Modelação Ecológica

AULA 17

13th November 2019

CEAUL

Centro de Estatística e Aplicações
Universidade de Lisboa

This is to certify that on the 5th November 2011

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attended the CEAUL worshop in Hidden Markov Models,
including a seminar on
"Hidden Markov Models of Animal Movement and Behavior"
and the short course
"Hidden Markov models using R"
with Théo Michelot (CREEM, University of St Andrews)

On behalf of CEAUL

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(Tiago A. Marques)

Exemplos reais de GLMs e GAMs em Modelação Ecológica

Sebastián-González, E.; Camp, R. J.; Tanimoto, A. M.; de Oliveira, P. M.; Lima, B. B.; Marques, T. A. & Hart, P. J. 2018 Density estimation of sound-producing terrestrial animals using single automatic acoustic recorders and distance sampling Avian Conservation and Ecology, 13:7

Fig. 1. Picture and spectrogram of an ´amakihi at the study area.

Fig. 2. Methodological steps suggested to estimate density from sound-emitting species.

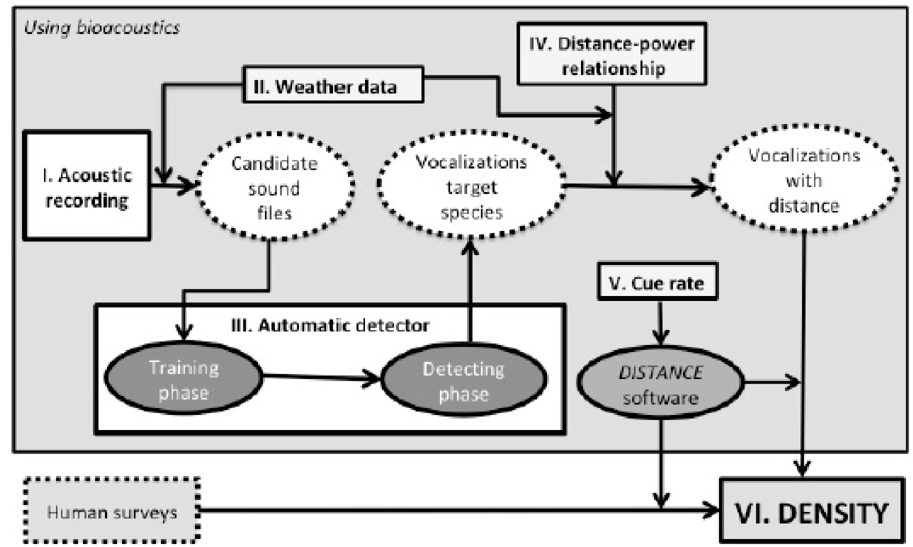
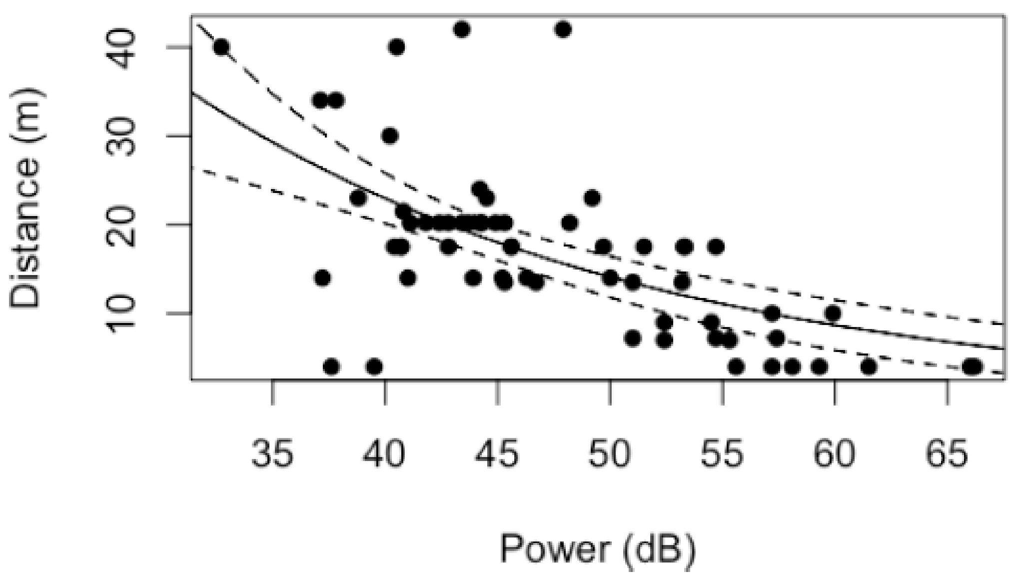


