Large scale habitat modelling in European waters – application to systematic and non-systematic surveys


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Contents

- Overview of habitat modelling

- Non-systematic heterogeneous survey
  - Example: ACCOBAMS Mediterranean Ziphius initiative

- Systematic homogeneous survey
  - Example: CODA-SCANSII-TNASS NE Atlantic surveys

- Challenges and usefulness….

Overview

Habitat Modelling incorporates data on the environment to generate a spatial prediction of relative or absolute density based on the preference for habitats defined by combinations of environmental covariates.

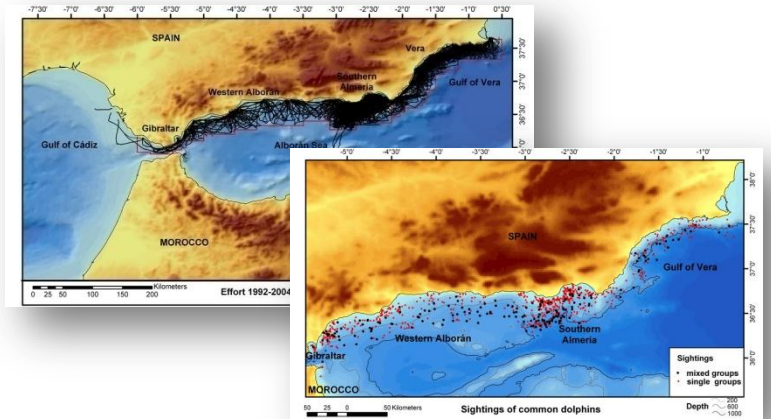Predicted abundance of single groups summer 1992 - 2004
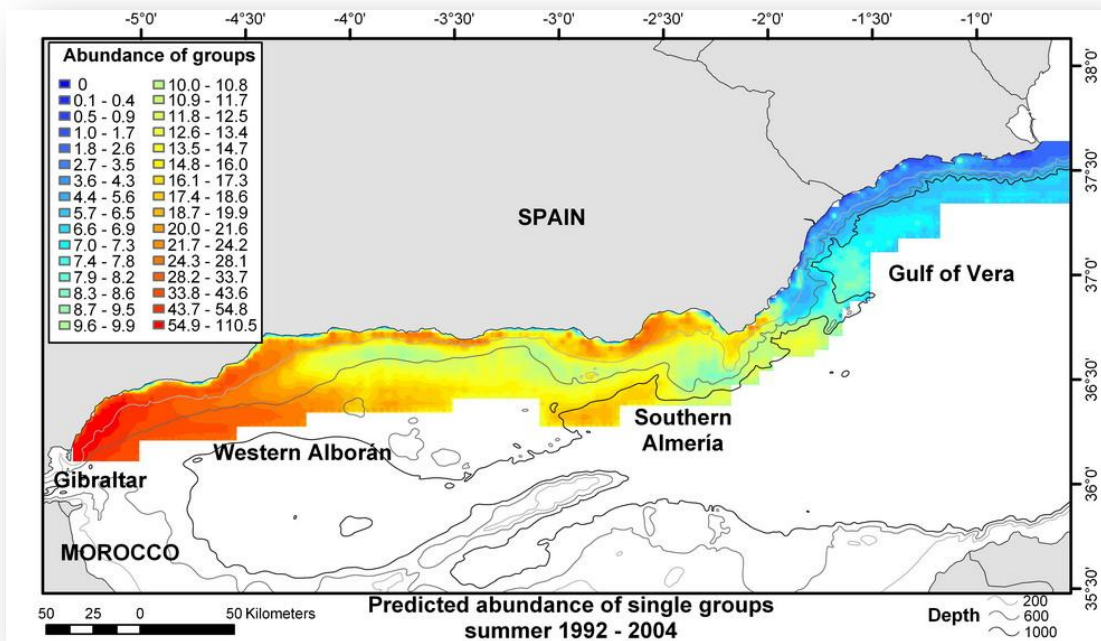
Provides the best description of distribution available, as informed by features of the environment shown to be important

Represents a great improvement over using simple measures of occurrence – e.g. distribution maps, encounter rates
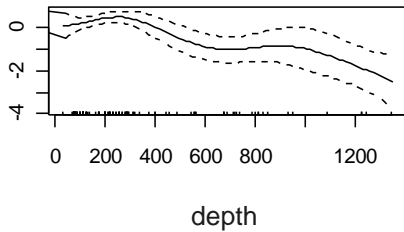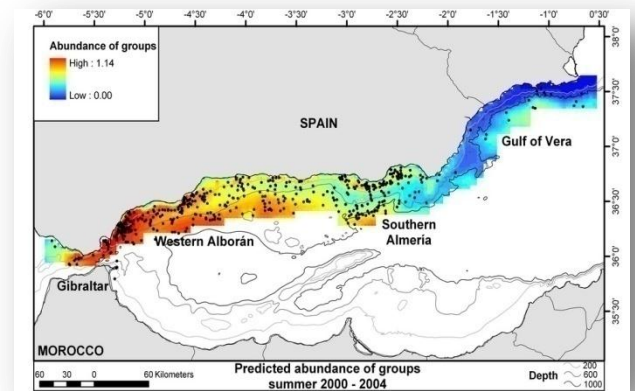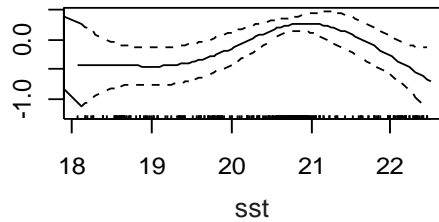
Overview
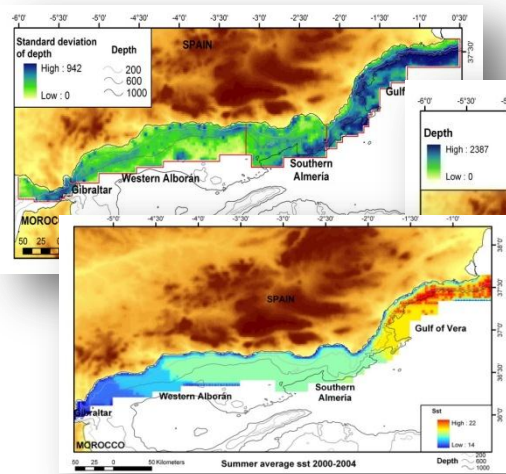
Features of the habitat

