Stranding networks:

10 ans de mise en œuvre du règlement CE 812/2004 : Est-il l'outil le plus efficace pour estimer les captures accidentelles de petits cétacés dans les pêcheries européennes ?

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Introduction

Cetacean conservation status

- All cetacean species are protected by various national and international legislation and agreements

- Conservation status must be provided :

Estimation of the extinction risk based on abundance estimations, distribution, health status, threats and pressures... (IUCN)

- Because of their protection status and their habitat, data and mostly biological samples are very hard and expensive to collect

Complexity in estimating conservation status

Interactions with fisheries

- Death in fishing gears is the main cause of death in European waters for small cetaceans (Kirkwood et al. 1997; Read et al. 2006; Rogan & Mackey 2007; Leeney et al. 2008; Murphy et al. 2009; Reeves et al. 2013; Prado et al., 2013)

- Since 1983 in EU: the Common Fisheries Policy

- Since 1990's, cetacean strong mortality events along French coasts (Van Canneyt, 2002)

- Tools available for evaluating cetacean bycatch:
  - Dedicated observers on fishing vessels (EU 812/2004 regulation)
  - Analyse of stranded carcasses

Complementary or differing tools?

Objectives

- Highlight relevant parameters estimated from each strategies
- In case of diverging estimations, what are consequences for cetacean conservation?

Case study : The Common Dolphin

Delphinus delphis

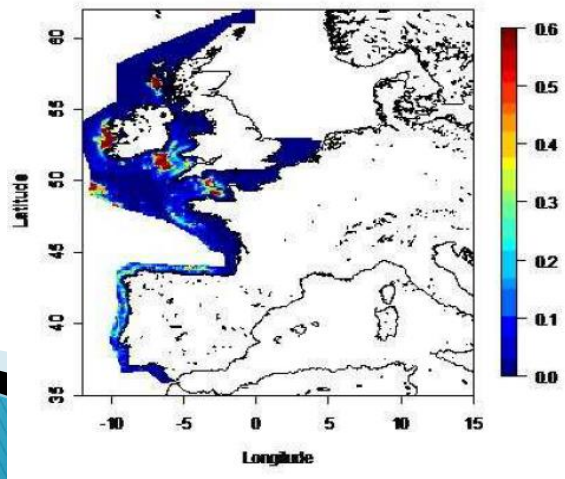
- Most abundant species in French and British waters (sightings and strandings) (McLeod et al. 2003; Kiszka et al. 2007; Certain et al. 2008; Leeney et al. 2008; Van Canneyt et al. 2010)

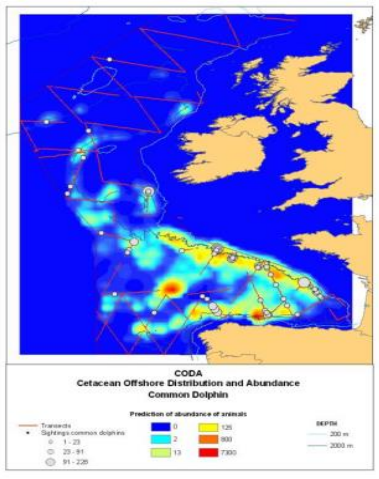
- SCANS-2 and CODA estimations:

-63,000 dolphins (CV=0,46) in coastal European waters (Hammond 2006)

-118,000 (CV=0,38) in offshore waters(CODA final report 2009)

- Incidental catches are the predominant cause of death (Kuiken et al. 1994; Kirkwood et al. 1997; Northridge et al. 2006, 2007; Rogan & Mackey 2007; Leeney et al. 2008; Murphy et al. 2009; Morizur et al. 2011)





THE EU 812/2004 REGULATION

Delicate historical context…

- Closing of drift-net fishery in Bay of Biscay in 2002:
  - High numbers of bycaught animals
  - Low selectivity
  - Fishery observation survey 1992-1993: 40% of fishing effort observed
  - Sudden and poorly understood closing of the fishery

Deterioration of scientist-fishermen relationships

The EU 812/2004 Regulation

- Under Common Fisheries Policy

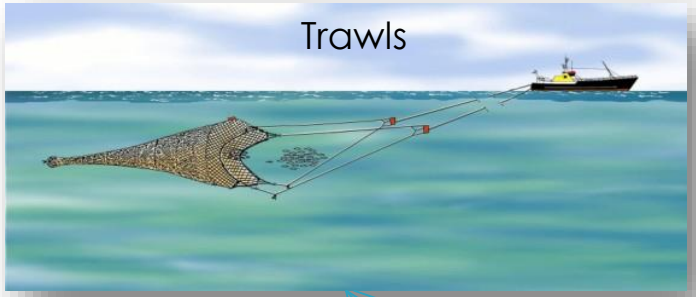
- Acoustical repellent devices on fishing gears known for high cetacean bycatch levels
(ex: nets in the Channel)

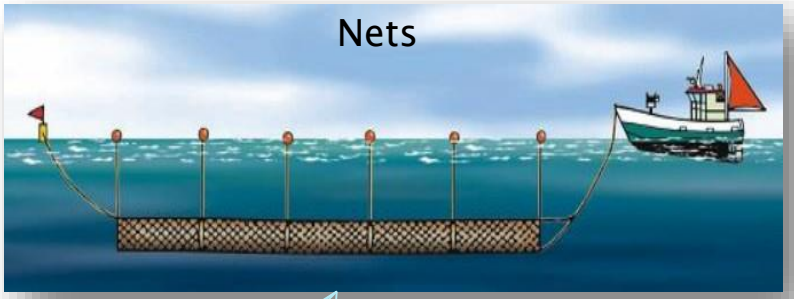
- Dedicated observers on 5-10% of >15 meters fishing vessels

