

Probability of Detection

- POD – How likely were you to have detected the subject (or clue, object) if it had been present in the area you were searching?

$$POS = POC \times \text{POD}$$

- To a Searcher, search is binary
 - ⊕ We found the subject (POD = 100%)
 - ⊕ We did not find the Subject (POD = 0%)
- POD is primarily for Planners
 - ⊕ However!!... A desired POD can help determine the recommended spacing for a search and the tactic utilized to search an area.



Probability of Detection...Why it is important

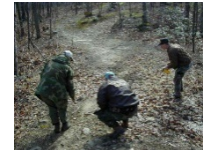
- Has two basic applications *(National SAR School)*
 - ⊕ Searching an individual segment
 - ✦ Helps to determine track spacing, as well as time and resources required to search a segment.
 - ⊕ For the overall search
 - ✦ Measure the effectiveness of individual searchers and the progress of the overall search effort -> POS
 - ✦ A factor in determining when to re-search an area
 - ✦ Helps in determining when to suspend a mission.
- POD is a challenging parameter to measure and estimate



Probability Related to Searchers (POD)

➤ Factors that influence POD?

- ⊕ Subject (Search Object) – behavior and physical characteristics
- ⊕ Environment – weather, season, vegetation, terrain, available light
- ⊕ Searchers
 - ★ Type of resource
 - ★ Track spacing
 - ★ Tactics/methods
 - ★ Search speed
 - ★ Available technology
 - ★ Information provided
 - ★ Searcher physical/mental state
 - ★ Searcher capability



POD Estimation

- POD is estimated by searchers in the field
 - ⊕ Very subjective and often times unreliable
 - ⊕ Imagine having to estimate the likelihood of finding something that you did not see and providing that estimate for a large area (some of which you did not search).

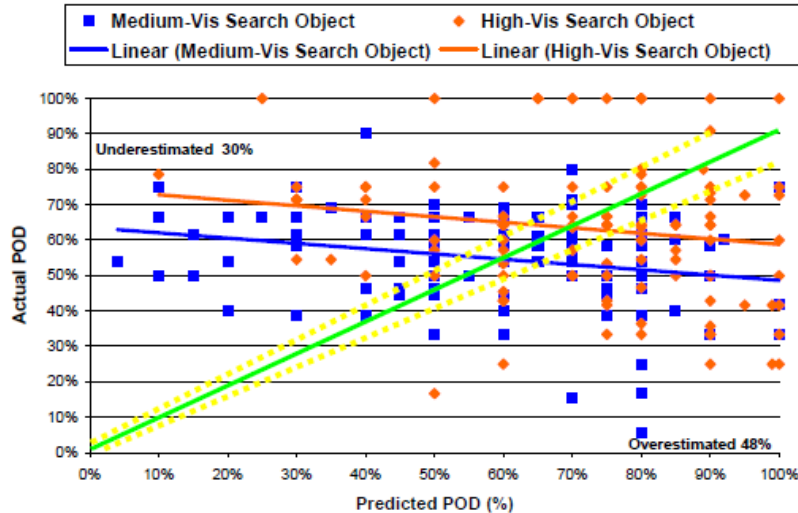


Fig. 8-14. Actual versus predicted POD for medium and high visibility targets.

Green line represents a perfect predict with the yellow lines at +/-10% a linear correlation

Actual data fits for high and med visibility targets suggests significant inaccuracies (78% of the time) in predicting POD

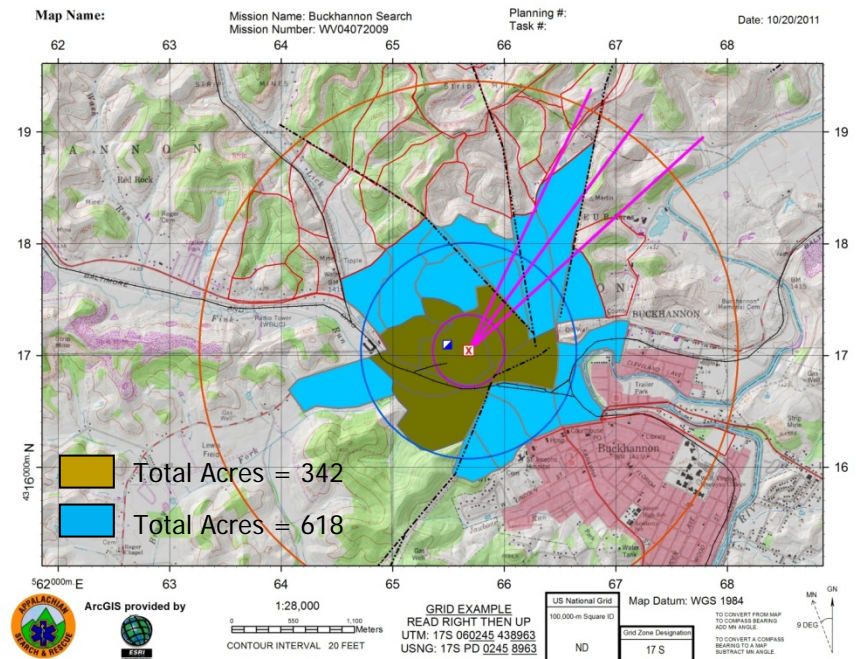
1. Koester, Cooper, Frost, Robe, "Sweep Width Estimation for Ground Search and Rescue"



POD - Determining Resource Demands

ICS Form 202

INCIDENT OBJECTIVES	1. INCIDENT NAME Buckhannon Search WV20080623A	2. DATE 07/04/2009	3. TIME 1300									
4. OPERATIONAL PERIOD (DATE/TIME) 04 July 2009, 1300 - 2200												
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9. PREPARED BY (PLANNING SECTION CHIEF) P.L. Anner		10. APPROVED BY (INCIDENT COMMANDER)										



Use desired POD and size of Search Area to determine resource needs.



POD - Determining Resource Demands

1. Specify a desired POD prior to the search effort

"Search segment AA08 to a POD of 50%"

$POD = 1 - \exp(-C)$

POD = 50%, requires a Coverage (C) = 0.693

Coverage = Area Effectively Search / Area Assigned

Area = 85.4 acres

Area Effectively Searched = 59.2 acres

If desire to search the entire area (85.4 acres):

Coverage = SW/Spacing

AMDR (Sweep Width) = 30 ft

Spacing = SW/C = 43.3 ft

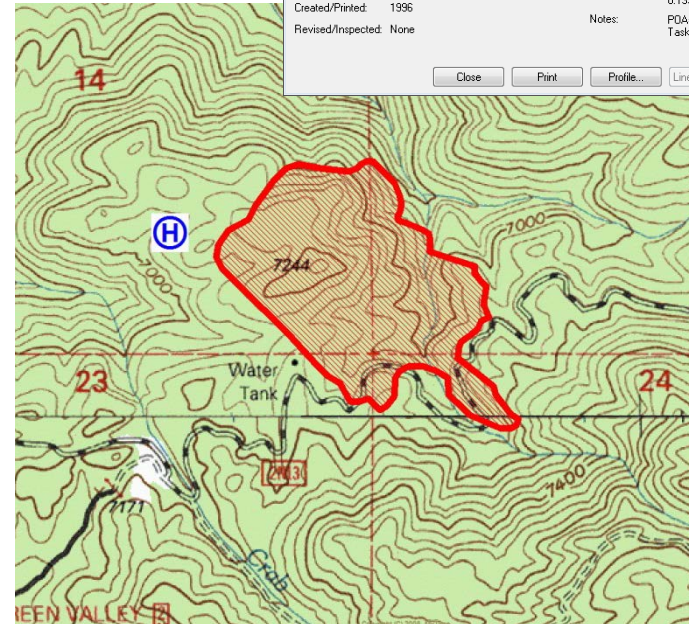
Area Searched = Effort x Spacing = N x TL x Spacing

