A Simple Guide to Conducting Ground Search and Rescue Detection Experiments

Volume I

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Acronyms Used

AMDR	Average Maximum Detection Range
CONUS	Continental U.S.
CD	Compact Disk
CONUS	Continental United States
Ecoregion	Ecological Region
ESW	Effective Sweep Width
GDA	Geocentric Datum of Australia
GPS	Global Positioning System
IDEA	Integrated Detection Experiment Assistant (MS Excel® workbook)
LR	Lateral Range
MS	Microsoft
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NLCD	National Land Classification Data
POD	Probability of Detection
SAR	Search and Rescue
SAREX	Search and Rescue Exercise
TD	Track Distance
TL	Track Length
URL	Uniform Resource Locator
U.S.	United States
UTM	Universal Transverse Mercator
WGS84	World Geodetic System of 1984

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Overview

Effective sweep width is the missing critical element to determining meaningful and accurate Probability of Detection (POD) values. Probability of Detection is essential for search planning and evaluating the effectiveness of a search task. This tool is then used to determine where to send future resources out into the field to maximize the Probability of Success. Simply put, knowing effective sweep widths saves lives. The only way to determine effective sweep widths is to take searchers and perform field experiments in the environments actual searches take place. This guide will help searchers plan and conduct effective sweep width experiments.

There are three classes of factors that affect detection. They are the characteristics of the following items that affect the detection process:

- The search object,
- The sensor in use, and
- The operating environment

The purpose of a detection experiment is to determine the "detectability" of a particular type of search object in a particular environment when using a particular sensor. The measure of "detectability" for a given set of conditions (search object, sensor, environment) is the Effective Sweep Width (ESW). The ESW, together with information about the amount of effort that has been or may be expended in some region and the region's area, provides a means for objectively estimating the probability of detecting the search object if it is present in the region. ESW provides a means for relating effort, area, and POD mathematically.

Conducting an effective sweep width experiment requires some planning, a large enough area, some limited equipment, searchers, data loggers, the Microsoft (MS) Excel® based Integrated Detection Experiment Assistant (IDEA) software, and a few days spread out over a period of time. The experiment itself can generally be conducted in one day. It will usually take from 1 to 4 hours for each searcher/data logger team to move through the experiment course. However, starting times may be more frequent so that several teams are on the track simultaneously, but not within sight or earshot of one another. The following steps are required: designing the experiment, finding a search area, taking environmental measurements, laying out the search track, placing search objects, conducting the experiment, entering data, and analyzing the results. This guide along with the IDEA software will greatly assist in conducting a well-run and scientifically useful experiment. The experiment will benefit not only operational planners but also searchers and ultimately the lost subjects.

Preparing for an Experiment

Almost all of the success of an Effective Sweep Width (ESW) experiment rests with the planning and preparation. The IDEA software exists to help an experiment designer through all of the planning and data analysis stages. Perhaps the most important planning consideration is to keep the experiment as simple and short as possible. It is far better to

have a successful experiment that determined a good ESW for one search object type than a long course with four different search object types under different conditions but failing to provide any useful results. Another important point to keep in mind is that, in some respects, it is far easier to conduct an experiment than to describe one. Therefore, while these instructions may seem detailed and long, the experiment itself is actually rather straightforward. The following steps are involved.

Pre-experiment
- Designing the experiment
- Selecting candidate search areas
- Scouting the search area
- Measuring environmental factors
- Planning to lay out the search track
- Laying out the search track
- Planning to place search objects
- Placing search objects

Experiment Day
- Establishing the command center
- Performing the necessary logistics
- Instructing searchers and data loggers
- Dispatching the teams at appropriate intervals
- Debriefing the teams and collecting data sheets.

Post Experiment
- Recovering search objects
- Scoring results
- Entering data
- Determining effective sweep width
- Sharing documentation and research findings.

Overview of Conducting an Experiment

There are numerous excellent reasons to conduct an Effective Sweep Width (ESW) experiment. First, ESW values are a critical planning factor since they characterize, with a single numeric "detectability index," just how easy or hard it is to detect a given object in a given environment with a given sensor. Second, ESW experiments provide excellent training opportunities for all participants, but especially the searchers and search planners/managers. Third, the experiments show why the word "probability" is in the term "probability of detection" (POD) because there will always be search objects within the maximum possible detection range that are missed. Detection is never a certainty until it actually occurs.

For planning purposes, a single individual is capable of conducting the initial planning, environmental measurements, course layout, data entry, and final data analysis. At least two people will be needed to set-out the search objects the day before the experiment. Search objects typically represent adults, children, or clues. The locations of the search objects are determined by the IDEA software.

On the day of the experiment, 12-30 search teams (searcher and data logger) need to go through the 1-4 hour course. The course will consist of a designated track clearly marked with surveyor's wire stake flags. In addition, flagging tape may be used as needed. A wire stake flag should be placed every 25 meters from the starting point of the course and labeled with its distance from the start point. As the searcher walks along the course (never leaving the track) they will point out to the data logger when they see (or think they see) a search object. The data logger will record the reported detection on a special data log, using the labeled surveyor's flags to determine the searcher's location at the time of the detection. At the end of the course, the team will be debriefed, and the searcher will complete a searcher profile form. Searchers may then become data loggers, but data loggers may not become searchers for they are aware of the position of certain objects. Appendix A, suggests possible modifications to this basic method to make collection of ESW possible for different types of search and rescue (SAR) resources.

At the end of the experiment, the locations of search objects are verified, and the course is cleaned up. Each searcher's detection log is scored, and the data is entered into the IDEA software. The software then automatically draws cross-over and lateral range graphs, while calculating the ESW. Documentation requirements are all captured in the IDEA software.

Sample Experiment Schedule

Day 1	Scout out candidate areas, select area, conduct Average Maximum Detection Range (AMDR) and environmental measurements.
Day 2	Determine and flag course (first pass). Roller wheel or pace course to set out 25 meter flags (second pass). Set out additional marker flags (third pass). Obtain Global Positioning System (GPS) track of course (third or fourth pass).
Day 3	Setout search objects.
Day 4	Conduct experiment.
Day 5	Break down course.

Note: If already familiar with the area and taking advantage of trails/roads, it is possible to combine day 1 and 2 provided an early start and sufficient light. Depending upon the end time, amount of light, willingness to work at night, types of search objects, number of helpers, and need to measure lateral ranges, it may be possible to combine conducting the experiment and break down activities into a single day.

The procedures and suggestions in this User's Guide are the culmination of refinements to previous ground experiments. Robe & Frost (2002) conducted the first pilot experiment in Logan West Virginia. This work helped to develop the basic principles and course layout. Koester, Cooper, Frost & Robe (2004) further refined the methodology using life-like search objects and flags to mark locations along the course. The methodology found in this guide is similar to that used in the Koester et al. (2004) report, a copy of which is included on the CD. Experiment designers will find it useful to read through the report prior to starting an experiment. However, after learning from the original experiments additional enhancements have been made to this guide and the forms used. Therefore, the user should follow the suggestions of this guide.

Using this Guide

Several tools are provided to make planning and conducting an experiment easier.

- Resource Library Compact Disc (CD). The resource library CD contains all the resources describing the experiment. The contents include a digital version of this guide, the MS Excel® based Integrated Detection Experiment Assistant (IDEA) software, MS Excel Reader® software for those who do not have MS Excel®, Adobe Reader Software for those who do not have Adobe reader, and the resource library which contains several documents related to Effective Sweep Width (ESW).

- The MS Excel® IDEA software. IDEA provides all of the forms and automates the experiment design and data analysis phases. It also provides a standard format for the collection of data from experiments. IDEA is a critical tool for the experiment designer.

- The Experiment Guide (in two volumes). This document, Volume I, should be printed so it may be referenced easily and consulted while out in the field. It explains, in a simple fashion, the steps that need to be followed to conduct a scientifically successful experiment. Volume II are the Appendixes of the guide that explain how to construct search objects, make modifications to the experiments, copies of the forms used, the scientific background of these experiments and other useful information. This guide uses the following icons to assist the reader.

Icons Used in this Guide

	Checklist: The manual provides a checklist of equipment required for that particular part of the experiment. Checklists are important when heading out to the experiment site. Forgetting a piece of equipment could cause large delays.
	Information tip: General information or a tip on how to better carry out a specific aspect of the experiment
	Critical Point: Failure to follow the point or step could result in the failure of the experiment.
	Form Required: One or more printed copies of a form that is available from the IDEA software is required for use in the field. In addition to the icon, whenever a form is required the text is highlighted in green.
	Input Required: Entry of data or information into the IDEA software is required. In addition to the icon, whenever entry of information is required the text is highlighted in blue.

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Integrated Detection Experiment Assistant (IDEA) Software

A critical tool for conducting detection experiments is the IDEA software. This tool essentially performs all the calculations and provides critical experiment layout recommendations. It also provides all of the required forms in a format where the user can edit them if required. The IDEA software is a MS Excel® workbook locked as a template. Therefore, MS Excel® is required to properly operate the software. While the CD provides free MS Excel Reader® software, this software only permits viewing and printing of the IDEA software. The MS Excel Reader® does not allow the entry of data or the editing of fields. Once the template format is opened and saved using the "save as" option on the File toolbar, data can be entered and forms edited in MS Excel®.

The explanations in this guide follow the same order as the IDEA software. It is recommended that when reading this guide the user also has the software opened. Some features link to internet resources, but a web connection is not required to use IDEA. The software itself is not required on the day of the experiment, nor required to be brought into the field as long as the person conducting the experiment has properly prepared ahead of time and printed out all of the necessary forms. However, it is recommended to have the software loaded onto a laptop that can be brought into the field. The experiment designer may find it necessary or desirable to add or remove a search object type at the last minute; in which case the IDEA software will be instrumental in determining new locations for all the search objects.

