An Roinn Ealaíon, Oidhreachta,
Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta

Department of Arts, Heritage,
Regional, Rural and Gaeltacht Affairs

Proceedings of the

TRANSNATIONAL BOTTLENOSE DOLPHIN CONSERVATION WORKSHOP

(© M. Oudejans)

Hosted by the National Parks & Wildlife Service,
7 Ely Place, Dublin.
Ireland

Wednesday 7th & Thursday 8th December 2016

Citation:
Ó Cadhla, O. & Marnell, F. (Eds.) (2017). *Proceedings of the Transnational Bottlenose Dolphin Conservation Workshop hosted in Dublin, 7-8 December 2016*. National Parks & Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Dublin, Ireland. 391 pp.

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Foreword

In Ireland, as elsewhere in Europe and other parts of the world, few animals hold the public's imagination, excitement and interest the way that Bottlenose dolphins do. The legacy of television characters such as *Flipper* and site-faithful wild dolphins like *Fungie - the Dingle Dolphin,* along with increasing human engagement with the marine environment, have meant that Bottlenose dolphins occupy a prominent position in our coastal and marine narrative.

Yet for all of the tales, anecdotes and images connected with this cetacean species the deeper understanding of its ecology, behaviour and its societies remains an elusive and challenging mission. The last two decades have however seen substantial progress in delivering key pieces of the Natural History puzzle where Bottlenose dolphins in Europe are concerned, both through the efforts of professional scientists and a myriad of talented postgraduate students and also through international and national legal protections that have provided an impetus to conserve and to get to know Bottlenose dolphins better.

Ireland's position at the western periphery of Europe's landmass places it in a tantalising space ecologically. For many years now we have been aware of the presence of Bottlenose dolphins far from our shores, some in Atlantic waters more than three kilometres deep. Still in a European context these mobile intelligent mammals also occupy and habitually use some of the shallowest coastal environments we know. Unsurprisingly the focus of much research and knowledge investment to date has centred on the latter coastal communities, or *populations* as they are commonly termed, from the Moray Firth to the Mediterranean.

Now at the close of 2016 we in Ireland have come to a natural conclusion in these endeavours with the completion of a doctoral study that has focused on the second of two genetically distinct coastal communities of Bottlenose dolphin. So this is a good time to take stock of what is known about the species in Ireland and in neighbouring coastal or offshore waters of the north-east Atlantic which hold similar communities of *Tursiops truncatus*. The resulting Workshop hosted in Dublin and these *Proceedings* are an effort to concisely capture that knowledge and to communicate the views of all participating experts regarding the major issues, information gaps and transnational actions that need to be addressed where Bottlenose dolphin ecology, research and conservation in this region are concerned.

We would like to sincerely thank our Director, Dr Ciaran O'Keeffe, for his enthusiasm and support for this initiative, and also the staff at The Knights, 8 Ely Place, Dublin for facilitating the event at this venue.

Oliver Ó Cadhla and Ferdia Marnell, January 2017

Scientific Unit, National Parks & Wildlife Service,

Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland

TRANSNATIONAL BOTTLENOSE DOLPHIN CONSERVATION WORKSHOP

List of Participants, 7-8 Dec 2016

Name	Affiliation
Ben Wilson	Scottish Association for Marine Science, Scotland, UK
Benjamin Guichard	Agence des Aires Marines Protégées, France
Charles Lindenbaum	Natural Resources Wales, Wales, UK
Ciarán O'Keeffe	NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland
Enrico Pirotta	Washington State University, USA
Eunice Pinn	Joint Nature Conservation Committee, UK
Ferdia Marnell	NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland
Florence Caurant	Université de La Rochelle, France
Isabel Baker	Galway-Mayo Institute of Technology, Ireland
Joanne O'Brien	Galway-Mayo Institute of Technology, Ireland
Karen Hall	Scottish Natural Heritage, Scotland, UK
Kate Brookes	Marine Scotland, Scotland, UK
Kelly Macleod	Joint Nature Conservation Committee, UK
Machiel Oudejans	Kelp Marine Research, Ireland and The Netherlands
Marie Louis	University of St. Andrews, Scotland, UK
Milaja Nykänen	University College Cork, Ireland
Mònica Arso Civil	University of St. Andrews, Scotland, UK
Nienke van Geel	Scottish Association for Marine Science, Scotland, UK
Oliver Ó Cadhla	NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland
Paul Jepson	Institute of Zoology London, England, UK
Peter Evans	Seawatch Foundation; Bangor University, Wales, UK
Rebecca Walker	Natural England, England, UK
Rob Deaville	Institute of Zoology London, England, UK
Ross Culloch	Queens University Belfast, Northern Ireland, UK
Simon Berrow	Galway-Mayo Institute of Technology; Shannon Dolphin & Wildlife Foundation, Ireland
Simon Ingram	Plymouth University, England, UK
Stephen Foster	Department of Agriculture, Environment and Rural Affairs, Northern Ireland, UK
Tom Stringell	Natural Resources Wales, Wales, UK

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Department of Arts, Heritage,
Regional, Rural and Gaeltacht Affairs

TRANSNATIONAL BOTTLENOSE DOLPHIN CONSERVATION WORKSHOP

Dates: **Wed 7th (2.00pm-5.40pm) & Thurs 8th Dec 2016 (09.15am-4.00pm)**

Venue: **8 Ely Place, Dublin, Ireland**

AGENDA

Workshop objectives:

(i) to investigate the potential for improved international collaboration for the benefit of the species' conservation, particularly around shallow or coastal waters subject to high levels of human disturbance;

(ii) to explore the pressures and/or threats acting on this mobile high trophic-level species and some potentially vulnerable European populations, both now and into the future;

(iii) to help contextualise the next Habitats Directive assessment and reporting of this species' conservation status in 2018-2019 incorporating its Range, Population, Habitat and Future Prospects.

Day 1: Wednesday 7th December (afternoon)

1.45-2.00pm Welcome

2.00-2.20 Introduction and Workshop goals – Ferdia Marnell (Chair) and Oliver Ó Cadhla

2.20-2.40 *Population structure of bottlenose dolphins in the North-East Atlantic and implications for conservation.* – Presenter: Marie Louis

2.40-3.00 *Current knowledge of bottlenose dolphin status, ecology and human interactions in the waters off northern and western France.* – Presenter: Florence Caurant

3.00-3.20 *Abundance, habitat use and foraging ecology of bottlenose dolphins in the Irish Atlantic.* – Presenter: Milaja Nykänen

TEA/COFFEE BREAK

Queries to:
Oliver Ó Cadhla, *for* Science & Biodiversity Section, NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs.
Email: oliverocadhla@gmail.com

3.40-4.00 *The eastern Scotland bottlenose dolphin population: current knowledge and future challenges.* – Presenter: Mònica Arso Civil

4.00-4.20 Tursiops *on the Scottish west coast: nomads & agoraphobics.* – Presenter: Nienke van Geel

4.20-4.40 *Status of bottlenose dolphins in Wales: approaches to monitoring and conservation.* – Presenter: Tom Stringell

4.40-5.00 *The Shannon population: Status and situation management.* – Presenter: Simon Berrow

5.00-5.20 Discussion & Conclusion

Day 2: Thursday 8th December (morning)

9.15am Introduction – Ferdia Marnell (Chair) and Oliver Ó Cadhla

9.20-9.40 *Who or what killed Flipper? Investigating bottlenose dolphin strandings around the UK coast over the last 100 years (1913-2015).* – Presenter: Rob Deaville

9.40-10.00 *The Iroise Marine Park: A case study of coastal dolphins and our efforts to conserve them.* – Presenter: Benjamin Guichard

10.00-10.20 *The effects of anthropogenic disturbance on bottlenose dolphins along the East coast of Scotland: existing evidence and research challenges.* – Presenter: Enrico Pirotta

10.20-10.40 *Persistent pollutants, persistent effects.* – Presenter: Paul Jepson

TEA/COFFEE BREAK

11.00-11.20 *Strategies for bottlenose dolphin conservation in Europe.* – Presenter: Peter Evans

11.20-11.40 *Conserving bottlenose dolphins effectively in large EEZs (part 1) – the UK experience for now and the future.* – Presenter: Eunice Pinn

11.40-12.00 *Conserving bottlenose dolphins effectively in large EEZs (part 2) – the French experience for now and the future.* – Presenter: Benjamin Guichard

12.00-12.20 *Integrating efforts for better protection.* – Presenter: Simon Ingram

12.20-12.30 Discussion & Conclusion

Queries to:
Oliver Ó Cadhla, *for* Science & Biodiversity Section, NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs.
Email: oliverocadhla@gmail.com

LUNCH BREAK

Day 2: Thursday 8th December (afternoon)

1.15pm Introduction – Ferdia Marnell (Chair) and Oliver Ó Cadhla

1.20-2.10 **Round-table discussion I** – THEME: Key research gaps and issues

2.10-3.00 **Round-table discussion II** – THEME: Key management/policy gaps and issues

TEA/COFFEE BREAK

3.10-3.55 **Round-table discussion III** – THEME: Transnational collaboration for better conservation

3.55-4.00 CLOSE OF WORKSHOP

Queries to:
Oliver Ó Cadhla, *for* Science & Biodiversity Section, NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs.
Email: oliverocadhla@gmail.com

Introduction & Goals of the Workshop

Oliver Ó Cadhla

Scientific Unit, National Parks & Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland

The Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs is the statutory authority in Ireland with responsibility for nature conservation and the protection and maintenance of Ireland's biodiversity. Within this Department the National Parks & Wildlife Service (NPWS) performs a wide range of conservation-oriented functions and roles including regulation and management, scientific support, the formulation of biodiversity policy, and engagement with international Directives and agreements.

At the 2012 annual conference of the European Cetacean Society held in Galway, NPWS' Scientific Unit presented its current views and perspective on Ireland's experience of implementing of the EU Habitats Directive (HD) where cetaceans are concerned. Among our take-home messages was Ireland's commitment to complete the designation process for all its marine Special Areas of Conservation in 2012, in accordance with the outcomes of the 2009 Marine Atlantic Biogeographic Seminar. This process would include any further site designations for the HD *Annex II* species Bottlenose dolphin *Tursiops truncatus*.

In relation to Risk Management for the benefit of all *Annex IV* cetacean species NPWS also emphasised that there is a continued need for targeted science with respect to threats or risks to cetaceans from a range of human activities, in order to facilitate effective management. A more harmonised approach to the provision of "strict protection" to cetaceans across the EU was further suggested to be a prudent way forward.

In 2016 it also remains our view that there is a need for supporting structures to develop a more harmonised methodological approach across the EU for *Natura*-related surveillance and management. In addition NPWS considers that there is an ongoing need to improve alignment and synergy between Habitats Directive and Marine Strategy Framework Directive surveillance and reporting, including through the use of transnational approaches.

Where Special Areas of Conservation for Bottlenose dolphin are concerned Ireland has designated two large inshore sites, the Lower River Shannon SAC (1999) and the West Connacht Coast SAC (2012), each of which contains a genetically distinct and site-faithful community of dolphins and a wide range of comparatively shallow dynamic habitats used regularly by the species. As part of NPWS' work at these sites the Scientific Unit has drawn up and published site-specific Conservation Objectives in each case (*see* https://www.npws.ie/protected-sites). It has also commissioned regular monitoring of and research into the local populations in order to evaluate their status, community connectivity and potential numerical trends (e.g., Berrow *et al*., 2010; Englund *et al*., 2008; Ingram *et al*., 2009; Oudejans *et al*., 2010; Rogan *et al*., 2015; *see* www.npws.ie/marine/marine-reports).

With regard to Bottlenose dolphins inhabiting continental shelf and deeper offshore waters, in addition to Ireland's research and monitoring efforts within the 2007-2012 HD reporting cycle, in October 2014 the Government established its ObSERVE Programme for the acquisition of new high quality environmental and scientific data from much of its EEZ. Funded and led by the Department of Communications, Climate Action & Environment in partnership with NPWS, two ObSERVE projects are currently under way for the period 2015-2018, with a total expenditure of almost three million euros. These projects comprise (i) ObSERVE Acoustic: a static and towed acoustic surveillance project concentrated in continental slope and adjacent waters of Ireland's Atlantic Margin (*see* www.observe-acoustic.ie), and (ii) ObSERVE Aerial: a comprehensive line-transect and strip-transect survey for cetaceans, seabirds and other marine megafauna across two successive summer and two successive winter seasons (*see* www.observe-aerial.ie). So far both projects have been emerging as extremely valuable contributors to the knowledge of cetacean species occurrence, distribution and seasonal abundance in the Irish offshore and, as a whole, the ObSERVE Programme is expected to provide important new insights in relation to offshore Bottlenose dolphin ecology.

Against this background, and with the recent completion of a doctoral study by Milaja Nykänen (2016) which was part-funded by NPWS, we felt that this would be an opportune time to actively draw together the experts on Bottlenose dolphins, their conservation and associated management, both from Ireland and from our immediate neighbouring countries in western Europe. The primary goals of NPWS for this Workshop would be to:

(a) Investigate the potential for improved transnational cooperation where Bottlenose dolphin conservation is concerned;

(b) Explore current knowledge of the pressures and threats faced by the species in the north-east Atlantic;

(c) Help contextualise the next HD assessment and reporting for the species that is due to take place in 2018-2019.

In these we would be mindful of the critical HD reporting parameters of Range, Population, Habitat for the species and Future Prospects through which the conservation status of listed species must be assessed by Member States.

References

Berrow, S.D., O'Brien, J., Groth, L., Foley, A., Voigt, K. (2010). *Bottlenose Dolphin SAC Survey 2010*. Report to the National Parks and Wildlife Service. Shannon Dolphin and Wildlife Foundation. 24pp.

Englund, A., Ingram, S., Rogan, E. (2008). *An updated population status report for bottlenose dolphins using the Lower River Shannon SAC in 2008.* Final Report to the National Parks and Wildlife Service. 34pp.

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Nykänen, M. (2016). *Phylogeography, population structure, abundance and habitat use of bottlenose dolphins, Tursiops truncatus, on the west coast of Ireland*. PhD thesis. University College Cork, Ireland. 260pp.

Oudejans, M., Ingram, S., Englund, A., Visser, F., Rogan, E. (2010). *Bottlenose dolphins in Connemara and Mayo 2008-2009. Movement patterns between two coastal areas in the west of Ireland.* Report to the National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government. 29pp.

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Transnational Bottlenose Dolphin Conservation Workshop

Introduction & Goals

Oliver Ó Cadhla

http://www.npws.ie/marine/

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@ ECS HD workshop 2012

- **SACs** – completion of IRL designations in 2012.

- **Risk Management**
- Continue to need targeted science w.r.t. threats/risks to facilitate effective management.
- More harmonised approach to strict protection across EU.

- **Surveillance \ Reporting**
- Supporting structures to develop a more harmonised methodological approach across the EU for Natura 2000.
- Need improved alignment & synergy between HD - MSFD surveillance and reporting, including *Transnational* approaches.

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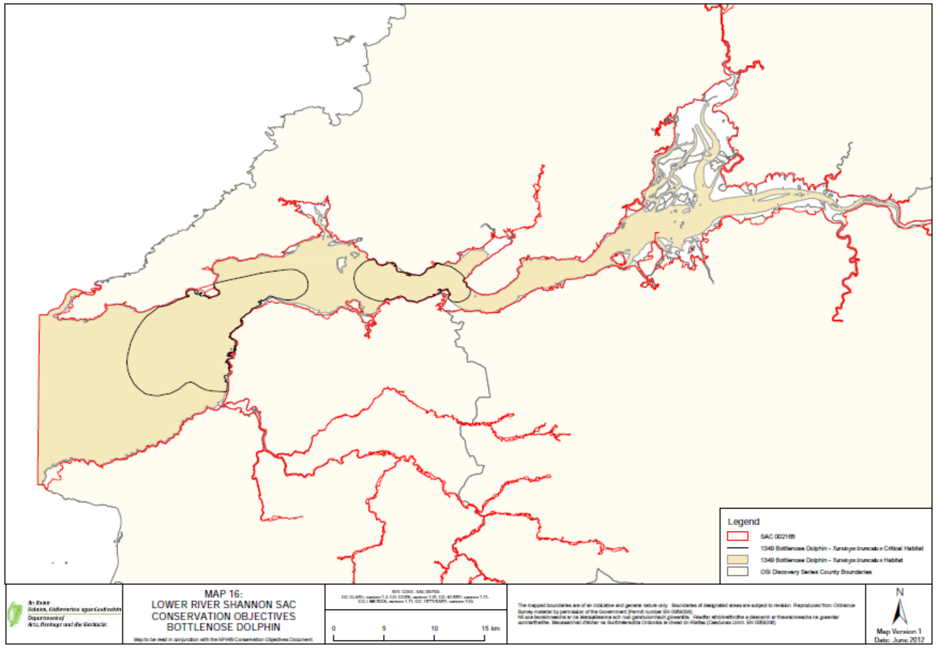
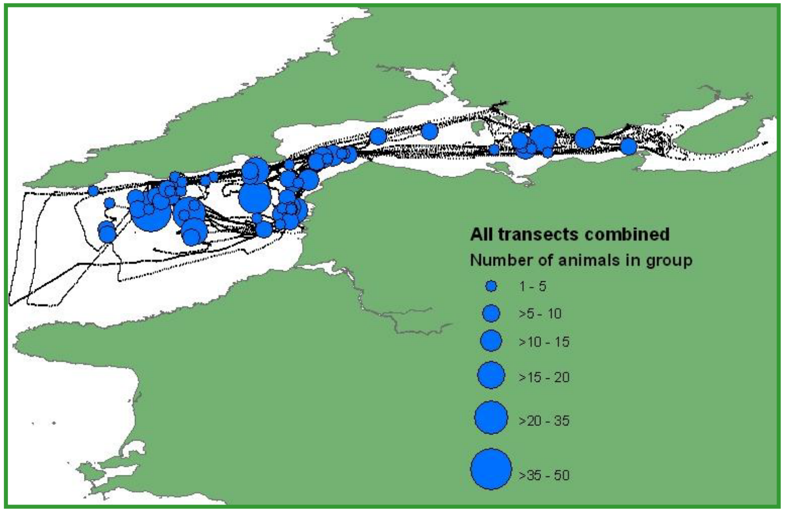
SAC actions

- Conservation Objectives
- SAC Monitoring





(Berrow *et al.*, 2010)

ObSERVE Programme (est.2014)

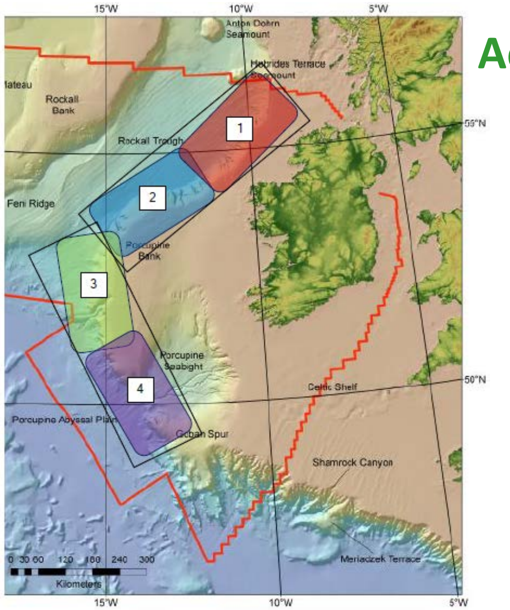


Figure 1. Acoustic study area showing the 4 zones of interest.

Acoustic Project

Aerial Project

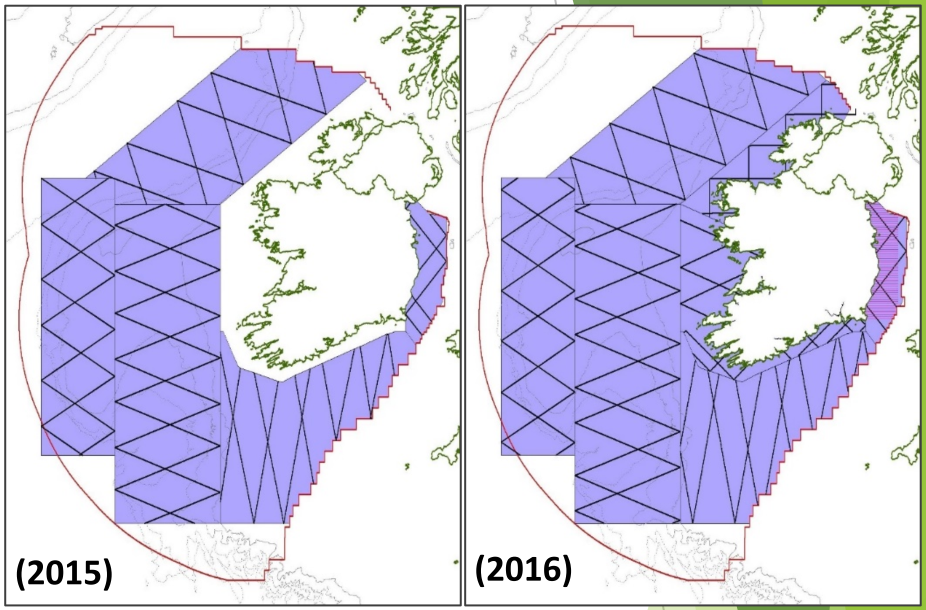


Figure 2. Aerial line transect designs for implementation within Ireland's EEZ (red border).

www.observe-acoustic.ie

www.observe-aerial.ie

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

An Roinn Ealaíon, Oidhreachta, Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta
Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs

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Our Goals

- **Investigate potential for improved collaboration**
- **Exploration of pressures and threats**
- **Help contextualise next HD assessment and reporting (2018-2019):**

Range, Population, Habitat and Future Prospects

Ní neart go chur le chéile

Population structure of bottlenose dolphins in the North East Atlantic and implications for conservation

Marie Louis[1,2,3], Amélia Viricel[2], Tamara Lucas[2], Hélène Peltier[4], Eric Alfonsi[5,6], Simon Berrow[7,8], Andrew Brownlow[9], Pablo Covelo[10], Willy Dabin[4], Rob Deaville[11], Renaud de Stephanis[12], François Gally[13], Pauline Gauffier[14], Rod Penrose[15], Monica A. Silva[16,17], Christophe Guinet[1], Benoit Simon-Bouhet[1]

(1) Centre d'Etudes Biologiques de Chizé

(2) LIENSs (Littoral Environnement et Sociétés), UMR CNRS-Université de La Rochelle

(3) Scottish Oceans Institute, University of St Andrews

(4) Observatoire PELAGIS, UMS 3462 CNRS/Université La Rochelle

(5) Océanopolis, Brest

(6) BioGeMME, UFR Sciences et Techniques, Université de Brest

(7) Irish Whale and Dolphin Group

(8) Galway-Mayo Institute of Technology, Dublin Road, Galway

(9) SAC Wildlife Unit, Inverness

(10) CEMMA (Coordinadora para o Estudo dos Mamíferos Mariños)

(11) Institute of Zoology, Zoological Society of London

(12) Estacion Biologica de Donana-CSIC, Sevilla

(13) GECC (Groupe d'Etudes des Cétacés du Cotentin)

(14) CIRCE (Conservation, Information and Research on Cetaceans)

(15) Marine Environmental Monitoring

(16) Centro do Instituto do Mar (IMAR) da Universidade dos Açores, Departamento de Oceanografia e Pescas

(17) Biology Department, Woods Hole Oceanographic Institution

Genetic structure assessment is needed to define appropriate conservation units and the spatial scales that are the most relevant for management and threat assessment. The status of the populations can then be assessed by the evaluation of their degree of genetic isolation, the estimation of effective population sizes and demographic trajectories.

In Europe, bottlenose dolphins are protected under the Habitats Directive where they are listed as a species whose conservation requires the designation of Special Areas of Conservation (SACs). Nevertheless, their population structure in the North-East Atlantic (NEA) was still poorly understood. They are found both in coastal waters, where they form either discrete resident groups of tens to hundreds of individuals or mobile groups, and in pelagic waters with abundance estimates of thousands of individuals. We investigated bottlenose dolphin genetic structure from Scotland to the Azores through analyses of biopsy samples (n=179) and samples from stranded animals (n=226) using 25 microsatellite markers.

Clustering analyses based on multilocus genotypes indicated that bottlenose dolphin genetic structure in the NEA is hierarchical. The highest level of genetic differentiation was found between coastal and pelagic dolphins, suggesting the existence of two distinct ecotypes, each of them being further divided in two populations. In the pelagic ecotype, individuals sampled in Gibraltar, Cadiz and the Mediterranean Sea formed a separate population from individuals sampled in pelagic waters of the North-East Atlantic. Likewise, coastal dolphins were divided in two populations: a population composed of individuals sampled in the United Kingdom and Ireland and a population composed of individuals sampled in France and south Galician waters. Effective population sizes and genetic diversity were significantly lower in coastal populations than in pelagic ones.

Additionally, past demographic history of the species in the NEA was reconstructed using Approximate Bayesian Computation analyses on the genetic data. The results showed that coastal bottlenose dolphins were founded by pelagic dolphins after the Last Glacial Maxima (c. 10,000 years ago), likely as a result of the colonisation of coastal habitats that became available after sea ice retreated.

Our results also have implications for conservation. Anthropogenic impacts may be different in coastal and pelagic areas. Moreover, coastal and pelagic bottlenose dolphins are highly genetically and ecologically differentiated. Thus it is very important to separate them in management plans as well when evaluating the impacts of anthropogenic activities (e.g. fisheries bycatch). As coastal environments are under increasing anthropogenic pressures, coastal populations which have small effective population sizes and low genetic diversity require adapted conservation policies to preserve their habitats. Pelagic bottlenose populations are large and highly diverse and could be a source population for coastal populations. It is therefore also important to put management measures in place for both ecotypes.

Lastly, the current genetic data indicated possible finer-scale population structure within the coastal populations. We are currently collaborating with Dr Milaja Nykänen and Dr Emer Rogan on a fine-scale population structure study of coastal bottlenose dolphins in the British Isles and northern France. This work will allow further definition of fine-scale population structure in Northern Europe, the contemporary gene flow among populations and their effective population sizes. The results should help to evaluate the role of SACs in maintaining connectivity among bottlenose dolphin populations.

Transnational bottlenose dolphin conservation workshop
Dublin 07-08/12/2016

Population structure of bottlenose dolphins in the North East Atlantic and implications for conservation

Marie Louis, Amélia Viricel, Tamara Lucas, Hélène Peltier, Eric Alfonsi, Simon Berrow, Andrew Brownlow, Pablo Covelo, Willy Dabin, Rob Deaville, Renaud de Stephanis, François Gally, Pauline Gauffier, Rod Penrose, Monica A. Silva, Christophe Guinet, Benoit Simon-Bouhet

Conservation genetics

Population genetics and conservation

→Population structure: define conservation units & spatial scale of management areas and threat assessment

→ Connectivity: evaluate the isolation of the units

→ Vulnerability to change: estimates of effective population sizes, genetic diversity and demographic trajectories

→ Risk assessment: impact of past environmental conditions & anthropogenic activities on demographic history to predict the impact of future changes

Bottlenose dolphins in Europe

Tursiops truncatus

→ Protected by Annex II Habitats Directive (92/43/22C)

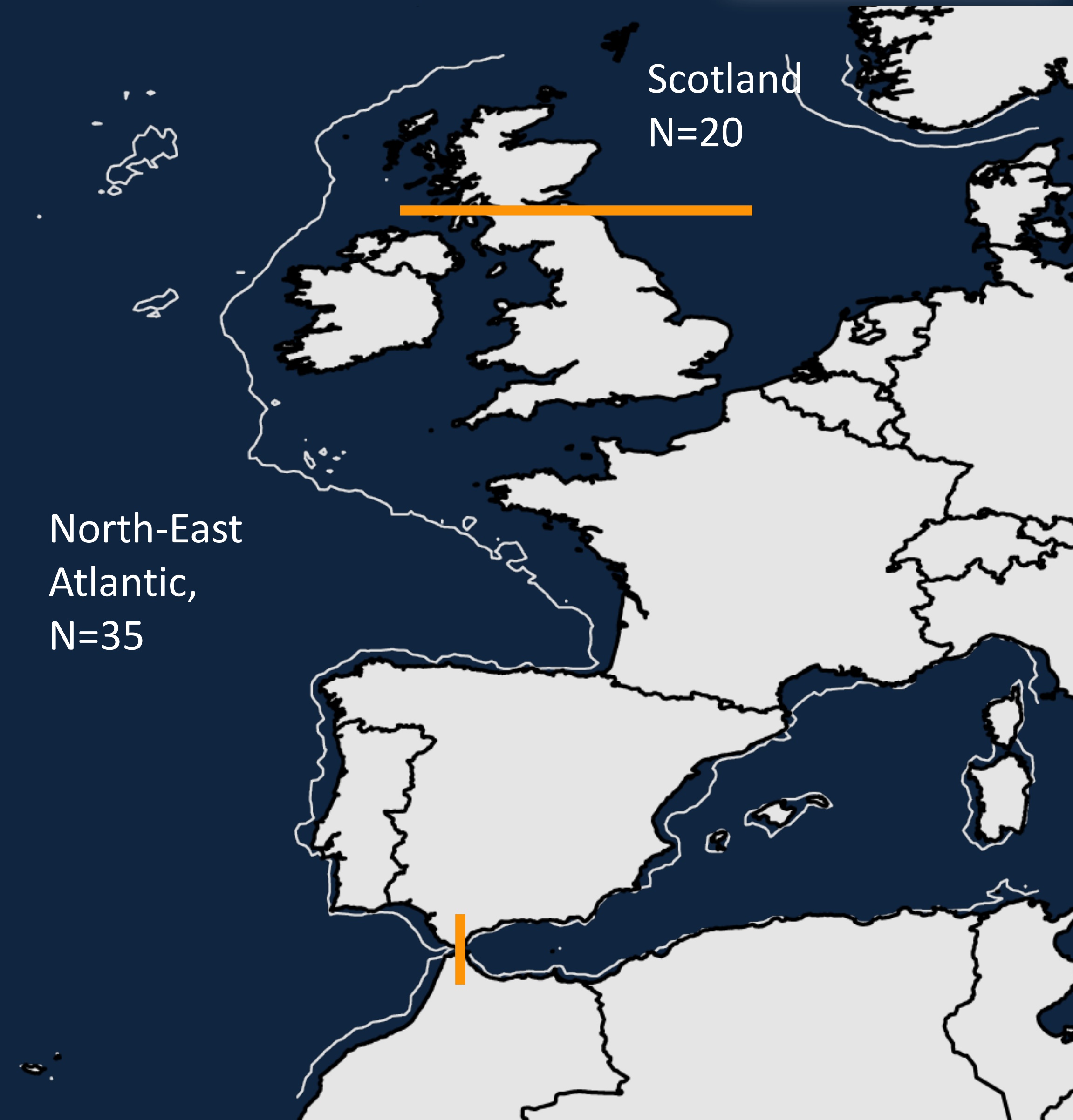
→ Species whose conservation requires the designation of Special Areas of Conservation (SAC)

Bottlenose dolphins in Europe

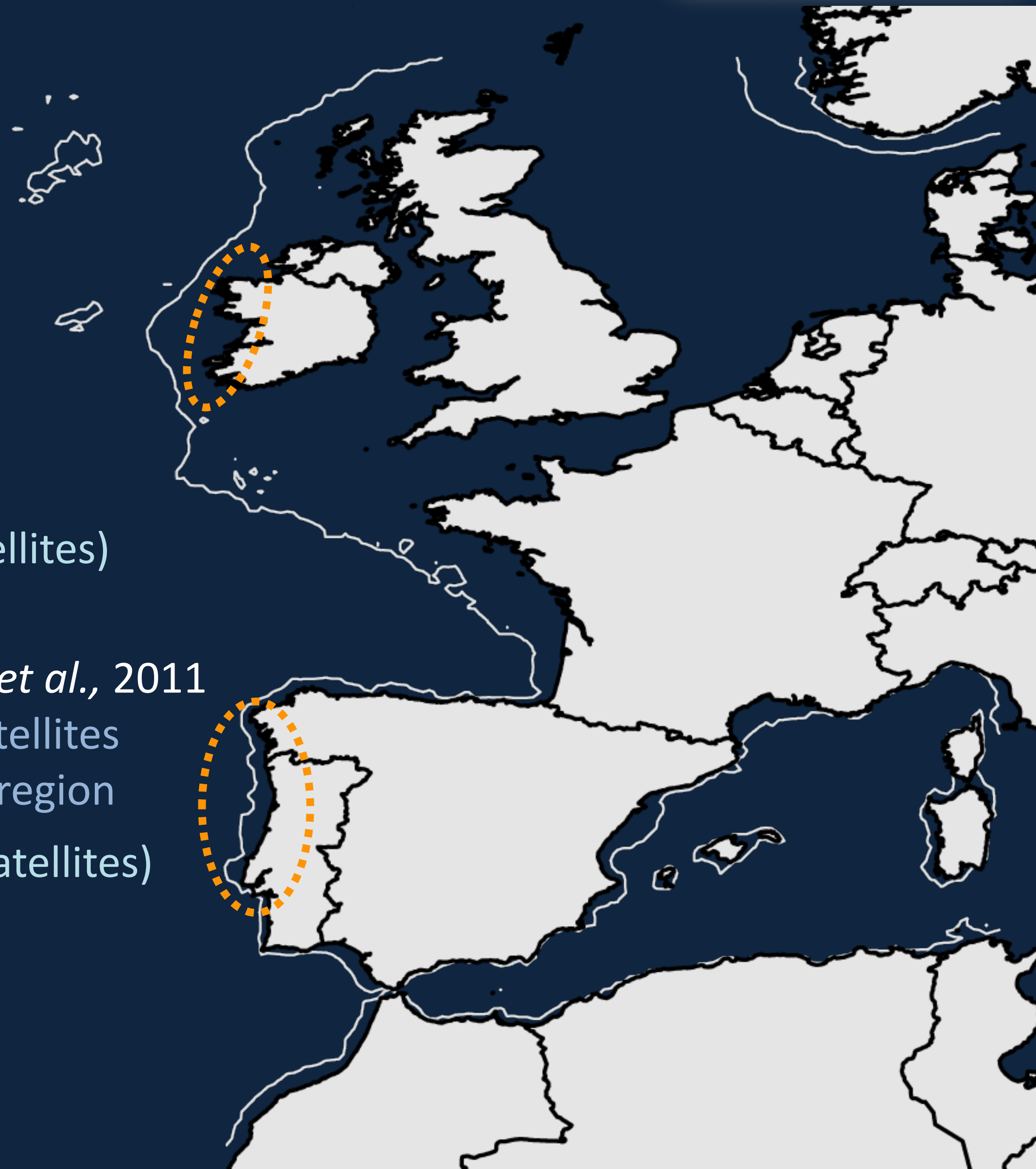
Previous genetic studies

Natoli *et al.*, 2005
9 microsatellites
mt control region

F_{ST} = 0.07 (microsatellites)



