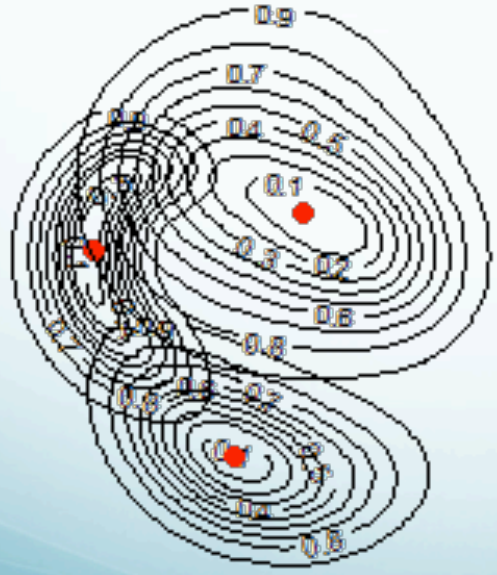
Workshop SECR no Ambiente R

"Modelo Espacialmente Explícito de Captura e Recaptura"

Introdução ao SECR

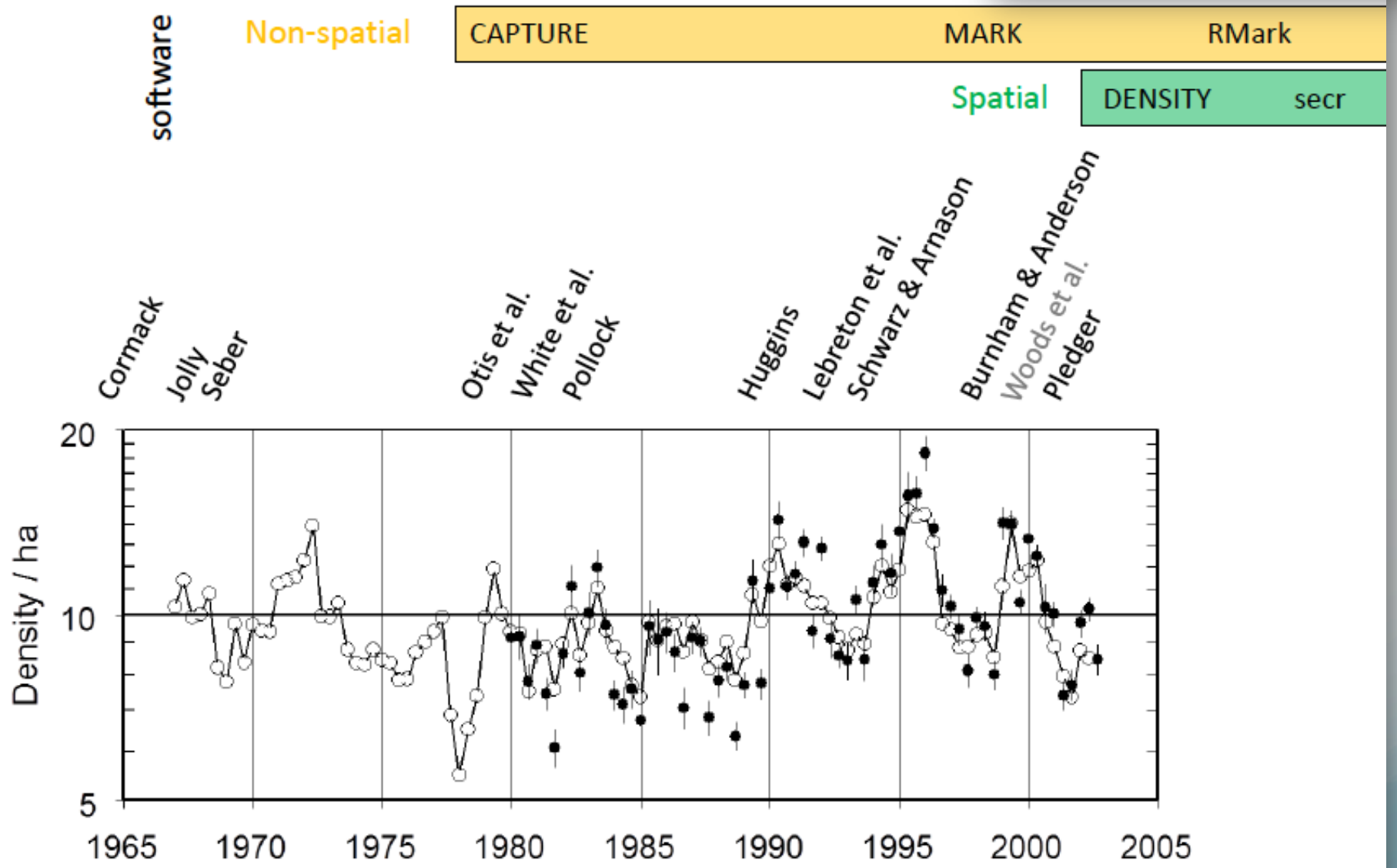


Francesca B.L. Palmeira
26/05/2014

Período: 26 a 30/05/2014
Local: Departamento de Ciências Florestais
ESALQ/USP, Piracicaba

Murray Efford
Western Black Bear Workshop
Coeur d'Alene ID May 2012

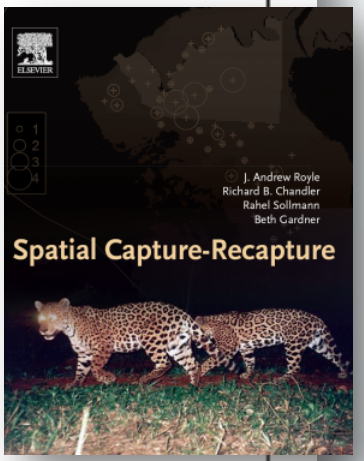
A partial history of capture-recapture...



