

new issues in searching: using search theory and a simple field technique to determine the probability of detection for a field team

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four papers published in 2008:

- ① 'Lateral range curves, search probabilities & grid searching': *mathematical; deals with aspects of search theory in land SAR including lateral range curves, sweep width, search probabilities and coverage v POD graphs*
- ② 'The Critical Distance method: estimating the POD for grid searching by a land SAR field team': *describes a field method that can be used to estimate POD for grid searchers, plus*
- ③ 'The critical distance POD curve': *the graph used with the Critical Distance method*
- ④ 'Critical Separation and the POD for Grid Searching by a land SAR Field Team': *describes a method for determining POD based on critical separation*

available at

www.searchresearch.org.uk

and

www.isaralliance.com

- probability of detection
- search theory
- using search theory to estimate field team POD

- probability of detection

the likelihood that a field team will find the object that they are looking for

what does it depend on?

- the object that they are looking for
- terrain, vegetation & visibility
- the tactics they are using
- fatigue, motivation, expectancy
- luck

□ probability of detection

how to find a probability ... can I find the probability that a coin will land heads up?

1. carry out a field trial ... spin the coin and record the result
2. use a theoretical approach

- probability of detection

how to find the probability of detection for a search resource ...

1. conduct field trials

2. use theory ... what theory?

- search theory

what is it

why should we consider using it to
determine field team POD

□ search theory

advantages

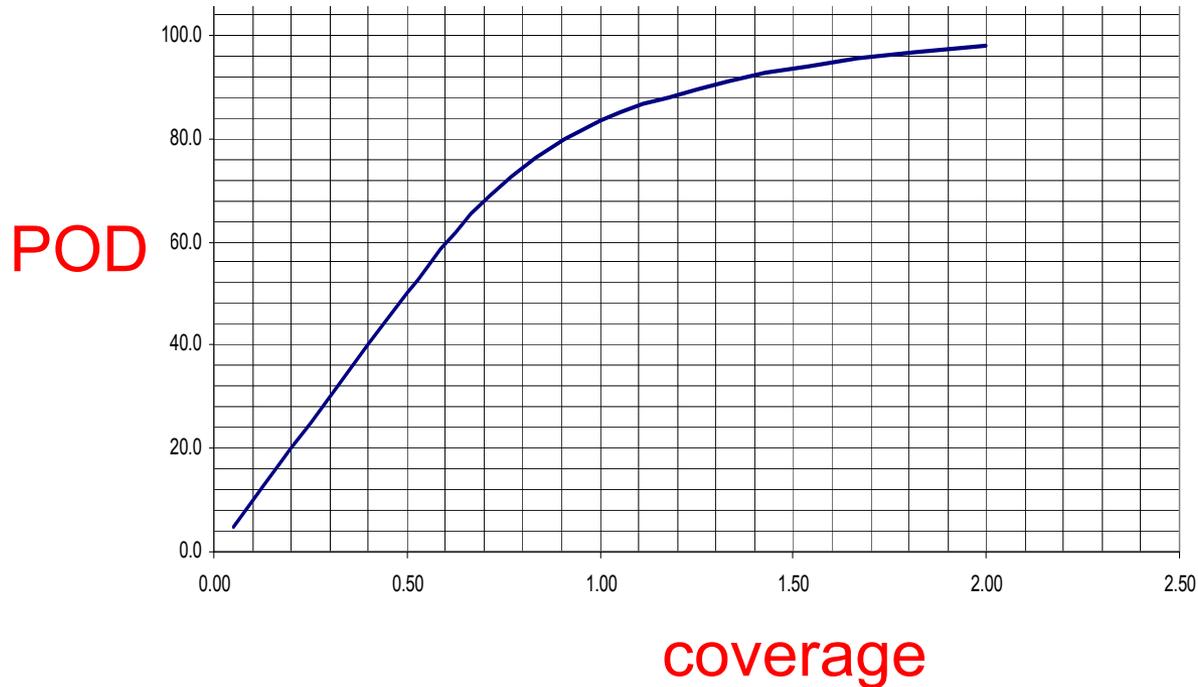
- ☺ objective
- ☺ consistent
- ☺ robust

disadvantages

- ☹ mathematical, not easily understood
- ☹ need to proceed with caution
- ☹ not designed for land SAR use

search theory ... finding POD for a field team

search theory ... finding POD for a field team



- ③ when we know their **coverage** we will be able to estimate their **POD**

search theory ... finding POD for a field team

- ② we will be able to work out their **coverage** once we know their **sweep width**
- ③ when we know their **coverage** we will be able to estimate their **POD**

search theory ... finding POD for a field team

- ① the field team uses a **field procedure** to determine their **sweep width** ...
 - for the object they are searching for
 - in the area that they are searching
 - under the current conditions
- ② we will be able to work out their **coverage** once we know their **sweep width**
- ③ when we know their **coverage** we will be able to estimate their **POD**

