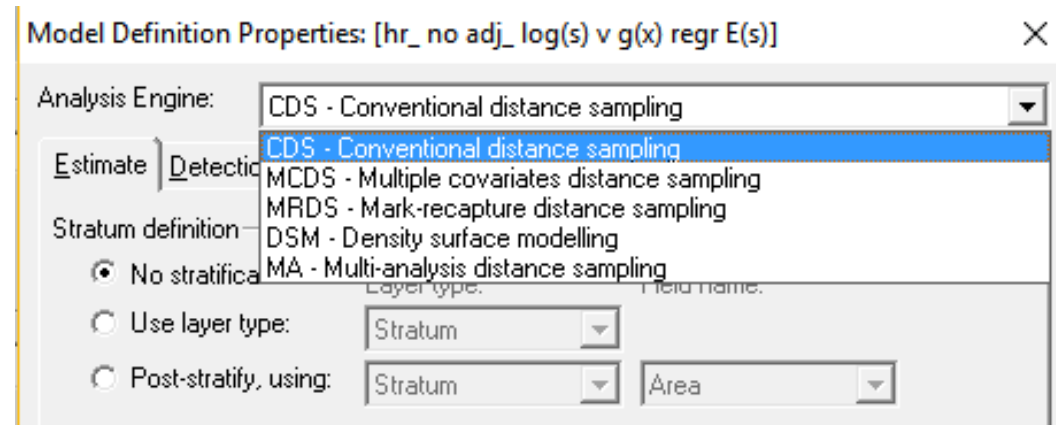# Advanced distance sampling analysis methods

Available using Distance software

Analysis engines inside Distance

- Conventional distance sampling
  - Classical analysis
- Multiple covariate distance sampling
  - Covariates included in detection function modelling
- Mark-recapture distance sampling
  - Detection at distance 0 (on trackline or on point) is less than 1
- Density surface modelling
  - Encounter rate modelled by covariates
- Multi-analysis distance sampling
  - Incorporating uncertainty in cluster size or species identity

Model Definition Properties: [hr_ no adj_ log(s) v g(x) regr E(s)]   ×

Analysis Engine: CDS - Conventional distance sampling   ▼

CDS - Conventional distance sampling
MCDS - Multiple covariates distance sampling
MRDS - Mark-recapture distance sampling
DSM - Density surface modelling
MA - Multi-analysis distance sampling

Estimate | Detecti

Stratum definition   Layer type: Field name:
○ No stratifica
○ Use layer type: Stratum   ▼
○ Post-stratify, using: Stratum   ▼   Area   ▼

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Simulation engine

- Evaluate precision and bias of proposed survey designs
- When assumptions are violated
- Contrast alternative survey designs
- Assess changes in precision associated with changing amounts of survey effort
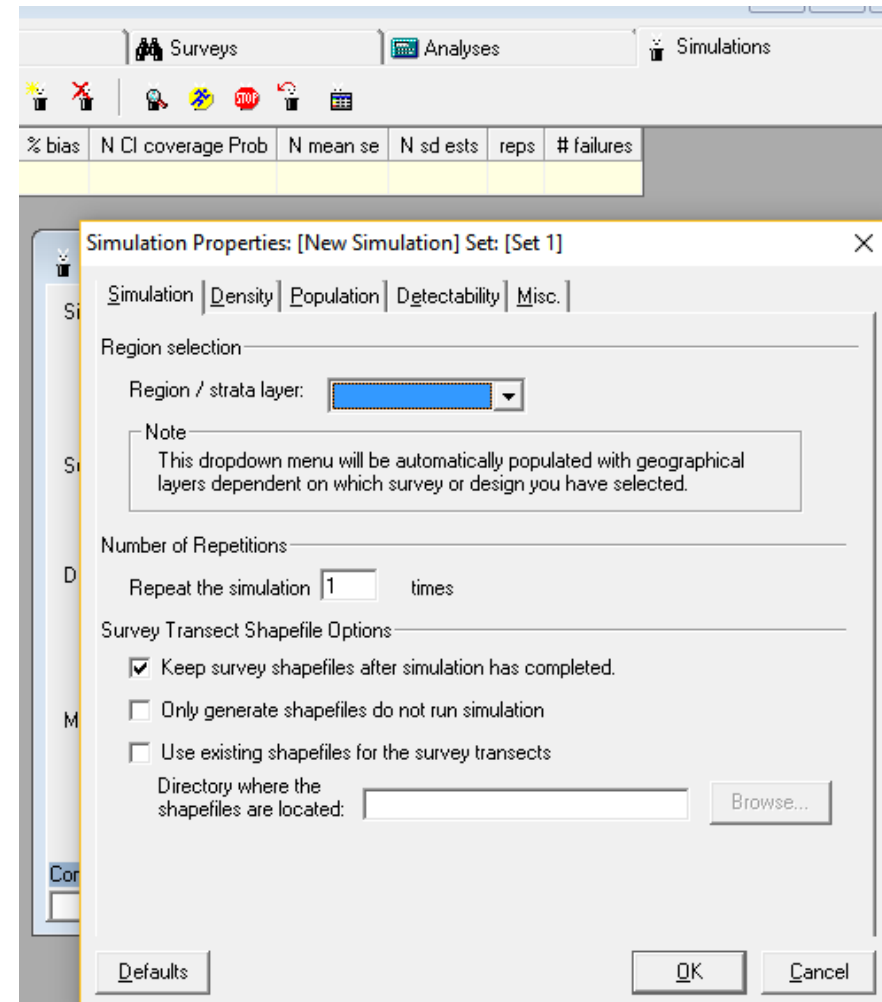
Detection at distance 0 less than 1

