

Second online training course

*Refreshing methods:
camera trap methods for
density estimation, EOW field
protocol and database
processing for analysis*

<https://wildlifeobservatory.org/>

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28th September 2022

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UNIVERSITA
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ENETWILD





Random Encounter Model (REM)

~~FIRST COURSE~~

Journal of Applied Ecology



British Ecological Society

Journal of Applied Ecology 2008

doi: 10.1111/j.1365-2664.2008.01473.x

**Estimating animal density using camera traps without
the need for individual recognition**

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~~FIRST COURSE~~

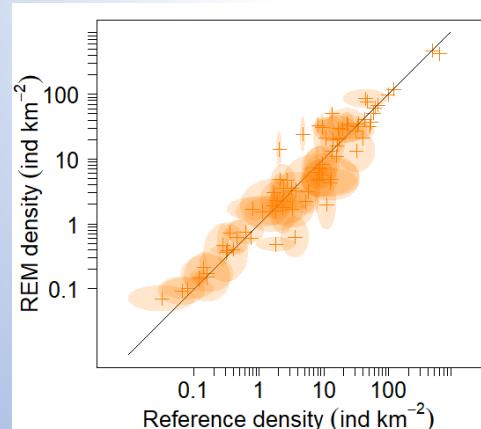
Why REM?

Remote Sensing in Ecology and Conservation

Open Access

ORIGINAL RESEARCH

Random encounter model is a reliable method of estimating population density of multiple species using camera traps



Reviewed

- 34 studies
- 45 species
- 77 REM-reference method comparisons
- 13 populations sampled





Density:

Number of individuals per unit area (individuals·km⁻²)

$$D = \frac{\pi}{t} \cdot \frac{y}{v \cdot r \cdot (2 + \alpha)}$$

The diagram illustrates the components of the density formula. A dashed orange circle represents the detection zone, with radius r and angle α . Inside this zone, three stars are labeled 1, 2, and 3. Star 1 is at the top, star 2 is at the bottom left, and star 3 is at the bottom right. A vertical dashed line extends from the center of the zone to star 1, with the distance y indicated. A horizontal dashed line extends from the center to star 3. Blue arrows point from the text definitions to their corresponding parts in the diagram.

Day range:

distance travelled by an individual during the day (km·day⁻¹)

Encounter rate:

Number of animals detected per sampling unit (animals·(cam·day)⁻¹)

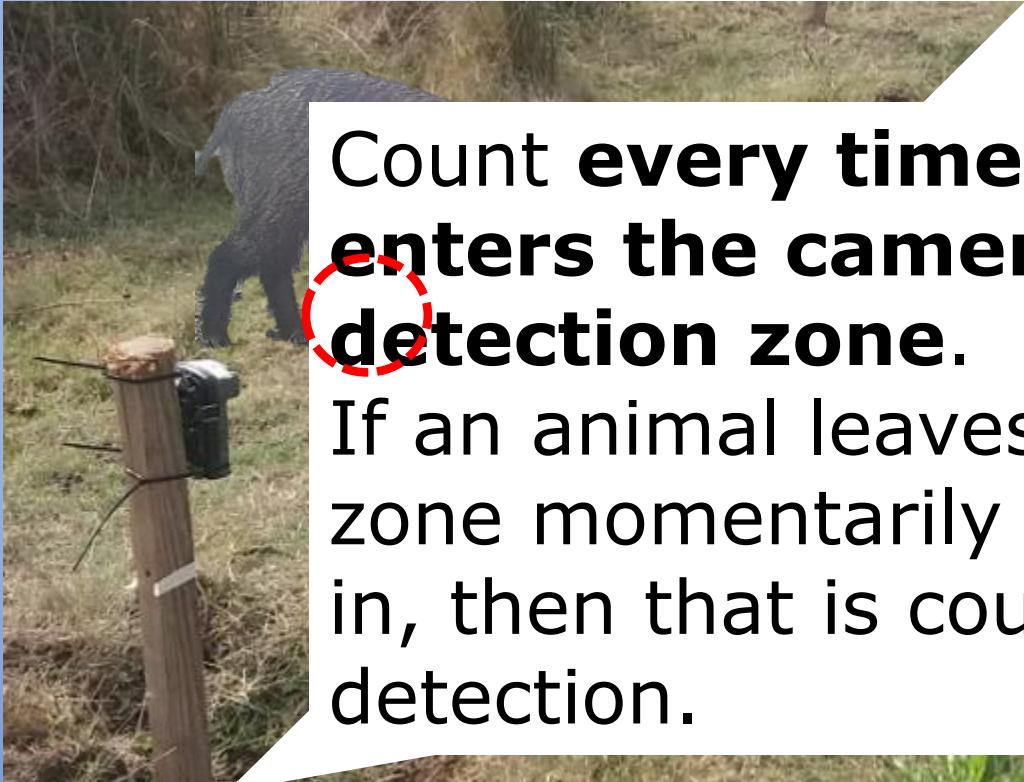
Detection zone:

Area in which the cameras effectively detect animals. Radius (km) and angle (radians)





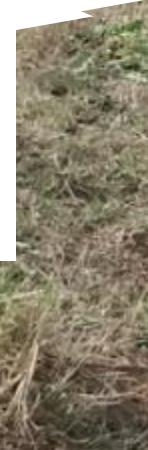
Encounter rate



Nº encounters: 2

Count **every time an animal enters the camera trap's detection zone.**

If an animal leaves the detection zone momentarily and comes back in, then that is counted as a new detection.





Detection zone: radius

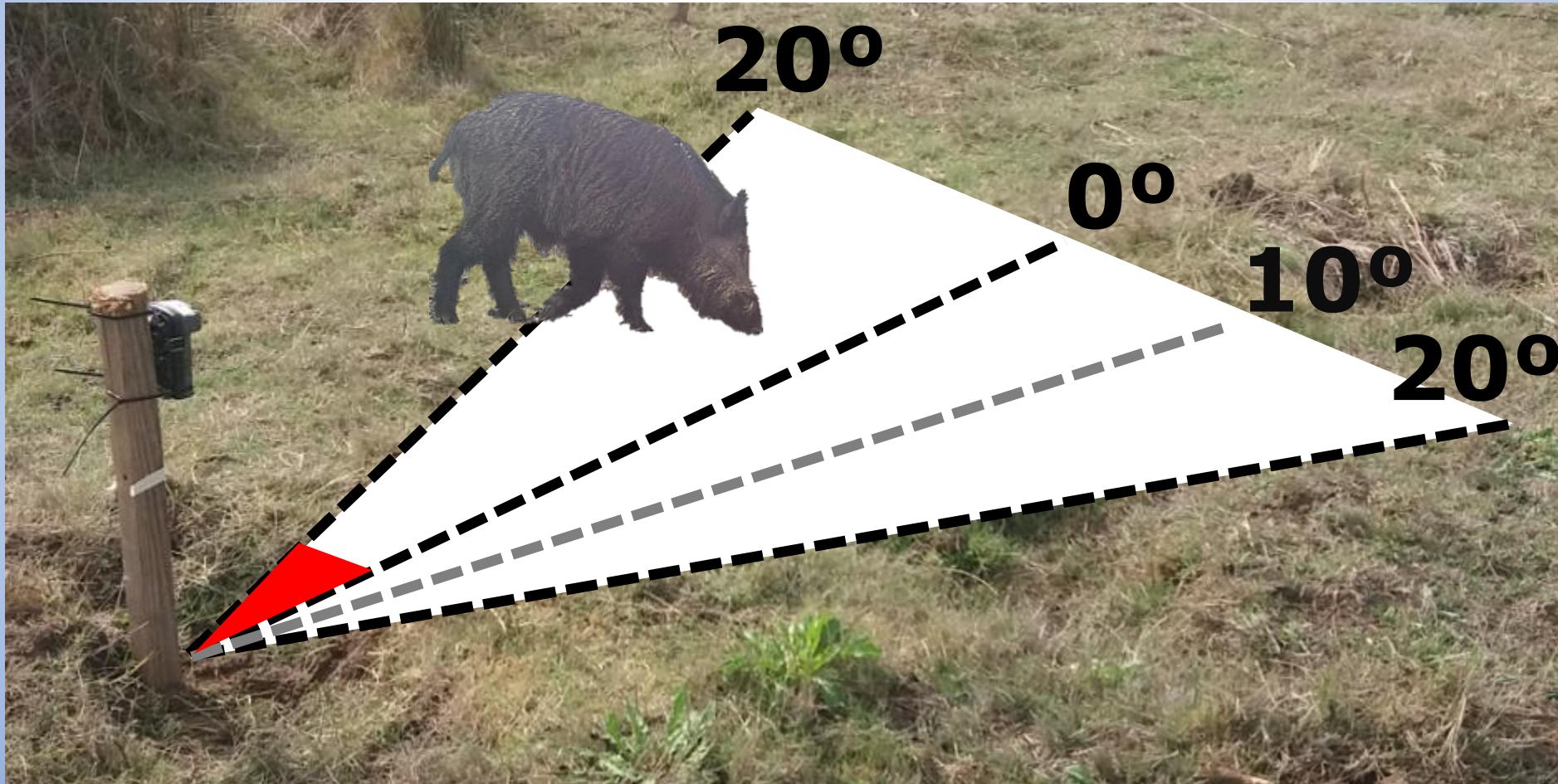