sequence of actions
suggested by
search theory

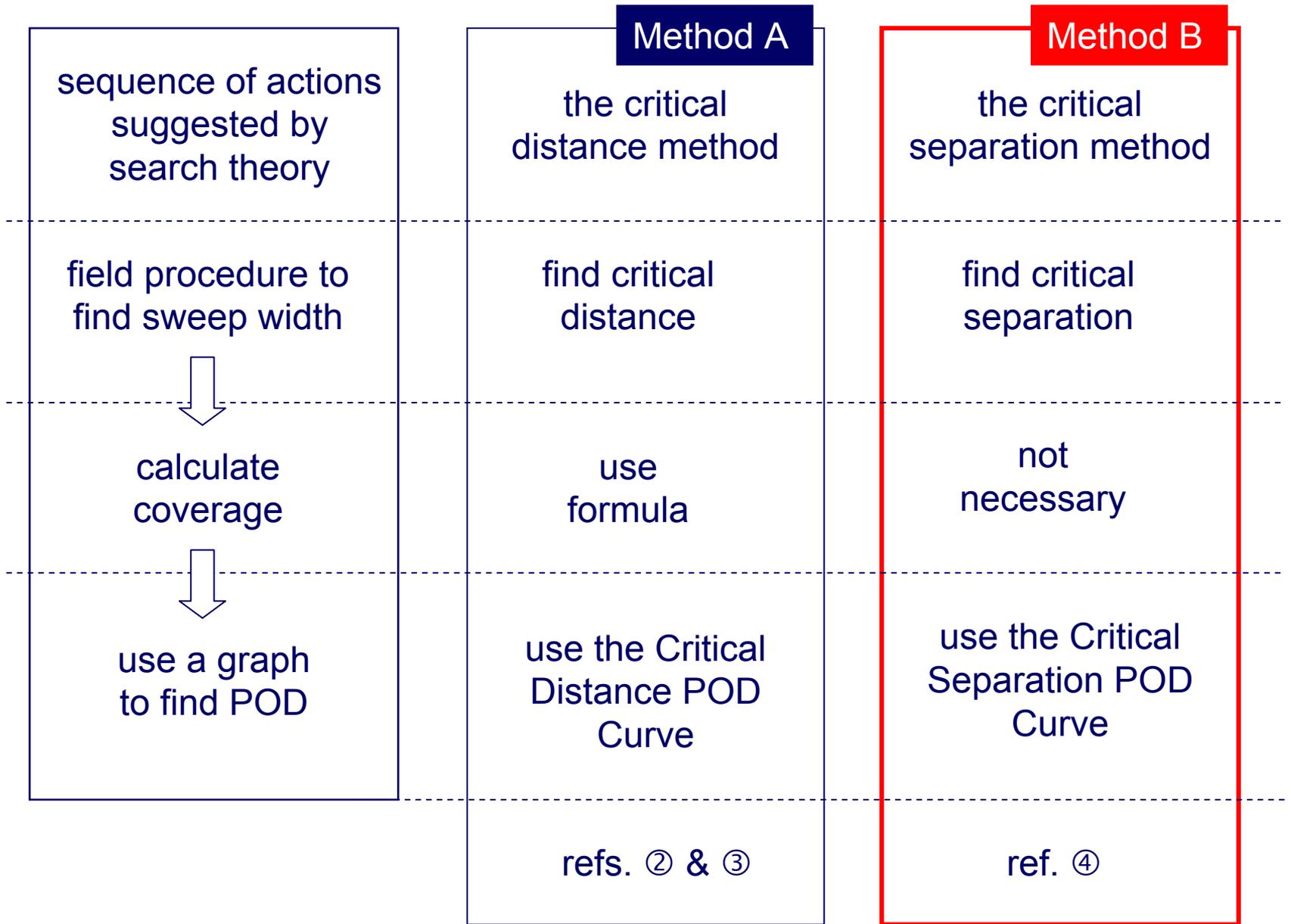
field procedure to
find sweep width



calculate
coverage



use a graph
to find POD



handout

recommended procedure

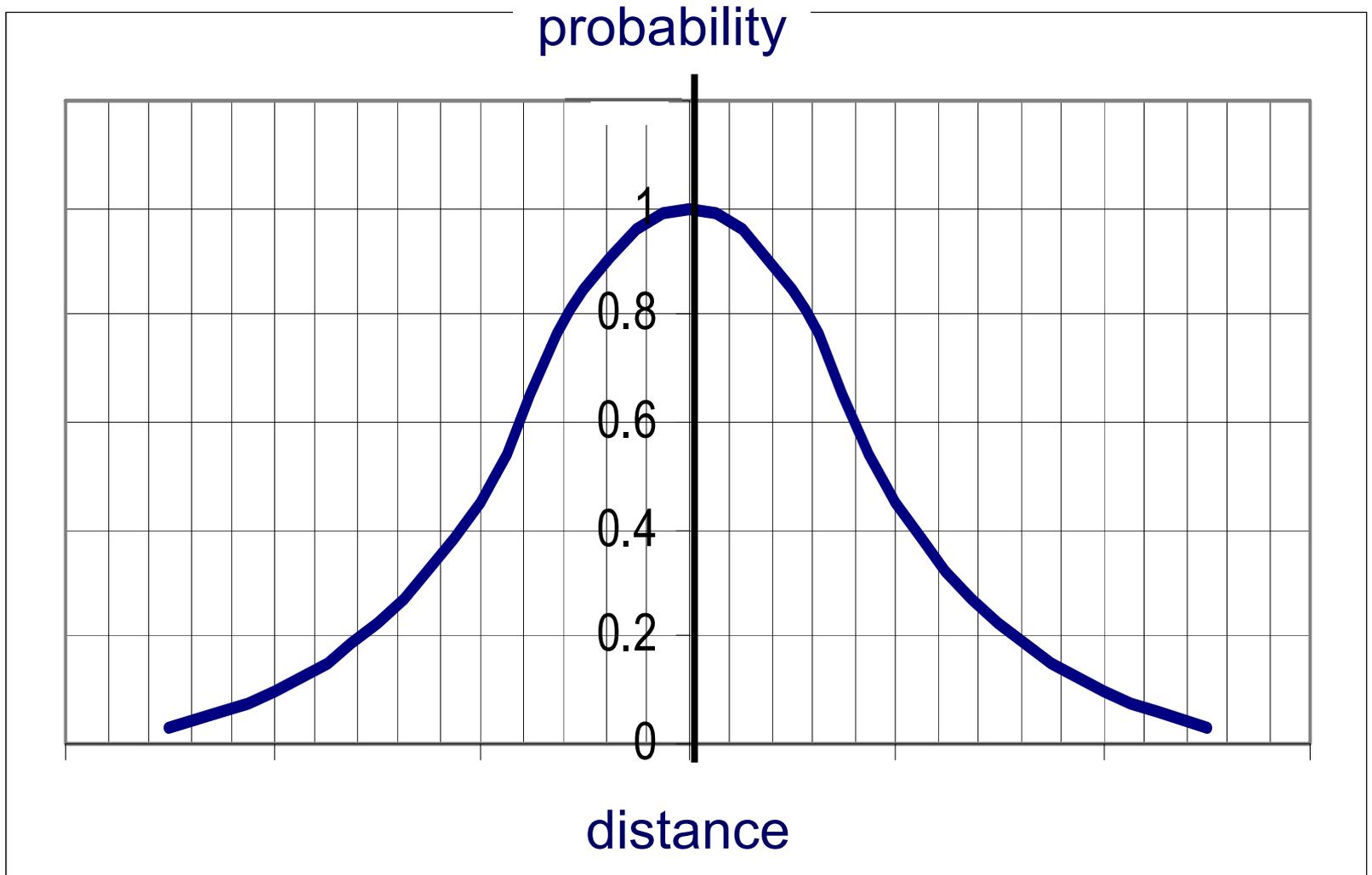
explanations needed for:

- sweep width
- critical distance
- ~~✗~~ coverage
- ~~✗~~ critical distance POD curve
- critical separation
- critical separation POD curve
- recommended procedure

