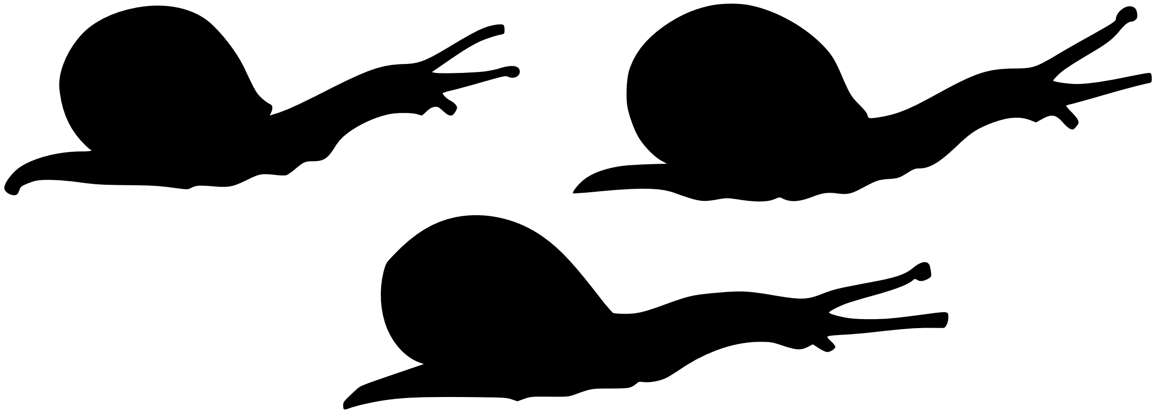
Distance Sampling and Animal Movement



Richard Glennie
University of St Andrews
rg374@st-andrews.ac.uk

University of St Andrews

CREEM
Centre for Research into Ecological and Environmental Modelling

Assumption: Objects are detected at their *initial* location.

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Violate: Move in response to observer.

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Mitigate:

- ✓ Survey Protocol
- ✓ Left truncation
- ✓ Double Observer Methods

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Conn, P.B. and Alisauskas, R.T., 2018. Simultaneous modelling of movement, measurement error, and observer dependence in mark-recapture distance sampling: An application to Arctic bird surveys. The Annals of Applied Statistics, 12(1), pp.96-122.

Assume: Objects are detected at their *initial* location.

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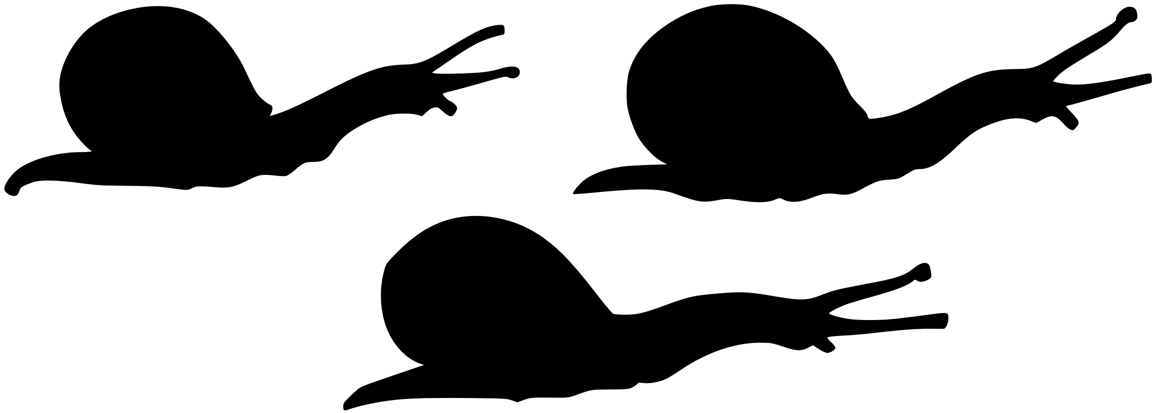
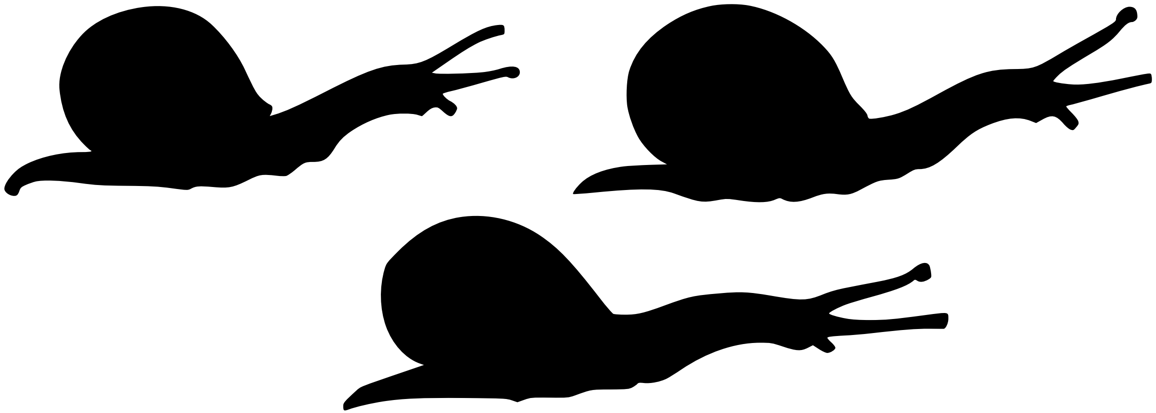


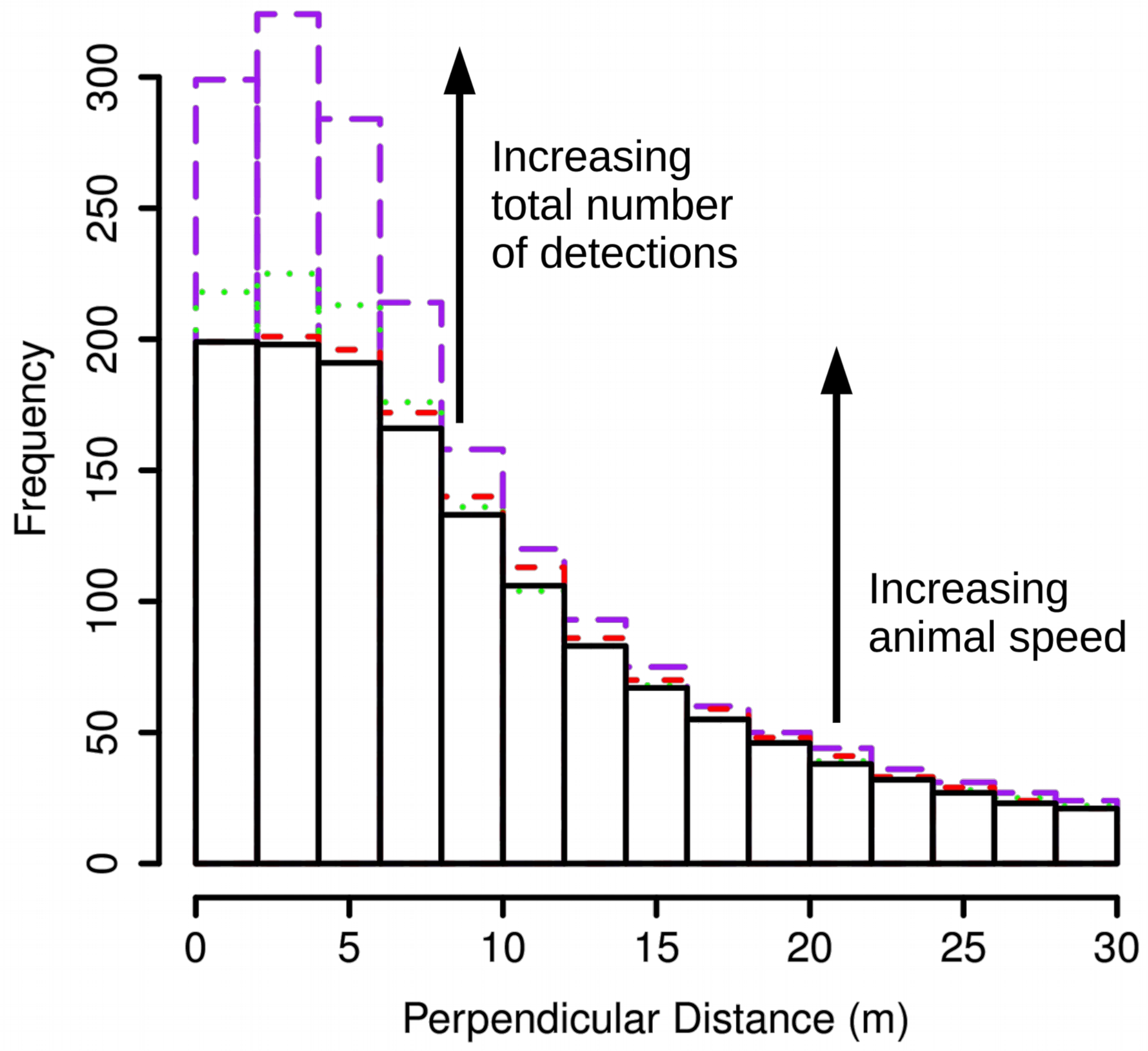
Assume: Objects are detected at their *initial* location.

Violate: Move independently of the observer.

Mitigate: ?



$$\hat{N} = \frac{n}{\hat{p}}$$



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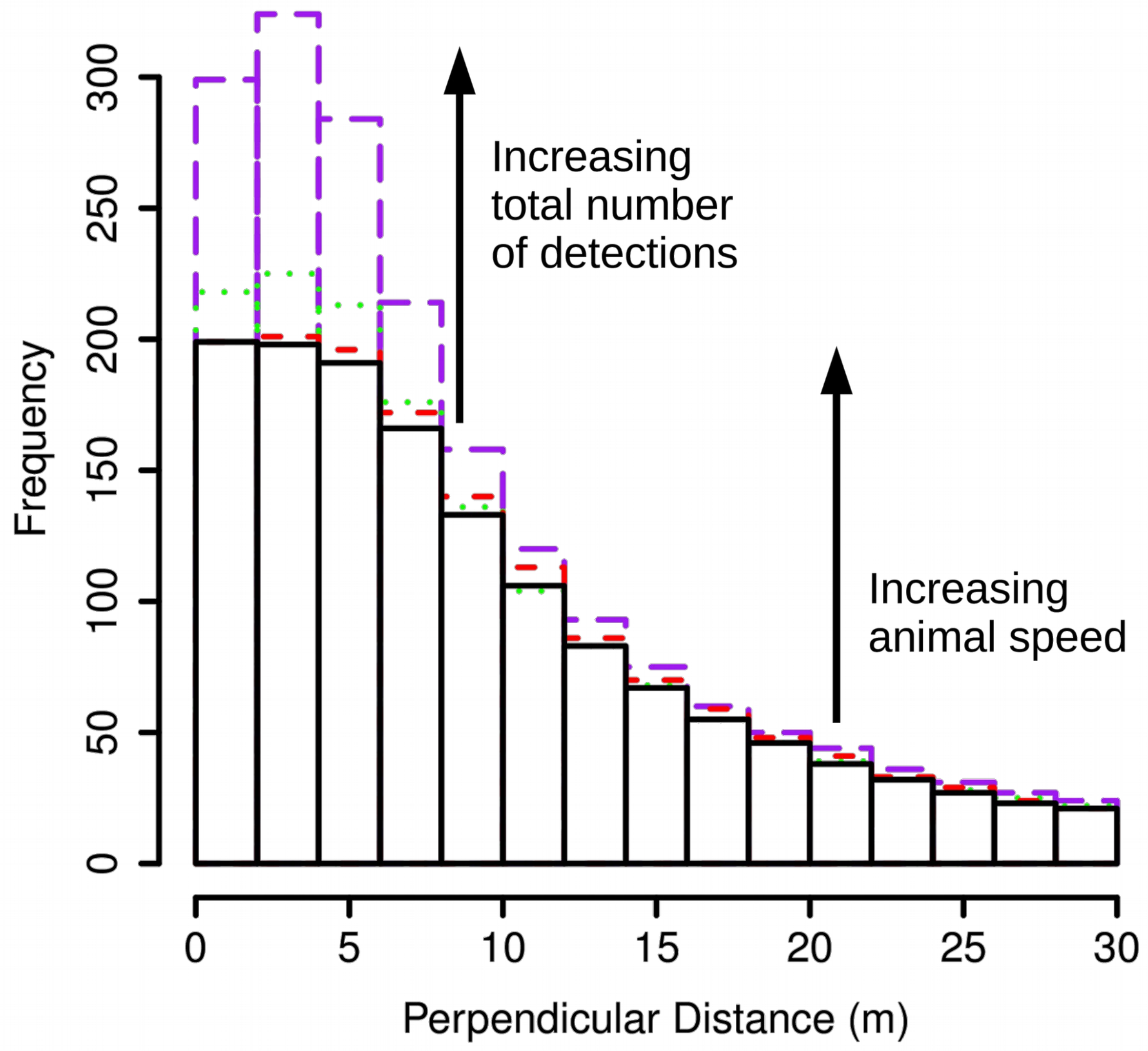