TL = Search Speed x Search Time = 1.0 mph x 4 hrs

$N = 85.4 \text{ Acres} / (4.0 \text{ mi} \times 43.3 \text{ ft})$
 $\times 8.25 \text{ ft-mi/acre} \sim 4$

*Would require 4 searchers, 4 hours at a speed of 1.0 mph
and an average spacing of 43.3 ft.*

Track Log Information			
CD Name:	California, South (CA16)	Point Number:	13
Map Name:	BUTLER PEAK	Point Time:	N/A
USGS Ref. Code:	34117-C1-TF-024	Elevation:	2139 meters
Map Scale:	1:24,000	Coordinates:	11 0495 070E
Map Type:	Topographic (Feet)		3790 592N
Vertical Datum:	National Geodetic Vertical Datum 1929	Track Name:	AA08
Horizontal Datum:	North American 1927	Track Length:	1 mile, 4252 feet
Contour Interval:	40 feet	Track Area:	85.418 acres
Created/Printed:	1996		0.133 sq. miles
Revised/Inspected:	None	Notes:	POA=10; POD=0; # Searched = 0;
			Task ID:
		Close Print Profile... Line of Sight... Help	



POD – Search Effectiveness

2. Measure the effectiveness and completeness after a “ given search effort

Team reports a POD = 40%, N = 5, Spacing = 5 m = 16.43 ft

Area Assigned= 85.4 acres

Area Searched = Effort x Spacing = N x TL x Spacing
 $= 5 \times (1 \text{ mi} + 3461/5280 \text{ mi}) \times 16.43/5280 \text{ mi}$
 $= 5 \times 1.66 \text{ mi} \times 16.43/5280 \text{ mi}$
 $= 0.026 \text{ mi}^2 = 16.5 \text{ acres}$

AMDR (Sweep Width) = 30 ft

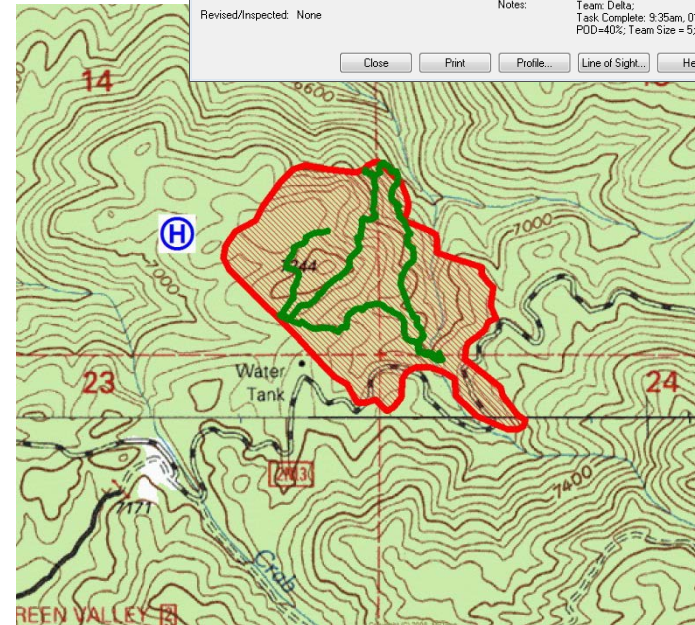
Effective Coverage = SW/Spacing = 30 / 16.43 = 1.83

Coverage = Eff Coverage x AS/AA
 $= 1.83 \times 16.5 / 85.4 = 1.83 \times 0.193$
 $= 0.353$

POD = 1-exp(-C) = 0.3 = 30%

Track Log Information			
CD Name:	California, South (CA16)	Point Number:	252
Map Name:	BUTLER PEAK	Point Time:	N/A
USGS Ref. Code:	34117-C1-TF-024	Elevation:	2195 meters
Map Scale:	1:24,000	Coordinates:	11 0495231E
Map Type:	Topographic (Feet)		3790313N
Vertical Datum:	National Geodetic Vertical Datum 1929	Track Name:	T0108-01
Horizontal Datum:	North American 1927	Track Length:	1 mile, 3461 feet
Contour Interval:	40 feet	Track Area:	Unclosed Track
Created/Printed:	1996	Notes:	Team: Delta; Task Complete: 9:35am, 01/08; POD=40%; Team Size = 5; Sweep
Revised/Inspected:	None		

Close Print Profile... Line of Sight... Help



35% of the assigned area was effectively searched (as opposed to 19%) resulting in a POD = 30% (based on random search theory)

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Area Searched

➤ Area Searched = Spacing x Effort

⊕ Spacing – Average actual distance between searchers in the field

⊕ Effort = $N \times TL$

✧ N - number of searchers on team

✧ TL – Track length

✧ Obtained from GPS track, or

✧ $TL = \text{Search speed} \times \text{Search time}$

➤ Area Effectively Searched = Effective Coverage * Effort



Coverage

Relative measure of how thorough an area has been searched.

$$\text{Effective Coverage} = \frac{\text{Area Effectively Searched}}{\text{Area Searched}}$$

$$\text{Total Coverage} = \text{Effective Coverage} \times \frac{\text{Area Searched}}{\text{Segment Area}}$$

Limited studies are available that relate POD to coverage. The bulk of these studies produce a result similar to that of Koopman's (1946) Random Search Theory.

Koopman's Random Search Theory

$$\text{POD} = 1 - e^{-\text{coverage}}$$

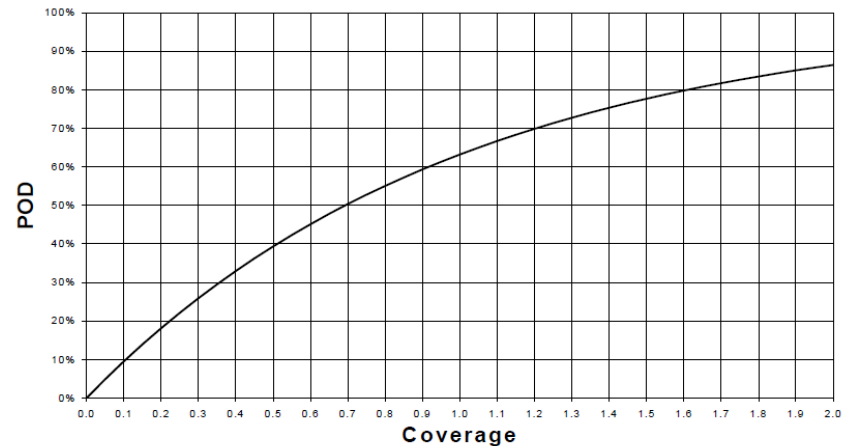
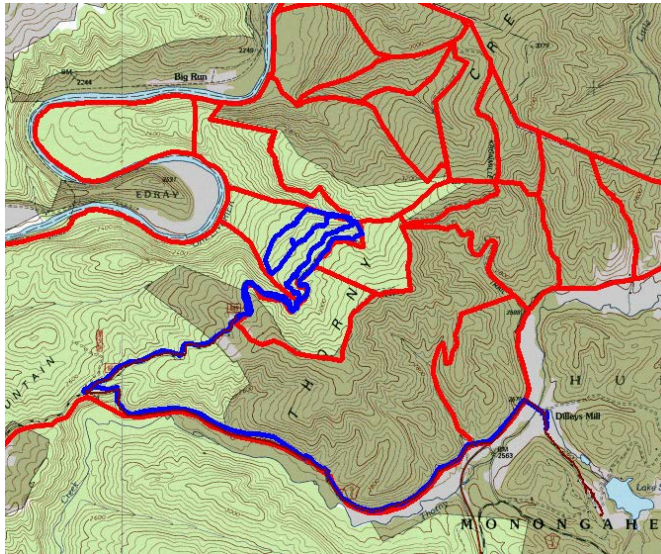


Figure 2-5. POD vs. Coverage (Koopman, 1946)

Cooper, Frost and Robe, "Compatibility of Land SAR Procedures with SAR Theory"



