Accounting for observer dependence in double-observer distance sampling.

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- Non-independent sightings $\rightarrow$ bias abundance estimates

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- Non-independent sightings $\rightarrow$ bias abundance estimates
- Previous approaches:
  - Use CDS on sightings by either observer, and MR to adjust $p_{\cdot}(0)$

    e.g., Borchers et al. 1998, Laake 1999
  - Model p_{12} as $\delta p_1 p_2$

    e.g., Buckland et al. 2010

Conceptual model

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- Define detection probability modelled as:

$$\text{logit}\left(p_{ij}|y_i, \boldsymbol{x}_i, z_{ik}\right) = f_j(\boldsymbol{\beta}_j|y_i, \boldsymbol{x}_i) + g(\boldsymbol{\alpha}|y_i, \boldsymbol{x}_i)z_{ik}$$

- z_{ij} = group i sighted by observer j
  $\sim Bern(p_{ij})$
- y_i = distance to group i
- $\boldsymbol{x}_i$ = other covariates

Dependence structures

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Full Independence: $g(\boldsymbol{\alpha}|y_i, \boldsymbol{x}_i) = 0$

Constant Dependence: $g(\boldsymbol{\alpha}|y_i, \boldsymbol{x}_i) = \alpha_0$

Point Independence: $g(\boldsymbol{\alpha}|y_i, \boldsymbol{x}_i) = \alpha_1 y_i$

Limiting Independence: $g(\boldsymbol{\alpha}|y_i, \boldsymbol{x}_i) = \alpha_0 + \alpha_1 y_i$

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- Line transect surveys conducted along east coast of South Island in 2013

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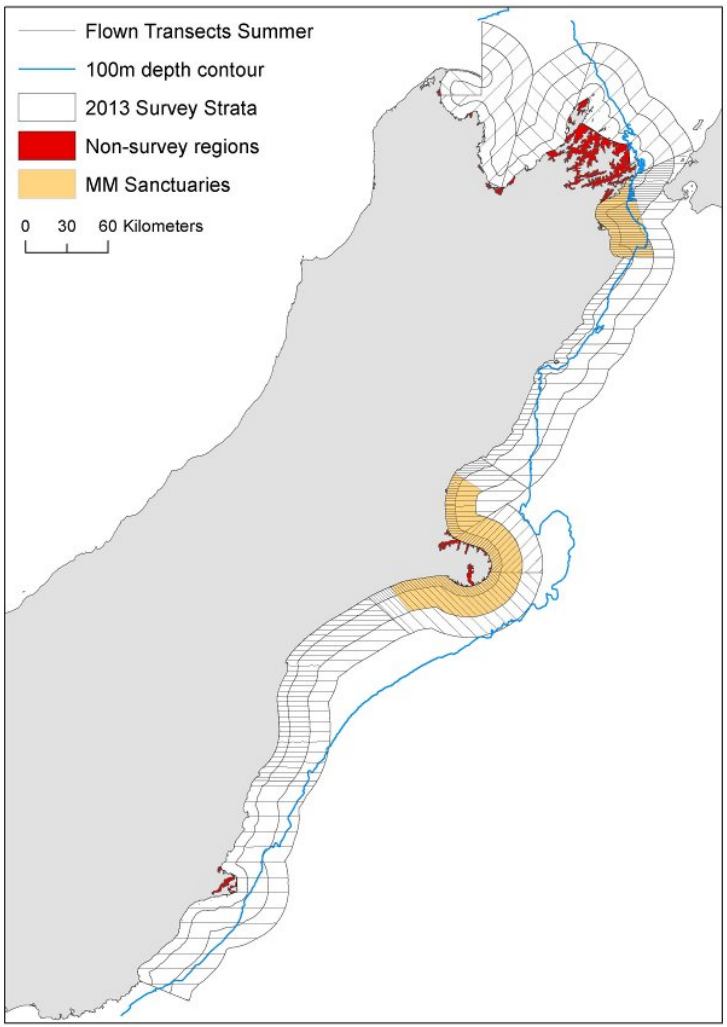