Previous genetic studies



Fine-scale population structure

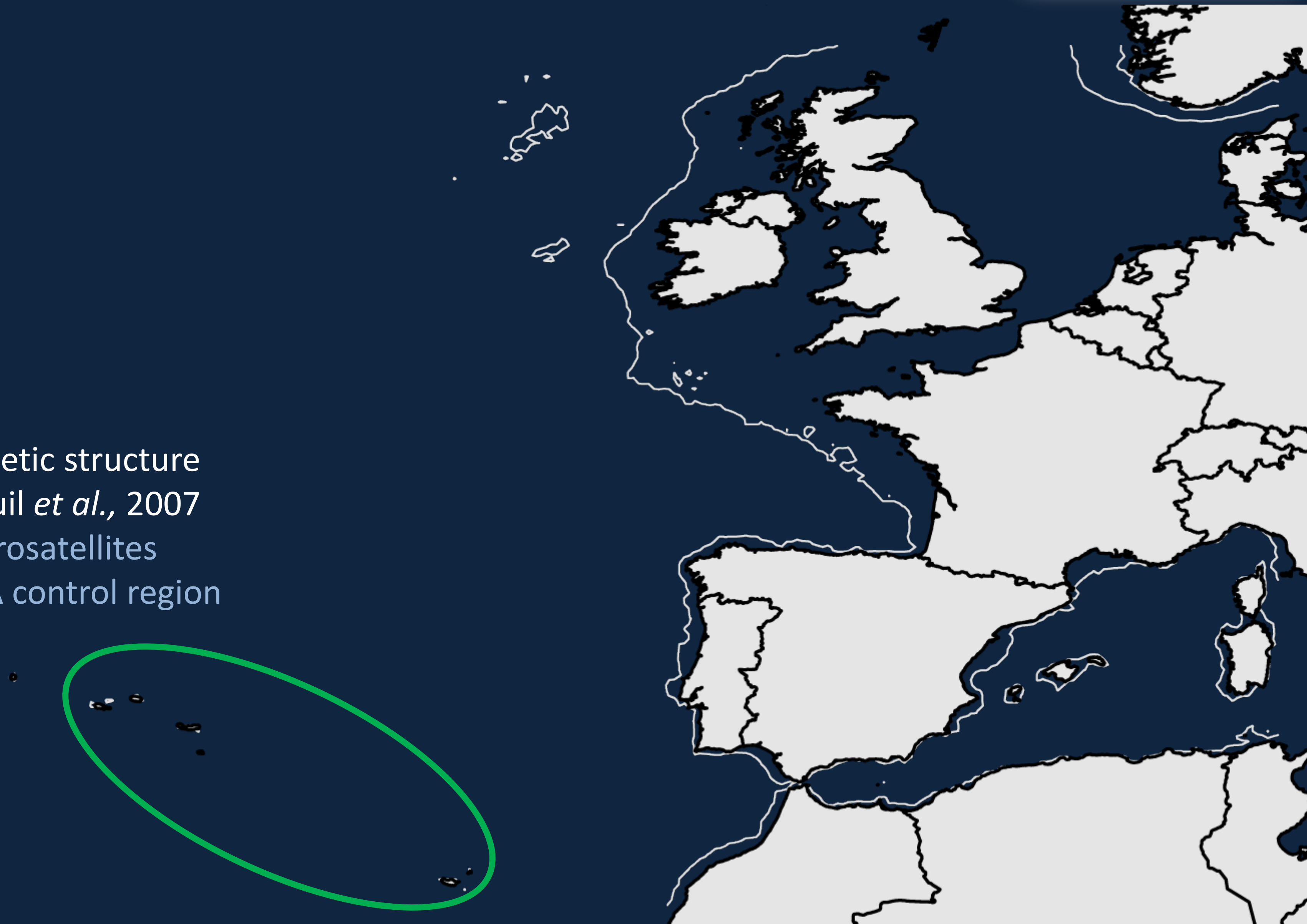
Mirimin *et al.* 2011
15 microsatellites
mt control region

F_{ST} = 0.17 to 0.18 (microsatellites)

Fernandez *et al.*, 2011
10 microsatellites
mt control region

0.12 < F_{ST} < 0.47 (microsatellites)

Previous genetic studies



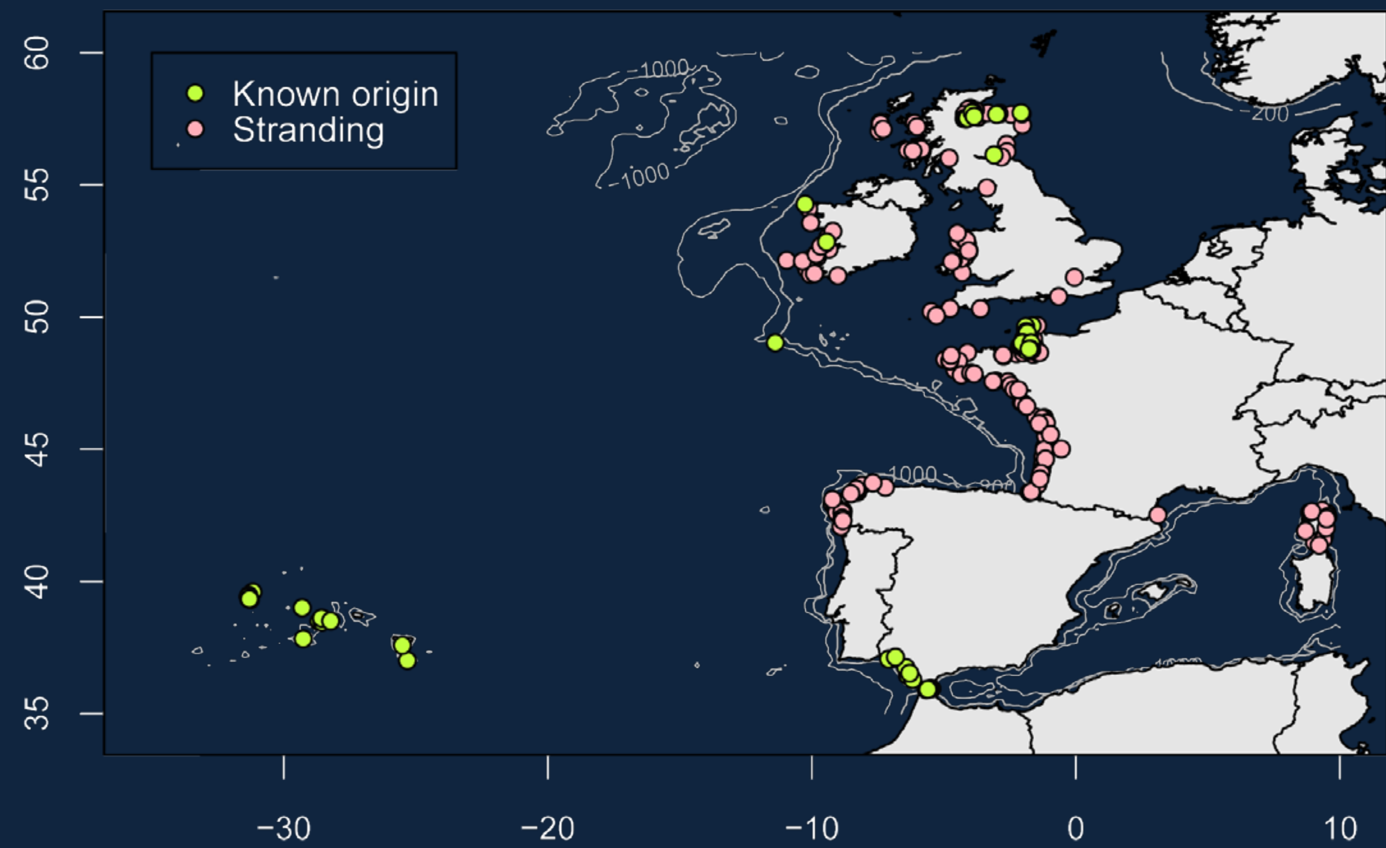
No genetic structure
Quérouil *et al.*, 2007
10 microsatellites
mtDNA control region

Aim of the study

Define genetic structure of bottlenose dolphins in the North-East Atlantic

Louis *et al.* 2014 Molecular Ecology
Louis *et al.* 2014 Proceedings of the Royal Society B

Samples

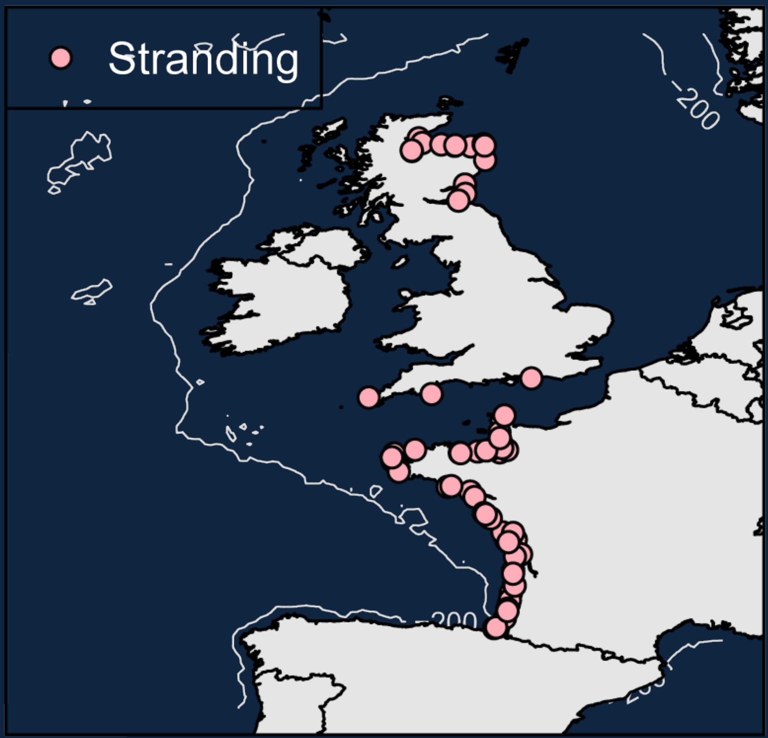


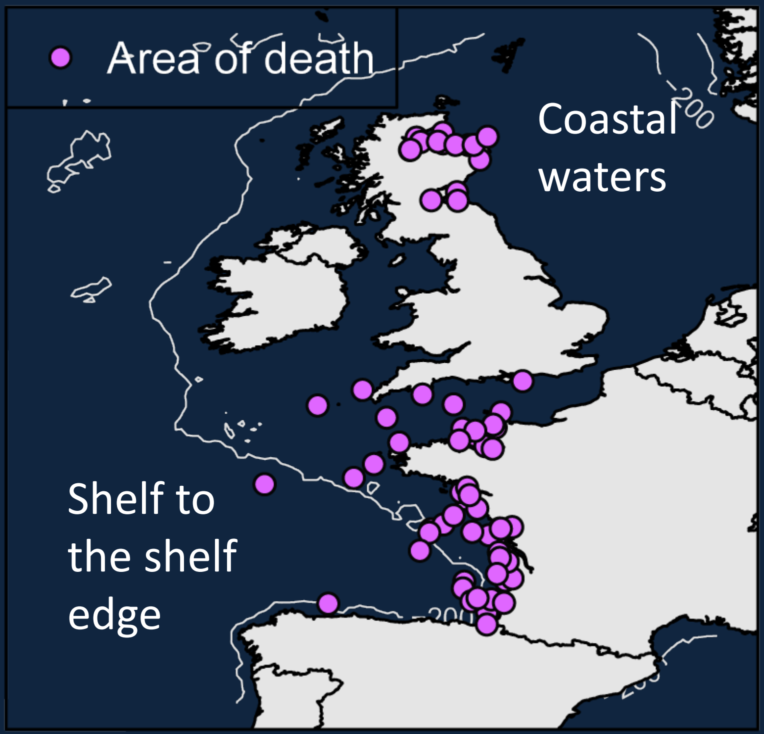
Known origin: biopsy samples (n=179)

Stranding: stranded animals (n=226)

405 samples

Samples





Carcass drift prediction model (Peltier *et al.*, 2012)

→ Possible in the areas encompassed by the model MOTHY (N=66)

Analysis methods

25 microsatellite markers

Bayesian clustering methods (microsatellites)

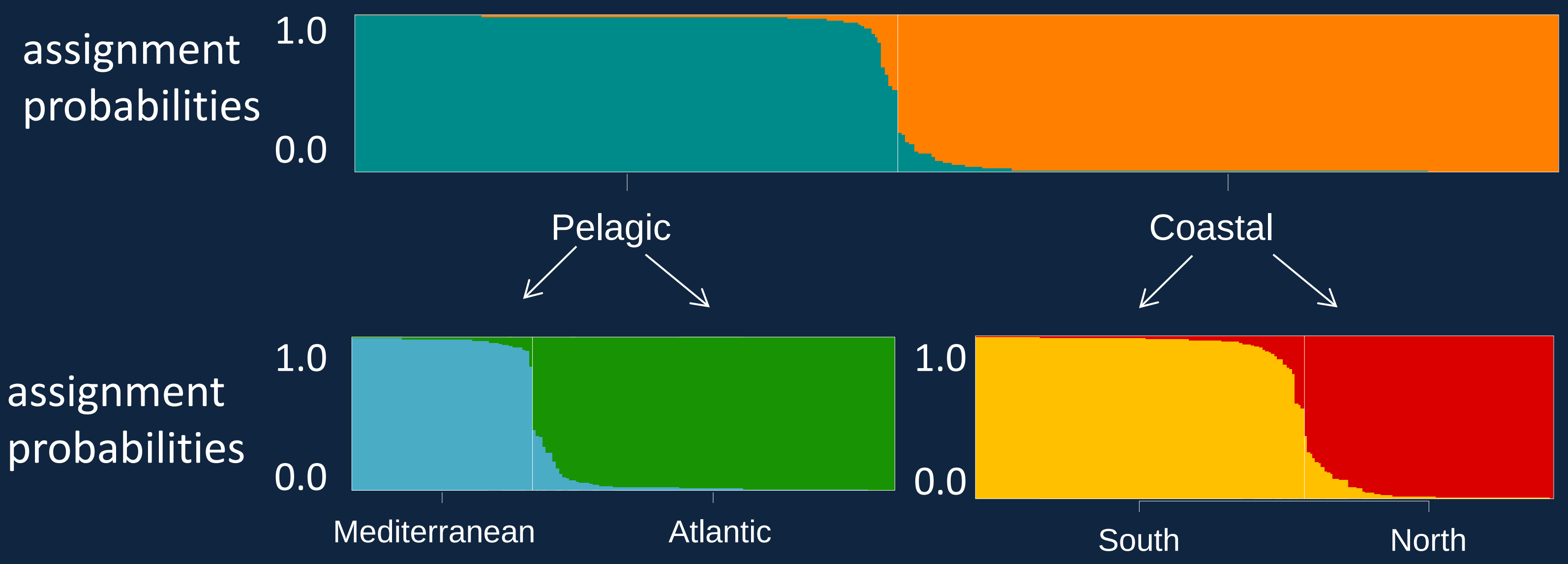
→ Method using multilocus genotypes: software *STRUCTURE* (Pritchard *et al.* 2000, Falush *et al.* 2003, Evanno *et al.* 2005)

→ Method using multilocus genotypes and geographical position of the sampled individuals, «landscape genetics»: software *TESS* (Chen *et al.* 2007, Durand *et al.* 2009)

Valsecchi and Amos 1996, Baker *et al*. 1998, Rooney *et al.* 1999, Rosel *et al.* 1999, 2005, Krützen *et al*. 2001, Dalebout *et al.* 2005, Nater *et al.* 2009

Results - Hierarchical structure

STRUCTURE barplots – assignment probabilities (y axis) for all individuals (x axis)

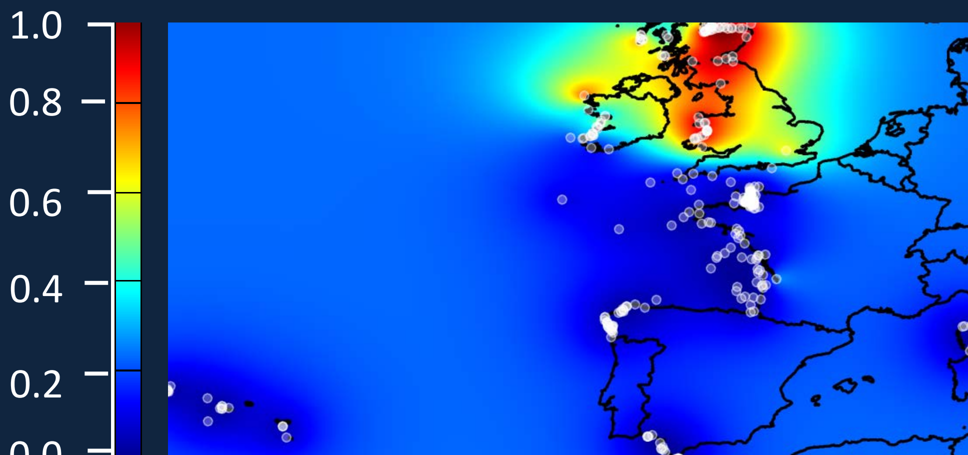


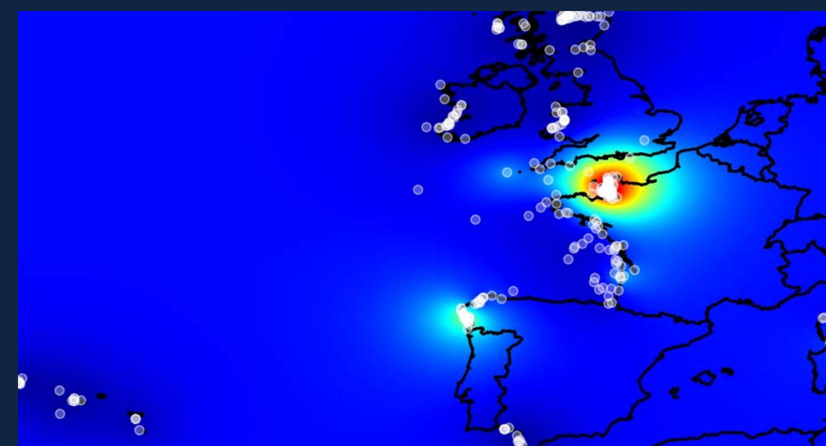
Landscape genetics

Methods using multilocus genotypes and geographical origin (microsatellites)

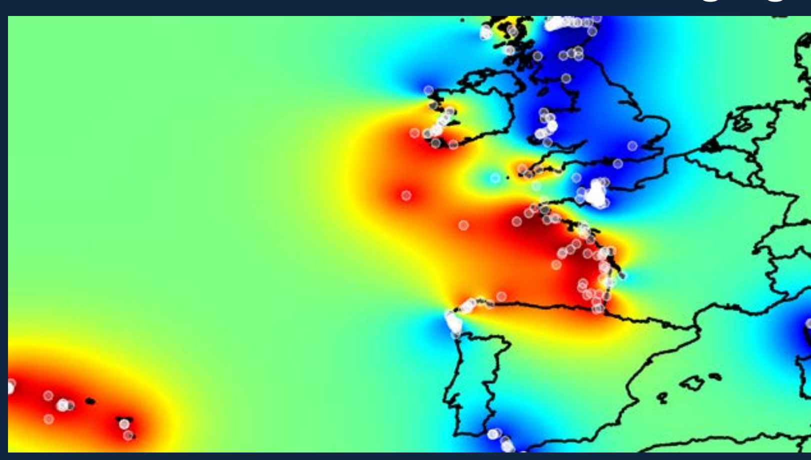
TESS – Most likely number of populations = **4**

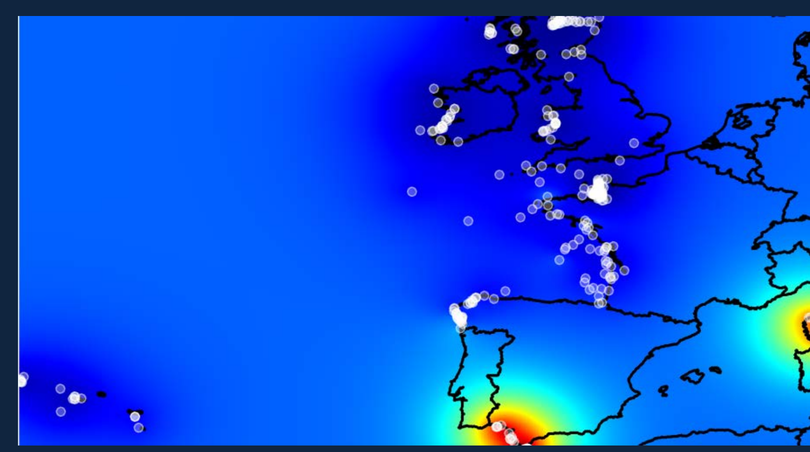
Coastal group from *STRUCTURE*





Pelagic group from *STRUCTURE*

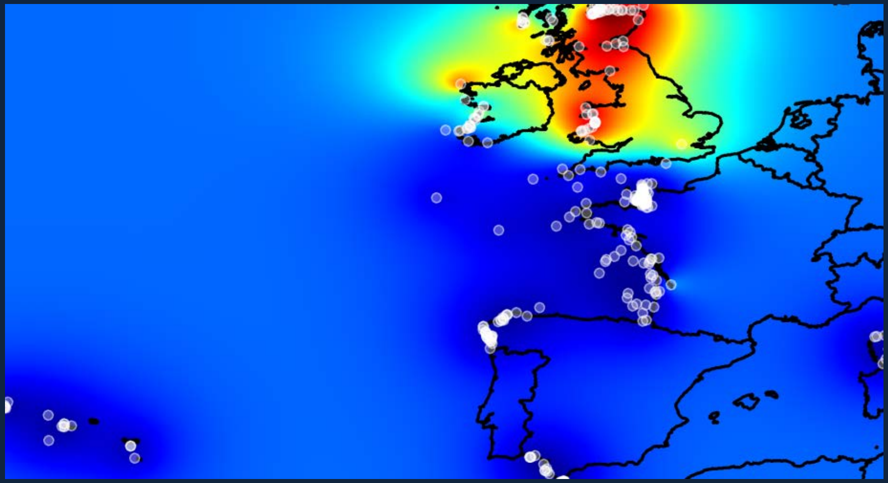




Landscape genetics

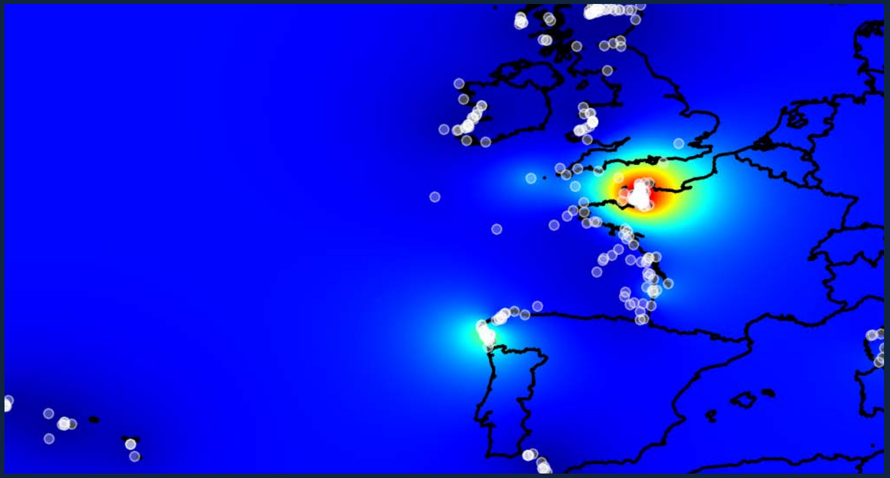
Methods using multilocus genotypes and geographical origin

Coastal dolphin Group



Coastal North (n=78)

Photo-identification matching between East Scotland, West Scotland and all around Ireland (O' Brien *et al.* 2009, Robinson *et al.* 2012)



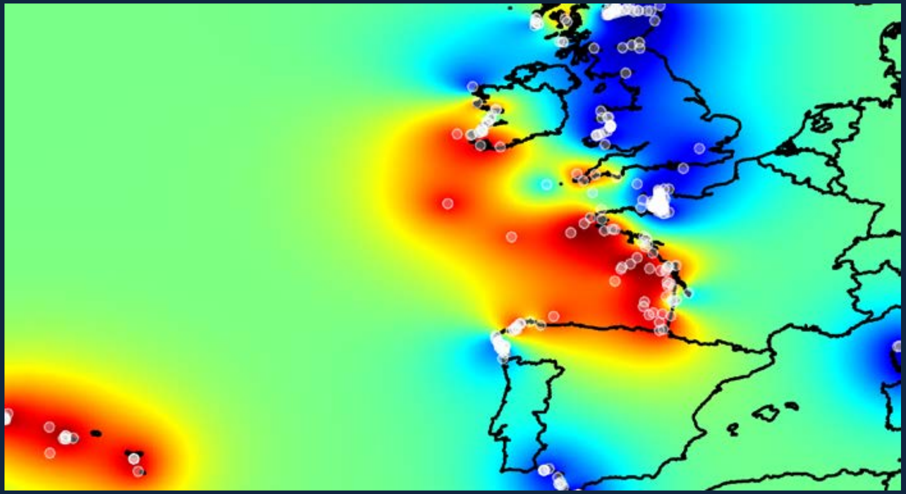
Coastal South (n=124)

English Channel
South Galicia (North-West Spain)

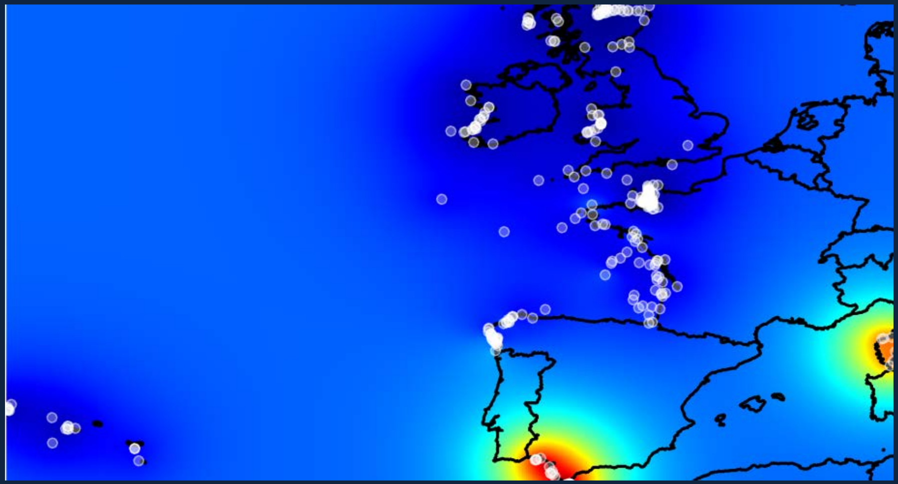
Landscape genetics

Methods using multilocus genotypes and geographical origin

Pelagic dolphin Group



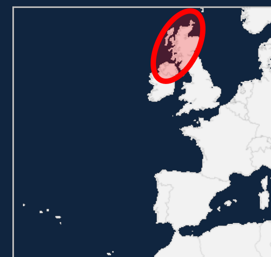
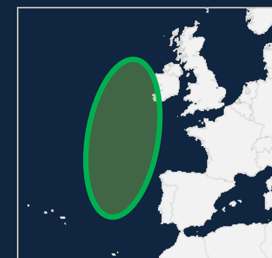
Atlantic (n=105)

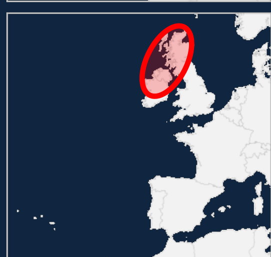
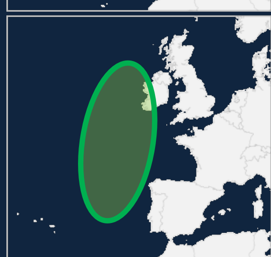


Cadiz - Gibraltar – Mediterranean (n=55)
→ Named « Mediterranean »

Population differentiation

Pairwise microsatellite F_{ST}

	Coastal North	Atlantic	Mediterranean
Coastal South	0.057**	0.133**	0.118**
Coastal North		0.149**	0.157**
Atlantic			0.043**

Hierarchical structure with the highest differentiation between the coastal and the pelagic group

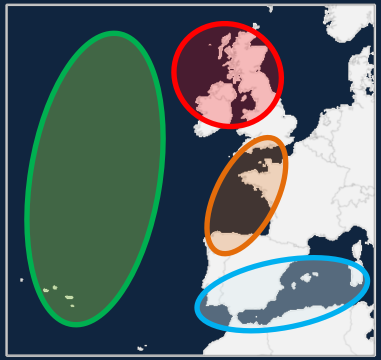
Population structure – main results

Two ecotypes in European waters: coastal and pelagic

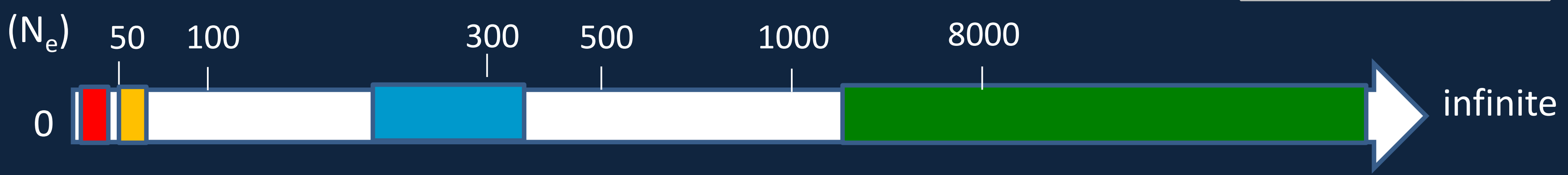
Two distinct coastal populations: North and South and two pelagic populations: Atlantic and Mediterranean

Possible finer-scale genetic structure within the coastal populations that needs further investigation

Effective population size (N_e)



N_e calculated in LDNe (Waples & Do 2008, 2010) – similar results with ONeSAMP (microsatellites)



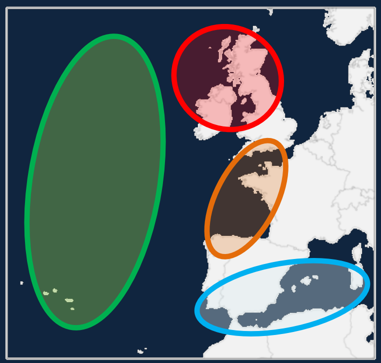
Coastal North
32 (28 – 37)

Pelagic Mediterranean
231 (168 – 360)

Pelagic Atlantic
7748 (1333 – infinite)

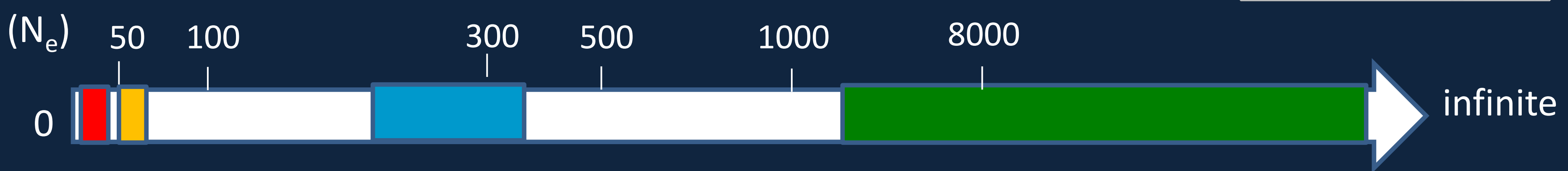
Coastal South
64 (56 – 74)

Effective population size (N_e)



N_e calculated in LDNe (Waples & Do 2008, 2010)

(microsatellites)



Coastal North
32 (28 – 37)

Pelagic Mediterranean
231 (168 – 360)

Pelagic Atlantic
7748 (1333 – infinite)

Coastal South
64 (56 – 74)

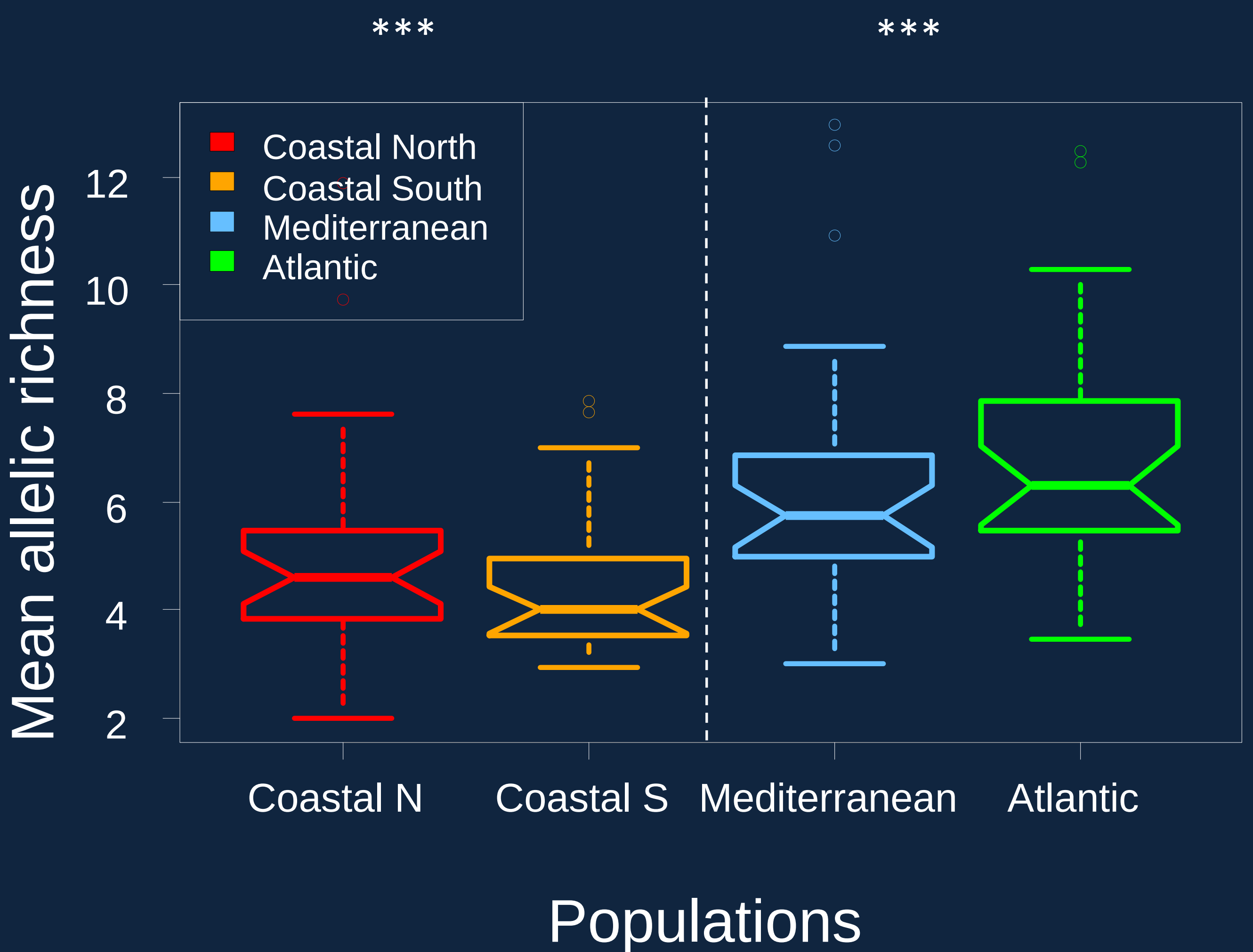
Population size (boat and aerial surveys) → thousands to tens of thousands

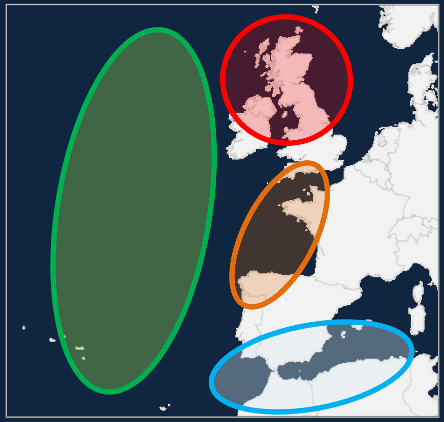
Population size (Mark-recapture studies) → hundreds

Lopez 2003, Forcada *et al.* 2004, Pesante *et al.* 2008, Hammond *et al.* 2009, Gnone *et al.* 2011, Mirimin *et al.* 2011, Cheney *et al.* 2012, Hammond *et al.* 2013