Fig. 3. Relationship between power and distance to the vocalizing bird. We also represent the regression line fron model used to estimate the distances.



The power of the cue was significantly related to the distance of the vocalizing individual (GLM, coefficient ± SE = -0.048 ± 0.009, Intercept ± SE = 5.077 ± 0.406, t-value = -5.221, DF = 60, $P < 0.001$, explained deviance = 37.45%) (Fig. 3, Fig. A1.1). This relationship was not affected by the presence of rain or wind (variables not included in the model with the lowest AIC). Also, the measured distance was significantly related to the predicted one (LM, coefficient ± SE = 1.043 ± 1.04, Intercept ± SE = -0.807 ± 3.085, $P < 0.001$, $R^2 = 0.36$) (Fig. A1.2).

Garcia-Barón, I.; Cortés-Avizanda, A.; Verburg, P. H.; Marques, T. A.; Moreno-Opo, R.; Pereira, H. M. & Donázar, J. A. 2018 How to fit the distribution of apex scavengers into land-abandonment scenarios? The Cinereous vulture in the Mediterranean biome Diversity and Distributions

We used generalized linear m
ence/absence of Cinereous vult
logit function). The data set wa
742 presences, 4,403 and 3,805
respectively). Thus, to balance
sences, 1,000 independent sam
selected for nesting and foragi
for each sample. Models were f
stepwise procedures, using Akai
select the best model of each tr
environment (version 3.1.1, R De
the function *glm* in the "stats" pa

