lorenzo at the St. Gotthard Hospice, a monastery in Switzerland. The monastery was part of a system of hospices from which monks would guide travelers through the mountain passes of Europe. The St. Bernard Hospice was part of the same system and known for the use of St. Bernard search and rescue dogs. In 1783, Father Lorenzo recorded average fatality rates (three to four per year) and the cause of the fatality (typically avalanches and freezing).[10]

Photo provided by Dennis Kelley

Fast forward to the twentieth century for the first modern collection of SAR statistics. Dennis Kelley, a volunteer member of the Montrose Search and Rescue team, took it upon himself to analyze the team's SAR reports. From 380 case histories he reported several different types of statistics: mobility, age, search outcome, mortality cause, injury cause, reason for becoming lost, number in party, and how long they were lost.[11] He published his findings in 1973 in what would become the first ground SAR management book in the US (*Mountain Search for the Lost Victim*). It was the beginning of lost person behavior research, although his work is now mostly unknown in the SAR community. His survivability statistics (based upon 45 cases gleaned from different sources) make up the basis of Survival Time, a software program that provides an estimated survival time.[12]

William Syrotuck made a significant impact on the ground SAR community when he published *An Introduction to Land Search: Probabilities and Calculations* in 1975. In this first paper he looked at 117 cases from Washington State.[13] In 1976, he published *Analysis of Lost Person Behavior: An Aid to Search Planning.*[14] In this book he had 229 cases, largely from Washington and New York states.

Syrotuck was the first to break out the data into subject categories. The original categories were children, hunters, hikers, elderly persons, and miscellaneous persons. In addition, he described "mentally challenged" and "despondents," but did not have sufficient data to report distances traveled. He was also the first to describe distances traveled from the *point last seen* (PLS) to the find location as the crow flies. He introduced the importance of describing the data using median versus average values. Syrotuck realized differences existed in data taken from flat terrain versus hilly or mountainous terrain. In his book he also pointed out that the results should be relevant to forested areas, since that was the source of the data.

Key Terms

- *Point Last Seen* (PLS)—The location the subject was last seen. Original term coined by Syrotuck. The PLS may move during a search incident.

- *Last Known Point* (LKP)—A location at which a significant clue (parked car, wallet) places the missing subject. The LKP can be revised during the search incident.

- *Initial Planning Point* (IPP)—The point that is initially used to plan the search incident. The IPP may be the original PLS or LKP. The IPP is the basis for distance from the IPP to the subject.

- *Median*—The number that represents 50% of cases. Half the numbers are greater, half the numbers are less.

Syrotuck was well trained in mathematics and analysis and served as an operations researcher. In his book he left out some data that would have been useful for other researchers. While the number of cases associated with each category is known, the number of cases associated with either the flat or hilly/

mountainous terrain is unknown. It is expected, however, that some of these numbers might have been quite small. In addition, Syrotuck did not report percentages related to subject sex or groups. To this day, his summary data chart is often reprinted in several key search management textbooks.[15,16,17] His 1976 text has been reprinted several times. It has been the best overall presentation of lost person behavior in one book until Ken Hill's review.

Photo provided by Barry Mitchell

The need for a larger database and an examination of regional differences became apparent to Barry Mitchell. With the endorsement of the National Association for Search and Rescue (NASAR), he launched an extensive data collection project in 1980. In 1985, he reported on his results after collecting 3,511 cases.[18] Mitchell was the first to show important regional differences, and found differences with the percentages of subjects going downhill originally reported by Syrotuck. He introduced mobility time and collected several survival factors. The NASAR project effectively ended in 1985 with Mitchell reporting "this represents the final documentation for the program." However, its legacy can be found with many teams still using modifications of the NASAR data collection form. Unfortunately, his data did not replace Syrotuck's smaller database. This might have been because he never found a succinct way of summarizing all of his data on a single page (although that may not have been possible).

Photo provided by Ken Hill

In 1991, Ken Hill reported on statistics from Nova Scotia based upon 107 cases.[19] He introduced the term "*walkaways*," which included dementia, mental retardation, and psychotic cases. He reported the first statistics for despondents based upon nine cases. He also introduced the youth (13-15) age category. His work showed that Syrotuck's original elderly category—combining healthy elderly with those with dementia—was not appropriate. Hill's work represented the first time someone with both a formal academic research background in behavior as well as SAR experience had conducted SAR lost person research. Hill is also responsible for the most recent book on lost person behavior. A collection of classic papers (all of which are reviewed in this history), it only achieved widespread distribution in Canada.[9] Hill's work continued with a current database of 388 cases collected from Nova Scotia. These results form the current basis of lost person statistics in NASAR's search management textbook.[20] As well, he has published other papers on lost person behavior.[21,22]

In 1992, Robert Koester (*photo*), along with David Stooksbury, reported on Alzheimer's disease search incidents. The original report was based upon 25 mid-Atlantic searches.[23] In a later paper, Koester reported on 87 cases, and introduced *track offset*, *travel direction offset*, *directionality*, subject survival times and population density statistics.[24] In addition, distance from the PLS was reported in quartile statistics. Koester also introduced new statistics for mental retardation, psychotic, and despondent cases. As the principal investigator for the ISRID project, he was responsible for introducing the use of *ecoregions*; separated out urban data;[25] vastly increased the number of cases; combined data from multiple sources, and described several additional subject categories.[26,27,28]