The IDEA software contains several forms that are formatted for printing on 8.5" x 11" paper. Some of these forms have a front and a back. Some are designed to be printed in portrait mode while other are formatted for landscape mode. The appropriate print settings have already been made. The user simply needs to select "print." Forms intended for the field (object placement, object location, and the detection log) should be printed on waterproof paper.

The IDEA software follows certain conventions to make it easier for users to determine when they need to input data, simply read over information, change default settings, or view calculated values. It should be noted that data only needs to be entered into the bright-yellow boxes.

Common Conventions

Meaning	Box Color
Data input REQUIRED, software will not function without value	
Default value provided, user may change value	
Value automatically calculated or carried over from previous cells, no input required	
Value automatically calculated, value within acceptable range	
Value automatically calculated, value NOT within acceptable range	
Instructions: Provides information to user	

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Pre – Experiment

Experiment Design

The first things to consider when designing an experiment are the general parameters that will be employed to determine the conditions in which to run the experiment. In the IDEA software, worksheet "1. Experiment Setup" asks the experiment designer to introduce data needed to develop recommendations, compute estimates, and provide parameters for the experiment. In this worksheet, the experiment designer is asked to:

1. Enter the date the experiment is scheduled to be performed.

2. Enter the location of the experiment (City, State/Province).

3. Enter local sunrise and sunset in 24 hour format (for example, 8:00 to indicate 8 am or 20:00 to indicate 8 pm). The worksheet has an internet link to obtain sunrise and sunset times worldwide.

4. Choose a season color to describe vegetation during the experiment. The choices are: brown, green, or white. The selected season color should represent the prevalent condition of the weather and the state of vegetation. For example, brown should be selected if winter-like conditions exist, lack of vegetation, dry environment, during most of autumn, or at the end of summer (at higher elevations). Green, on the other hand, should generally represent spring, summer, most of fall, when deciduous trees are green, or in tropical weathers where vegetation is green and growing. Finally, white should be selected if snow is on the ground at the time of the experiment.

5. Choose an expected terrain type where the experiment will be conducted. The terrain type is later used by IDEA to document the terrain and determine the estimated Average Maximum Detection Range (AMDR) for each search object type. The choices are:
   - California Oak/Field
   - Eastern Forest (Mountain, Green)
   - Eastern Forest (Mountain, Brown)
   - Eastern Forest (Steep Mountain side, Green)
   - Field (flat) 15 cm vertical ground cover
   - Field (flat) 35 cm vertical ground cover
   - Field (flat) 75 cm vertical ground cover
   - High Density Urban
   - Medium Density Urban
   - New Mexico Pine Forest (Mountain)
   - Orchard (Green)
   - Western (Maritime) pine (Green)

6. Choose the chart or map datum that will be used throughout the experiment. This step is for documentation only. Currently, the choices are:

Map Datum

Abbreviation	Name
AGD66	Australian Geodetic Datum 1966
AGD84	Australian Geodetic Datum 1984
European 1950	European 1950- Austria, Belgium, Denmark, Finland, France, Germany, Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
European 1979	European 1979- Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland
GDA94	Geocentric Datum of Australia 1994
Geod Datm '49	Geodetic Datum '49- New Zealand
NAD27 Alaska	North American Datum 1927- Alaska
NAD27 Canada	North American Datum 1927- Canada and Newfoundland
NAD27 Caribbn	North American Datum 1927- Caribbean (Barbados, Caicos Islands, Cuba, Dominican Republic, Grand Cayman, Jamaica, Leeward and Turks Islands)
NAD27 Central	North American Datum 1927- Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua)
NAD27 CONUS	North American Datum 1927- Mean Value (CONUS)
NAD27 Mexico	North American Datum 1927- Mexico
NAD83	North American Datum 1983- Alaska, Canada, Central America, CONUS, Mexico
Old Srvy GB	Old Survey Great Britain- England, Isle of Man, Scotland, Shetland Isl., Wales
Prov S Am '56	Prov So American '56- Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela
South Asia	South Asia- Singapore
Sth Amrcn '69	S. American '69- Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela, Trinidad/Tobago
Tokyo	Tokyo- Japan, Korea, Okinawa
WGS 72	World Geodetic System 72
WGS 84	World Geodetic System 84

7. Choose the units that will be used for measurements. The preferred choice is meters for use with the Universal Transverse Mercator (UTM) Grids, but IDEA also allows for the use of yards. All distance and speed calculations are dependent on choosing an appropriate unit of measure that will be used consistently throughout the experiment.

8. Choose the **event type** where the experiment will be conducted. Choose the option that best describes the type of event where the experiment will be held. IDEA has the following choices:

a. **Compare search techniques-** Experiments that compare two different search techniques can be conducted two different ways. One method involves conducting the experiment on two different days with different searchers. This has the disadvantages of more complex scheduling and the need for similar weather. It has the advantage of allowing for a longer course with more searchers. The second technique conducts the experiment on the same day. The course will need to be longer and no more than two search objects should be used.

b. **Conference-** The following are different conference events.
   SAR Conference: If held at a SAR Conference a large pool of SAR personnel are typically available. However, the experiment may compete with other activities. Important planning considerations include:
   - Setting up the course at or adjacent to the SAR conference site,
   - Strong prior recruitment and publicity,
   - Make sure the experiment is listed in all conference handouts including the conference web site if it exists,
   - On the website allow for participants to pre-register for the experiment, including desired times,
   - Consider mailing out materials to all participants who have pre-registered for the experiment.
   - Onsite recruitment, and
   - Making it possible to complete the course in 1-2 hours so participants will miss at most one lecture time period. IDEA will limit the course time to 2 hours for suggested timeframe.

   Search and Rescue Exercise (SAREX): A Search and Rescue Exercise is typically a simulation that brings together a large number of SAR personnel. Careful scheduling is required to make sure both objectives are achievable. If participants are given a choice of participation in the experiment or the simulation the same issues that affect experiments at SAR conferences may arise.

c. **Correction factors-** Experiments that obtain correction factors will depend upon the type of correction factor being tested. All weather or condition (i.e. night) correction factor experiments will need to be designed so baseline ESW values are obtained during optimal weather and additional ESW values are obtained during the test conditions. Correction experiments should be conducted with only one or two different search objects. Since environmental conditions can change rapidly, the course should be limited to 1-2 hours.

d. **Specific ESW**- The major objective is to determine ESW values for specific combinations of sensor(s), search objects, and environmental factors (terrain, vegetation, light levels, etc.). ESW values will then be used later for operational purposes. This is the ideal choice to determine the ESW for the maximum number of search objects (4).

e. **Training-** The following are types of trainings.
General Training: The major objective is to provide searchers the opportunity to search along the course. At the end of the exercise searchers are told how many search objects they missed. Ideally, an opportunity is provided to the searchers to view the search objects they missed and how they could have been detected. A training objective can be satisfied in as little as 1 hour but up to 4 hours may be usefully dedicated. For optimal training at least two different search objects should be used.

Dedicated Team Training: A single team may decide to conduct a sweep width experiment. Time will not usually be a critical factor but the number of people available may be limited. The upper limit of 4 hours for an experiment may be applied. The number of search objects may need to be increased while the number of types of search objects should be limited. A team has the advantage of possibly setting up a permanent course, which significantly reduces future experiment overhead time.

Dedicated Regional Training event: This represents the ideal situation: a larger number of search personnel gathering for the specific purpose of conducting a sweep width experiment. However, since only a limited number of people can be out on the course at any one time, it will be necessary to either schedule staggered arrival times or have flexible alternative activities planned.

9. Choose the Ecological-Region (Ecoregion) in which the experiment will be conducted. IDEA provides links to a world-map that shows ecoregions (Figure 1, top), USA map of ecoregions (Figure 1, bottom), and an internet link to the U.S. National Atlas. This information is for documentation only.

10. Choose the Forest Cover. IDEA provides an internet link to Forest Cover map. This information is for documentation.

11. Choose a Land Classification type in which the experiment will be conducted. This information is for documentation.

Figure 1. World (top) and United States (bottom) Ecoregion maps.

Now, the general parameters are set for the next step in designing an experiment: choosing or determining the search object types that will be used in the experiment. IDEA allows up to four different search object types for each experiment. In the IDEA software, worksheet "2. Search Object Types" and titled "Selecting Search Object Types" the experiment designer does the following:

1. Review the recommended maximum number of search object types, course time, course length, and the specific search object types. The experiment user would then determine the number and specific search object types desired for the experiment.

2. In step 5 of the worksheet, enter the number of search objects. The allowed entries are whole numbers between one and four.