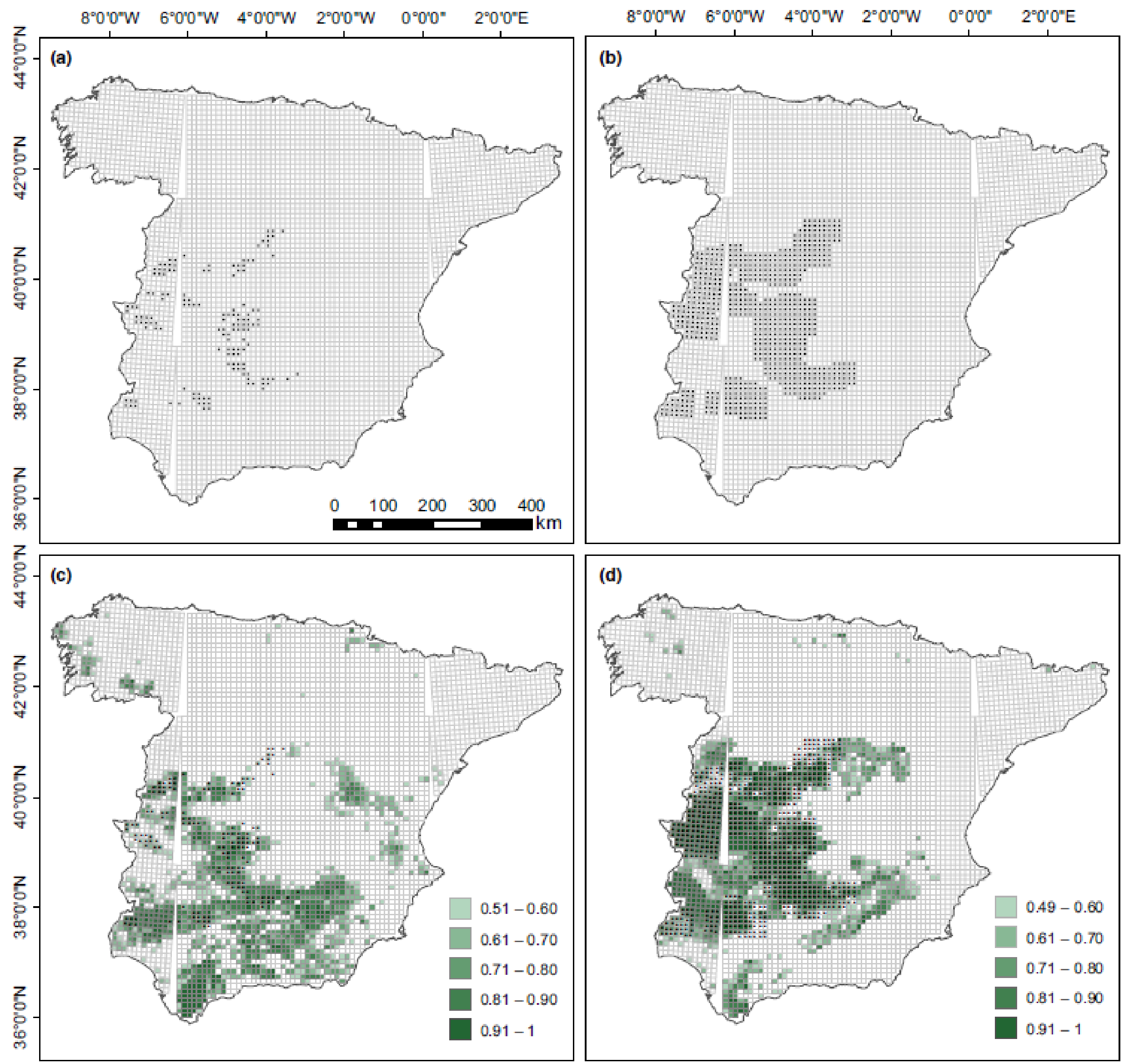


FIGURE 1 Distribution of Cinereous vultures in Peninsular Spain (a) nesting (based on Martí & del Moral, 2003); and (b) foraging (created according to inference from radio-tracking studies (Carrete & Donázar, 2005; Moreno-Opo et al., 2010). The last two maps represent the average prediction of the 1,000 final models showing each UTM 10 × 10 km cells predicted as suitable according to the cut-off value, (>0.51 for nest-site habitat and >0.49 for foraging habitat): (c) nest-site habitat; and (d) foraging habitat

Um exemplo
de
aplicação
de um
GAM:
a primeira estimativa
de
densidade de cetáceos
usando
acústica passiva

Estimating cetacean population density using fixed passive acoustic sensors: An example with Blainville's beaked whales

Tiago A. Marques[a] and Len Thomas
Centre for Research into Ecological and Environmental Modelling, The Observatory, University of St Andrews, St Andrews KY16 9LZ, Scotland

Jessica Ward and Nancy DiMarzio
Naval Undersea Warfare Center Division, 1176 Howell Street, Newport, Rhode Island 02841