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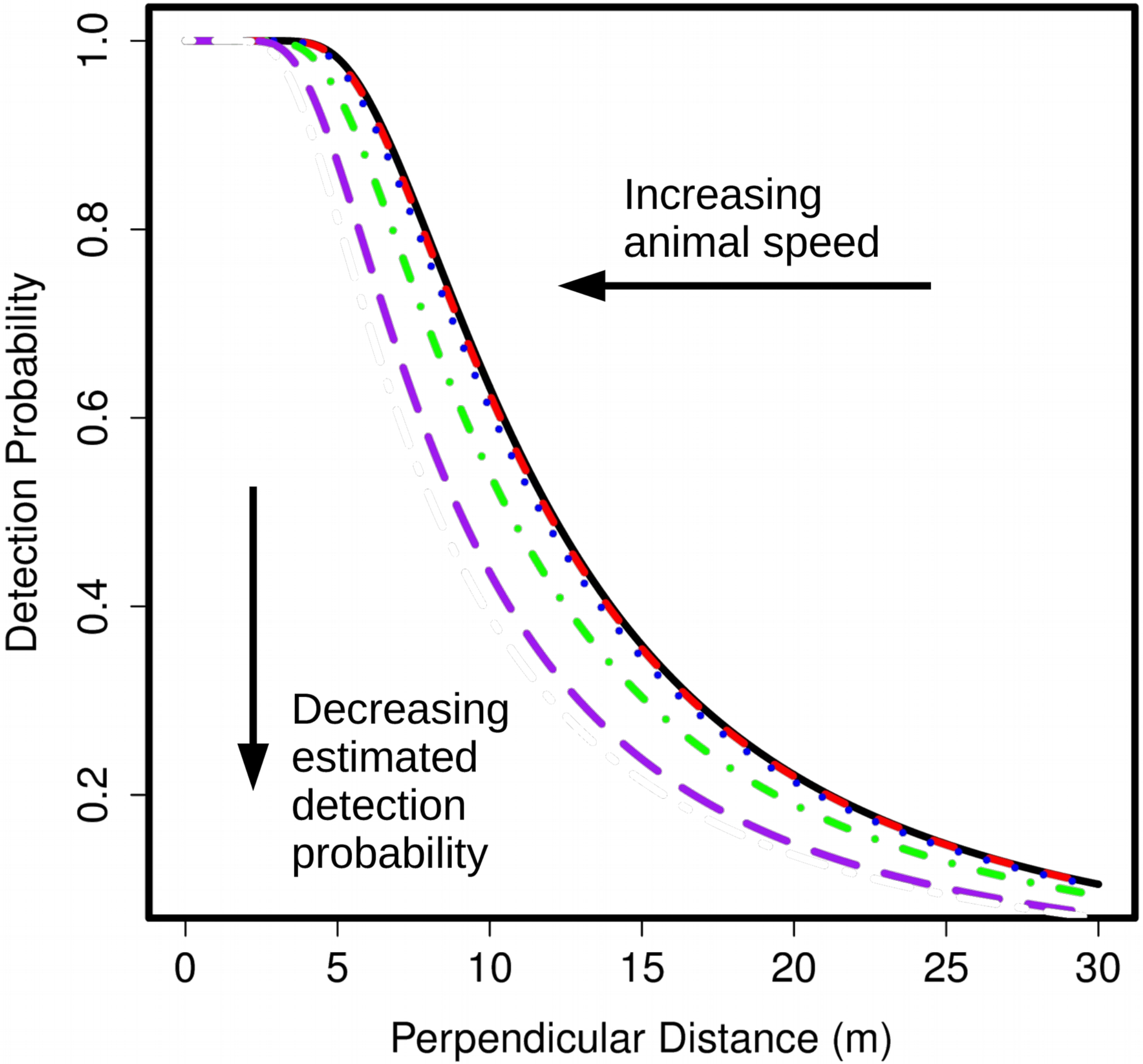

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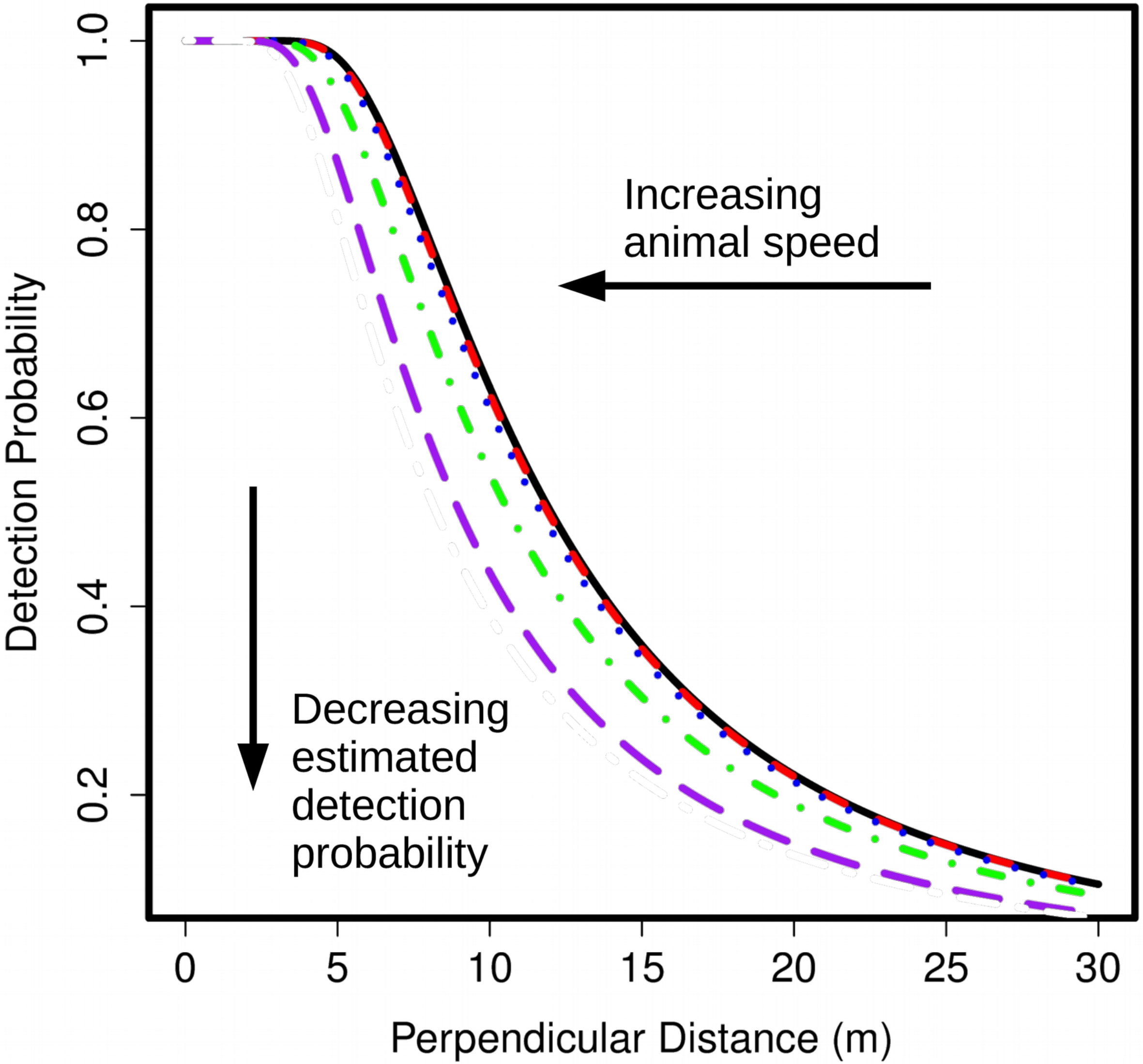
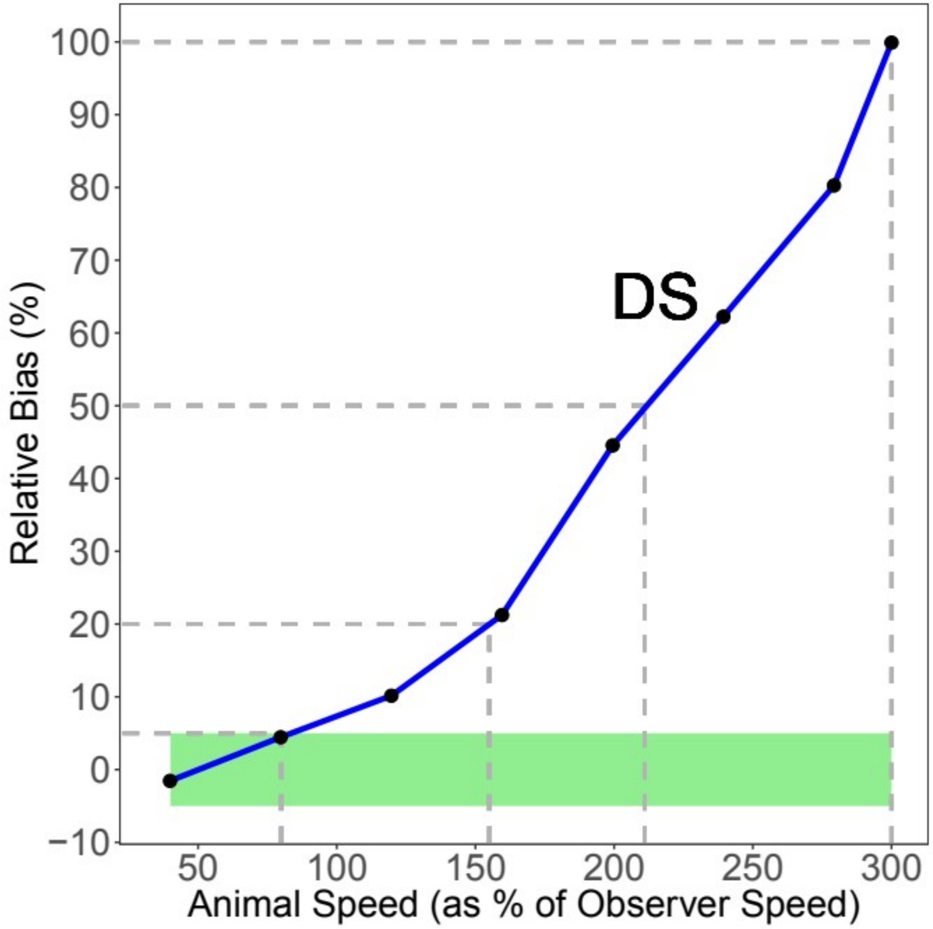