3. In steps 6 thru 9, choose each search object type. These steps determine the estimated AMDRs for the specific terrain types. For the maximum of four search object types, there are nine choices. If possible and appropriate, attempt to always include a high-visibility adult search object to create an upper bound for ESW values. Currently nine standard search objects exist based upon size and visibility. High-visibility adult or child search objects are usually white with an orange vest, or all orange for a clue (glove). Medium-visibility search objects are usually blue, and low-visibility search objects are usually olive green or brown. If the terrain type is white for snow, high-visibility search objects are covered in orange, medium-visibility search objects are usually covered in blue, and for low-visibility search objects are usually covered in white. For further explanation of the construction and visibility of certain objects, see Appendix B. The choices are:

- Adult High-Visibility
- Adult Medium-Visibility
- Adult Low-Visibility
- Child High-Visibility
- Child Medium-Visibility

- Child Low-Visibility
- Clue High-Visibility
- Clue Medium-Visibility
- Clue Low-Visibility

The next thing the experiment designer needs to do is to develop an experiment design using estimated AMDRs found in the IDEA software worksheet "3. Estimate Experiment Design" and titled "Experiment Design Using Estimate AMDRs." In the worksheet, the experiment designer will enter the number of searchers that will participate and the amount of time allotted for the experiment. IDEA will then provide a recommended course design including maximum number of search objects to be placed along the track distance (TD), the track length (TL), and the estimated average time that the experiment would need. To complete this worksheet, the experiment designer will:

1. Estimate the **number of search teams** (searcher and data logger) that will be able to go through the course. Enter this number into the IDEA software. It is possible to convert a searcher to a data logger after they have gone through the course. It is possible, however, that a data logger can go through the course numerous times, but

their role needs to remain as data logger for they will have been exposed to object locations. It is also necessary to allow for debriefing and rest between sorties. If possible recruit data loggers well ahead of the actual experiment. For estimating purposes the typical separation between teams should be 10 minutes. For daylight experiments teams should not be launched until sunrise and the last team launched must be able to complete the course by sunset. The limiting factor is usually the number of searchers and data loggers that can be recruited.

2. Review the provided estimates of speed for the search teams. If the estimates are not considered reasonable for the experiment, then scroll down and find the section with "optional" inputs to estimate the **average speed** search teams will move through the course. The IDEA software uses a default search speed of 1.75 km/hour for the average, 2.5 km/hr for the max, and 1 km/hr for the minimum (these figures are converted to yards when necessary). This was based largely on flatter courses. Courses with substantial uphill and downhill climbs averaged 1.4 km/hr. The user, based upon local knowledge, may change the default values.

3. Estimate the **time available** for participants to complete the course. Enter a value between one and four hours into the IDEA software. A maximum time value will already be entered based upon the answers to the event type and course purpose questions. The user may insert a lower time value. Remember that in addition to time on the course, time is required to brief and debrief and this time is not included in the time available to complete the course.

4. Review the number of desired search objects determined in the IDEA software worksheet "2. Search Object Types."

5. Review the terrain type previously entered in the IDEA software worksheet "1. Experiment Setup."

6. Review the estimated AMDRs for each Search Object Type selected. IDEA provides an estimated AMDR for each search object type chosen, depending on the terrain type and correction factors for size and visibility of each search object type. The estimate is only for initial planning purposes. The actual course will be determined using measured AMDR values. If the estimates are not considered realistic, then scroll down to the "optional" input section to enter correction factors for size and visibility. For the purposes of estimating, use the following charts.

AMDR Estimates for Adult High Visibility

Terrain Type	Adult High Visibility AMDR
California Oak/Field	41 meters
Eastern Forest (Mountain, Brown)	80 meters
Eastern Forest (Mountain, Green)	19 meters
Eastern Forest (Steep Mountain side, Green)	35 meters
Field (flat) 15 cm vertical ground cover	45 meters
Field (flat) 35 cm vertical ground cover	12 meters
Field (flat) 75 cm vertical ground cover	4 meters
High Density Urban	8 meters
Medium Density Urban	10 meters
New Mexico Pine Forest (Mountain)	34 meters
Orchard (green)	14 meters
Western (Maritime) pine (Green)	34 meters

Correction Factors for Search Objects

Search Object Size	Correction Factor	Search Object Contrast	Correction Factor
Adult	1.0	High Visibility (Orange/white)	1.0
Child	0.75	Medium Visibility (Blue)	0.75
Clue (glove)	0.4	Low Visibility (Green)	0.6

Example: The corrective values modify the predetermined AMDR for a High-Visibility Adult, for a chosen terrain type, in order to estimate the AMDR of other search objects such as child or clue size objects as well as medium or low visibility objects. For example, using the predetermined corrective values for size and visibility we can determine the estimated AMDR for other search objects. The worksheet already provides the estimated AMDR for an Adult High-Visibility search object in Eastern Forest (steep mountainous terrain) in full vegetation is 35 meters. But, for an Adult Low-Visibility object, the worksheet corrects the 35 meter value to 21 meters (35 meters x 0.6 correction for low-visibility = 21). For a Child Medium-Visibility the worksheet would correct the 35 meter value to 20 meters (35 meters x 0.75 correction for child size x 0.75 correction for medium-visibility = 20 meters). Finally, for a Clue High-Visibility, the worksheet corrects the 35 meter value to 14 meters (35 meters x 0.4 correction for clue size x 1.0 correction for high visibility = 14). The estimated AMDR for an Adult High-Visibility search object in Eastern Forest (steep mountainous terrain) in full vegetation is 35 meters. For an Adult Low-Visibility object it would be 0.6 x 35 = 21, for a Child Medium-Visibility it would be 35 x 0.75 x 0.75 = 20, and for a Clue High-Visibility it would be 35 x 0.4 x 1.0 = 14. **Note: these are only estimates and should not under any circumstance replace collecting actual AMDR values.**

IDEA calculates the estimated number of search objects, expected TL, and the amount of time expected to complete the course. Below the expected values are the experiment design check boxes. If the expected course length or number of search objects fall outside of desirable parameters the experiment designer is alerted. The variables that the designer may easily change are the number and type of search objects along with the number of searchers. A typical problem is a course that is too long because the entered number of participating searchers is small. An ideal solution is to recruit more searchers, but this is often difficult. During the pilot studies, the situation of having more searchers than expected occurred only once. The more typical solution is to use either fewer search object types or to switch to a search object that has a smaller AMDR (either less contrast or smaller in size). However, an effort should be made to maintain the high contrast adult search object if the purpose of the experiment is to determine ESW for a new set of environmental conditions. The suggested track line length is a guide to the amount of area required for

conducting the experiment. The calculator uses one hour as the minimum time required to conduct a valid experiment.

Select a Candidate Detection Experiment Area

For conference and SAREX events the correct search area is critical to the success of the experiment. In these settings it will be difficult to recruit searchers if they have to travel any distance from the conference or SAREX area to the site. Every effort should be made to find a site adjacent to conference events.

1. Site **selection factors** include the type of terrain/vegetation for which detection data is desired, size, location, uniformity, safety, and logistical support. If unfamiliar with local conditions it may be necessary to scout several possible sites.

2. **Determine the size** of the search area. The dimensions of the search area will depend upon whether the course is straight or makes a circuit. The easiest type of course to set up from a logistical standpoint is a circuit. Searchers will start and finish in roughly the same location. However, this is not an absolute requirement. The dimensions for most courses with an outward-bound leg and return are: for length, half the total course length plus 1.5 times the AMDR of the most visible search object; for width, 7 times the AMDR of the most visible search object. If the course is between two widely separated locations, then the length is the same as the TL and the width is 3 times the AMDR of the most visible search object.

3. **Select potential locations**. The location is largely defined by the event type, purpose of the experiment, and logistical concerns. Conference and SAREX events must be staged close to the actual conference to ensure searchers are available. If alternative arrangements are made prior to the conference to ensure sufficient searchers are available, especially when combined with making the experiment a pre-conference activity, then the site may be more remote. Courses may be laid out along a road/trail, cross-country, or a mixture of both. Courses may be laid out largely at the same elevation, or with significant elevation changes. In all cases it should accurately represent what a searcher would encounter during a typical SAR task in the area.

> The selected location should be reasonably uniform with respect to vegetation and terrain. In many cases it may be difficult to know whether the area has the desired vegetation type(s) prior to scouting the location. Topographic and orthographic maps are important tools in making a site selection. Both will help in determining whether a potential site is uniform. Avoid steep climbs unless this is an element being tested.
>
> Since a valid experiment needs to last at least and hour and the typical searcher moves at 1.75 km/hr, the minimum course length will need to be at least 1.75 km.

4. **Consider logistical requirements** for potential sites. Logistical needs of an experiment include parking, permission to use the land, a staging area, location or building for command and control, water, restrooms, and no unacceptable hazards.

5. **Select candidate sites**. Two or three potential sites may be selected prior to the scouting trip if unfamiliar with the area. Use local resources as much as possible to obtain information on the potential sites.

Prepare for Scouting Trip

1. Prepare for the first site visit by obtaining good driving directions to the site, a topographic map of the site (printed on waterproof paper), aerial photograph of the site, and any other special maps that may be available. Maps may be obtained from the USGS, several commercial mapping software applications, or online. Online resources include terraserver (http://terraserver.microsoft.com) or The National Map (http://nationalmap.gov). These sites have both topographic and orthographic resources.

2. If meeting local resources who are knowledgeable about the site, be sure to have phone numbers and alternative contact information.

3. Be knowledgeable of any hunting activity at the site or any other unique hazards that may impact the experiment.

4. Bring the following equipment for the initial site visit.
   - Maps and compass
   - Print IDEA software worksheet "4. Env. Measurement" and titled "Environmental Measurements."
   - Print IDEA software worksheets "6. AMDR Adult," "7. AMDR Child," and "8. AMDR Clue" and titled "Determining AMDR—Adult," "Determining AMDR—Child," and "Determining AMDR—Clue" respectively (printed on waterproof paper).
   - Clipboard
   - GPS unit
   - Lux Meter
   - Laser Range Finder or Tape measure
   - Digital camera
   - Extra batteries
   - One of each type of search object (white, blue, and green coveralls along with orange, blue, and green glove).
   - Flagging tape
   - Ruler
   - Cardboard box (for search objects' chest)
   - Cardboard shipping tube (for leg and Robel pole)
   - Typical SAR pack and contents (to carry everything and stay safe).