"the g(0) problem"

Data requirements

Observation data must have:

2 rows per object – one for Observer 1 and one for Observer 2

Fields for:

object ID

observer (1 or 2)

detected (1=yes, 0=no)

Additional covariate data can go in fields at the appropriate level

Example: (golf tee project)
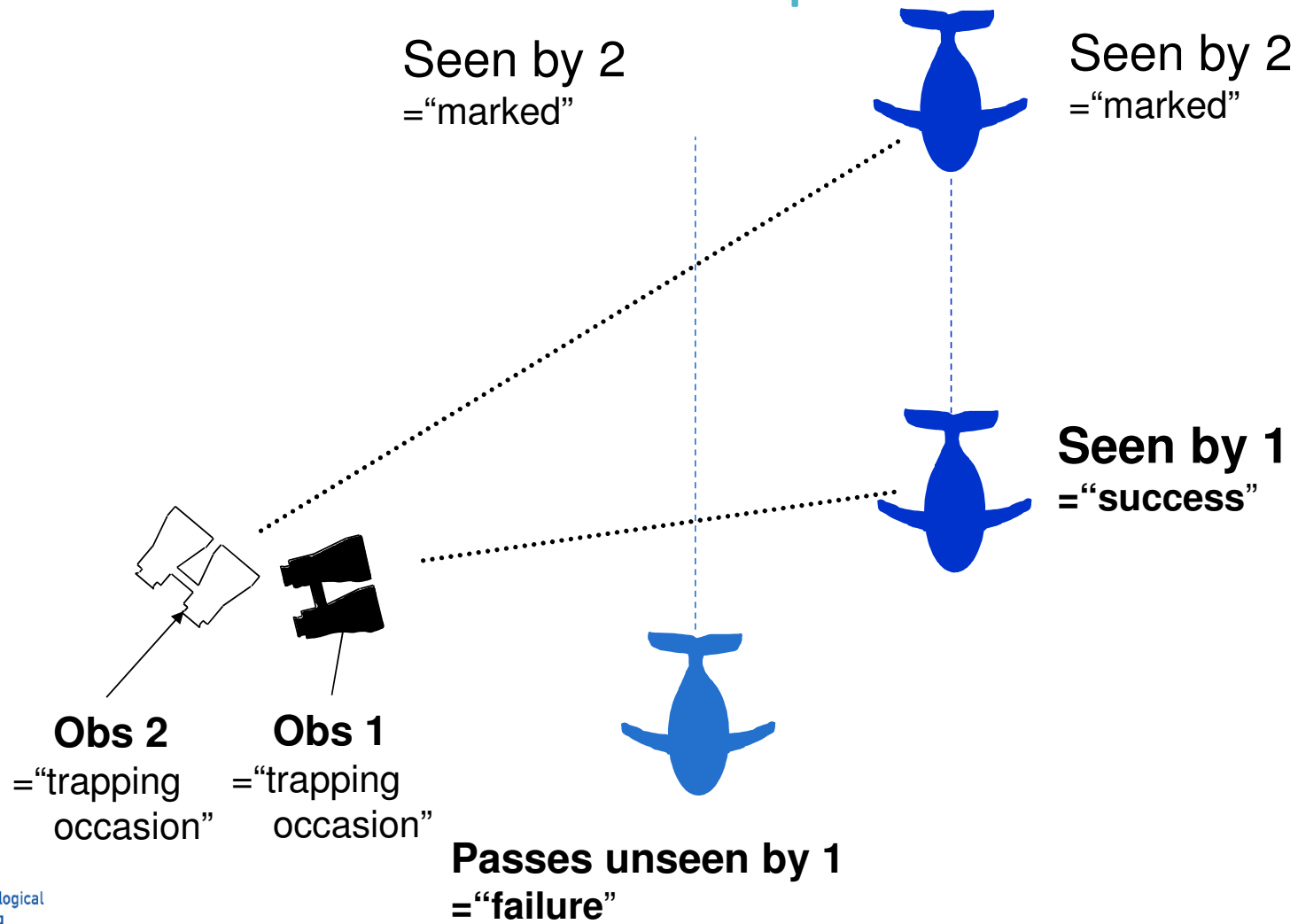

the 3 new required fields