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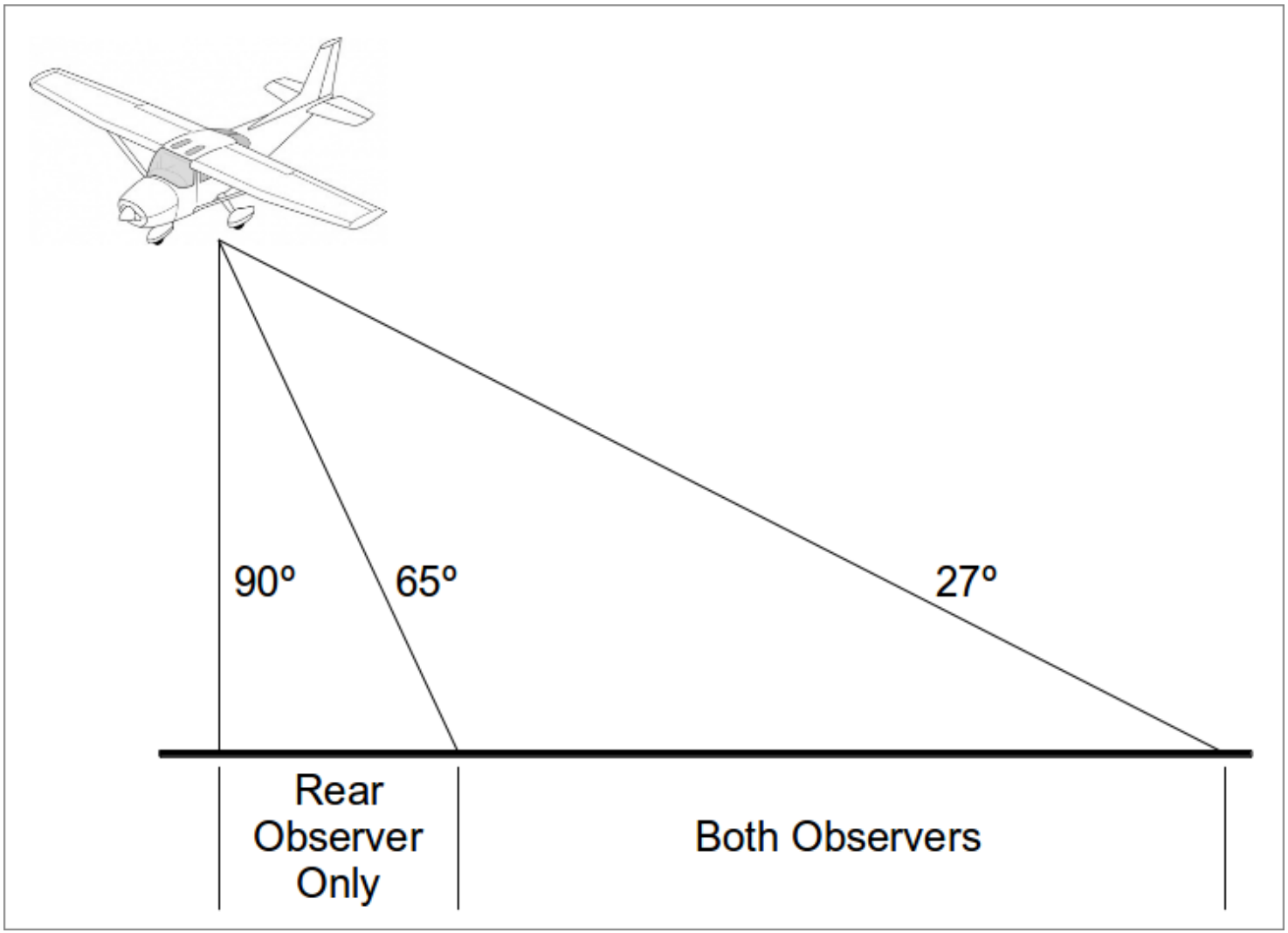

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- Example results: models with quadratic distance and group size effects

Model	ΔAIC	K	$-2l$	$\hat{N}_C$	SE	$\hat{\alpha}_0$	$\hat{\alpha}_1$ (km)
LI	0.00	6	472.95	967	41	-3.01	18.39
PI	4.05	5	479.01	1,233	118		9.7
FI	21.96	4	498.91	970	36		
C	22.14	5	497.09	1,086	105	0.91	

$\hat{N}_C$ is estimate of available dolphins within survey strip width, and not total abundance.

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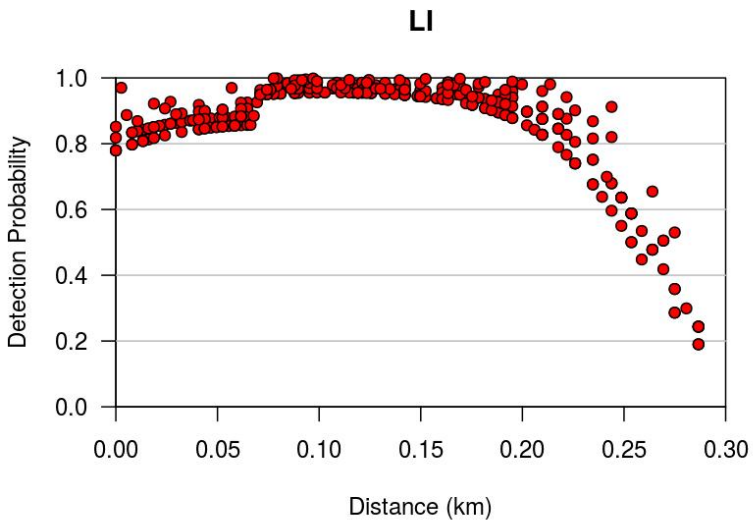