Scouting the Experiment Area

1. Upon arriving, confirm and update driving directions, land ownership, hunting, hazards, etc.

2. Drive around the borders of the area if possible. It is acceptable to have the course cross a road. This often makes logistics easier and makes it possible to shorten the course if required.

3. Walk the area to confirm features on the map, identify missing features, assess the general operating environment, uniformity of vegetation and terrain, desired type of vegetation, existence of unmarked roads and trails, and get a general feel for the area. **Even if familiar with an area, it is useful to scout it from the perspective of conducting an experiment. Generally, ruling out an area that is unacceptable takes little time; determining that an area is appropriate takes more time.**

4. Scout the area from a logistical standpoint. Look at parking areas, staging sites, command and control location, start and finish of course, location versus other events/venues, and support (restroom, shelter, water, electricity, lighting, radio communications, cell phone coverage, etc.).

5. If the area is acceptable, take environmental measurements and determine AMDR as outlined below.

Environmental Measurements

1. **Choose a site** to collect AMDR measurements. The site should be selected at random, but it must also be a good representation of the search area. One method of selecting a random location is to find a good general location first. Then, ask another person to pick two numbers between 1 and 360. Use one number as the compass direction and the other number the distance to travel. If alone, use a compass, give it several spins without looking, and use the values for direction and distance. If the final location is not representative of the area repeat the process.

2. At the site, complete the information needed for IDEA software worksheet "4. Env. Measurements" and titled "**Environmental Measurements**". The form requests general administrative information (1-4).

3. In completing **weather information** (5-11)**,** the ideal is to take measurements with instruments in the field. This will require a handheld thermometer, anemometer, and Lux meter. If an anemometer is not available, the wind speed can either be estimated or obtained from the weather service. If a Lux meter is not available (box 7), then the descriptive terms found in box 10 will suffice.

4. **General Characteristics** (12-16). Items 12 -15 should be automatically filled in from the IDEA software worksheet "1. Experiment Setup." Item 16 is optional for specific characteristics of the field being used for the experiment.

   The **Ecoregion** system used is the Bailey Ecoregions index. This information should already be filled out from worksheet "1. Experiment Setup." Ecoregion index numbers may be obtained from the U.S. National Atlas (http://nationalatlas.gov). Open the Uniform Resource Locator (URL), click on map maker, click on the find tab, enter either the general location or zip code, click on zoom to feature, click on the map layers tab, click on the triangle to the left of biology, on the Ecoregions – Bailey selection box choose "Provinces and Sections", then click on redraw map tab (under map layers). The Ecoregion is then layered onto the map. To determine the experiment site's ecoregion, click on map key tab.

   The **forest cover type** is only applicable if in a forested area. This information should already be filled out from worksheet "1. Experiment Setup." To determine the forest cover type the U.S. National Atlas is also used. If at the same location used to determine the Ecoregion, go to the Map Layer tab. On the Ecoregion-Bailey option box make sure "none selected" is chosen. Select the Forest Cover Types. Click on "Redraw Map." Zoom in or out as appropriate. Click on the Map Key to determine the appropriate forest cover type. Record the results.

   The **National Land Classification Data (NLCD)** classifies land use into several different broad categories. This information should already be filled out from the worksheet "1. Experiment Setup." The NLCD classification can be determined from The National Map (http://nationalmap.gov). Open the URL, click on "Go to Viewer" red tab, click on find place. If a GPS coordinate is available, use Point; otherwise, find the location as a feature or go to the county. Once the search area is found, zoom to the appropriate level. Then click the black triangle to the left of Land Use / Land Cover on the right hand layers section. Scroll down to "USGS NLCD" and select the box, and then click the Refresh Map button at the bottom of the layer section. Click on the legend and scroll down to find the appropriate color and record the results on the form.

5. While out in the field, record the **GPS coordinates** where environmental measurements are taken. Record the datum being used by the GPS unit. If time permits, measurements should be taken from two locations and the results averaged.

6. **Vegetation type.** List the types and sizes of the ground cover, mid-story (small trees, larger bushes), and canopy (types of trees, range in diameter of the trees). If scientific names are used, be sure to include the common name (common names are preferred). A comprehensive list is not required, just sufficient detail to give a general sense of the predominant vegetation.

7. **Ground Cover height:** The height of the ground cover is measured using the Robel Pole technique. Construction of a Robel pole is described in Appendix C. To make a measurement place the Robel pole (or box) firmly on the actual ground. Use the string to measure a distance four meters away from the pole, and the last knotted meter of the string to measure a height one meter from the ground to use as the height of eye when looking back at the Robel pole. With eyes one meter above the ground, look back at the Robel pole and note the height of the last visible number. This is just above the lowest point that is covered by vegetation. The Robel pole is also sometimes called the visual obstruction pole.

8. **Slope:** Using an inclinometer (built into better compasses) estimate the slope of the terrain.

9. **Obstructions:** In a 10-meter radius around the AMDR site, count the number of obstructions (rocks, tree stumps, fallen trees, etc.) that are at least a cubic foot in size. Count standing trees with a diameter greater than 30 cm (1 foot).

10. **Horizontal Obstructions.** The horizontal plane is eventually obstructed either by downed trees/vegetation or by the land itself. The horizontal measurement captures how far it is possible to see along the horizontal plane (at breast height). For each cardinal direction determine how far a person could possibly see another person standing up. If a second person is available, have that person pace off the distance until they disappear. If a laser range finder is available, directly measure the distance to that person or range on an object that approximates a person's size. A person could disappear either due to vegetation or the land. Enter into the second column the reason they disappeared ("V" for vegetation, "L" for land). If the land is perfectly flat with no obstructions and disappearance distance exceeds the capability of the laser range finder, either record "U" for unlimited or pace off the distance. When in forested areas, it is possible that a nearby tree exists exactly on one of the cardinal directions. If this occurs, look for the farthest a person can see within approximately 15 degrees on either side of the cardinal direction.

11. In addition to completing the form in the field, enter the data into the IDEA software after returning from the field.

Photographs

Digital pictures should be taken of the AMDR site. In order to document the area in a consistent format, the following photographs are recommended.

1. Standing **at the site** of search object placement take a picture heading North, East, South, and West.

2. Standing **10 meters away** from the site (closer if in thick vegetation) take a picture showing each search object and the surrounding vegetation.

3. At a nearby location, take a picture that provides a **broad overview** of the surrounding terrain. This is often a wide landscape style photograph.

4. **Document** the photographs in a photo log or diary as they are taken.

5. At a later point, **paste or upload** the photographs into the IDEA software worksheet "5. Photos" and titled "Photographic Site Record."

6. Additional photos may be taken, as long as they are properly documented.

Establish the AMDR

1. From the IDEA software, print out the worksheets for adult, child, and clue AMDR (worksheets labeled "6. AMDR Adult," "7. AMDR Child," and "AMDR Clue"). It is ideal to print them on waterproof paper. Make sure to bring the appropriate pencil or pen that works with the paper.

2. Complete the header information.

3. Determine an AMDR for all nine of the basic search object types. Determine the AMDR with the same type of resource that will be conducting the experiment. If the experiment is for ground searchers, determining the AMDR should be conducted on foot. If for mounted searchers, determining the AMDR should be conducted on horseback.

    a. Place the first search object (typically the high visibility adult search object type) at the spot used for the environmental measurements. **Appendix A provides a complete and detailed description of how to build search objects. Following the standard is critical so results from one experiment can be compared with results from other experiments conducted in the same or a different area.**

    b. Two different measuring techniques can be used. One requires a laser range finder (the preferred method) and the second involves counting paces.

4. AMDR (laser range finder method) only requires one person. If a second person is available, they can hold the clipboard and record the distances. Both people could also switch roles for different search object types.
    a. Walk away from the search object until it is well lost from sight. The initial direction could be due west (to match the illustration), but this not important.
    b. Turn around and walk back towards the search object (due east in the illustration). At the moment the search object is spotted, record the distance to the search object with the laser range finder. This distance is the AMDR *detection* distance.
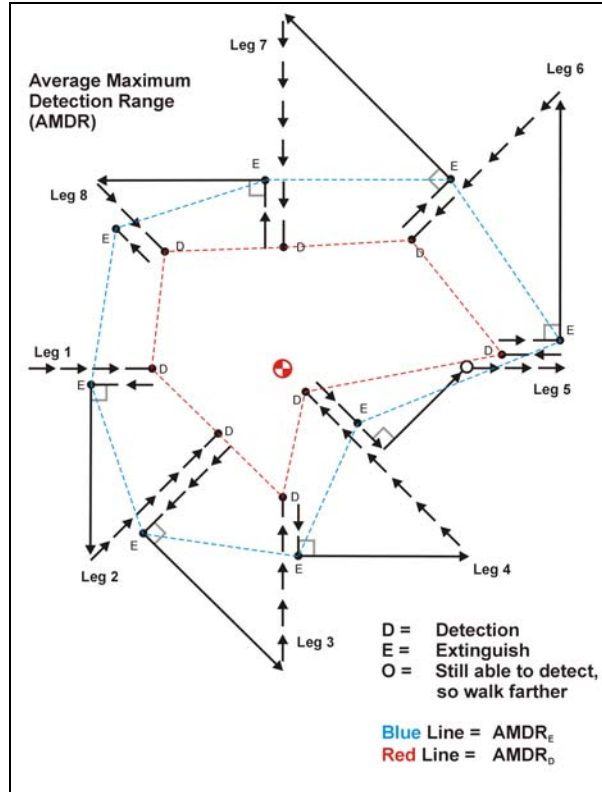
Figure 2. Determining Average Maximum Detection Range (AMDR)

c. Keeping the search object in sight, walk backwards until the search object can no longer be seen at all or the distance at which the portion still visible is so small it would not be detectable without the advantage of already having sighted the object and kept it in sight. For high contrast search objects, always move backwards to the point where the search object cannot be seen at all. For the low contrast search objects, use the point the search object can no longer really be discerned. Measure this distance and record it as the AMDR *extinguish* distance.

d. While still facing the search object, turn 90 degrees (to the right to match the illustration, but this not important as long as the observer consistently turns in the same direction) and pace off the same distance as just measured.

e. Turn 45 degrees (to the left in the illustration) and face towards the search object.

f. If the search object cannot be seen, begin walking forward. If the search object can be spotted immediately after turning towards it, simply turn around and walk farther away (illustrated on Leg 5 in the drawing) until it is well lost from sight, then turn around and walk back toward it until it can be detected and record the resulting detection distance. Move away until it is no longer detectable and record the extinguish distance.

g. Repeat this process and continue recording the AMDR detection and extinguish distances on all eight legs around the search object.

h. Repeat steps a-g for each of the different visibility colors for each sized search object type.

       i.   Repeat steps a-g for each of the different sizes. This will require a total of 9 tests. Each AMDR form contains spaces to record the results from each of the visibility ranges used for the same size search object type.