*First image of each sequence



Detection zone: angle

CT angle: 40°



**First image of each sequence*



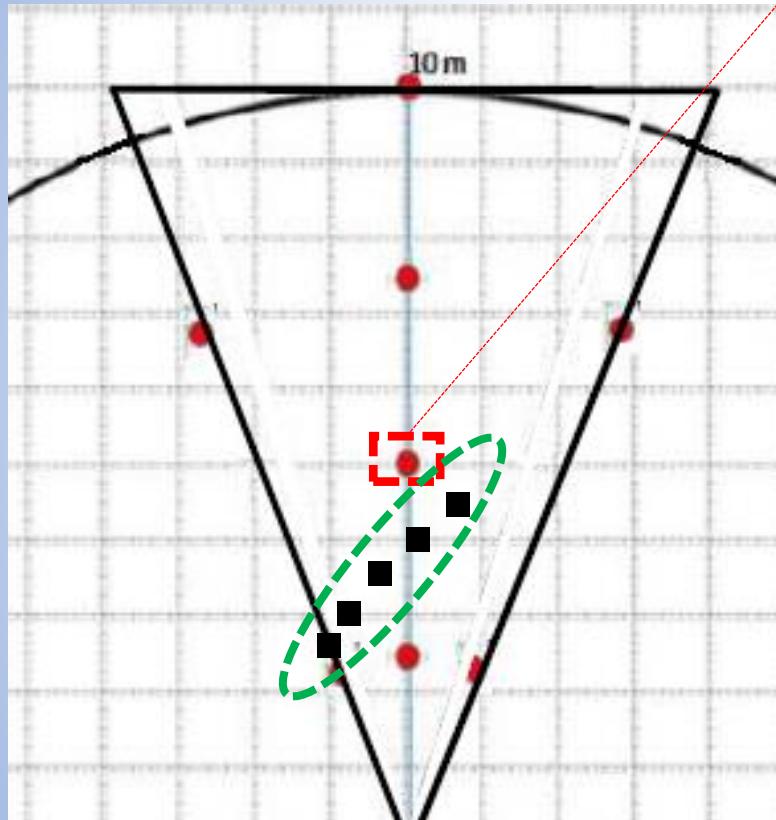
10 C

TRANSCAM14

● 04/17/2022 06:06:23PM

Day range: speed

5m



$$speed = \frac{d}{t} = \frac{2.5m}{2s} = 1.25m \cdot s^{-1}$$

Rowcliffe *et al.*, 2016 – RSECPalencia *et al.*, 2019 – J. Zool.Palencia *et al.*, 2021 – Methods Ecol. Evol.



