Search Probability Theory:

Measuring Probabilities of Area and Detection

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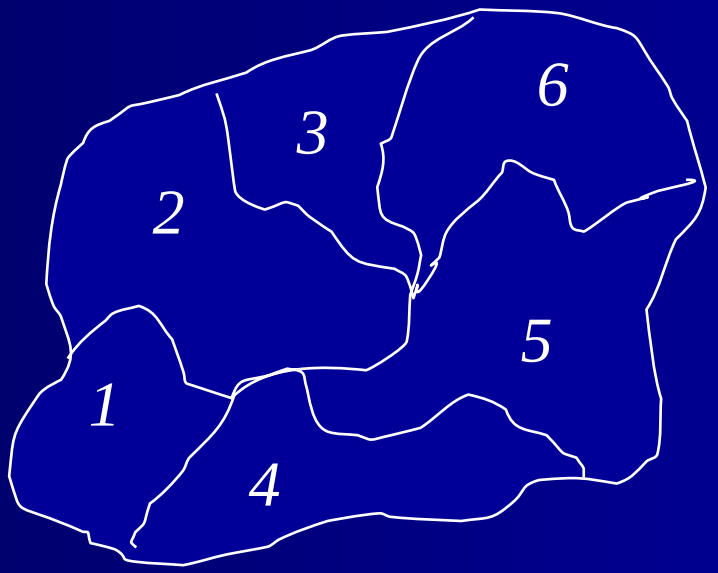
Objectives

- Describe the concept of determining Probability of Area .
- Describe the process of segmenting the area.
- Describe the consensus method of assigning POA.
- Describe the scenario analysis procedure for assigning POA when alternate lost person scenarios are plausible.
- Define the concept of probability of detection (POD).
- Compute the POD of a segment that has been searched more than once.
- Explain the significance of POD for effective search management.
- Estimating the POD for various search resources.

Setting Priorities: The Probability Of Area (POA)



Probability of Area (POA)

The probability that the subject or clue is in the segment (POA).

Defining Segment Boundaries

- The choice of boundaries must be based on what can be seen and readily identified in the field by all searchers.
  - Natural: Ridge lines, canyon bottoms, and rivers
  - Artificial: Fences, walls, roads, ditches, and power lines
  - Improvised: Compass lines (stringed or flagged)

Size of Segments

- Determined by terrain, vegetation, weather, and the type of resource assigned to the segment
- Can be searched by resources in 4-6 hours.
- .25 square mile, .40 square kilometers, or 160 acres

Further Consideration When Drawing Segments

- Avoid interior barriers.
- If critical separation is going to be used, consider segments that are as uniform as possible with respect to visibility.
- Don’t wait until all segments are drawn on the map before tasking resources.
- Number segments as boundaries are drawn
- Use biodegradable flagging and string.

The Consensus Approach to Assigning POA

- A group of planners ***individually*** and ***independently*** assign values to each segment.
- The total of each person's values ***must*** add up to exactly 100 percent.
- Included in this total of values must be the "Rest of the World" (ROW) "segment."

PROBABILITY EVALUATION OF SEARCH AREA

	SEGMENT								
EVALUATOR	1	2	3	4	5	6	7	ROW	TOTAL
Jim	15	5	20	10	5	25	13	7	100%
Bill	25	20	13	4	12	5	5	16	100%
Greg	50	5	8	5	5	17	5	5	100%
Peggy	30	10	35	5	6	5	5	4	100%
TOTAL	120	40	76	24	28	52	28	32	
AVERAGE	30	10	19	6	7	13	7	8	100%

Note: ROW = "Rest of the World"

Advanced Planning Concepts: Scenario Analysis

- The setting of Planning POA taking into account two or more different scenarios.
  - The different possible scenarios are established
  - The search segments for each scenario are drawn on the map.
  - The POA for every segment in each scenario is established.

Advanced Planning Concepts: Scenario Analysis

- The probability of each scenario is then evaluated and given a value.
- The POA in each segment is multiplied by the probability of each scenario. This is the ***Weighted POA.***
- The ***Planning POA*** is the sum of the Weighted POA for all scenarios.

