

S2 - Estimating land-based survey effort

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Supporting information S2 to “From land and sea, long-term data reveal persistent humpback whale breeding habitat in New Caledonia”, 2018. Contact information: solene.derville@ird.fr

Runs on R version 3.4.4 (2018-03-15) Platform: x86_64-pc-linux-gnu (64-bit)

In this appendix, we describe the approach to the estimation of the spatial extent of survey effort from a land-based look-out.

1 - Define detection function

A logistic function was used to model the survey effort from the land-based look-out as a function of distance from the look-out (Fig. S2.a). This function was selected as it reflects the strong detectability of whales in the immediate vicinity of the look-out, and the rapid decrease of detectability as distance from the observer increases. The logistic function was parametrized based on the average and maximum distances at which whales were detected (11.3 km and 36 km respectively).

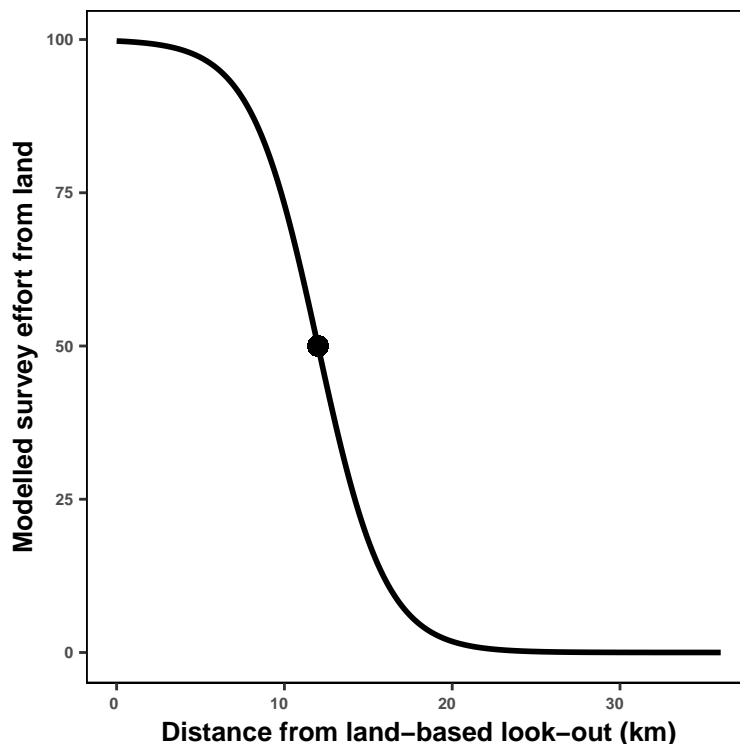


Figure S2.a: Logistic detection function from the land-based look-out. The mid-point of the curve was set at 12 km and the maximum detection distance at 36 km.

2 - Calculate daily raster of survey effort

Using the logistic function above, survey effort was calculated over a raster grid covering the study area. This raster represents land-based survey effort from an average survey day (Fig. S2.b).

```
# project the coordinates of the land-based look-out in a UTM CRS
lookout <- project(matrix(c(166.924745, -22.390923), ncol = 2),
                      "+proj=utm +zone=58S +datum=WGS84 +ellps=WGS84 +towgs84=0,0,0")
# create empty raster based on an empty raster of the study area
land_ras <- raster(grid)
# calculate raster of distances to the land-based look-out
land_ras <- raster::distanceFromPoints(land_ras, lookout)
# convert to km instead of meters
land_ras <- land_ras / 1000
# set limit of detection to 36 km from the look-out
land_ras[land_ras > 36] <- NA
# mask areas out of sight from the look-out
land_ras <- mask(land_ras, hid.shp, inverse = T)
# calculate effort rasters based on distance
land_ras <- calc(land_ras, function(x) {100 / (1 + exp(0.5 * (x - 12))) })
```