In 1998, Ed Cornell (*left*) and Donald Heth (*right*) reported on 162 cases from wilderness areas in southwestern Alberta, Canada.[6] They introduced the categories of camper, cross-country skier, mountain biker and scrambler. They also provided additional data for the travel direction offset calling it *degree of dispersion*. Their paper on the dispersion angles for children in an urban environment is found in several SAR textbooks.[29] This work led to the creation of SAR software specifically designed for *urban searches*. They were trained as search managers and revived academic interest in lost person behavior by publishing significant research in scientific journals.[30,31,32,33,34,22]

Dave Perkins (*left*), Pete Roberts (*center*), and Ged Feeney (*right*) released the results of the Mountain Rescue Council (UK) database in 2002.[35] The first report was made in 2001, the last report in 2005.[36] They reported on 708 cases collected from the United Kingdom, Northern Ireland, and Eire. They made widespread use of statistical significance testing, and report on the sub-divisions of categories (male versus female, urban versus non-urban) when the results were statistically different. They were also the second to report country-wide data versus regional or local data.

Photo provided by Charles Twardy

Charles Twardy collected lost person data (550 cases) from Australia starting in 2001, but his ultimate goal was to use the data in developing computer models.[37] His area of expertise is *Bayesian statistics* and modeling. While no new categories have been added, more complex models and ways of looking at lost person behavior data are currently being explored. In addition, Twardy has played a major role in the ISRID project and with Koester reported several of the initial results[28] along with other collaborations.[27]

Photo provided by Penny Woolnough

Graham Gibb (*left*) and Penny Woolnough (*right*) collected police reports of lost persons (3,000 incidents) from the United Kingdom. They released their results in 2007 in a publication called *Missing Persons: Understanding, Planning, Responding.*[38] The publication focuses on lost person reports from a mostly urban environment (children, despondents, dementia, psychosis, bipolar, and water incidents). In addition, it is the first publication to look at the effect of attention deficit hyperactivity disorder (ADHD) on distances traveled in lost children cases. They combine the perspective of law enforcement involved in SAR incidents with an academic background in psychology.

These researchers and authors are the primary contributors to the field of lost person behavior research. However, a small handful of other researchers have published papers regarding search statistics. Ela reported on the type of injuries found in SAR incidents using data from New Hampshire.[39] Adams, et al. reported on survivability factors with somewhat dubious conclusions using the Oregon SAR data.[40] Also using Oregon SAR data, Kleinbaum releases a yearly compendium providing summary type information.[41] Kramer reported distance from the PLS on 46 urban elderly subjects as part of a book on urban search (with limited distribution).[42] Bruce and Rosewarne looked at wandering (dementia cases) and search implications in Australia.[43] Silverstein and Salmons reported on urban wandering among Alzheimer's disease subjects using data collected directly from caregivers.[44] Adcock looked at national differences between the ISRID database and New Zealand results for hunters and hikers.[7] An overview of SAR, including behavior research, can be found in Auerbach's comprehensive tome on wilderness medicine.[45]

Self-reported and agency-reported accidents can be found in *Accidents of North America Mountaineering*, a summary of accident reports and analysis issued each year by the American Alpine Club and the Alpine Club of Canada. Similar reports can be found in the National Speleological Society's *American Caving Accidents*. While these organizations provided summary tables to the ISRID project, their data was not included since the cases were largely rescues rather than searches, were sometimes self-reported, and actual searches may have been duplicated from state data sources. Although not added to the ISRID database, some facts from those reports are cited in the appropriate section.

This brings the reader up-to-date with previous work. The book will describe the newest database of lost person behavior in detail later.

Role of Statistics in SAR

It is important to recognize the overall role lost person statistics play in search management. All searches start with investigation as the foundation. Without *searching data* (subject description, picture, a list of items carried by the lost person, name to call, etc.), search teams don't know what they are looking for. While guidance such as "bring back any two-year-old you find" might suffice in the middle of the woods, in an urban environment that advice could be criminal. Search management must also have basic *planning data* (initial planning point, subject type or activity) in order to begin the planning process. Without a subject type, lost person behavior statistics and profiles cannot be used correctly. Once those basics are obtained it is possible to use statistics and profiles based upon previous cases. These statistics and profiles will allow rapid deployment of resources using reflex tasking.
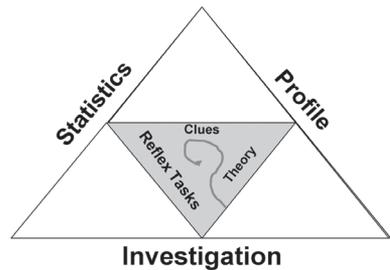
The details of reflex tasking will be discussed in Chapters 8 and 9. In many cases, reflex tasking will locate the lost person. However, it is also possible that a significant clue will be located that further refines the search area and shifts the probability of area. Solid clues often result in rapid finds. However, in

some cases, the find does not come quickly and easily. In these searches, the use of formal *search theory* is required. Every serious search planner should be prepared to face the multi-*operational period* search with a full set of search planning tools and knowledge. So while the statistics provide a starting place, they are not in themselves the total answer for SAR planning. In fact, the author agrees with the statement that search planning involves analytical skills that require more training and experience than simply statistical application.

Throughout this book the term "search planner" is used. This is a generic term for the person or team that is planning tactical assignments. On a small search it may only be the incident commander using the Incident Command System (or any of the other systems that exist around the world). On a medium search it may be the Plans Section Chief, while on a larger search it would be an entire team of planners.