- ❑ sweep width
- ❑ critical distance

the sweep width for a particular sensor, searching for a particular object in a given environment, is the area under that sensor's lateral range curve for the object and environment under consideration

a typical LRC

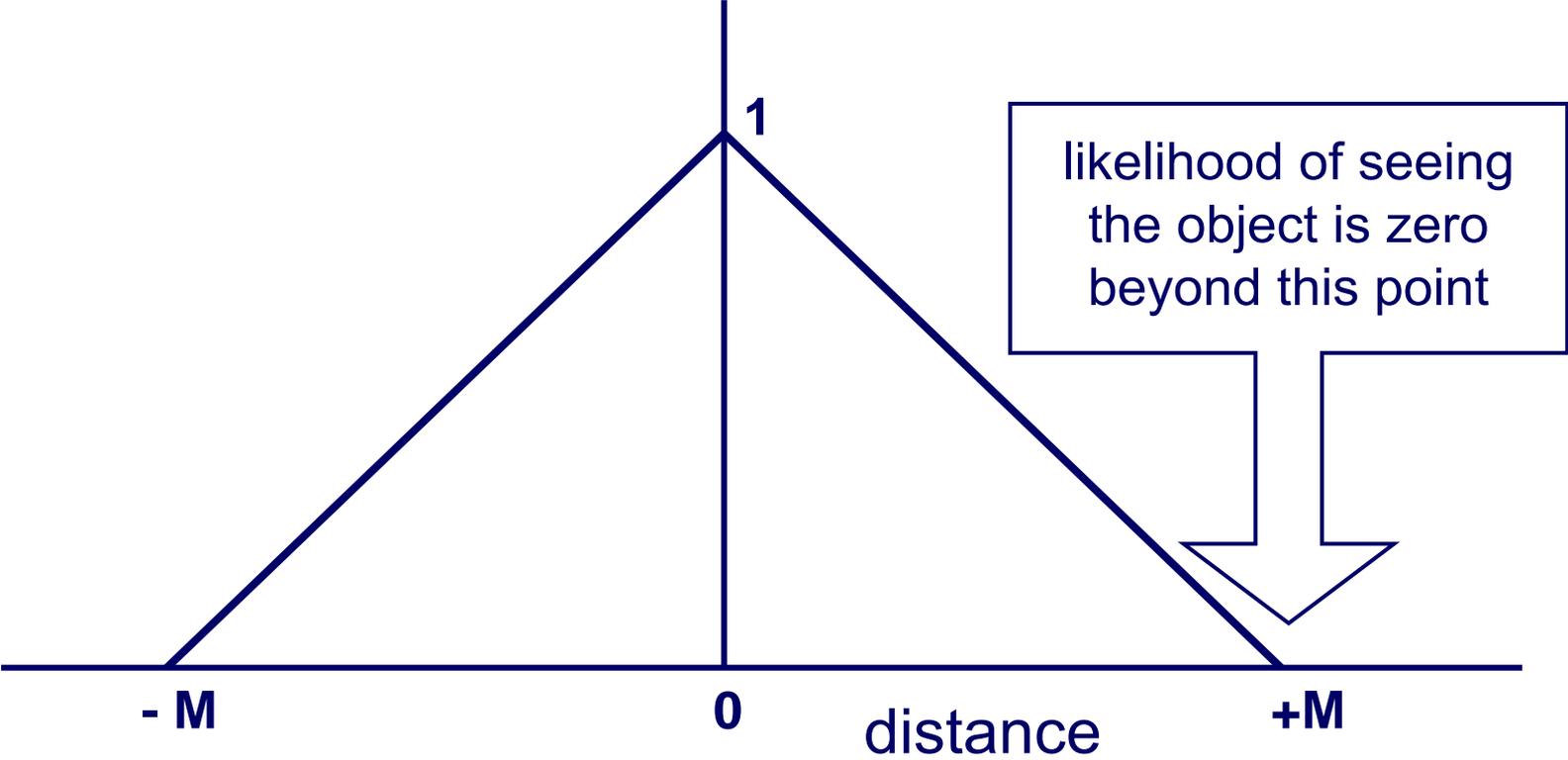


a. $0 \leq \text{probability} \leq 1$

b. 'distance' means the shortest distance from the sensor's path to the object (CPA)

linear lateral range curve

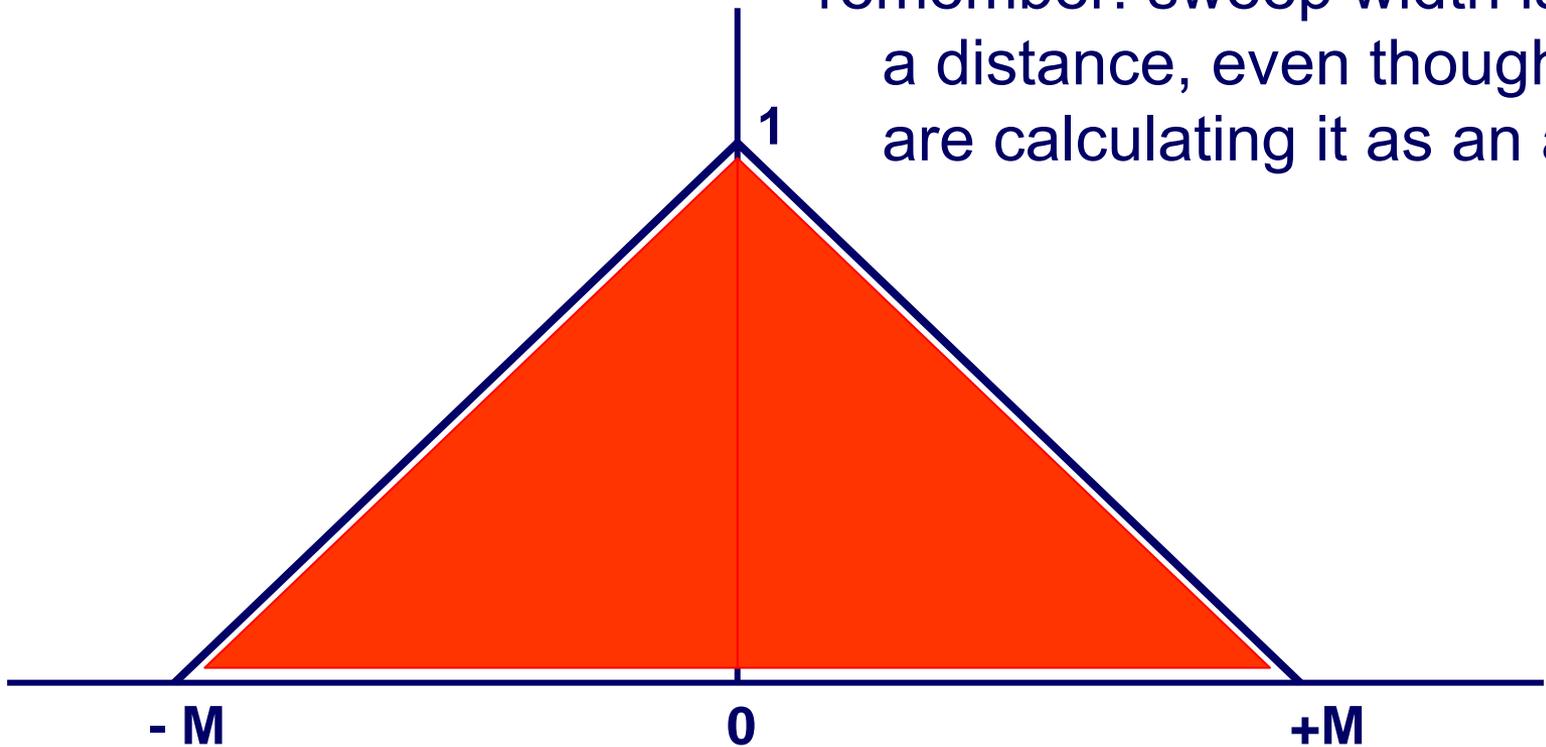
probability of detecting
an object at distance x