Determining Coverage and Cumulative POC

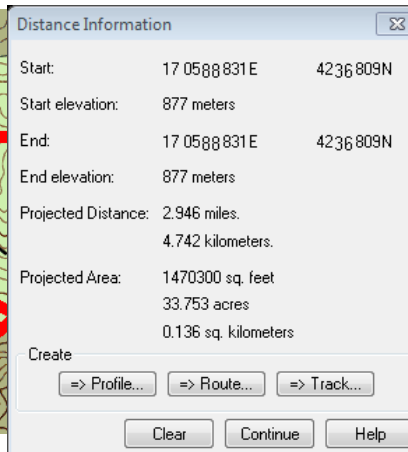
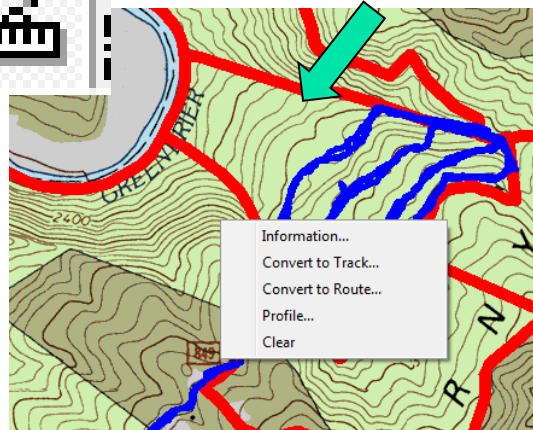


- Use the Measure Tool to trace the section of the track you are interested in
- Right click for "Information" to obtain track length of desired section.
- Combine track length with team size and effective spacing to determine area searched.



Area Assigned = 111 acres

Area Searched = TL x # on team x spacing



$$Coverage = \frac{Area\ Searched}{Area\ Assigned}$$

Related Coverage to POD using
Koopman's Random Search Theory

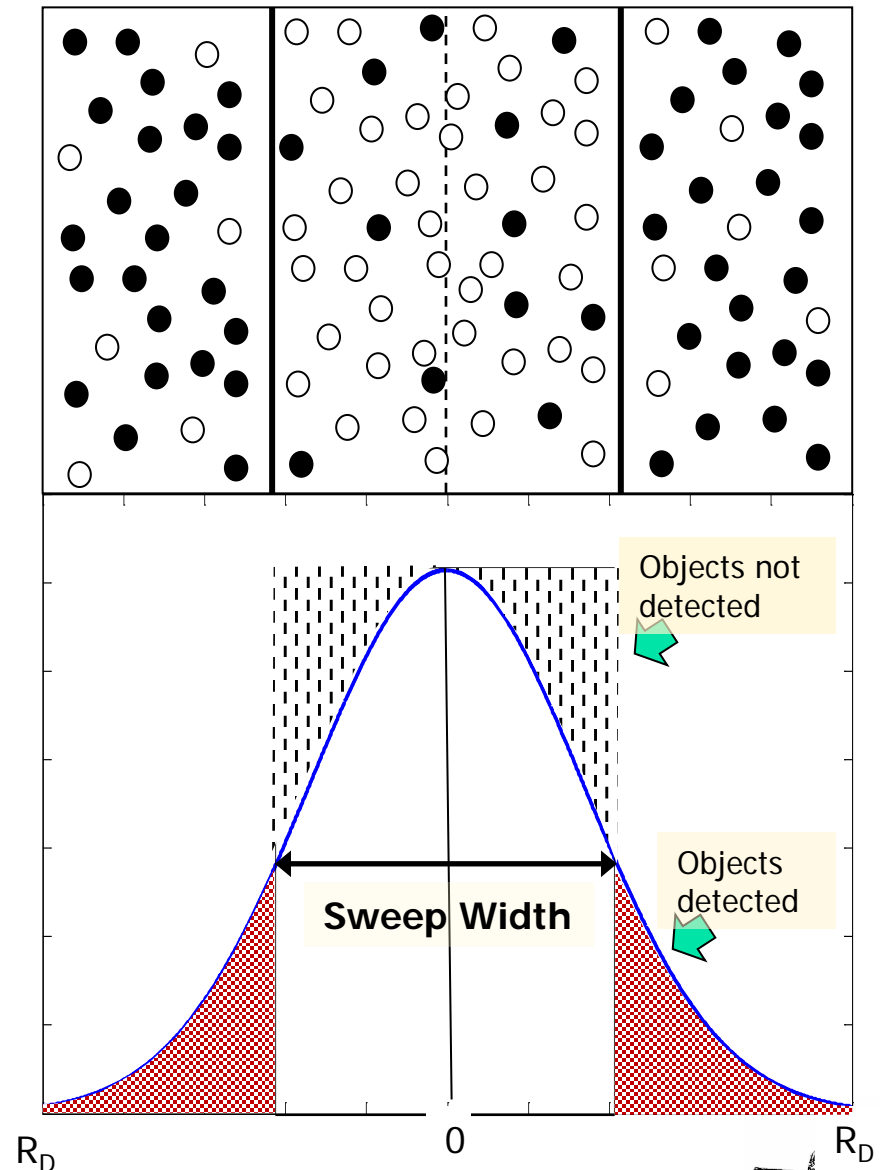
$$POD = 1 - e^{-coverage}$$

$$POC_{s,n} = POC_{s,n-1} \times (1 - POD_{s,n})$$



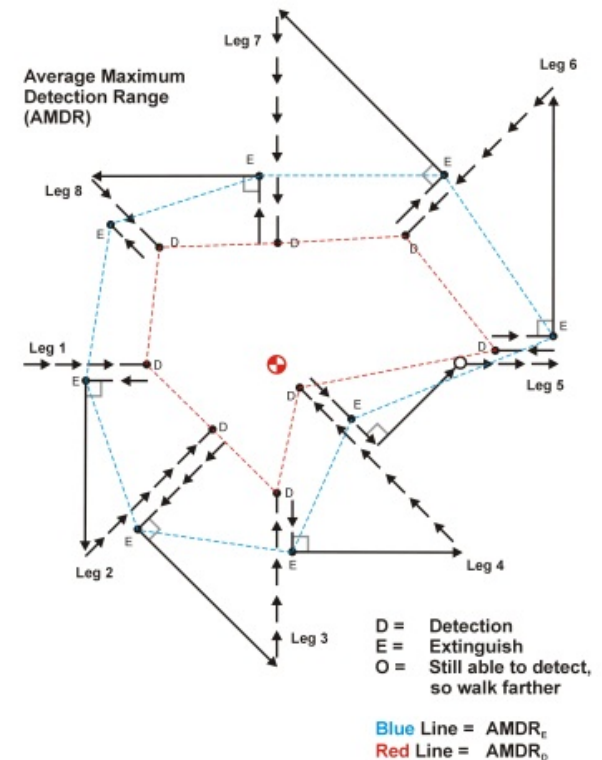
Sweep Width

- Measure of the average ability of a given sensor to detect a specific object under a specific set of environmental conditions.
- Distance at which the likelihood of detection is equal to the likelihood on non-detection.
 - Number of objects missed inside the width is equal to the number of objects outside the width that were detected.