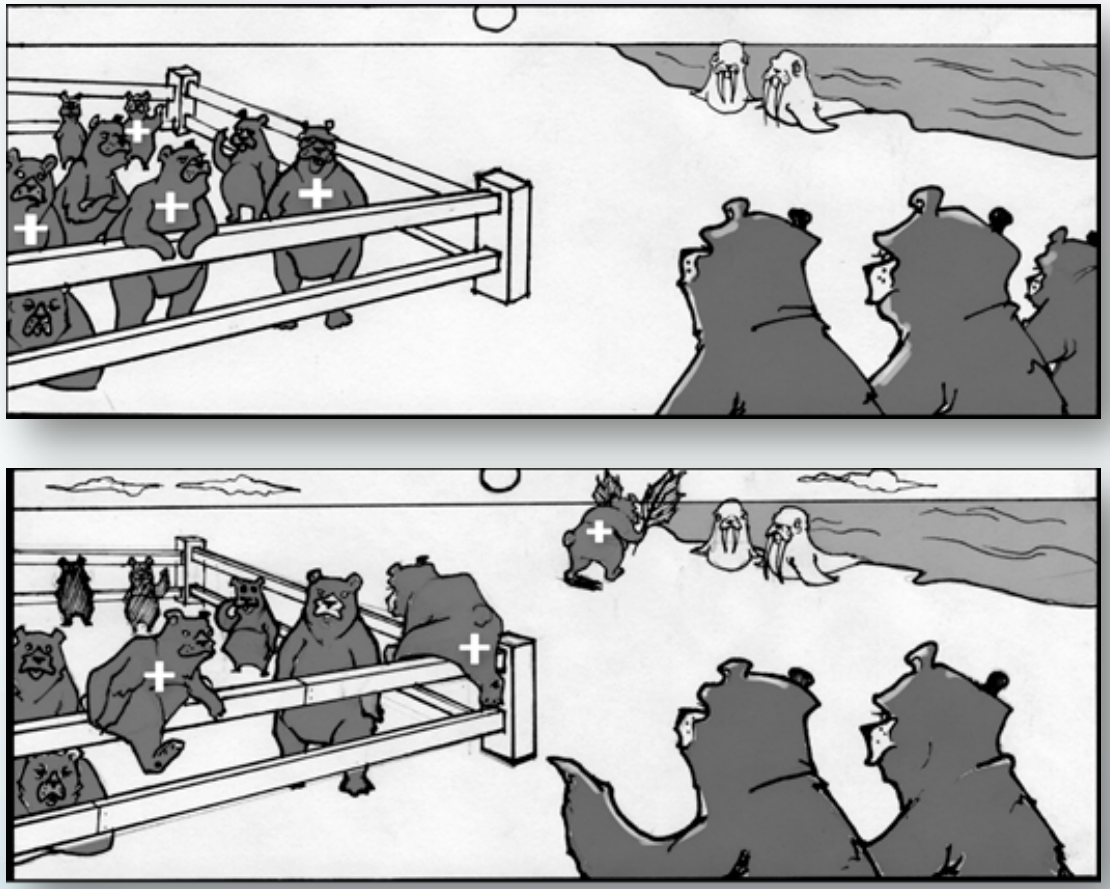
<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>

Table 20.1 Google Scholar citations by year based on a search of "spatial capture recapture" OR "spatially explicit capture recapture" conducted on March 6, 2013. The estimated growth rate of this population of papers was 33.4%.

Time Period	Cumulative Cites	Cites in Year Previous
Since 2002	274 cites	
Since 2003	274 cites	0 articles published in 2002
Since 2004	271 cites	3 articles published in 2003
Since 2005	269 cites	2 articles published in 2004
Since 2006	264 cites	5 articles published in 2005
Since 2007	261 cites	3 articles published in 2006
Since 2008	253 cites	8 articles published in 2007
Since 2009	242 cites	11 articles published in 2008
Since 2010	222 cites	20 articles published in 2009
Since 2011	176 cites	46 articles published in 2010
Since 2012	111 cites	65 articles published in 2011
Since 2013	27 cites	84 articles published in 2012
		27 published so far in 2013, since March 6



Contando indivíduos de uma população...



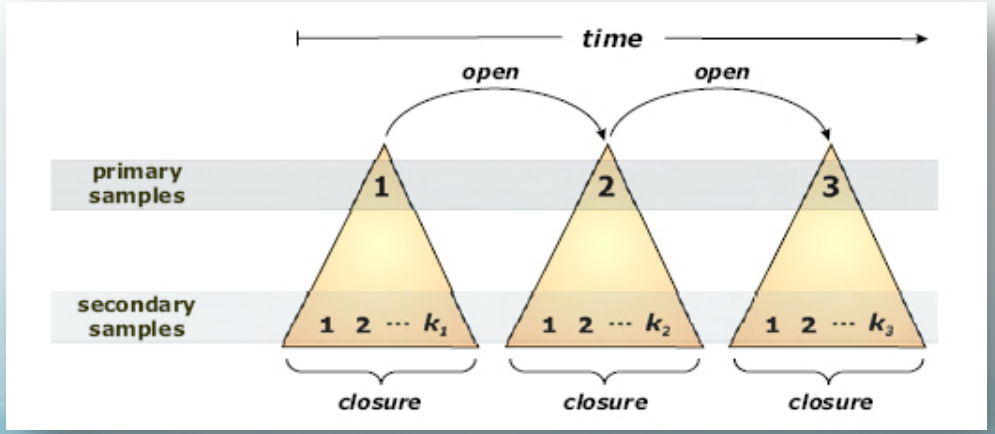
Jim Steele, San Francisco State University