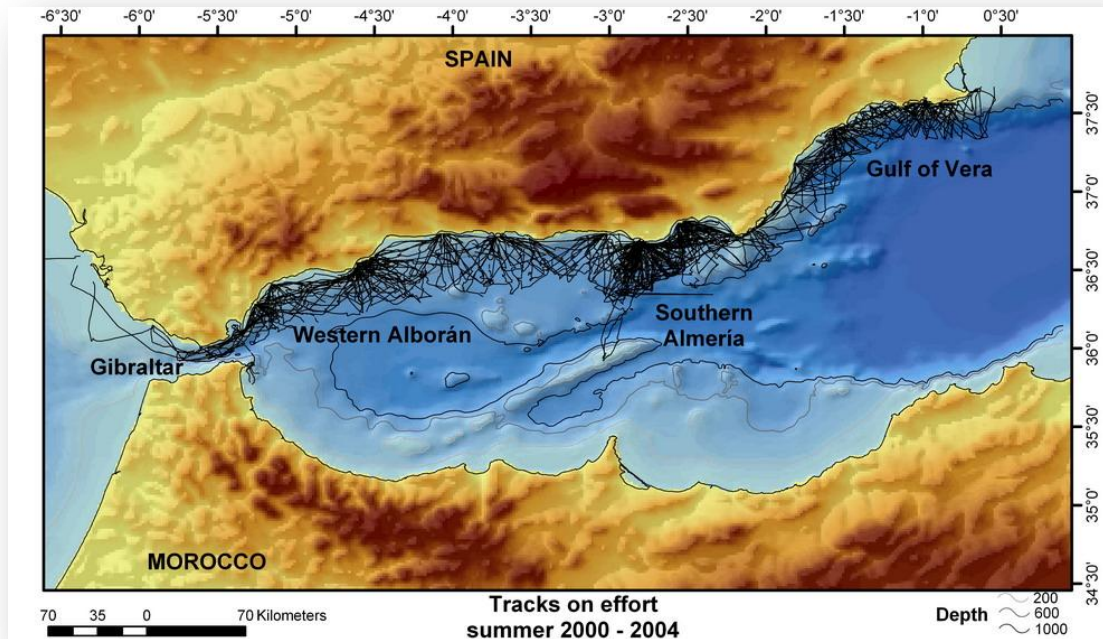Effort and sightings data

Species - habitat relationships

Spatial prediction of density

Overview

When habitat modelling is combined with line transect sampling (**model-based method**)

➡ alternative technique to conventional line transect sampling (**design-based method**) for abundance estimation

Tracks on effort summer 2000 - 2004

Overview

Response variables

Presence/absence

    In each segment/gridcell, were animals seen or not?

Counts

    In each segment/gridcell, number of groups (schools) of animals

    How large those groups are (school size)

    Relative to segment length – encounter rate

"Absolute" abundance

    Counts of groups corrected by probability of detection

        Using line transect (distance) sampling methods

"Hurdle" models

    Models with two (or more) stages

        E.g. first estimate abundance of groups, then estimate group size

        Then multiply predictions together

Overview

Error structure of response variables

Presence/absence (1 or 0)

    Errors structured according to Binomial distribution

    Data used to estimate the probability of presence

Counts (0, 1, 2, etc)

    Errors structured according to Poisson distribution …. (or Tweedie)

    Data used to estimate the expected number of events occurring in a given interval

Poisson distribution assumes events occur randomly

    Tendency for too many zero counts and too many high counts

    Over-dispersion: variance bigger than mean

    Use of quasi-poisson

Overview

Explanatory variables

Continuous (measured variables)

Most variables: lat, lon, depth, distance from shore, sst, etc

Factors (categorical variables)

Ordinal (can be ranked)

E.g. depth classes (shallow, deep, very deep)

Nominal (no intrinsic order)

E.g. habitat types (coastal, shelf, seamount, etc..)

Fixed (no temporal change)