5. No laser Range finder method (one person)(Figure 2).
    a. Start at the search object location.
    b. Walk away from the search object in a cardinal direction (due west in the illustration).
    c. Turn around and walk back towards the search object (due east in the illustration).
    d. At the point the search object is detected, start counting paces.
    e. Keep pacing toward the search object.
    f. Upon reaching the search object record the AMDR detection distance.
    g. Keep walking straight (due east in this example) keeping track of the search object and maintaining a pace count from the object's location.
    h. When the search object disappears, record the distance, which represents the AMDR extinguish distance.
    i. Turn 90 degrees (either left or right, but always turn in that direction, this illustration shows a LEFT turn relative to the observer's previous motion away from the search object).
    j. Walk the same distance as the AMDR extinguish.
    k. Turn 45 degrees towards the search object.
    l. Walk towards the search object, until spotted.
    m. Repeat steps d-l. The entire 8-leg pattern will need to be repeated twice in order to collect both detection and extinguish distances on each leg.

6. No laser Range finder method (multiple people).
    a. It will be quicker to obtain AMDR values if multiple people are present.
    b. If two people are available, start opposite of each other (e.g., East and West leg). Each person would complete the 8-armed course once.
    c. If four people, start one at each of the cardinal directions.
    d. If eight people, each starts on one of the legs.
    e. Good record keeping is required to keep each leg in order.

7. Once out of the field, enter the values in the corresponding AMDR forms of the IDEA software. These actual values will be used to confirm the experiment design plan and to calculate the locations to place the search objects.

> Even when planning to use only one search object type in the experiment, gathering AMDR data for all types has tremendous experiment value and is well worth the time to collect. In addition, it is common to revise the search object types at the last moment and the AMDR values will be required.

Planning to Lay-out the Search Track

1. <mark>Enter the actual AMDR and environmental data into the IDEA software if not already done.</mark>

2. In the IDEA software worksheet "9. Actual Experiment Design" and titled "Experiment Design Using Actual AMDRs," the IDEA software provides the number of search objects to place, the minimum acceptable course length or TL, and the average time it would take to complete the experiment. The experiment designer should review the new results using actual AMDR values, and determine whether the number of searchers, searcher speed, or amount of time allocated needs to be changed. If any of these need new values, <mark>enter appropriate value in the indicated cells</mark>. The course may be longer (as long as it does not exceed the time limit of 4 hours). However, this must be balanced against other practical considerations. The IDEA software will point out when recommended limits have been exceeded, but it will not prevent setting up an improper course.

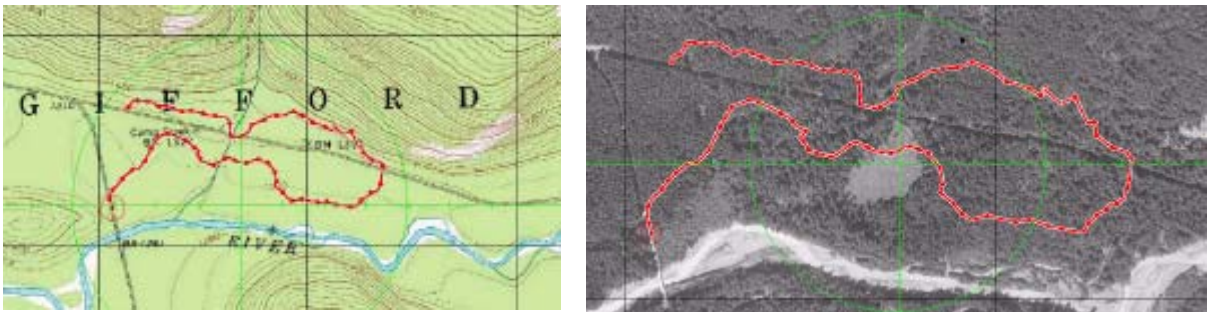3. Plot the tentative course onto a topographic map and determine whether the course length is adequate.

Figure 3. Topographic map (left) and aerial photograph (right) with course setup shown in red.

<div style="border:1px solid black">

Course Layout Considerations

- Determine whether the course will be out and back or linear (out and back may simplify the logistics of moving searchers to/from the experiment site).
- Determine whether the course will follow road/trail, cross-country, or a mixture of both.
- If out and back, try to use a natural feature such as a ridge to make sure search objects from the outward leg cannot be viewed from the inbound leg.
- Attempt to lay out the course similarly to a search task. Avoid steep climbs and descents unless part of the experiment.
- Avoid sharp bends in course.
- Avoid placing the course in areas where vegetation and terrain differ widely from the area that was tested for AMDR.

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4. Obtain the following equipment needed to lay out the course:
    - Maps (With grid for use with GPS)
    - GPS (check map datum setting to make sure consistent with map)
    - Compass
    - Flagging tape (at least 6 rolls per kilometer or per 1,000 yards)
    - Surveyor's Flags (stake wire vinyl flags) – Colors may be substituted depending upon availability and natural background. The goal is to provide a high contrast.
        a. Yellow flags (3 per kilometer or per 1,000 yards)
        b. Lime green flags (40 per kilometer or per 1,000 yards)
        c. Red flags (200 per kilometer or per 1,000 yards if dense)
        d. Orange flags (10 per kilometer or per 1,000 yards)
    - Stake wire flag carrier (not required but makes carrying the flags easier)
    - Flagging dispenser holster (not required but makes flagging easier)
    - Roller wheel (metric or yards depending upon units that will be used.)
    - Permanent marker (recommend bringing two in case one gets dropped and lost).
    - Signs identifying course (if required).
    - SAR pack and contents to stay safe and carry everything.

Laying-out the Search Track

1. **Establish the course initially**. With map, GPS, compass, and flagging tape start flagging the course. Flagging tape should be sufficient for the experiment designer to find the route.

2. Make adjustments as needed. It is common after setting down a segment of flags to find a slightly better route.

3. **Walk the course a second time** (after the course has been established and adjusted with flagging tape) with roller wheel and surveyor's flags (stake wire flags).

4. Place Surveyor's flags as follows:
    a. Place a yellow stake wire flag at the start of the course. Write "START" on it. Consider actual signs and/or flagging tape to make clear.
    b. Using the roller wheel measure 25 meters (yards).

When no Measuring Wheel is Available

If a roller wheel is not available, the distance may be paced off. Slight inaccuracies in the track line length will not alter the calculations for ESW. The person doing the pacing should be sure to calibrate their pace count for the terrain. In addition, some method of keeping track of the last flag should be used to avoid duplicating or skipping a number.

Using the Measuring Wheel

The counter on the wheel greatly helps keeping track of which number needs to be written on the flag. If the wheel is rolled too far, it may be rolled backwards to get back to the correct location. Every attempt should be made to obtain a wheel with a large diameter to make it easier to measure in vegetation. If in thick vegetation, the wheel may be rolled over logs, brush, ground cover, and still continue to measure distances. Some struggles are expected when in thick vegetation.

Figure 4. Left: Use of the measuring wheel to measure course. Right: Track marked with different colors of surveyor's tape.
Yellow marked start, pink clearly marks track, green marks 25 meters.

c. Place a lime green flag (or appropriate color) and write 25 on it.
d. Measure an additional 25 meters and place another lime green flag stake, write 50 on it.
e. Continuing measuring the course with the roller wheel placing a green flag every 25 meters (distance written on flag) with the following color exceptions.

          i.   Place a yellow flag at start, at 100 meters, 500 meters, every 500 meter interval, and end.

          ii.   Place an orange flag at every 100-meter interval (except where yellow flag)

          iii.   Make sure to write the distance on every flag.

5. **Walk the course a third time** with flagging tape and red marker stake wire flags.
   a. Place red flags along the route as needed to make the route clear and easy to follow.
   b. Place plenty of flags at any turn or location where searchers may easily wander off the experiment track (e.g., along a game trail instead).
   c. Use enough flags; remember even trained searchers can wander off a well-marked trail when intent on searching.
   d. Try to use the wire stake flags versus flagging tape, since excess flagging tape at eye-level is more distracting to searchers.

6. **Walk the course a fourth time** with a GPS unit to plot the course track. Keep the GPS unit in its optimal position (for many models it needs to be held flat). Make sure GPS is recording route traveled. In some cases the GPS track may be obtained at the same time the third walking of the course. However, if alone, it might be difficult to lay flags and keep GPS in a good position. It is also possible to obtain the GPS track while serving as a data logger during the actual experiment. In this case, it would not be possible to print out maps with the course marked on them for the data loggers.