Peter L. Tyack
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543

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Methods are developed for estimating the size/density of cetacean populations using data from a set of fixed passive acoustic sensors. The methods convert the number of detected acoustic cues into animal density by accounting for (i) the probability of detecting cues, (ii) the rate at which animals produce cues, and (iii) the proportion of false positive detections. Additional information is often required for estimation of these quantities, for example, from an acoustic tag applied to a sample of animals. Methods are illustrated with a case study: estimation of Blainville's beaked whale density over a 6 day period in spring 2005, using an 82 hydrophone wide-baseline array located in the Tongue of the Ocean, Bahamas. To estimate the required quantities, additional data are used from digital acoustic tags, attached to five whales over 21 deep dives, where cues recorded on some of the dives are associated with those received on the fixed hydrophones. Estimated density was 25.3 or 22.5 animals/1000 km^2, depending on assumptions about false positive detections, with 95% confidence intervals 17.3–36.9 and 15.4–32.9. These methods are potentially applicable to a wide variety of marine and terrestrial species that are hard to survey using conventional visual methods. © *2009 Acoustical Society of America.* [DOI: 10.1121/1.3089590]

PACS number(s): 43.30.Sf, 43.80.Ka [WWA] Pages: 1982–1994

I. INTRODUCTION

Cetaceans (whales and dolphins) form a key part of marine ecosystems, and yet many species are potentially threatened with extinction by human activities. One essential element of an effective conservation or management strategy is a reliable estimate of population size ("abundance") or, equivalently, number per unit area ("density"). However, most cetacean species are hard to survey, since they live at low density over large areas of ocean and spend almost all of their time underwater. The object of this paper is to increase the repertoire of tools available for making species assessments, by developing and demonstrating methods for estimating cetacean density from surveys of their vocalizations collected from fixed passive acoustic sensors.

Currently, the main method for obtaining estimates of density is through visual line transect surveys. A set of randomly placed lines is traversed by an observation platform (e.g., ship, airplane, or helicopter) and all sighted animals of the target species are recorded, together with their perpendicular distance from the line. In the standard method, it is assumed that all animals on the transect line (i.e., at zero distance) are seen with certainty, but that probability of detection declines with increasing distance from the line. The distribution of observed detection distances is then used to estimate the average probability of detection, and this in turn allows estimation of population abundance or density. Line transects are a special case of distance sampling methods, which are described in detail in the two standard texts by Buckland *et al.* (2001, 2004).

Visual line transect methods have a number of disadvantages for surveying cetaceans: they can only be performed during daylight hours and are strongly dependent on good weather conditions; they do not work well for species that spend long periods of time underwater; they are expensive to do well and have restricted temporal coverage. On the other hand, some cetacean species make frequent and characteristic vocalizations, and this has led to increasing recent interest in the use of passive acoustic methods for monitoring cetacean populations (see review by Mellinger *et al.*, 2007b). One solution is to replace or supplement the visual observers on a shipboard line transect survey with a towed passive acoustic platform, since even a simple two-element hydrophone array can be used to obtain locations of repeatedly vocalizing animals, and hence the required perpendicular distances. This has proved particularly effective for sperm whales (*Physeter macrocephalus*), which are long, deep divers and hence hard to detect visually, but produce loud

[a]Electronic mail: tiago@mcs.st-and.ac.uk; URL: http://www.creem.st-and.ac.uk/decaf/

TABLE I. Details about the tagged whales used in case study analysis: Tag ID, date the animal was tagged, number of dives while animal was tagged, and number of dives with data available for estimating the detection function $g(y)$.

Tag	Date	Number of Dives	Dives for $g(y)$
Md296	23 Oct 2006	3	3
Md227	15 Aug 2007	6	0
Md245	2 Sep 2007	4	3
Md248a	5 Sep 2007	4	4
Md248b	5 Sep 2007	4	3
Total		21	13