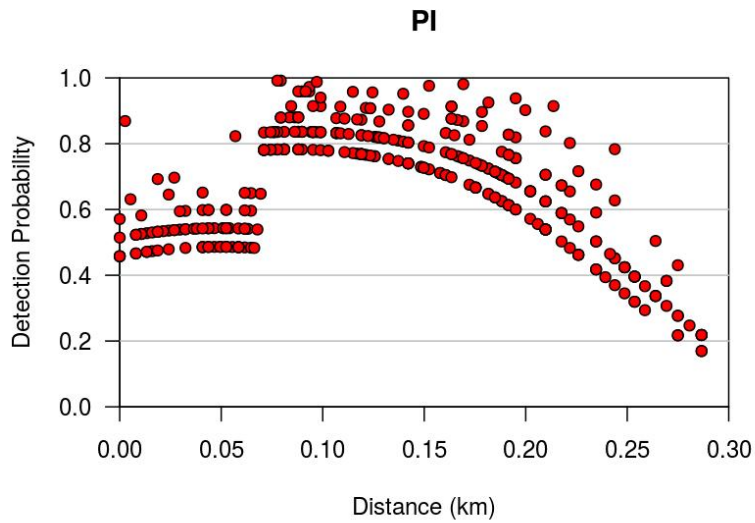

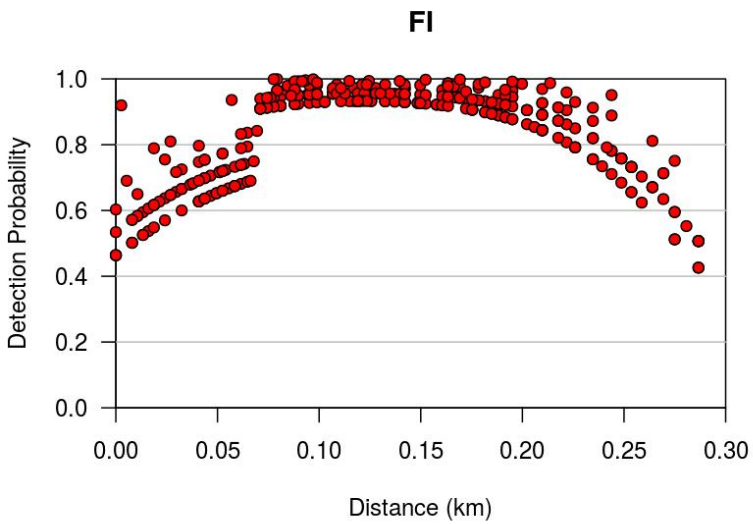

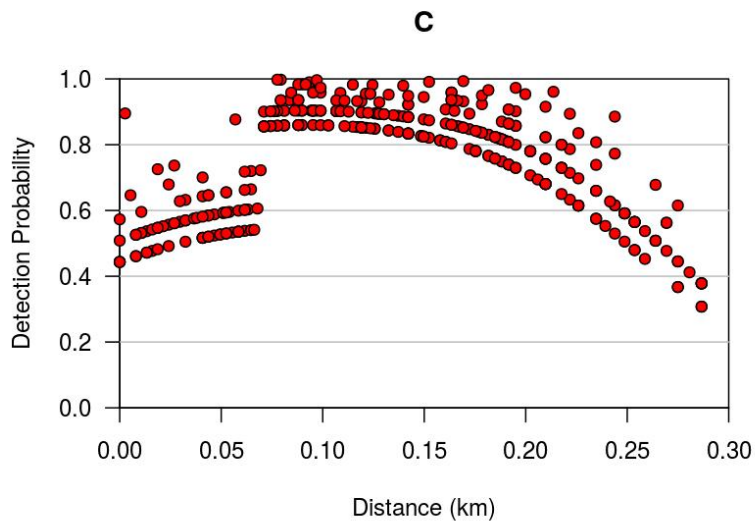

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Final comments

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- Assumed dependence structure can effect abundance estimates

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- Assumed dependence structure can effect abundance estimates
- Intuitively simple idea

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- Assumed dependence structure can effect abundance estimates
- Intuitively simple idea
- Leads to multinomial cell probabilities

Final comments

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- Alternative link functions?

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- Alternative link functions?
- Extension to >2 observers?

Final comments

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- Alternative link functions?
- Extension to >2 observers?
- Other applications?