SWEEP WIDTH is defined as the area under the LRC

$$\begin{aligned}\text{sweep width} &= \text{area of } \blacktriangle \\ &= \frac{1}{2} \times 2M \times 1 \\ &= M\end{aligned}$$

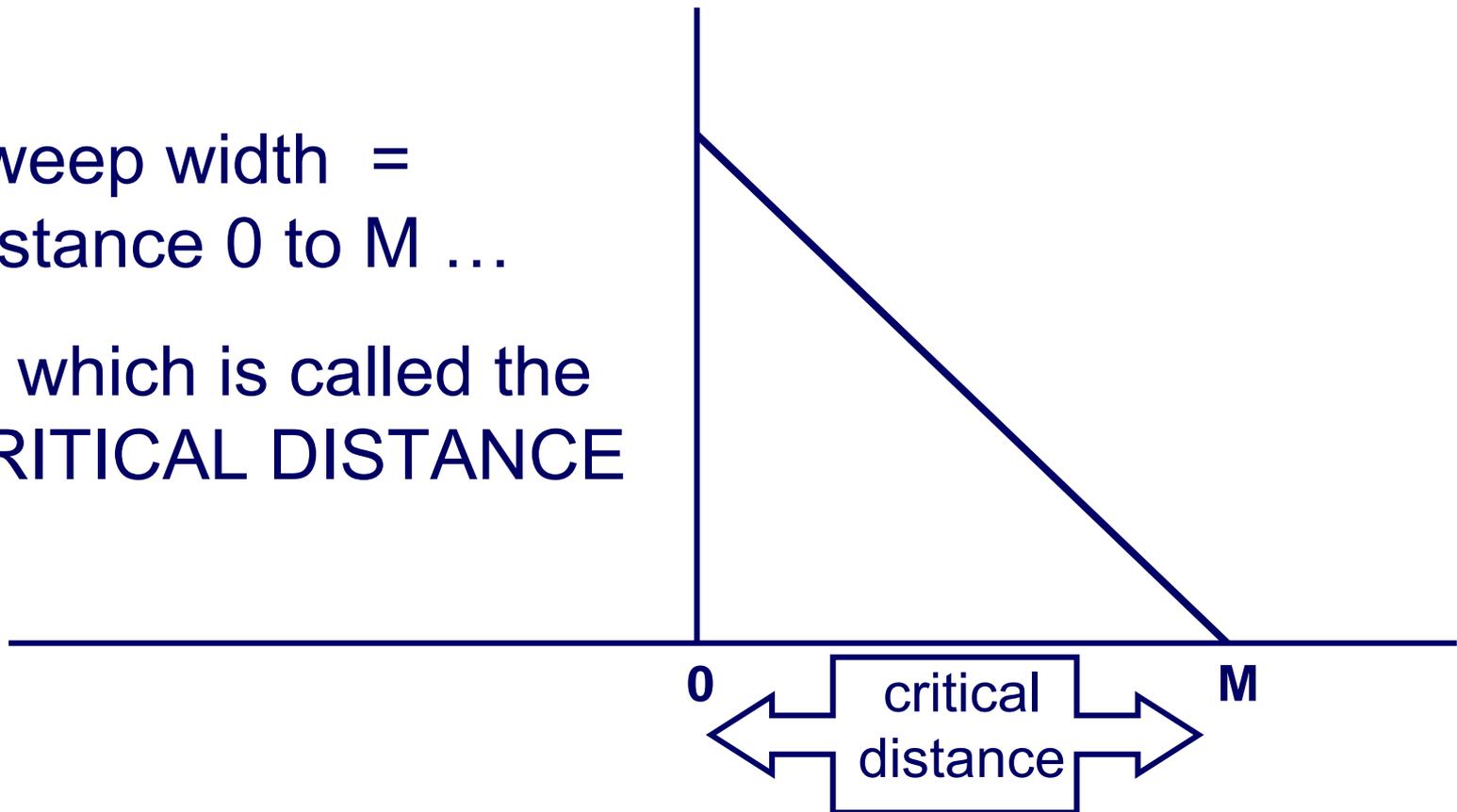
remember: sweep width is a distance, even though we are calculating it as an area



SWEEP WIDTH is defined as the area under the LRC

sweep width = distance 0 to M ...

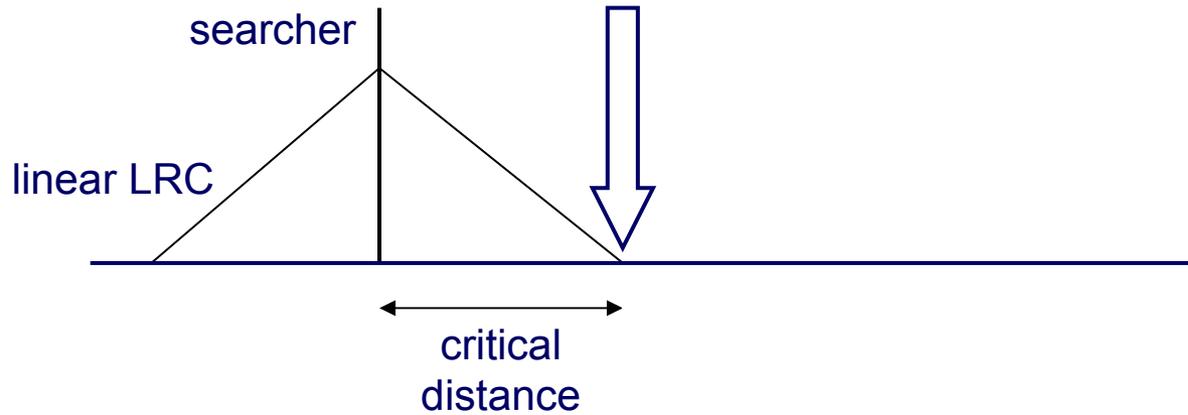
... which is called the **CRITICAL DISTANCE**



- ☑ sweep width
- ☑ critical distance
- ☒ coverage
- ☒ critical distance POD curve
- ☐ critical separation
- ☐ critical separation POD curve
- ☐ recommended procedure