Improving POD Estimation

- Researchers have development methods for predetermining optimal distances between searchers to achieve a desired POD.
 - ⊕ Sweep Width is difficult to measure
 - ⊕ AMDR or “one-half critical separation” is a conservative estimate, in absence of experimental data.
- Benefits of predetermined values
 - ⊕ Improves accuracy of field team estimates
 - ⊕ Assists SAR Managers with effort allocation and estimating resource needs

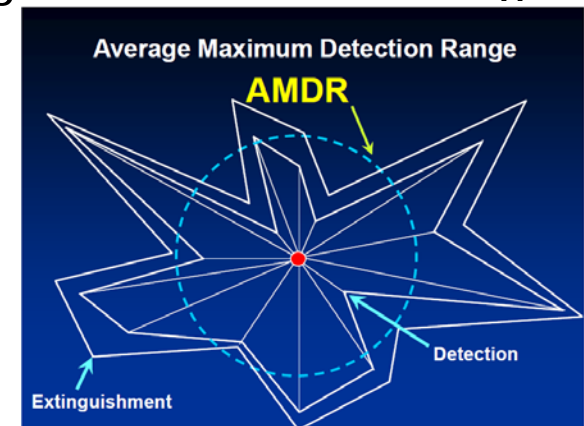


Average Maximum Detection Range¹

➤ Similar in concept to CS

- ⊕ Searchers are situated around the object at a range where the object cannot be seen. Searchers then move toward the object to a location where it can be detected. (*Detection Range*) The distance to the object is recorded.
- ⊕ Next the searchers move away until they cannot see any part, piece or portion of the object. An average is determined for the distance of Extinguishment for each leg.

➤ The average of those two values (Detection and Extinguishment) will be the AMDR for that object in that environment.



1. Stoffel, R.C., "Managing Land Search Operations", ER International, Cashmere, WA, 2006.



Critical Separation (Perkins and Roberts, 1989)

- CS - the visual horizon for each searcher falls at roughly the middle of the measured distance between any two searchers¹.
 - ⊕ Combined both increasing efficiency and establishing a reasonable POD estimation
 - ⊕ Searchers are stationed around the object at a distance beyond where they can see the object. They then turn and walk toward the object until they can clearly see it. Searchers then paces off the distance from “detection” to the object. All of the distances are then averaged. Twice the average distance is what is called Critical Separation.

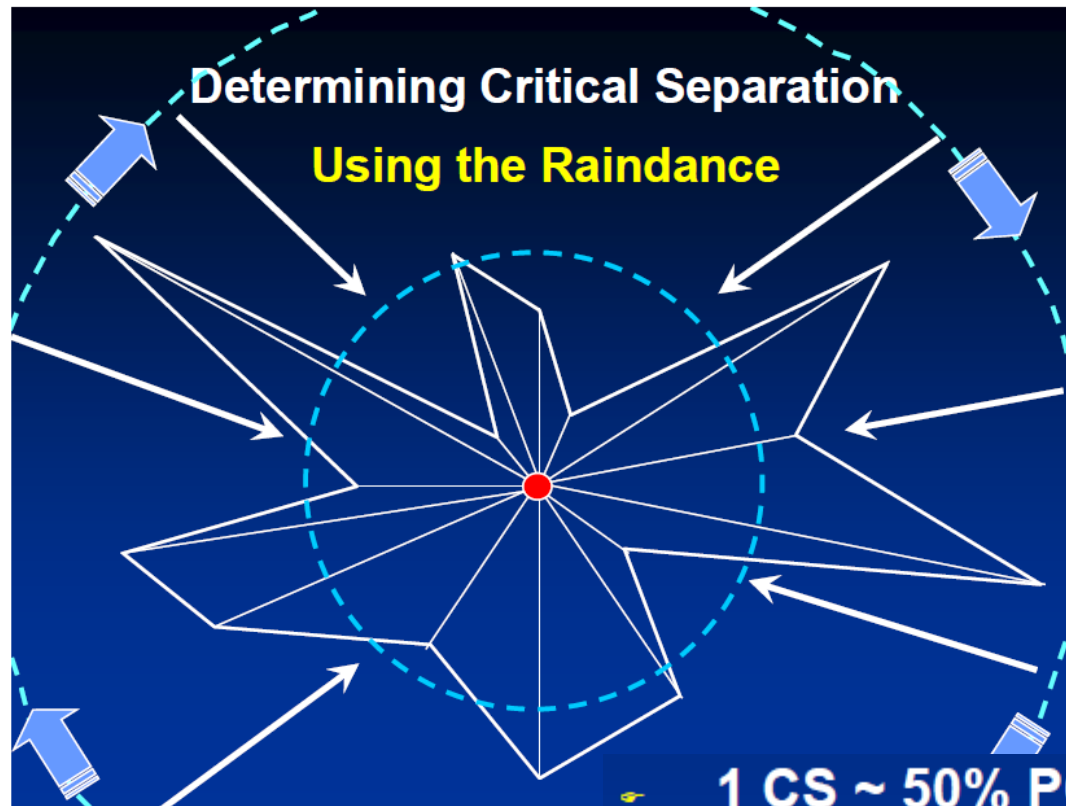


1. Stoffel, R.C., "Managing Land Search Operations", ER International, Cashmere, WA, 2006.
Appalachian Search and Rescue Conference