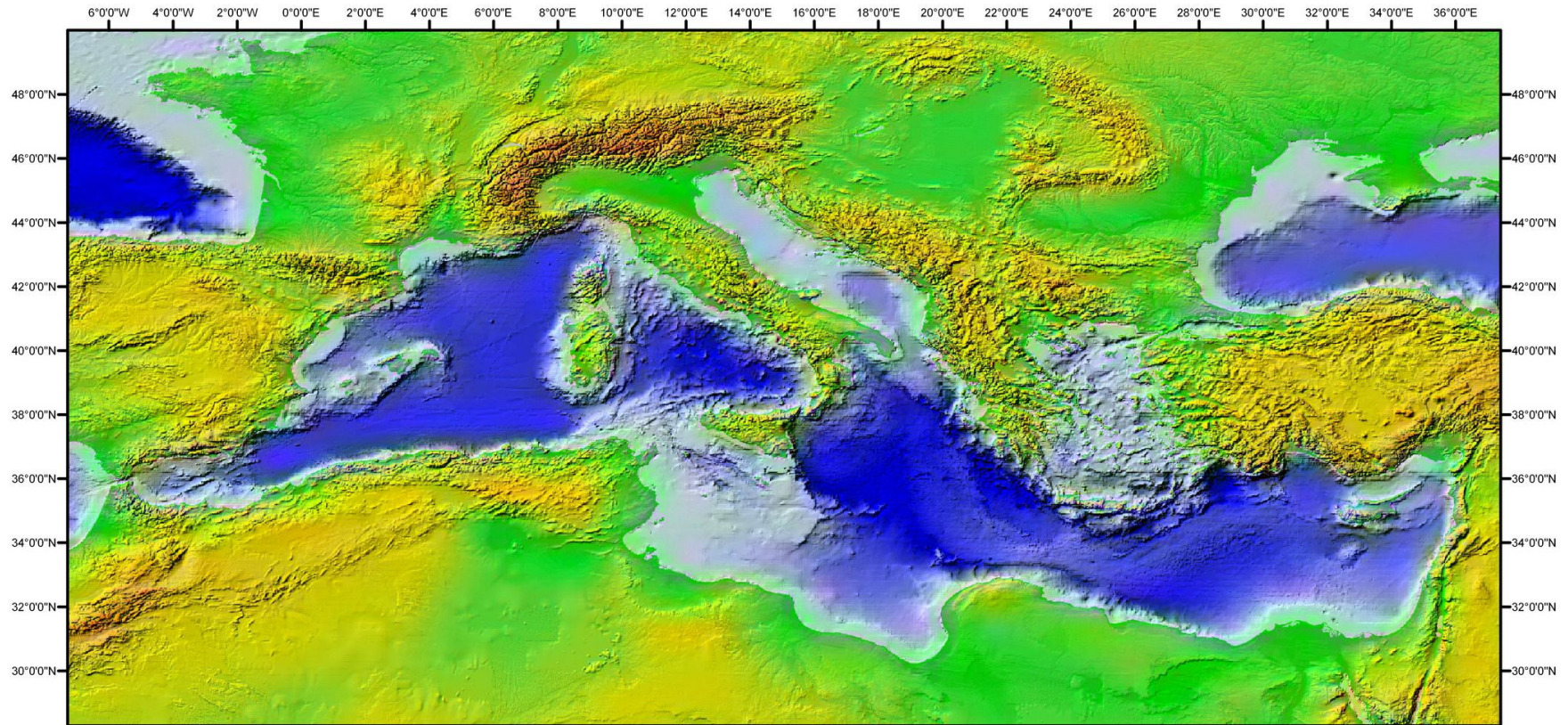lat, lon, depth, distance from shore, etc..

Dynamic (change with time)

Sst, chla, etc..

Non-systematic heterogeneous surveys

Example: ACCOBAMS Ziphius initiative (Mediterranean)

Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

- <u>Main objective</u>: Identify important areas to inform interested parties

- ACCOBAMS initiative
  - Man-made noise and mass strandings in the Mediterranean
  - Identifying main potential areas of distribution
  - Promoting collaboration

- Large temporal scale: 1990-2010

- Collaborative effort: 17 providers
  Tethys Research Institute, Pelagos Institute, GREC, CRC_Marineland, IFAW, Oceana, Barbara Mussi, U. of Valencia, SMRU, Spanish SGPM, SEC-ANSE, Alnitak, Marina Pulcini, CNRS, NURC, WHOI, ISPRA
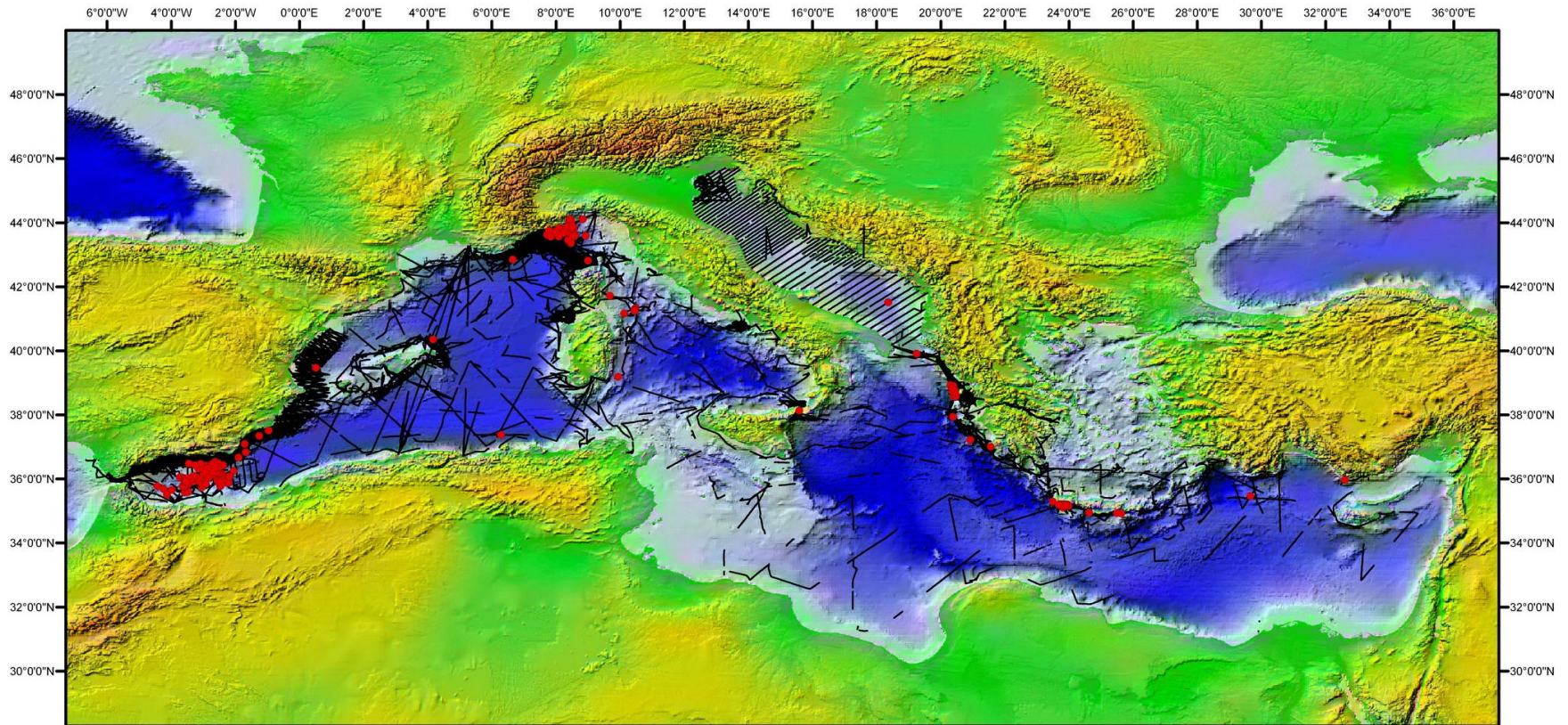
Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