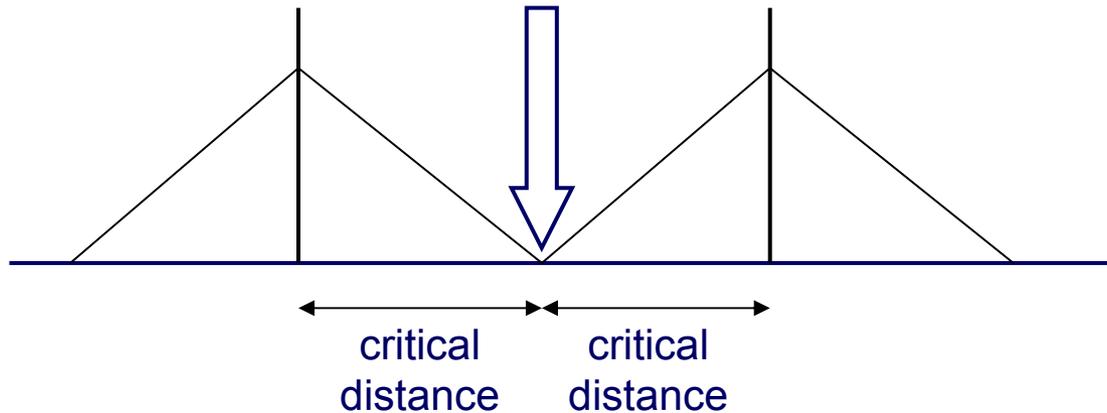
critical separation

an object placed here
would be on the limit of
visibility for this searcher



critical separation

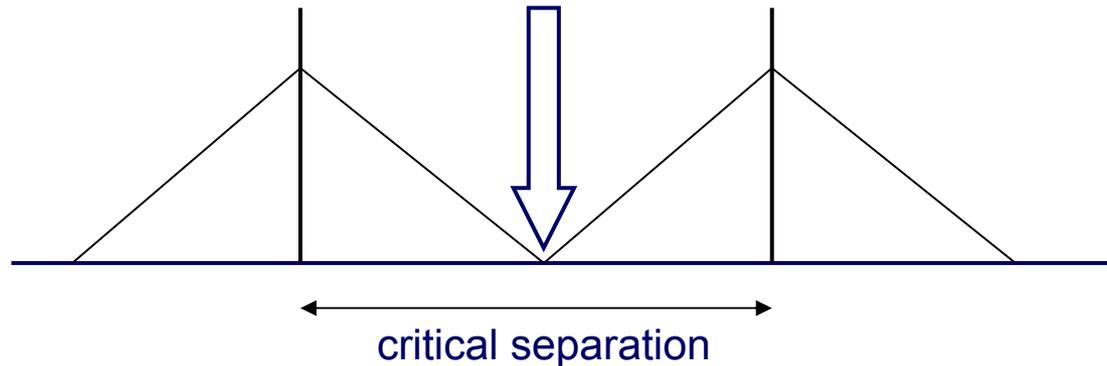
an object placed here
would be on the limit of
visibility for both searchers



definition: two searchers are at critical separation
if an object placed midway between them is on
the limit of visibility of each of them

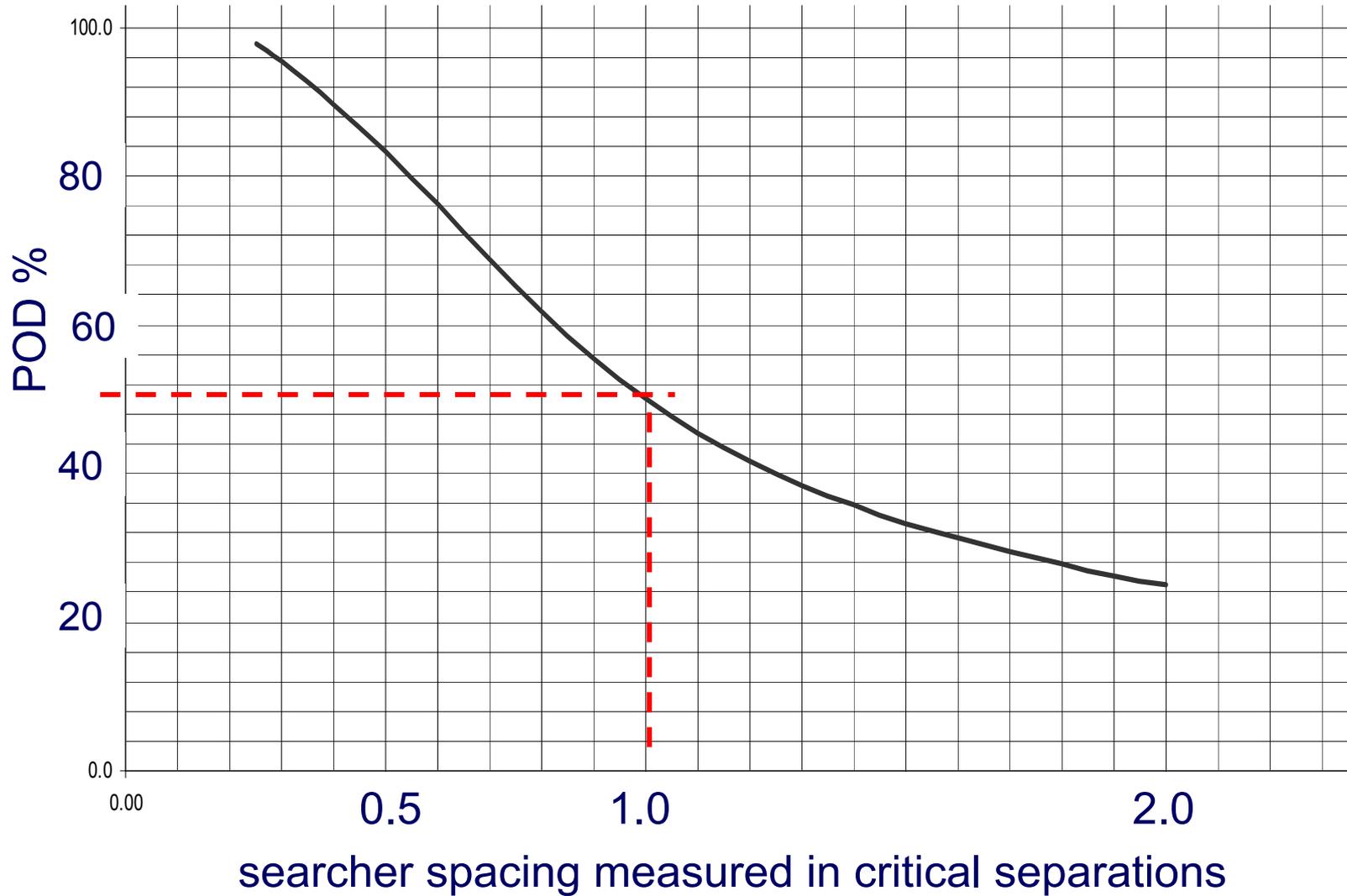
critical separation

an object placed here
would be on the limit of
visibility for both searchers



- POD for searchers at CS is 50%
- if the spacing changes then the POD changes

the critical separation POD curve



- sweep width
- critical distance
- coverage
- critical distance POD curve
- critical separation
- critical separation POD curve
- recommended procedure