observation-level covariates – fields created during data import

Visual Mark-Recapture

Seen by 2
="marked"

Obs 2
="trapping
occasion"

Obs 1
="trapping
occasion"

Visual Mark-Recapture

Seen by 2
="marked"

Seen by 2
="marked"

Seen by 1
="success"

Obs 2
="trapping
occasion"

Obs 1
="trapping
occasion"
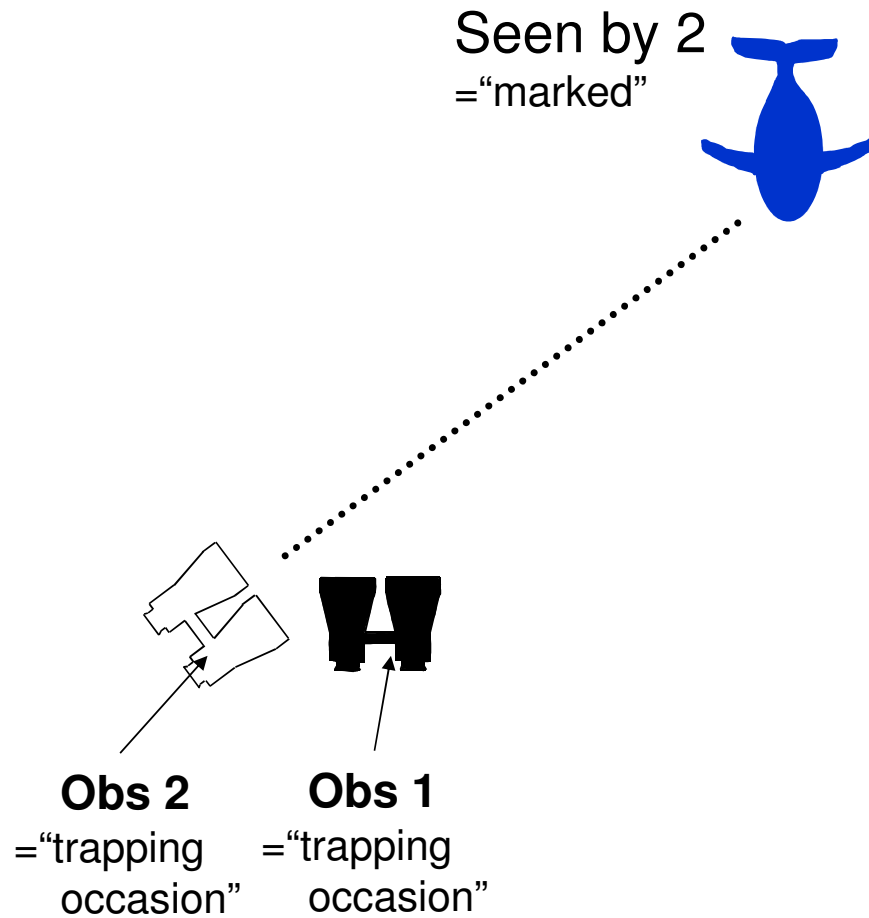
Passes unseen by 1
="failure"