Planning the Location of Search Objects

Once the final course has been determined, review the initial placement locations and numbers of search objects. This step needs to be done well in advance of the actual experiment to make sure sufficient supplies are obtained to make the search objects.

1. The number of search objects (obtained from worksheet "9. Actual Experiment Design" and titled "Experiment Design Using Actual AMDRs") and their locations are dependent on the track length and AMDR of each search object type (AMDRs were previously entered in the worksheets "6. AMDR Adult," "7. AMDR Child," and "AMDR Clue").

2. Review the object placement results in worksheet "10. Obj. Placement Tabl & Chart" and titled "Object Placement Table & Chart" No data needs to be entered, but note that the placement results change every time new information is entered anywhere in the IDEA software or when the F9 (calculate) key is pressed. The worksheet provides a graphic representation of how the search objects should be placed and a number of search objects to sufficiently cover the estimated length of the track. The worksheet places the search objects randomly 3 AMDRs along the track and 1.5 AMDRs on each side of the track as "Lateral Range," calculating a predetermined number of search objects for each Search Object Type. The option closest to a

uniform distribution is optimal for these experiments. The worksheet can be calculated by hitting the F9 key as many times as desired. Each iteration is not preserved; therefore, it is necessary to click on the "You must click here to keep these results and print" green button before printing. After clicking on the green button, then print as normal. The results will be saved in the lower portion of the worksheet. The green button appears as follows:

You must click here to keep these results and be able to print.

3. Print several copies of the worksheet "10. Obj. Placement Tabl & Chart" and titled "Object Placement Table & Chart" on waterproof paper. Remember to first click on the button labeled "You must click here to keep these results and print."

4. If no printer is available, transcribe the locations and placement details (search object number, track distance (TD), lateral range distance, left or right designation, search object type (# and description), and orientation).

5. A sufficient number of supplies to construct "extra" search objects should be obtained well in advance of the experiment.

Placement of Search Objects

Placement of search objects typically takes 8 hours with two teams. No search objects should be placed the day of the experiment. **Therefore, allow an entire day before the experiment for the placement of search objects in the field.** Each team needs at least two people.

1. Assemble all the required equipment for putting out the search objects.
   - Print worksheet labeled "10. Obj. Placement Tabl & Chart" and titled "Object Placement Table & Chart" on waterproof paper
   - Print worksheet labeled "11. Search Object Location" and titled "Search Object Location Log" on waterproof paper
   - Pencil or pen appropriate for waterproof paper
   - Map of area
   - Compass
   - Clipboards
   - Laser range finder
   - Orange vests for placement team
   - Ruler

2. Assemble all the required equipment for constructing search objects.
   - Colored coveralls (adult and child sized search objects)
   - Orange vests for search objects (if high-visibility adult)

- Can of appropriate paint to touch up objects if needed
- Colored gloves for clue size if needed
- Cardboard "stuffing" (best left unassembled until at search object location)
- Tent stakes (logs or rocks may also be used to prevent objects from blowing away)

3. Drive search objects to easy access points close to the course. The direction of the course does not have to be followed for the placement of objects.

4. Carry the search objects to the general area indicated as Track Distance (TD). Go slightly past the indicated distance in the direction the searchers will travel. The purpose of going past the actual distance (always farther from the start point) is that track/clue aware searchers may notice the assembly point and look harder at that point.

5. Assemble the search object (if required) along the track.

6. One team member (the "spotter") carries the search object to the left or right of the track depending upon the search object placement worksheet. Make sure when leaving the track not to depart straight to the eventual site. Instead, walk well past the site to avoid making detectable track to the search object. The actual distance will depend upon the type of terrain and potential skill of the searchers.

7. The team member still on the track (the "pointer") moves to the closest 25-meter flag, then paces the distance to the TD found on worksheet "10. Obj. Placement Tabl & Chart" and titled "Object Placement Table & Chart". Once standing at the correct spot the pointer directs the spotter carrying the search object to move so they are 90 degrees to the track.

8. Next, the pointer directs the spotter to move closer or farther away by using the Laser Range Finder to determine the correct off-track distance or lateral range. When the spotter is in the correct position, the pointer directs them to place the search object.

Using the Laser Range Finder to Measure Track Off-set

Moving the spotter to the correct track offset is usually simple. The pointer ranges on the spotter and directs them to move in or out. However, in thicker vegetation it may be difficult to know if you are correctly targeting the spotter. In this situation, ask the person to step one-meter forward or backwards, if the range changes by one-meter you have correctly ranged on the spotter. Unfortunately, some vegetation is simply too thick to successfully range. In this situation, find an intermediate object (usually a distinctive tree) to range. The pointer can then record the intermediate distance, move to that location and then direct the spotter to the correct distance. Finally, most laser range finders have a minimum distance at which they operate (10 meters is common). If a search object needs to be placed at a closer distance, then pacing such a short distance is accurate enough.

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9. Use the compass direction from worksheet "10. Obj. Placement Tabl & Chart" and titled "Object Placement Table & Chart" to determine in which direction the search object should point.

10. Place the object. If placing an adult or child size object, crush down any ground vegetation to simulate how an actual person would rest. A person is much heavier than the simulated object and would not be supported by most ground cover. If placing a clue, drop the clue over the shoulder.

11. Stake down the object. Use either tent stakes or native material that is available.

12. Note the search object's location on the "Search Object Location Log" (in IDEA, worksheet labeled "11. Search Object Location").

Placing Targets Reality: Left vs. Right

In an ideal world the placement of targets would strictly follow the parameters randomly chosen by the IDEA software. However, real courses present situations that may require modifications. There are several reasons why the randomly chosen location may not be the most ideal. They may include:
- Falls on private property
- Falls on the inside of a sharp turn the trail may take
- Is readily visible from the opposite leg of the course
- Falls on terrain not typical of the search area
- Falls on a road or the actual trail if a sharp turn
- Falls on a body of water

If this occurs, it is acceptable to move the search object from the left to right or right to left as needed.

Placing Targets Reality Check: Virtual Search Objects

One other situation will warrant relocating a search object from the location selected by the IDEA software. In some situations, once the object is correctly placed it is impossible to see the object from anywhere along the track. Since each search object requires a good bit of effort to haul into the woods and the number of search objects may be limited, this appears to be a waste of effort. Two additional steps are required if this situation arises. The first is confirmation that the search object is undetectable from the track. This requires the spotter to continue to stand by the search object (wearing blaze orange) while the pointer walks at least 50 meters in both directions along the track to confirm it is impossible to spot the search object. It is amazing how often changing the angle and looking backwards may make a search object detectable from alternative viewpoints. In addition, if setting search objects in darkness and the experiment will be conducted during the day, search object locations should **NOT** be moved. After confirming it is impossible to spot the search object, the next step is to move the search object to a location where it can be seen. This is accomplished by the spotter simply walking towards the track until the pointer (standing at the established TD) can spot the object. The new distance is measured with the laser range finder. Two objects will need to be recorded on the "Search Object Location Log" (IDEA software worksheet "11. Search Object Location."

1. The virtual search object. Record the original location of where the search object should have been placed. Place a "v" next to the search object number.
2. The new actual search object. Record the new location and give this search object a new number.

13. After returning from the field, enter the actual locations into the IDEA software worksheet "11. Search Object Location" and titled "Search Object Location Log").

Experiment Day

On experiment day, all course preparation should be complete. The following should be true: the course is already laid out, the search objects are already in place, and all arrangements for personnel (searchers, data loggers, experiment and overhead team) are done. Activities on experiment day include: establishing the command center and making required logistics arrangements (can be done the day before in some cases), briefing the searchers, briefing the data loggers, assigning participants to two-person teams consisting of a searcher and a data logger, dispatching the teams, debriefing the teams, collecting the data, and breaking down the course (may be done the following day).

Command Center and Logistics

The experiment management team should arrive one to two hours prior to the arrival of searchers to establish the command center and prepare logistics. The command center and coordination of teams is quite similar to the management of a search incident, except that every team is given essentially the same task and teams are dispatched at timed intervals. Every person needs to be accounted for, briefed, tracked, and debriefed. The paperwork is similar to that used on searches with a few modifications to meet the needs of the experiment. Logistical support can range from a simple location with limited resources to a building with parking, restrooms, electricity, copiers, tables, food, water, radio communications, etc.

1. Assemble the research team. The number will vary depending upon the size of the experiment, the number of searchers and average time between arrivals, the experience of data loggers, and amount of logistical support.
   - Experiment coordinator (may fulfill other roles as needed)
   - Briefers/debriefers (may be fulfilled by data loggers if they have prior experience)
   - Radio operator (if radios are issued to teams, there will also be a need to assist in checking these radios out and back in)
   - Drivers (if needed to transport teams from command center to course)
   - Initial data loggers (best to arrange first data loggers so no teams are delayed)

Searcher and Data Logger Recruitment

Searcher and data logger recruitment must not wait until the day before the experiment. Instead it must be an integral part of planning an experiment. The estimated number of teams is an important component of course planning. More importantly a lack of search teams is the most likely situation to cause an experiment to fail. Recruitment must start early in the planning process. The best method of recruitment will largely depend upon the type of event.