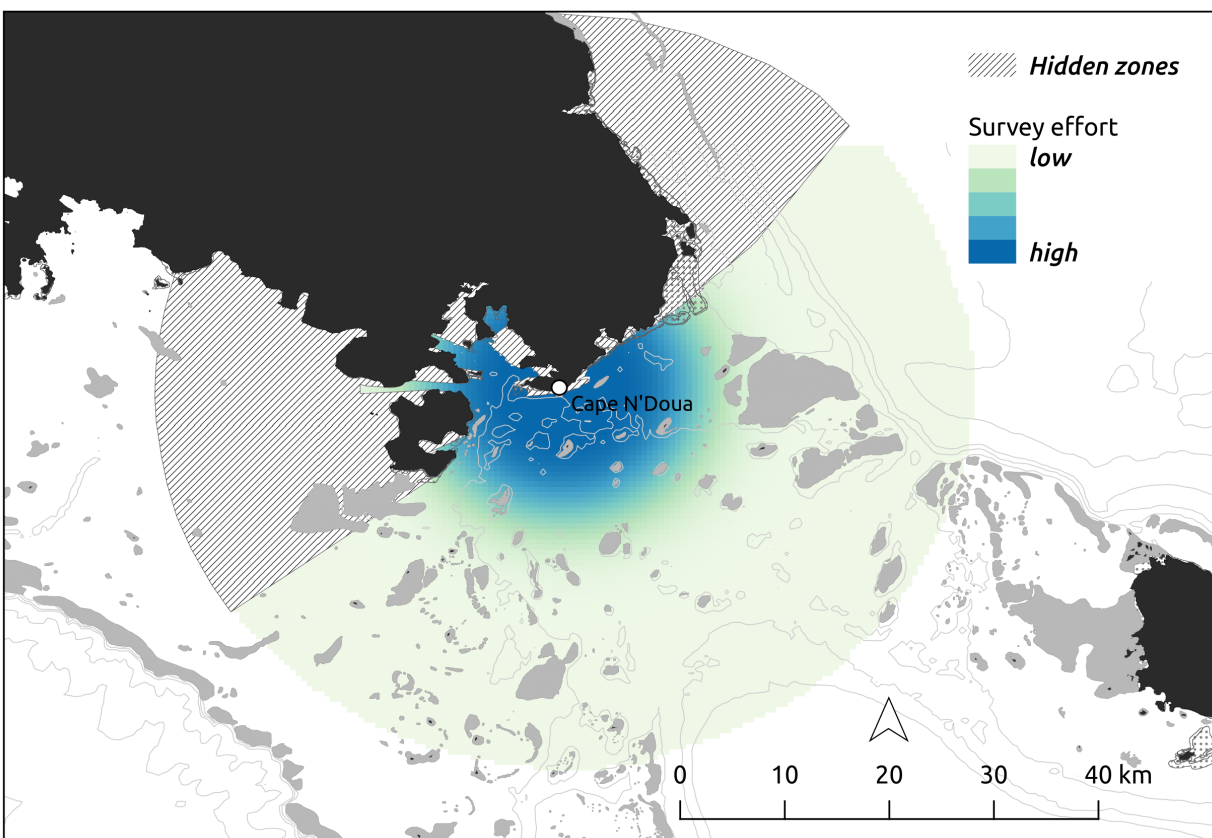


Figure S2.b: Map of daily survey effort from land showing the relative density of effort on a colour scale. Dashed areas are hidden from the observers at the land-based look-out of Cape N'Doua.

3 - Calculate annual rasters of survey effort

Rasters of annual land-based survey effort were estimated by multiplying the basic raster of effort **land_ras** by the time on effort (**time_obs**) and an index reflecting the numbers of observers (**obs_index**).

```
# calculate annual raster layers of survey effort
# accounting for time on effort per day and number of observers
land_effort_years <- dlply(terre_obs, ~ year, function(d){
  tot_time <- sum(d$time_obs * d$obs_index)
  return(land_ras*tot_time)
})

# calculate maximum effort value per year
max_per_layers <- llply(land_effort_years, function (r) {
  return(r@data@max)
})

# rescale to 0-100 using the maximum of the annual maxima
land_effort_years <- llply(land_effort_years, function (r) {
  r <- calc(r, function(x) (x * 100) / max(unlist(max_per_layers)))
  return(r)
})
```