Segment	Initial POA		Weighted POA		Planning POA
	East	*West*	*East (p = .70)*	*West (p = .30)*	
1	.30	.10	.70 X .30 = .210	.30 X .10 = .030	.210 + .030 = **.240**
2	.25	.05	.70 X .25 = .175	.30 X .05 = .015	.175 + .015 = **.190**
3	.20	.05	.70 X .20 = .140	.30 X .05 = .015	.140 + .015 = **.155**
4	.10	.30	.70 X .10 = .070	.30 X .30 = .090	.070 + .090 = **.160**
5	.05	.25	.70 X .05 = .035	.30 X .25 = .075	.035 + .075 = **.110**
6	.05	.20	.70 X .05 = .035	.30 X .20 = .060	.035 + .060 = **.095**
ROW	.05	.05	.70 X .05 = .035	.30 X .05 = .015	.035 + .015 = **.050**

Note: *p* = probability that scenario is valid; ROW = "Rest of the World".

Measuring Coverage: Probability of Detection (POD)

- The probability that a clue will be detected by the search action, given the existence of the clue in the area being searched.
- POD is expressed as a decimal value between zero and one (e.g., .50).

The Importance of POD to Search Management

- Incident objectives should be expressed as POD values.
- Search resources should be *briefed* in terms of desired POD.
- Searchers should be *debriefed* in terms of actual POD the resource obtained.

Computing Multiple Coverage

- $POD_{cum} = 1 - (a \times b \times c.... \times z)$

  where a = 1 - POD of first search

  b = 1 - POD of second search

  c = 1 - POD of third search

  z = 1 - POD of *n th* search

  where *n* = number of searches

POD this Search

POD Prior to this Search

	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
5	10	15	19	24	29	34	38	43	48	53	57	62	67	72	76	81	86	91	95
10	15	19	24	28	33	37	42	46	51	55	60	64	69	73	78	82	87	91	96
15	19	24	28	32	36	41	45	49	53	58	62	66	70	75	79	83	87	92	96
20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
25	29	33	36	40	44	48	51	55	59	63	66	70	74	78	81	85	89	93	96
30	34	37	41	44	48	51	55	58	62	65	69	72	76	79	83	86	90	93	97
35	38	42	45	48	51	55	58	61	64	68	71	74	77	81	84	87	90	94	97
40	43	46	49	52	55	58	61	64	67	70	73	76	79	82	85	88	91	94	97
45	48	51	53	56	59	62	64	67	70	73	75	78	81	84	86	89	92	95	97
50	53	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90	93	95	98
55	57	60	62	64	66	69	71	73	75	78	80	82	84	87	89	91	93	96	98
60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98
65	67	69	70	72	74	76	77	79	81	83	84	86	88	90	91	93	95	97	98
70	72	73	75	76	78	79	81	82	84	85	87	88	90	91	93	94	96	97	99
75	76	78	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
85	86	87	87	88	89	90	90	91	92	93	93	94	95	96	96	97	98	99	99
90	91	91	92	92	93	93	94	94	95	95	96	96	97	97	98	98	99	99	99
95	95	96	96	96	96	97	97	97	97	98	98	98	98	99	99	99	99	99	99

Probability of Detection Formula

- POD% = 100 - (.5 x spacing)

  Example: for 40 feet spacing

  POD% = 100 – (.5 x 40)

  = 100 - 20

  = 80% (or .80)

POD "trials" should be a component of every SAR training program, and the results should be recorded in the preplan and regularly updated.

To Search One Square Mile

Spacing (ft.)	Hours	No. of Searchers	Searcherhours	POD
100	3.5	53	185.5	50%
60	3.5	88	308.0	70%
20	3.5	264	924.0	90%

Grid Search Planning Formulas

$$\text{Searchers} = \frac{\text{Area (sq mi)} \times 5280 \times 3.5}{\text{Spacing (feet)} \times \text{Hours}}$$