Genetic diversity

25 microsatellites





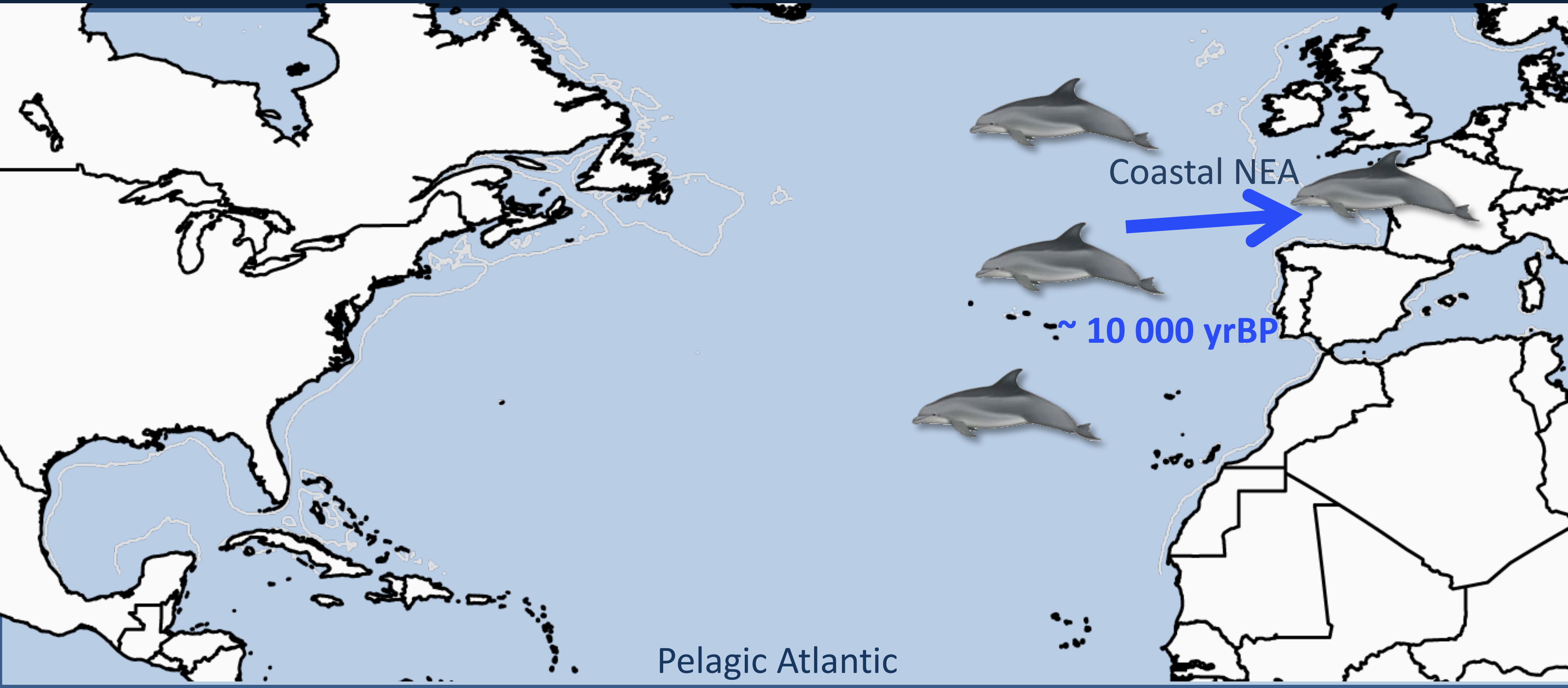
Wilcoxon test

Coastal populations may be more vulnerable

Evolutionary history in the NEA

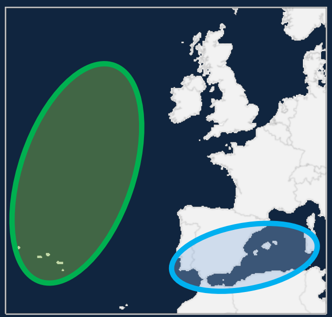
Divergence time= ~ **10,320 yrBP** (95%CI: 4,300–47,800)
End of the Last Glacial Maximum (LGM): 18,000 yrBP

Colonisation of coastal habitats by pelagic invidivuals after sea ice retreated



Implications for conservation

Pelagic dolphins



Coastal dolphins

Habitat destruction

Noise pollution

Noise pollution

Chemical pollution

Bycatch

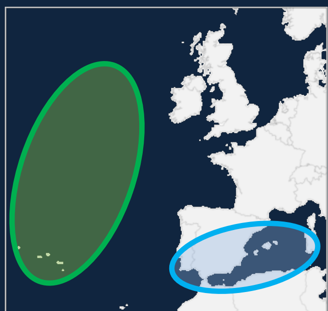
Sharply genetically and ecologically differentiated

↓

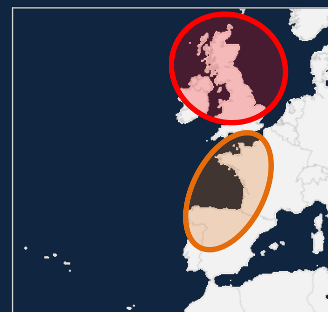
Separate in management plans – threat assessment

Implications for conservation

Pelagic dolphins



Coastal dolphins



Habitat destruction

Noise pollution

Noise pollution

Chemical pollution

Bycatch

Sharply genetically and ecologically differentiated

↓

Separate in management plans – threat assessment

Large and highly diverse

Small and weakly diverse

Low recent migration rates using BayeAss (min = 0.003 and max = 0.011)

↓

Sensitivity to disturbance

Habitat modelling

Supports offshore Natura 2000 sites

Supports the protection of their habitat (Special Areas of Conservation)

On-going projects and future directions

Gaps in knowledge	Status
Fine-scale population structure in coastal waters	On-going - microsatellites

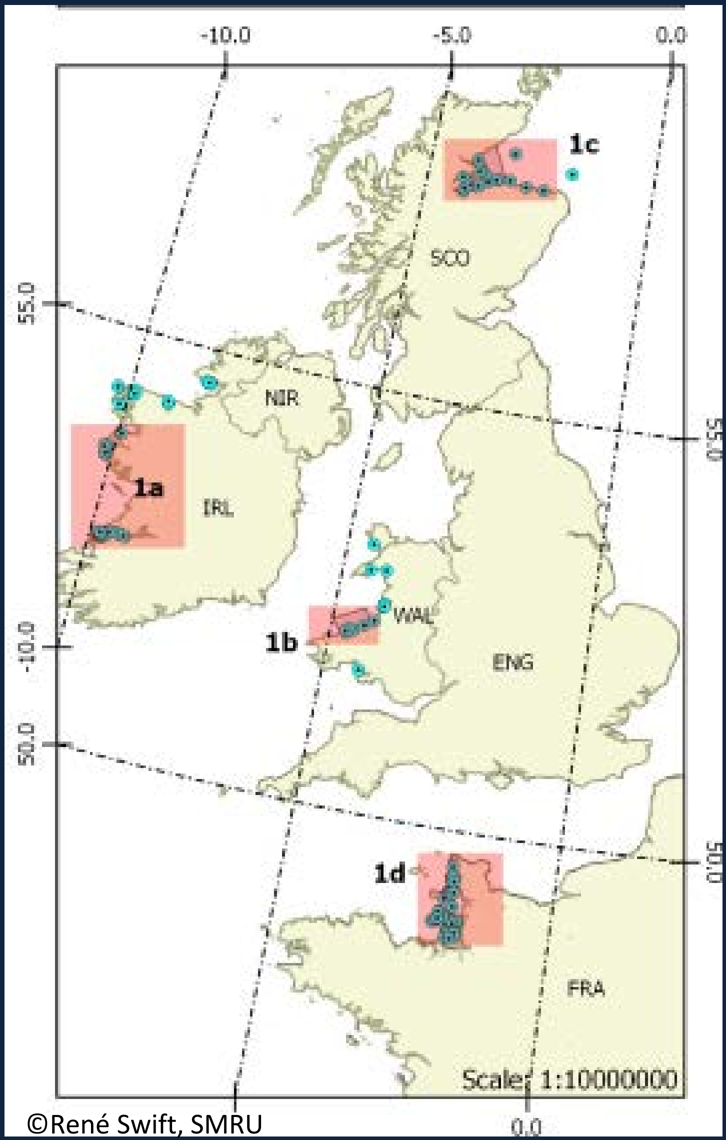
On-going projects and future directions

Fine-scale genetic structure in coastal dolphins in the British Isles and northern France
Milaja Nykänen and Emer Rogan (University of Cork)

Genotyping Irish samples for the same markers as the European study

→ Define fine-scale population structure
→ Estimate contemporary gene flow and effective population sizes

Evaluate connectivity between dolphin populations in different SACs and spatial gaps in protection



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Gaps in knowledge

Gaps in knowledge	Status
Fine-scale population structure in coastal waters	On-going - microsatellites
Recent demographic history – impact of recent past human activities → risk assessment	Limitations with microsatellites – need genomic data – samples available but lack of funding
Adaptation to coastal and pelagic habitats	On-going – whole-genome re-sequencing

On-going projects and future directions

Population genomics of bottlenose dolphins

Supervisors : Oscar Gaggiotti (SOI), Michael Fontaine (University of Groningen), Andrew Foote (University of Bangor), Benoit Simon-Bouhet (University of La Rochelle)

1) Demographic history of the species
2) Adaptation to coastal and pelagic habitats worldwide

→ Whole genome resequencing

Fondation Fyssen

TOTAL CORPORATE FOUNDATION

Gaps in knowledge

Gaps in knowledge	Status
Fine-scale population structure in coastal waters	On-going - microsatellites
Recent demographic history – impact of recent past human activities → risk assessment	Limitations with microsatellites – need genomic data – samples available but lack of funding
Adaptation to coastal and pelagic habitats	On-going – whole-genome re-sequencing
Fine-scale adaptations to local environment conditions in coastal dolphins → vulnerability to environmental changes	Need genomic data – samples available but lack of funding

Acknowledgments

Thanks to all sample contributors

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Yves Cherel, Jerome Spitz, Michael Fontaine, Gael Guillou, Pierre Richard, Tamara Lucas, Hélène Peltier, Amélia Viricel

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Thanks for your attention!

Current knowledge of bottlenose dolphin status, ecology and human interactions in the waters off northern and western France

Caurant, F.[1], Authier, M.[2], Dabin, W.[2], Dars, C.[2], Demaret, F.[2], Doremus, G.[2], Lambert, C.[1], Laran, S.[2], Louis, M.[1], Peltier, H.[2], Spitz, J.[2], Van Canneyt, O.[2], Ridoux, V.[1, 2]

[1] *Centre d'Etudes Biologiques de Chize (CEBC), UMR 7372, CNRS-Université de La Rochelle, Villiers-en-Bois 79360, France*

[2] *Observatoire PELAGIS, UMS 3462, Université de La Rochelle – CNRS, Pôle analytique - 5 allées de l'Océan - 17000 La Rochelle*

In the French EEZ, bottlenose dolphins mostly dwell in offshore waters and more coastal units are located in the Iroise Sea and the Gulf of Saint Malo. Abundance estimates, distribution and habitat modelling were derived from SAMM surveys ("*Suivi Aérien de la Mégafaune Marine*"), two dedicated aerial surveys conducted in winter 2011-2012 and summer 2012 following a strip-transect methodology deployed from the coast to oceanic waters. The study area spanned 375,000 km². Whereas the English Channel only included a continental shelf stratum (92,900 km²), the Bay of Biscay (282,100 km²) was stratified into three bathymetric strata: the continental shelf, the continental slope and the oceanic stratum. A total of 111 sightings were collected on effort within the English Channel and the Bay of Biscay. Bottlenose dolphins showed no clear seasonal change of their abundance with a corrected abundance of about 18,700 dolphins (95 %CI: 7,537-47,026) for the total area in winter and 13,884 dolphins (95 %CI: 6,654-30,987) in summer. A large number of 'pelagic' encounters were observed both in winter and in summer (Laran *et al*., 2017).

Lambert *et al*. (2017a) explored seasonal variations of their habitat preferences with Generalised Additive Models, using physiographic variables and oceanographic predictors for both seasons. In winter the species was predicted to mostly avoid coastal and shelf waters and the model resulted in bottlenose dolphins being mainly predicted in the southern Bay of Biscay, especially over the shelf edge, and in adjacent oceanic waters. In summer, bottlenose dolphins have also a marked preference for the shelf edge but they are more dispersed. Higher densities were also predicted in the Gulf of Saint Malo, whereas densities were close to zero in the eastern Channel (Lambert *et al*., 2017a). An annual integrated ecosystemic ship-based survey (PELGAS, *Pélagiques Gascogne)* conducted every spring between 2004 and 2014 in the Bay of Biscay allowed the collection of sighting data on marine megafauna, following a linear transect methodology. Bottlenose dolphin mean density was highest around the shelf break in spring, which is consistent with aerial survey results.

The Proportion of Utilized Area (PUA) by bottlenose dolphins in the Bay of Biscay can also be studied with a single-visit site-occupancy model. This PUA is an indicator of distributional range and suggested a 40% decline in PUA between 2004 and 2014. Strandings are another important source of information for marine mammals. About 540 strandings of bottlenose dolphins were recorded on the French coasts over the last 27 years. The two areas with the most numerous strandings are the Manche county along the east side of the Gulf of Saint Malo where one coastal resident group is observed, and the southern Bay of Biscay, an area with a narrow continental shelf. Between 1990 and 2015 a yearly average of 16 individuals have been reported from along the Atlantic coast and 5 individuals from the Channel. Yet a clear increase of the number of stranded individuals was shown over the period as well as marked seasonal variations, with higher numbers of stranded individuals from January to May.

Based on samples collected from stranded individuals, Louis *et al*. (2014) confirmed the ecological differentiation between coastal and pelagic individuals through the analysis of nitrogen, sulphur and carbon stable isotopes in skin. These results were also supported by the dietary segregation shown by stomach content analysis (Louis *et al*., 2014). The contamination status of resident individuals from the Gulf of Saint Malo was also assessed from biopsies (Zanuttini, 2016). As in numerous European populations, bottlenose dolphin individuals exhibited high levels of PCBs and PCB-dioxin like compounds, whereas organochlorine pesticides appeared to be of less concern (Zanuttini, 2016).

Besides pollution this species has to face numerous other potential threats in relation to increasing human activities. These threats can be slightly different between pelagic and coastal waters but both include noise pollution, disturbance by tourism activities, as well as trophic and operational interactions with fisheries. The work carried out by Spitz *et al*. (2006) and Louis *et al.* (2014) showed that bottlenose dolphins feed partly on commercial fish such as hake, inducing trophic interactions with fisheries. Thus, over the last 25 years, the percentage of stranded individuals exhibiting bycatch marks was c. 24% (27 out of 113 individuals), highlighting the need for more investigation on this issue.

Finally, the networks of existing Natura 2000 sites and proposed offshore areas of biological interest were assessed by examining how much of the whole population would live with AMPs (Lambert *et al*., 2017). The existing Marine Protected Areas (MPA) under the Birds Directive have been shown to be relevant for cetaceans and among these sites the largest two sites were the most relevant, both of them including more than 1% of the bottlenose dolphin "national population" in summer and winter. On the other hand, only 2.4% of Habitats Directive designated sites had bottlenose dolphin exceeding the 1% threshold value of the population, in summer only. The proposed large offshore areas of interest would constitute a highly relevant network allowing 40% of the bottlenose dolphin population to be included with low variation between summer and winter (Lambert *et al*., 2017b).

Despite the research effort dedicated to this species, gaps in knowledge are still to be noted, in particular concerning the conservation status of offshore populations and the connectivity between offshore and coastal bottlenose dolphins. Finally, although they are more or less identified, the spatial distribution and cumulative impact of threats still have to be clarified and quantified.

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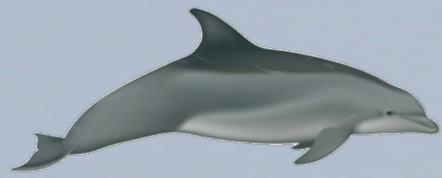
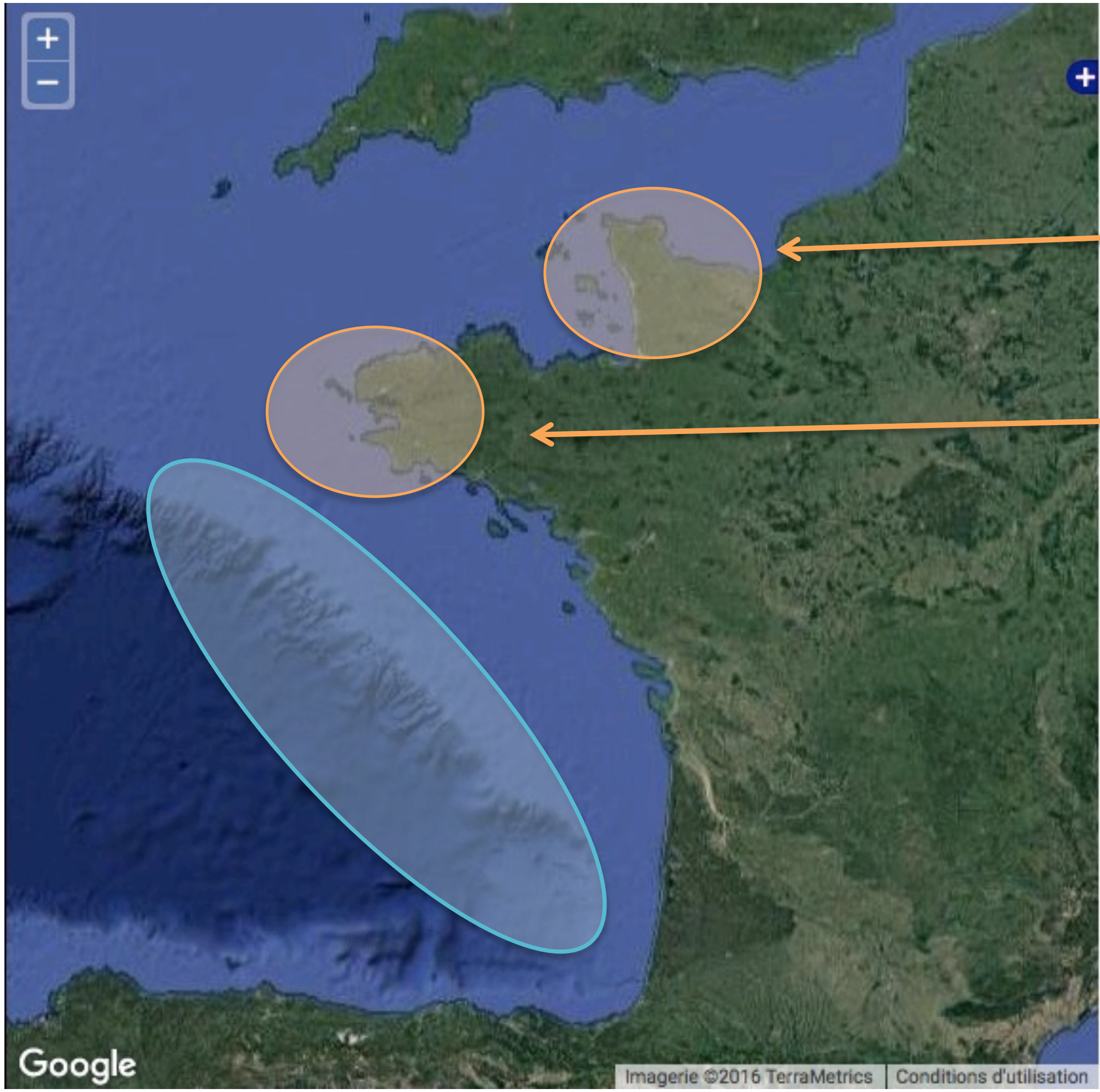


Current knowledge of bottlenose dolphin status, ecology and human interactions in the waters off northern and western France

PELAGIS & CEBC

TRANSNATIONAL BOTTLENOSE DOLPHIN CONSERVATION WORKSHOP
Wed 7th & Thurs 8th Dec 2016



Gulf of Saint-Malo

Iroise Sea

Offshore bottlenose dolphins

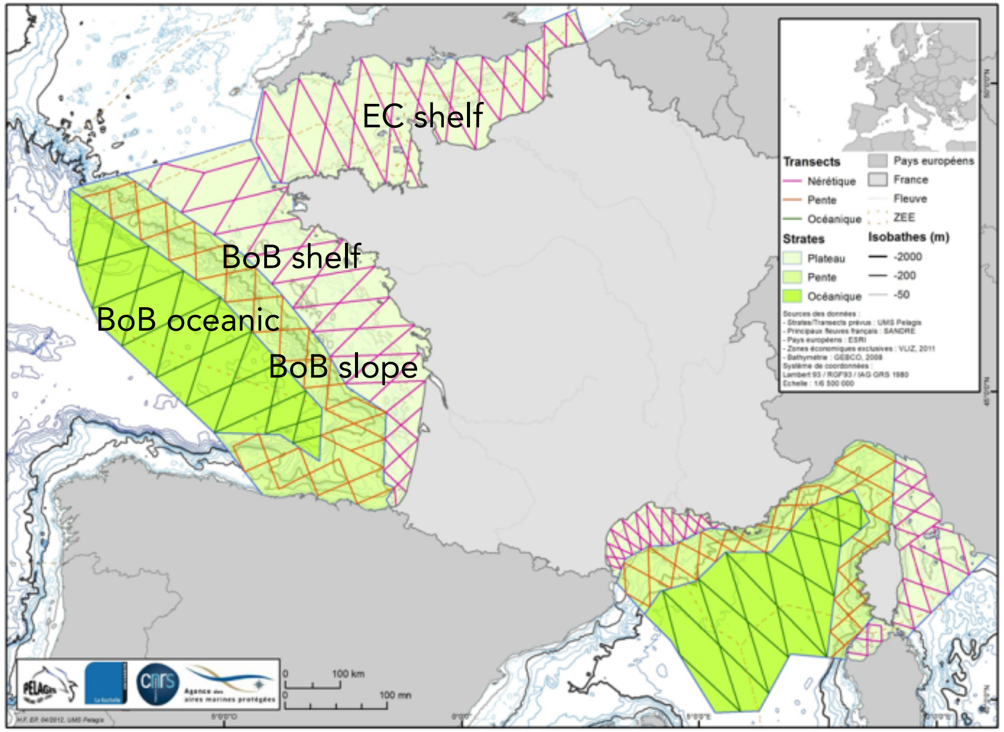
1. Abundance estimates and habitat preferences from:
   - a dedicated aerial survey “Suivi Aérien de la Mégafaune Marine” conducted in winter 2011-2012 and summer 2012
   - Ship-based surveys PELGAS in spring 2004 to 2014

2. Bottlenose dolphin strandings: evidence for temporal trends ?

3. Coastal vs offshore ecological differentiation : stable isotope analysis and stomach content analysis

4. Human interactions

Aerial Census of Marine Megafauna (SAMM)

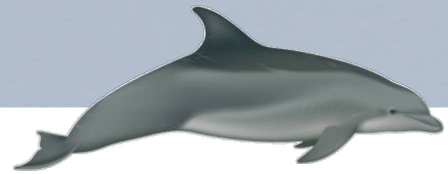


✓ Two surveys:
Nov-Fev. 2011/12, Mai-Août 2012

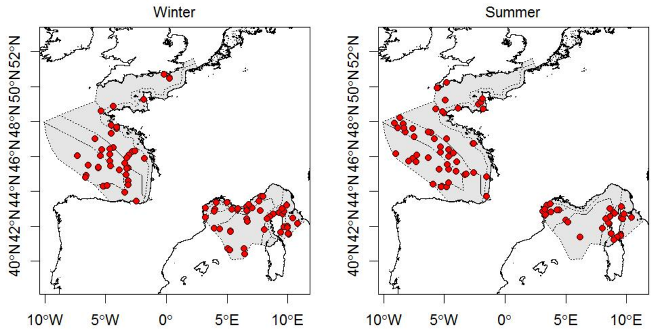
✓ 3 bathymetric strata: continental shelf, slope, oceanic part
→ large scale distribution to identify offshore habitats

Total effort: 98,610 km (with Mediterranean Sea)
48,624 km (Atlantic and English Channel)
91% with sea state < Beaufort 4
And SC greater than medium

Habitat preferences



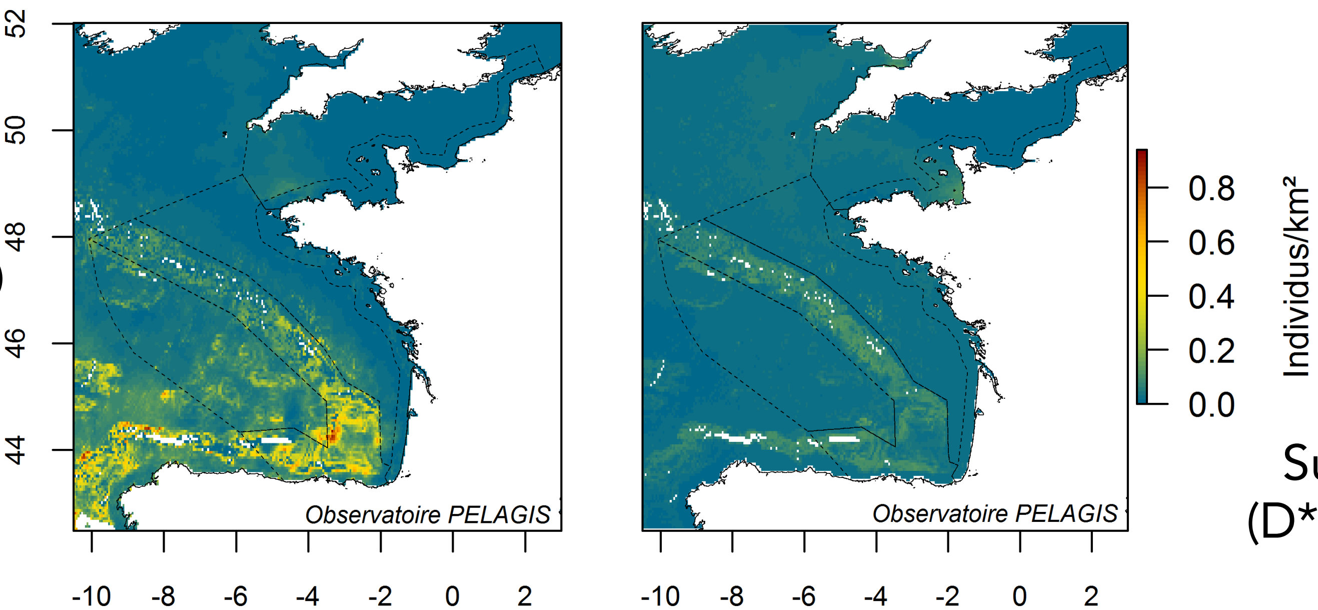
A total of 111 sightings



	Abundance		CI 95%
Bay of Biscay & English Channel	Winter	18,739	7,537-47,026
	Summer	13,884	6,654-30,987

Laran et al, in press

Winter (D* = 24.9%)

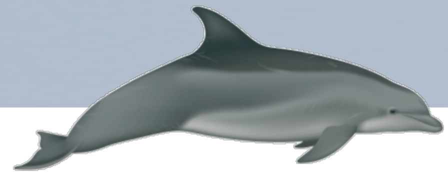


Summer (D*= 15.4%)

preference for warm waters (>15°C) and long-term predictable mesoscale features associated to shelf edge (eddies/fronts)

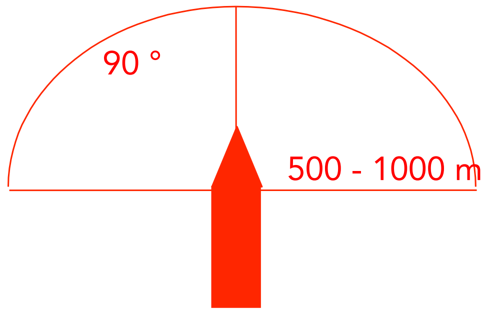
Preference for negative SSH and high slopes

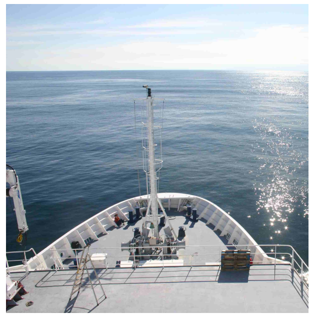
Lambert et al 2016

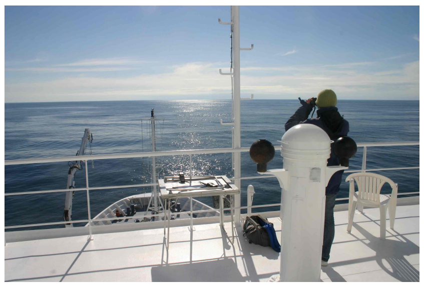


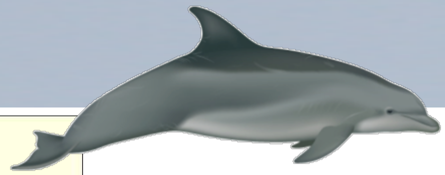
PELGAS: Ship-based survey in spring 2004 to 2014

Since 2004, the annual PELGAS survey, led by the IFREMER, collects data on the distribution of marine top predators

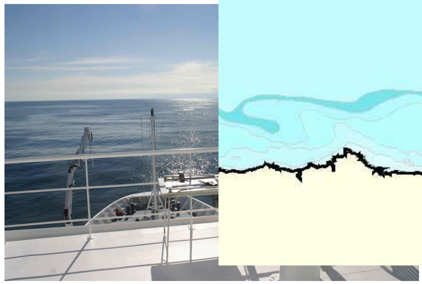


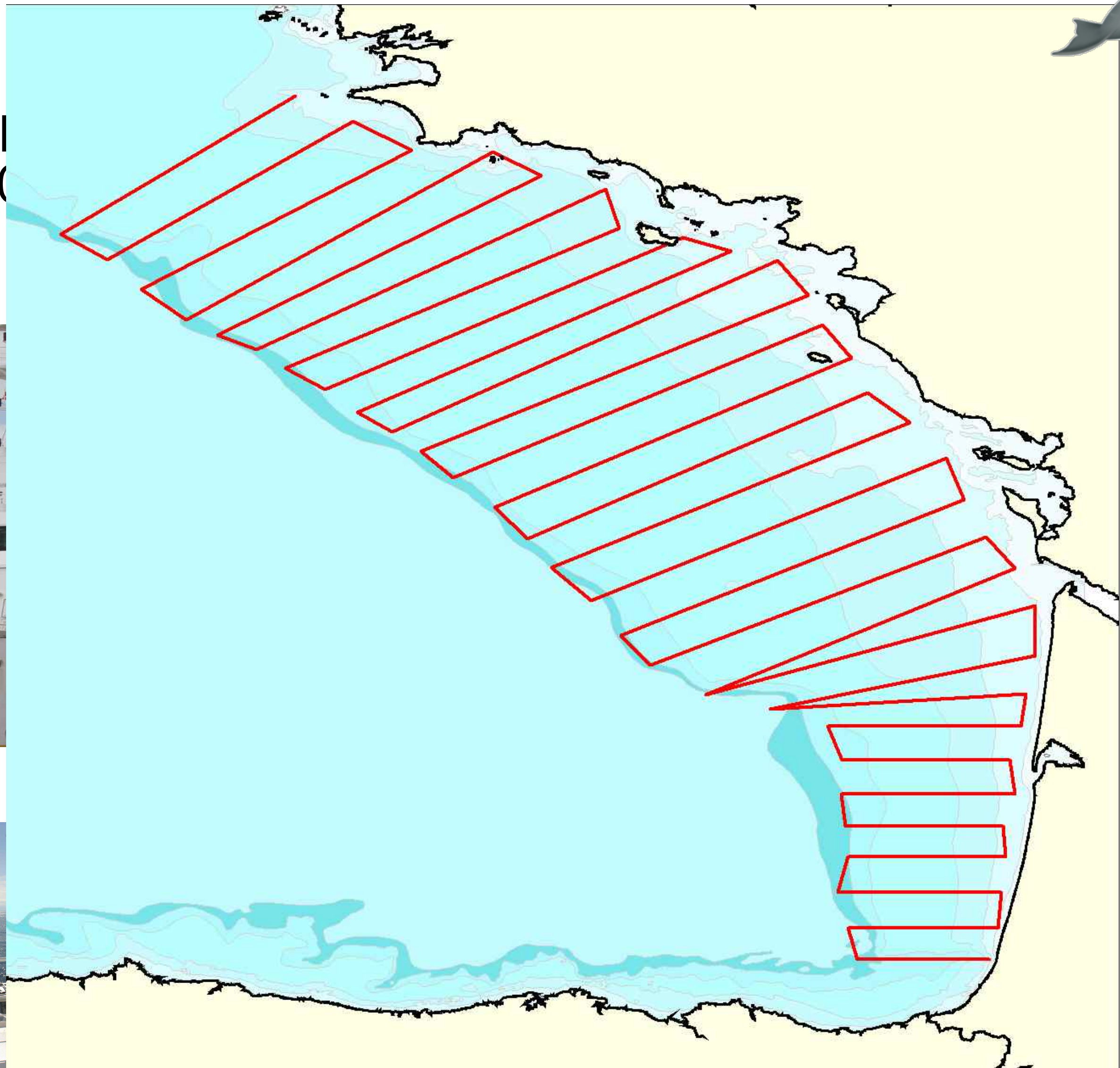


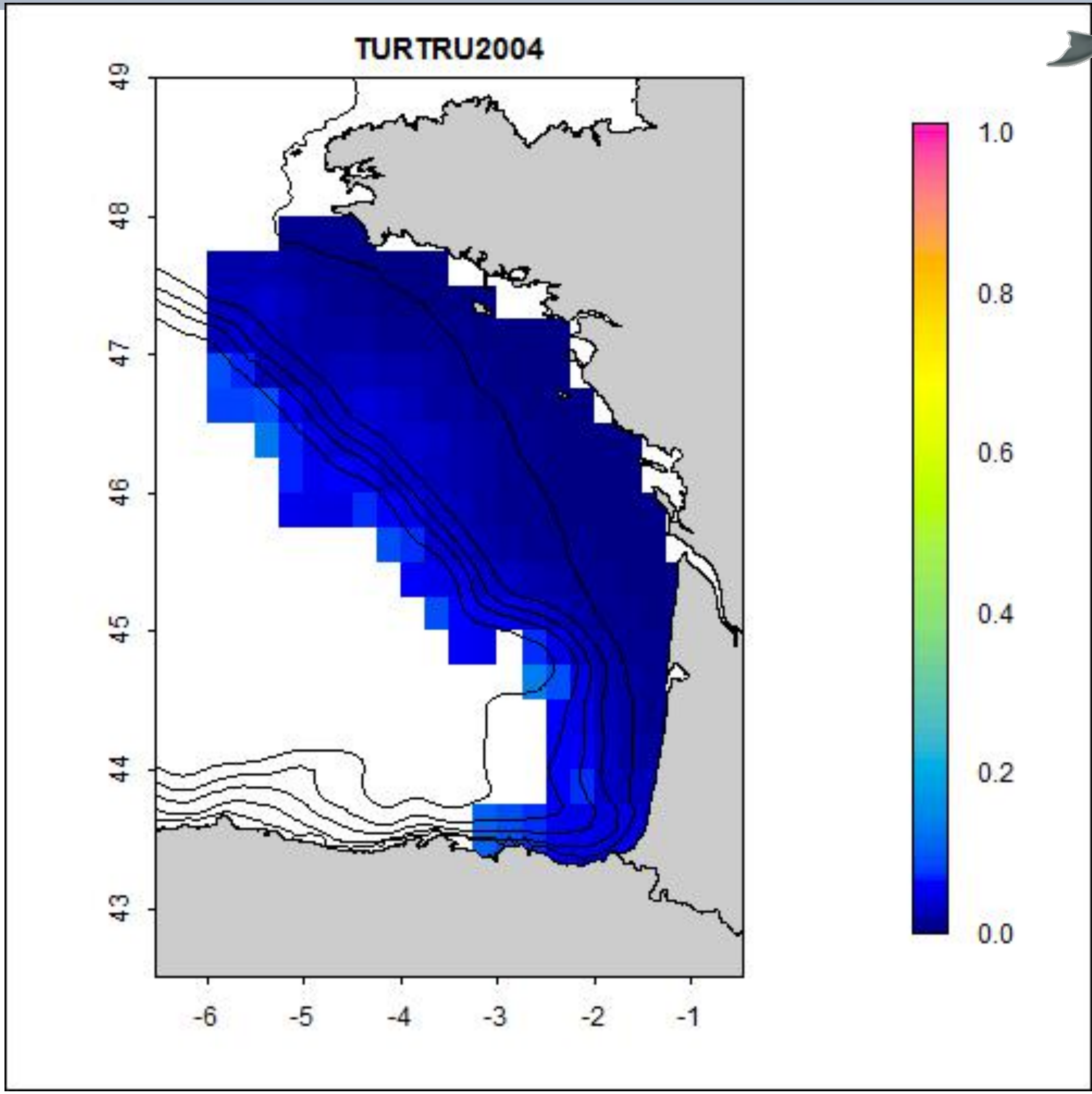




PELGAS: Shi[...]
in spring 2[...]