$$\uparrow \uparrow \hat{N} = \frac{n \uparrow}{\hat{p} \downarrow}$$

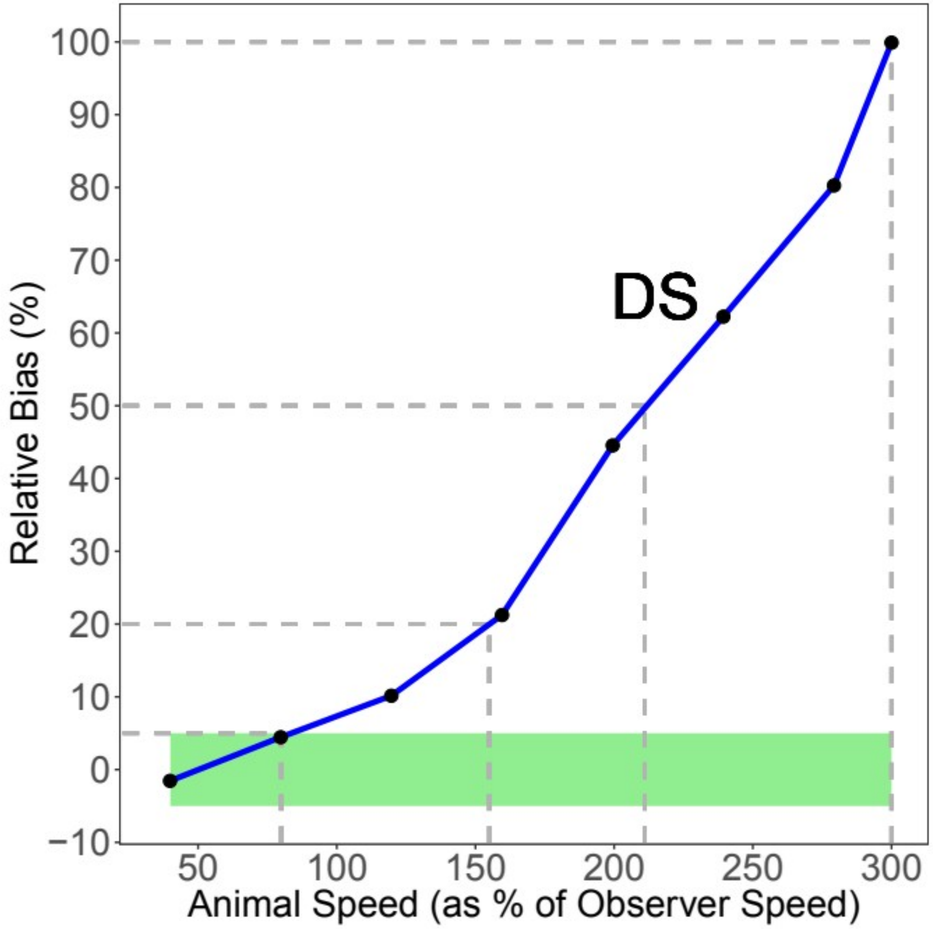
SIMULATION

SIMULATION

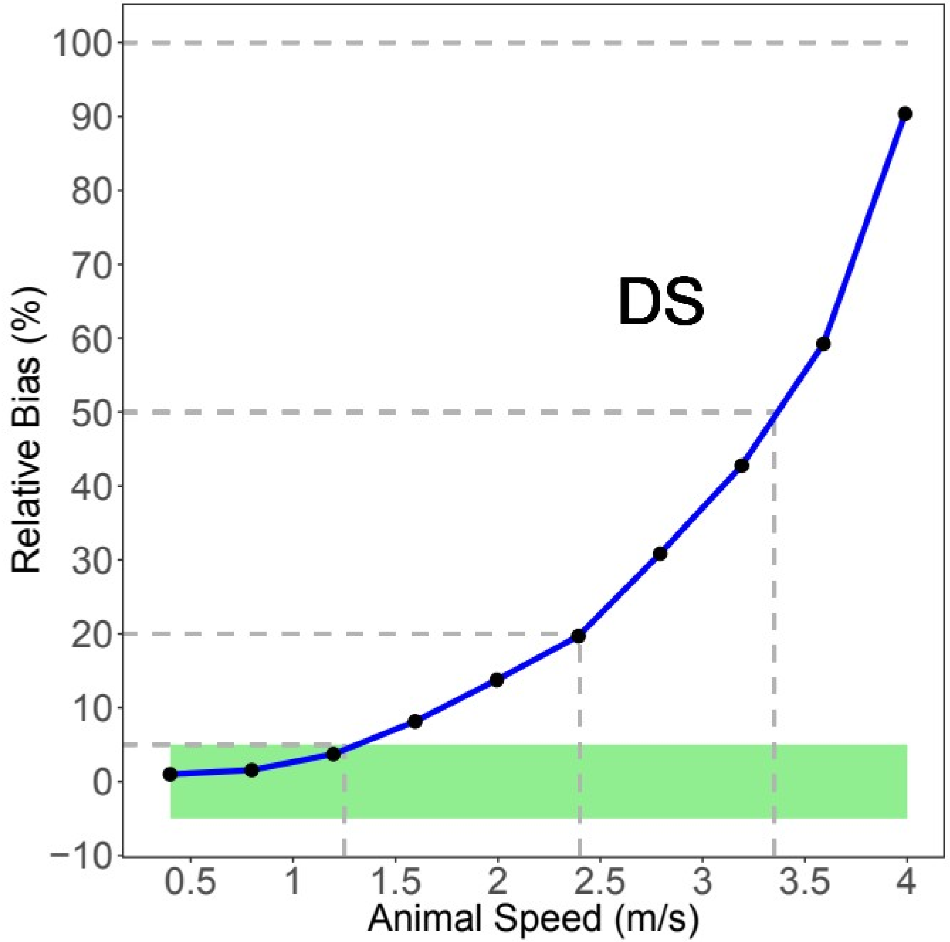


LINE TRANSECTS

SIMULATION



Line transects



Point transects

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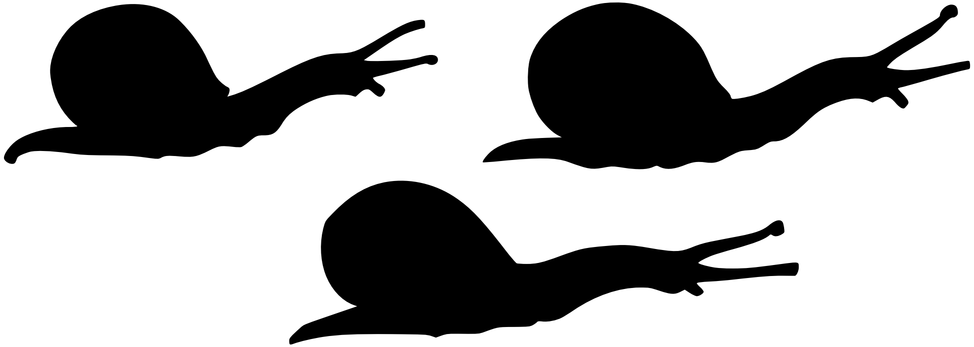
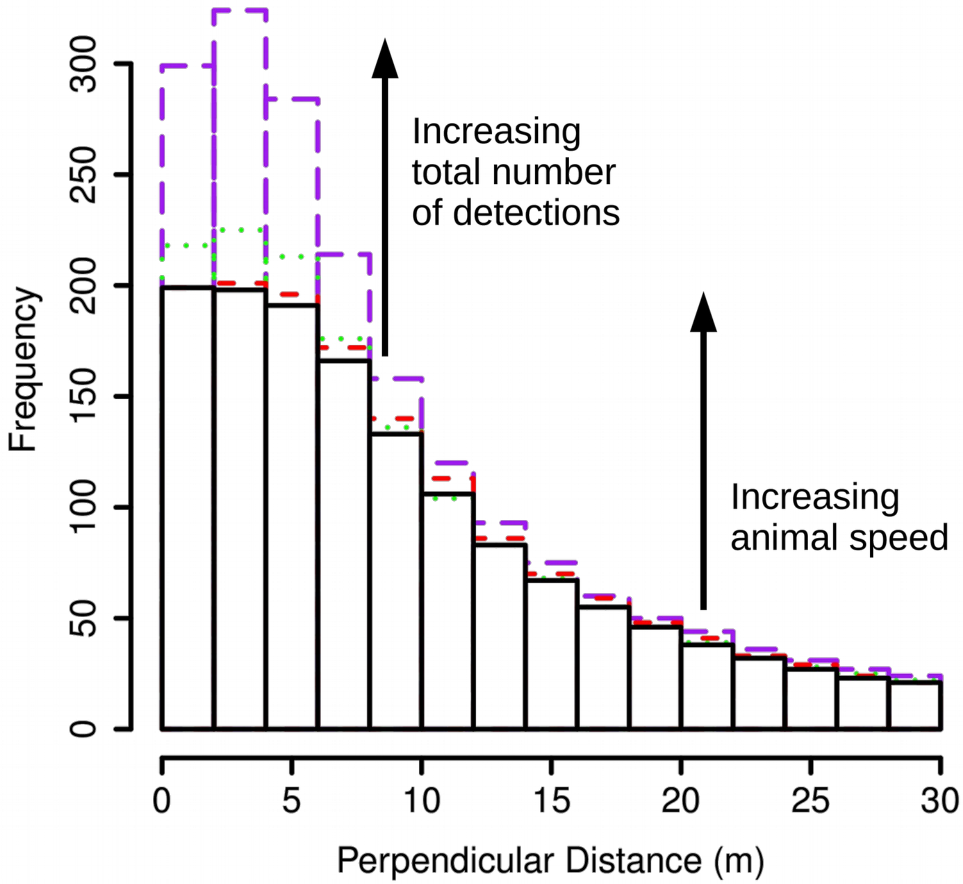
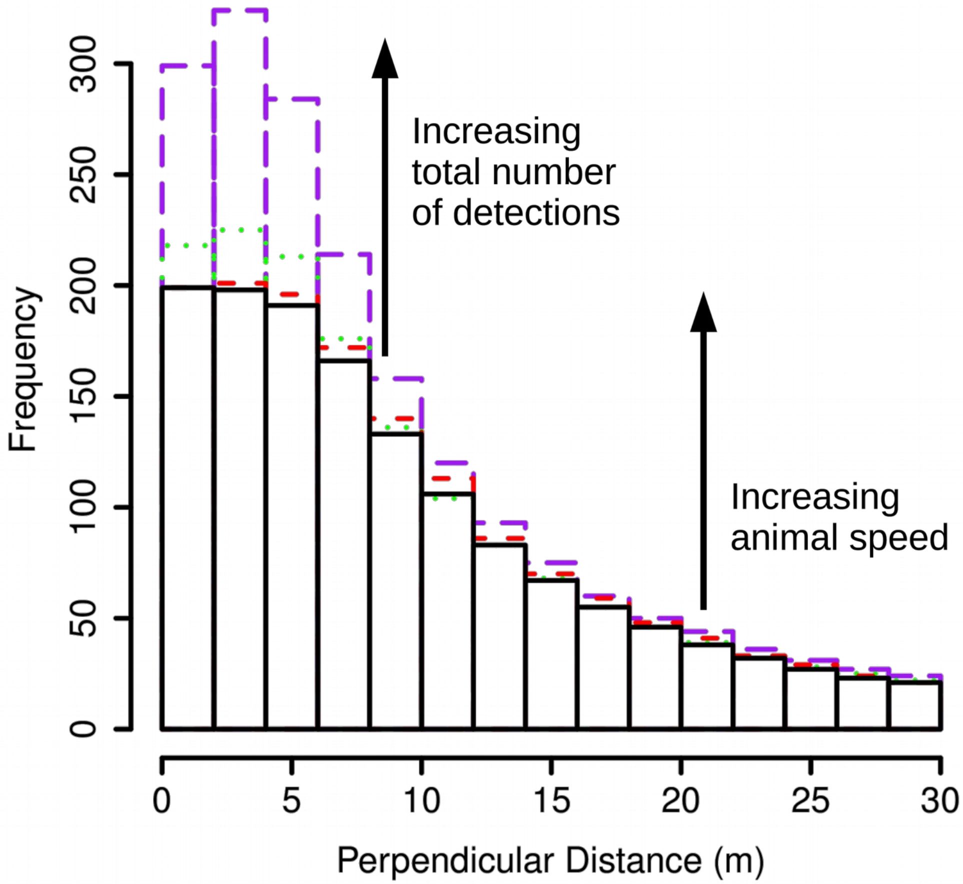
Mitigate:

- ✓ Survey Protocol



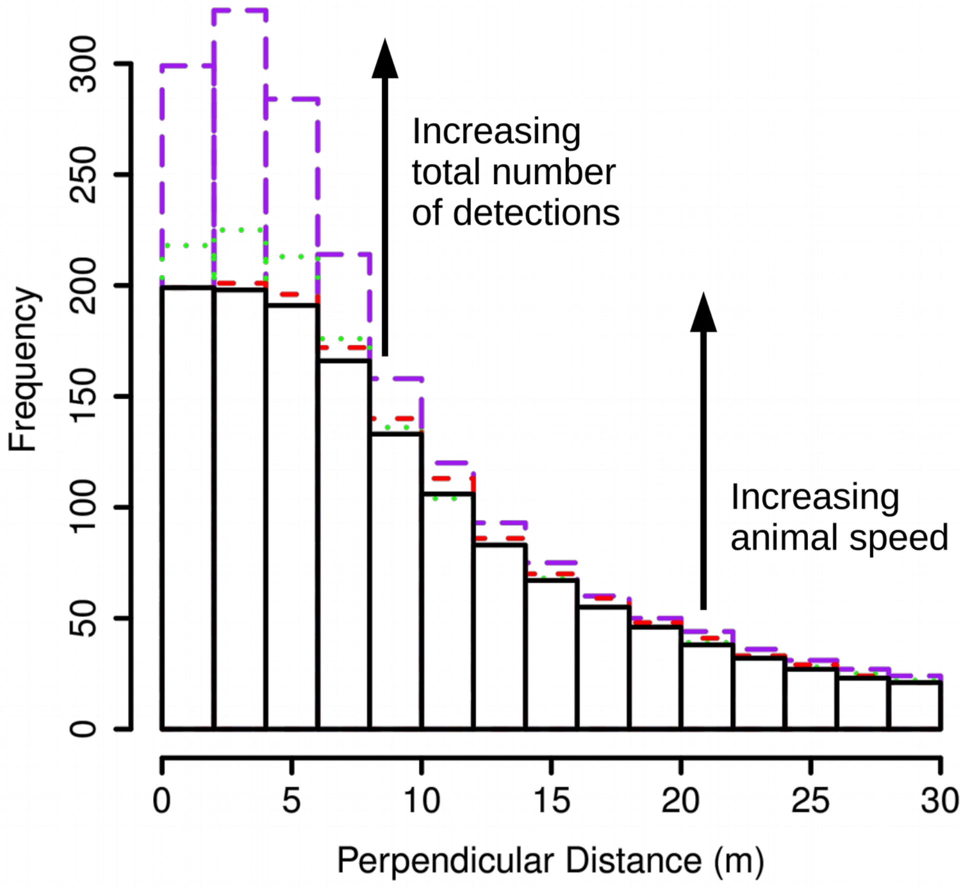
Survey Protocol





Survey Protocol

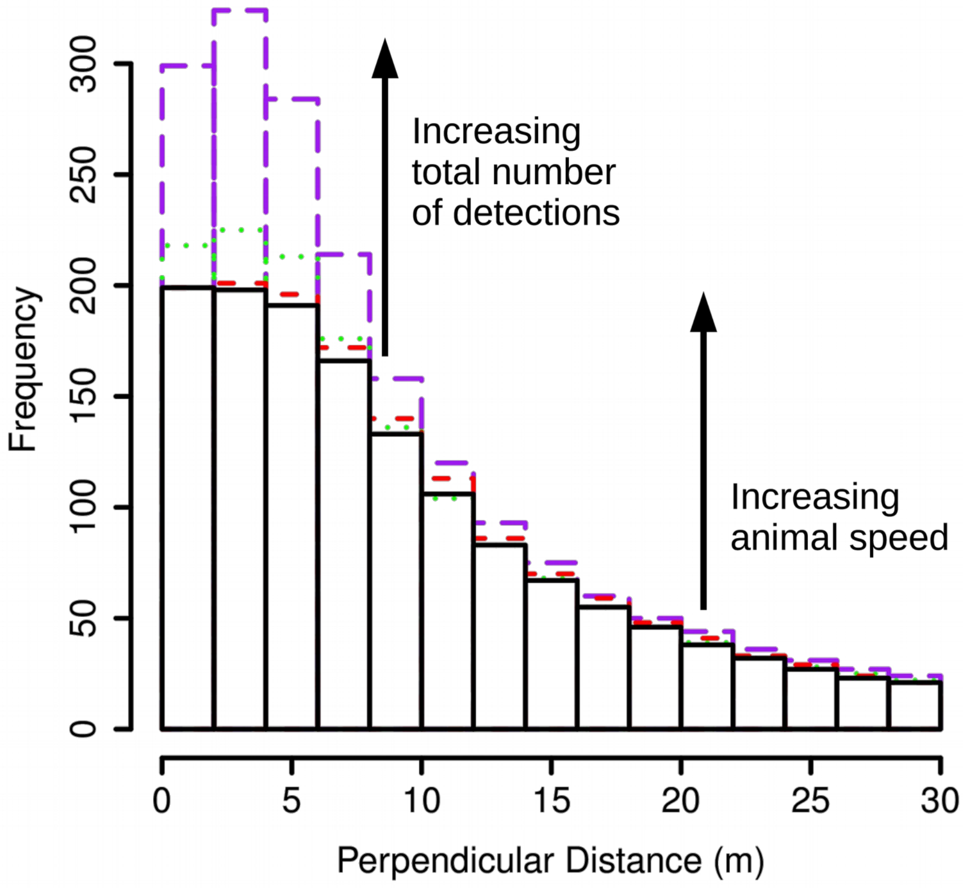
1. Search further.



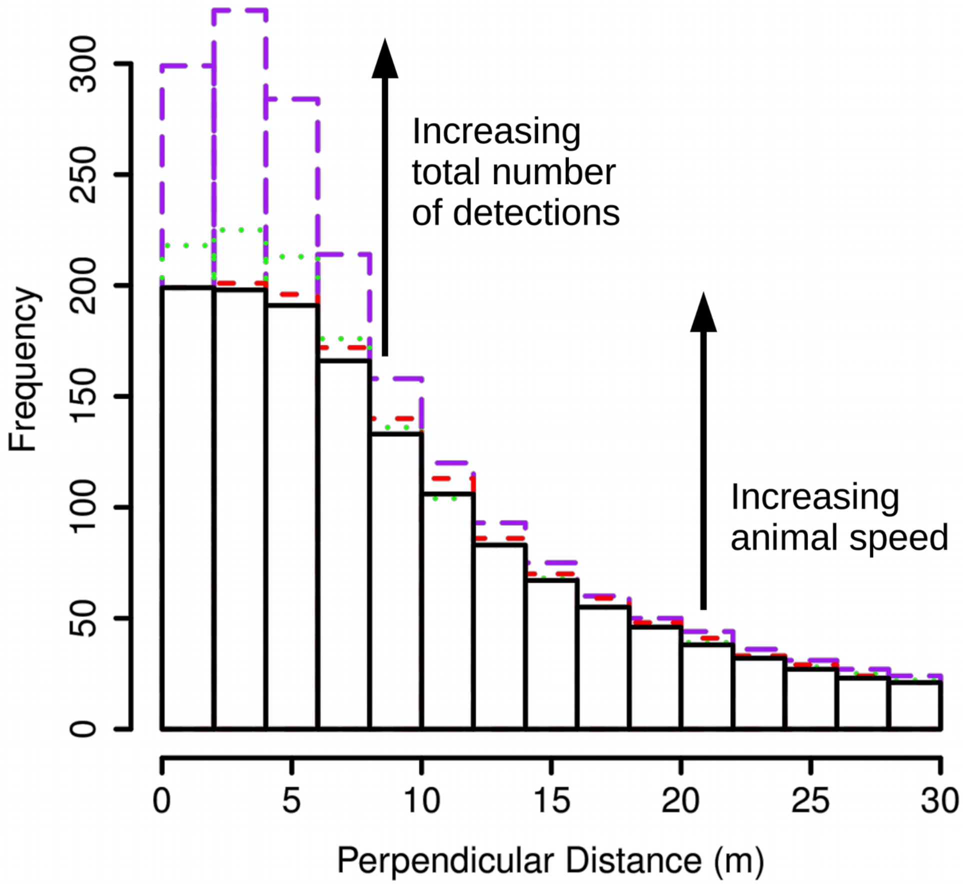
Survey Protocol

1. Search further.
2. Ignore overtaking animals.

Survey Protocol



1. Search further.
2. Ignore overtaking animals.
3. Take a snapshot.



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Glennie, R., Buckland, S.T. and Thomas, L., 2015. The effect of animal movement on line transect estimates of abundance. PloS one, 10(3), p.e0121333.

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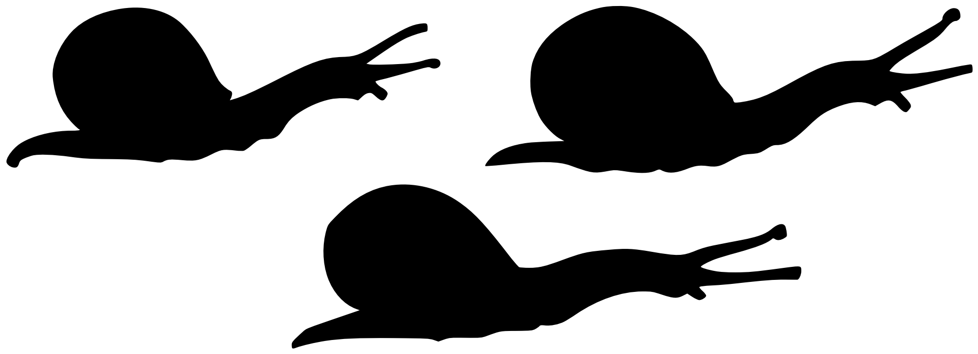
Mitigate:

- ✓ Survey Protocol
- ✓ Truncate?