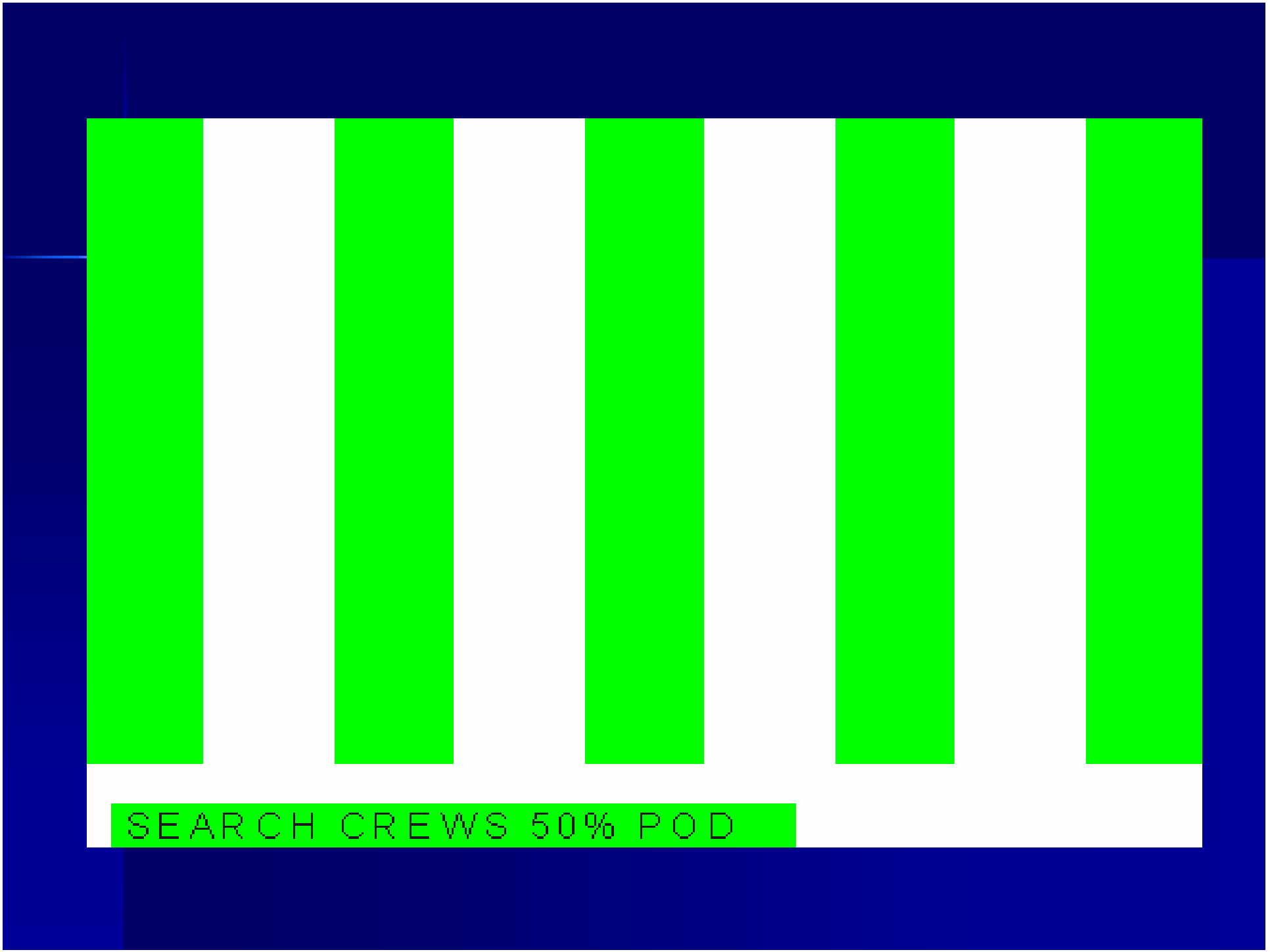
$$\text{Area (sq mi)} = \frac{\text{Spacing} \times \text{Hours} \times \text{Searchers}}{5280 \times 3.5}$$