sequence of actions
suggested by
search theory

field procedure to
find sweep width



calculate
coverage



use a graph
to find POD

Method B

the critical
separation method

find critical
separation

not
necessary

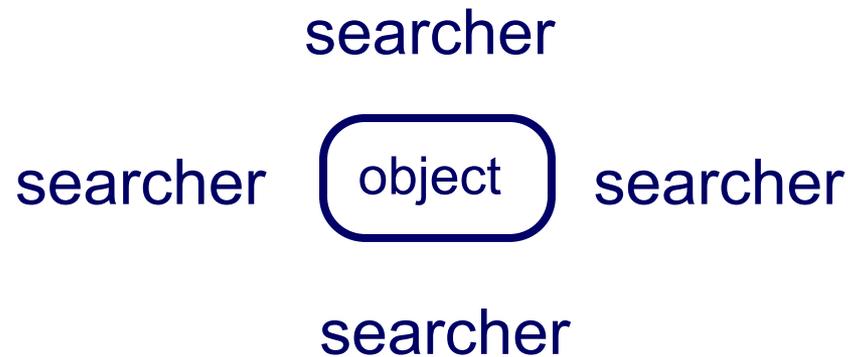
use the Critical
Separation POD
Curve

ref. ④

handout

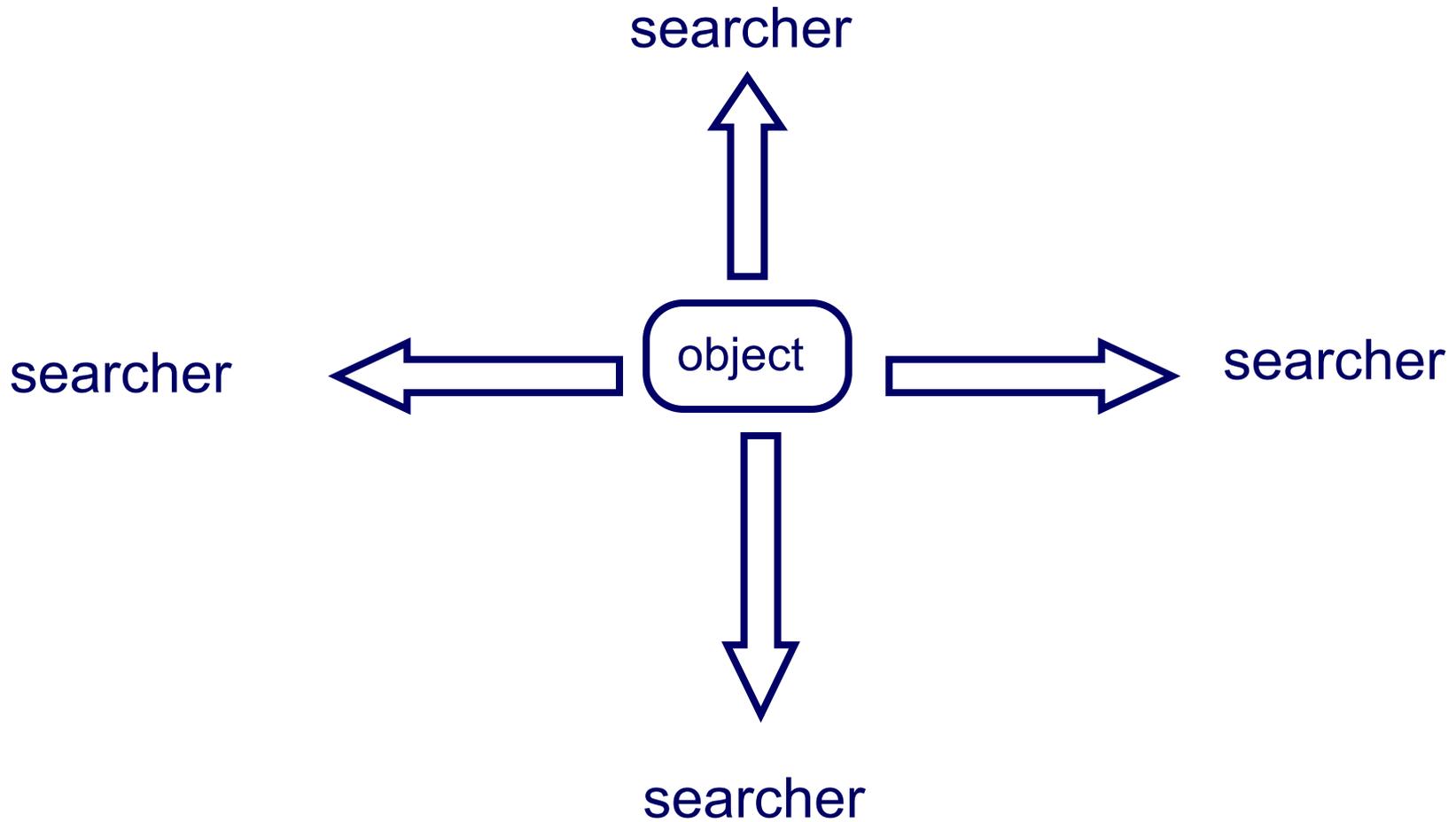
recommended procedure

1. place a suitable object on the ground and gather round it

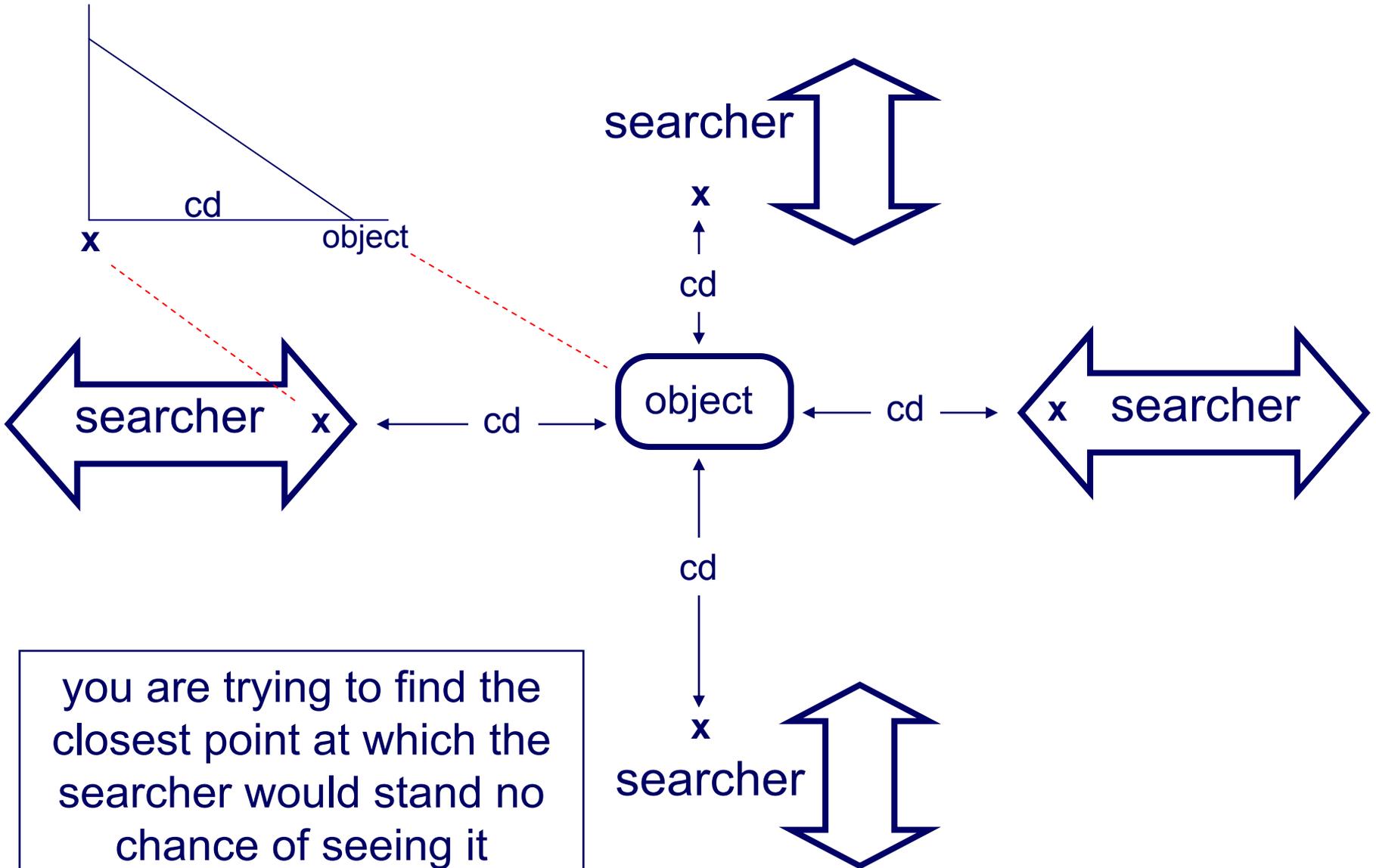


field procedure to find critical separation

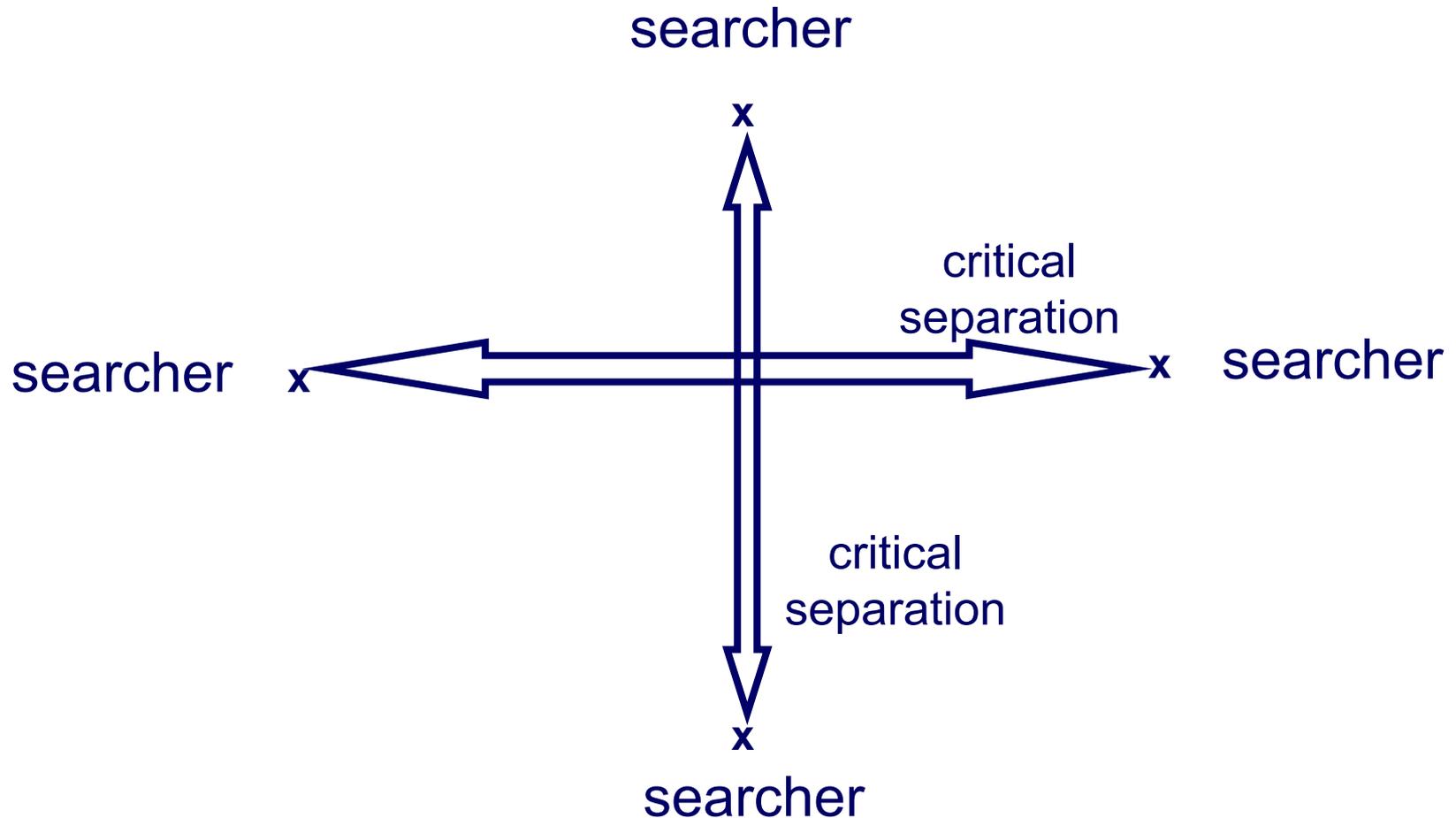
2. move away from it until it is no longer visible