Mountaineer Area Rescue Group



Critical Separation¹



- 1 CS ~ 50% POD
- 2 CS ~ 25% POD
- 1/2 CS ~ 75% POD

Theoretical

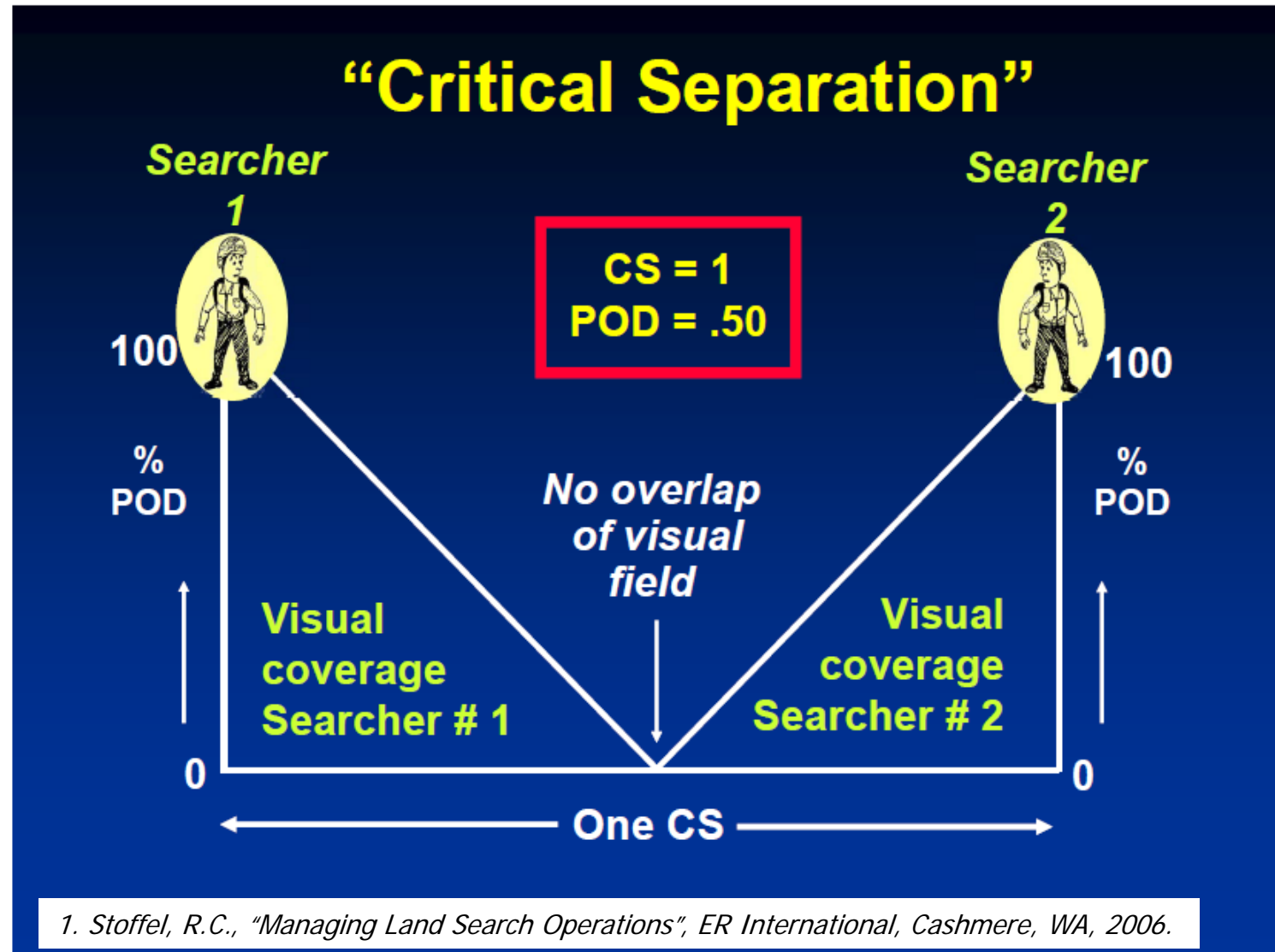


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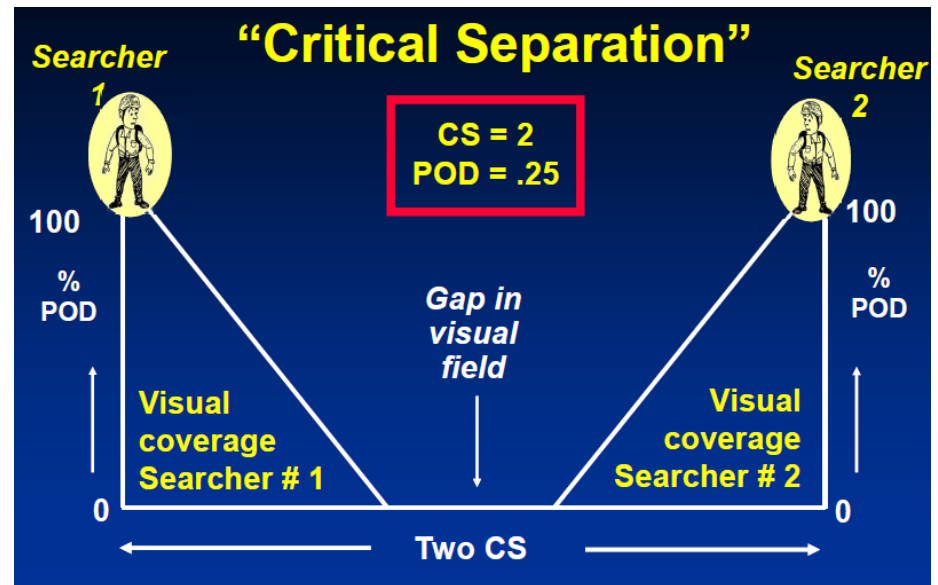
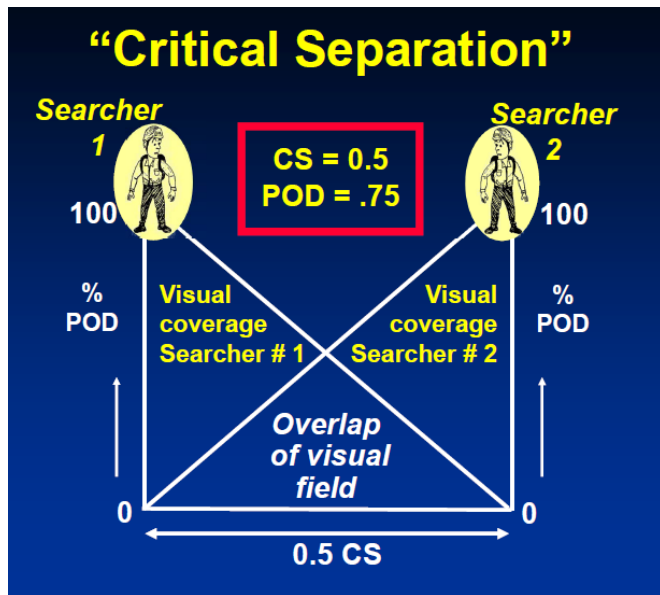
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Critical Separation¹



Critical Separation¹



➤ Limitations

- ⊕ Doesn't account variations in terrain, environment, search object
- ⊕ Effect of searcher speed not considered.

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Incident Objectives (Mapping Support)

ICS 202 – Incident (Shift) Objectives

ICS Form 202

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4. OPERATIONAL PERIOD (DATE/TIME) 04 July 2009, 1300 - 2200												
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➤ SAR Managers and Planners often identify a series of Objectives for a given Operational Period.

⊕ How does the Planning team estimate the resources needed to accomplish these objectives?

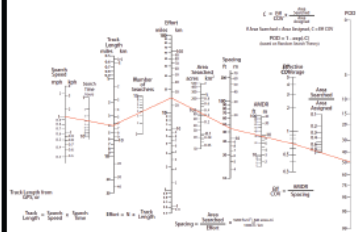


Search Planner Worksheet

- The latest version of the Search Planner Worksheet was derived from BASARC Form SAR-138.
 - ⊕ Some corrections were made and the form was expanded.
- This current version of the form is only for ground searchers
- Has multiple uses
 - ⊕ Estimate time/resource requirements to accomplish a desired POD
 - ⊕ Estimate post-search POD



SAR Planner Worksheet

SEARCH PLANNING WORKSHEET	1. INCIDENT NAME	2. DATE	3. ASSIGNMENT IDENTIFIER
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">  <p>Example of completed worksheet</p> </div> <div style="width: 65%;"> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Search Speed</p> <p>mph kph</p> <p>4 6.4</p> <p>3 4.8</p> <p>2 3.2</p> <p>1 1.6</p> <p>0.9 1.4</p> <p>0.8 1.3</p> <p>0.7 1.1</p> <p>0.6 1.0</p> <p>0.5 0.8</p> <p>0.4 0.7</p> <p>0.3 0.5</p> </div> <div style="width: 45%;"> <p>Search Time</p> <p>hours</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p> <p>9</p> <p>10</p> </div> </div> <p>Track Length from GPS, or</p> <p>Track Length = Search Speed x Search Time</p> </div> <div style="width: 45%;"> <p>Track Length</p> <p>miles km</p> <p>0.5 0.8</p> <p>0.6 1.0</p> <p>0.7 1.1</p> <p>0.8 1.3</p> <p>0.9 1.4</p> <p>1 1.6</p> <p>2 3.2</p> <p>3 4.8</p> <p>4 6.4</p> <p>5 8.0</p> <p>6 9.6</p> <p>7 11.2</p> <p>8 12.8</p> <p>9 14.4</p> <p>10 16.0</p> <p>20 32.0</p> <p>30 48.0</p> <p>40 64.0</p> <p>50 80.0</p> <p>60 96.0</p> <p>70 112.0</p> <p>80 128.0</p> <p>90 144.0</p> <p>100 160.0</p> </div> <p>Number of Searchers</p> <p>10</p> <p>8</p> <p>6</p> <p>5</p> <p>4</p> <p>3</p> <p>2</p> <p>1</p> </div>			

Effort

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Effort

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POD Two Primary Uses

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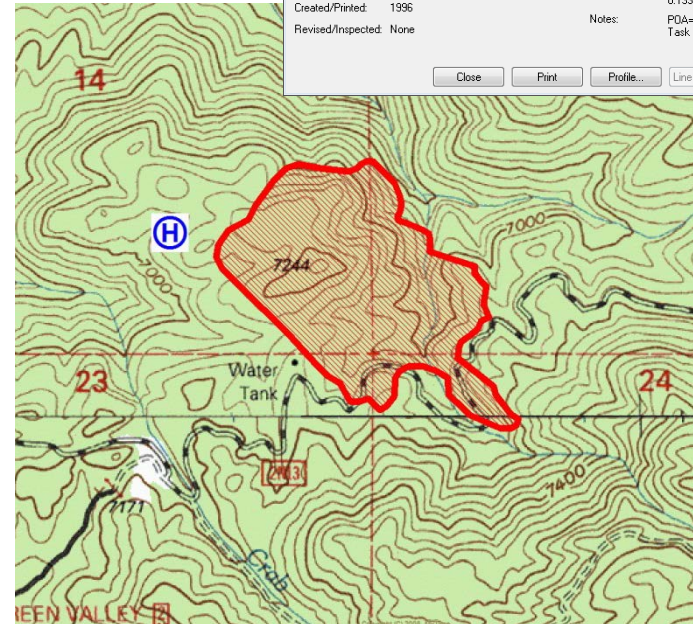
Area Searched = Effort x Spacing = N x TL x Spacing