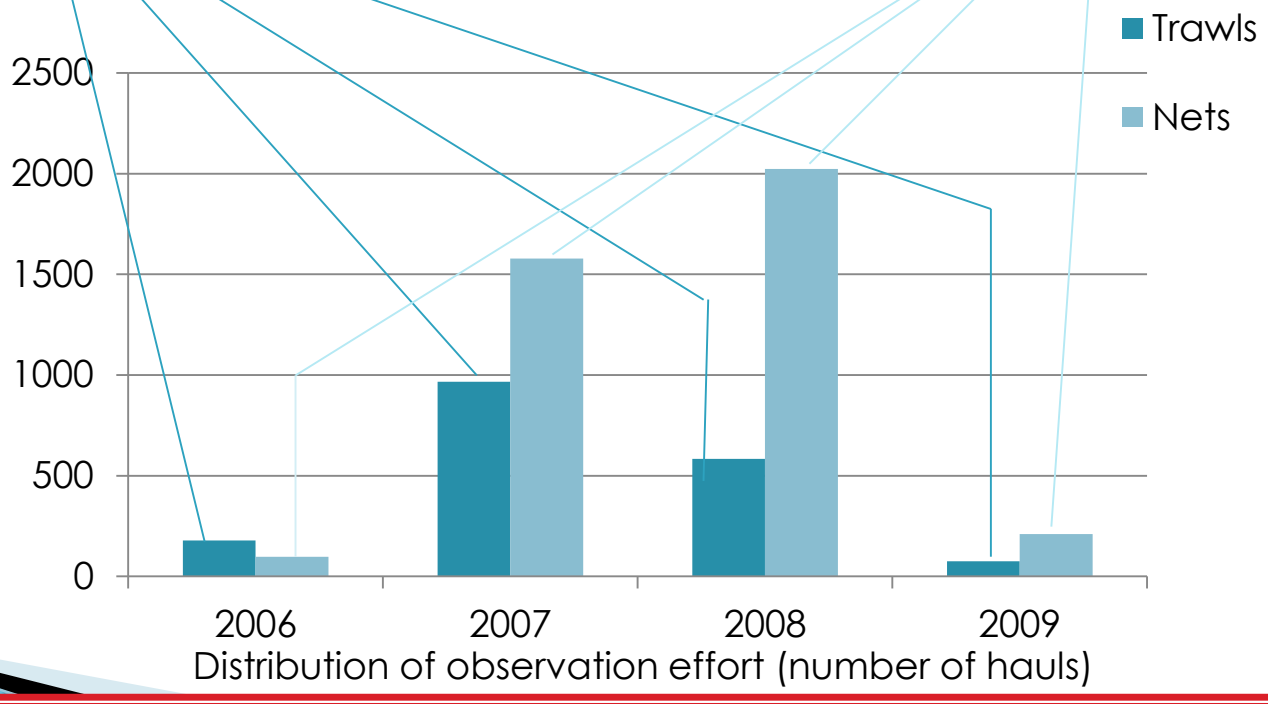
- In France: OBSMAM then OBSMER programs in charge of bycatch estimations (IFREMER)

The OBSMAM Program

2 main fishing gears





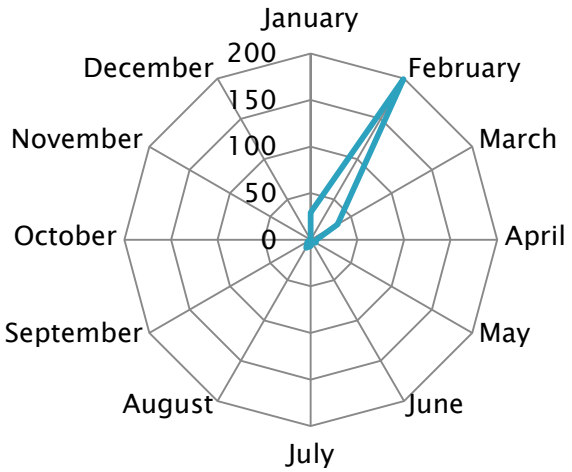


Heterogeneity in observation effort, lack of recent years

The OBSMAM Program

The case of common dolphins
Delphinus delphis

- 68% of bycaught marine mammals
- 88% of bycaught common dolphins in seabass fisheries (pelagic trawls)
- Strong seasonality
- Mostly females (64.7%)
- Mostly immature (62.3%)



Monthly distribution of bycaught common dolphins (n)

Specificity of the interaction with fishing gears

The OBSMAM Program

Common dolphin bycatch estimations

- Correction of bycatch numbers by total fishing effort

Year	2007	2008	2009	2010
Bycatch estimation	(Fr) 240 + (UK)0	(Fr) 400 + (UK) 0	(Fr)1000 + (UK) 260	(Fr) 12 + (UK)287

IFREMER

The OBSMAM Program

Limitations…

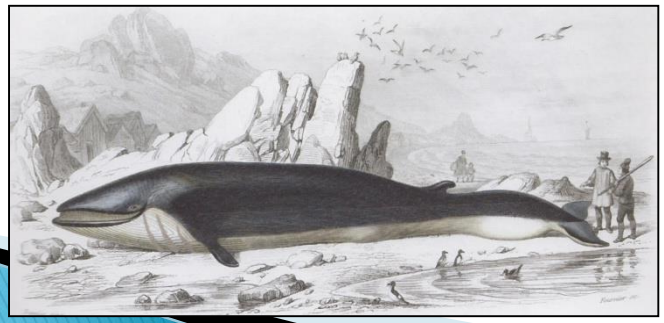
- Dedicated observers on 5-10% of >15m fishing vessels: in France, **around 80% of <15m vessels**
- Spatial and temporal heterogeneity of sampling effort (according to fishermen willing…)
- Administrative complexity for taking observers on board
- No observers on Spanish and Danish vessels in Bay of Biscay (32% of catch selling value)
- Total fishing effort not available for bycatch estimations

Need in complementary strategies

The use of Stranding Data

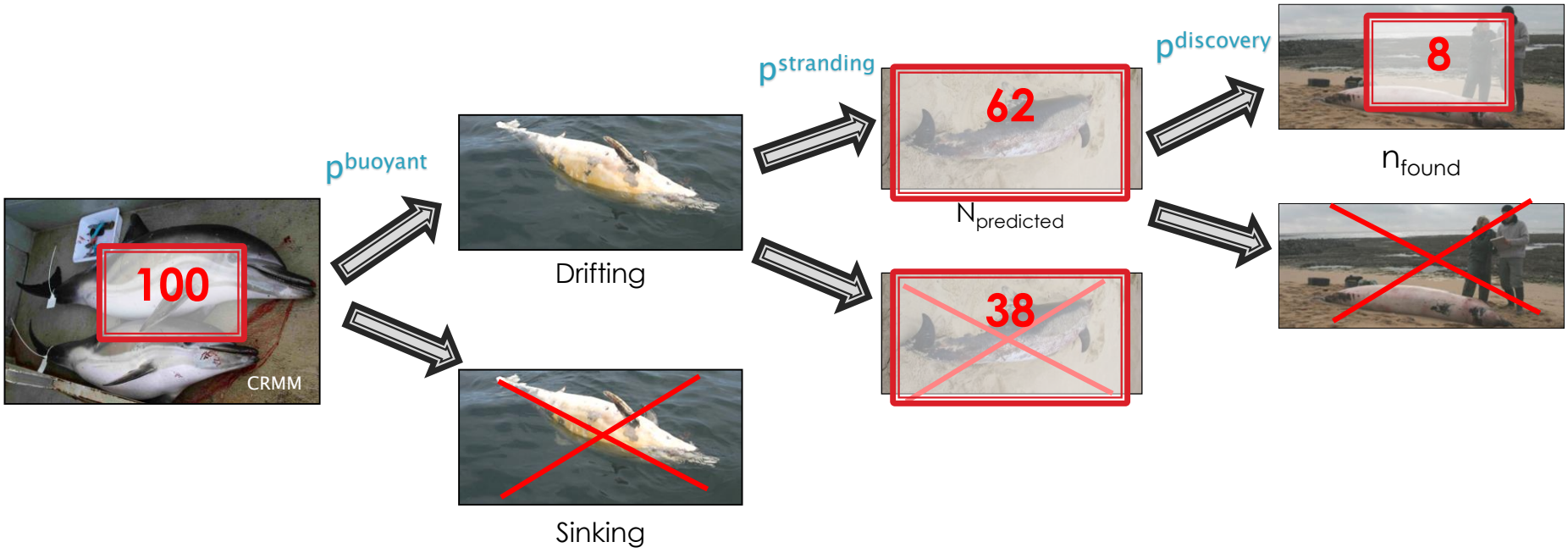
The use of strandings as source of population Indicators