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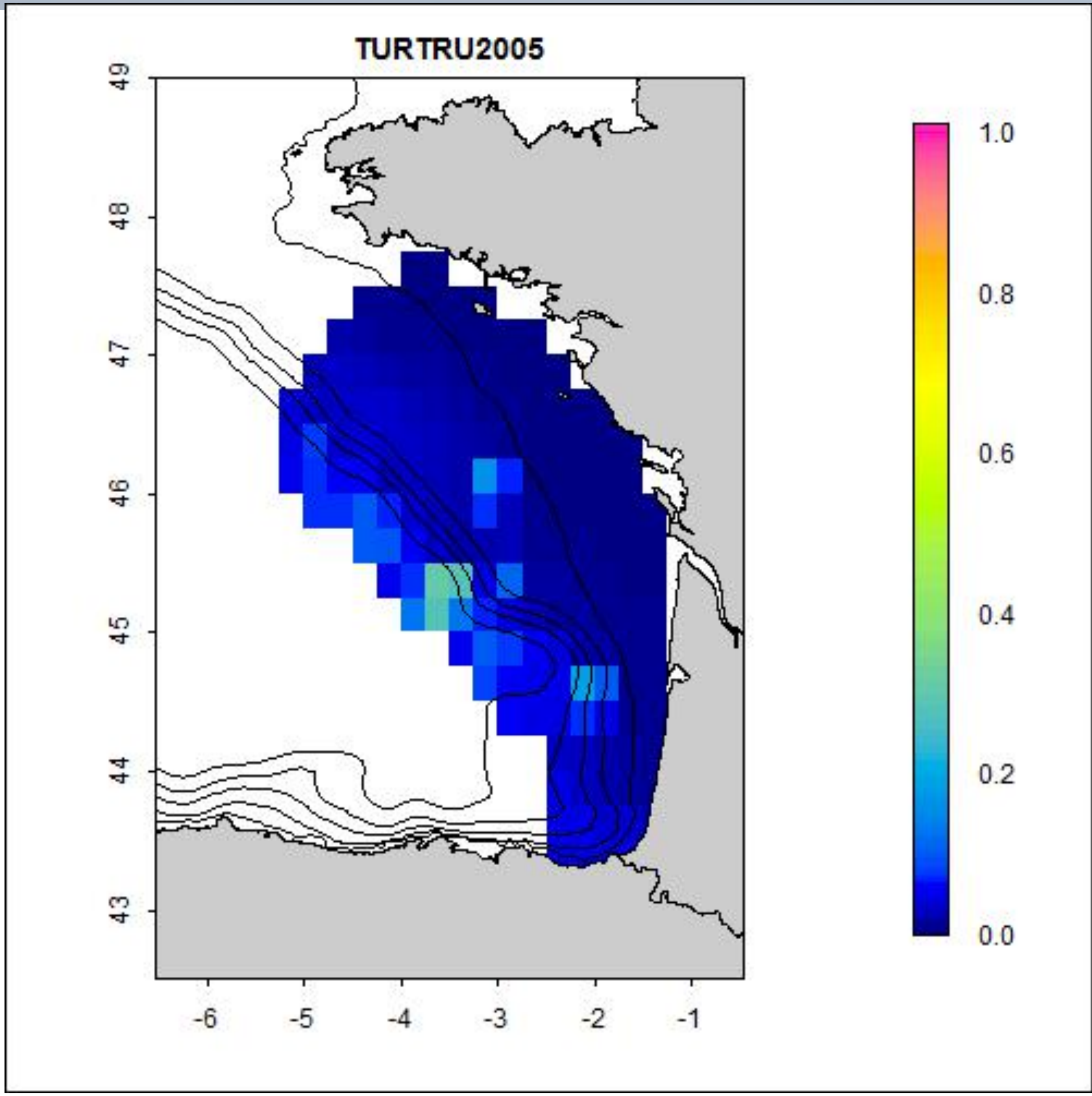
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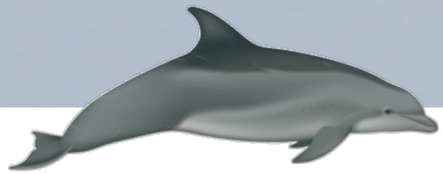

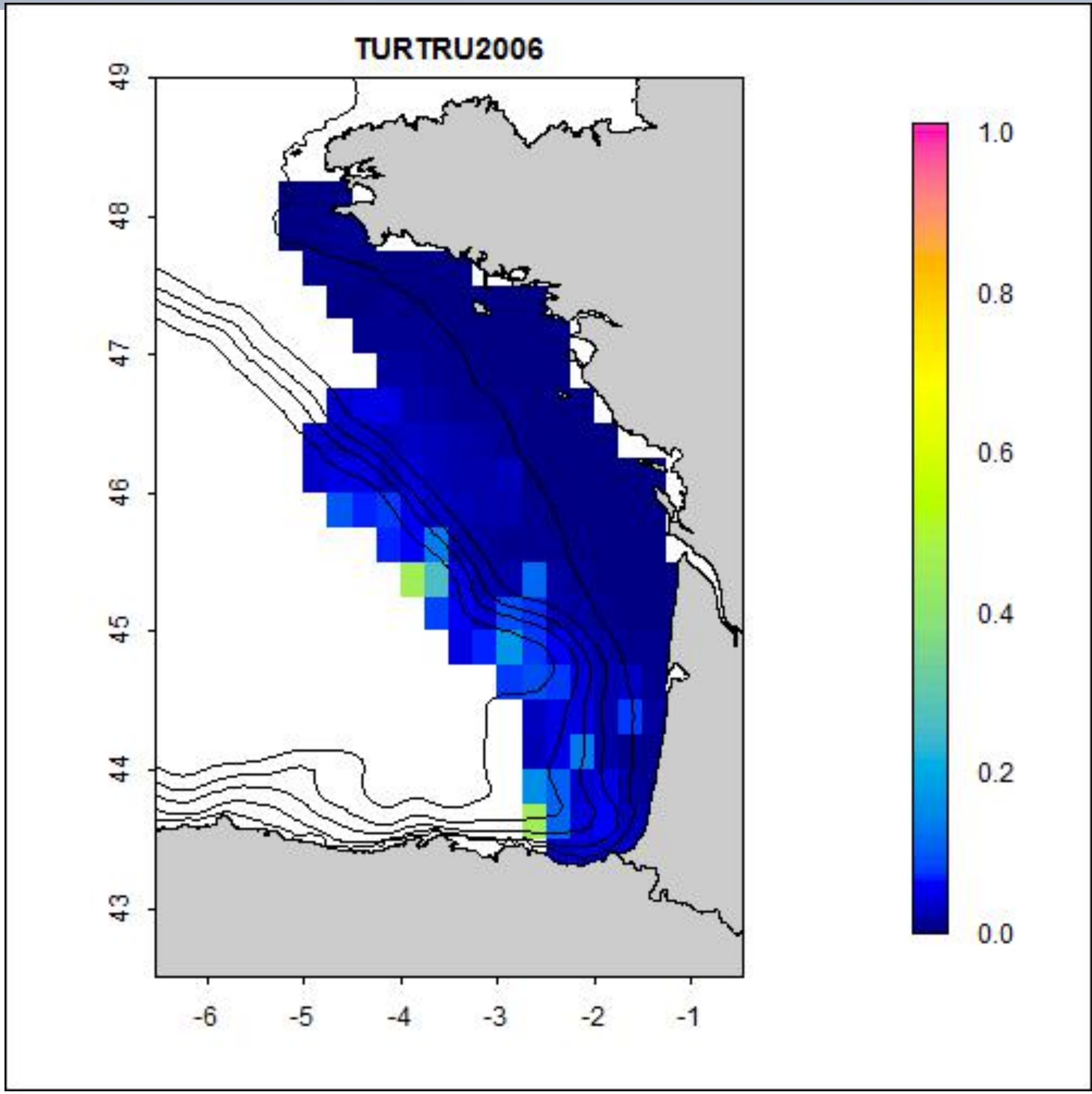
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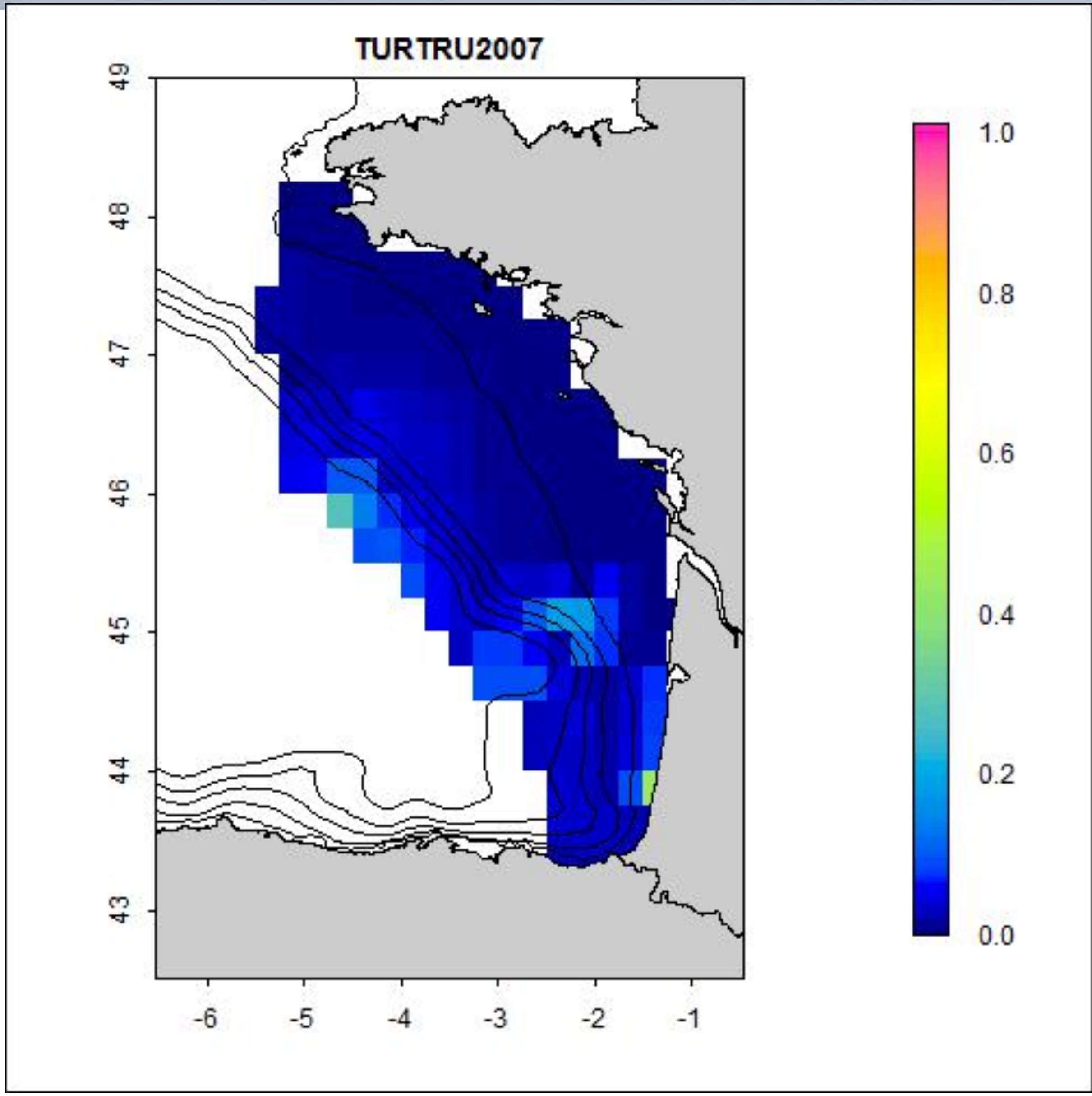
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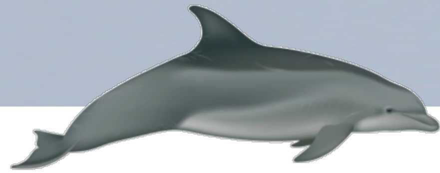

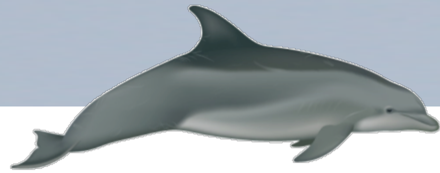

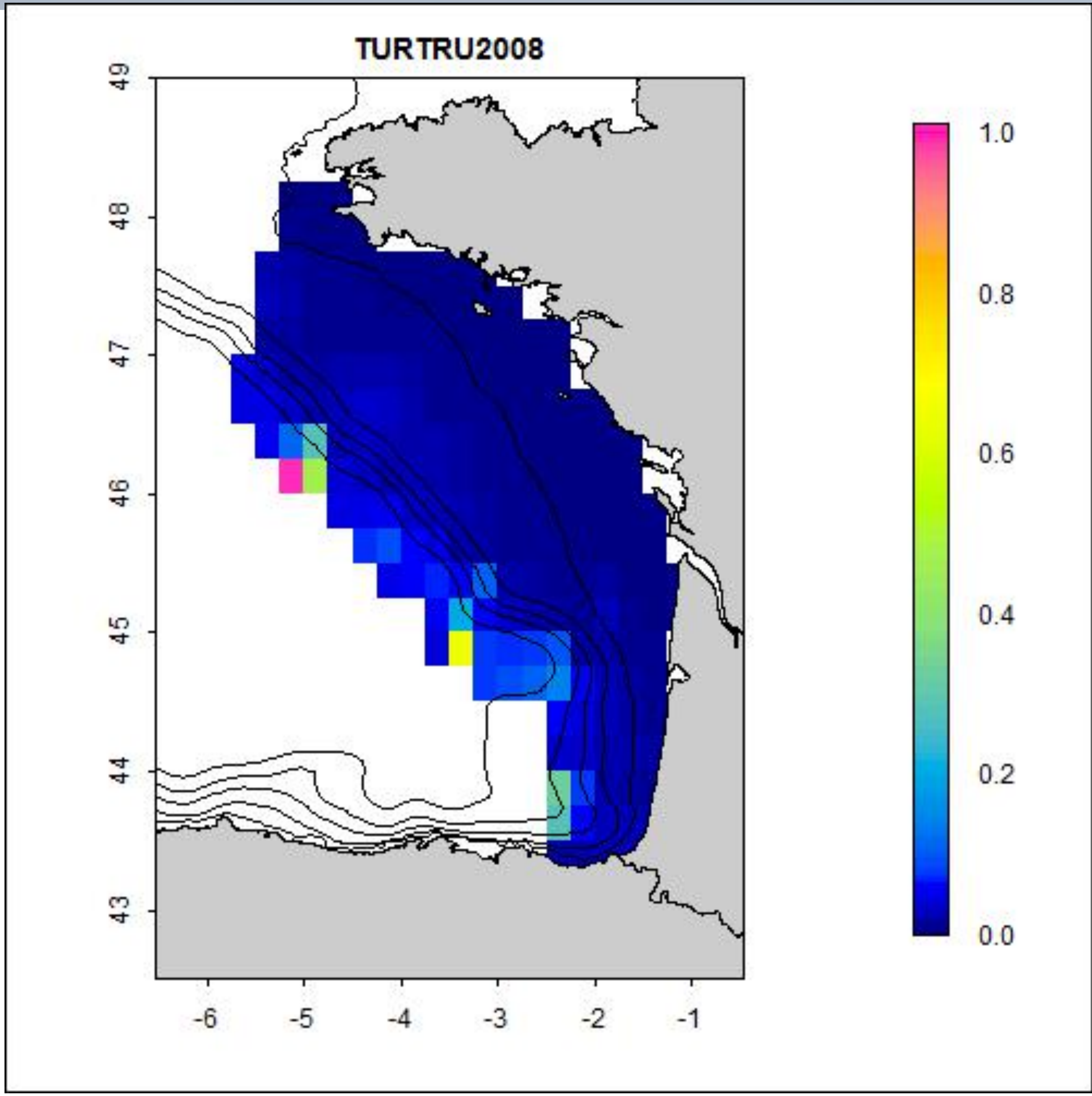
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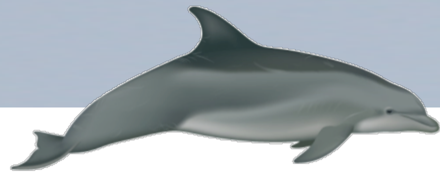

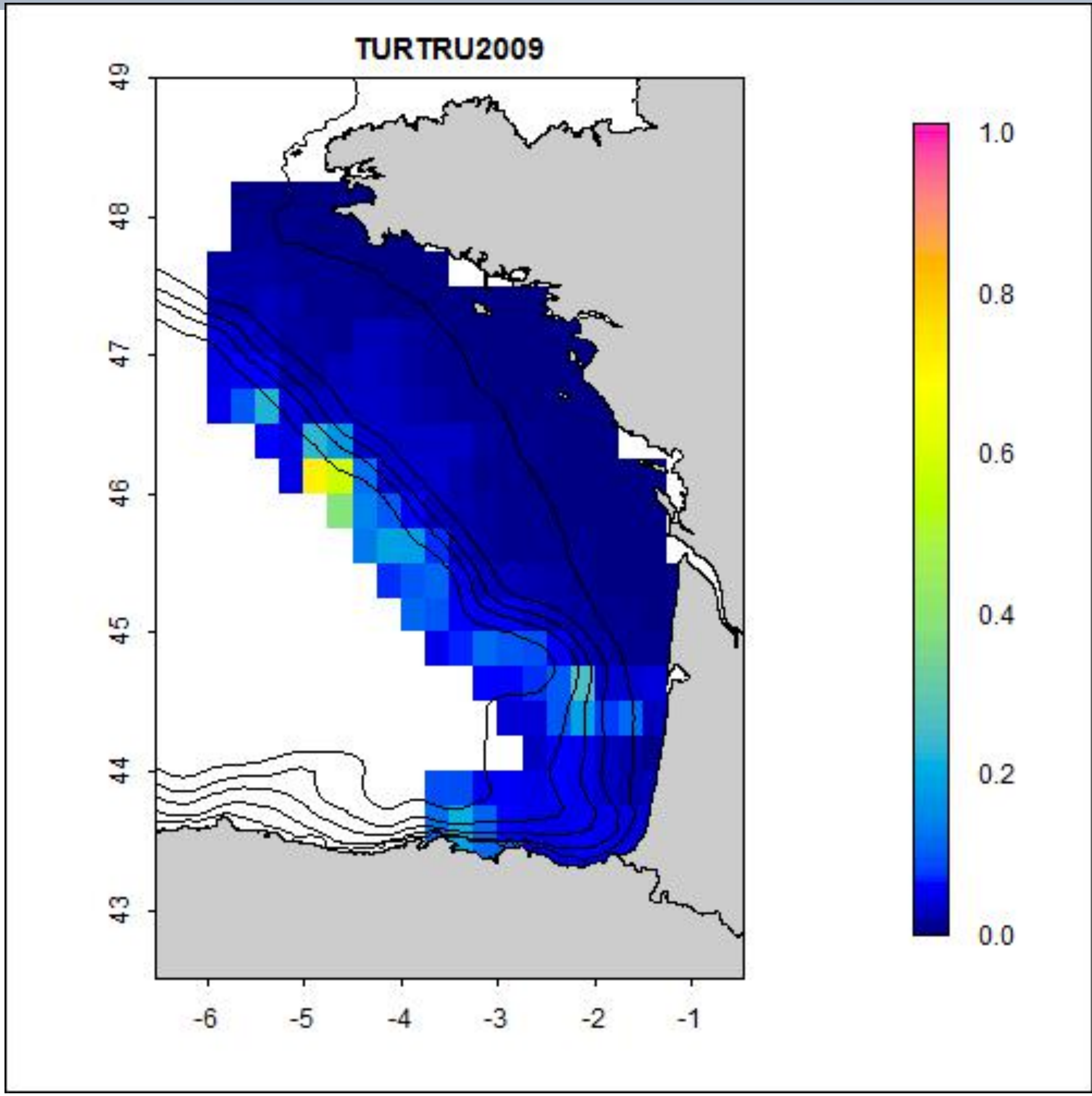
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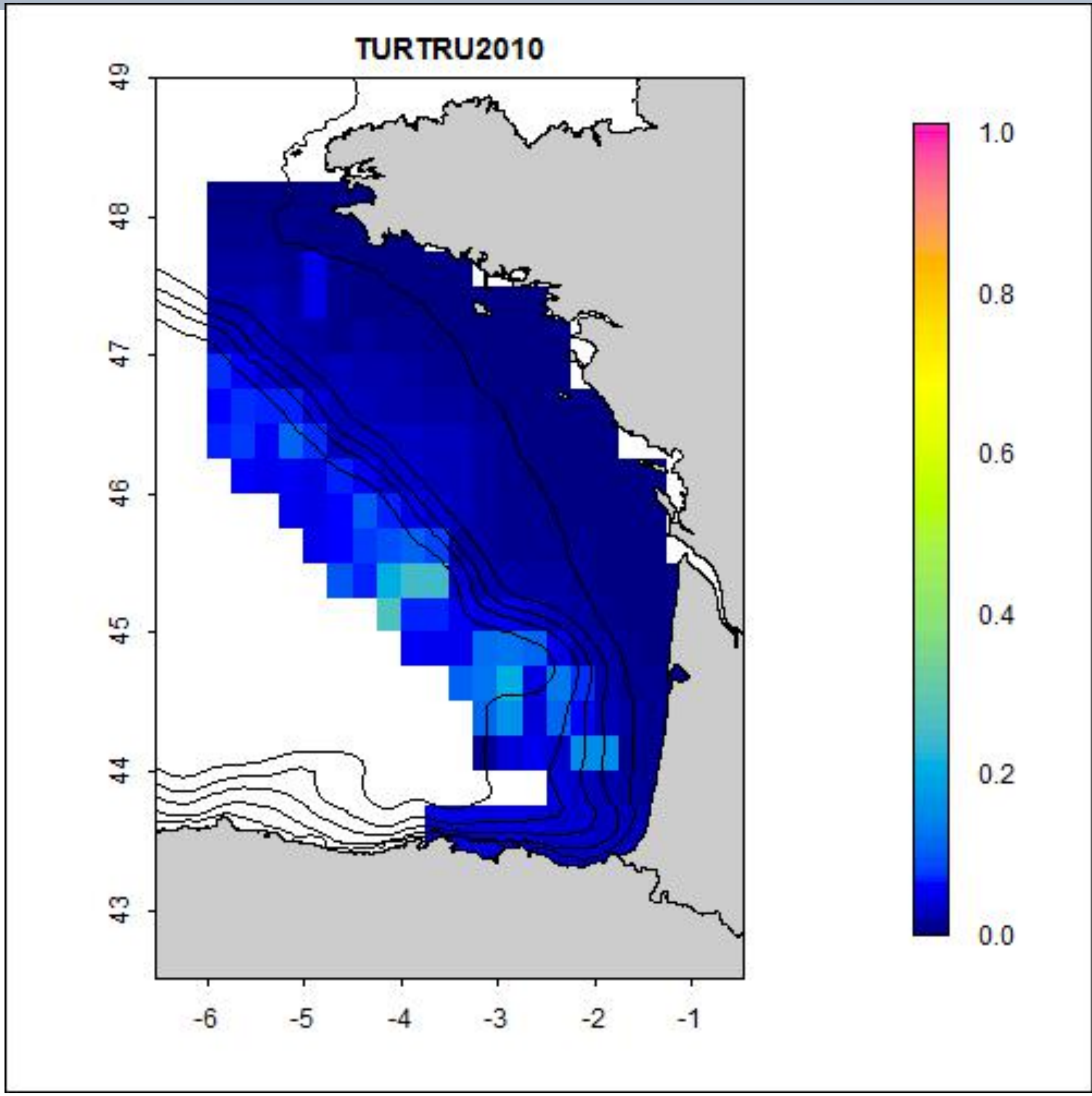
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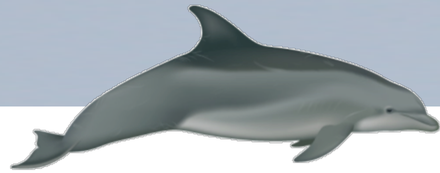

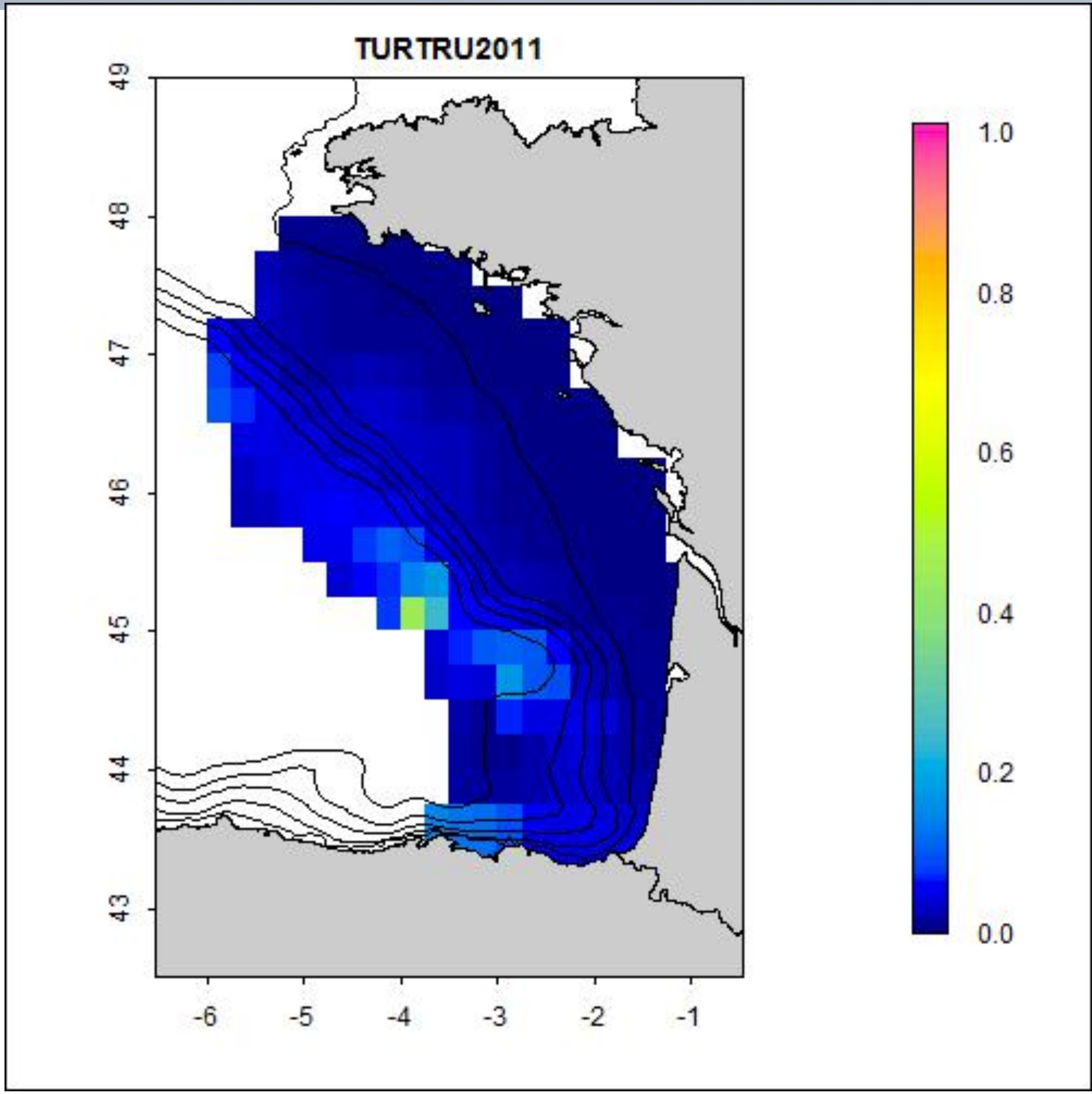
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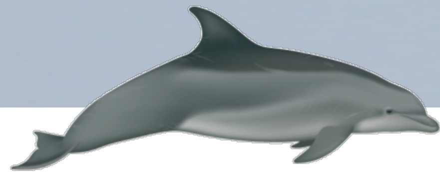

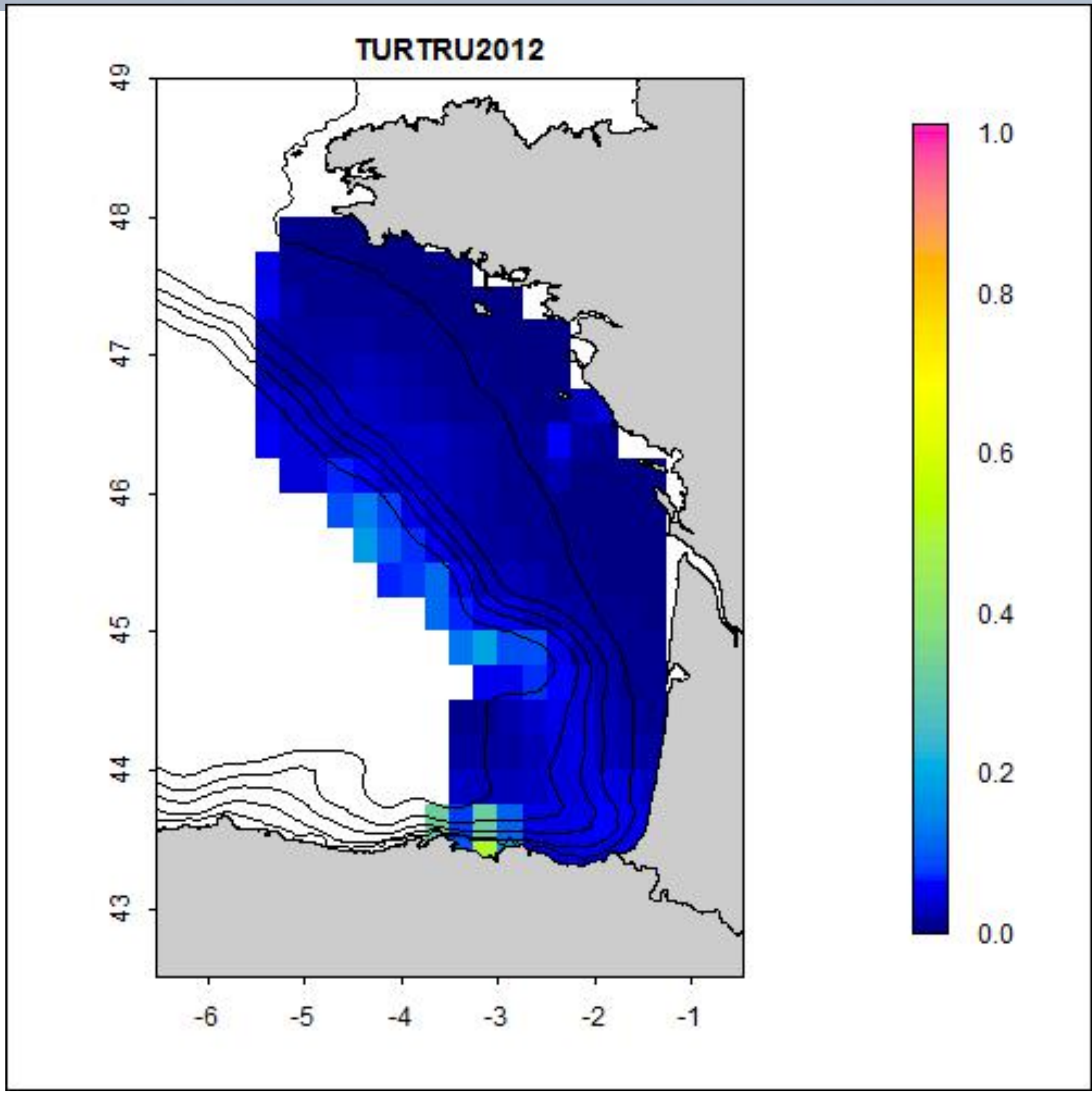
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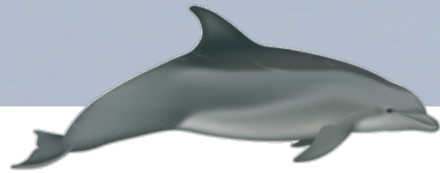