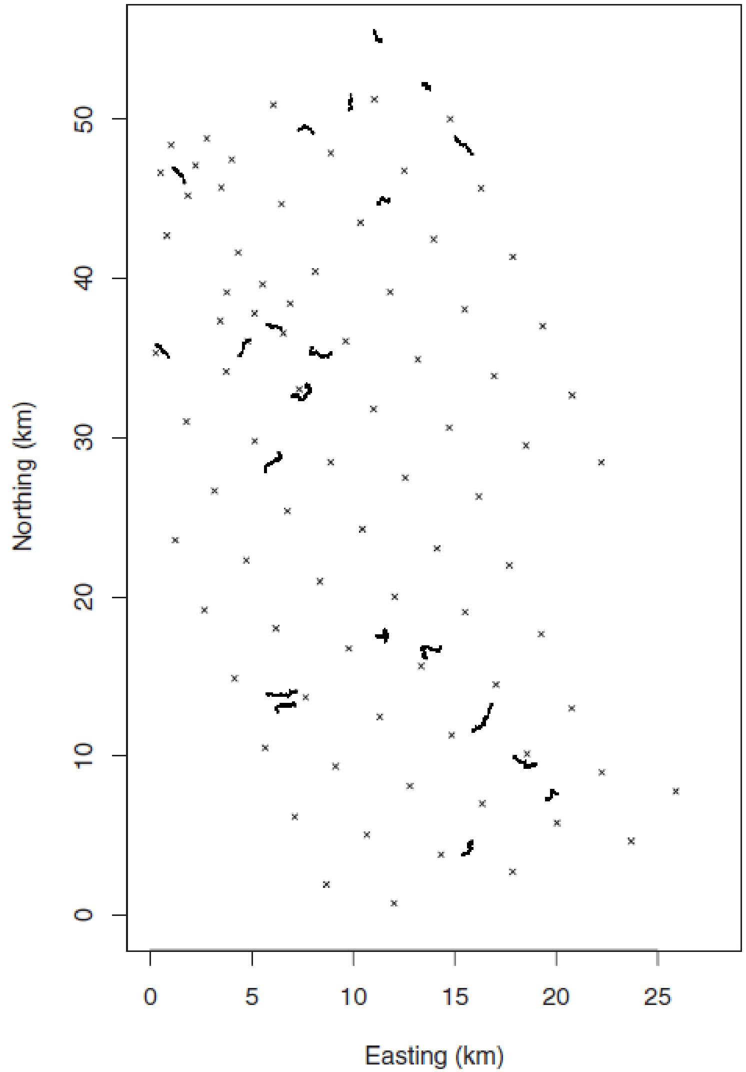

FIG. 1. The spatial layout of the AUTEC hydrophones that were recording during the collection of the primary survey data, represented by small crosses. Also shown as dots (perceived as solid lines) are the locations of the tagged Blainville's beaked whales when each click recorded on the DTag was produced.

Marques, T. A.; Thomas, L.; Ward, J.; DiMarzio, N. & Tyack, P. L. 2009 Estimating cetacean population density using fixed passive acoustic sensors: an example with Blainville's beaked whales *The Journal of the Acoustical Society of America* **125**:1982-1994