- Discovery of cetaceans and their natural history since centuries thanks to strandings (Hunter and Banks, 1787; Le Clerc de Buffon & Sonnini, 1804; Cuvier, 1836)
- Today: most important source of biological samples (Kirkwood et al. 1997; Geraci et al. 1999; Jepson et al. 1999; Wilkinson & Worthy 1999; Evans & Hammond 2004; Lahaye et al. 2005; McFee et al. 2006; Spitz et al. 2006; Hall et al. 2010; Tollit et al. 2010; Norman et al. 2011)
- Good indicators of specific richness, relative abundance(Maldini et al., 2005; Pyenson 2010, 2011)
- Wide spatial and temporal range
- But their use is limited by the lack of sampling strategy



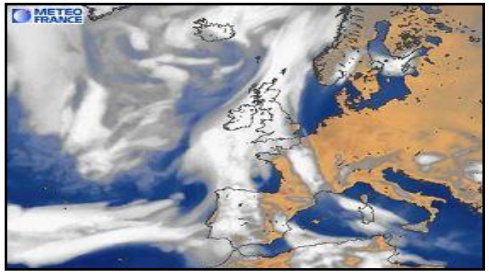
Charles d'Orbigny, 1841

The use of strandings as source of population Indicators



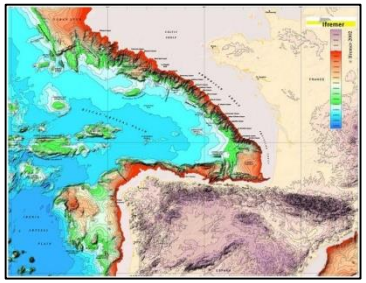
$$n_{found} \sim \text{Binomial}\ (N_{predicted},\ p^{buoyant}\ ,p^{discovery}\ )$$

The drift model MOTHY

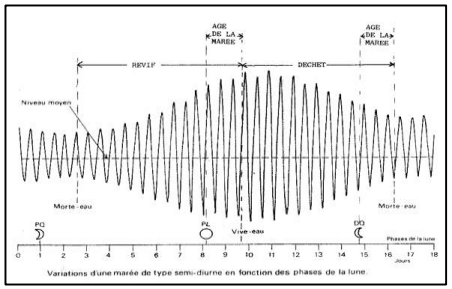


-Atmospheric model calibrated by observations

-Provided by European Center for Medium-Range Weather Forecasts



Bathymetry provided by SHOM



-Hydrodynamic tidal model

-Water velocity : coupling 2D hydrodynamic model and 1D eddy viscosity model

MOTHY

Based on Saint-Venant equations:

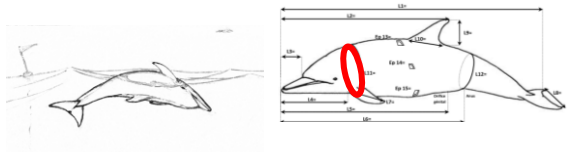
$$\frac{\partial \vec{q}}{\partial t} + \vec{q}\nabla\vec{q} + f\vec{k}\Lambda\vec{q} = -g\vec{\nabla}\eta - \frac{1}{\rho}\vec{\nabla}P_a + \frac{1}{\rho H} \times (\vec{\tau}_s - \vec{\tau}_b) + A\nabla^2\vec{q} \qquad (1)$$

$$\frac{\partial \eta}{\partial t} + \nabla(H\vec{q}) = 0$$

where t denotes time, q the depth-integrated current, η the sea surface elevation, H the total water depth, f the Coriolis parameter, k a unit vector in the vertical, P_a the atmospheric surface pressure, τ_s the surface wind stress, τ_b the bottom frictional stress, ρ the density of water, g the gravitational acceleration, A the horizontal diffusion coefficient (2000 m^2/s).

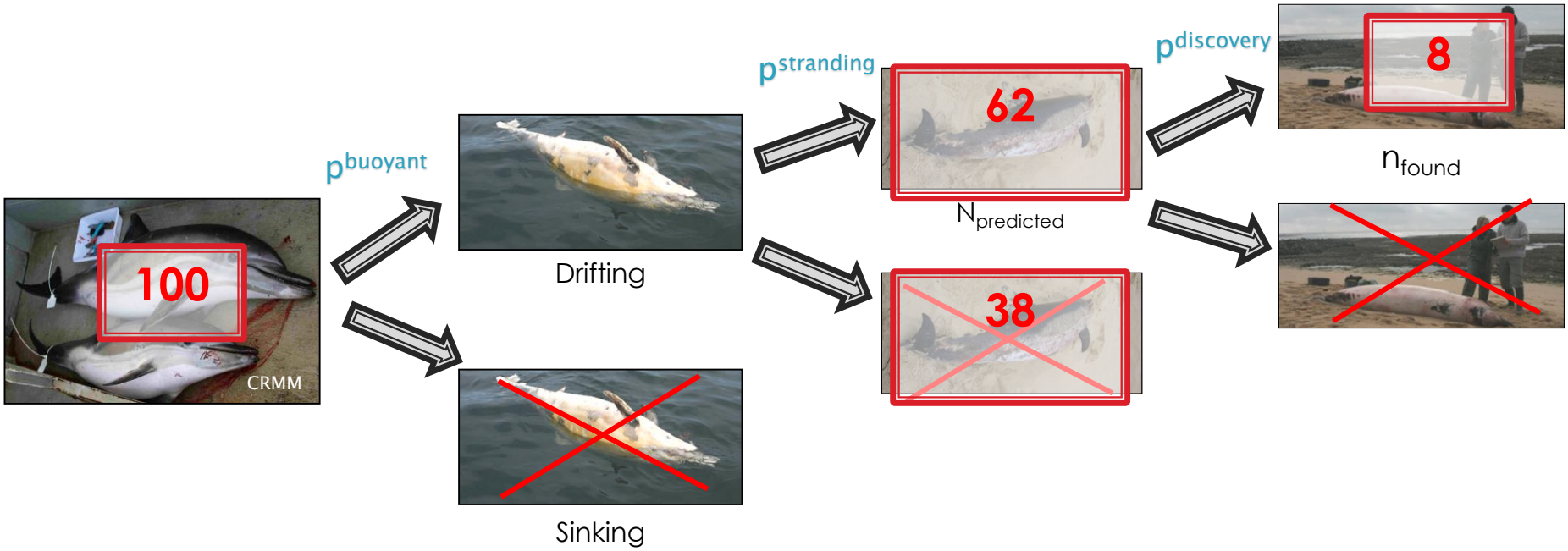
Parameters needed:

-Thickness (estimated from cetacean circumference measured on stranded animals)
-Date of drift beginning
-Drift duration
-Immersion rate



Daniel et al., 2002

The use of strandings as source of population Indicators



$$n_{found} \sim \text{Binomial}(N_{predicted}, p^{buoyant}, p^{discovery})$$

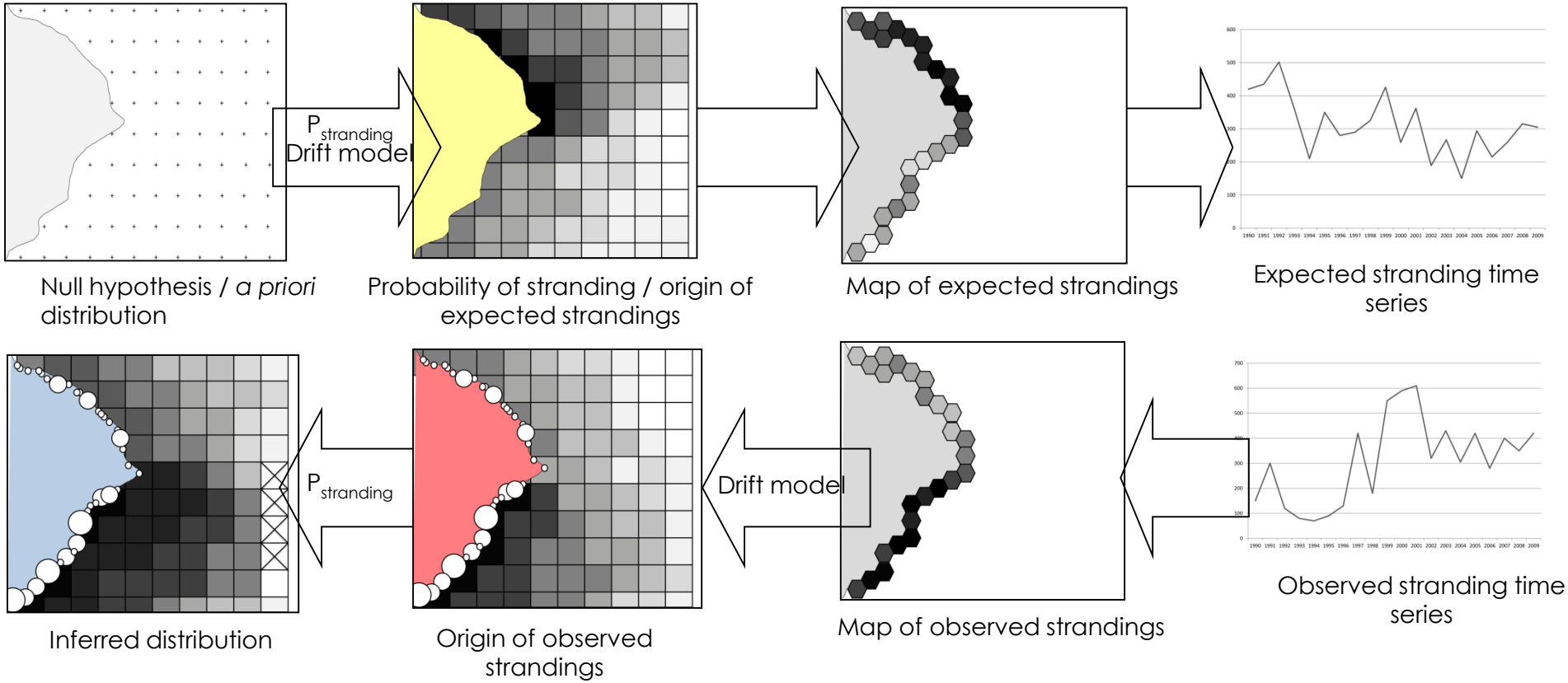
$P^{discovery} \sim \text{Beta}(36,3.71)$ and 95% CI [0.800-0.975]

The use of strandings as source of population Indicators

- Use of « add 2 successes and 2 failures » rule and following model implemented in WinBUGS v1.4.3 :

$$\begin{cases} (n_{found}+2) \sim Binomial(N_{predicted}+4, p^{buoyant}\, p^{discovery}) \\ p^{discovery} \sim Beta(36,3.71) \\ p^{buoyant} \sim Beta(1,1) \end{cases}$$

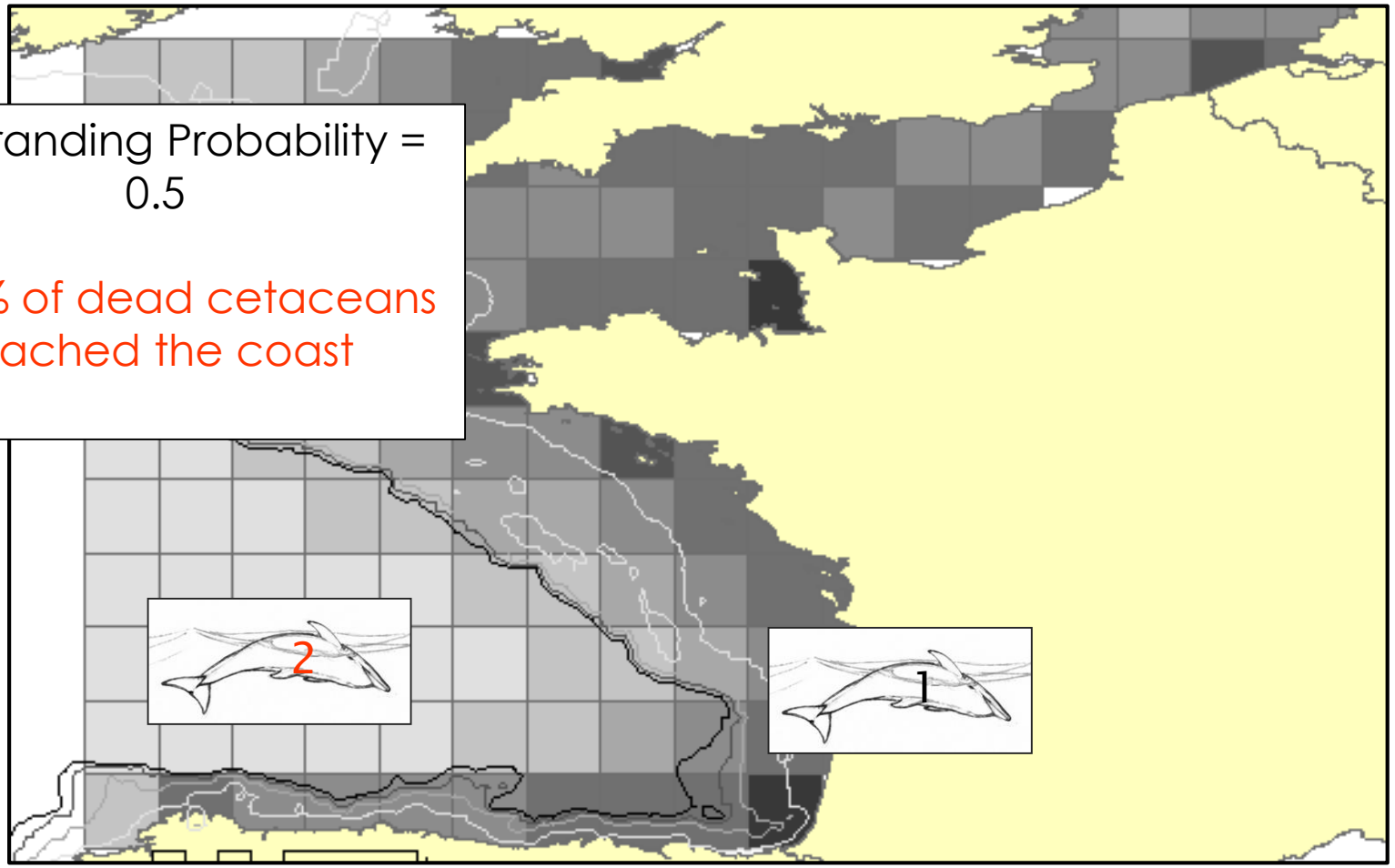
$p^{buoyant}$ = 17.91% [9.28%; 28.81%]