TL = Search Speed x Search Time = 1.0 mph x 4 hrs

*$N = 85.4 \text{ Acres} / (4.0 \text{ mi} \times 43.3 \text{ ft})$
 $\times 8.25 \text{ ft-mi/acre} \sim 4$*

*Would require 4 searchers, 4 hours at a speed of 1.0 mph
and an average spacing of 43.3 ft.*

Track Log Information			
CD Name:	California, South (CA16)	Point Number:	13
Map Name:	BUTLER PEAK	Point Time:	N/A
USGS Ref. Code:	34117-C1-TF-024	Elevation:	2139 meters
Map Scale:	1:24,000	Coordinates:	11 0495 070E
Map Type:	Topographic (Feet)		3790 592N
Vertical Datum:	National Geodetic Vertical Datum 1929	Track Name:	AA08
Horizontal Datum:	North American 1927	Track Length:	1 mile, 4252 feet
Contour Interval:	40 feet	Track Area:	85.418 acres
Created/Printed:	1996		0.133 sq. miles
Revised/Inspected:	None	Notes:	POA=10; POD=0; # Searched = 0;
			Task ID:
		Close Print Profile... Line of Sight... Help	



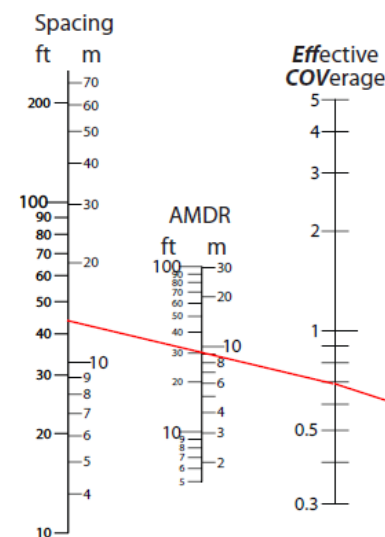
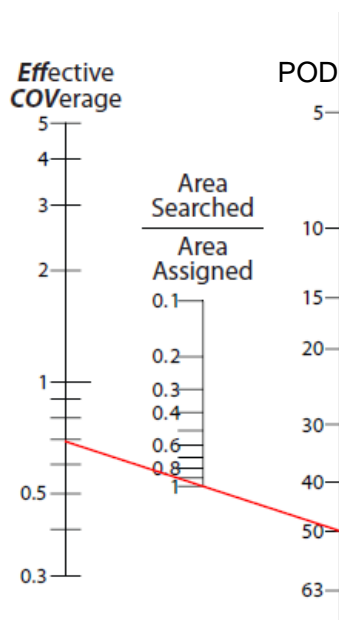
Exercise...Search Planning Worksheet

- Pass out worksheet



Search Planning Worksheet – Resource Needs

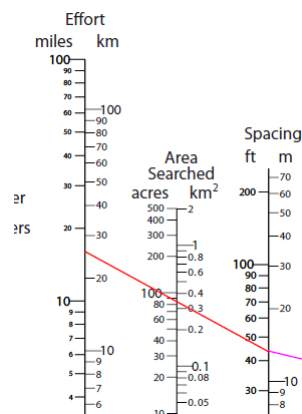
1. Desire POD = 50%
2. Since you are planning to search the entire assigned area (85.4 acres), Area Searched / Area Assigned = 1.0
3. Determine the Effective Coverage
4. You have measured your AMDR to be use as a surrogate for Sweep Width, AMDR = 30 ft
5. Determine your needed spacing relative to your AMDR in order to achieve a POD = 50%



Search Planning Worksheet – Resource Needs

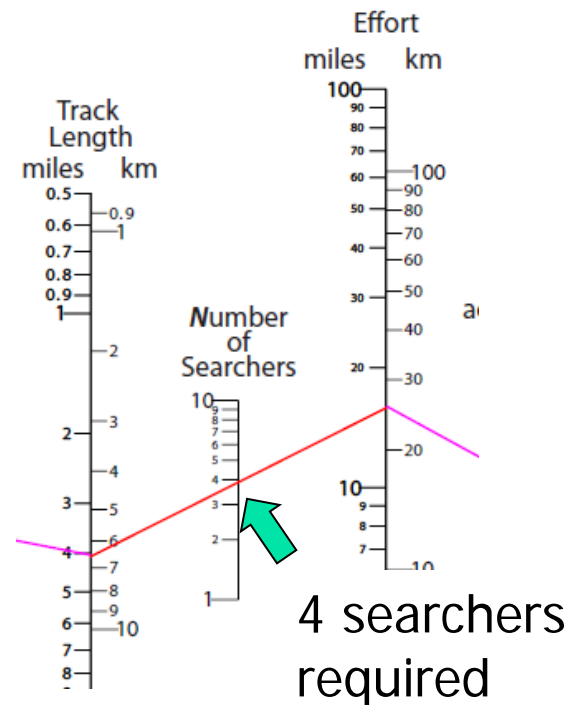
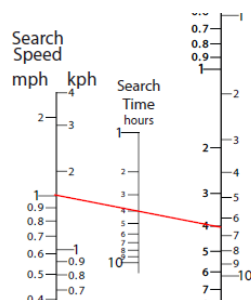
6. Area Searched = 85.4 acres

7. Determine your Effort

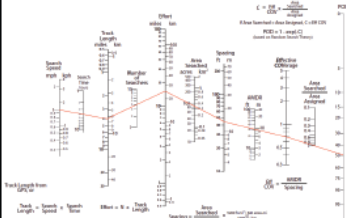


9. Draw a line between Track Length and Effort in order to estimate the Number of Searchers required to complete this task in the allotted 4 hours.

8. Track Length = Search Speed (1 mph) x Search Time (4 hours) = 4 miles



Search Planning Worksheet – Resource Needs

SEARCH PLANNING WORKSHEET	1. INCIDENT NAME	2. DATE	3. ASSIGNMENT IDENTIFIER
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">  <p>Example of completed worksheet</p> </div> <div style="width: 65%;"> <div style="text-align: right; margin-bottom: 10px;"> $C = \frac{\text{Eff}}{\text{COV}} \times \frac{\text{Area Searched}}{\text{Area Assigned}}$ <p>If Area Searched = Area Assigned, $C = \text{Eff COV}$</p> <p>$\text{POD} = 1 - \exp(-C)$ (based on Random Search Theory)</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Search Speed mph kph</p> <p>Search Time hours</p> <p>Track Length miles km</p> <p>Number of Searchers</p> </div> <div style="width: 45%;"> <p>Effort miles km</p> <p>Area Searched acres km²</p> <p>Spacing ft m</p> <p>Effective COV</p> <p>AMDR ft m</p> <p>Area Searched / Area Assigned</p> </div> </div> <div style="margin-top: 20px;"> <p>Track Length from GPS, or</p> <p>Track Length = Search Speed x Search Time</p> <p>Effort = N x Track Length</p> <p>Spacing = $\frac{\text{Area Searched}}{\text{Effort}} \times \frac{5280 \text{ ft-mi}^2 / 640 \text{ acres-mi}}{1000 \text{ m}^2 / \text{km}}$</p> </div> </div> </div>			
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POD Two Primary Uses