<http://wattsupwiththat.com/2013/07/03/how-science-counts-bears/>

Closed population

Open population

Pollock's Robust Desing (Pollock, 1982)



<http://www4.ncsu.edu/~pollock/index.html>

Primeiros estudos de captura e recaptura

American Fisheries Society Symposium 7:9–29, 1990

EXTERNAL TAGS AND MARKS

Historical Review of the Development of External Tags and Marks

G. A. McFarlane

Department of Fisheries and Oceans, Biological Sciences Branch
Pacific Biological Station, Nanaimo, British Columbia V9R 5K6, Canada

Richard S. Wydoski

U.S. Fish and Wildlife Service, Division of Federal Aid
Denver Federal Center, Denver, Colorado 80225, USA

Eric D. Prince

National Marine Fisheries Service, Southeast Fisheries Center
75 Virginia Beach Drive, Miami, Florida 33149, USA

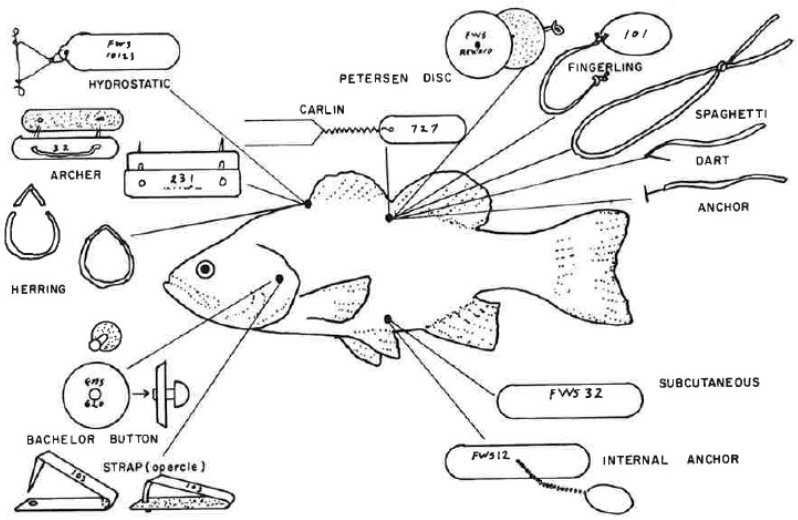


FIGURE 3.—Principal types of external tags and anatomical sites for attachment on fish.

TABLE 1.—Historical development of tags and marks to identify fish.

Tag or mark	Year	Species[a]	Remarks	Reference
Attachment tags: ribbons, threads, wires				
Ribbons; colored wool	1653	Atlantic salmon	Attached by private landowners	Walton and Cotton (1898)
Wire in tails or jaws	1851	Atlantic salmon	Attached by private landowners	Delany (1978)
Archer tag	1888	Atlantic salmon	Flat strip of silver with ends pointed and at right angles attached to dorsal fin	Rounsefell and Kask (1945)
Silver wire loops	1905	Tay salmon		Delany (1978)
Collar tag	1872	Atlantic salmon	Rubber band encircling caudal peduncle	Marukawa and Kamiya (1930)
Collar tag	1911	Bluefin tuna	Copper chain encircling caudal peduncle	Sella (1924)
Collar tag	1925	Mackerel	Celluloid poultry tag band around caudal peduncle	Rounsefell and Kask (1945)
Hook tag	1927	Tuna	Numbered hooks to indicate locality	Rounsefell and Kask (1945)