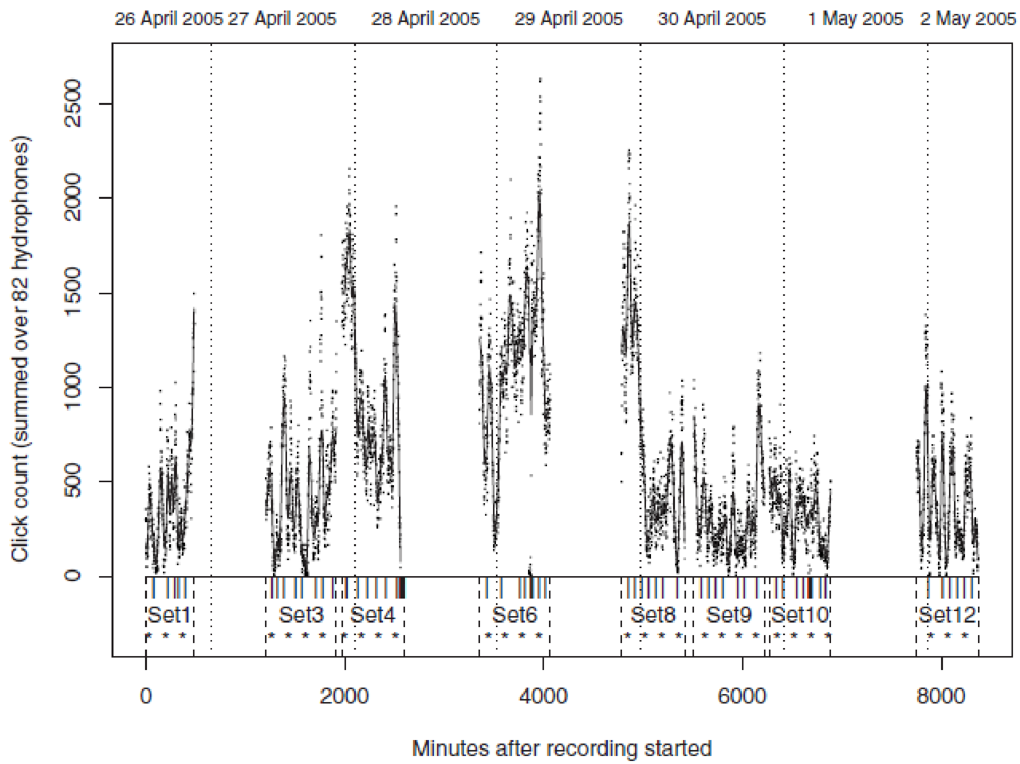

FIG. 2. Click counts per minute, summed over the 82 recording hydrophones, for the 6 day period of the primary dataset. Time is indexed as minutes since recording started. For operational reasons the data were divided into sets, and some sets (2, 5, 7 and 11) were not used. A standard lowess smooth of click counts over time is shown for the sets used. The small black vertical dashes ("|") are scattered minutes within the 8 sets used which were faulty and hence removed from the data. The sample periods used for the estimation of the false positive proportion are represented by " *". The limits of each day and set are represented by dotted and dashed lines, respectively.

Marques, T. A.; Thomas, L.; Ward, J.; DiMarzio, N. & Tyack, P. L. 2009 Estimating cetacean population density using fixed passive acoustic sensors: an example with Blainville's beaked whales *The Journal of the Acoustical Society of America* **125**:1982-1994