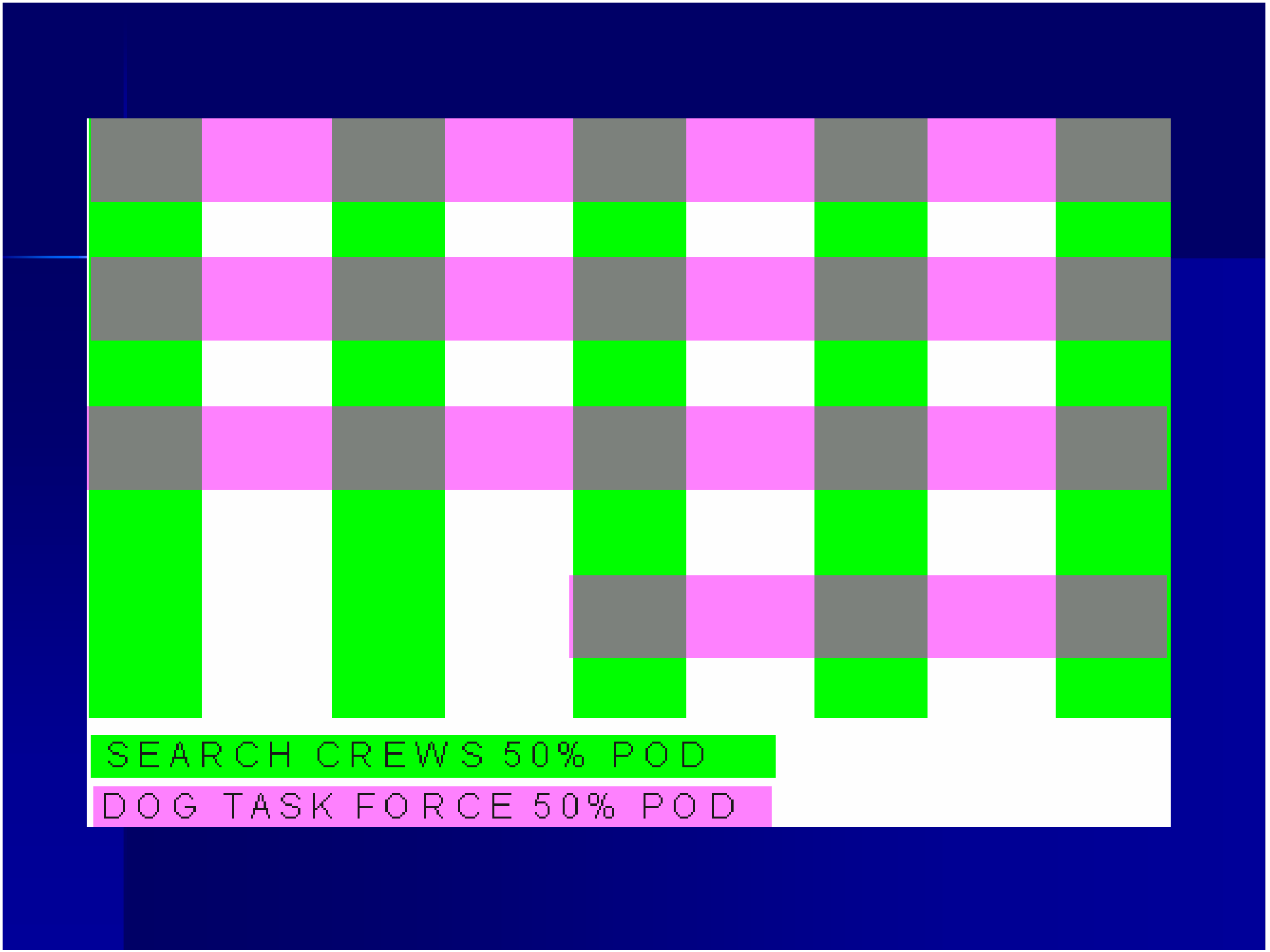
$$\text{Spacing (feet)} = \frac{\text{Area (sq mi)} \times 5280 \times 3.5}{\text{Searchers} \times \text{Hours}}$$