Evolução dos métodos de captura e recaptura

Monitoring Elusive Mammals

Unattended cameras reveal secrets of some of the world's wildest places

James G. Sanderson and Mogens Trolle

148 American Scientist, Volume 93

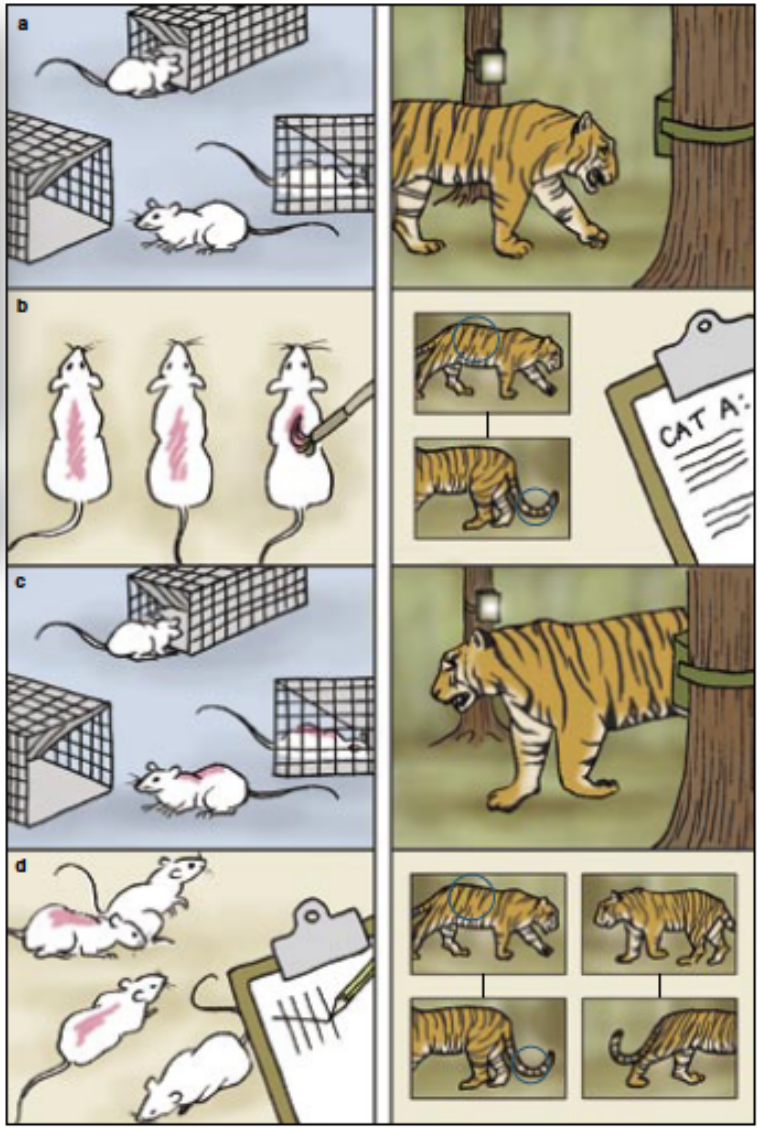
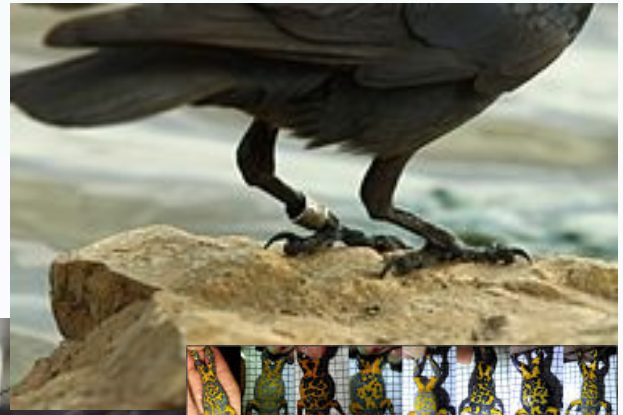
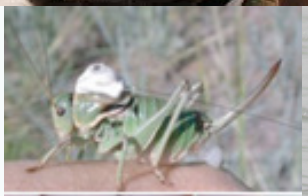


Figure 5. A classic "mark-recapture" analysis is often used to gauge population density (*panels at left*). In such studies, animals are captured (*a*), marked in some way (here with splotches of paint, *b*) and then released. A second round of trapping (*c*) then allows the total number of animals to be inferred by tallying the proportion marked (*d*), assuming that the newly captured ones constitute a representative sample of wild population. Exactly the same type of analysis can be done using camera traps when individuals can be identified from their markings (*right*).


©the Pomacea Project






Gwenaël Beaufet

Pioneirismo dos estudos com populações de tigre (*Panthera tigris*)

<http://www.conservationindia.org/articles/india-adopts-a-new-refined-protocol-to-monitor-tigers>

Ecology, 79(8), 1998, pp. 2852–2862

ESTIMATION OF TIGER DENSITIES IN INDIA USING PHOTOGRAPHIC CAPTURES AND RECAPTURES

K. ULLAS KARANTH[1,3] AND JAMES D. NICHOLS[2]

[1] *Wildlife Conservation Society (International Programs), Bronx, New York 10460-1099 USA*
[2] *U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland 20708-4017 USA*

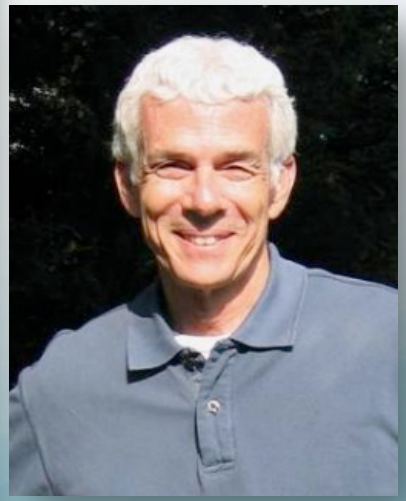
FIG. 1. Differences in stripe patterns between two tigers in Nagarahole noted from photographic captures using camera traps.

FIG. 2. Repeated photographic captures of the same tigress in Nagarahole.

WILDLIFE CONSERVATION SOCIETY

<http://cwsindia.org/>

USGS
Patuxent Wildlife Research Center



<http://www.pwrc.usgs.gov/staff/profiles/documents/nichols.htm>

biology letters

Biol. Lett.
doi:10.1098/rsbl.2009.0028
Published online

Population ecology

A tiger cannot change its stripes: using a three-dimensional model to match images of living tigers and tiger skins

Lex Hiby[1,*], Phil Lovell[2], Narendra Patil[3], N. Samba Kumar[3], Arjun M. Gopalaswamy[3] and K. Ullas Karanth[3]

[1]*Conservation Research Ltd, 110 Hinton Way, Great Shelford, Cambridge CB22 5AL, UK*
[2]*Sea Mammal Research Unit, Gatty Marine Laboratory, University of St Andrews, St Andrews, Fife KY16 8LB, UK*
[3]*Wildlife Conservation Society—India Programme, Centre for Wildlife Studies, 1669, 31st Cross, 16th Main, Banashankari 2nd Stage, Bangalore 560 070, India*
**Author for correspondence (lexhiby@gmail.com).*

Figure 1. The three-dimensional model fitted to a camera trap image of a tiger. The yellow dots placed on the screen by the user indicate the position of shoulder, hip and tail base points and the red and blue dots indicate the upper and lower margins of the image, respectively (note the second tiger behind the first, which might make automated segmentation of the first image from the background difficult).