2. Measure the effectiveness and completeness after a “ given search effort

Team reports a POD = 40%, N = 5, Spacing = 5 m = 16.43 ft

Area Assigned= 85.4 acres

$$\begin{aligned}\text{Area Searched} &= \text{Effort} \times \text{Spacing} = N \times \text{TL} \times \text{Spacing} \\ &= 5 \times (1 \text{ mi} + 3461/5280 \text{ mi}) \times 16.43/5280 \text{ mi} \\ &= 5 \times 1.66 \text{ mi} \times 16.43/5280 \text{ mi} \\ &= 0.026 \text{ m}^2 = 16.5 \text{ acres}\end{aligned}$$

AMDR (Sweep Width) = 30 ft

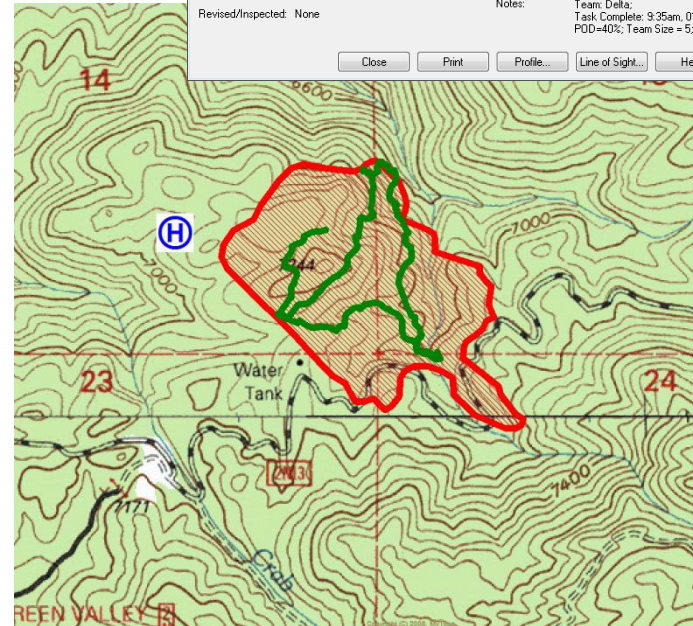
Effective Coverage = SW/Spacing = 30 / 16.43 = 1.83

$$\begin{aligned}\text{Coverage} &= \text{Eff Coverage} \times \text{AS/AA} \\ &= 1.83 \times 16.5 / 85.4 = 1.83 \times 0.193 \\ &= 0.353\end{aligned}$$

$$\text{POD} = 1 - \exp(-C) = 0.3 = 30\%$$

Track Log Information			
CD Name:	California, South (CA16)	Point Number:	252
Map Name:	BUTLER PEAK	Point Time:	N/A
USGS Ref. Code:	34117-C1-TF-024	Elevation:	2195 meters
Map Scale:	1:24,000	Coordinates:	11 0495231E
Map Type:	Topographic (Feet)		3790313N
Vertical Datum:	National Geodetic Vertical Datum 1929	Track Name:	T0108-01
Horizontal Datum:	North American 1927	Track Length:	1 mile, 3461 feet
Contour Interval:	40 feet	Track Area:	Unclosed Track
Created/Printed:	1996	Notes:	Team: Delta; Task Complete: 9:35am, 01/08; POD=40%; Team Size = 5; Sweep
Revised/Inspected:	None		

Close Print Profile... Line of Sight... Help



35% of the assigned area was effectively searched (as opposed to 19%) resulting in a POD = 30% (based on Koopman's Random Search Theory)

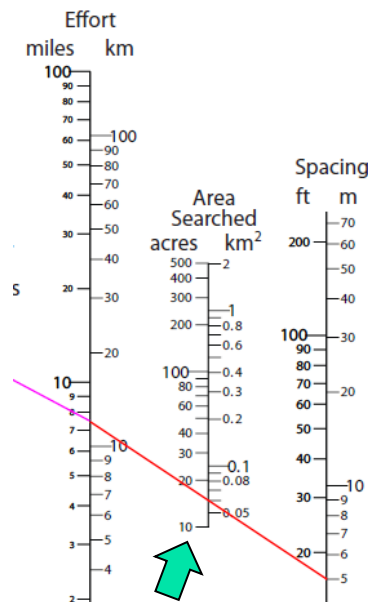
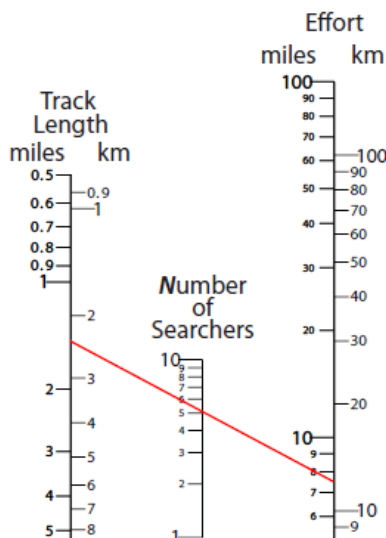
Appalachian Search and Rescue Conference

Mountaineer Area Rescue Group



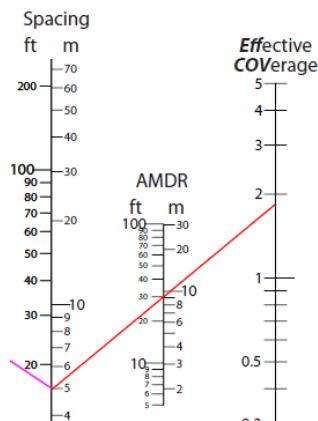
Search Planning Worksheet – POD Estimate

1. Team estimates their POD = 40%
2. Track Length is measured by GPS to be $(1 \text{ mi} + 3461/5280 \text{ mi}) = 1.66 \text{ miles}$
3. Five searchers were assigned to the team, $N = 5$.
4. Determine the Effort
4. The team indicated their average Spacing = 5 m = 16.43 ft
5. This produces an Area Searched equal to ~ 16.5 acres