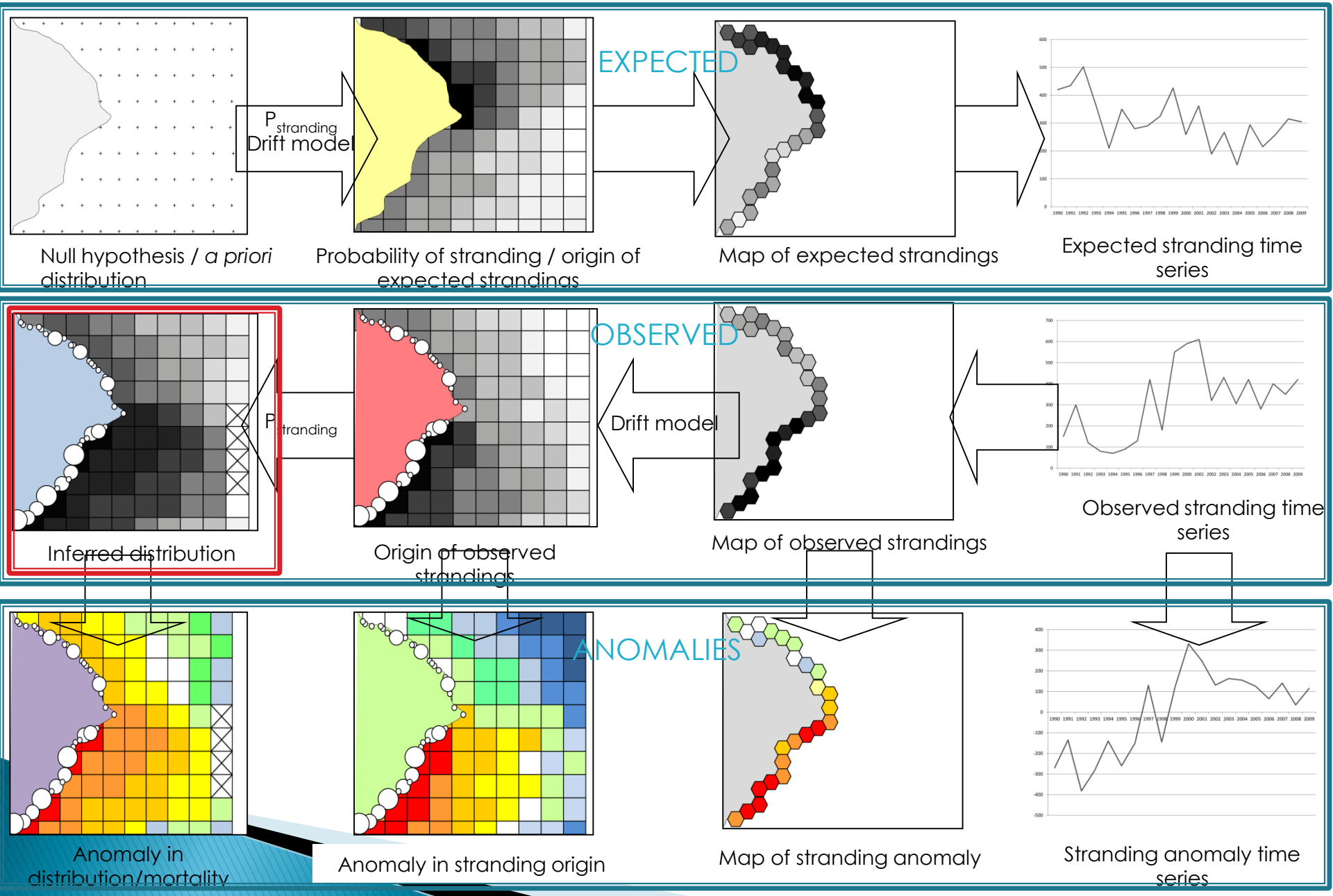

P stranding
Drift model
Null hypothesis / *a priori* distribution
Probability of stranding / origin of expected strandings
Map of expected strandings
Expected stranding time series
Inferred distribution
P stranding
Origin of observed strandings
Drift model
Map of observed strandings
Observed stranding time series