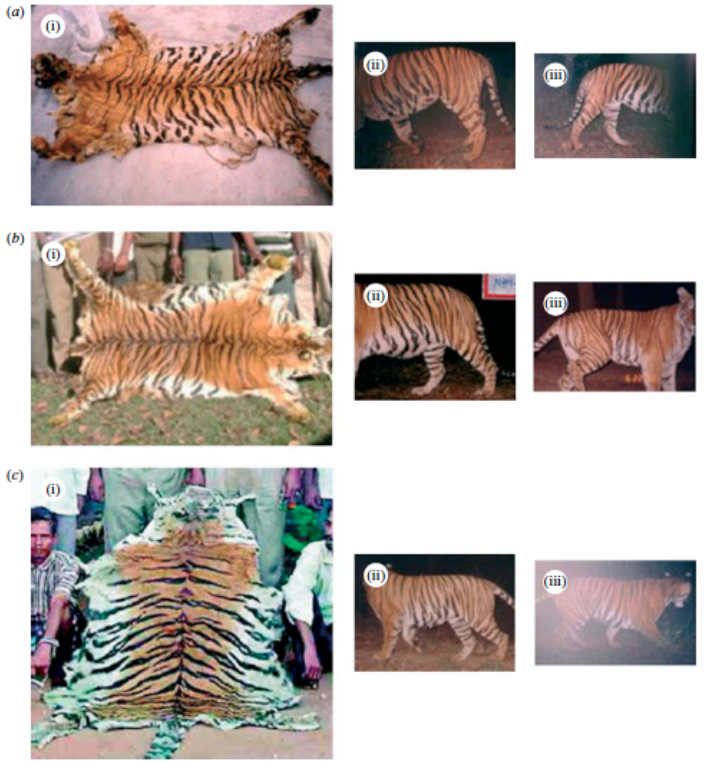


Figure 2. (*a–c*) Images of (i) tiger skins confiscated locally and (ii) left and (iii) right camera trap images of the living tigers taken in the reserves from which the animals were poached. Five of the six pattern samples taken from the skin images generated the highest similarity score with an image of the correct animal from the catalogue. The pattern on the right side of the tiger (*c* (i)) skin image was not scored as similar to the right side of the camera trap image of that tiger (iii).