Day range: activity

Frequency plot: all animals captured in all cameras from 00:00 to 00:59



REM: what do we need??



Encounter rate

Camera	Encounters	Days
1	20	21
2	7	21
3	52	14
4	0	21
...
N	3	21

Detection zone

Animal_ID	Radius (m)	Angle (°)
1	2.3	20
2	7	17
3	4	14
4	2.8	18
...
N	3	0

Day range

Animal_ID	Time	Speed (m/s)	Group size
1	23:30:02	1.3	2
2	06:43:50	2.1	1
3	08:01:45	0.3	1
4	22:12:00	0.4	3
...
N	03:40:56	1.8	1

$$D = \frac{y}{t} \cdot v \cdot r \cdot (2 + \alpha)$$

π Speed
 y Activity
 t
 v
 r
 α



Operativity matrix

CT placements

CAM	29/10/2018	30/10/2018	31/10/2018	01/11/2018	02/11/2018	03/11/2018	04/11/2018	05/11/2018	06/11/2018	07/11/2018
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	0	0	0	0
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1

1: camera was operative all the day (24h)

0: the camera was not operative (empty batteries, full card, stolen...)



Some examples...



 Bushnell

 TROPHY CAM

48°F 8°C 

12-18-2018 17:31:32



Example-1



Bushnell M TROPHY CAM 48°F 8°C 12-18-2018 17:31:32



Bushnell M TROPHY CAM 48°F 8°C 12-18-2018 17:31:33



Bushnell M TROPHY CAM 48°F 8°C 12-18-2018 17:31:34

- Encounter rate
- Detection angle
- Detection radii
- Time
- Speed

Speed

Speed

Encounter rate

Camera	Encounters	Days
X	1	Y

Detection zone

Animal_ID	Radius (m)	Angle (°)
1	4.3	11

Day range

Animal_ID	Time	Speed (m/s)	Group size
1	17:31:32	1.2	1



Example-2



- Encounter rate
- Detection angle
- Detection radii
- Time
- Speed

Encounter rate

- Speed

Detection zone

- Speed

Day range

- Encounter rate
- Detection angle
- Detection radii

Camera	Encounters	Days
X	2	Y

Animal_ID	Radius (m)	Angle (°)
1	4.8	14
2	2.7	19

Animal_ID	Time	Speed (m/s)	Group size
1	21:22:25	1.15	2



Example-3



- Encounter rate
- Detection angle
- Detection radii
- Time

Encounter rate

Camera	Encounters	Days
X	1	Y

Detection zone

Animal_ID	Radius (m)	Angle (°)
1	2.7	11

Day range

Animal_ID	Time	Speed (m/s)	Group size
1	04:23:03	-	1

Example-4



- Encounter rate
- Detection angle
- Detection radii
- Time
- Speed

Encounter rate

X Speed

Behavioural response to the camera (curiosity), don't estimate speed

X Speed

X Speed

X Speed

Detection zone

Animal_ID	Radius (m)	Angle (°)	Animal_ID	Time	Speed (m/s)	Group size
1	4.1	2	1	20:54:18	NO	1



Example-5



Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:02:44 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:02:45 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:02:46 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:02:47 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:02:48 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:02:49 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:04:09 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:04:12 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:04:13 Bushnell TROPHY CAM 38°F 3°C ● 12-05-2018 22:04:14