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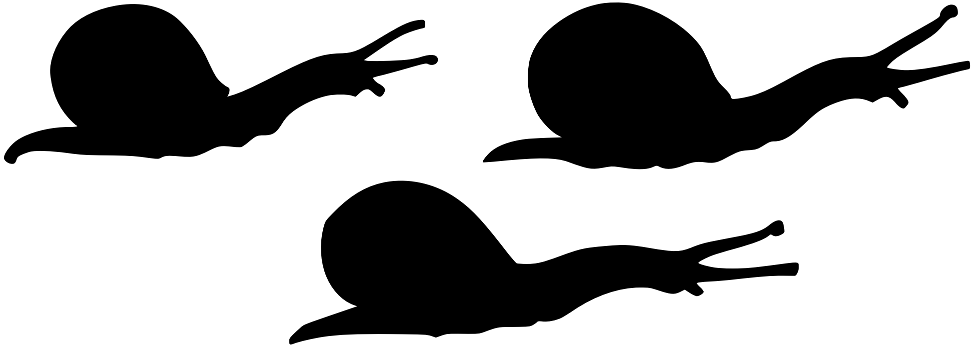
- ✗ ~~Truncate?~~



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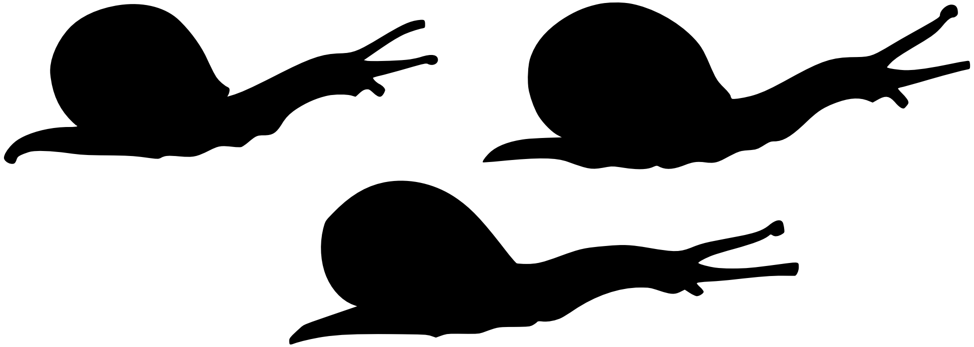
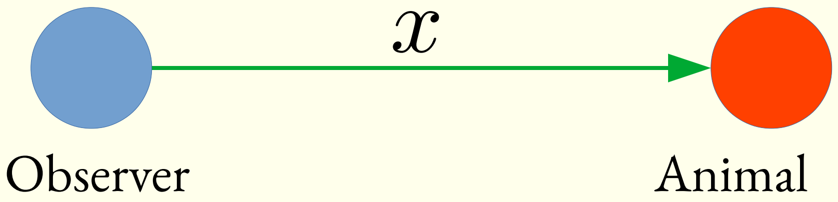


Distance Sampling



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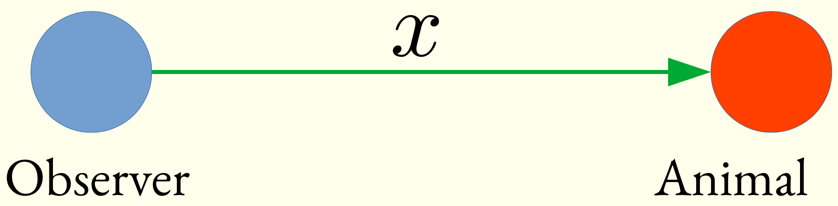
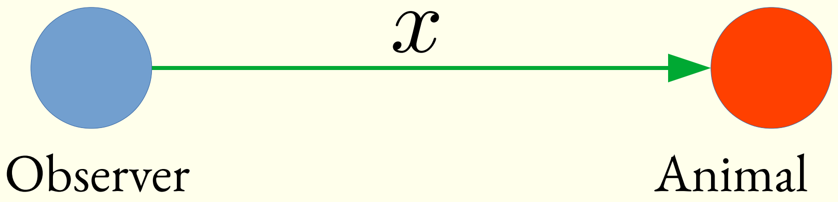


$$g(x) = \mathbb{P}(\text{detected} \mid \text{located at } x)$$

Distance Sampling



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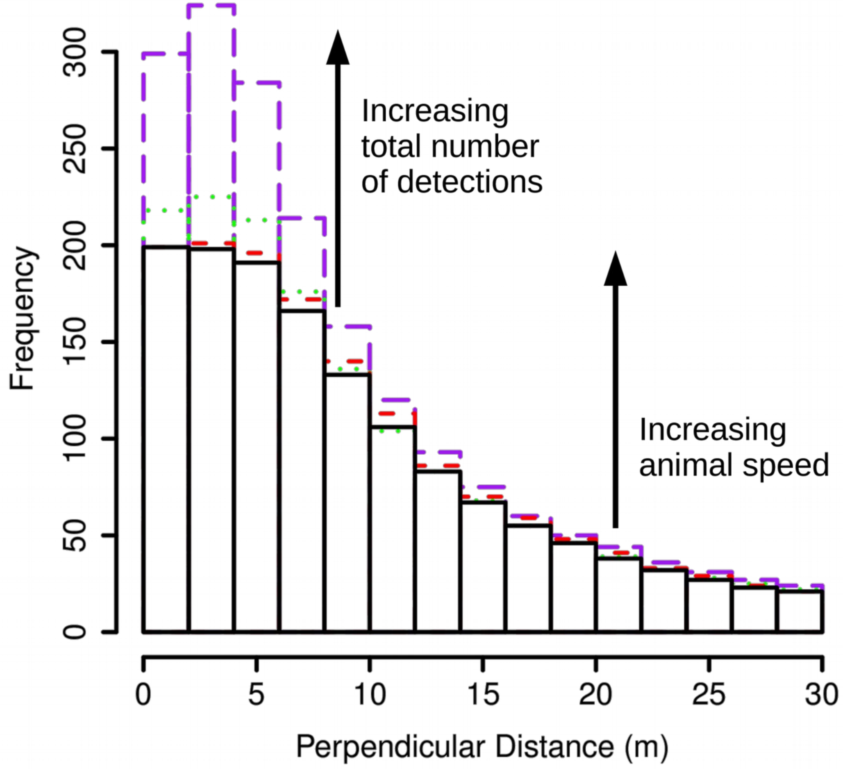

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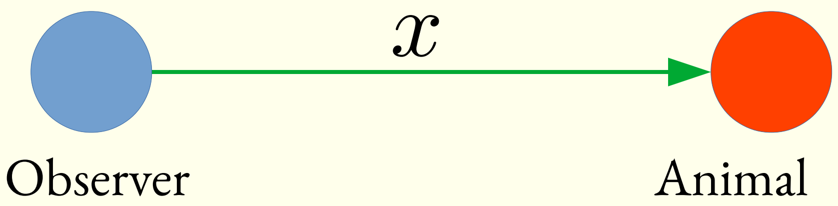

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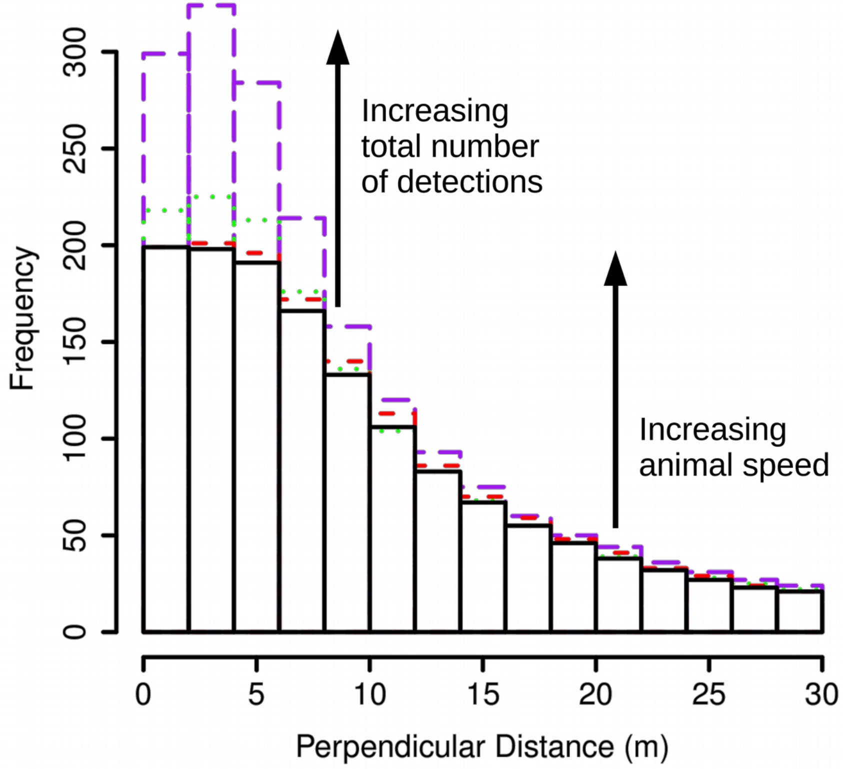

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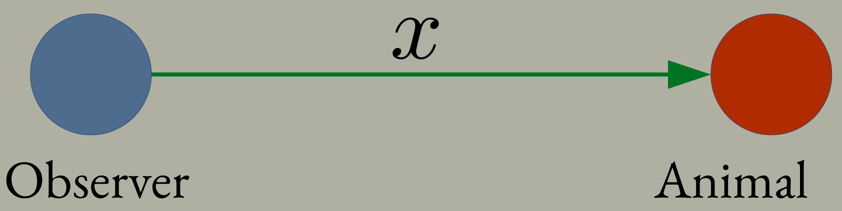

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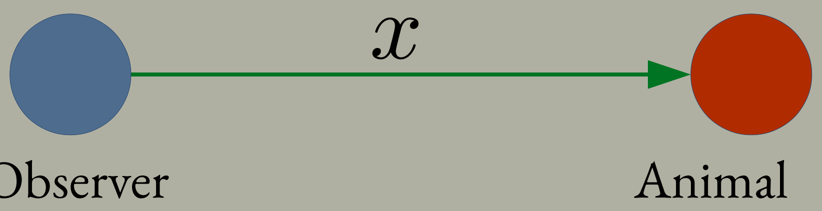

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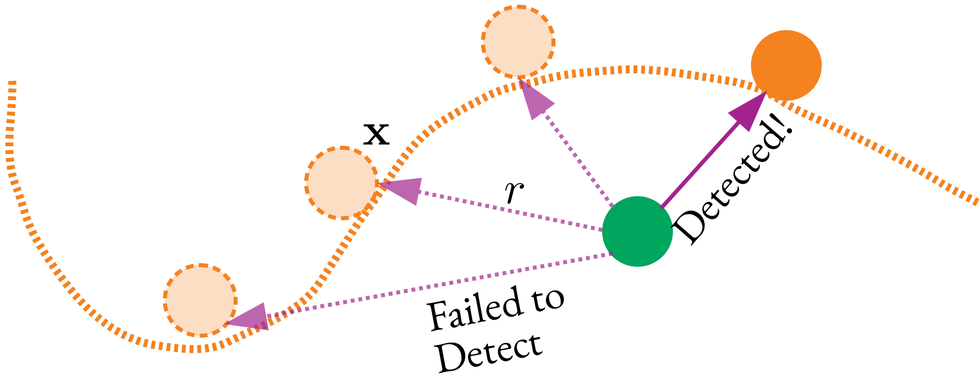
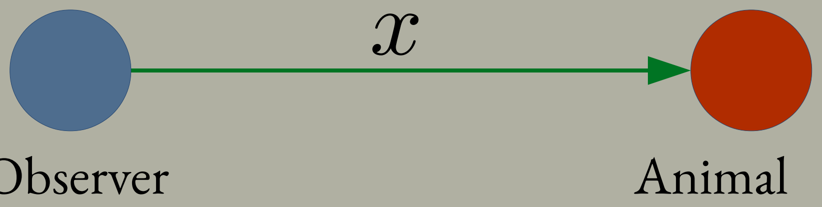