3. check this position carefully and mark it

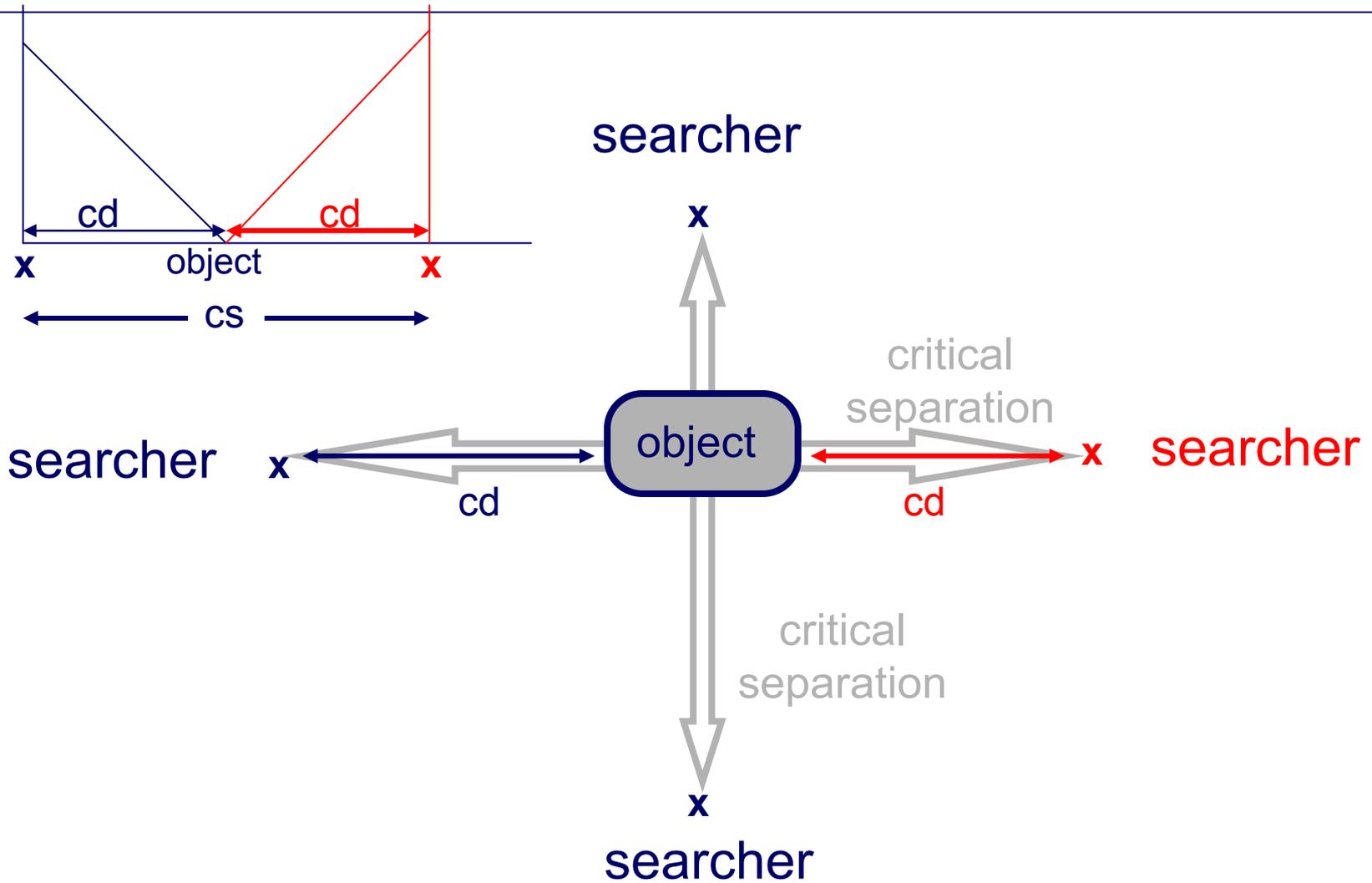


4. measure* the distances mark-to-mark across the object and find the average, but ...



* e.g. by pacing

5. ... it may be simpler to find the average critical distance and double it



how large is the area being searched?

for a field team:

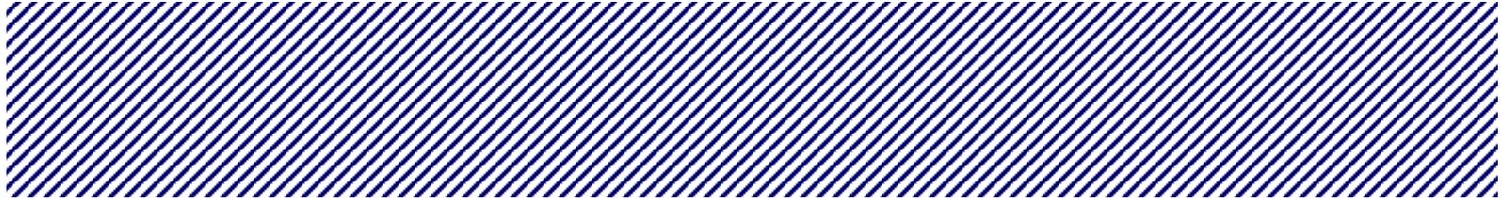
$$\text{coverage} = \frac{\text{total track length} \times \text{ESW}}{\text{area of sector}}$$

coverage (and therefore POD) only has meaning in relation to a known area

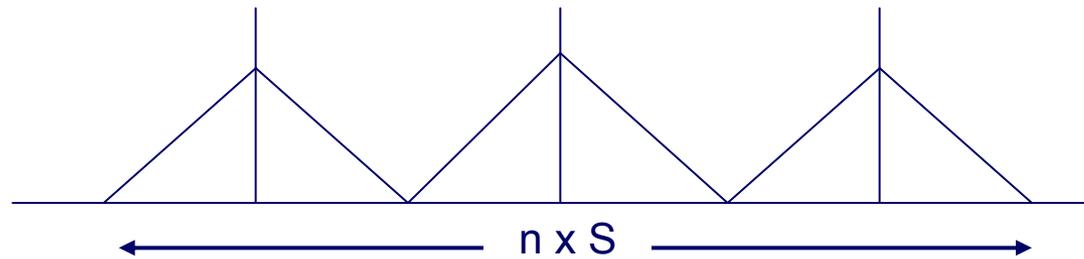
what
is it?

distance travelled

$n \times S^*$



* this is the important bit



the area covered by a field team consisting of n searchers searching with a constant spacing of S is $n \times S \times$ distance travelled; it extends to a distance of $\frac{1}{2} S$ beyond the end searcher

final comments

- using search theory enables us to estimate the POD of a field team in a way that is objective, consistent and robust
- in order to use an approach based on search theory we need to know the sweep width for the search resource, the search target, the terrain, the level of vegetation and the visibility
- critical distance gives us a measure of sweep width; critical separation is twice critical distance
- the corridor searched extends to $\frac{1}{2}$ x spacing beyond the end searcher
- we need to fully understand the field procedure and how to use the critical separation POD graph ... read ④