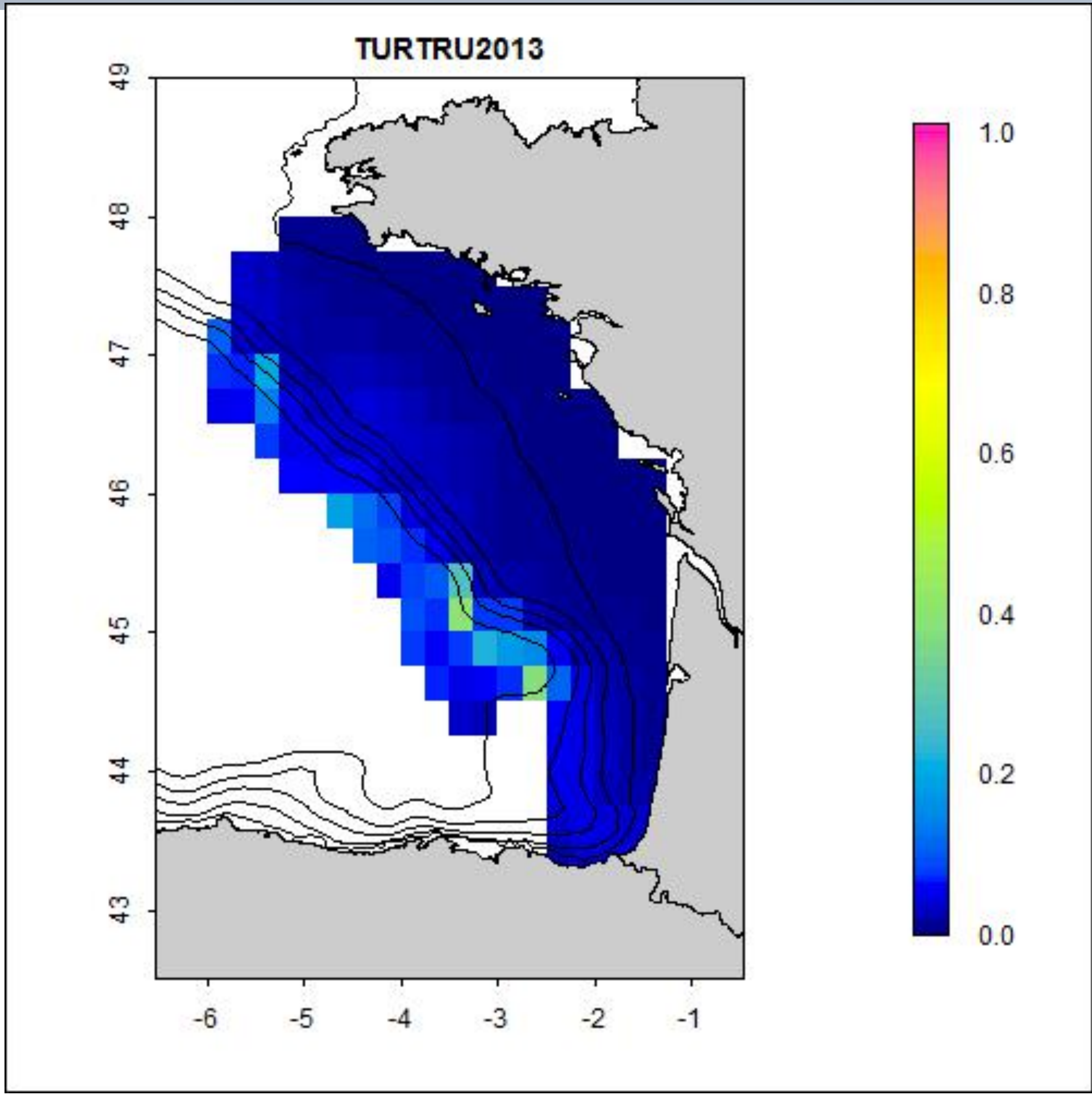
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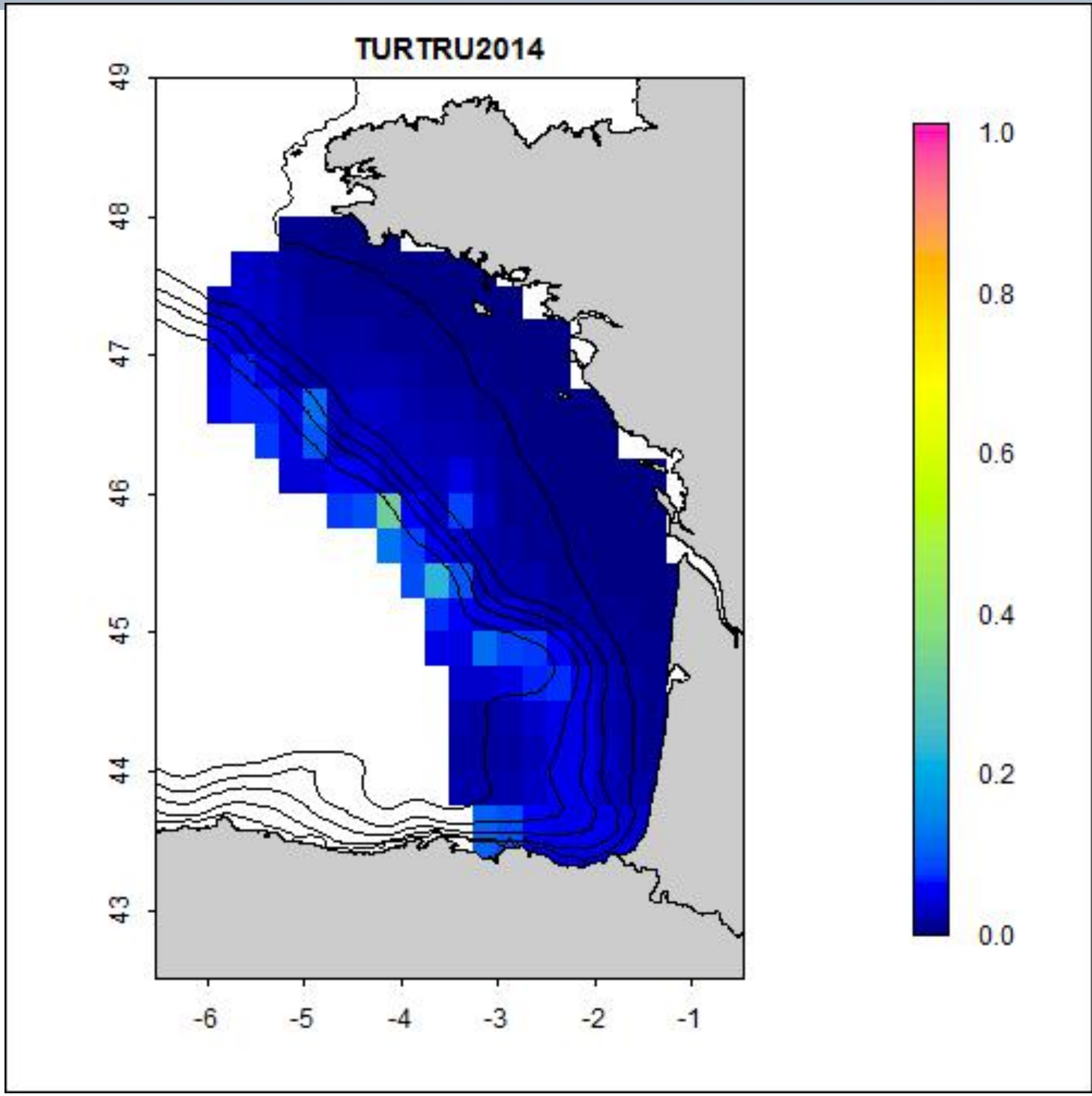
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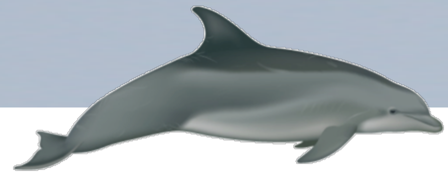
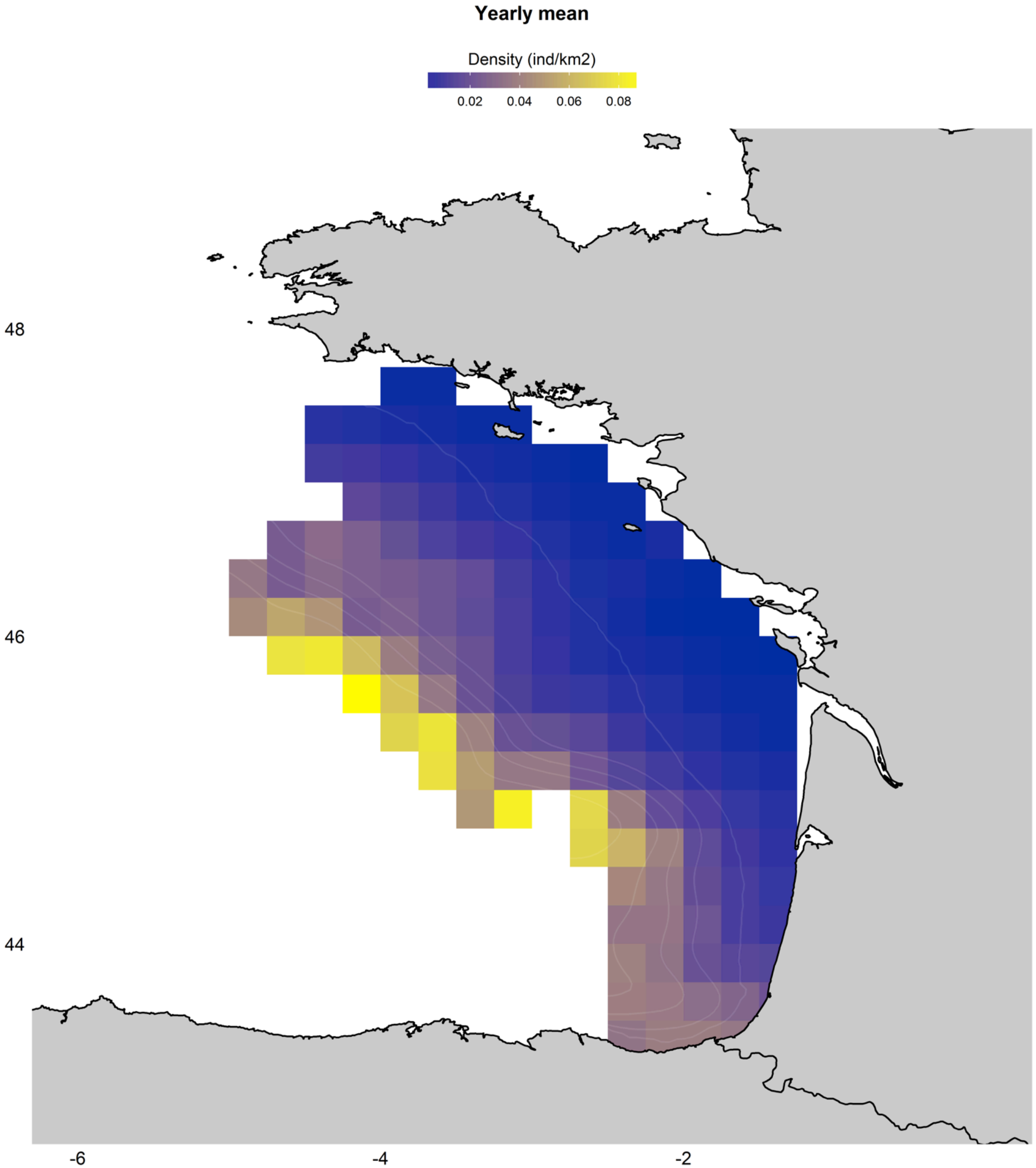




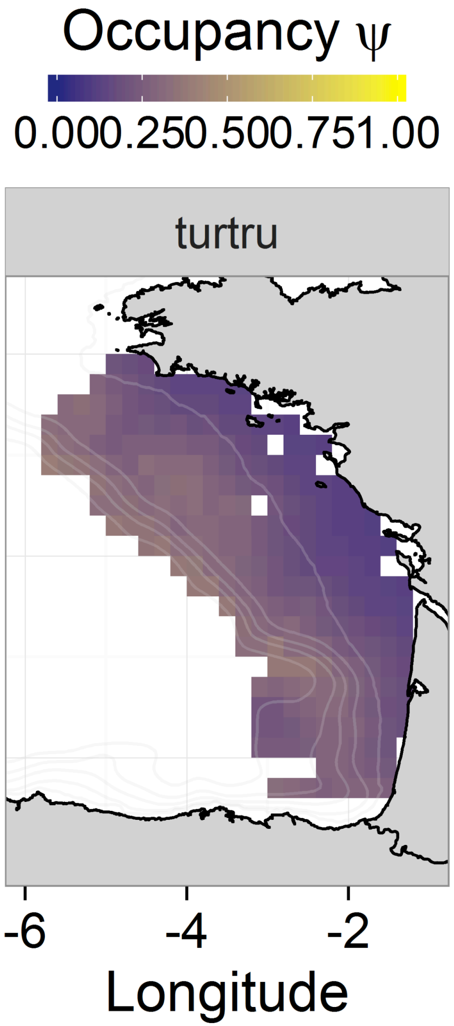
PELGAS
Mean density (2004 to 2014)

Results consistent with aerial survey:

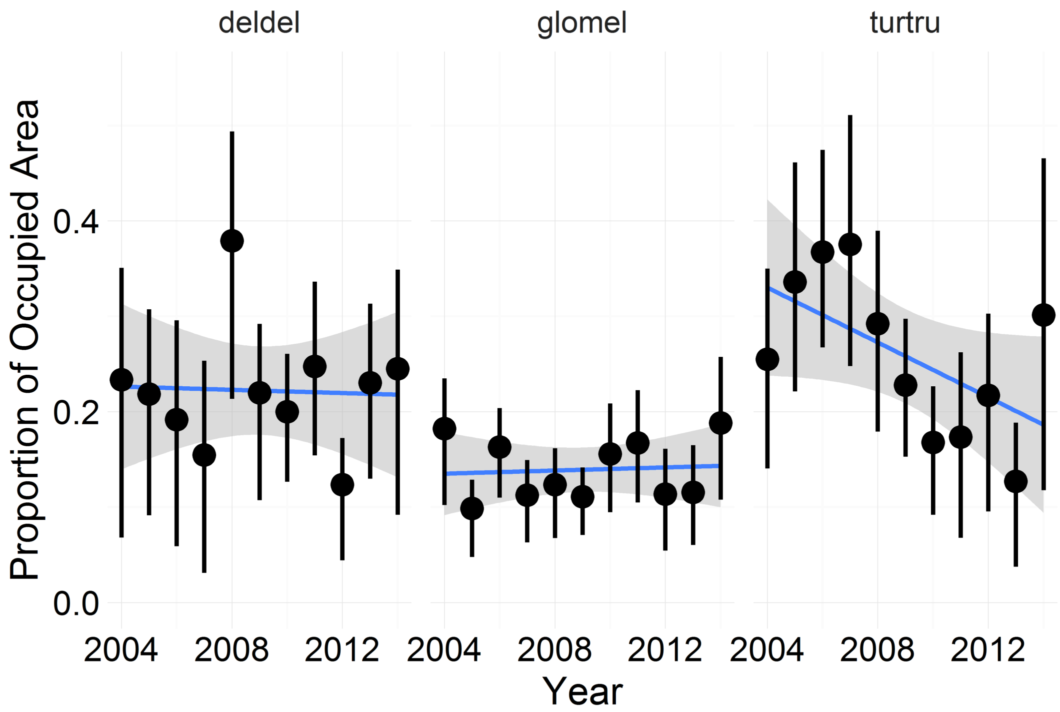
Issues on the slope during spring

Authier et al, 2016

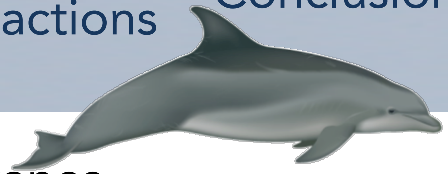
Estimated utilisation for bottlenose dolphin during spring 2014 in the Bay of Biscay



Occupancy models allow inference on the Proportion of Utilised Area (PUA) by a species. PUA (in %) is an indicator of distributional range that can be tracked to assess GES.

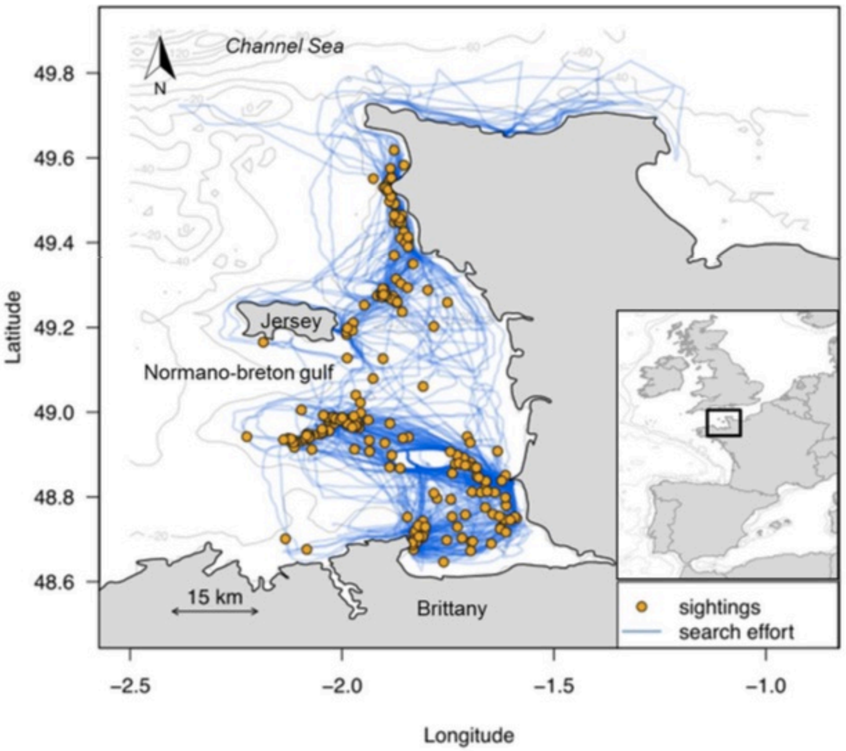


PUA of common dolphin and Long-finned pilot whales were stable between 2004 and 2014. In contrast, the spring PUA of bottlenose dolphins declined by 40% over the same period.



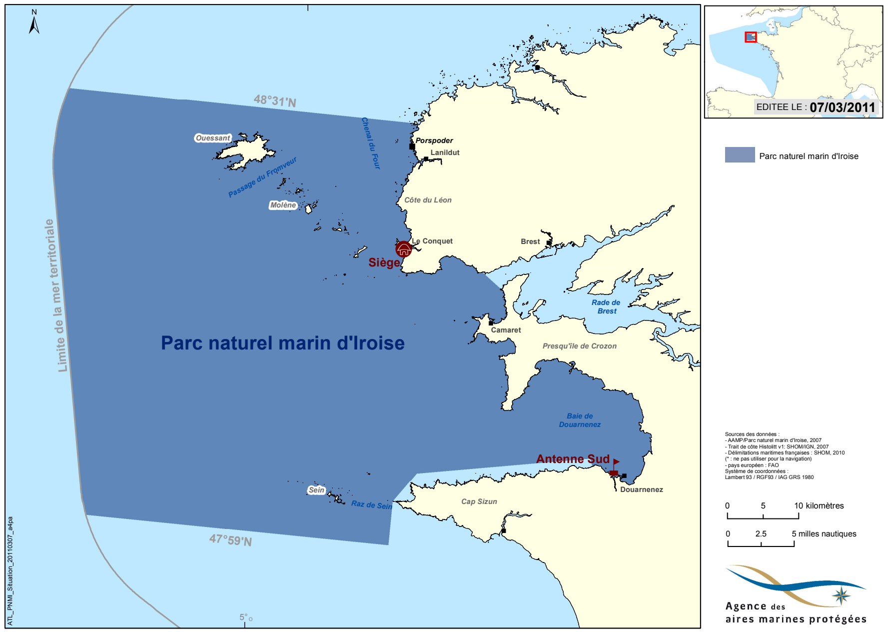
Two areas with resident bottlenose dolphins in France

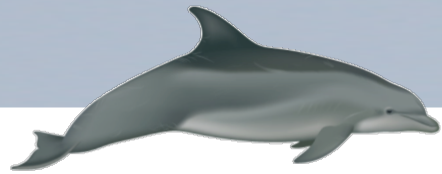
Golfe of Saint-Malo
420 individuals(95% CI: 331- 521)



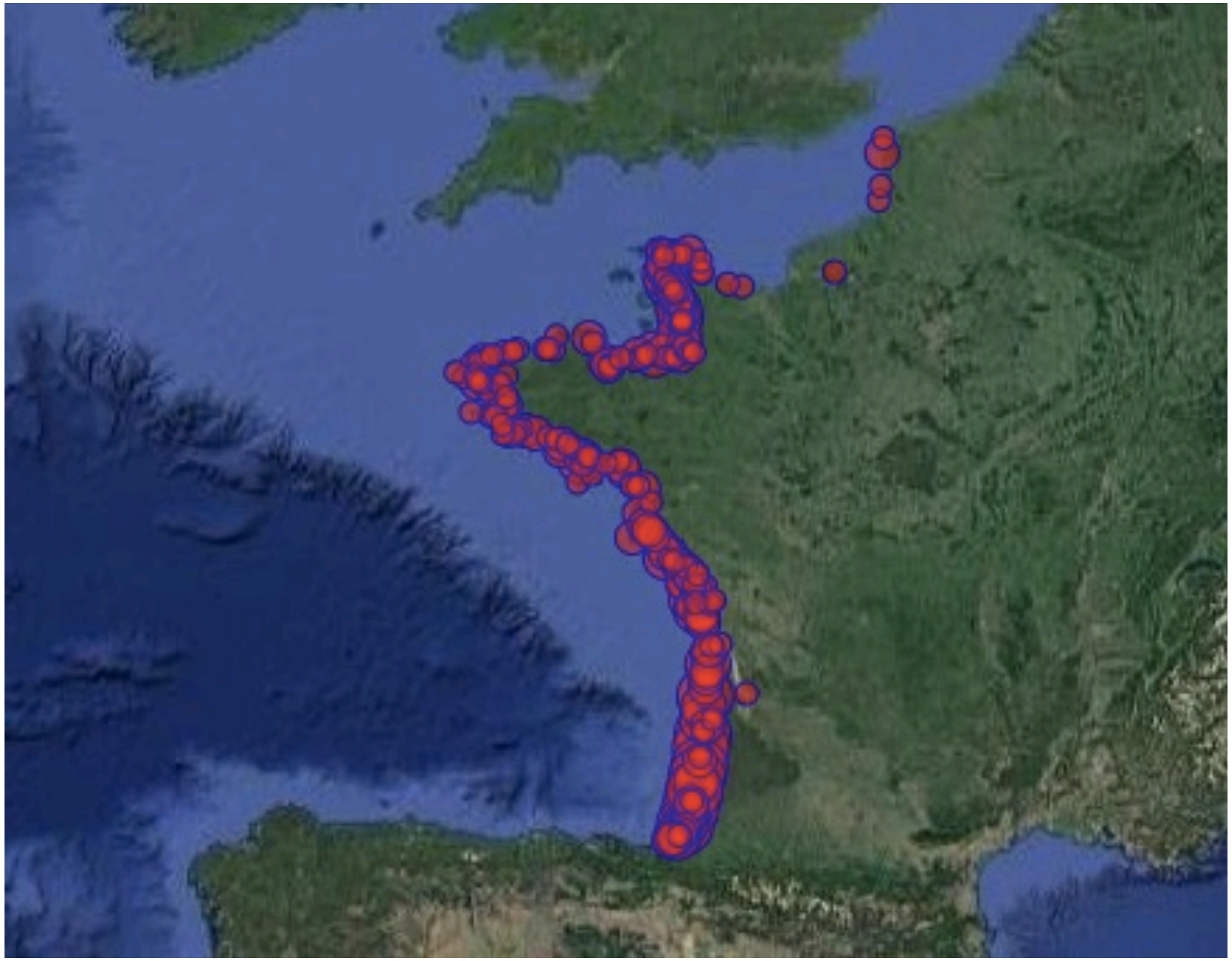
Location of the study area, distribution of survey effort and location of sightings of bottlenose dolphins from 2007 to 2010 (Louis, 2014)

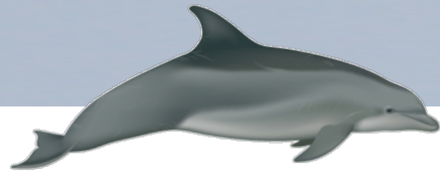
Marine park of Iroise



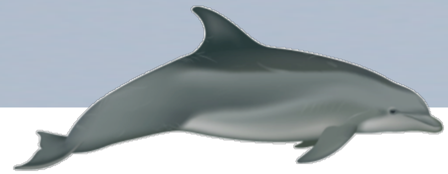


Locations of strandings between 1990 and 2016

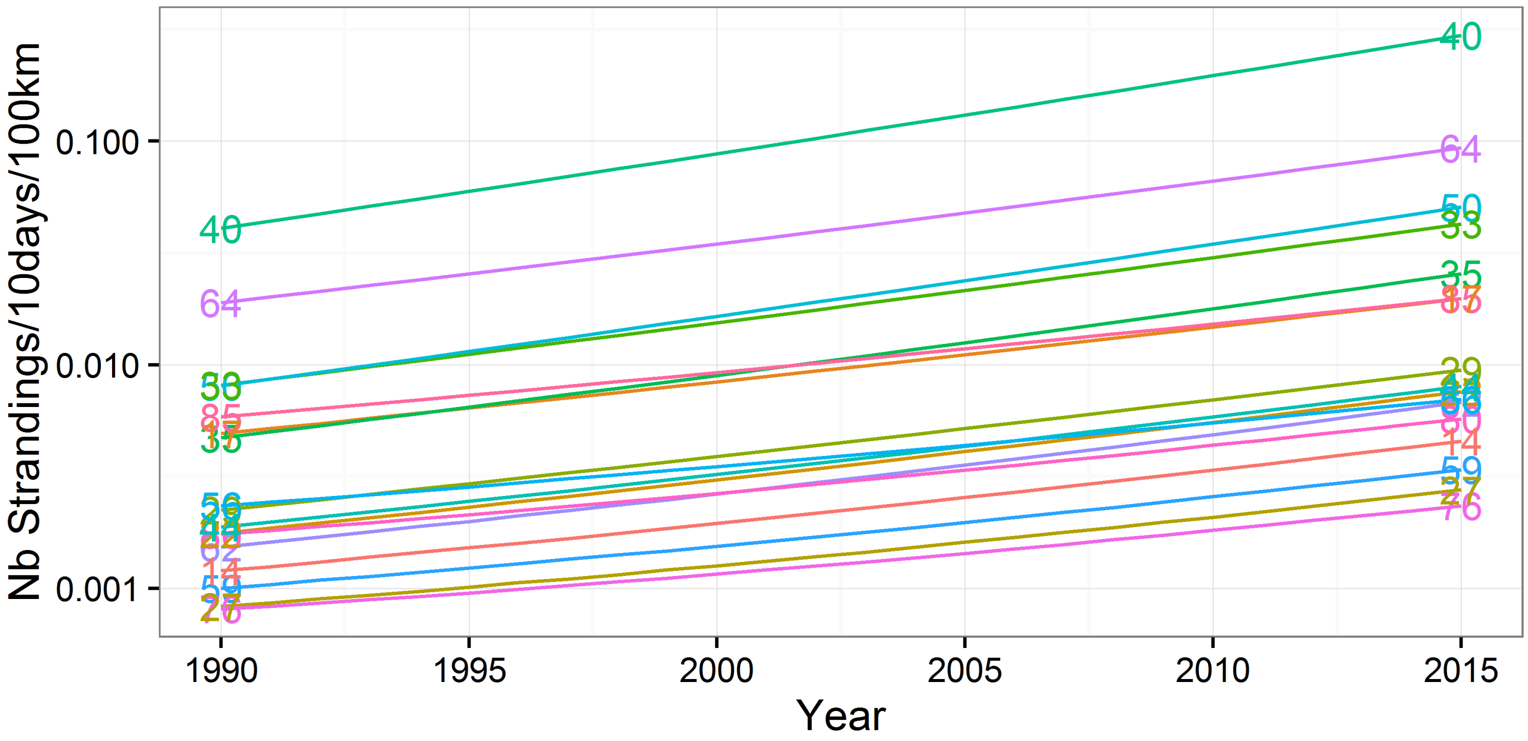




Locations where number of strandings ≥ 5 per year (1990-2016)



Very few strandings:
between 1990 and 2015 : a mean of 16 individuals along the Atlantic coasts and 5 along the Channel coasts

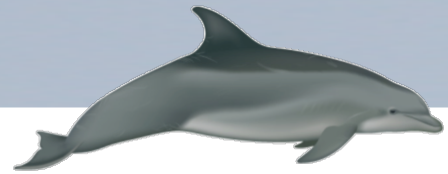


Landes

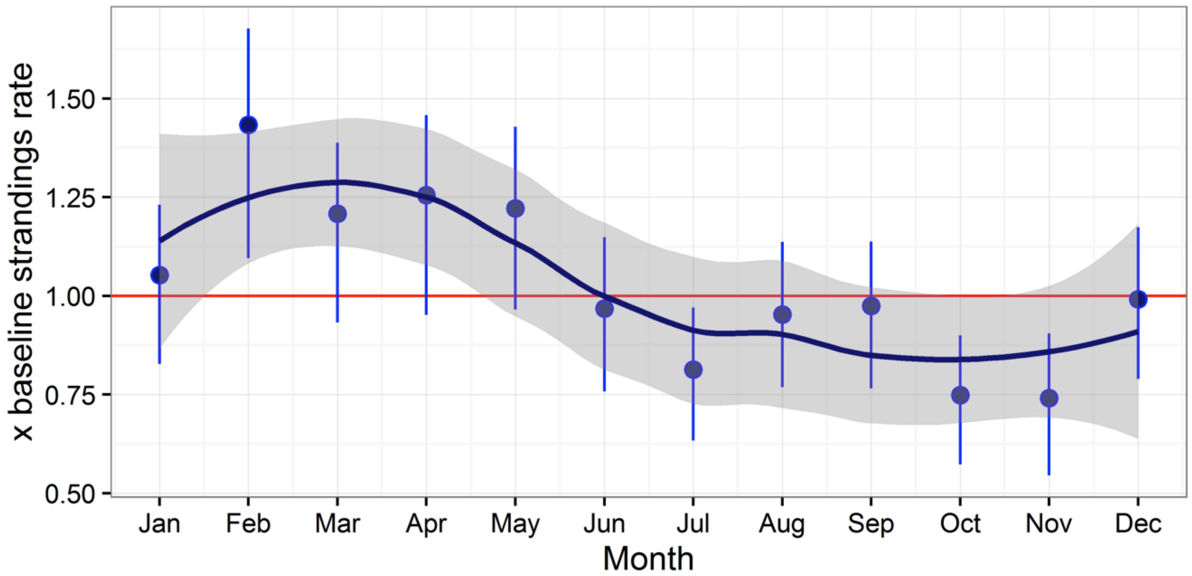
Pyrénées atlantiques

Manche & Gironde

Temporal trends of strandings in the French departments

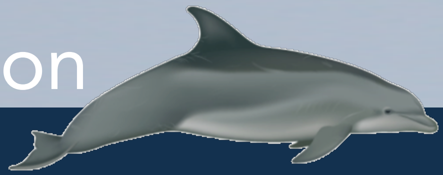


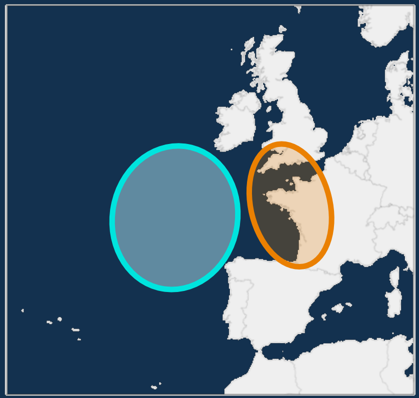
Seasonal trends of strandings (1990-2015)



Among 113 stranded individuals, 27 by-catch marks, that is 23.9%

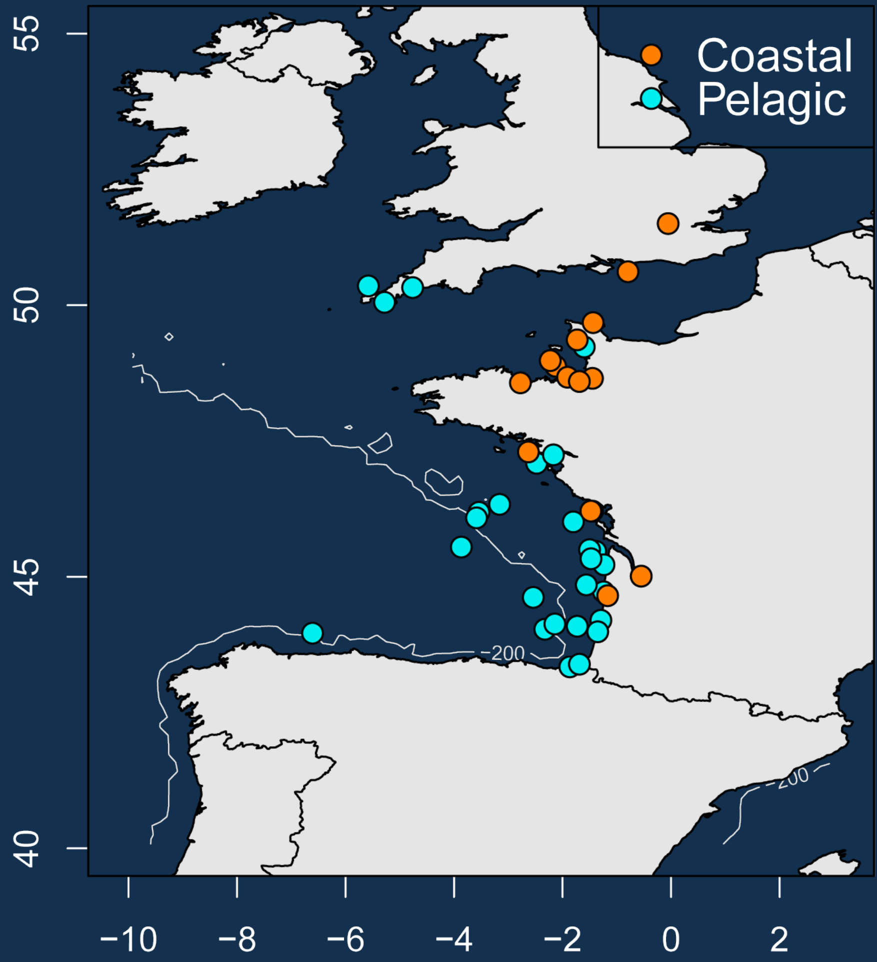
Coastal vs offshore ecological differentiation





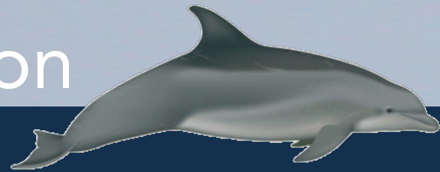
N Coastal = 21
N Offshore = 42

Sample locations

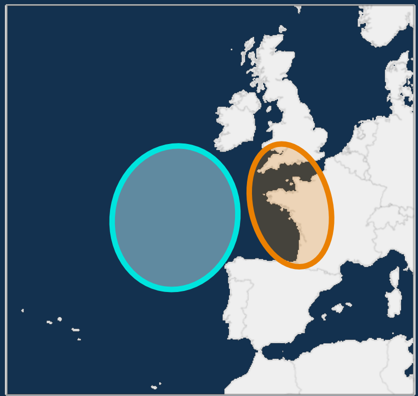


Louis et al, 2014

Coastal vs pelagic ecological differentiation



Stomach contents



N Coastal = 6
N Offshore = 24

Both ecotypes: mainly demersal fish but prey composition vary → dietary segregation

Offshore: 30 species including fish, cephalods and shrimps

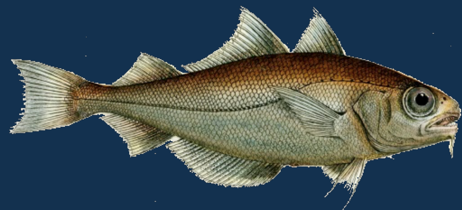
Largely dominated by hake (Merluccius merluccius) %M = 54.6 (28.2-75.5)

Coastal: 14 species including fish, cephalods and shrimps

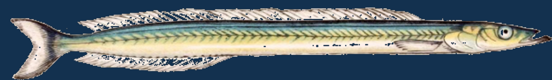
Low sample size

© J. Tomelleri

Mugilidae
%M = 29.8 (0-63.9)



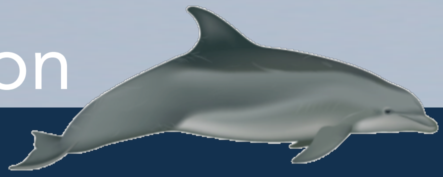
Trisopterus spp.
%M = 31.1 (5.8-66.9)

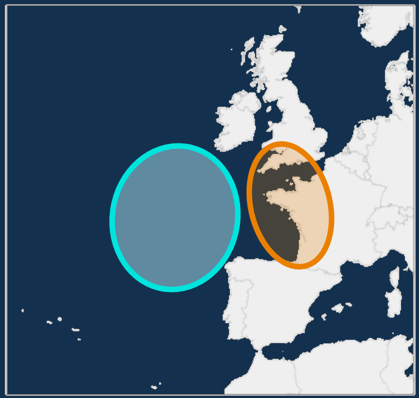


Ammodytidae
%M =5.2 (0-20.5)

Santos et al. 2001

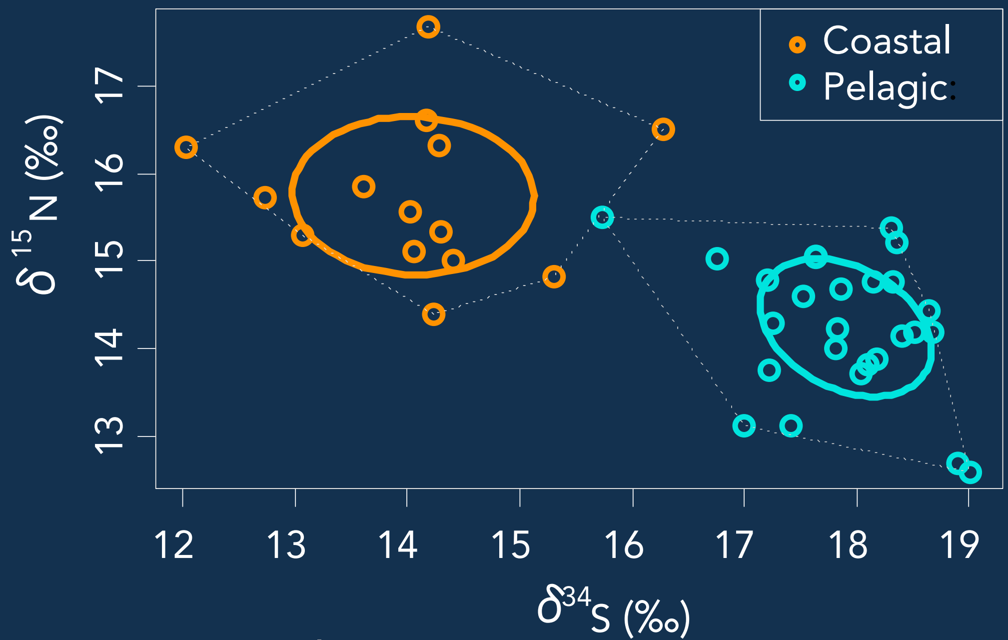
Coastal vs pelagic ecological differentiation





$N_{Coastal} = 14$
$N_{Offshore} = 26$

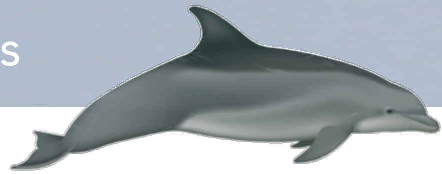
δ^{34}S and δ^{15}N stable isotope niches
SIBER Jackson et al. 2011



coastal ⟵⟶ offshore

→ Distinct ecological niches

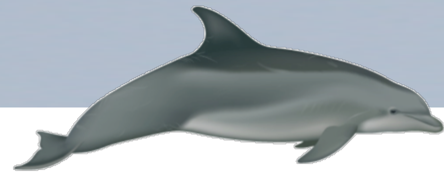
→ Consistent genetic and stable isotope clustering results



One study realised by Zanuttini (2016) within GECC (Groupe d'Etude des Cétacés du Cotentin).