OPEN ACCESS Freely available online

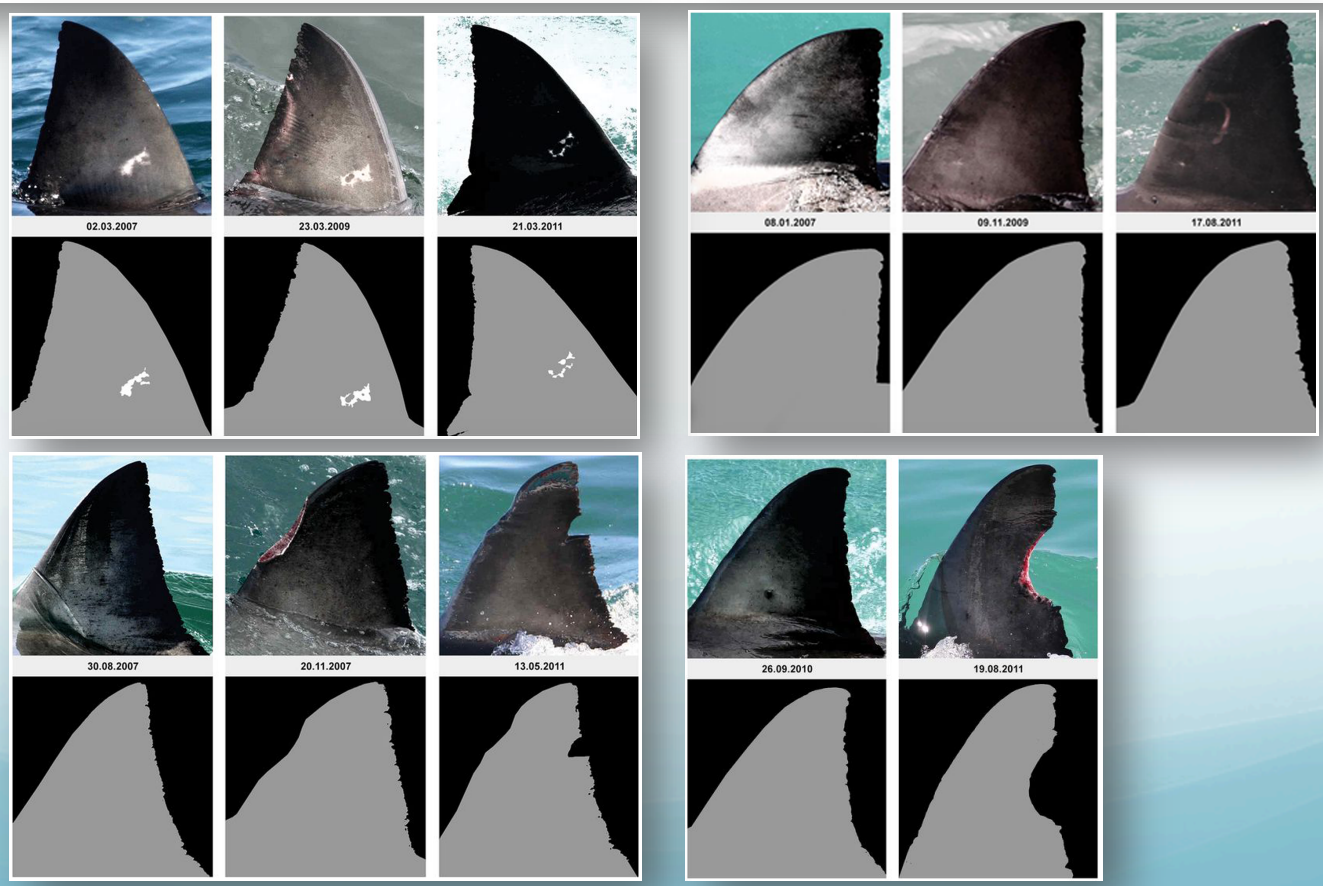
June 2013 | Volume 8 | Issue 6 | e66035

PLOS ONE

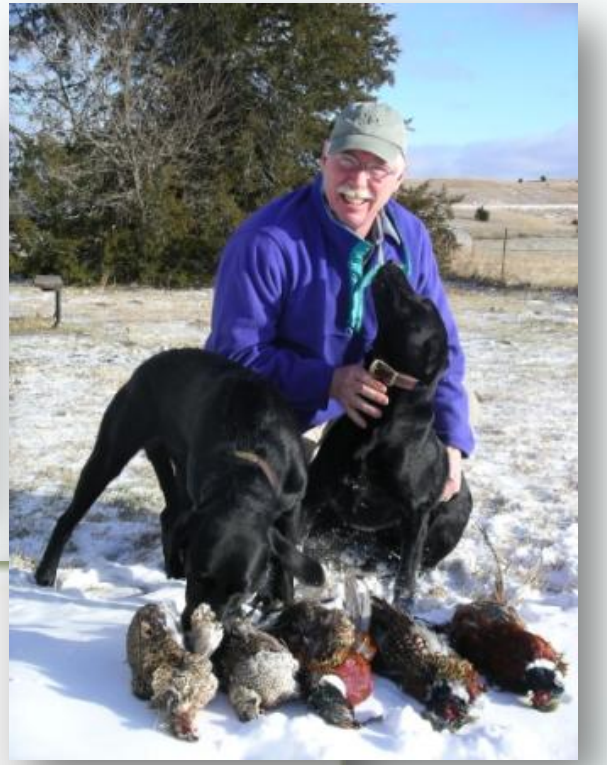
Gauging the Threat: The First Population Estimate for White Sharks in South Africa Using Photo Identification and Automated Software

Alison V. Towner[1,2], Michelle A. Wcisel[1,2], Ryan R. Reisinger[3], David Edwards[1], Oliver J. D. Jewell[1,3]*

1 Dyer Island Conservation Trust, Great White House, Kleinbaai, Gansbaai, South Africa, **2** Department of Zoology, University of Cape Town, Rondebosch, South Africa, **3** Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Hatfield, South Africa



<http://warnercnr.colostate.edu/~gwhite/>



Program MARK

You can obtain context-sensitive help with the F1 key,
and can investigate objects with the Shift-F1 key.
See the Help menu for known problems.

Photo by Mat Lavine

<http://www.phidot.org/software/mark/>

Package 'secr'

April 3, 2014

Type Package

Title Spatially explicit capture-recapture

Version 2.8.1

Depends R (>= 3.0.0)

Imports abind, MASS, utils, parallel, nlme, sp

Suggests maptools, spsurvey, rgdal, rgeos, raster

Date 2014-04-03

Author Murray Efford

Maintainer Murray Efford <murray.efford@otago.ac.nz>

Description Functions to estimate the density and size of a spatially distributed animal population sampled with an array of passive detectors, such as traps, or by searching polygons or transects. Models incorporating distance-dependent detection are fitted by maximizing the likelihood. Tools are included for data manipulation and model selection.

License GPL (>= 2)

LazyData yes

LazyDataCompression xz

URL http://www.otago.ac.nz/density

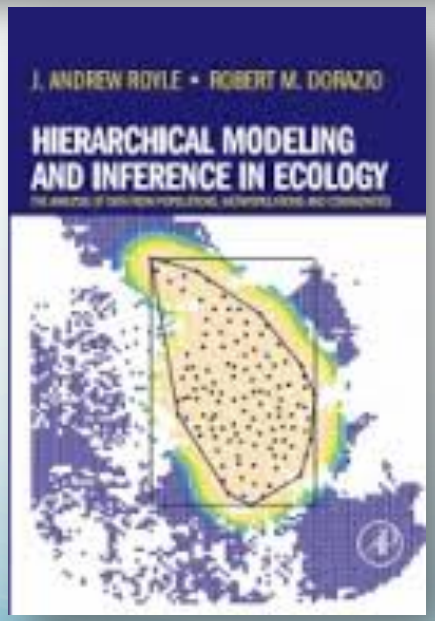
USGS
Patuxent Wildlife Research Center

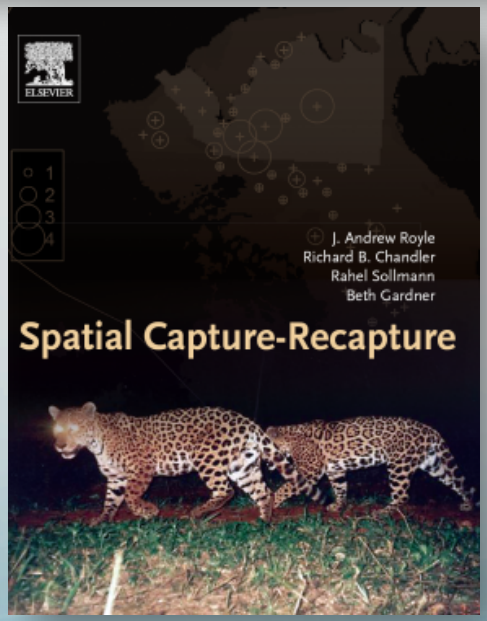
Ecology, 90(11), 2009, pp. 3233–3244

Bayesian inference in camera trapping studies for a of spatial capture–recapture models

J. Andrew Royle,[1,3] K. Ullas Karanth,[2] Arjun M. Gopalaswamy,[2] and N. Samba Kumar[2]

[1]*U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland 20708 USA*
[2]*Wildlife Conservation Society-India Program, Centre for Wildlife Studies, Bangalore, Karnataka-560042, India*





<http://www.pwrc.usgs.gov/staff/profiles/documents/royle.htm>

Biological Conservation 159 (2013) 109–118

Contents lists available at SciVerse ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Estimating jaguar densities with camera traps: Problems with current designs and recommendations for future studies

Mathias W. Tobler[a,*], George V.N. Powell[b]

[a] San Diego Zoo Global, Institute for Conservation Research, 15600 San Pasqual Valley Road, Escondido, CA 92027-7000, USA
[b] World Wildlife Fund Conservation Science Program, 1250 24th Street, NW, Washington, DC 20037, USA

Murray Efford
Western Black Bear Workshop
Coeur d'Alene ID May 2012

Summary: What is SECR good for?