Data collection:

- Different platforms: airplane, vessels of all sizes

- Different data collection protocols

- Different observers / experience

- Mostly non-systematic surveys, with no pre-defined design

Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

Data organization:

- Grid of cells: 0.2º (494 km^2), total 6881

- Spatial and environmental covariates

  - Fixed features

  - Dynamic features (average 1992-2006)

- Sampling units (<Beaufort 4)

  - Segments: ~18.5 km, total 23,658 segments, 336,709 km,

    - number of groups/animals (272/582)

  - Grid cells: total 2016 with effort (30% from total), sum of effort, groups, animals

    - Larger proportion of positive observations

    - Eliminate variability of positive/negative observations over identical features

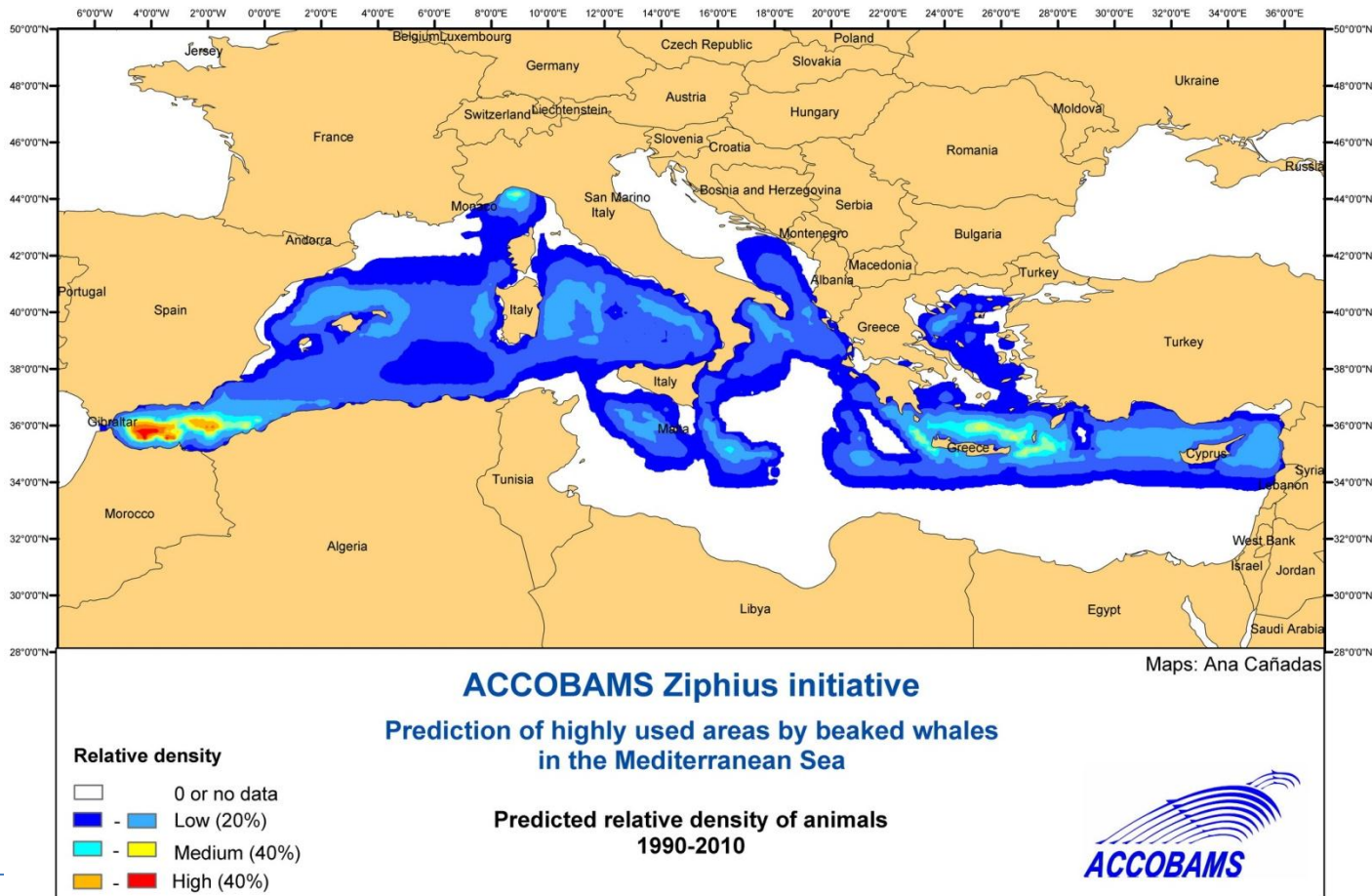# Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