Visual Mark-Recapture
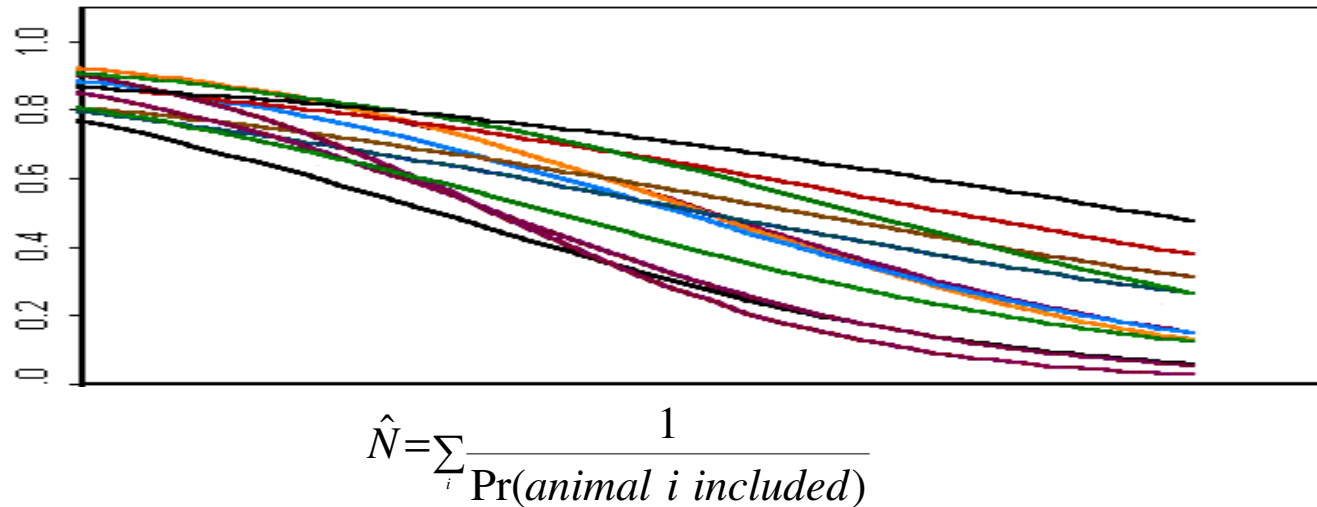
Seen by 2
="marked"

Seen by 2
="marked"

**Passes unseen by 1
="failure"**

**Seen by 1
="success"**

- We know 2 animals passed
(because Obs 2 saw them)

- Of these, Obs 1 saw 1

- So **estimate:**
Pr(Obs 1 sees) = $\hat{p}_1 = \frac{1}{2} = \frac{n_{12}}{n_2}$ = $\dfrac{\text{number "duplicates"}}{\text{number seen by 2}}$

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Note: In this section, we use p, not g for the detection function

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Main Topic 1: $g(0)<1$: MRDS

$$\hat{N} = \sum_i \frac{1}{\Pr(animal\ i\ included)}$$

Pr(*animal i included*) depends on covariates of *animal i* and $g(0)$ can be <1.

- **Remove/reduce bias due to g(0)<1**
- **Can examine effects of covariates**

Density surface modelling

Encounter rate varies spatially as a function of environmental covariates

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After adjusting for imperfect detectability

Modelling of adjusted counts with generalised additive models (GAMs)
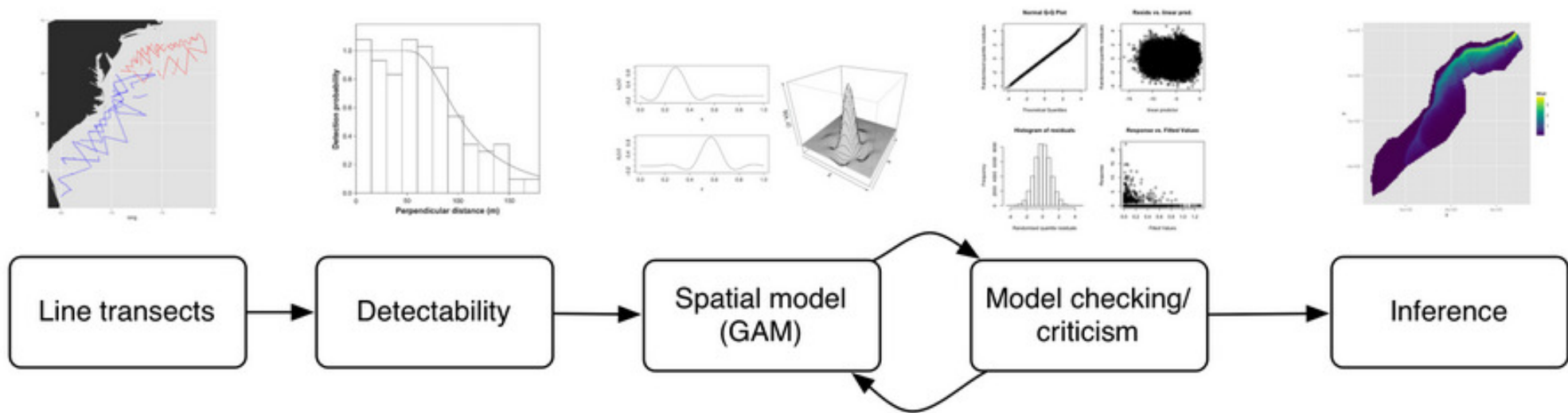
Multi-analysis engine