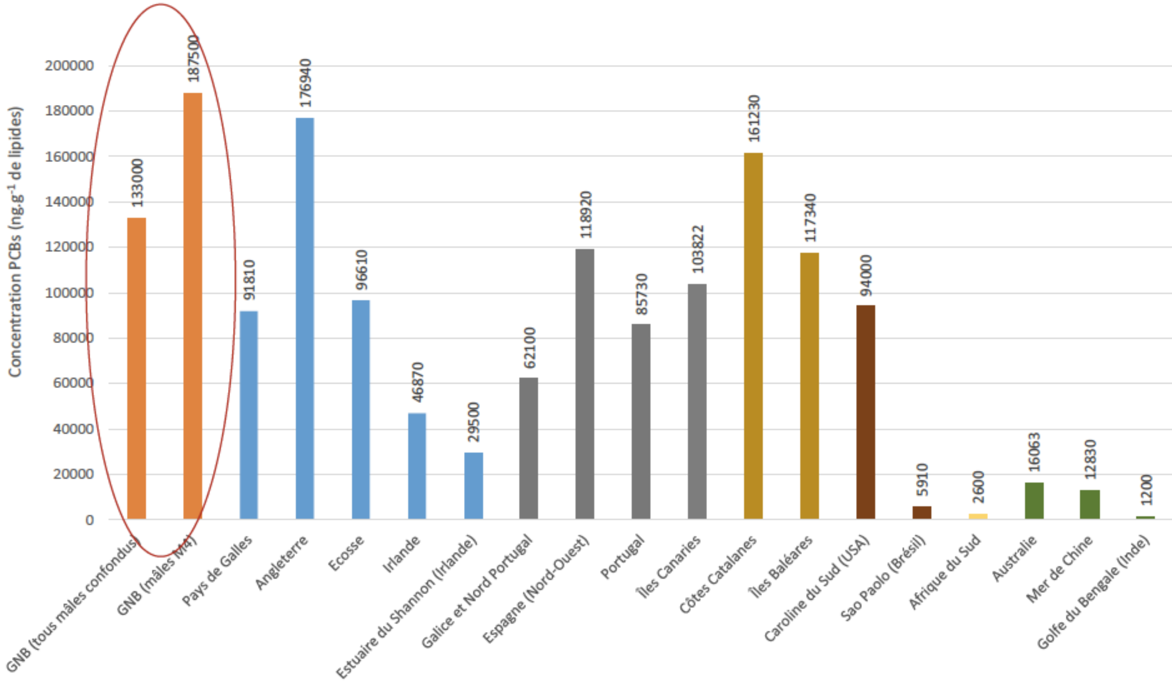
Assessment of the contamination status of the bottlenose dolphin off the Gulf of Saint-Malo through biopsy analysis

- 58 individuals analysed for Σ6PCBs, ΣDDTs, HCHs, HCB et ΣPBDEs
- 11 individuals analysed for PCDDs/Fs et PCB-DL
- 21 individuals analysed for Σendosulfan, dieldrine et Σchlordane
- 69 individuals analysed for T-Hg

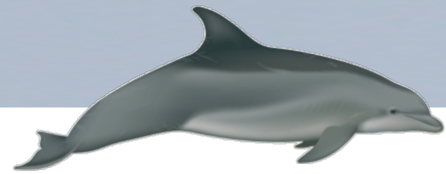


One study realised by Zanuttini (2016) within GECC (Groupe d'Etude des Cétacés du Cotentin).

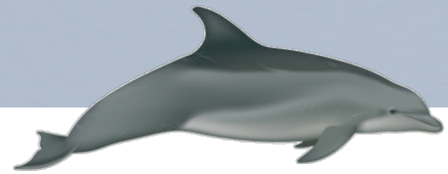
Assessment of the contamination status of the bottlenose dolphin off the Golfe normano-breton through biopsy analysis

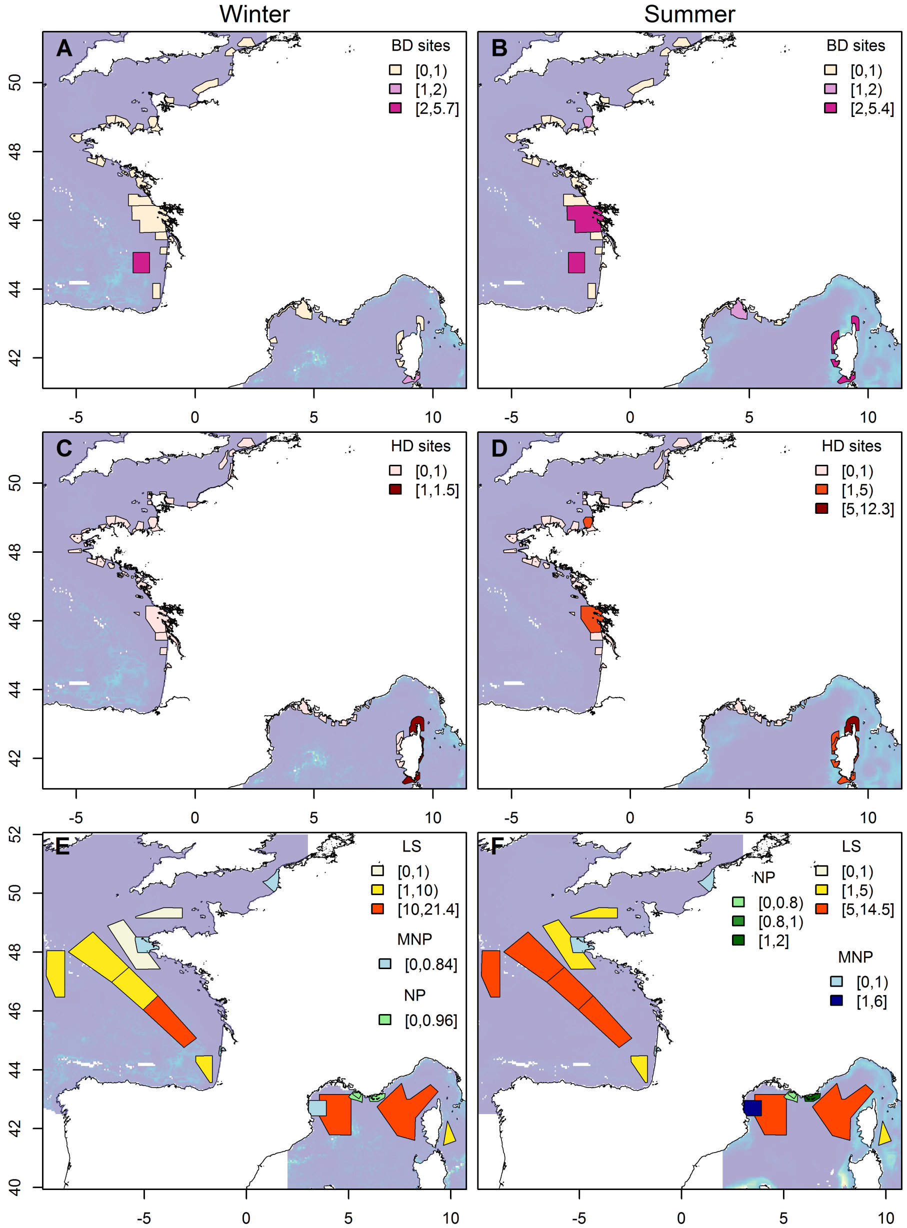


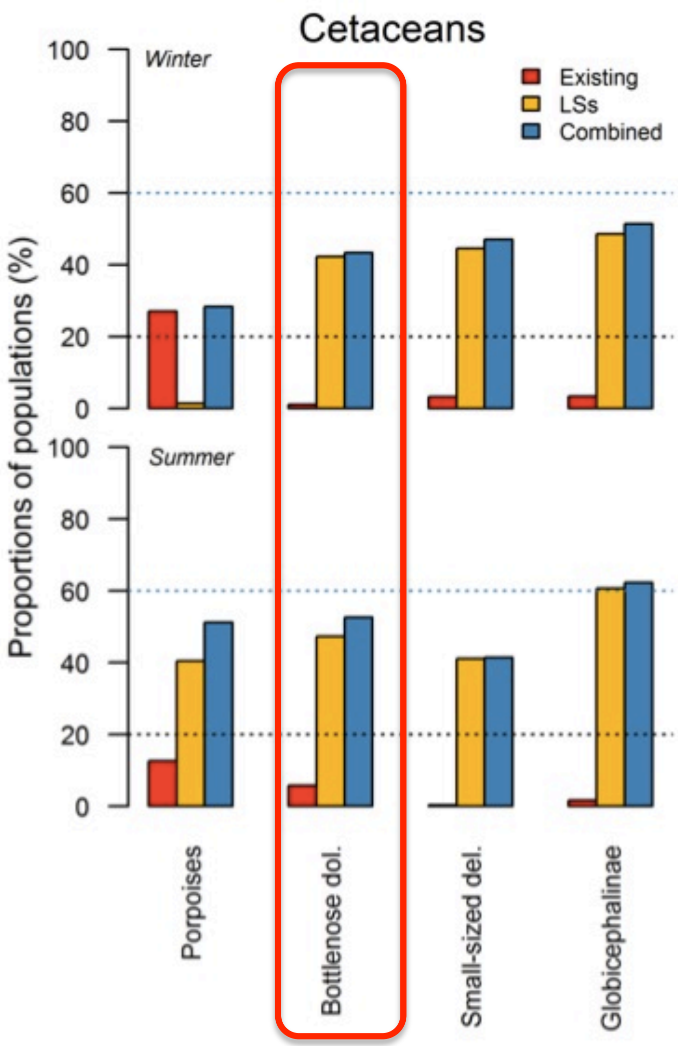
- High levels of PCBs and PCB-DL as in numerous European populations
- Organochlorine pesticides are of less concern
- Influence of sex, age (indicated by mark level), and feeding habits (through stable isotopes)



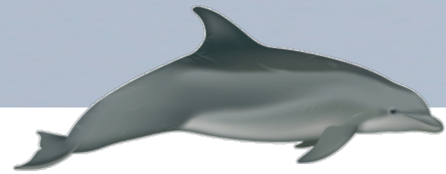
Pelagic waters		Coastal waters	
Pollutants	POPs, heavy metals, PAH	Pollutants	POPs, heavy metals, PAH
Marine litters		Marine litters	
Noise pollution	seismic, oil and gas explorations	Noise pollution	Offshore water and wind turbines, seaweeds extraction, shipping
Bycatch	Pelagic trawl and drift net fisheries	Bycatch	Small coastal fisheries
		Disturbance by tourism activities	
		Habitat destruction	





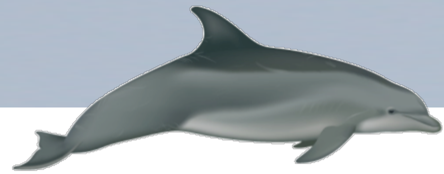


Lambert et al, 2016



Gaps in knowledge:

- Conservation status of offshore bottlenose dolphins
- Connectivity between offshore and coastal bottlenose dolphins and between coastal groups
- Threats
    - Spatial distribution
    - Cumulative impact

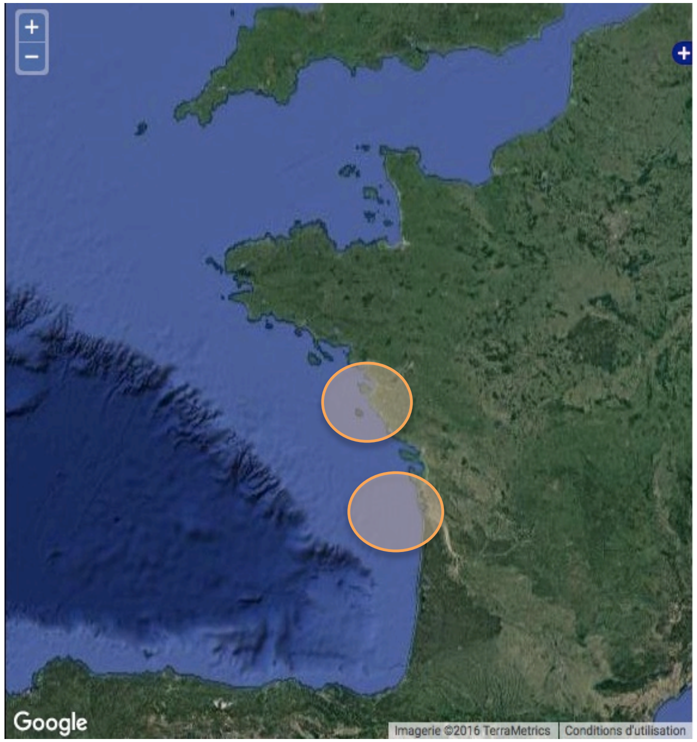


Gaps in knowledge:

- Conservation status of offshore bottlenose dolphins
- Connectivity between offshore and coastal bottlenose dolphins and between coastal groups
- Threats
    - Spatial distribution
    - Cumulative impact

Two groups disappeared:

- 2006, Pertuis charentais, 5 individuals
- 2001 Arcachon, 6 individuals
- Group suspected in South of Brittany




Thanks for your attention

Abundance, habitat use and foraging ecology of bottlenose dolphins in the Irish Atlantic

E.Rogan[1], M. Nykänen[1], S.N Ingram[2]

[1] *School of Biological, Earth and Environmental Sciences, University College Cork*

[2] *School of Biological and Marine Sciences, University of Plymouth*

Bottlenose dolphins (*Tursiops truncatus*) have a very large global distribution, with evidence of different ecotypes in parts of their range. To date, most research on bottlenose dolphins has been conducted on resident communities inhabiting bays and estuaries with the focus of conservation efforts subsequently directed to small areas that are relatively easy to monitor. However, there is a general lack of knowledge surrounding mobile coastal animals and animals further offshore, and understanding the abundance, ranging patterns and the degree of isolation of these populations are key to successful conservation measures for the species.

In the North-East Atlantic large scale multinational surveys have collected data on the summer distribution and abundance of cetaceans, including bottlenose dolphins, in offshore and shelf waters (SCANS: Hammond *et al*., 2002; SCANS-II: Hammond *et al*., 2013; CODA: CODA, 2009). These surveys have highlighted that large numbers of bottlenose dolphins are present in the waters around Ireland, occurring in coastal waters, over the continental shelf, and in deeper waters in the Rockall Trough for example. The on-going ObSERVE aerial survey project will provide further insight into summer and winter distribution and abundance of bottlenose dolphins in the Irish EEZ.

Photo-identification studies have shown that there is large scale movement of bottlenose dolphins along the coast of Ireland and further afield (Ingram *et al*., 2003; Berrow, 2008, O'Brien *et al*., 2009; Ryan *et al*., 2010; Nykänen *et al*., 2015), and Oudejans *et al*. (2015) demonstrated the presence of "inshore" and "offshore" social communities off northwest Ireland. Against this background we used a multi-site approach and focused research effort on bottlenose dolphins using the waters around Connemara, Mayo (which are part of the West Connacht Coast SAC) and Donegal to estimate abundance and examine the movement of these individuals between sites. We also used genetic techniques and stable isotope analysis to examine the population structure and feeding strategies.

Bayesian inference and a hierarchical log-linear model was applied to mark-recapture photo-identification data to derive a multi-site abundance estimate for this wide ranging population. The model-averaged median estimate for an area extending from Connemara and Co. Mayo to Donegal Bay (Co. Donegal) was 145 (95% HPDI = 111–239) in 2013, and 189 (95% HPDI = 162–232) in 2014. The dolphins used the entire study area during the two summers of survey effort with nearly half (43%) of all well-marked animals sighted in more than one of the three survey blocks during 2013–2014 (Nykänen *et al*., 2015). Passive acoustic monitoring (PAM) at two sites, one within and one outside the SAC, showed that dolphins were present almost year-round in both locations. More click detections were logged in Killary (located within the SAC), especially in Spring, and this may be related to prey availability. The use of PAM, at least in these two locations, can be used in conjunction with visual surveys and as part of a long-term monitoring tool in a cost effective way.

Using a combination of biopsy sampling of dolphins in specific coastal areas and collecting samples from stranded animals, Mirimin *et al*. (2011) showed that at least three genetically distinct populations occur in Irish waters (the Shannon estuary population, the west coast population and a third population thought to have a more oceanic habitat). The separation of coastal and oceanic populations was also found by Louis *et al*. (2014). Recent genetic analysis by Nykänen (2016), using a larger sample size over a wider spatial scale, has confirmed the presence of three populations in Irish waters. Only low levels of demographic dispersal were found between the west coast bottlenose dolphin population and those in the Shannon estuary and non-significant (zero) recent genetic connectivity was observed, supporting the effective isolation of the two populations. Both populations should therefore be managed and monitored separately. However, the west coast animals may be demographically and genetically connected to other coastal subpopulations around the coastal waters of the UK and this should be investigated further.

In the absence of physical barriers to gene flow, one of the drivers for the persistence of small populations may be philopatry, supported by feeding specialisations. Although the sample size is small, stomach content analysis suggests that the bottlenose dolphins around Ireland are predominantly feeding on fish but consuming a wide range of prey species (Hernandez-Milian *et al*., 2015). Stable isotope analysis suggests that there are differences in the feeding ecology between the Shannon population and the west coast population with Shannon animals feeding over a wider ecological niche with more generalist feeding strategies, whereas the coastal “non-Shannon” animals appear to be more specialised (Rogan *et al*., in prep.).

Future work should focus on resolving the spatial range of these populations including the extent or depth/habitat preferences of the wider-ranging coastal population. Demographic information including life-history characteristics of any of these populations is lacking, including parameters such as age at sexual maturity, inter-birth interval and longevity, making management of these populations difficult in the absence of robust population viability analysis. Risk assessments should be carried out at a population level to assess vulnerability to anthropogenic disturbances, such as fishing (similar to Brown *et al*., 2013, Breen *et al*., 2016). The extent and population structure of the oceanic population(s) is unknown. There may be undiscovered finer-scale structure in this population which could be resolved with further sampling effort.

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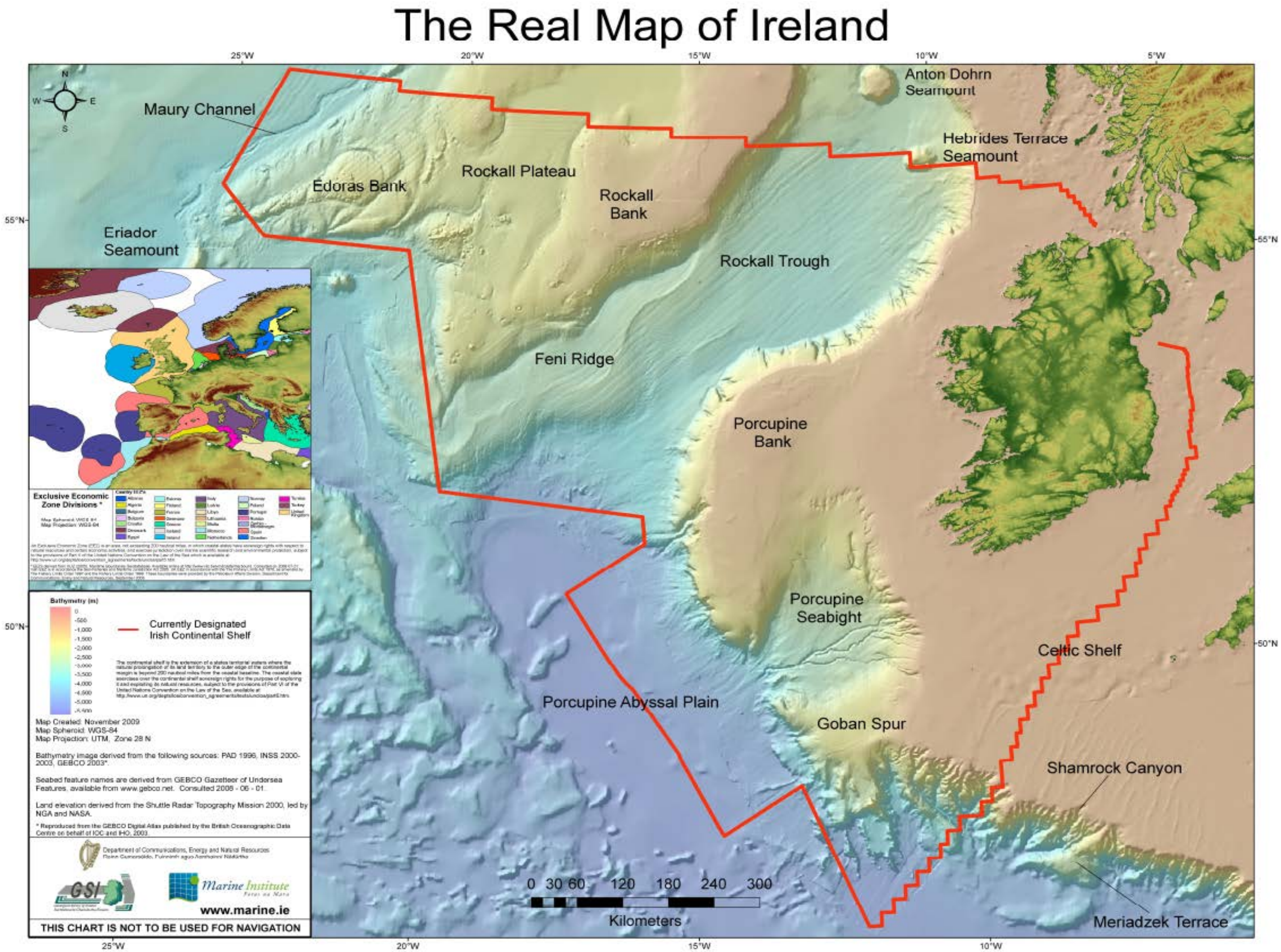
Abundance, habitat use and foraging ecology of bottlenose dolphins in the Irish Atlantic

M. Nykänen, A. Kavanagh, A. Englund, G. Hernandez-Milian, P. Breen, M. Oudejans, A. Foote, J. Durban, M. Gkaragkouni, S. Ingram, E. Rogan

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh
School of Biological, Earth and Environmental Sciences

The "Irish" Atlantic



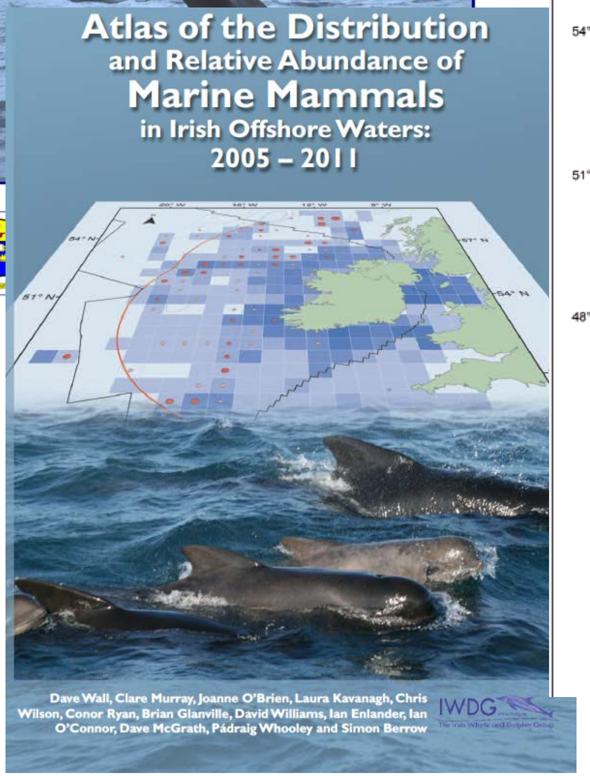
Distribution & Relative abundance

Petroleum Affairs Division

Cetaceans and Seabirds of Ireland's Atlantic Margin

Volume II

CETACEAN DISTRIBUTION & ABUNDANCE



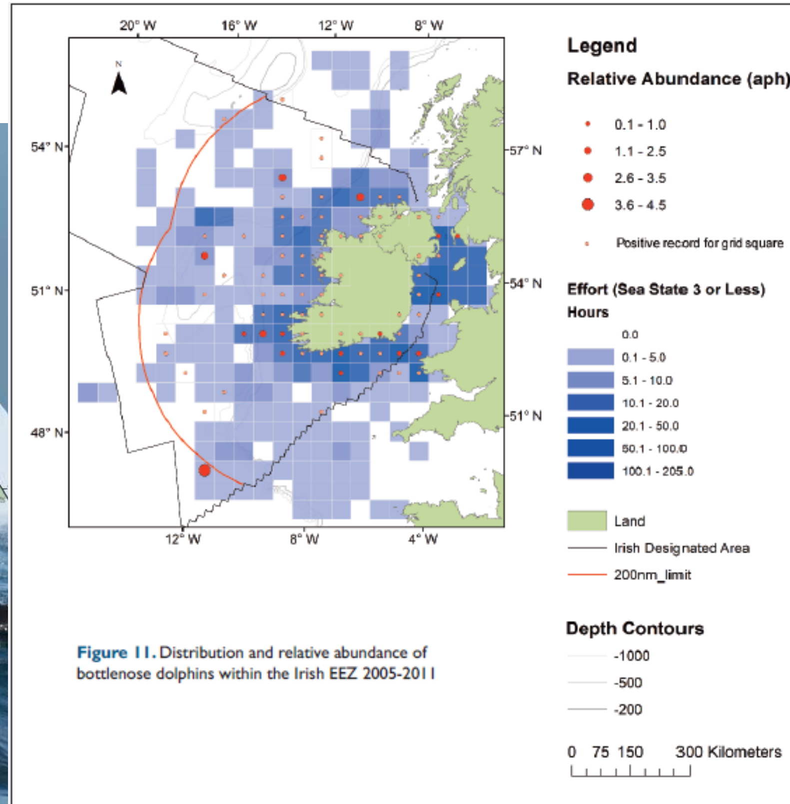
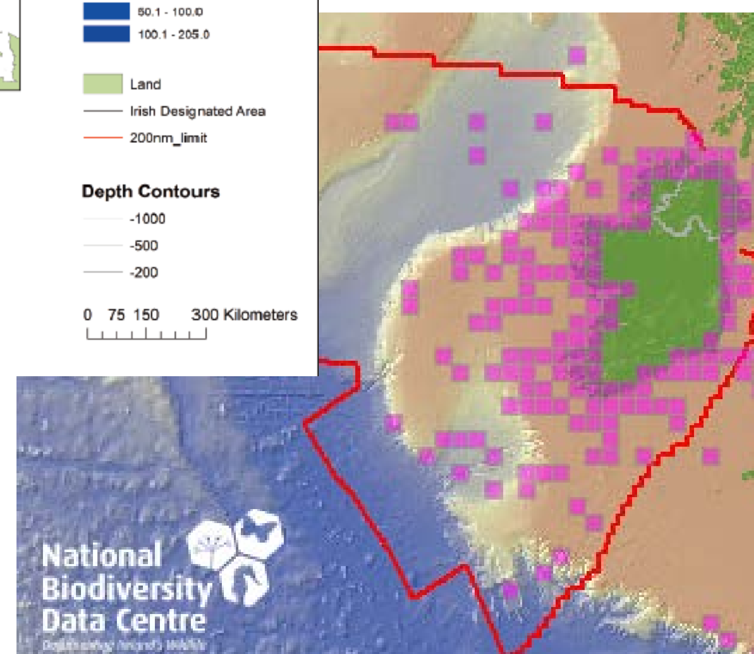


Figure 11. Distribution and relative abundance of bottlenose dolphins within the Irish EEZ 2005-2011



O'Cadhla et al., 2004, Wall et al., 2013

Bottlenose dolphin abundance

1,130 (0.68)

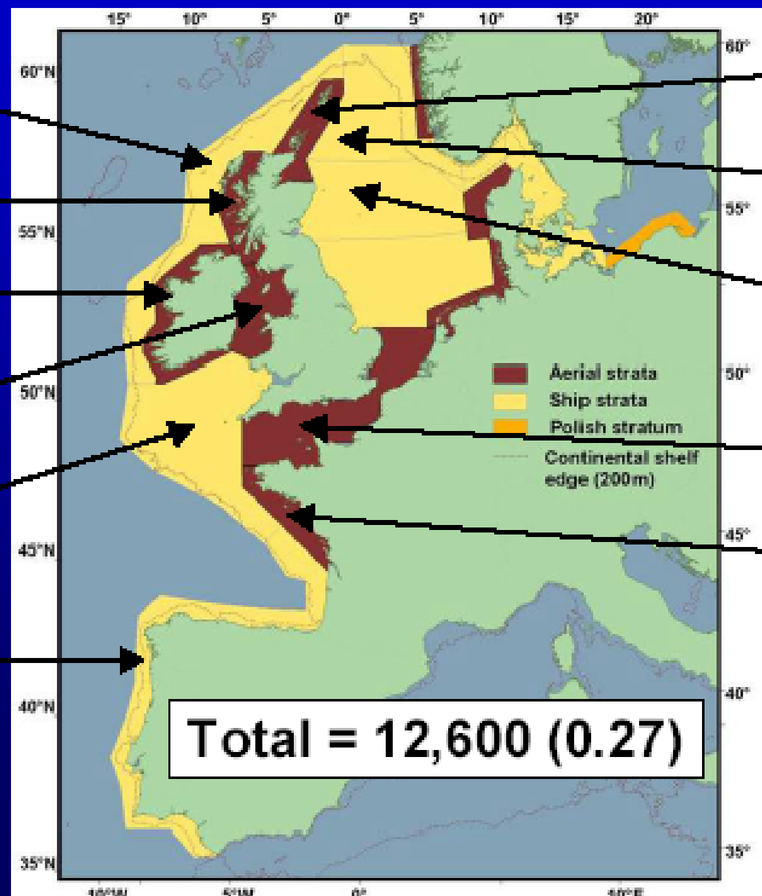
246 (1.04)

313 (0.81)

235 (0.75)

5,370 (0.49)

3,940 (0.38)



412 (0.86)

117 (0.79)

123 (4.38)

395 (0.74)

369 (0.81)

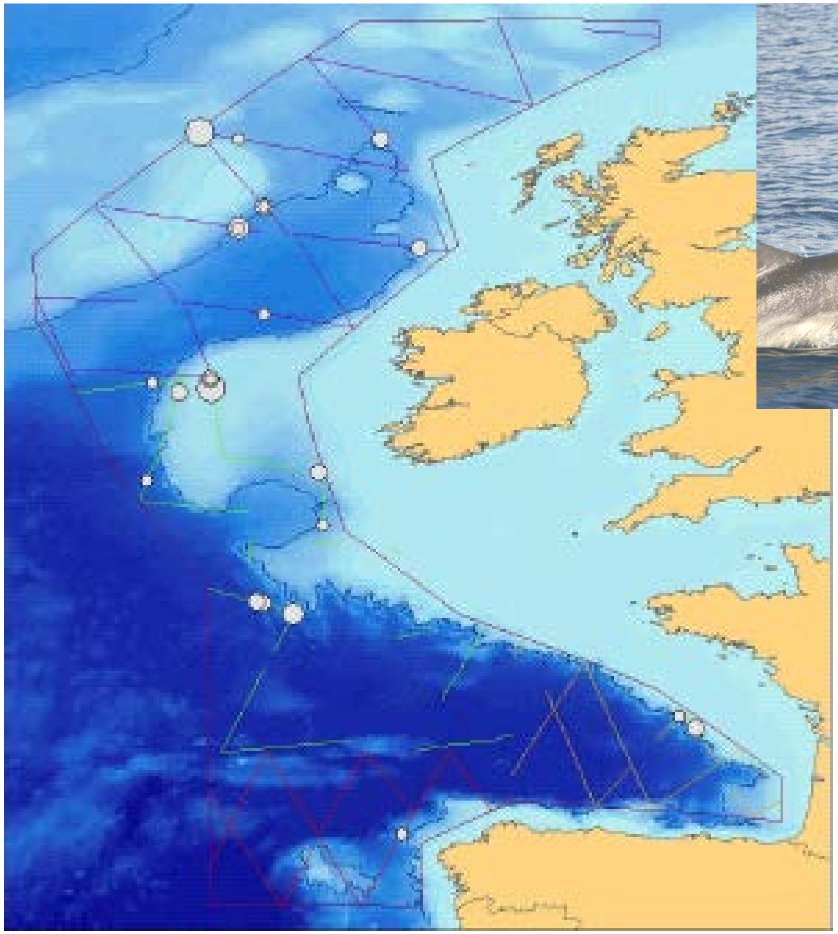
SCANS 2 2005 ; Hammond et al., 2013

Bottlenose dolphins

BLOCK 1
5,709 (0.35)

BLOCK 2
11,536 (0.35)

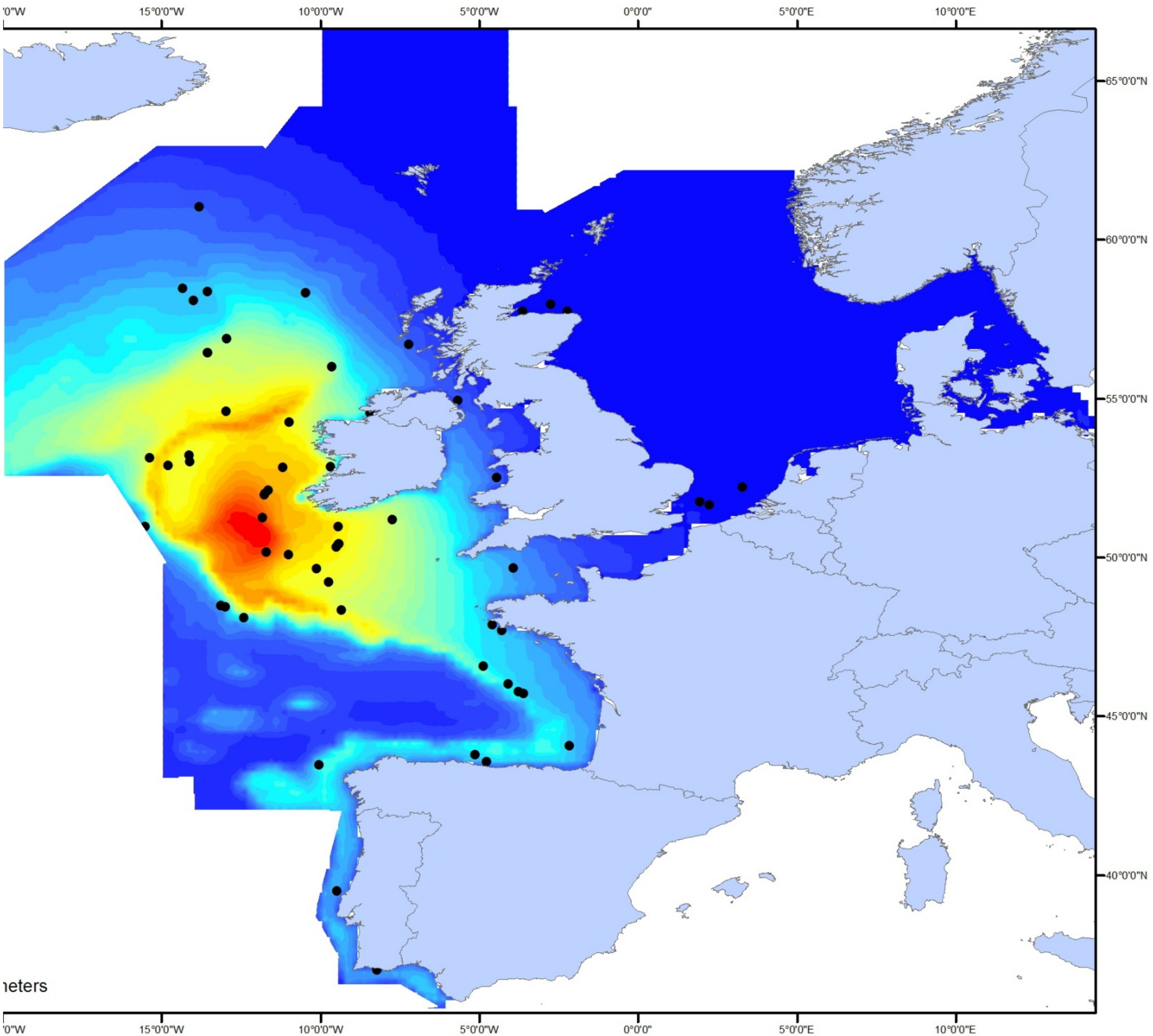
BLOCK 3
876 (0.82)



BLOCK 4
1,174 (0.45)

TOTAL 19,295 (0.25)
[11,842 - 31,440]