Data analysis:

- Four approaches:
  - Segments with number of animals (1 step)
  - Gridcells with number of animals (1 step)
  - Gridcells with number of groups + group sizes (2 steps)
  - Gridcells with presence/absence + group sizes (2 steps)
- Final approach: gridcells with number of animals (one step)
- GAM – quasipoisson
- Predictions of relative density
- Non-parametric bootstrap with replacement (to show important areas even at the lower 95% CI)

Non-systematic heterogeneous surveys

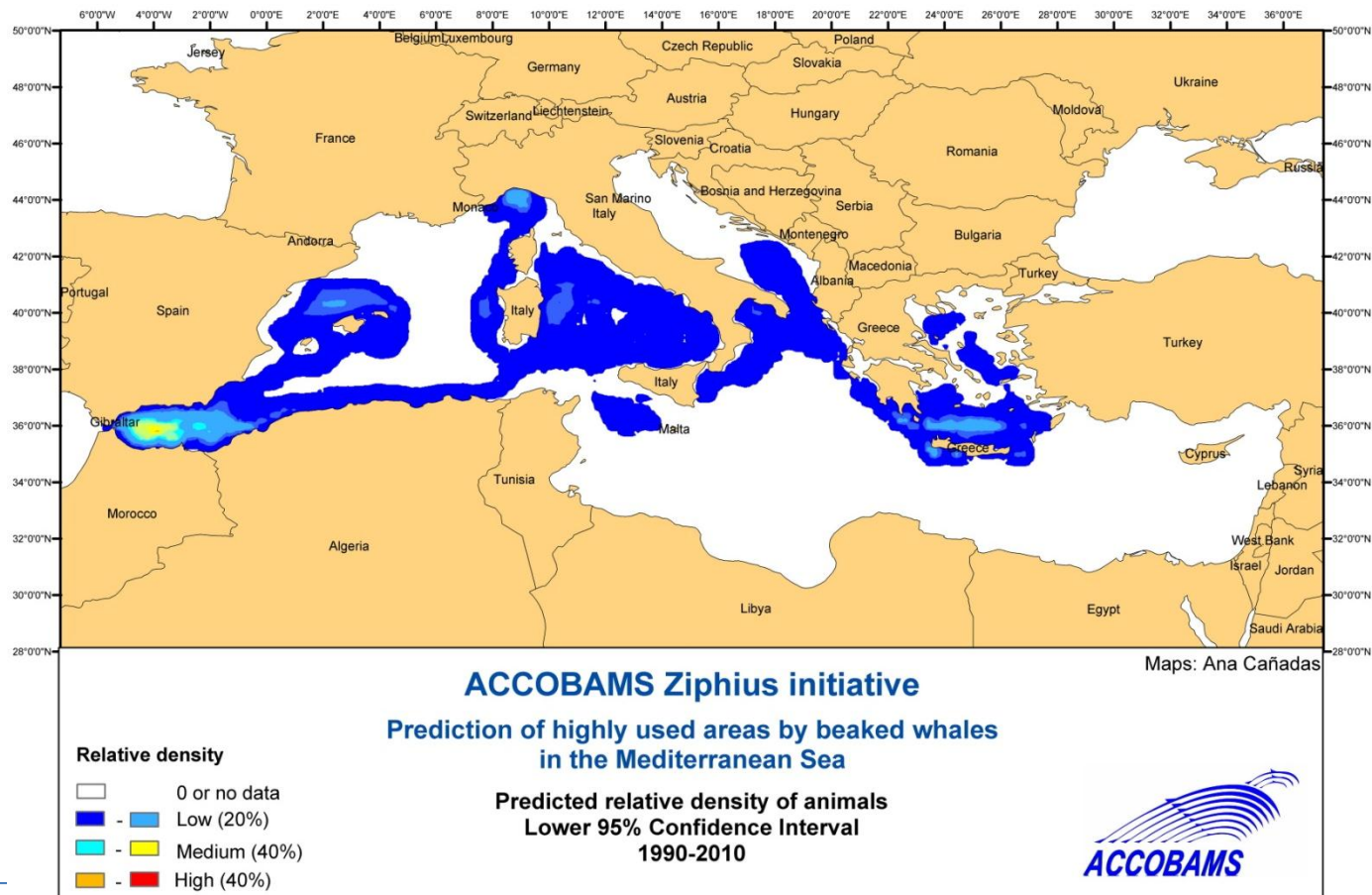## ACCOBAMS Ziphius initiative (Mediterranean)

ACCOBAMS Ziphius initiative

Prediction of highly used areas by beaked whales in the Mediterranean Sea

Predicted relative density of animals 1990-2010

Maps: Ana Cañadas

Relative density
- ☐ 0 or no data
- ■ Low (20%)
- ■ Medium (40%)
- ■ High (40%)

Depth – sst-Latitude

57.8% deviance explained

Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

ACCOBAMS Ziphius initiative

Prediction of highly used areas by beaked whales in the Mediterranean Sea

Predicted relative density of animals
Lower 95% Confidence Interval
1990-2010

Maps: Ana Cañadas

Relative density
- ☐ 0 or no data
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- ■ - Medium (40%)
- ■ - High (40%)

Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)
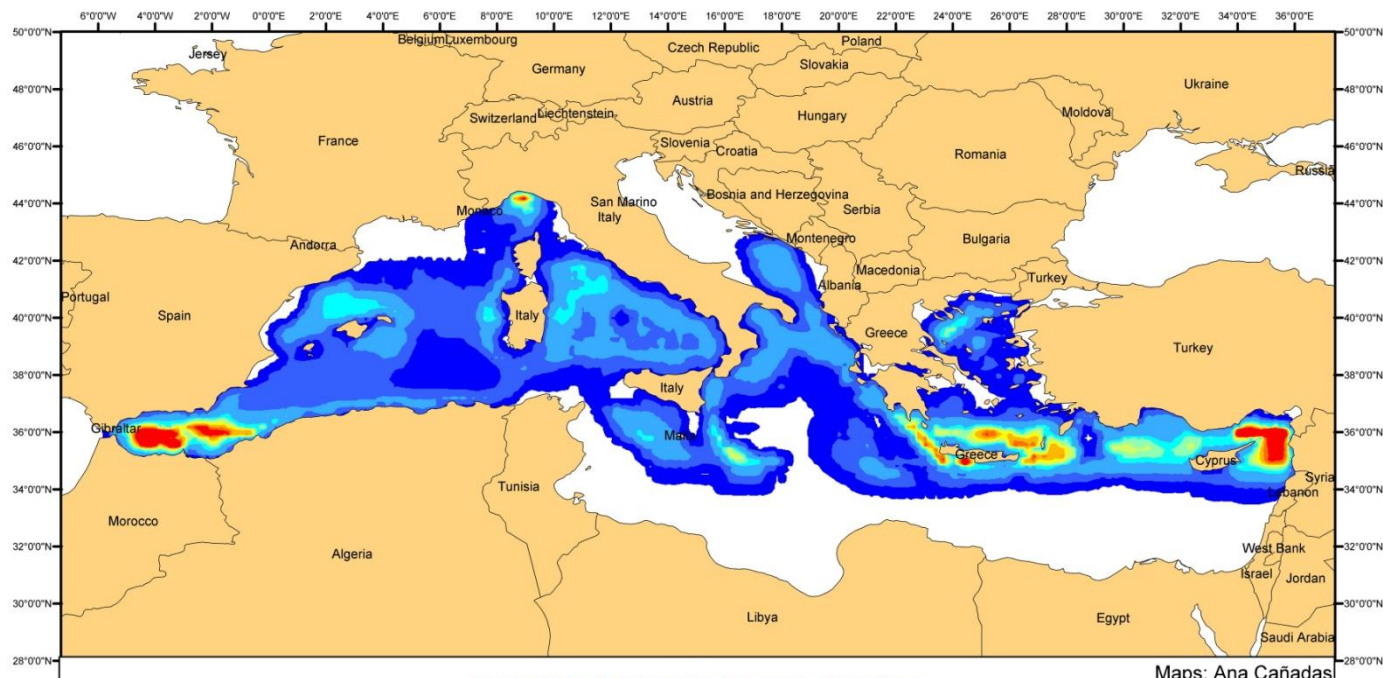
ACCOBAMS Ziphius initiative
Prediction of highly used areas by beaked whales in the Mediterranean Sea
Predicted relative density of animals
Upper 95% Confidence Interval
1990-2010

Maps: Ana Cañadas

Systematic homogeneous surveys

Example: CODA-SCANSII-TNASS (NE Atlantic)

- Main objective: estimate abundance to put threats into context

- Follow up and extension of SCANS Survey (1994)

- Snapshot: July 2005 (SCANS-II) and July 2007 (CODA & TNASS)

- Collaborative effort: LIFE (EC) Project, governments and Research Institutes
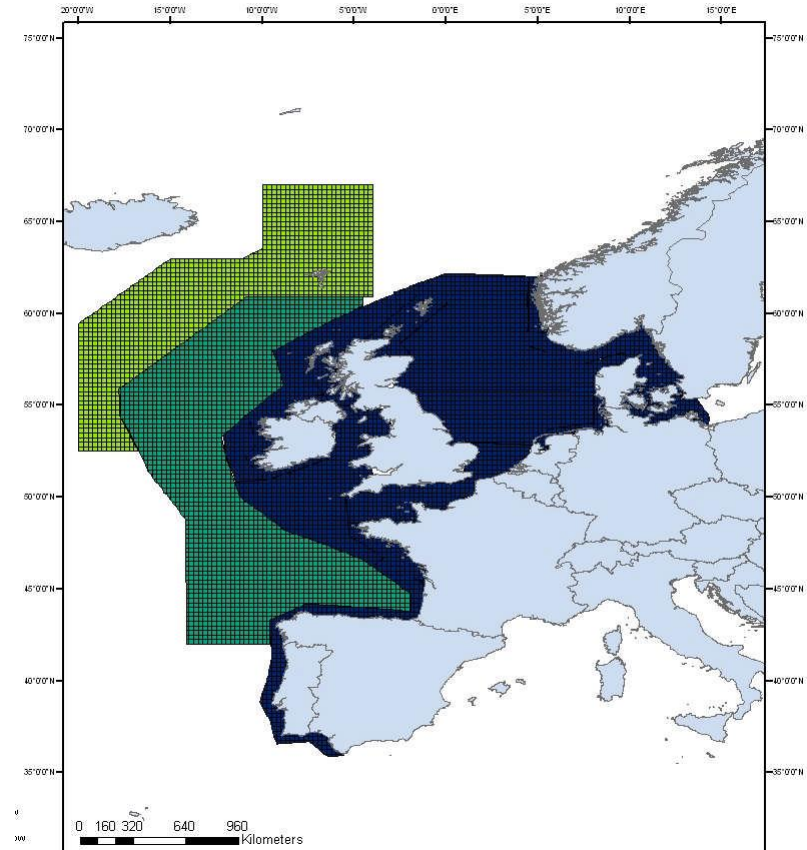
Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)