MDS



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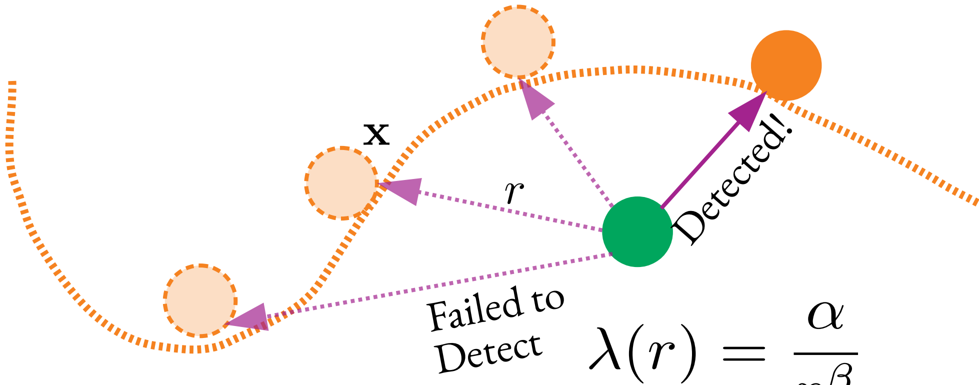
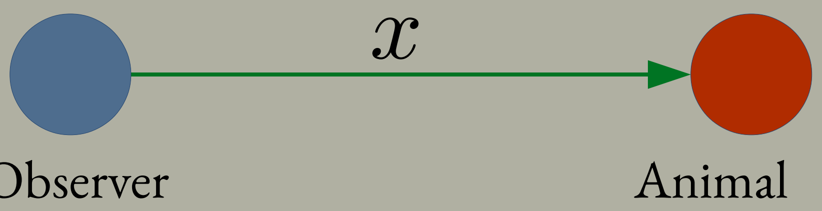


$$\lambda(r) = \frac{\alpha}{r^{\beta}}$$

MDS



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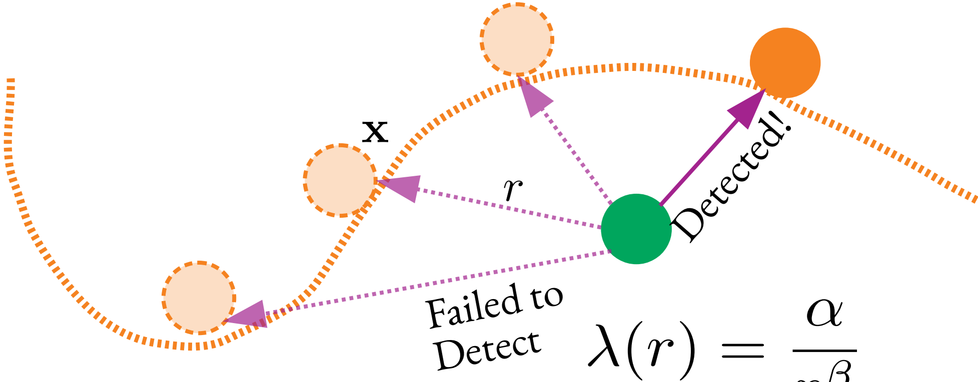
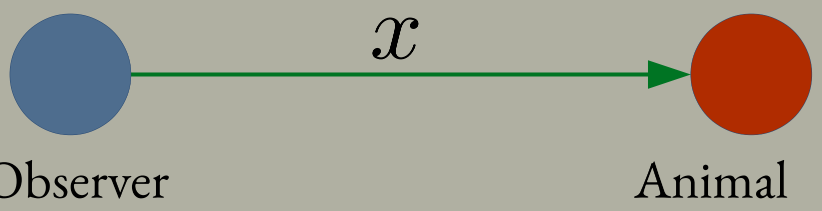


$$\lambda(r) = \frac{\alpha}{r^{\beta}}$$

$$g(\vec{\mathbf{x}}, t) = \lambda(\vec{\mathbf{x}}_t) \exp\left(-\int_0^t \lambda(\vec{\mathbf{x}}_s)\ \mathrm{d}s\right)$$

MDS



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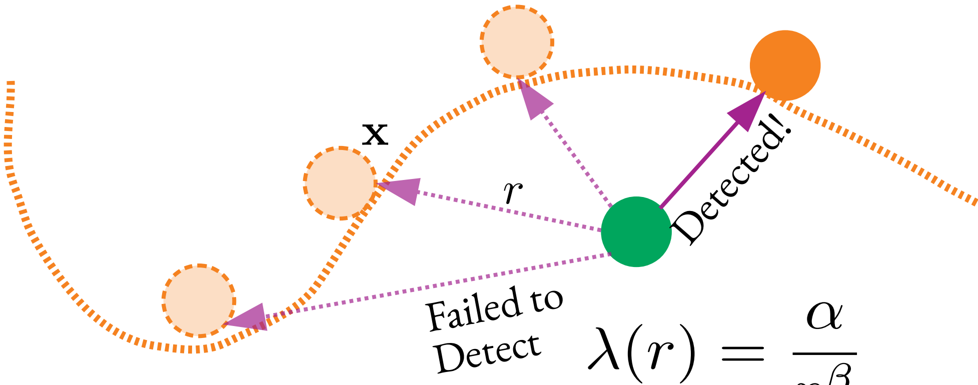

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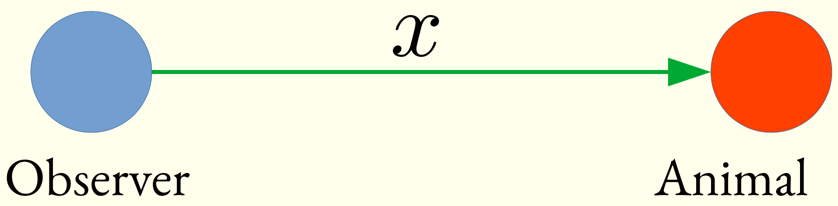
MDS



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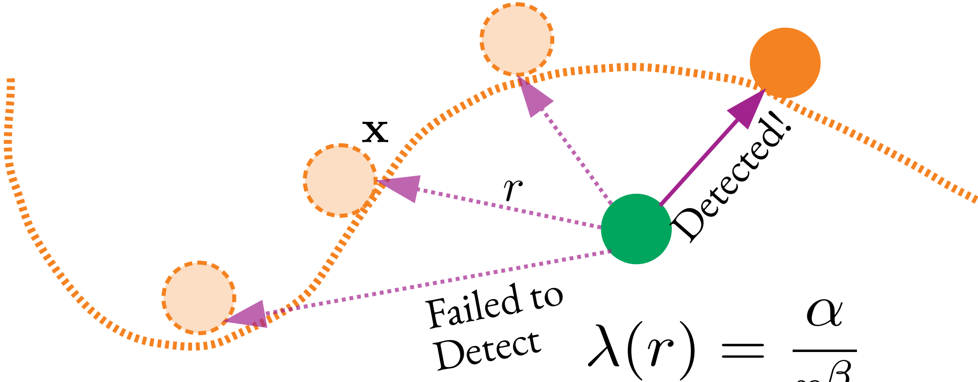

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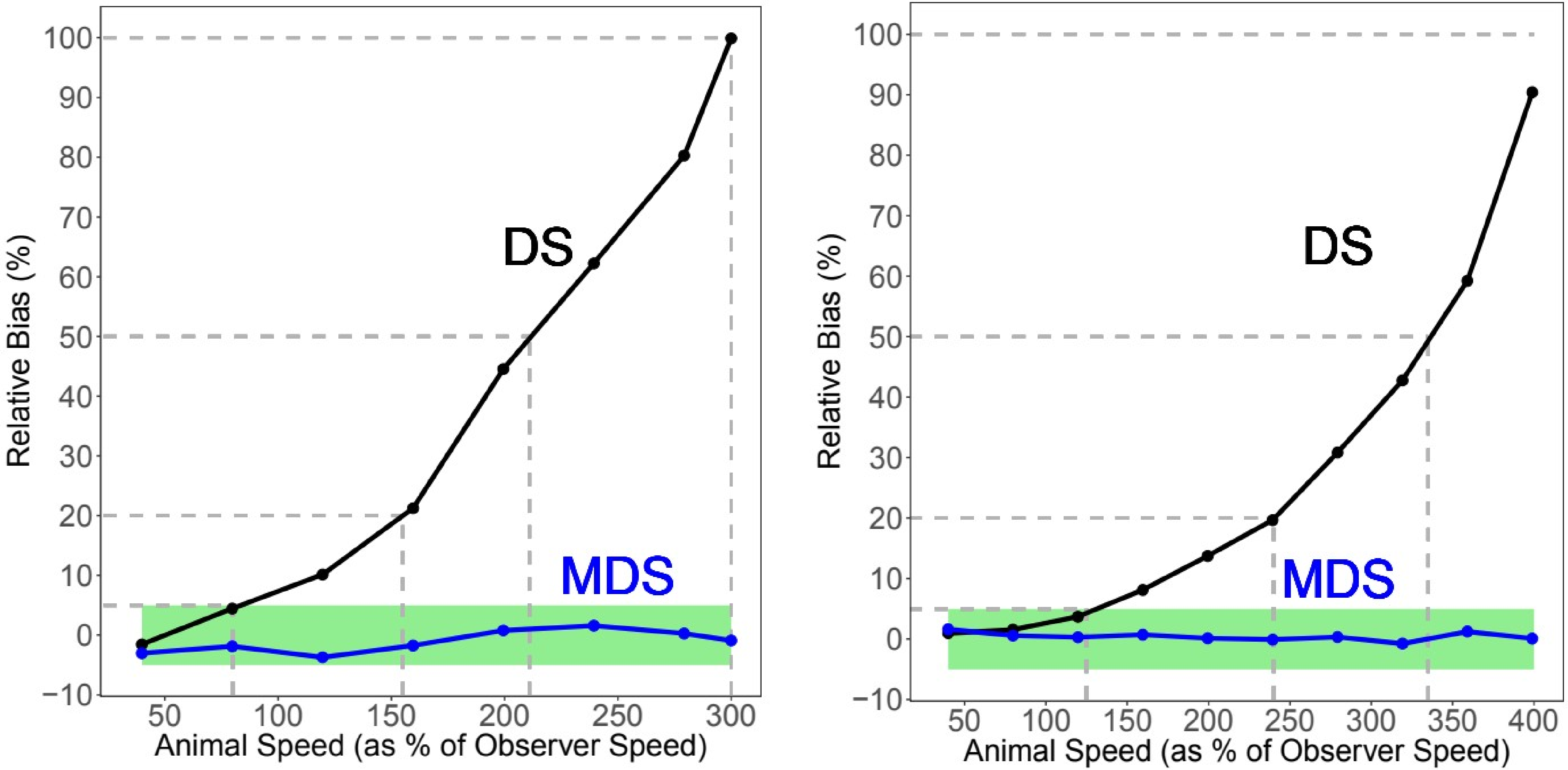
Distance Sampling

MDS

SIMULATION



LINE TRANSECTS

POINT TRANSECTS

APPLICATION

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- Applied to Spotted Dolphins in the Eastern Tropical Pacific.