Include uncertainty in various phases of data collection into the analysis

Multi-analysis engine

Unidentified sightings

    Sightings cannot be identified to species

    Causes bias when there are unidentified sightings on the transect

Covariate uncertainty

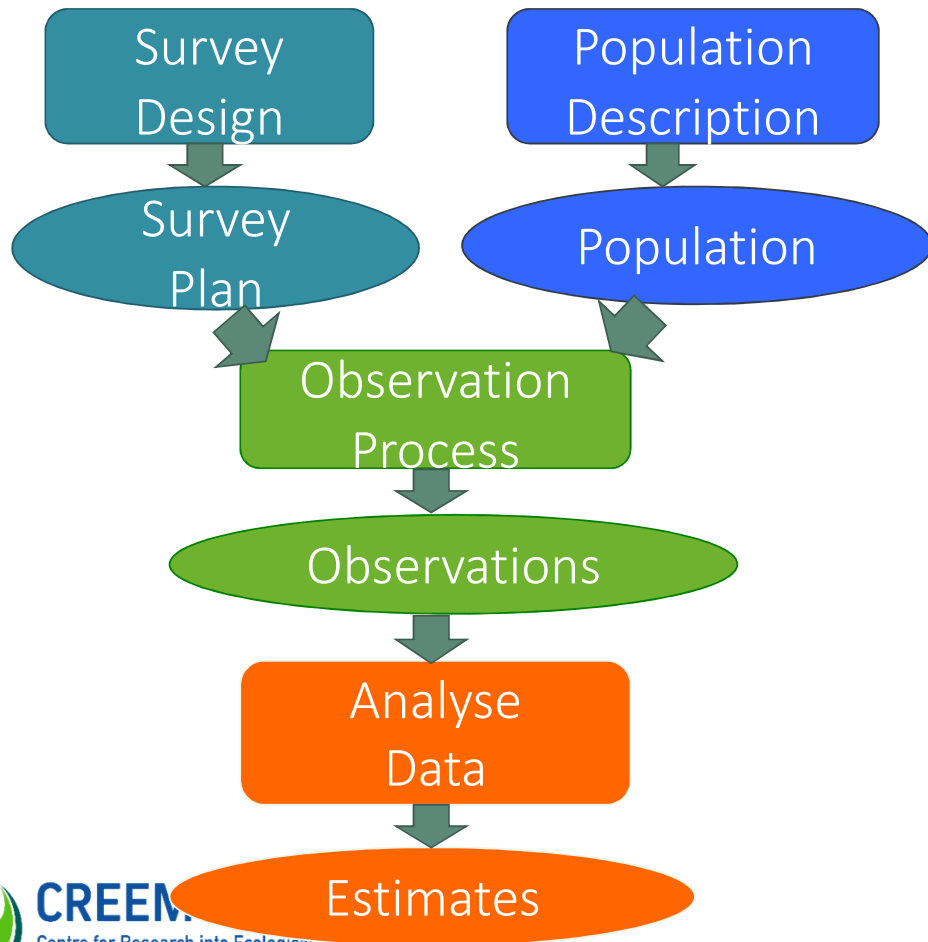   E.g. uncertainty in cluster size, distance, angle, multipliers