	Software* DENSITY	secr
Estimating population density without edge effects	●	●
Testing survey designs	●	●
Estimating population size in a defined region		●
Relating density to habitat, time etc.		●

All difficult or impossible with non-spatial methods

* see Appendix of secr-overview.pdf for detailed comparison

<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>

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Coeur d'Alene ID May 2012

4. What are the limitations of SECR?

- Computationally intensive
- It's still capture-recapture
  - Good to have plenty of data
  - Poor model selection may or may not lead to bias
  - Too many models to choose from
- Under development
  - Overdispersion estimation and goodness-of-fit tests
  - Semi-parametric surfaces
  - Open-population and mixed-data methods
  - Documentation of robustness (transients and elongated home ranges – effects not usually severe)

<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>

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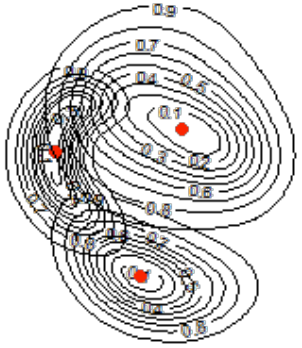
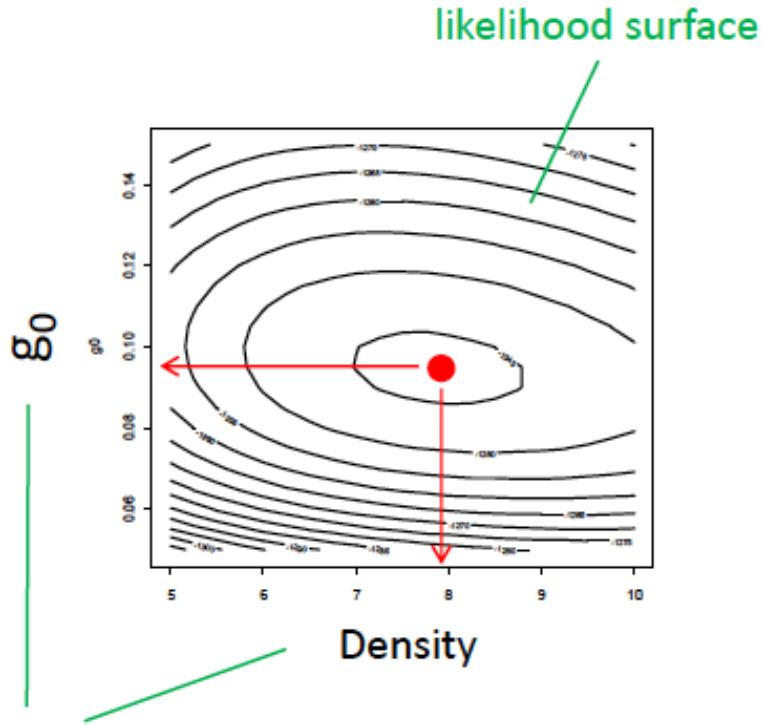


Maximum-likelihood estimation

- Likelihood can be calculated from data for given parameter values
- Maximum likelihood corresponds to 'best' parameter estimates
- Use numerical (computer) methods* to find maximum, given some starting values



g_0 and Density are model parameters

* alternative algorithms: Newton-Raphson, Nelder-Mead, BFGS

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Possible terms in the detection model

only with full likelihood

Term	Description	Notes
g	group factor	interaction of the capthist individual covariates listed in argument 'groups'
t	time factor	one level for each occasion
T	time trend	linear trend over occasions on link scale
b, bk	learned response	step change in real parameter after first detection of animal (bk site-specific)
B, Bk	transient response	real parameter depends on detection at previous occasion (Markovian response)
session	session factor	one level for each session
h2	2-class mixture	finite mixture model with 2 latent classes