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- Use tag data on 19 individuals to estimates movement speed using a Brownian motion movement model.

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	CDS1D			CDS2D			MDS2D		
Year	Est.	CV	95% CI	Est.	CV	95% CI	Est.	CV	95% CI
1999	1073	22%	(700, 1644)	1166	18%	(750, 1581)	918	18%	(588, 1248)
2000	947	23%	(601, 1493)	999	19%	(627, 1372)	787	19%	(492, 1082)
2003	1518	19%	(1053, 2189)	1550	15%	(1087, 2013)	1223	15%	(854, 1592)
2006	1213	24%	(755, 1947)	1342	20%	(809, 1874)	1059	20%	(636, 1481)

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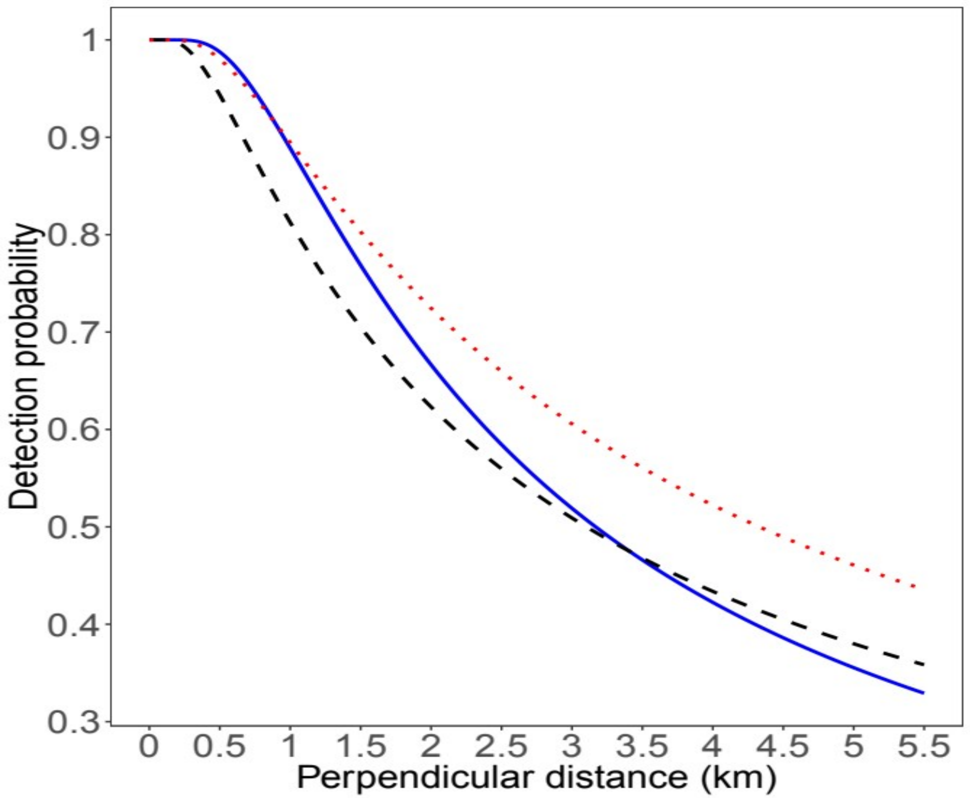

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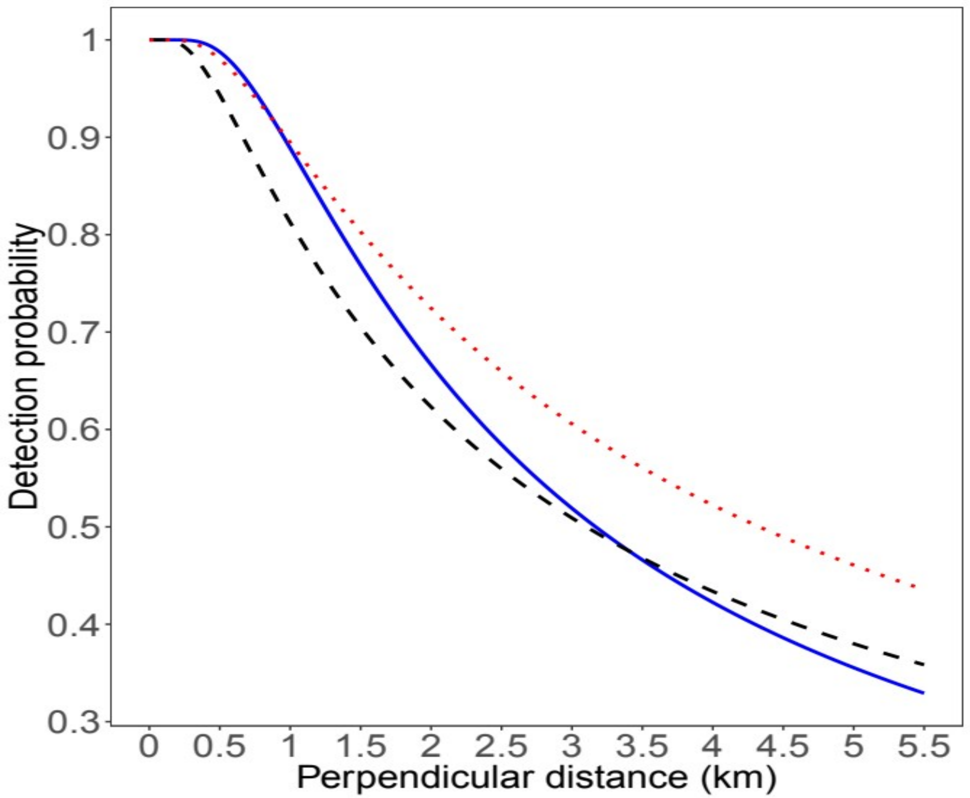

Glennie, R., Buckland, S.T., Langrock, R., Gerrodette, T., Ballance, L., Chivers, S., Scott, M. and Perrin, W., 2019. Incorporating animal movement into distance sampling. Journal of the American Statistical Association. *Under Revision.*

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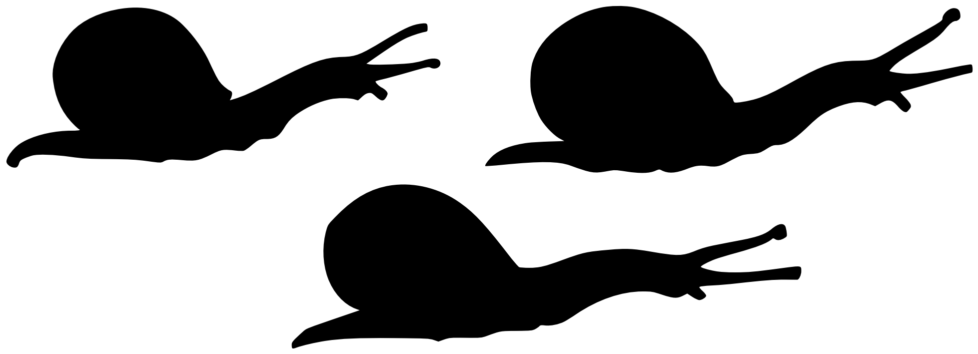
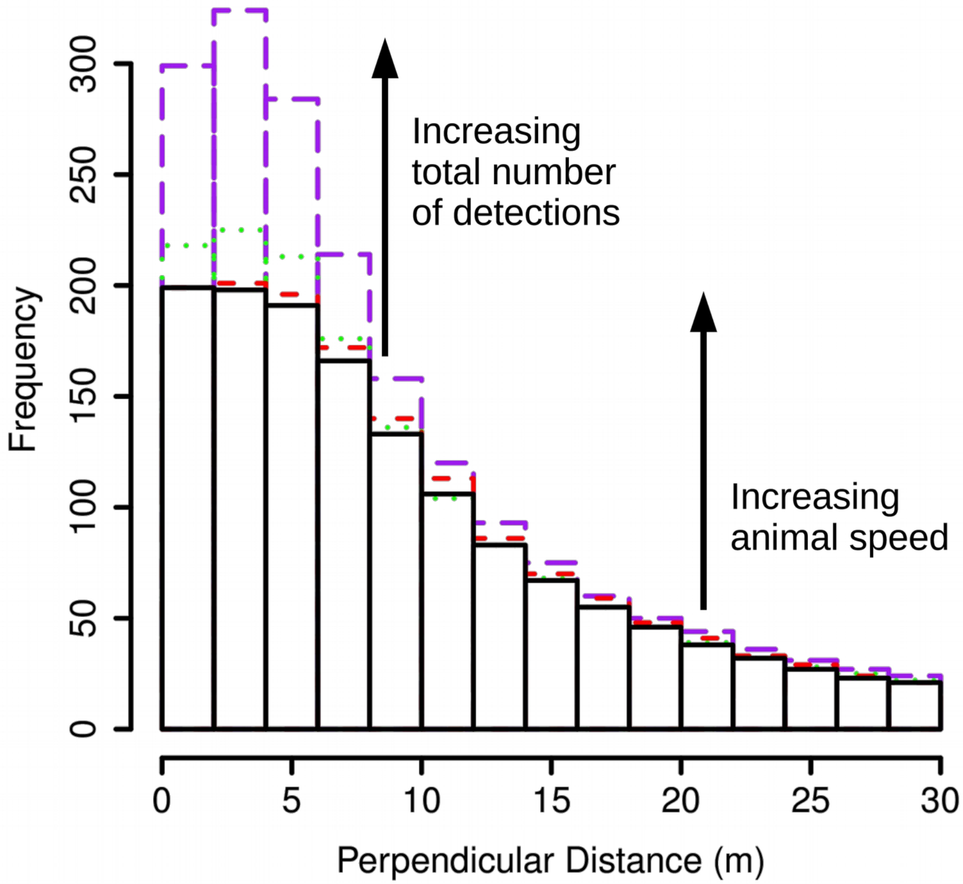
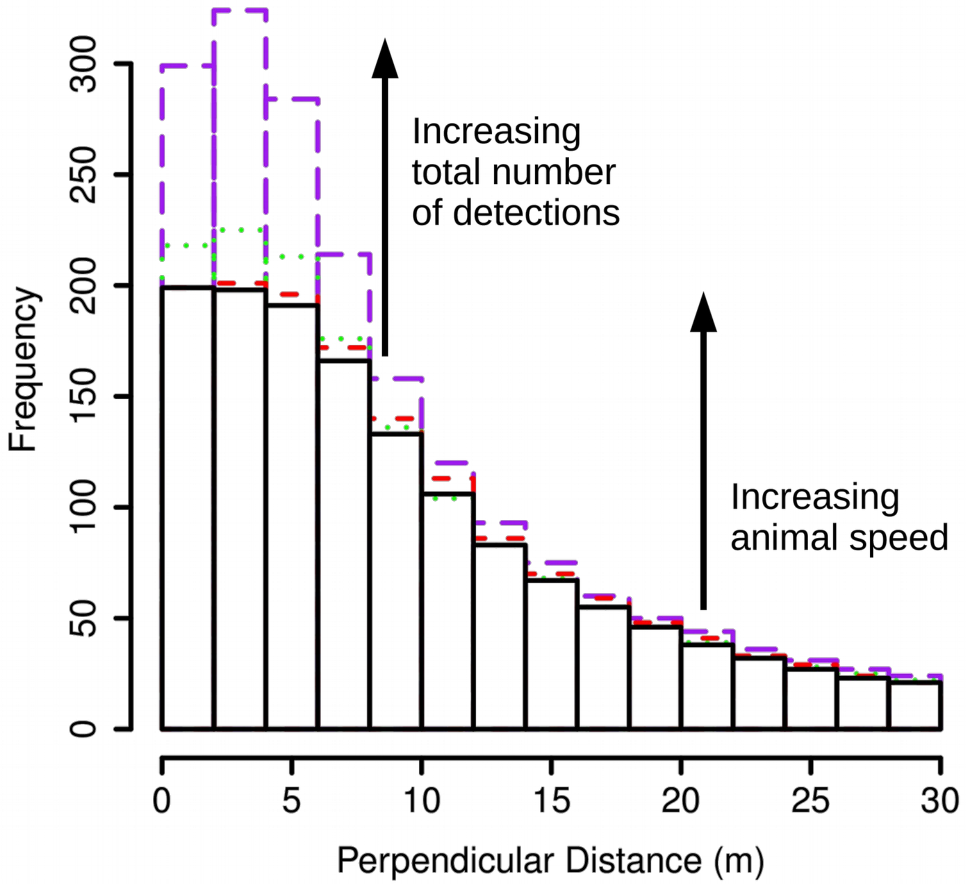