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2. Assemble the suggested equipment for conducting an experiment
   - IDEA software worksheet "12. Searcher-Participant Log" and titled "Searcher—Participant Log." Print three (3) copies.
   - IDEA software worksheet "13. Team Sign-Up" and titled "Team Sign-Up." Print one (1) copy.
   - IDEA software worksheet "14. Subject Information Sheet" and titled "Subject Information Sheet." Print one (1) copy per searcher. Make changes depending upon scenario.
   - IDEA software worksheet "15. Task Instructions" and titled "Task Assignment Form." Print one (1) copy per searcher.
   - IDEA software worksheet "16. Data Logger Briefing" and titled "General Briefing Data Logger." Print one (1) copy per data logger.
   - IDEA software worksheet "17. Team Tracking" and titled "Team Tracking Log." Print one (1) copy per searcher.
   - IDEA software worksheet "18. Vision Tests" and titled "Color Vision Tests." Print three (3) copies on color printer.
   - IDEA software worksheet "19. Searcher Profile" and titled "Searcher Profile." Print one (1) copy per searcher.
   - IDEA software worksheet "20. Detection Log" and titled "Detection Log." Print one (1) copy per searcher on waterproof paper.
   - Clear plastic or acetate
   - Clipboards (6-12)
   - Pencils/Pens (12-24)
   - Stapler (2)
   - Cellophane or similar adhesive tape
   - Large Permanent Marker
   - Blank paper/cardboard for making signs
   - Folders (3, labeled planned tasks, tasks in-progress, tasks complete)
   - Flagging tape
   - Anemometer (or guide for wind speed estimation)
   - Thermometer (suggested)
   - Lux meter (suggested)
   - Map of course
   - Map to get from command center to course (if needed)

3. Assemble logistical support equipment (depending upon location and type of event all or none of the following may be required to support the experiment).
   - Water
   - Food
   - Toilet paper
   - Shelter
   - Tables
   - Chairs
   - Whiteboard
   - Laptops
   - Electrical (generator, extension cords, power strips, battery backups)
   - Traffic cones

4. Prepare "team" packages on clipboards. Since each team will require the following pieces of paperwork, it is best to prepare them ahead of time on a clipboard before the teams arrive.
    - Subject information sheet
    - "Task Assignment Form", IDEA software worksheet "15. Task Instructions"
    - Data logger briefing
    - Searcher Profile
    - Detection Log
    - Clipboard
    - Clear plastic or acetate cover

Instructions to Searchers

Instructions to all searchers should be as uniform as possible. To assist with this, a searcher information sheet and a task assignment form have been produced. It would be helpful if a professional-grade briefing video could be made.

1. Have all participants sign-in to the experiment using the "Searcher—Participant Log" IDEA software worksheet "12. Searcher-Participant Log." This includes the experiment team and data loggers. Pair searchers with data loggers and schedule times (if not done previously) using the team sign-in form.

2. Brief the searchers using the Subject Information Sheet and the Task Assignment Form. Explain the objectives of the experiment and the experiment scenario.

3. Describe the search area and the track.

4. Describe the nature of the search objects or instruct searchers to report anything out of the ordinary. All searchers need to be given identical instructions.

5. Instruct searchers how to report a possible detection to the data logger.
    - Point at object, state what they see
    - Give estimated distance
    - Give clock direction relative to track (12 o'clock is directly ahead, 3 o'clock is 90 degrees to the right, 7 o'clock is behind and to the left, etc.)

6. Tell searchers not to discuss the search with other participants.

7. Have each searcher fill in Part A of "Searcher Profile" IDEA software worksheet "19. Searcher Profile." Assist the searcher in completing part B. Keep the Searcher profile form at the command center while the searcher is in field. The form should be placed in the task in progress folder.

8. When the team departs, make sure the team and departure time are recorded on the "Team Tracking Log" IDEA software worksheet "17. Team Tracking."

Instructions to Data Loggers

The data loggers are instrumental to the success of the experiment. If they fail to collect the data correctly the data will be lost or will alter the experiment results. Data loggers typically come from the experiment team or from searchers who have been through the course already. If someone is functioning as a data logger for the first time, it may be useful to shadow them on the initial part of the course and verify they record the information from the first search object (which is designed to be easy to spot) correctly. (These are only the key points – the data logger should be thoroughly familiar with all the data logger instructions provided.)

1. All data loggers should also sign-in on the "Searcher—Participant Log," IDEA software worksheet "12. Searcher-Participant Log."

2. Data loggers can be scheduled using the Searcher—Participant Log. However, since data loggers may go through the course multiple times, their scheduling is often more dynamic.

3. The data logger follows the searcher and records all relevant information, comments, and data.

4. Each data logger will be furnished the following:
   - Map of search area and track
   - "General Briefing Data Logger" instructions, IDEA software worksheet "16. Data Logger Briefing"
   - "Detection log," IDEA software worksheet "20. Detection Log" (printed on waterproof paper).
   - Clipboard
   - Two pens or pencils (depending upon type of waterproof paper)

5. Briefer fills out the Detection Log header information, Worksheet "20. Detection Log". The briefer should tell the data logger what the actual search object types are (this avoids the data logger recording every piece of discarded trash in the area).

6. During the experiment, while following the searcher, the data logger will record the following times:
   - Start time on course (should be a yellow flag)
   - Time at each yellow flag (start, 100 meters, every 500 meters, end)
   - Time of each announced detection
   - End time

7. A set of the colored flags used on the course should be available during the briefing, so the data logger can see each color and be told what each flag represents. Default purposes of color flags will need to be changed on instruction sheets if a different color scheme is used.

8. The data logger will <mark>record a possible sighting on the "Detection Log"</mark> IDEA software worksheet "20. Detection Log" as follows:
   - Determine current position along the track. This is typically done by recalling the last distance marker flag passed, or finding the nearest marked flag. Distances can be either estimated or paced from the nearest distance-marker flag.
   - Place a dot on the detection log that corresponds to that distance.
   - Place an arrow on the detection log that corresponds to the direction (estimated clock bearing) in which the searcher is pointing.
   - Record the searcher's estimated distance to the search object
   - Record what search object the searcher reported seeing.
   - Examples of a proper data record are included on the detection log.

Is it a detection?

A common dilemma for a data logger is when a searcher stops and thinks they see something but they aren't sure. In some cases searchers eventually satisfy themselves that they didn't see anything. In this case, nothing is recorded. In other cases, searchers remain unsure. The data logger is allowed to ask the searcher, "On a real search would you go over and investigate what you think you see?" If the reply is "yes," then the possible sighting is recorded as a detection on the Detection Log. If the reply is "no", then nothing is recorded.

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9. <mark>Review all instructions on the "General Briefing Data Logger"</mark> IDEA software worksheet "16. Data Logger Briefing" including:
   - Data logger is team leader
   - Staying on the track at all times
   - Stay behind the searcher at all times, including when they turn around
   - Monitoring searcher speed
   - Not talking to or otherwise distracting the searcher
   - Giving no clues to the searcher
   - Passing rules if another team is overtaken.

10. Do not tell the searcher the results of the search, and do not discuss the experiment with anyone until the entire experiment has been completed and the last searcher has been debriefed.

11. Each data logger and searcher must return to command post for debriefing.

Debrief Search Team

Each team must be debriefed upon completion of the course. It is critical to collect the Detection Log from the data logger. Review the Detection Log for clarity and accuracy. Resolve any questions about how to interpret the data logger's marks immediately.

Complete the remaining portions of the "Searcher Profile" IDEA software worksheet "19. Searcher Profile." Otherwise, some or all of that team's effort and data will be lost.

1. Collect the Detection Log from the data logger and staple it to the searcher profile (taken out of the task in progress folder).

2. Note the time the team returned on the "Team-Tracking Log" IDEA worksheet "17. Team Tracking."

3. Return any communications equipment that was checked out, unless the data logger is returning to the course.

4. Debrief the searcher, completing part C of the "Searcher Profile" IDEA worksheet "19. Searcher Profile." An experienced data logger may conduct the debriefing.

5. A member of the experiment team should review the searcher profile form and detection log form making sure nothing has been left blank and that any confusing elements are clarified.

6. Ask the searcher if they are willing to serve as a data logger. Thank the searcher and tell when results will be released.

7. Ask the data logger whether they are willing to go out again, and if so, how long of a break, if any, is required.

8. Store the "Searcher Profile" IDEA software worksheet "19. Searcher Profile" and the "Detection Log" IDEA software worksheet "20. Detection Log" in the task-completed folder. **KEEP THIS FOLDER SAFE!**

Recovery of Search Objects

After the experiment, the course will need to be cleaned up. The only exception would be a permanent course or an experiment in two parts where the course will be repeated with different resources or searchers. In every case, search object locations need to be confirmed either at the end of the day or on the following day.

1. Assemble the following equipment:
   - Updated Search Object Location Log, IDEA software worksheet "11. Search Object Location"
   - Clipboard
   - Pen/pencils
   - GPS
   - Laser range finder or tape measure
   - Large plastic leaf bags
   - Stake wire flag holders

2. If possible, assemble into two or more teams of at least two people.

3. Using the Search Object Location Log one person stands at the indicated track line distance on the course while the second person goes to retrieve the search object.

4. If the search object was initially placed by pacing, then the lateral range needs to be verified by either a laser range finder or tape measure.

5. Once a search object's location is verified, <mark>a checkmark can be made on the Search Object Location Log</mark>, and the object removed from the field (if appropriate).

6. Typically after all the search objects are removed, one last trip is made to pick up all the surveyor flags and flagging tape.

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Analyze Results

Analyzing the results is largely automated by the IDEA software. Data analysis consists of scoring each searcher's results, entry of each searcher's profile data and the searcher's detection results, and the automated calculation of ESW.