    If not included you may underestimate variability

ETP Data Unidentified Sightings
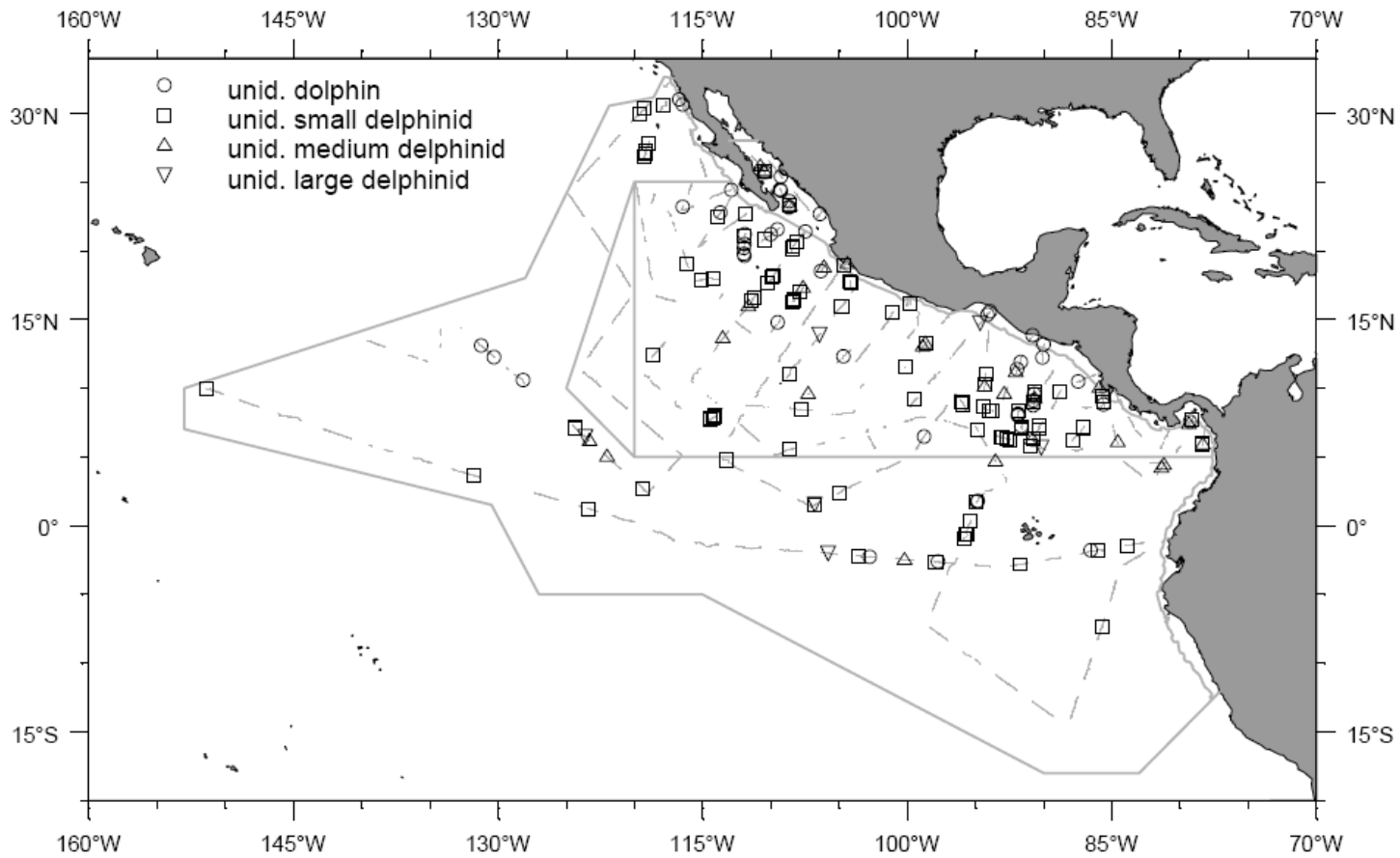
Simulation of distance sampling

What does it do?

Survey Design

Survey Plan

Population Description

Population

Observation Process

Observations

Analyse Data

Estimates

Population Description

Survey Design

AIC = 2747

- Population size or density
- Zig zag design
- Density surface
- Equal Spaced
- Detectability
- Spacing = 10km
- Clusters?
- Minus sampling
- Covariates affecting?

AIC = 2748

Y-coords (km)

Advanced topics are delivered in our St Andrews training workshops

Check the website for dates of next workshop
Workshops are available for persons attending in person or attending remotely (via internet)