- Follow up and extension of SCANS Survey (1994)

- Snapshot: July 2005 (SCANS-II) and July 2007 (CODA & TNASS)

- Collaborative effort: all riparian countries (some governments, research institutes, etc)

(see details in Hammond and Cañadas talk on Friday)

Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)
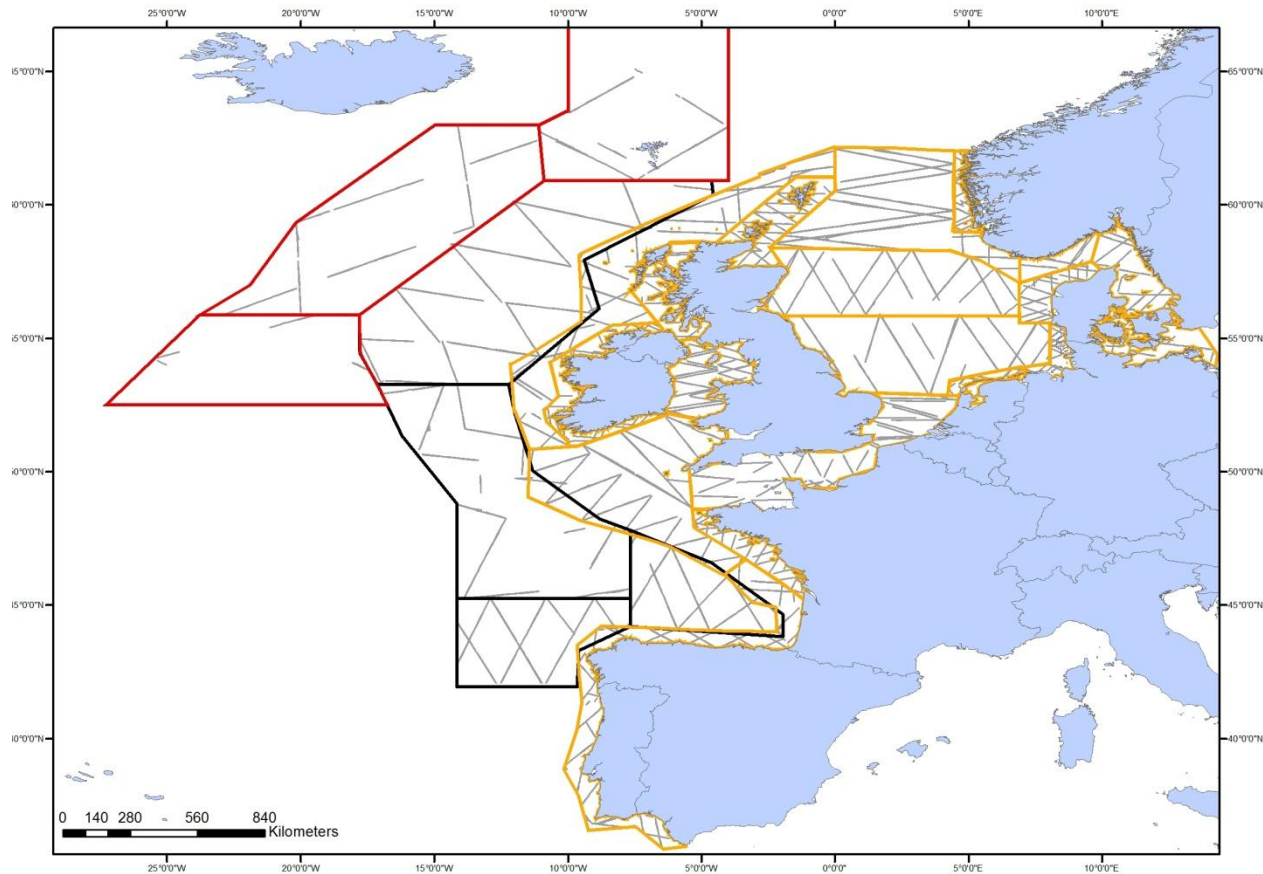
Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)

Data collection:
- Different platforms: airplane, large vessels (similar)

- Same data collection protocols
    - Double platform
    - Standardised protocols, identical for all vessels / airplanes

- Different observers / similar experience

- Systematic surveys with design

Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)

Data organization:

- Grid of cells: 0.25º (329 to 557 km^2 – N to S), total 3295
- Spatial and environmental covariates
  - Fixed features
  - Dynamic features (average July 2005 and July 2007)

- Sampling units (=<Beaufort 4)
  - Segments: ~6 km, total 8169 segments, 47718 km,
  - Response variable: estimated number of groups + group sizes