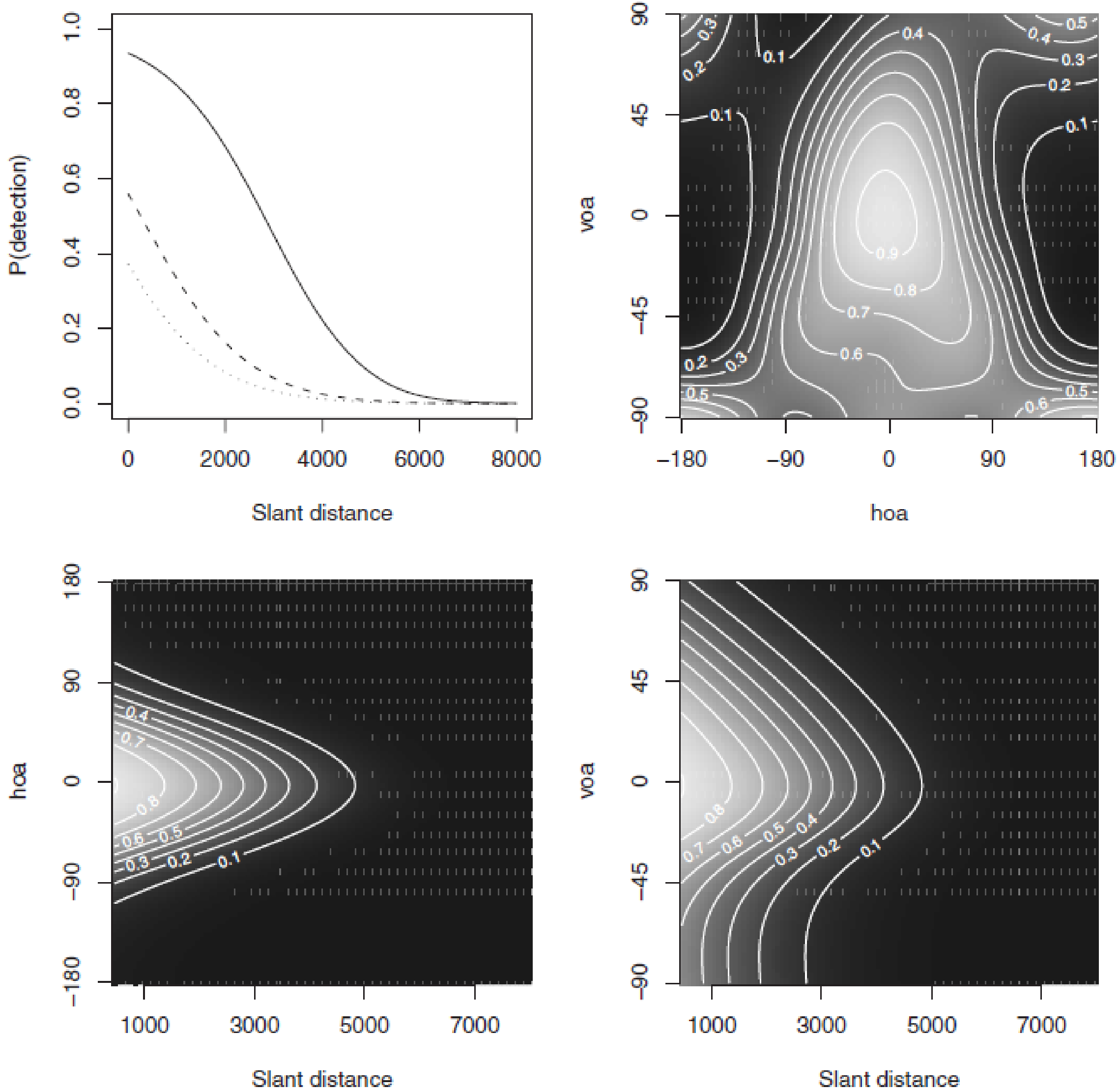

FIG. 3. The estimated detection function. Partial plots (on the response scale) of the fitted smooths for a binomial GAM model with slant distance and a 2D smooth of *hoa* and *voa*. For the top left plot, the off-axis angles are fixed at 0, 45, and 90° (respectively the solid, dashed, and dotted lines). Remaining plots are two-dimensional representations of the smooths, where black and white represent respectively an estimated probability of detection of 0 and 1. Distance (top right panel) and angle not shown (bottom panels) are fixed respectively at 0 m and 0 °.

Marques, T. A.; Thomas, L.; Ward, J.; DiMarzio, N. & Tyack, P. L. 2009 Estimating cetacean population density using fixed passive acoustic sensors: an example with Blainville's beaked whales *The Journal of the Acoustical Society of America* **125**:1982-1994

Para mim, a mais importante classe de modelos para quem trabalha em ecologia são os modelos de regressão (e dentro destes, GLMs e GAMs).

I would call these the cornerstone of statistical ecology.

Breve síntese

- Modelos construídos com base na análise estatística (por tentativas) de diferentes elementos (variáveis) do modelo
- Relações desconhecidas *a priori*;
- Muito utilizados numa ampla diversidade de situações aplicadas à ecologia;
- Opções metodológicas dos modelos com extremo impacto no resultado final;
- Em geral, a componente aleatória não explicada por estes modelos é considerável.

Let’s play with real data!

https://highstat.com/Books/BGS/GAM/Data/Parasites3.txt

https://highstat.com/Books/BGS/GAM/Data/BaileyDensity.txt

https://highstat.com/Books/BGS/GAM/Data/Gannets2.txt