Construction of the Indicator

Ex: Stranding Probability = 0.5

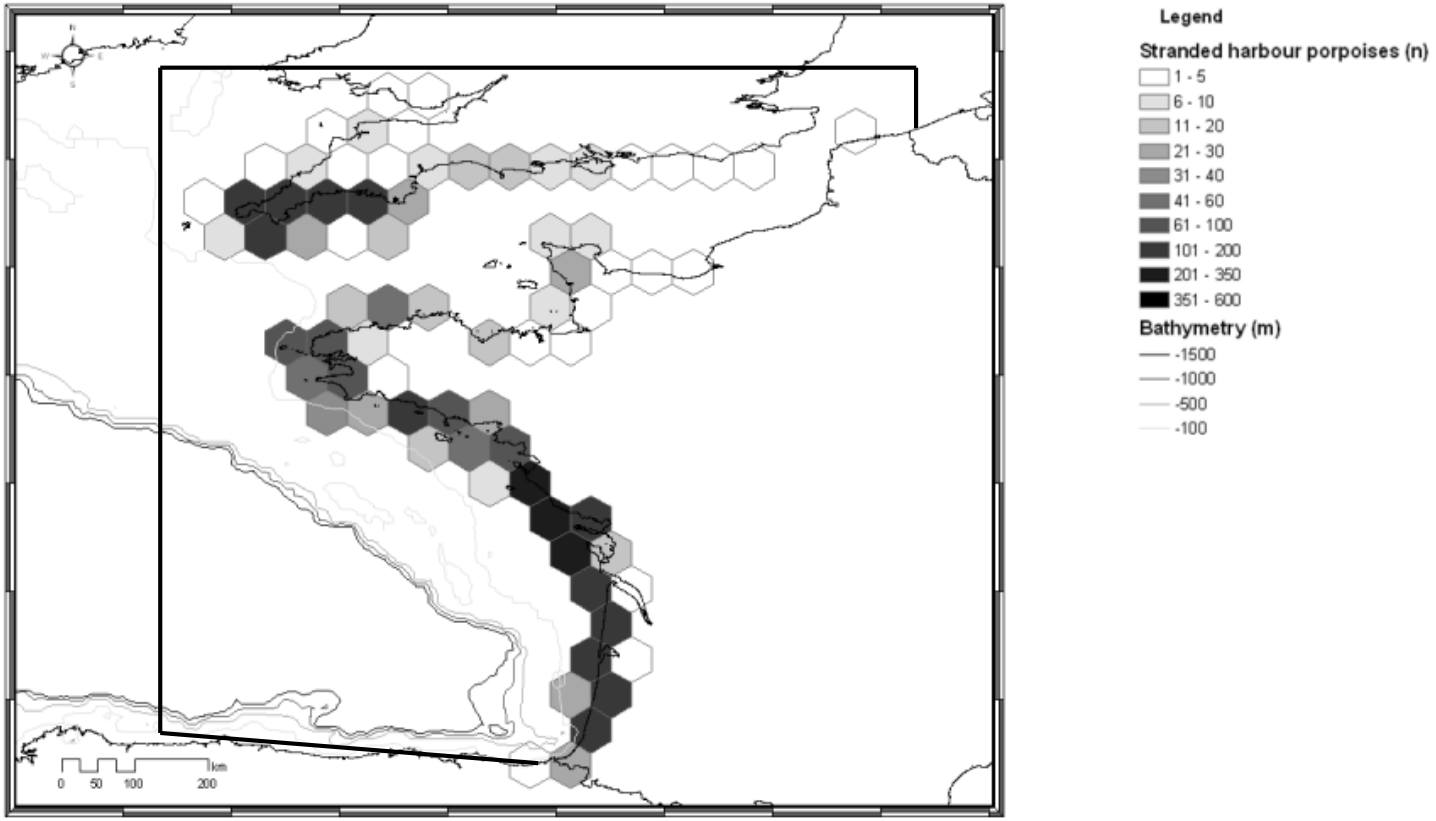
=>50% of dead cetaceans reached the coast




EXPECTED
P stranding
Drift model
Null hypothesis / *a priori* distribution
Probability of stranding / origin of expected strandings
Map of expected strandings
Expected stranding time series
OBSERVED
P stranding
Drift model
Inferred distribution
Origin of observed strandings
Map of observed strandings
Observed stranding time series
ANOMALIES
Anomaly in distribution/mortality
Anomaly in stranding origin
Map of stranding anomaly
Stranding anomaly time series

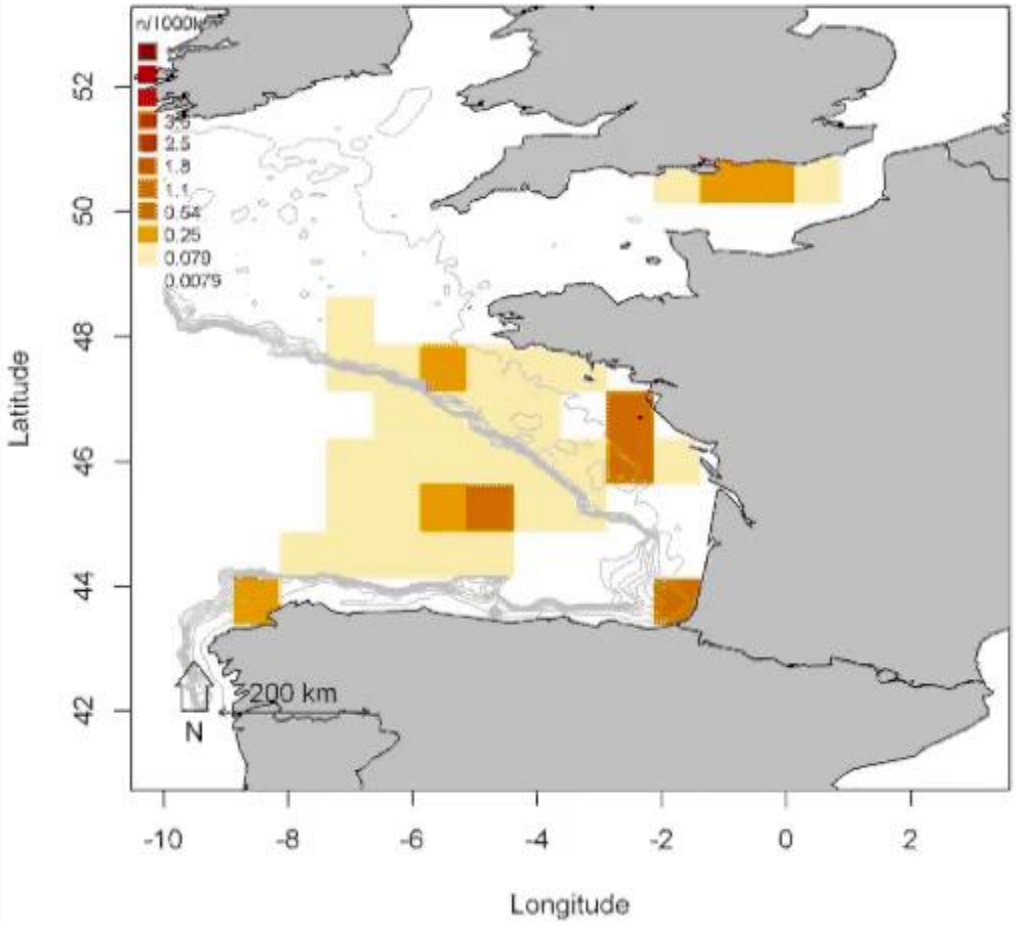
The Common Dolphin

A total of 6,182 common dolphin strandings were collected between 1990 and 2009 by stranding networks from United Kingdom and France.