- Encounter rate
- Detection angle
- Detection radii
- Time
- Speed

Speed

Speed

- Encounter rate
- Detection angle
- Detection radii

Speed

Speed

Speed

Two encounters

Encounter rate

Camera	Encounters	Days
X	2	Y

Detection zone

Animal_ID	Radius (m)	Angle (°)
1	7.1	16
2	2.1	20

Day range

Animal_ID	Time	Speed (m/s)	Group size
1	22:02:44	0.35	1



Take home messages

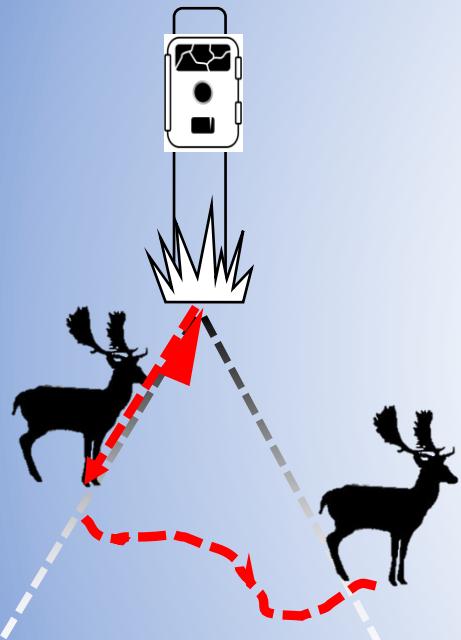


- 1. EOW focused on mammals' community (unmarked methods preferred)**
- 2. Locate animals in the field of view (needed for most of the methods)**
- 3. REM, method to be applied**



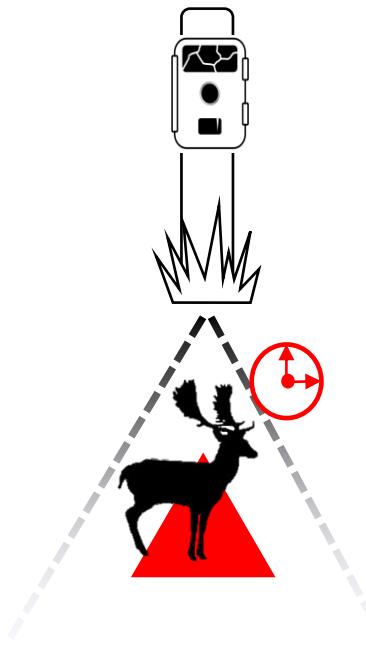


REM



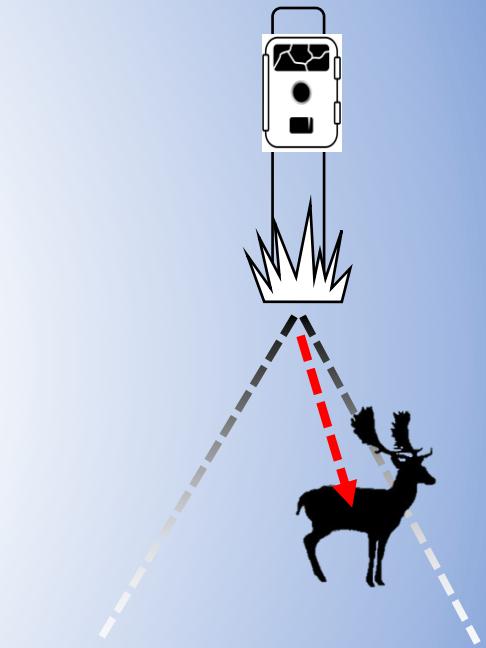
$$D = \frac{Y}{H} \cdot \frac{\pi}{v \cdot r \cdot (2 + \theta)}$$

REST



$$D = \frac{Y \cdot T}{S \cdot H}$$

CT-DS



$$D = \frac{Y}{\pi \cdot w^2 \cdot e \cdot P}$$



Rowcliffe *et al.*, 2008 – J. Appl. Ecol.



Nakashima *et al.*, 2018 – J. Appl. Ecol.



Howe *et al.*, 2017 – Methods Ecol. Evol.



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RESEARCH ARTICLE

Journal of Applied Ecology



Assessing the camera trap methodologies used to estimate density of unmarked populations

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Abstract

1. Population density estimations are essential for wildlife management and con-



Appendix S2

Assessing the camera-trap methodologies used to estimate density of unmarked populations

Pablo Palencia, J. Marcus Rowcliffe, Joaquín Vicente & Pelayo Acevedo

Journal of Applied Ecology

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Questions??

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