Some Examples
For a line of 1000 m, along which 100 individuals are observed, we estimate Density as:

\[ D = \frac{100}{(2)(100)(1000)(0.5)} = 0.001/ \text{m}^2 \]
Section 3

ESTIMATING BIRD DENSITIES USING DISTANCE SAMPLING

Huw Lloyd, Alexis Cahill, Martin Jones and Stuart Marsden
Figure 14. Bird detection curves – some problems.

a) Good detection curve with broad shoulder and steep tail

b) Skulking bird often recorded on paths

c) Birds move in response to recorder presence

d) Outliers. There may also be a problem with heaping (at 50 and 100m)
Figure 15. The basic shapes of the uniform and alternative key functions.
Line-transect survey of Hector’s dolphin abundance between Farewell Spit and Motunau

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Deanna Clement, Elisabeth Slooten, Stephen Dawson and Sam DuFresne
Figure 3. Sightings v. distance and the fitted detection function for strata inside Sounds (hazard/cosine, n = 70, GoF = 0.952).

Figure 4. Sightings v. distance and the fitted detection function for open coast strata (uniform/cosine, n = 89, GoF = 0.837).
### TABLE 2. ABUNDANCE ESTIMATES (FAREWELL SPIT-MOTUNAU).

<table>
<thead>
<tr>
<th>STRATUM</th>
<th>GROUPS SEEN</th>
<th>ESW (m)</th>
<th>$N_U$</th>
<th>%CV($N_U$)</th>
<th>CI$_L$</th>
<th>CI$_U$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queen Charlotte Sound (d)</td>
<td>3</td>
<td>215.7</td>
<td>20</td>
<td>100.48</td>
<td>4</td>
<td>110</td>
</tr>
<tr>
<td>Cloudy/Clifford Bay (f)</td>
<td>13</td>
<td>276.9</td>
<td>162</td>
<td>55.43</td>
<td>56</td>
<td>474</td>
</tr>
<tr>
<td>Cape Campbell-Motunau (g)</td>
<td>5</td>
<td>276.9</td>
<td>102</td>
<td>58.22</td>
<td>34</td>
<td>305</td>
</tr>
<tr>
<td>Study Area</td>
<td>21</td>
<td></td>
<td>285</td>
<td>38.55</td>
<td>137</td>
<td>590</td>
</tr>
</tbody>
</table>

ESW effective half strip width; $N_U$ estimated abundance (corrected); %CV($N_U$) percentage coefficient of variation; CI$_L$ lower 95% confidence interval; CI$_U$ upper 95% confidence interval.
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated abundance (corrected), $N_u$</td>
<td>1882</td>
</tr>
<tr>
<td>Percentage coefficient of variation, $CV(N_u)$</td>
<td>21.28</td>
</tr>
<tr>
<td>Lower 95% confidence interval, $CI_L$</td>
<td>1246</td>
</tr>
<tr>
<td>Upper 95% confidence interval, $CI_U$</td>
<td>2843</td>
</tr>
</tbody>
</table>
Distribution and abundance of beluga whales in the Mackenzie estuary, southeast Beaufort Sea, and west Amundsen Gulf during late July 1992

Lois A. Harwood, Stuart Innes, Pamela Norton, and Michael C.S. Kingsley
Fig. 3. Distribution of beluga whales observed in the Mackenzie estuary during an aerial survey on 23 July 1992.
Fig. 2. Perpendicular distance from plane track of beluga whale sightings made during the 23–25 July 1992 aerial survey of the Beaufort S Mackenzie estuary, and west Amundsen Gulf.
Fig. 5. Frequency distribution of group sizes of beluga observed on transect by primary observers during the 23–25 July 1992 aerial survey of the Beaufort Sea, Mackenzie estuary, and west Amundsen Gulf.
Table 2. Estimated density of beluga (number/km²) and standard error (SE), applied adjustment for missed clinometer readings (AF), and estimated number, standard error (SE), and 95% confidence interval (CI) of surfaced, visible beluga, based on observations by the primary observers in the 23–25 July 1992 aerial survey of the Mackenzie estuary, southeast Beaufort Sea, and west Amundsen Gulf.

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Substratum</th>
<th>Density</th>
<th>No. of beluga&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>Estuary</td>
<td>Kugmallit</td>
<td>1.137</td>
<td>0.225</td>
</tr>
<tr>
<td></td>
<td>Shallow</td>
<td>0.314</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>East Mackenzie Bay</td>
<td>0.355</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>West Mackenzie Bay</td>
<td>0.721</td>
<td>0.060</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1.998</td>
<td>0.184</td>
</tr>
<tr>
<td>Offshore</td>
<td>West Beaufort Sea</td>
<td>0.166</td>
<td>0.0314</td>
</tr>
<tr>
<td></td>
<td>Middle Beaufort Sea</td>
<td>0.135</td>
<td>0.0490</td>
</tr>
<tr>
<td></td>
<td>East Beaufort Sea</td>
<td>0.311</td>
<td>0.0465</td>
</tr>
<tr>
<td></td>
<td>West Amundsen Gulf</td>
<td>0.099</td>
<td>0.0286</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>13 309&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1 490</td>
</tr>
</tbody>
</table>

Note: na, not applicable.

<sup>a</sup>Estimated number of surfaced, visible beluga as determined by a strip-transect method (estuary stratum) and line-transect method (offshore stratum).

<sup>b</sup> Determined by adding substratum estimates calculated to 0.01, then rounding to a whole number.
DISTANCE SAMPLING FOR SONORAN DESERT TORTOISES

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Fig. 1. Map of study area for distance sampling for Sonoran desert tortoises, Rincon Valley, Pima County, Arizona. Squares are 1-km transects (250 m on each side). Staggered line delineates rockier, steeper northeast portion of study area from less rocky, southwest portion. Open circles are observations of adult and subadult tortoises during this study.
Fig. 2. Detection probability function from distance sampling for Sonoran desert tortoises, Rincon Valley, Pima County, Arizona. (A) Detection probability histogram based on raw data for tortoises ≥150 mm and uniform/cosine model in Program Distance. (B) Histogram based on truncating 10% of the largest observations and grouping the data into 3-m intervals.
The uniform/cosine model resulted in the best fit of the data (AIC = 112.64), 0.13 units better than the half-normal key series with both cosine or hermite polynomial series expansions (AIC = 112.77).

The bootstrapped uniform/cosine model provided a density estimate of 0.523 tortoises/ha (CV = 23.0%, CI = 0.29-0.79).

Estimated abundance of tortoises >150 mm MCL in the study area was 193 individuals (CV = 23.0%, CI = 107-291).

Twenty-eight sub-adult tortoises were marked and released during the first coverage of transects, and 15 were captured during the second coverage. We recaptured only 1 individual in the second coverage. The Lincoln-Petersen method produced an estimate of 224 tortoises (CV = 53.9%, CI = 72-440).