Results

Dead dolphin distribution inferred from strandings during multiple stranding events

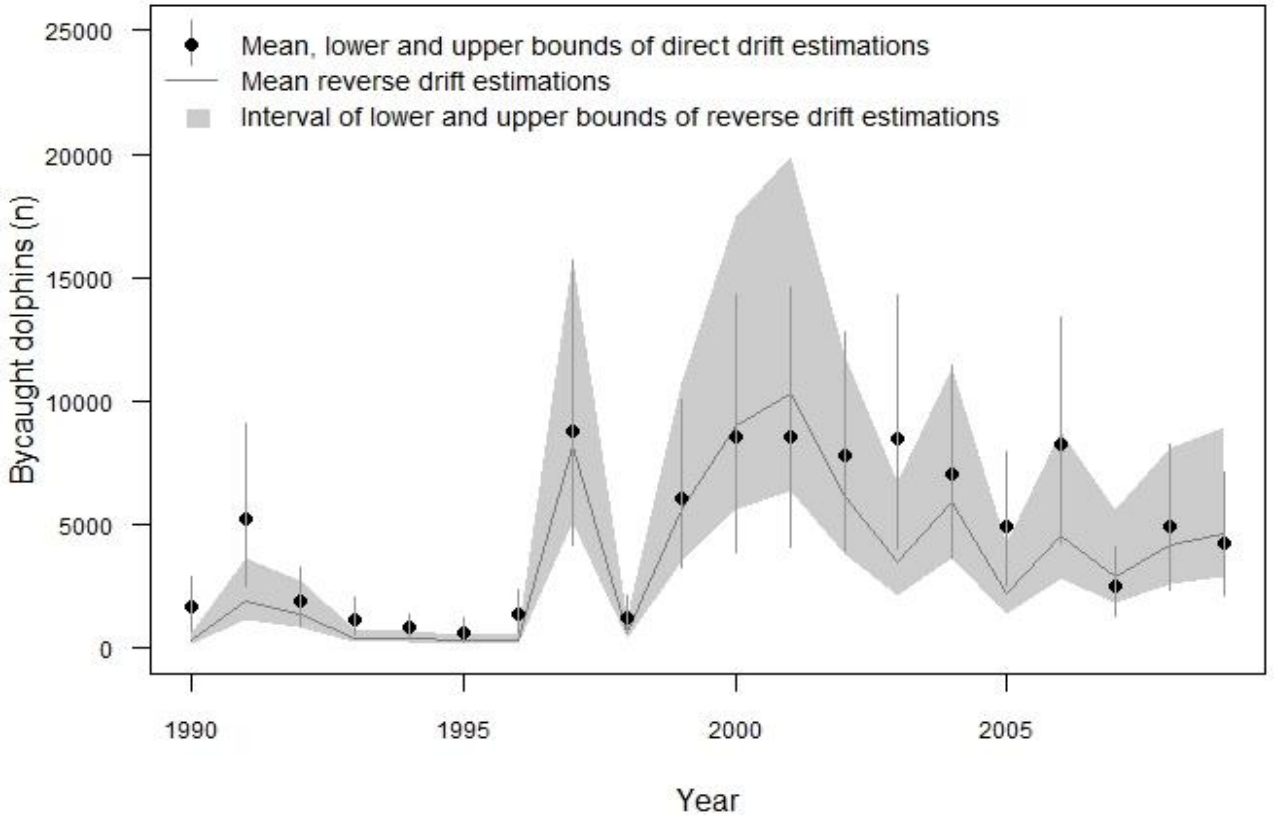


Bycatch estimations

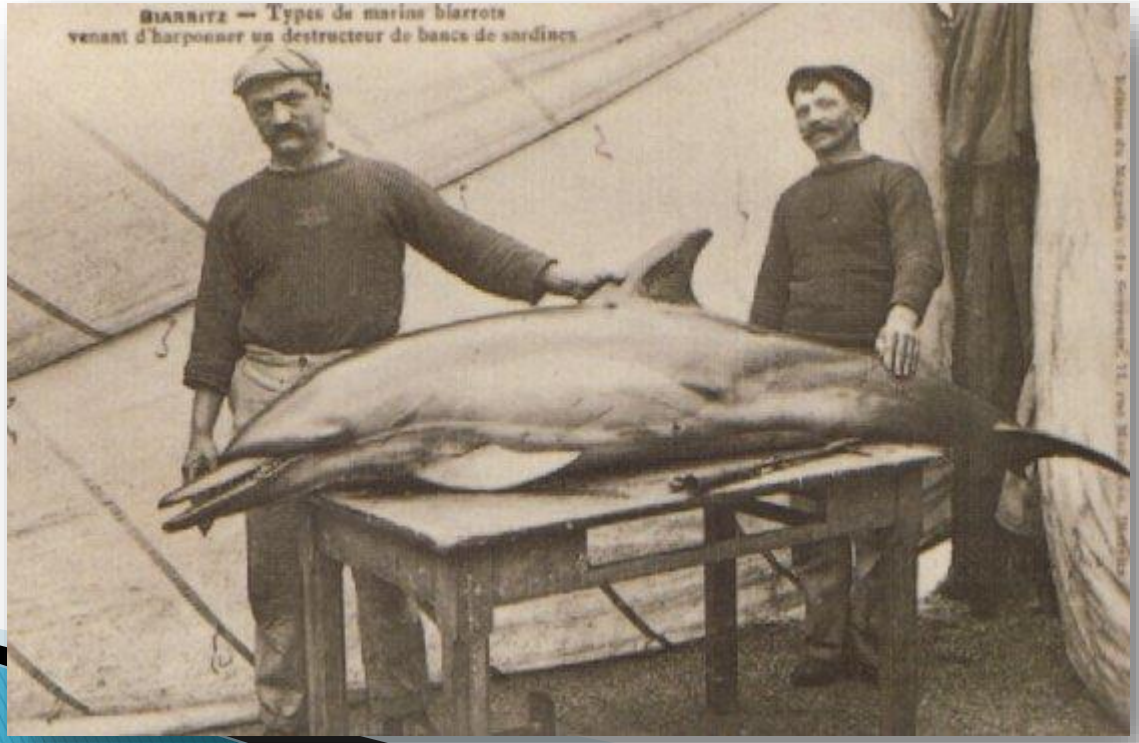
- **Estimations based on direct drift modelling**, presented by Matthieu Authier in Montpellier (provide measures of uncertainties, attractive way to deal with 0 but not spatialized). They constitute the plausible upper bound of estimations.

- **Estimations based on reverse drift modelling**: Annual sum of bycaught dolphins at sea, corrected by $p^{buoyant}$(spatialized method, but do not consider areas far from the coasts and cannot generate measures of uncertainty). They consitute the plausible lower bound of estimations.