CODA 2007

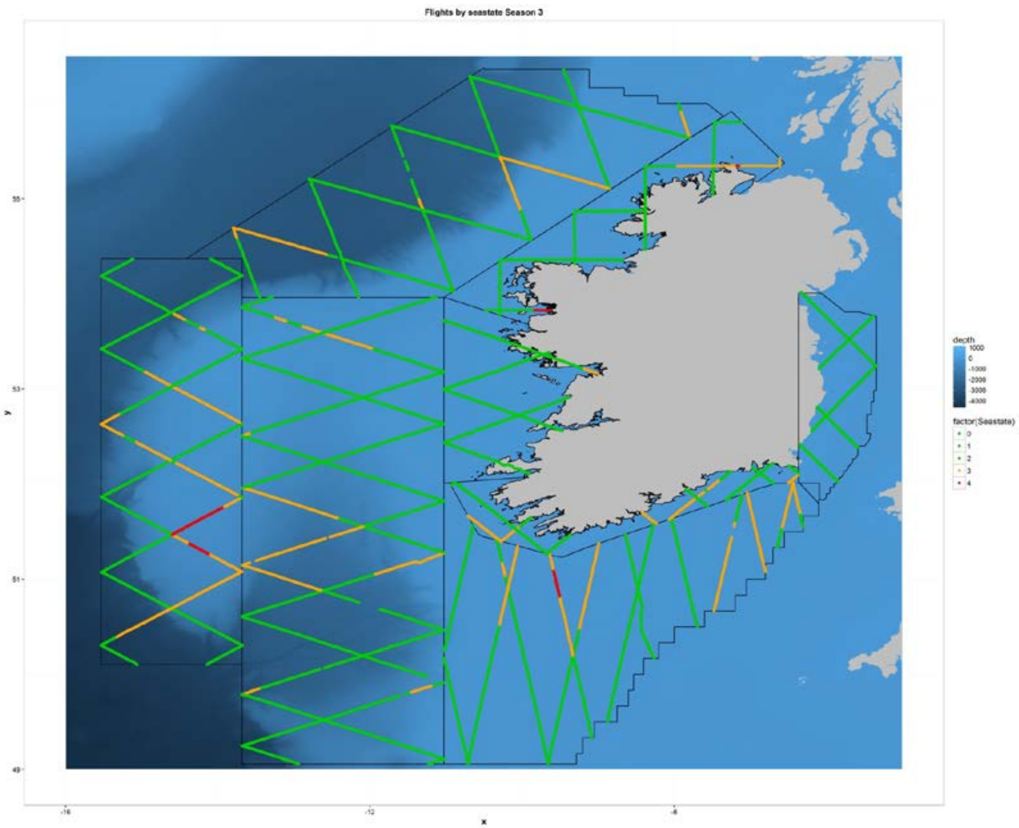


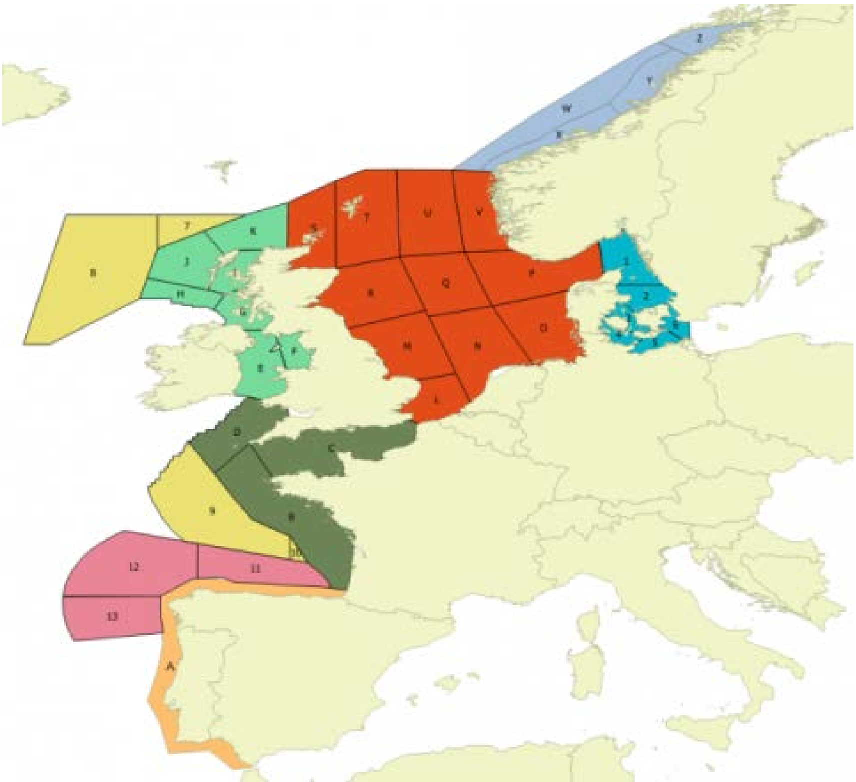
Combined SCANS & CODA

More recently

ObSERVE aerial
Summer & Winter 2015/2016 & 2016/2017
"Inshore" lines

SCANS 3 summer 2016



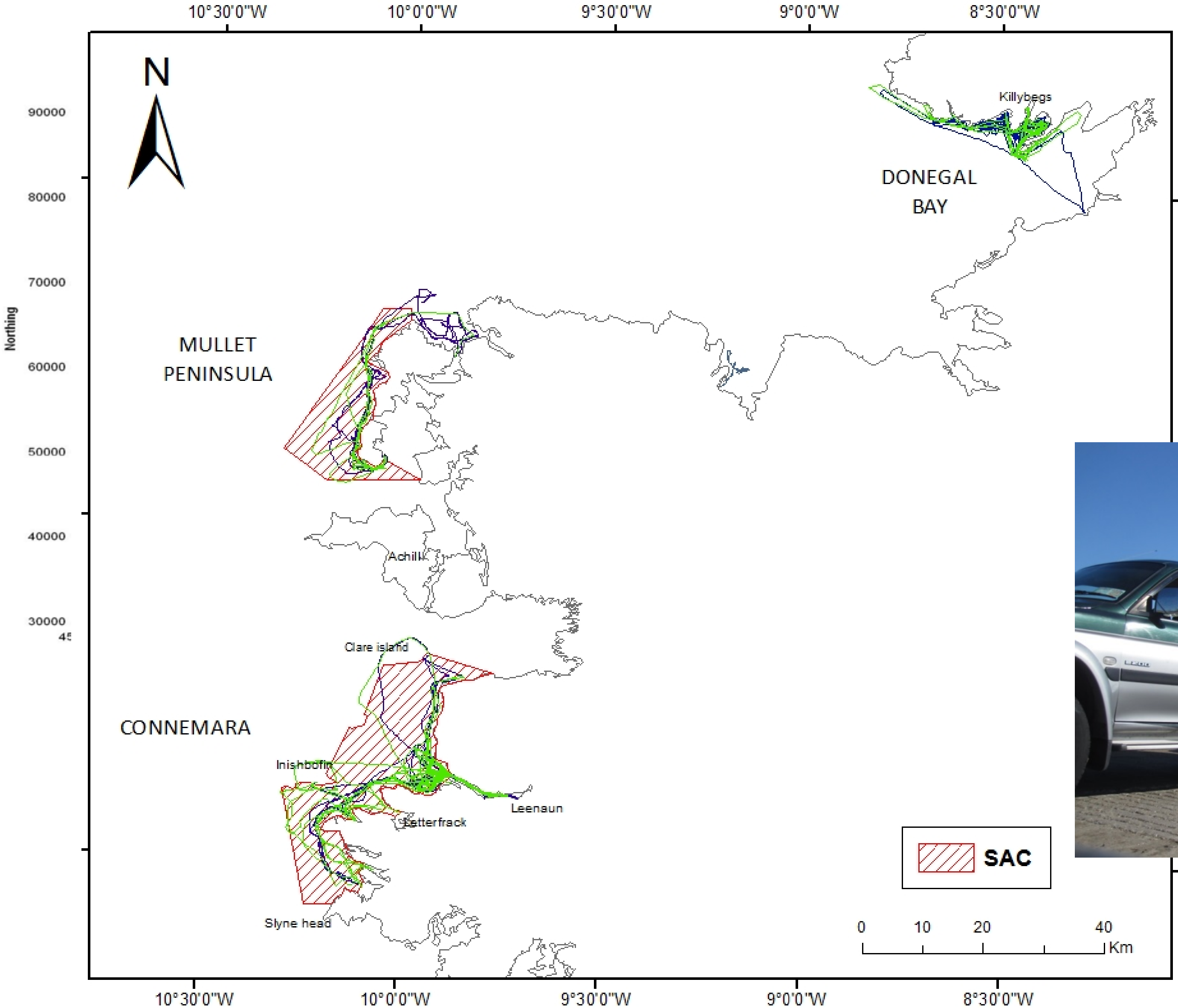


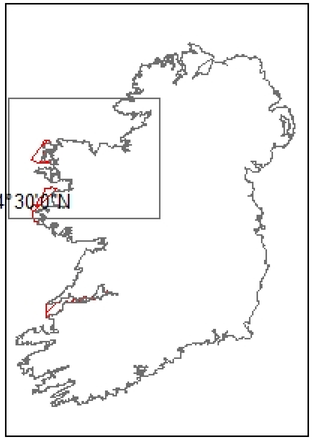
West coast of Ireland

Photo-identification & genetic studies

- Shannon population discrete community (Mirimin et al., 2011, Nykänen, 2016)
- Considerable movement of animals along west coast (Ingram *et al.*, 2003; Berrow 2008, O'Brien *et al.*, 2009; Ryan *et al.*, 2010; Nykänen et al., 2015)
- One or several populations?

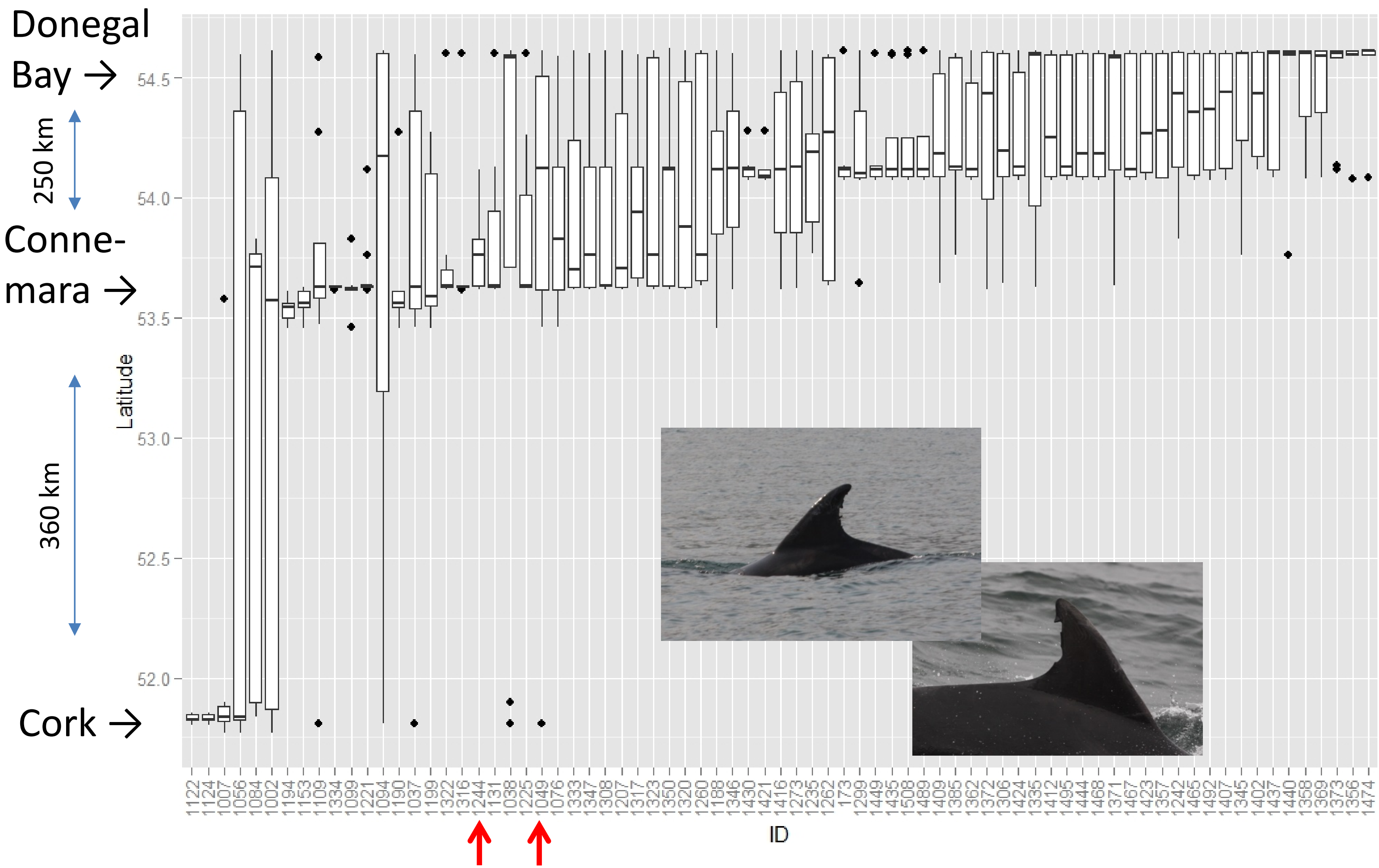
West coast surveys





Ingram et al., 2009; Nykänen et al., 2015

Abundance and movement



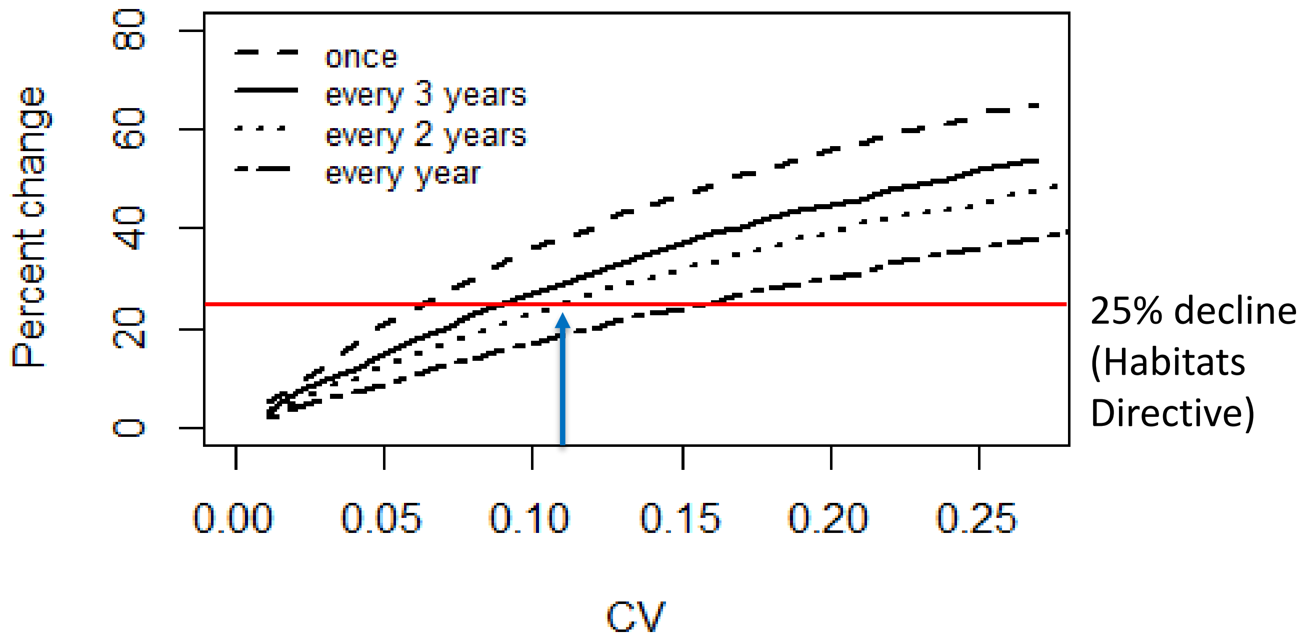
Nykänen et al., 2015, Nykänen 2016

Abundance and movement

Bayesian multi-site abundance estimates:

Year	Median abundance	95% HPDI	CV	θ
2013	145	111-239	0.30	0.55
2014	189	162-232	0.11	0.57

Abundance and movement



The effect of coefficient of variation (CV) to the minimum detectable change in the abundance of a theoretical population with different levels of effort spread uniformly during a 6-year period.

Abundance and movement: Conclusions

Bayesian multi-site model

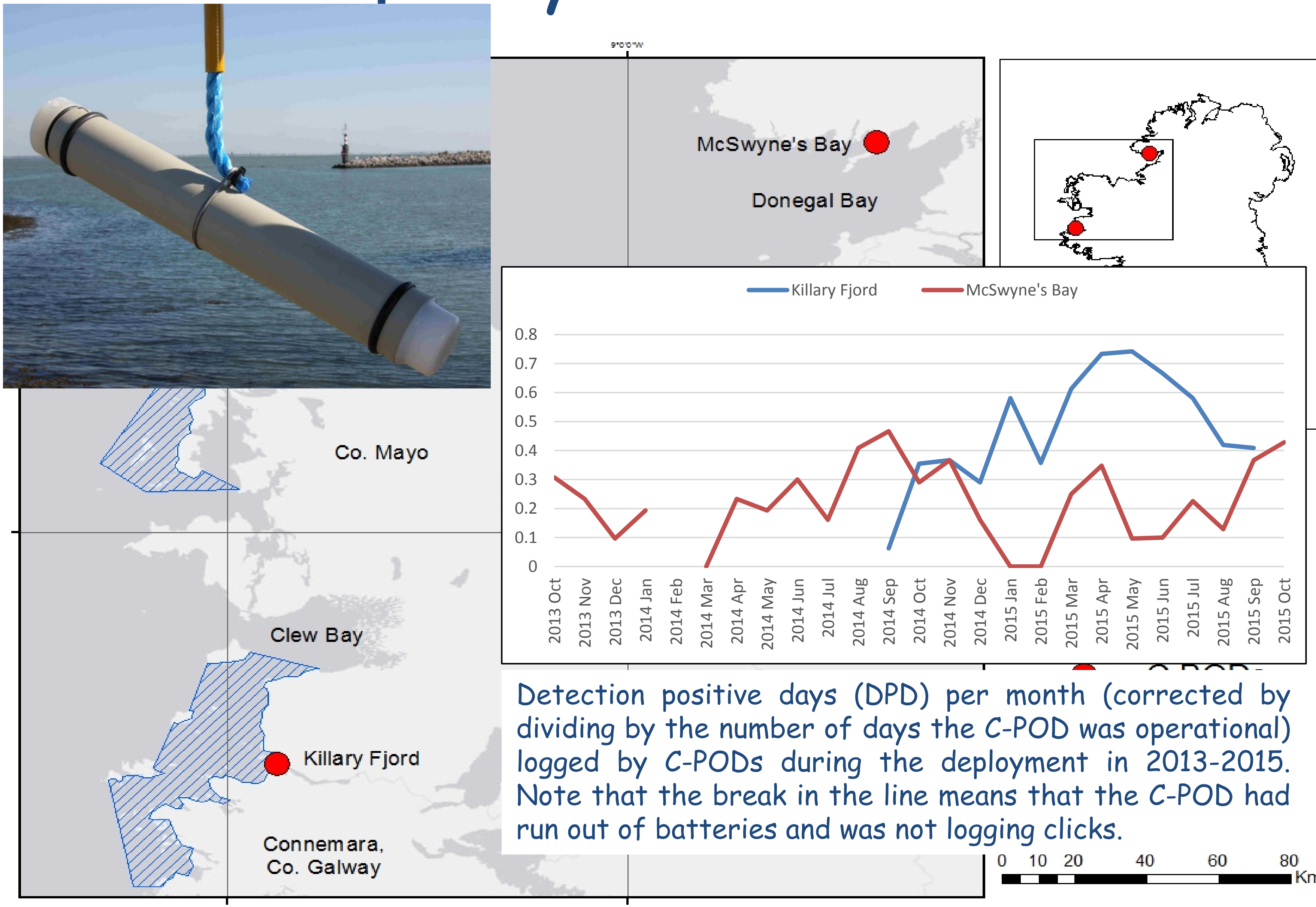
- Precise abundance estimate (i.e. 2014)
- Opportunistic sampling possible without having to sample the entire range – cost effective

Management implications: comparison to "favourable level"

- Annual/biannual sampling regime required in order to detect 25% overall decline in abundance over 6-year reporting period
- Detection of yearly decline of 1% not likely to be realistic – CV would have to be 0.02!

Site occupancy and habitat use: Passive Acoustic Monitoring

Site occupancy & habitat use: PAM



Detection positive days (DPD) per month (corrected by dividing by the number of days the C-POD was operational) logged by C-PODs during the deployment in 2013-2015. Note that the break in the line means that the C-POD had run out of batteries and was not logging clicks.

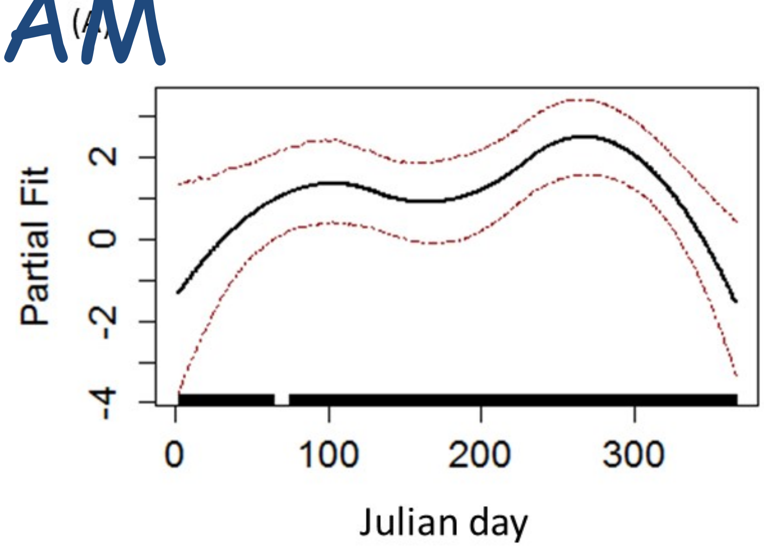
Site occupancy and habitat use: PAM

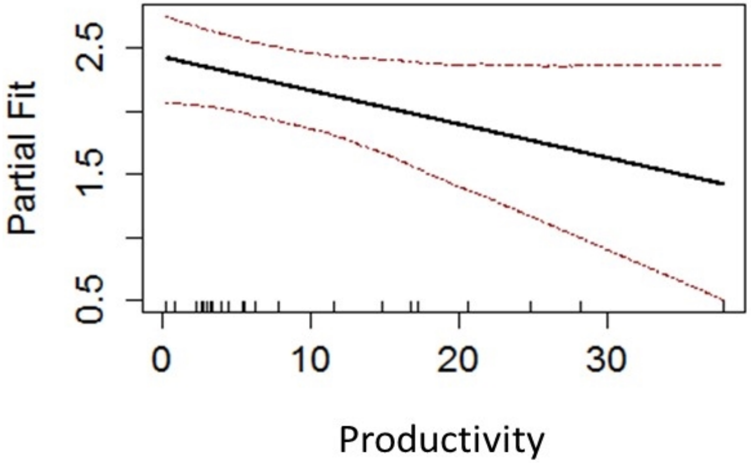
Significant covariates kept in the best GEE-GAM:

Hourly model
- Daylight (day > night)
- Current speed
- Current direction

Daily model
- Site (Killary > Donegal Bay)
- Julian day
- Site:Julian day interaction

Monthly model
- Productivity (P = 0.071)

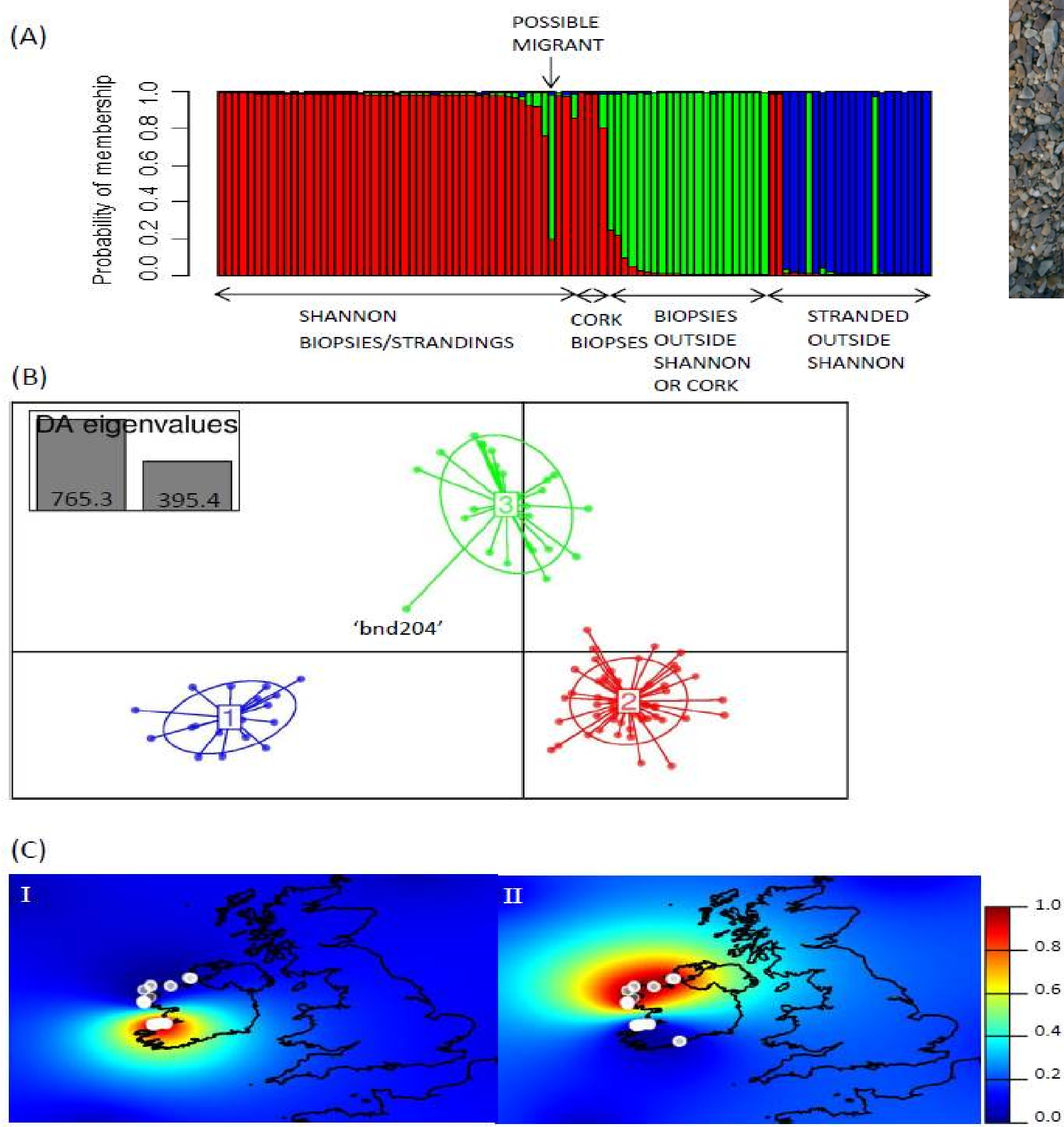




Site occupancy and habitat use: PAM

- Possible that the increased probability of dolphin detections at faster current speeds and during incoming and outgoing tides reflects the movements of prey species
- More detections in Killary - hydrographic features combined with currents resulting from tidal flow may gather and concentrate prey
- Increase in detections in the spring in Killary – may be influenced by prey movements
- PAM, at least in these locations, can be used as part of a long-term monitoring tool in a cost effective way

Population structure and dispersal



Nykänen 2016

Population structure & genetic dispersal

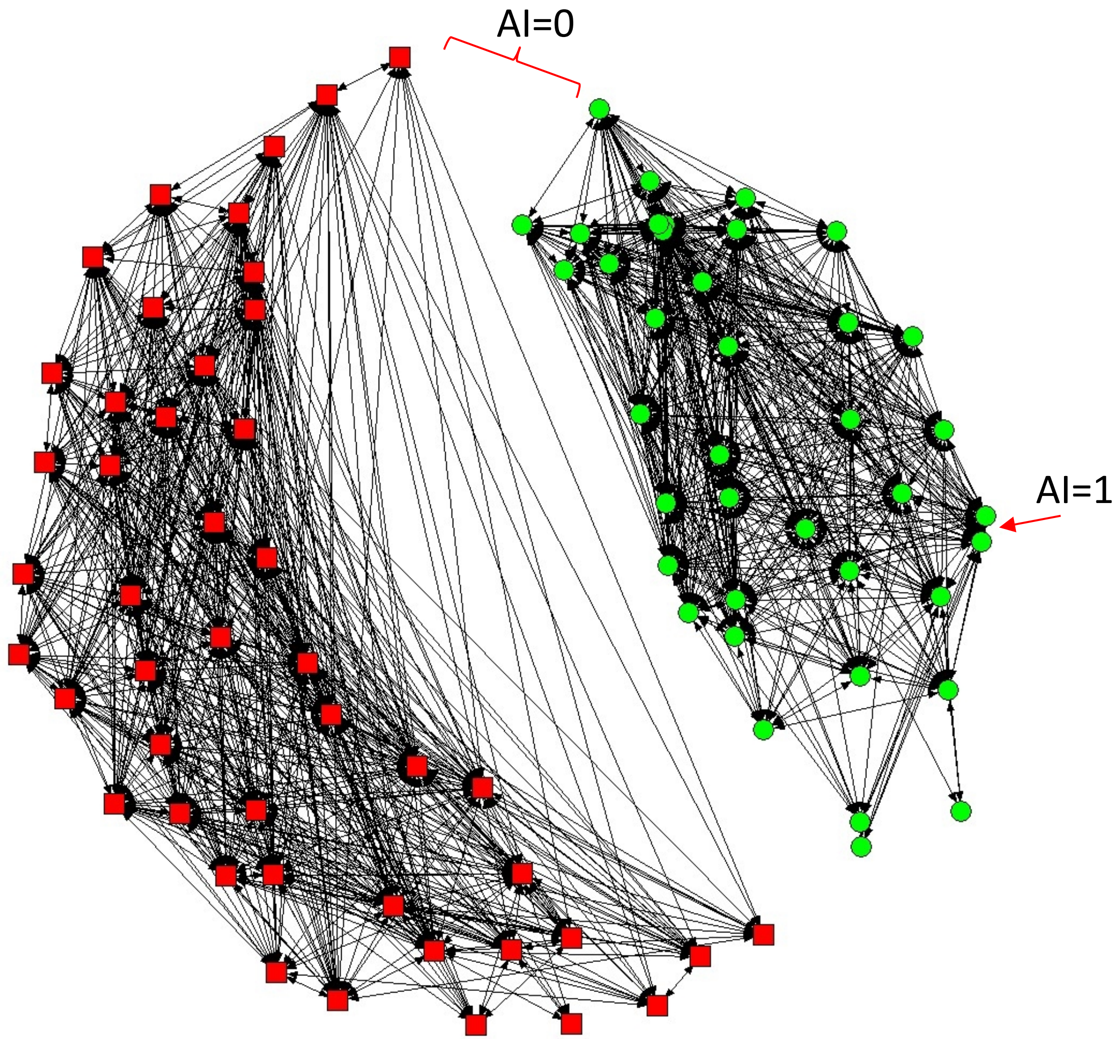
Pairwise F_{ST}-values based on 15 microsatellite loci (given as average with 95% HPDI) between the different populations *Coastal Shannon*, *Coastal mobile* and *Pelagic*. Values above the diagonal are for the whole dataset, and values below the diagonal after removal of close relatives ($r \geq 0.45$).

	Coastal Shannon	*Pelagic*	*Coastal mobile*
Coastal Shannon	-	0.173 (0.151-0.200)	0.181 (0.147-0.218)
Pelagic	0.154 (0.131-0.181)	-	0.186 (0.154-0.222)
Coastal mobile	0.161 (0.121-0.205)	0.172 (0.139-0.209)	-

Inferred (posterior) mean migration rates (with 95% HPDI) between the different Irish bottlenose dolphin populations identified by STRUCTURE and DAPC, given as proportion of migrants per population. Values for self-recruitment are given in diagonal.

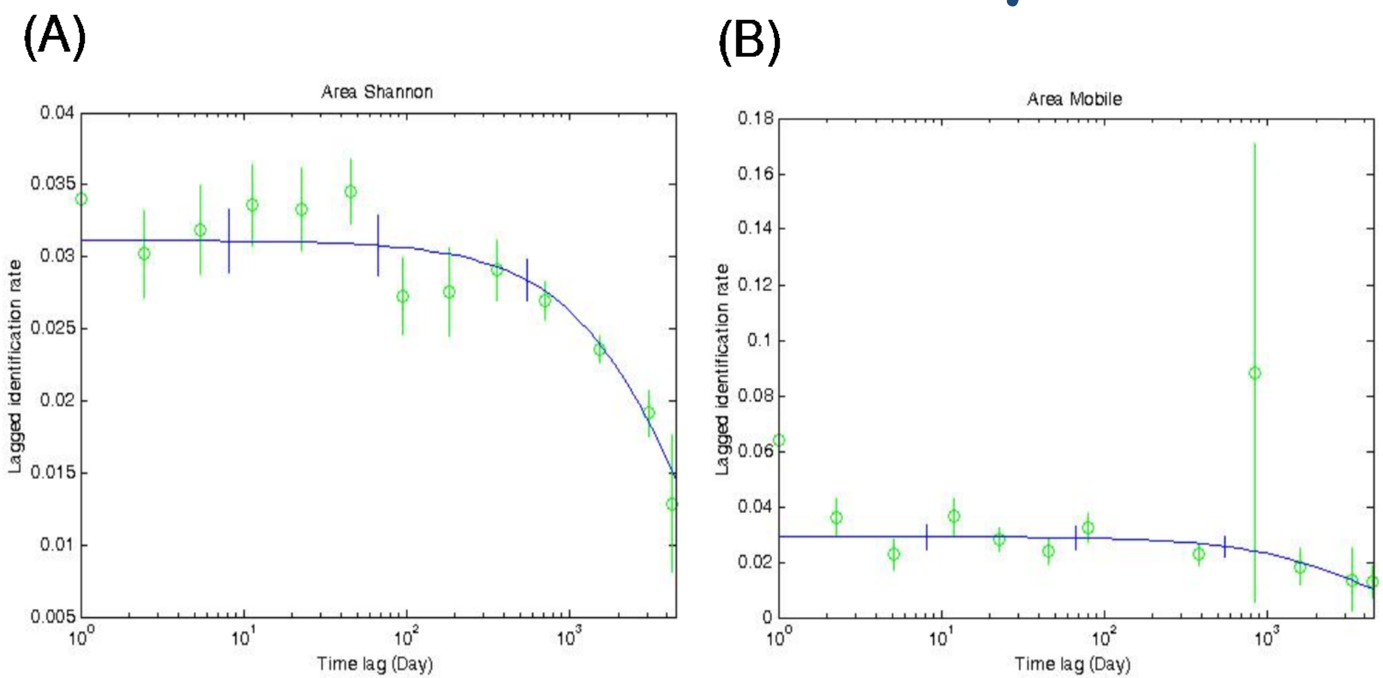
		Sink		
		Coastal Shannon	*Pelagic*	*Coastal mobile*
Source	*Coastal Shannon*	0.987 (0.969-1.000)	0.006 (-0.005-0.017)	0.008 (-0.007-0.022)
	Pelagic	0.016 (-0.014-0.046)	0.948 (0.892-1.000)	0.036 (-0.014-0.086)
	Coastal mobile	0.034 (-0.011-0.078)	0.012 (-0.010-0.034)	0.955 (0.906-1.000)

Social structure



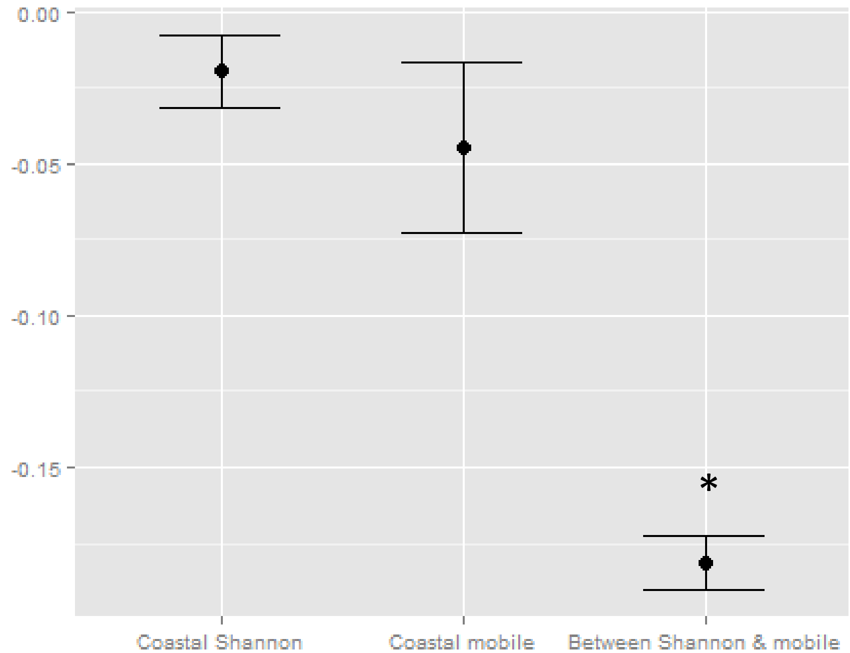
Social network diagram of bottlenose dolphins encountered at least on five occasions during the data collection 1996-2014. Boxes represent a social cluster of individuals encountered in the Shannon estuary, and circles a cluster of the 'mobile' dolphins encountered on the west and north-west coast of Ireland. The length of the line in the network diagram represents the strength of the association (inversely) between a dyad calculated as HWI.