MODELLING

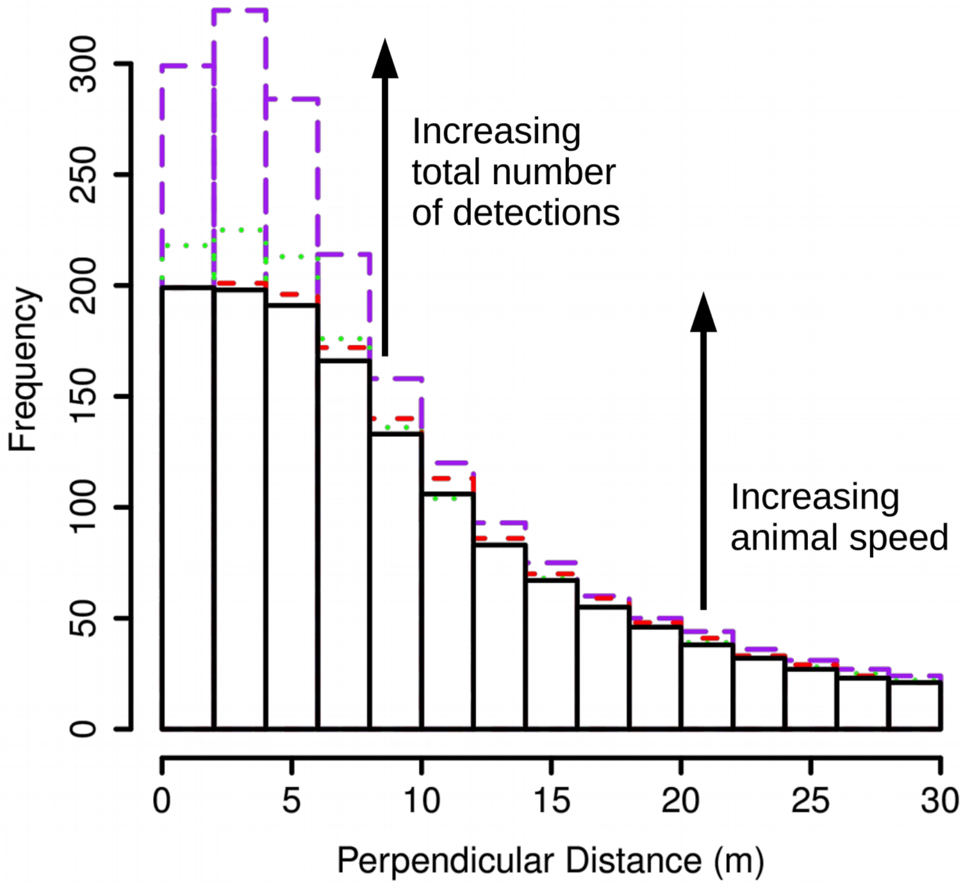


Increasing
total number
of detections
Increasing
animal speed
Frequency
0
50
100
150
200
250
300
0
5
10
15
20
25
30
Perpendicular Distance (m)



MODELLING

1. Need Detection Times and 2d locations.

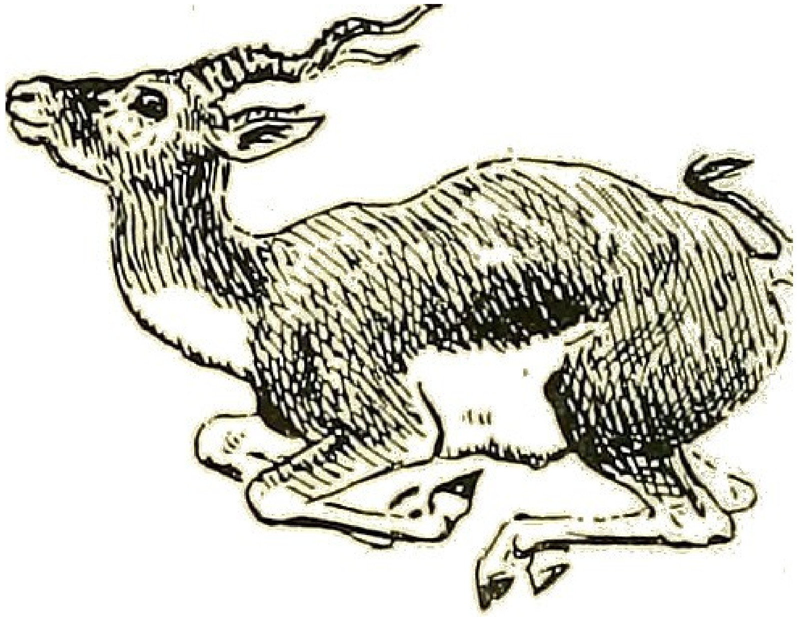


MODELLING

1. Need Detection Times and 2d locations.

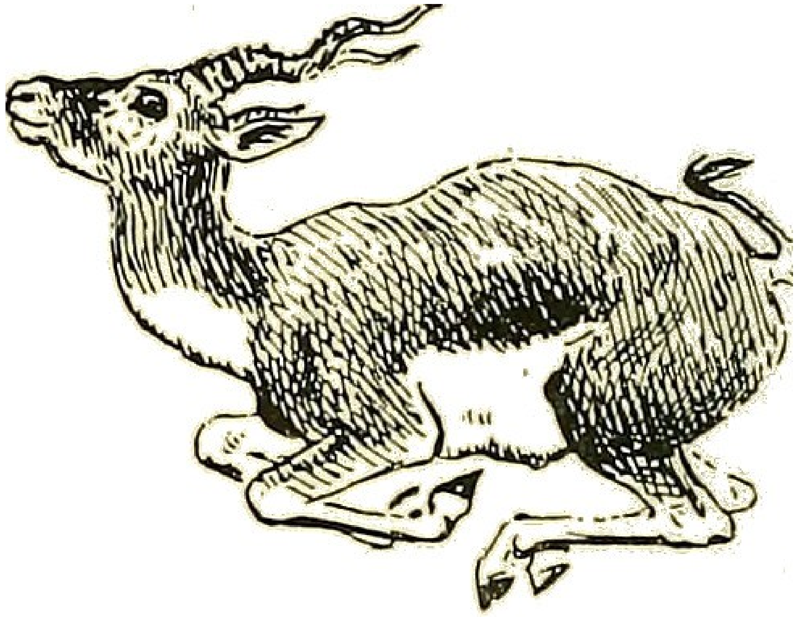
2. Need information on movement.

FURTHER DEVELOPMENTS



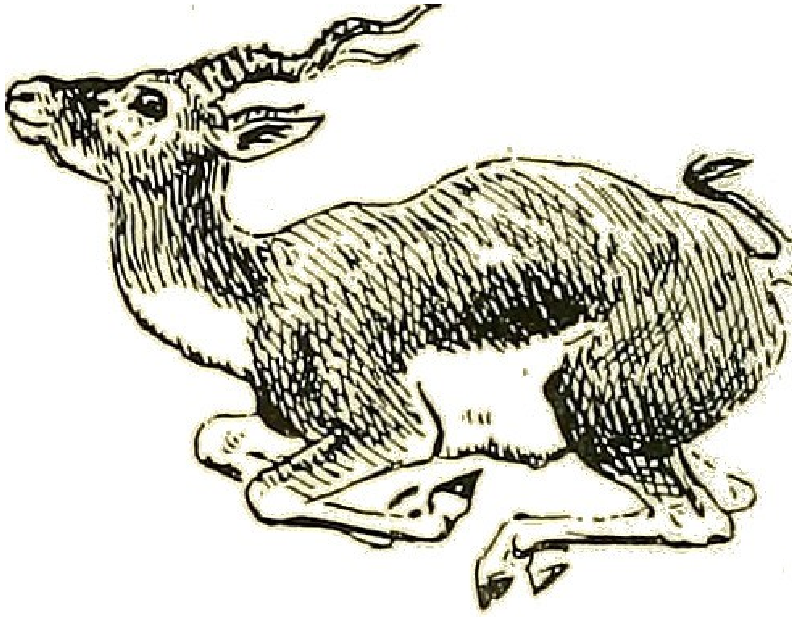
FURTHER DEVELOPMENTS

1 Cameras and Gliders



FURTHER DEVELOPMENTS

1. Cameras and Gliders
2. Responsive Movement



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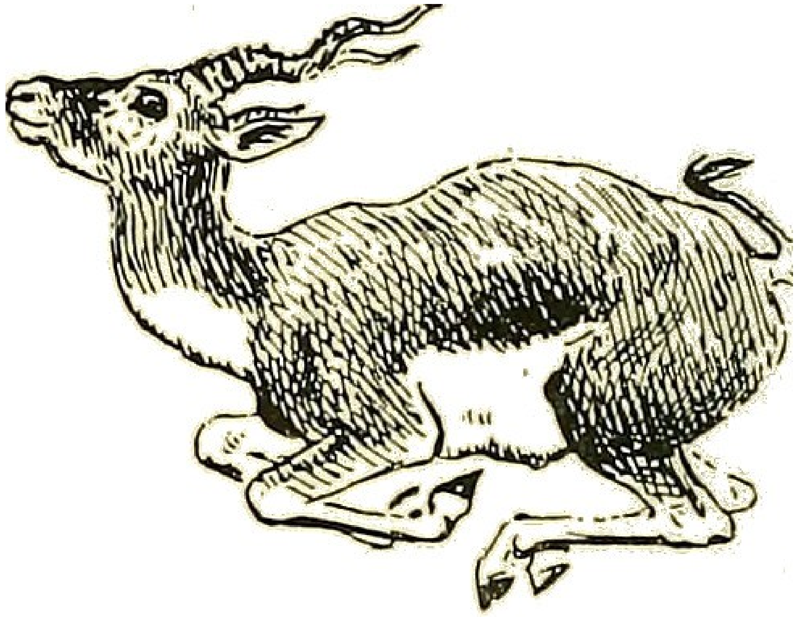
FURTHER DEVELOPMENTS

1. Cameras and Gliders
2. Responsive Movement
3. Behaviour-Switching Movement



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Distance Sampling and Animal Movement

README.md

moveds

Fits models that account for non-responsive, Brownian motion of individuals during distance sampling surveys.

Install

In R, the latest release can be installed using the `devtools` package with command

```
devtools::install_github("r-glennie/moveds@v0.1.0", build_vignettes = TRUE)
```

The package requires you have a C compiler installed on your system. Windows users may need to install R-tools for this reason. It is assumed Linux and Mac users have a compiler installed.

Richard Glennie
University of St Andrews
rg374@st-andrews.ac.uk

University of St Andrews

CREEM
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