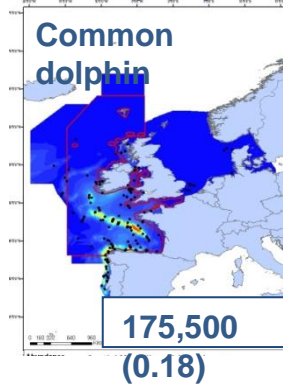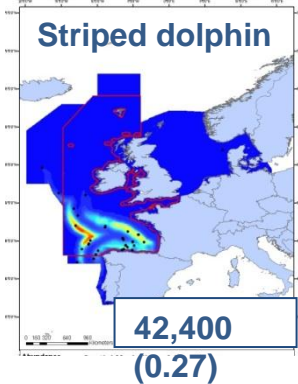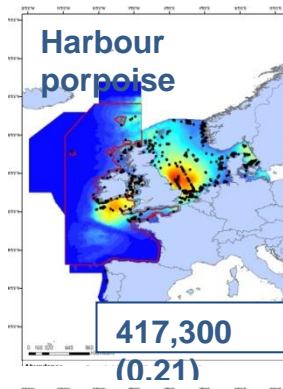# Systematic homogeneous surveys
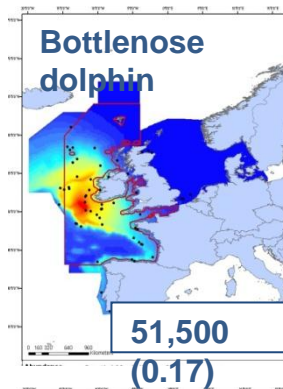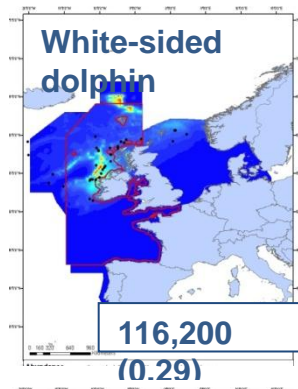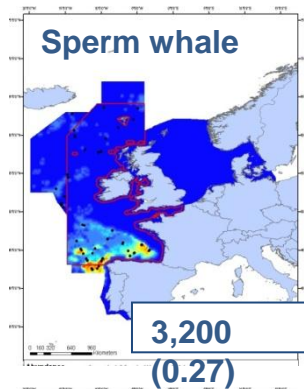
CODA-SCANSII-TNASS (NE Atlantic)

Data analysis:

- Detection function
- Two steps:
    - Abundance of groups
    - Group sizes (corrected for bias)
- GAM – quasipoisson
- Predictions of abundance of animals
- Non-parametric bootstrap with replacement, stratified

Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)

See talk by Hammond (Friday)

Minke whale — 42,900 (0.37)

Sperm whale — 3,200 (0.27)

White-sided dolphin — 116,200 (0.29)

Bottlenose dolphin — 51,500 (0.17)

Harbour porpoise — 417,300 (0.21)

Beaked whales — 24,400 (0.23)

Fin whale — 22,100 (0.17)

Striped dolphin — 42,400 (0.27)

Common dolphin — 175,500 (0.18)

Pilot whale — 137,700 (0.25)

White-beaked dolphin — 26,100 (0.36)
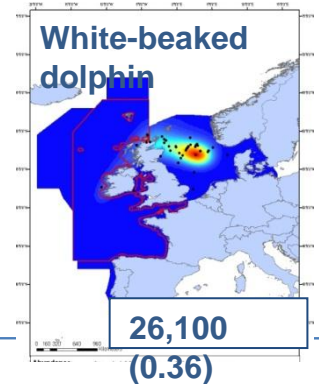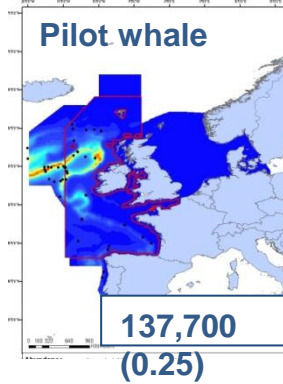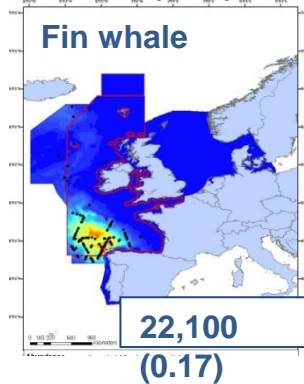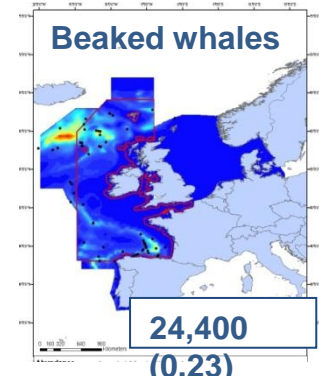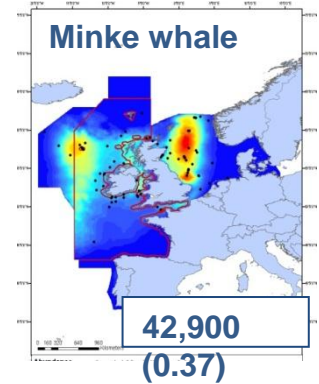
Discussion

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Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

Difficulties and challenges:

- Heterogeneity
  - Platforms
  - Data collection methods
  - Years and seasons
  - Coverage

- Low density – reduced positive observations

- Dynamic covariates

Addressing them:

- Had to live with it…… (and too much interpolation in some areas…..)

- Grid cells as sampling units

- Mean values…. VERY coarse

Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)

Difficulties / challenges:

- Low density of some species – reduced positive observations

- Low coverage and areas with almost none

- Dynamic covariates

Addressing them:

- Fewer covariates in the models… and… had to live with it..

- Interpolation…..in some areas a bit too much…?

- Monthly mean… not too coarse

Non-systematic heterogeneous surveys

ACCOBAMS Ziphius initiative (Mediterranean)

Usefulness and limitations of results:

✔ First wide collaborative effort in the area

✔ First basin-wide exploration of potential Ziphius habitat

✖ Sensitive to large heterogeneity of effort

✖ Not suitable to estimate abundance

✔ First indication to managers where NOT to do military manouvres…

✖ Very careful interpretation of results towards managers….

Systematic homogeneous surveys

CODA-SCANSII-TNASS (NE Atlantic)

Usefulness and limitations of results:

✔ Robust unbiased large scale estimates of abundance for several species

✔ Large scale collaborative and coordination effort

✔ Comparisson with previous estimate 10 years before

✖ Very expensive

✖ Low coverage and large unsurveyed areas