These are available automatically; others may be supplied as covariates

<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>

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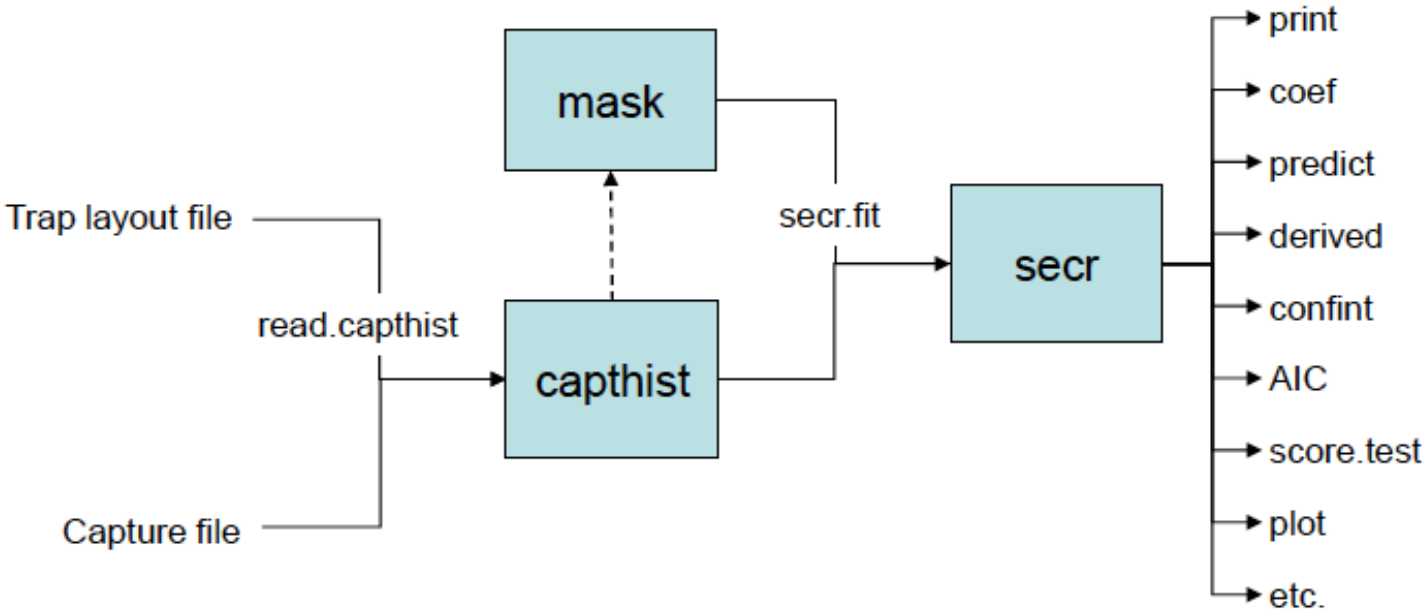
secr.fit() returns an 'secr' object



<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>

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print.secr makes a readable summary

call

```
secr.fit( capthist = stoatCH, buffer = 1000, detectfn = 0 )
secr 1.4.0, 16:35:36 03 May 2010
```

data

```
Detector type       multi
Detector number     94
Average spacing     250 m
x-range             -1500 1500 m
y-range             -1500 1500 m
N animals        :  20
N detections     :  30
N occasions      :  7
Mask area        :  2500 ha
```

model

```
Model            :  D~1 g0~1 sigma~1
Fixed (real)     :  none
Detection fn     :  halfnormal
Distribution     :  poisson
N parameters     :  3
Log likelihood   :  -144.0016
AIC              :  294.0033
AICc             :  295.5033
```

coefficients (on link scale)

```
Beta parameters (coefficients)
           beta   SE.beta       lcl       ucl
D     -3.800341 0.2865730 -4.362014 -3.238668
g0    -2.913927 0.4445352 -3.785200 -2.042654
sigma  5.552586 0.1721433  5.215191  5.889981

Variance-covariance matrix of beta parameters
                D         g0        sigma
D      0.082124067 -0.04108776 -0.007142058
g0    -0.041087764  0.19761153 -0.054651267
sigma -0.007142058 -0.05465127  0.029633332
```

'real' parameters

```
Fitted (real) parameters evaluated at base levels of covariates
       link     estimate  SE.estimate         lcl         ucl
D       log   0.02236315   0.006542529   0.01275268   0.03921609
g0    logit   0.05146938   0.021702884   0.02220026   0.11479676
sigma   log 257.90358775 44.727329279 184.04698278 361.39826673
```

Estimated density animals / hectare

<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>

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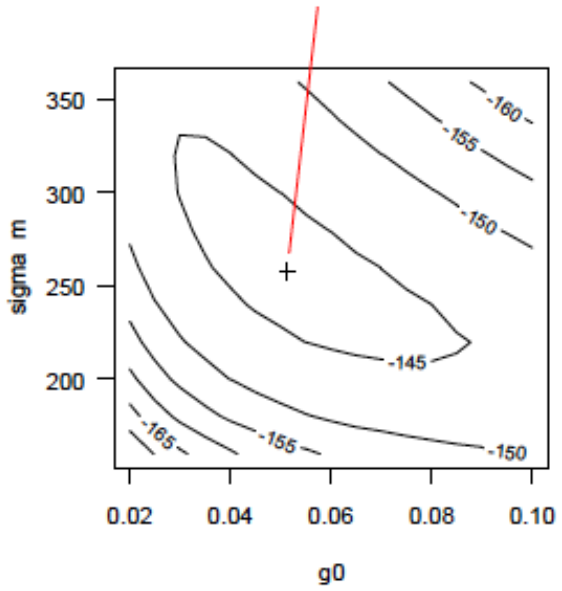
model

```
Model             :  D~1 g0~1 sigma~1
Fixed (real)      :  none
Detection fn      :  halfnormal
Distribution      :  poisson
N parameters      :  3
Log likelihood    :  -144.0016
AIC               :  294.0033
AICc              :  295.5033
```

Poisson vs binomial *n*

maximum




```
LLsurface.secr (stoat.model.HN, c("g0", "sigma"),
  xval = seq(0.02,0.10,0.005), yval = seq(160,360,20))
```

D held constant at ML estimate

<http://fishandgame.idaho.gov/public/wildlife/workshops/blackBear/Efford.pdf>


E PRA QUE É QUE SERVE ISSO?
NÃO SABEMOS, NÓS FAZEMOS PESQUISA BÁSICA.
MUITO BONITO! NÓS AQUI NOS MATANDO DE ROLAR PEDRAS PESADAS E DE ARRASTAR ANIMAIS POR AÍ E VOCÊS BRINCANDO DE INVENTAR COISAS INÚTEIS!
TROPEK 2011