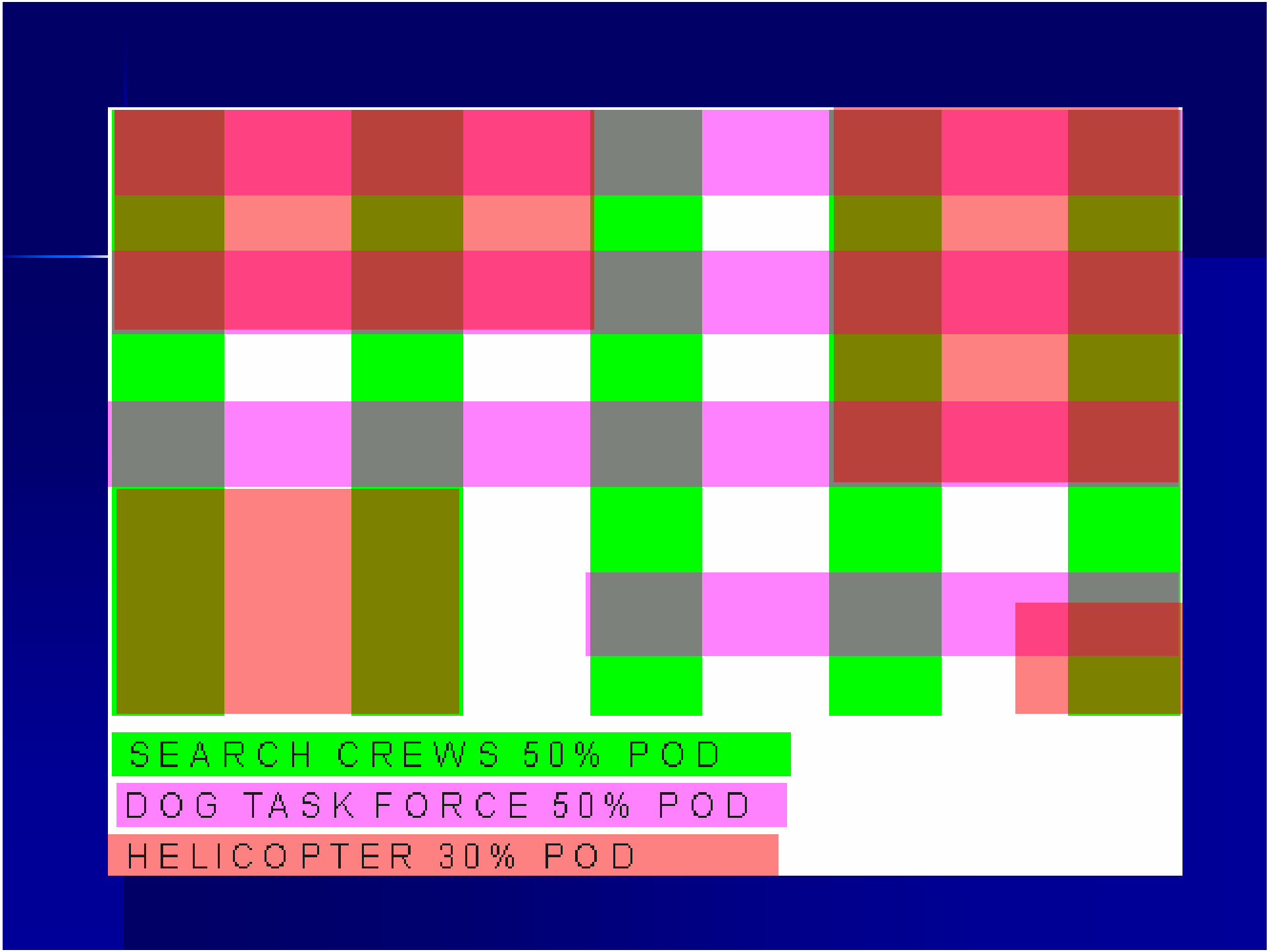
$$\text{Hours} = \frac{\text{Area (sq mi)} \times 5280 \times 3.5}{\text{Spacing (feet)} \times \text{Searchers}}$$

Decremental Effects on Probability of Detection

- Weather
- Time of day
- Searcher fatigue
- Searcher expectations
- Searchers training
- Poor leadership


SEARCH CREWS 50% POD


SEARCH CREWS 50% POD
DOG TASK FORCE 50% POD


SEARCH CREWS 50% POD
DOG TASK FORCE 50% POD
HELICOPTER 30% POD

POD Factoring

A system to more accurately quantify subjective POD evaluations based upon 10 criteria rated 1-10, with 10 being optimum.

1. Terrain
2. Hazards
3. Vegetation
4. Weather
5. Team Composition
6. Light
7. Area Size
8. Tactic
9. Spacing
10. Instinct & Variables

Sum of all categories = POD

Thank You

Questions?