Bycatch estimations



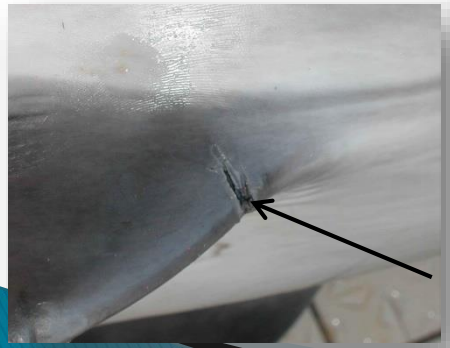
Discussion


BIARRITZ — Types de marins biarrots
venant d'harponner un destructeur de bancs de sardines

Bycatch estimations from strandings

Limitations…

- Cause of death determination depend on decomposition status
- Estimation of drift duration
- Drift model limitations
- How to deal with 0?
- Measures of uncertainty
- Finally both approaches must be considered as bounds of the interval of bycatch estimations

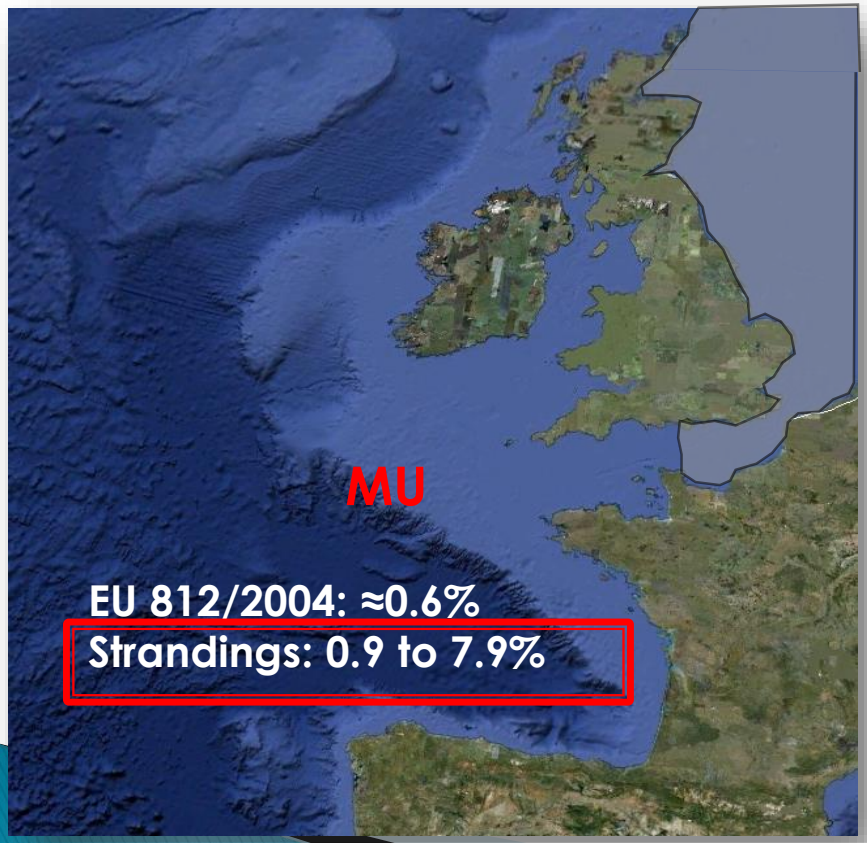


Complementary or differing tools?

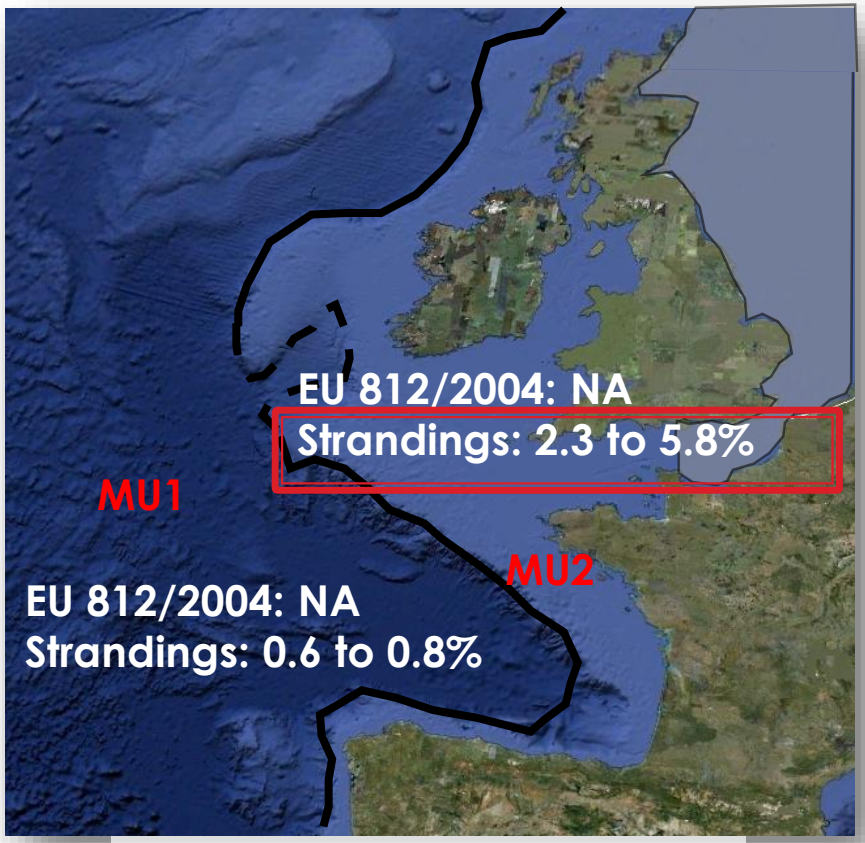
	EU 812/2004	Strandings
Specificity of interaction	Yes	No
Spatial scale	Administrative	Population
Reproducibility	Difficult	Yes
Long term time series	10 years	40 years
Sampling strategy	Difficult	In progress…
Biological samples	Yes	Yes
Estimations (mean)	≈400	≈4 000

Consequences for common dolphin conservation

- Estimation of mortality rate due to bycatch, using absolute abundance estimations : 182,000 common dolphins in European waters (Hammond, 2006, CODA final report, 2007)
- 1.7% of additional mortality is unsustainable for cetacean population



1 Management Unit



2 Management Units

Consequences for common dolphin conservation

- 1.7% of additional mortality is unsustainable for cetacean population
- Bycatch specificity: seabass fisheries using pelagic trawls in winter
- Mostly immature females: Worrying for long term population trends (Mannocci et al, 2012)

Conclusion and perspectives

- Complementary approaches for many parameters

- High differences in mortality rate estimations (sustainable vs critical).

- Choice of estimation can have terrible and irreversible conservation consequences for common dolphins

- And next?
  - Improve estimations based on strandings
  - Improve fishermen/scientist relationships (focus-groups, reduce administrative constraints for dedicated observers on board...)
  - Join both strategies for reporting by-catch estimations to EU

Thank you for your attention