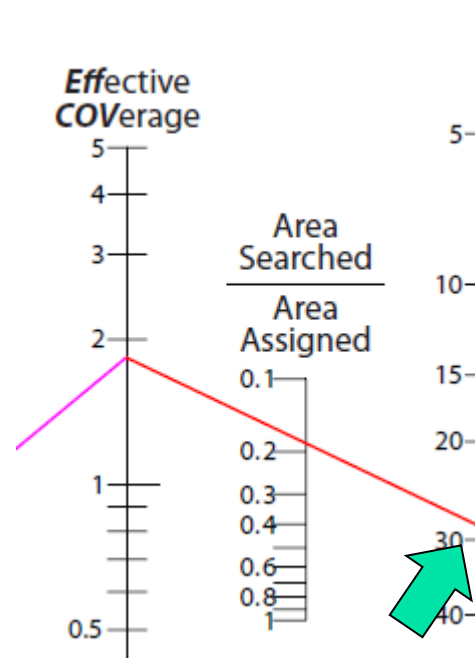


Search Planning Worksheet – POD Estimate

6. Knowing that the AMDR = 30 ft
7. Determine the Effective Coverage



8. $\text{Area Searched} / \text{Area Assigned} = 0.193$

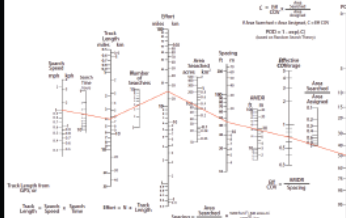


POD = 28%

As opposed to the team estimated 40%



Search Planning Worksheet – POD Estimate

SEARCH PLANNING WORKSHEET	1. INCIDENT NAME	2. DATE	3. ASSIGNMENT IDENTIFIER
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">  <p><small>Example of completed worksheet</small></p> </div> <div style="width: 65%;"> <div style="text-align: right; margin-bottom: 10px;"> $C = \text{Eff} \times \frac{\text{Area Searched}}{\text{Area Assigned}}$ <p>If Area Searched = Area Assigned, C = Eff COV</p> $\text{POD} = 1 - \exp(-C)$ <p>(based on Random Search Theory)</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Search Speed</p> <p>mph kph</p> <p>10 — 0.3</p> <p>2 — 0.5</p> <p>1 — 0.6</p> <p>0.9 — 0.7</p> <p>0.8 — 0.8</p> <p>0.7 — 0.9</p> <p>0.6 — 1.0</p> <p>0.5 — 1.2</p> <p>0.4 — 1.5</p> <p>0.3 — 2.0</p> </div> <div style="width: 45%;"> <p>Search Time</p> <p>hours</p> <p>10 — 1</p> <p>2 — 2</p> <p>1 — 3</p> <p>0.9 — 4</p> <p>0.8 — 5</p> <p>0.7 — 6</p> <p>0.6 — 7</p> <p>0.5 — 8</p> <p>0.4 — 9</p> <p>0.3 — 10</p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div style="width: 20%;"> <p>Track Length</p> <p>miles km</p> <p>0.5 — 0.8</p> <p>0.6 — 1.0</p> <p>0.7 — 1.2</p> <p>0.8 — 1.5</p> <p>0.9 — 2.0</p> <p>1 — 2.5</p> <p>2 — 5</p> <p>3 — 10</p> <p>4 — 20</p> <p>5 — 30</p> <p>6 — 40</p> <p>7 — 50</p> <p>8 — 60</p> <p>9 — 70</p> <p>10 — 80</p> <p>20 — 30</p> <p>30 — 40</p> <p>40 — 50</p> <p>50 — 60</p> <p>60 — 70</p> <p>70 — 80</p> <p>80 — 90</p> <p>90 — 100</p> </div> <div style="width: 20%;"> <p>Number of Searchers</p> <p>10 — 1</p> <p>5 — 2</p> <p>4 — 3</p> <p>3 — 4</p> <p>2 — 5</p> <p>1 — 10</p> </div> <div style="width: 20%;"> <p>Effort</p> <p>miles km</p> <p>100 — 100</p> <p>90 — 90</p> <p>80 — 80</p> <p>70 — 70</p> <p>60 — 60</p> <p>50 — 50</p> <p>40 — 40</p> <p>30 — 30</p> <p>20 — 20</p> <p>10 — 10</p> <p>5 — 5</p> <p>2 — 2</p> <p>1 — 1</p> </div> <div style="width: 20%;"> <p>Area Searched</p> <p>acres km²</p> <p>500 — 2</p> <p>400 — 1.6</p> <p>300 — 1.2</p> <p>200 — 0.8</p> <p>100 — 0.4</p> <p>80 — 0.3</p> <p>60 — 0.2</p> <p>40 — 0.1</p> <p>30 — 0.08</p> <p>20 — 0.05</p> <p>10 — 0.025</p> </div> <div style="width: 20%;"> <p>Spacing</p> <p>ft m</p> <p>100 — 30</p> <p>90 — 27</p> <p>80 — 24</p> <p>70 — 21</p> <p>60 — 18</p> <p>50 — 15</p> <p>40 — 12</p> <p>30 — 9</p> <p>20 — 6</p> <p>10 — 3</p> </div> <div style="width: 20%;"> <p>Effective COVERAGE</p> <p>5 — 0.1</p> <p>4 — 0.2</p> <p>3 — 0.3</p> <p>2 — 0.4</p> <p>1 — 0.6</p> <p>0.5 — 0.8</p> <p>0.3 — 1.0</p> </div> <div style="width: 20%;"> <p>Area Searched / Area Assigned</p> <p>0.1 — 1</p> <p>0.2 — 2</p> <p>0.3 — 3</p> <p>0.4 — 4</p> <p>0.6 — 6</p> <p>0.8 — 8</p> <p>1 — 10</p> </div> </div> <div style="text-align: right; margin-top: 10px;"> <p>POD</p> <p>0 — 0</p> <p>5 — 5</p> <p>10 — 10</p> <p>15 — 15</p> <p>20 — 20</p> <p>30 — 30</p> <p>40 — 40</p> <p>50 — 50</p> <p>63 — 63</p> <p>75 — 75</p> <p>86 — 86</p> <p>95 — 95</p> <p>99 — 99</p> </div> </div> <div style="margin-top: 10px;"> <p>Track Length from GPS, or</p> <p>Track Length = Search Speed x Search Time</p> <p>Effort = N x Track Length</p> <p>Spacing = $\frac{\text{Area Searched}}{\text{Effort}}$ x $\frac{5280 \text{ ft} \cdot \text{mi}^2}{640 \text{ acres} \cdot \text{mi}}$ or $\frac{1000 \text{ m}^2}{\text{km}}$</p> </div> </div>			
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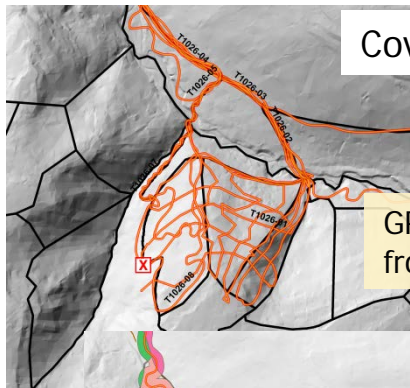
Utilizing GIS to Determine Coverage

- Use GPS tracks, operational team information and search segment/probability region details to calculate the ratio of area search to area of the segment or region.
- Coverage provide a more accurate description of how well the team performed than a Team Leader estimate of POD.
- Often times teams accidentally or purposefully search outside of their assigned search area. Only using reported POD for their assignment does not credit the unassigned areas for being searched.



Utilizing Coverage to Estimate POD

- POD Estimates from teams tend to be inaccurate
 - ⊕ Estimating a single POD for the entire area
 - ⊕ Only consider area assigned
- Utilize GPS tracks to estimate "Coverage"

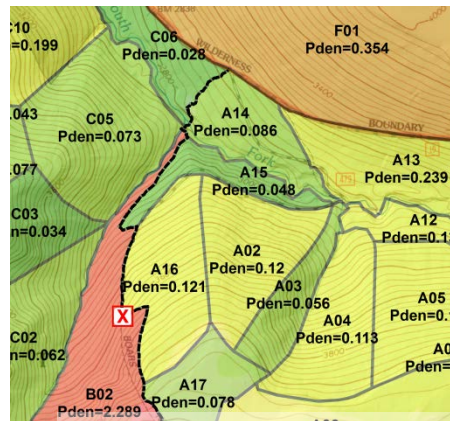


Coverage = Area Effectively Search / Segment Area * Eff COV

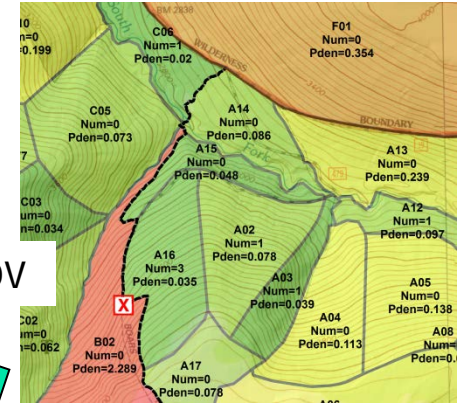
Random Search Theory
 $POD = 1 - e^{-coverage}$

GPS tracks collected from field teams

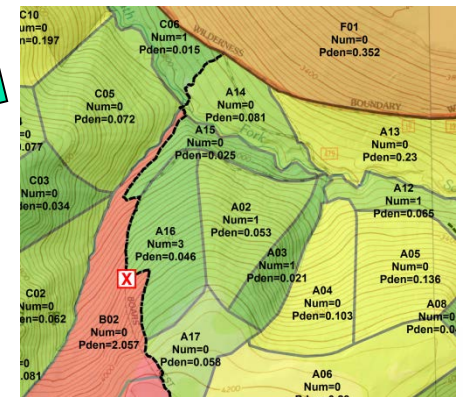
Tracks are buffered to account for team size and spacing



Original Pden estimates



Pden from POD estimates



Pden from Coverage