Scoring Results

Scoring results takes about 3-5 minutes for each searcher. A lot of the extra work of laying down marked flags and using grid detection logs makes the scoring process rapid and fairly straight forward. However, it does greatly help if the scorer walked the course at least once and ideally as a data logger. Ideally the scorer will be the same person who designed and ran the experiment.

1. Copy the "Detection Log Scoring Template" IDEA software worksheet "21. Detection Template" onto clear acetate.

2. Using the "Search Object Location Log" IDEA software worksheet "20. Detection Log," place a color-coded (by search object type) dot onto the acetate for each search object corresponding to its TD, lateral range distance, and left vs. right.

3. For each searcher, print out a "Detection Scoring" form, IDEA software worksheet "22. Detection Scoring."

4. Place the acetate Detection Log Scoring Template over each searcher's actual Detection Log. See Figure 5.

5. Record the results of each detection opportunity on the Detection Scoring form. For a valid detection place a "1" in the appropriate box, for non-detections use a "0". IDEA already shades the specific search object type for location number that needs to be entered. In the cases where changes in location numbers were made after worksheet "10. Obj. Placement Tabl & Chart" was printed, and then changes would have to be made and noted manually onto the sheet. The use of "0" (zero) and "1" must be adhered to since the IDEA software is programmed to expect only those two scores. See Figure 6.

6. Crosscheck each scored sheet carefully. Make sure the correct number of scores exist for each column. Make sure multiple detections or misses are not recorded on the same row (location number).

7. Score each searcher's detection log and staple the scoring sheet, detection log, and searcher profile together.

Figure 5 scores two search object types, and the scoring is apparent. Location number 1 was scored as a detection (data loggers were told not to score it since it fell right on the track). Location number 2 was detected; location number 3 was missed; number 4 was detected; number 5 was missed; number 6 was detected (the arrow point the wrong direction but the course took a sharp turn – showing the value of having the scorer walk the course as a data logger); number 7 was missed; number 8 was missed; number 9 was detected; number 10 was missed; number 11 was missed; number 12 was detected; number 13 was detected; number 14 was missed (able to see data logger notes about a possible detection the data logger made); number 15 was missed; numbers 16-19 were detected; number 20 was missed; and number 21 was detected.
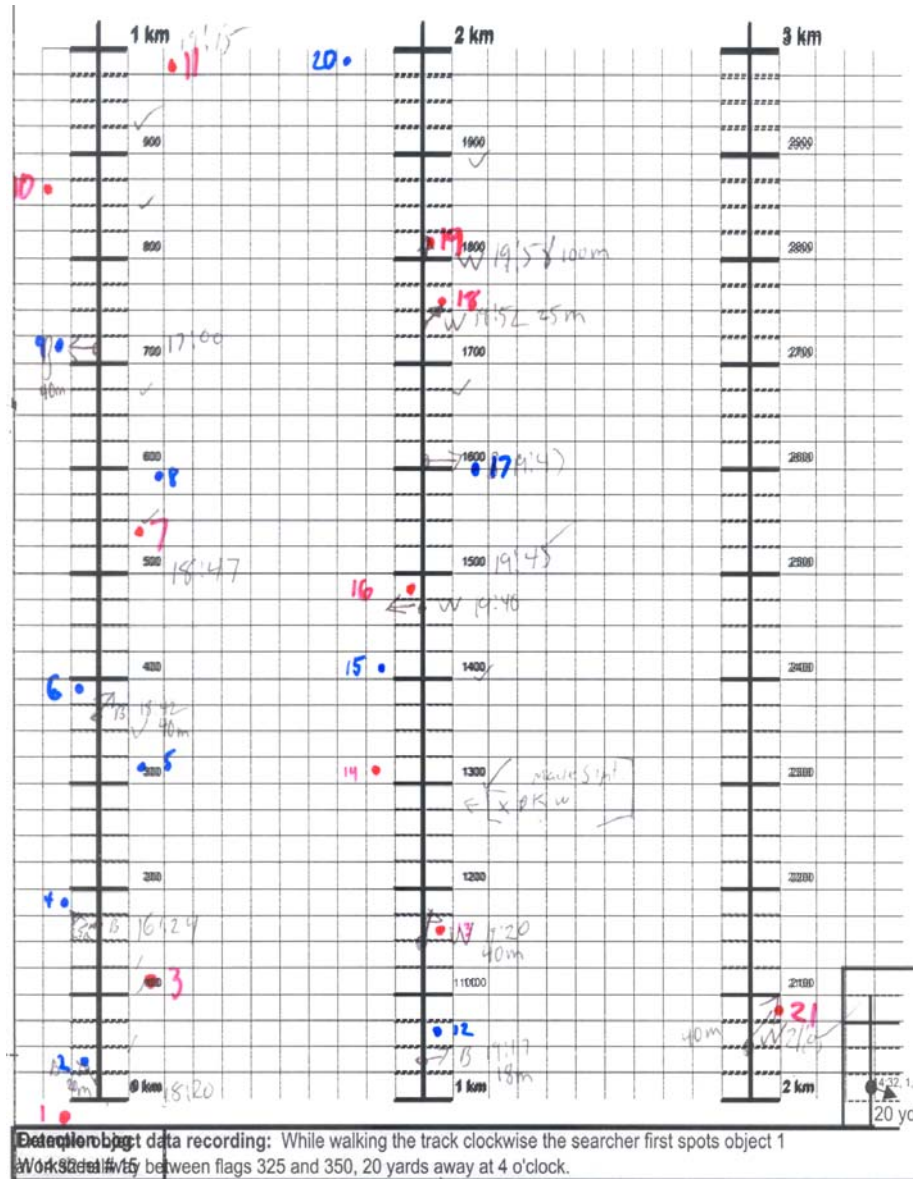

Figure 5. Detection Log with scoring template overlay.

Figure 6 shows the Detection Scoring Sheet. Note that in this example two Search Object Types were used and that no location number has more than one Search Object Type marked. One detection scoring worksheet is required for each searcher. After it is scored it is stapled to the Searcher Profile – Detection log package.

Instructions: Using the searcher's **Detection Log** (Worksheet #22) and the **Detection Template** (Worksheet #23) record below if a valid detection occurred. Record a zero "0" in the appropriate search object column if the search object was missed. Record a one "1" in the appropriate search object column if that search object was detected. Leave the other search object column blank. Staple together the following forms; the Searcher Profile (#21), the Detection log (#22), and the scored Detection Scoring (#24). The results from this paper form will be inputted into the Data Input Object 1, 2, 3 and 4 Worksheets in order to determine the Sweep Width value for each object.

Location Number	Search Object 1	Detections Object 2	Detections Object 3	Detections Object 4		Location Number	Detections Object 1	Detections Object 2	Detections Object 3	Detections Object 4
1	1					51				
2		1				52				
3	0					53				
4		1				54				
5		0				55				
6		1				56				
7	1					57				
8		0				58				
9		1				59				
10	0					60				
11	0					61				
12		1				62				
13	1					63				
14	0					64				
15		0				65				
16	1					66				
17		1				67				
18	1					68				
19	1					69				
20		0				70				
21	1					71				
22						72				
23						73				
24						74				
25						75				

Figure 6. Detection Scoring Sheet.

Data Entry

Careful data entry is required to make sure all the data are captured correctly.

1. Once all detection logs are scored on the Detection Scoring form, open the IDEA software to Worksheet "23. Data Input Object # 1" and titled "Data Input Search Object Type #1."

2. Enter the results for search object type number one using 0 and 1. Leave blank if a detection opportunity was not present. This can occur if an object cannot be found in

its proper location during the break down phase, or if a team took a detour that eliminated a portion of the track.

3. Be sure to include the lateral range off track distance for each location number.

4. Include the lateral range for any virtual location number.

5. Enter the data for each searcher.

6. Repeat for each search object using IDEA software worksheets "24. Data Input Object # 2", "25. Data Input Object # 3", and "26. Data Input Object # 4".

7. Enter all of the information into worksheet "27. Searcher Profile Data" and titled "Searcher Profile Data Entry."

Determining ESW

The IDEA software largely automates the actual calculations required to determine effective sweep width. It takes advantage of the crossing over phenomenon between cumulative detections and cumulative misses.

1. In the IDEA software, go to the worksheet "28. Data Summary Object # 1."

2. To sort data by lateral ranges, click on the green button labeled "Click here to complete Search Object # 1 processing." The button sorts the results by Lateral Range and determines the effective sweep width. The green button appears as follows:

3. After the sort, the ESW is calculated and displayed at the bottom of the worksheet.

4. A crossover graph is automatically drawn and can be observed in the worksheet labeled "29. Object #1 SW Estimator."

5. A lateral range curve showing detection probability as a function of distance off track is automatically drawn and can be observed on the worksheet labeled "30. Object 1 Lateral Range Curve."

6. For each search object type, repeat steps 1-5.

7. All raw data is automatically summarized in the worksheet labeled "40. Raw Data Summary."

Sharing Documentation and Research Findings

At this time, a single collection point for data collection and experiment coordination does not exist. However, IDEA does provide a summary report sheet to be used for future data collection efforts, worksheet "41. Summary Report." In addition, the following email addresses are provided as potential sources of information for questions, data collection, or limited experiment coordination.

Don Cooper	PMG	Cooper@raex.com
Jack Frost	USCG	JFrost@comdt.uscg.mil
Robert Koester	PMG	Robert@dbs-sar.com

The entire IDEA software file can be sent via the internet and represents the best form of documentation.

In IDEA software worksheet "42. POD Calculation," the effective sweep width and other data can be entered to determine the probability of detection. This is the main benefit of conducting the experiment. Worksheet "43. POD vs. Coverage" graphically depicts the calculated probability of detection and the graph against coverage.