Site-fidelity



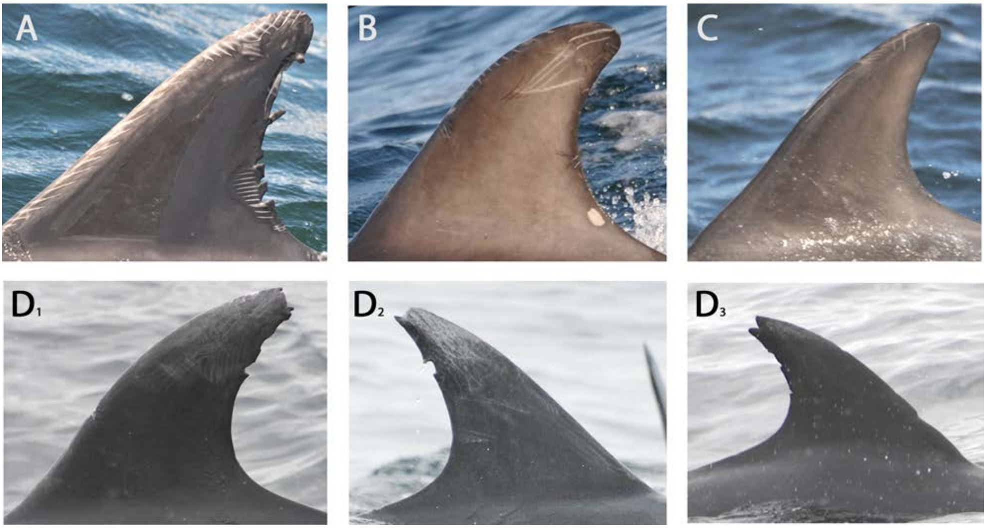
Lagged identification rate (LIR) for bottlenose dolphins encountered ≥5 times (A) in the Shannon Estuary, and (B) outside the Shannon Estuary in the coastal waters of Ireland during the study period 1996-2014. The graph describes the probability that a dolphin photographed at time 0 will be identified again at time X within the area. Data points are represented as green circles (with SE) and the best fitting model ("emigration/mortality" in the *Coastal Shannon*, and "emigration+reimmigration+mortality" in the *Coastal mobile* subset) is displayed as the blue line. Time lag (number of days) is given on logarithmic scale.

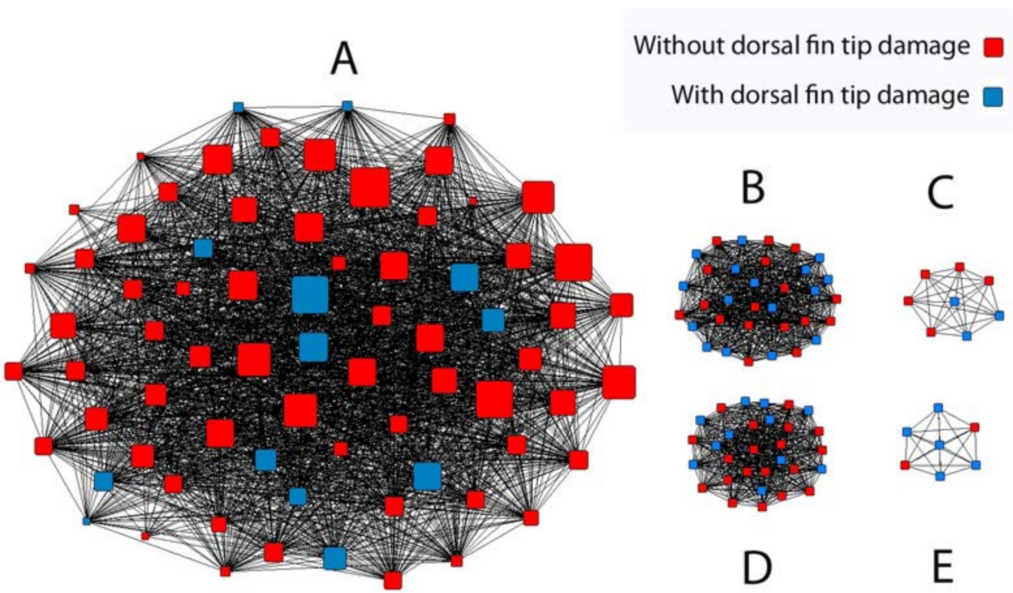
Relatedness

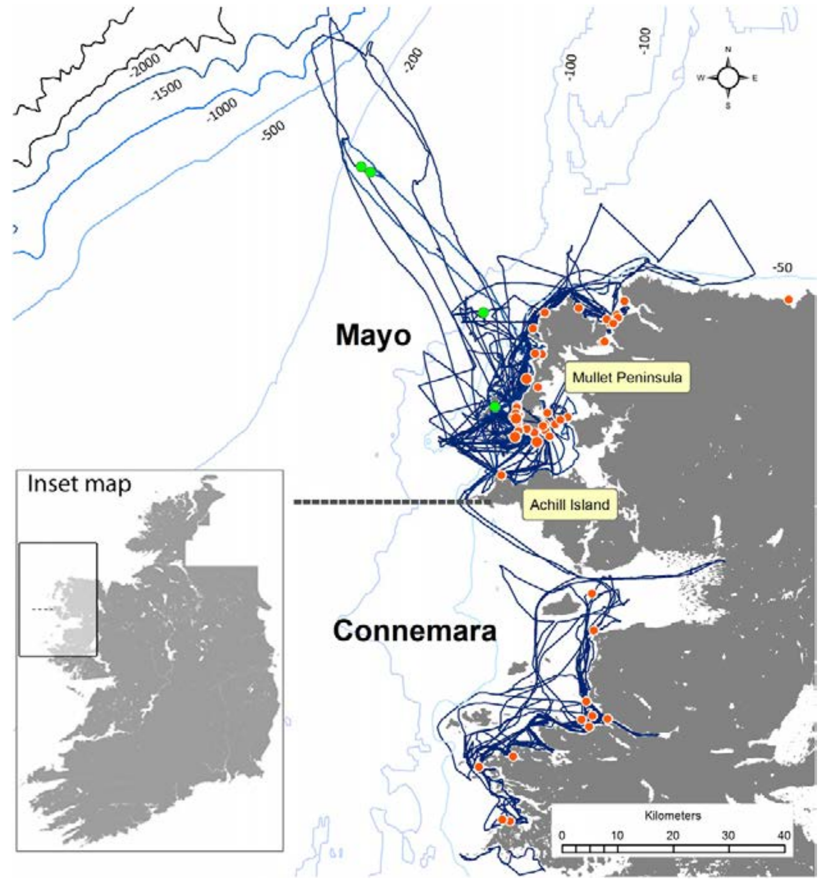


Mean relatedness coefficient *r* (Queller & Goodnight 1989) with 95% confidence interval within and between the two bottlenose populations, *Coastal Shannon* and *Coastal mobile*. * denotes a significant difference with Kruskal-Wallis *P* < 0.0001.

“Offshore” communities







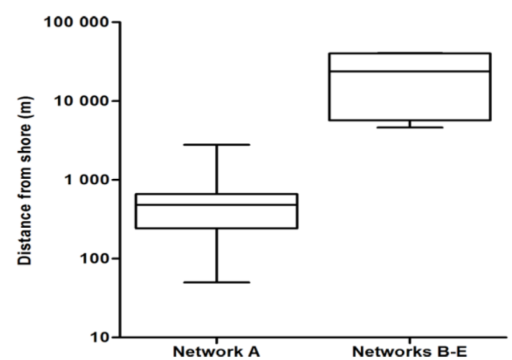
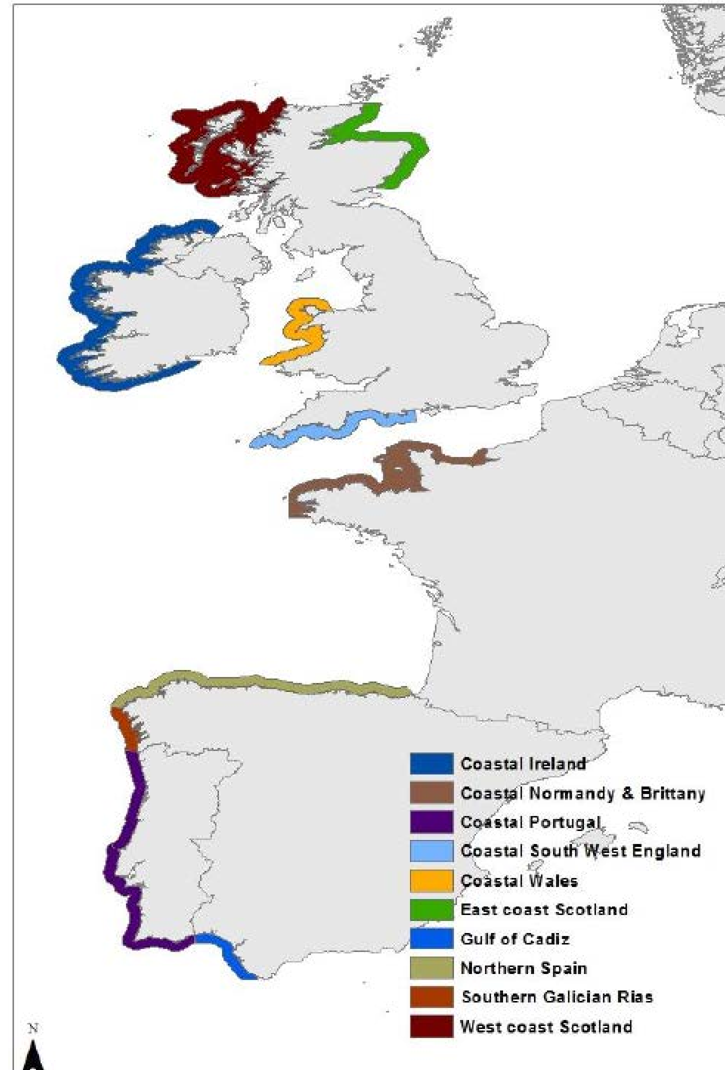


Fig 5. Distance from shore. The distance from shore for bottlenose dolphin groups that comprised network A (left) and networks B-E (right). The boxplot displays the mean and the 1st and 3rd quartile of the distance from shore. Whiskers indicate one standard deviation from the mean. Note the logarithmic scale of the Y-axis.

Oudejans et al., 2015

Population structure & dispersal: Conclusions

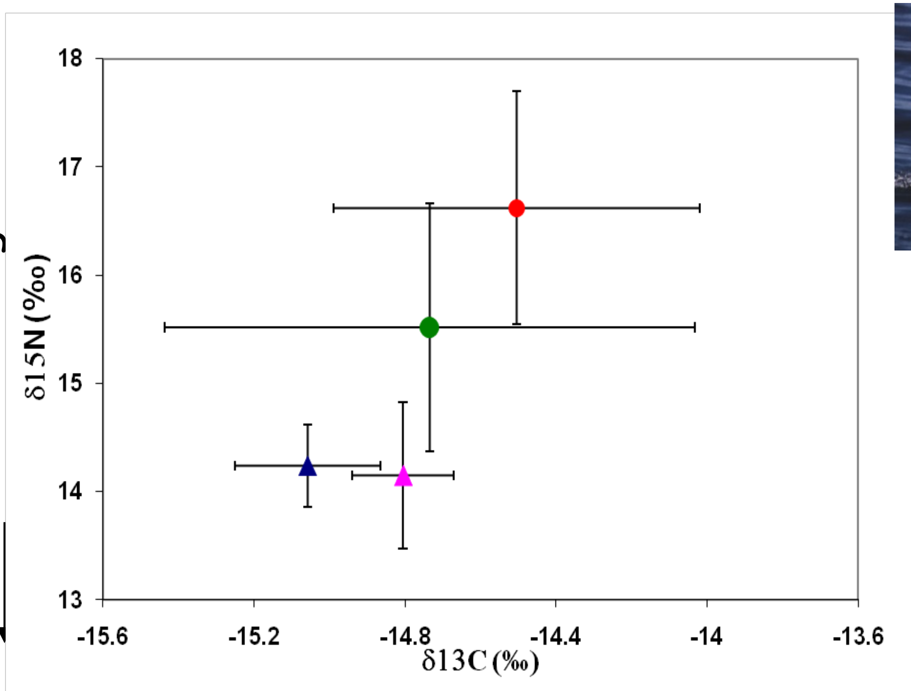
- Effective social & reproductive isolation between the three identified populations
- Only low levels of demographic & non-significant (zero) genetic connectivity observed
- Current designation of separate SACs for the two coastal populations validated – they should be treated as separate MUs
- Site-fidelity, associations, relatedness & perhaps foraging specializations possible drivers of population structure



(ICES Advice 2014, Book 1)

Foraging / feeding preferences

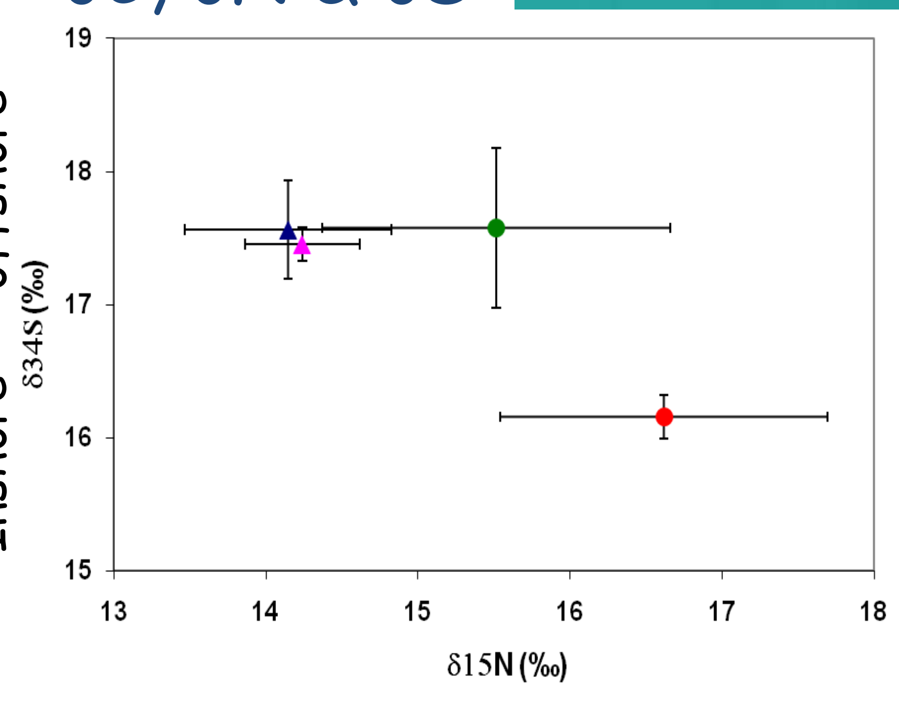
Low TP High TP



Pelagic/offshore Coastal/benthic

- δC, δN & δS

Inshore offshore



Cork (n = 4)
Shannon (n = 23)
Connemara (n = 6)
Mayo (n = 3)

δN & δS ANOVA p < 0.003

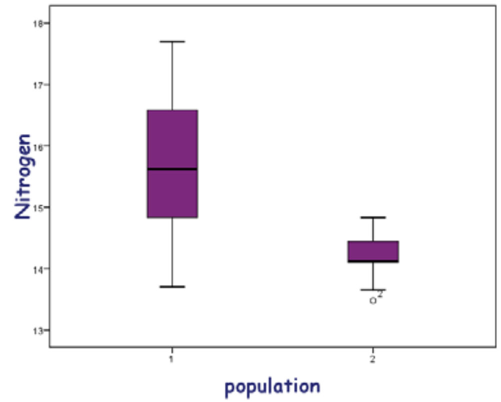
Population variation?

- Discriminant function analysis (Wilks' lambda 0.624, X^2 10.15, $p < 0.017$)
- 81.1% correctly assigned, N most important

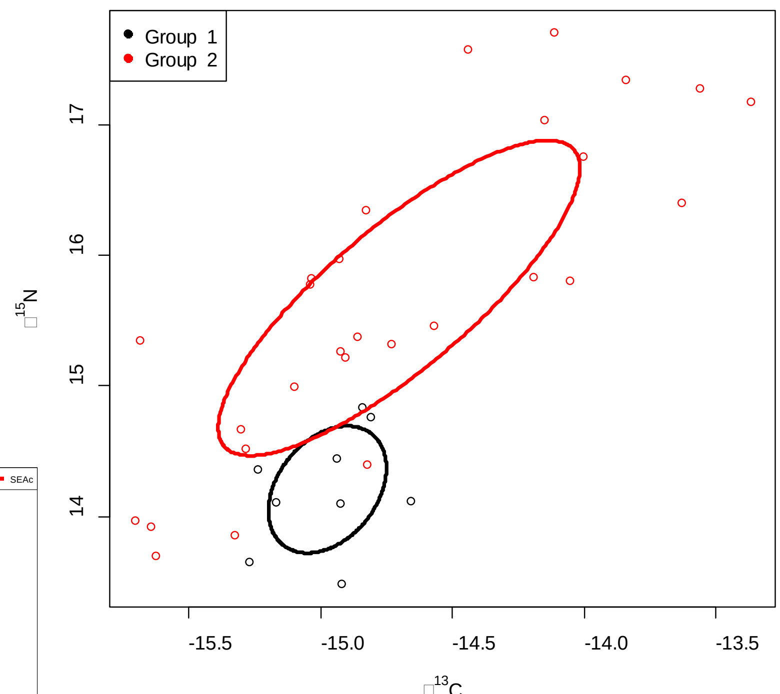
- Difference in feeding ecology between populations

Trophic niche width

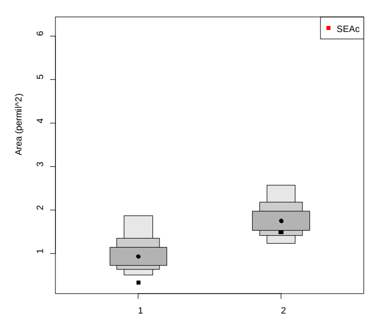
- Differences between Shannon-Cork & Connemara-Mayo δN (U-test, $p < 0.001$).



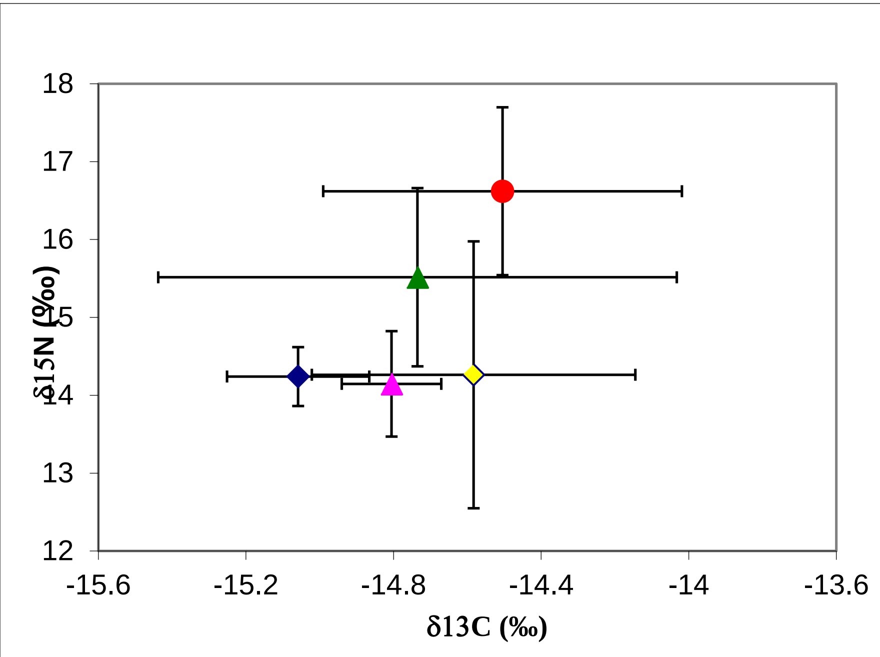
- F-test (Bearhop *et al.* 2004; Foote *et al.*, 2009) $F_{28,7}$ $p < 0.01$

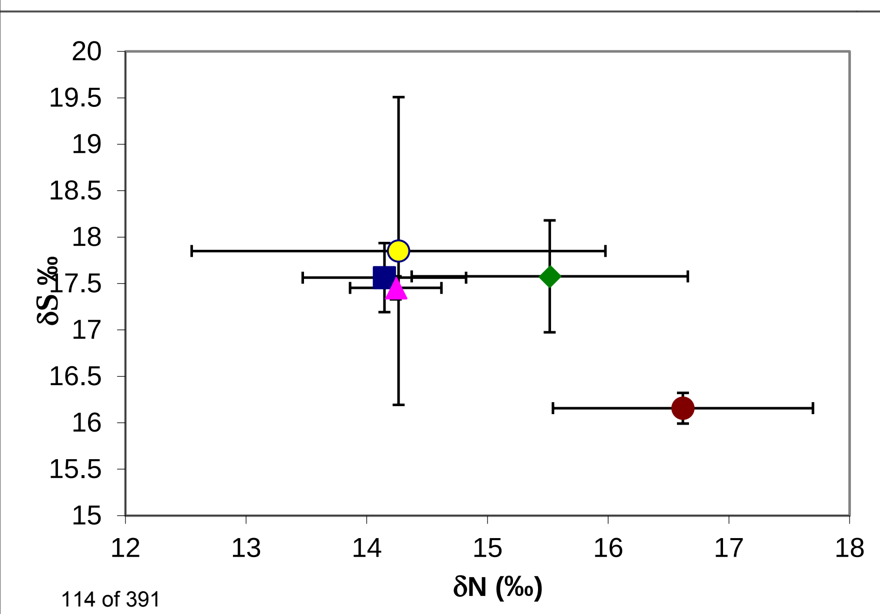


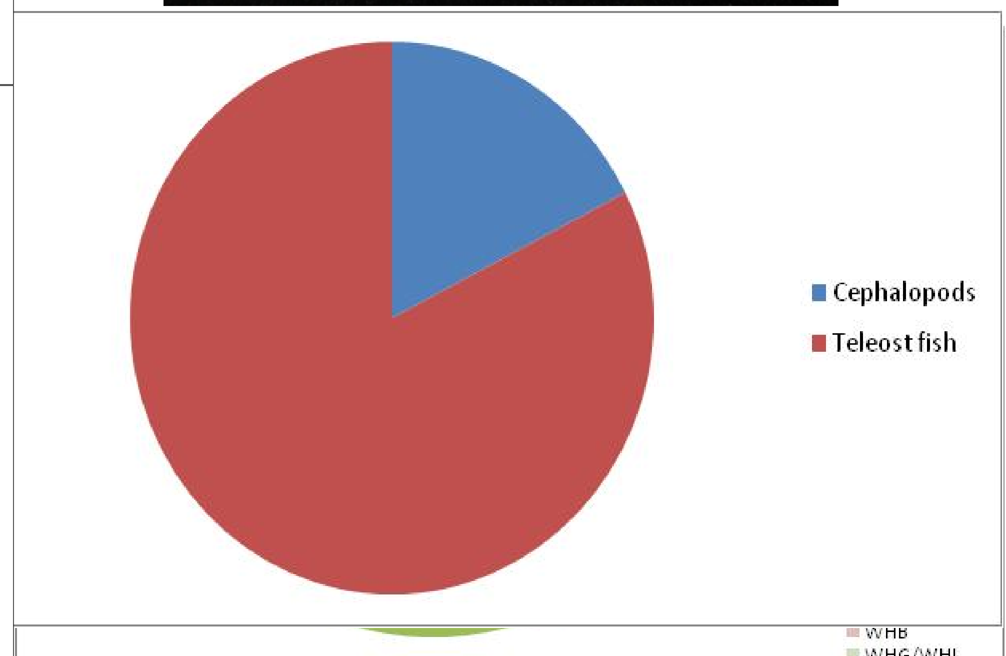
- Isotopic niche width (SIBER, Jackson 2011, 2012).
- Standard ellipse area (SEAc)
- Probability niche overlap low ($p < 0.07$)



"Stranded" population







Hernandez-Milian et al., 2015

To summarise…

- Large numbers of bottlenose dolphins occupy Irish coastal, continental shelf and offshore waters
- Significant population and social differentiation between the three populations in Irish waters with zero recent genetic dispersal (effectively isolated)

- Analyses suggest differences in foraging behaviour & reflects different habitat use
    - Shannon-Cork more generalist feeders, with some individuals feeding at higher trophic levels
    - Connemara-Mayo more specialist feeders, moving between optimal but likely unpredictable prey patches

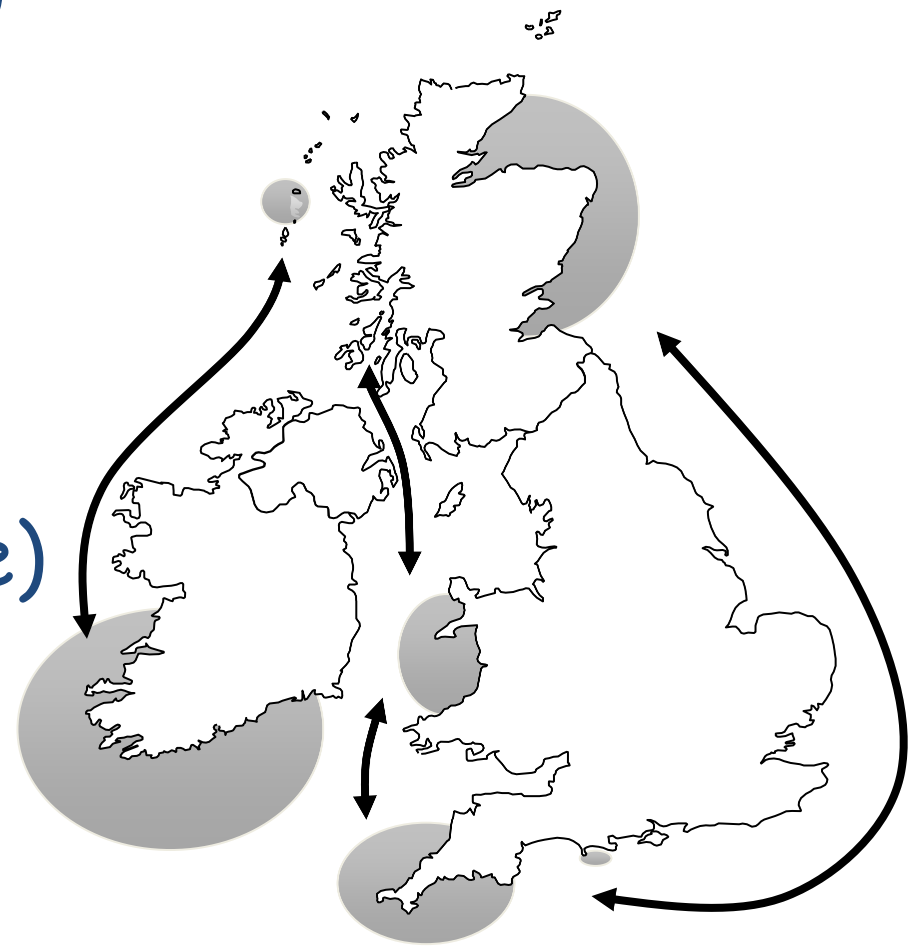
- Third population (pelagic?) likely coastal/continental shelf

What we don't know (gaps)

- Range of population(s)

(or what is coastal, for example?)

- Pop. level life history characteristics (Age, ASM, IBI, longevity) needed for PVA
- Movement(habitat use)
- Fine-scale pop. structure in the "offshore"?



Go raibh míle maith agaibh

- A very, very large number of people gave of their time and effort for all the studies cited here.
- We are extremely grateful to LIST LOTS of people, IWDG, and sponsors: Crawford-Hayes fund, special thanks to Drs Eamonn Kelly, Ferdia Marnell and Oliver Ó Cadhla for their help and support during the project. Warm thanks also to Ruadhán O'Kelly, Marie Kearns, Eileen Dillane, Lochie O'Kelly, Brian and Cyndi Graham, Machiel Oudejans, Dr Ross Culloch, Damien Haberlin, Martha Gosch, Barry McGovern, Róisín Pinfield, Claudia Melville, Caroline Tuffy, Killary Cruises, skippers of the Pirate Queen, Jarlath Hession, Shane Bisgood, John Britain, Máirtín Ó Meallaigh, Selkie sailing, Killybegs Coast Guard, Paddy Byrne, Robert Beirne, and all the lovely people of Connemara, Mayo and Donegal

An Roinn Ealaíon, Oidhreachta agus Gaeltachta
Department of Arts, Heritage and the Gaeltacht

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
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Ecosystems Approach to Fisheries Management

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The east coast of Scotland bottlenose dolphin population: Current knowledge and future challenges

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The population of bottlenose dolphins off the east coast of Scotland has been the focus of an intensive research programme carried out by the University of Aberdeen Lighthouse Field Station (AULFS) and the Sea Mammal Research Unit (SMRU, University of St Andrews) since the late 1980s. Early work by Hammond and Thompson (1991) and Wilson *et al*. (1999) provided information on the abundance, distribution and seasonality of this population. To meet the UK's commitments to the EU Habitats Directive, a candidate Special Area of Conservation (cSAC) was put forward in 1996 for the Inner Moray Firth. The cSAC boundaries were determined based on data from the 1980s and early 1990s, which suggested that the inner Moray Firth was the main area of occurrence of this population. The population expanded its distributional range during the 1990s (Wilson *et al*., 2004), with the current known distributional range being much larger than the SAC and extending from the Moray Firth to the Firth of Forth. All bottlenose dolphins within this distributional range are considered to be part of the same population. The total population was estimated at 195 dolphins (95% HPDI: 162-253) in 2006 (Cheney *et al*., 2013), and 114 (95% HPDI: 96-135) individuals were estimated to be using the SAC in 2010 (Cheney *et al*., 2014). While the wider population is likely to be stable or increasing, there has been decline in the use of the SAC (Cheney *et al*., 2014).

Outside the SAC, data are mostly available for the southern outer Moray Firth and Aberdeenshire (Culloch and Robinson, 2008; Weir *et al*., 2008; Cheney *et al*., 2013), and for St Andrews Bay and the Tay estuary, where effort began in the late 1990s and dedicated photo-identification surveys have occurred annually since 2009. Around 50% of the total population used the area of St Andrews Bay and the Tay estuary every summer between 2009 and 2013 and around 25% of the population used the area between Aberdeen and Stonehaven during 2012 and 2013 (Arso Civil, 2014). Photo-identification data suggest individual preferences for certain areas within the distributional range. In a single summer (May to September) most of the identified individuals are seen in either the SAC or in St Andrews Bay and the Tay estuary, with few individuals being seen throughout the range during those months. However, this changes over time as individuals seen in one particular area for one or more summers may then be seen in another area in following years (Arso Civil and Hammond, 2016). Individuals also range further south past the Firth of Forth, but it remains unknown what proportion of the population does this, how far the range extends and how often those trips occur.

Photo-identification and acoustic data show some seasonality in the presence of bottlenose dolphins at certain sites (Wilson *et al*., 1999; Thompson *et al*., 2011). In the Moray Firth, concentrations of dolphin sightings have been linked to the narrow channels characterised by deep waters, steep seabed gradients and strong tidal currents, which may increase the foraging efficiency of the dolphins (e.g. Wilson *et al*., 1997; Hastie *et al*., 2003; Bailey and Thompson 2010; Pirotta *et al*., 2014). In St Andrews Bay work by Arso Civil (2014) identified a high use area at the entrance of the Tay estuary, where the presence of dolphins seems to be influenced by the tidal state. Apparent survival for juveniles and adults in this population (0.946, 95% CI: 0.934 – 0.955) is similar to other populations; sex-specific survival estimates show a higher survival estimate for females than for males, although the difference is not significant (Arso Civil, 2014). The population has an estimated inter-birth interval of 4.49 years and a fecundity rate of 22% (Arso Civil *et al*., in review).

Similar to other coastal bottlenose dolphin populations, this population may potentially be impacted by a range of anthropogenic threats which include prey depletion, coastal developments (e.g. Pirotta *et al*., 2013), high PCB levels (Jepson *et al*., 2016), and oil and gas and the marine renewable industry. However, there is no evidence that any of these are currently impacting on the population. Existing knowledge on this population highlights the importance of ensuring long-term monitoring within and outside the SAC, and points towards the need for a conservation plan for the entire population.

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University of St Andrews
600 YEARS

The east coast of Scotland bottlenose dolphin population: Current knowledge and future challenges

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Sea Mammal Research Unit

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Transnational Bottlenose Dolphin Conservation Workshop – Dublin, 7th December 2016

Early data on abundance and distribution

1989: Minimum estimate of 62 individuals (land-based watch) (Hammond & Thompson (1991))

1992: Population abundance of 129 (110-174) individuals (photo-identification mark-recapture) (Wilson *et al*. (1999))

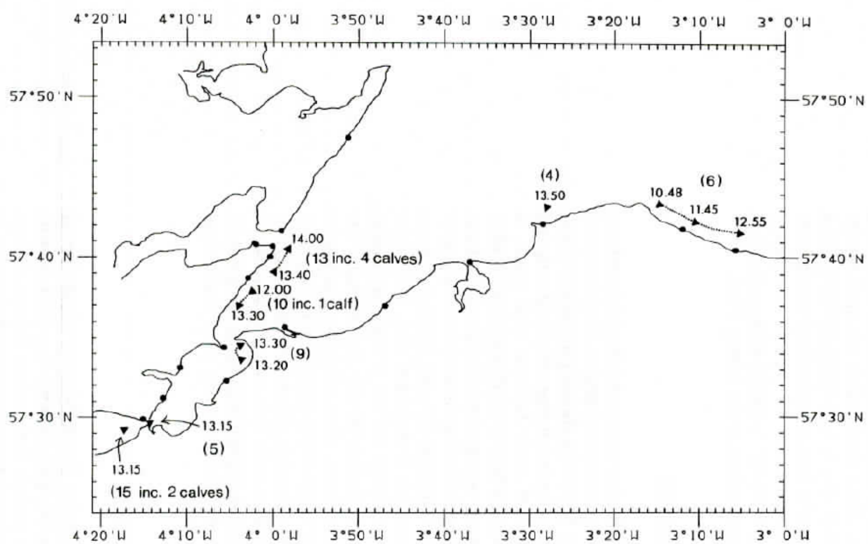


Fig. 1. Map of the Moray Firth showing observation sites (●) and tracks of dolphin groups (···▼···) seen between 1130h and 1400h. The numbers of animals in each group (in brackets) are minima.

82 P. S. Hammond, P. M. Thompson

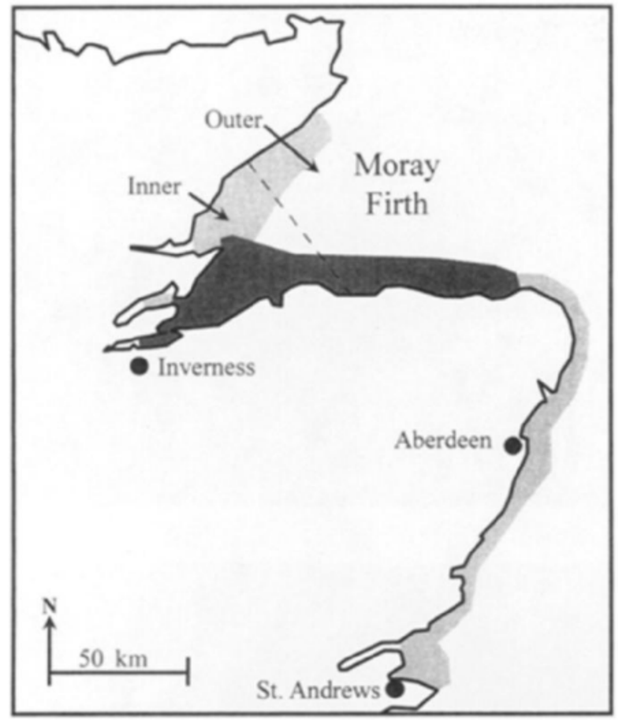
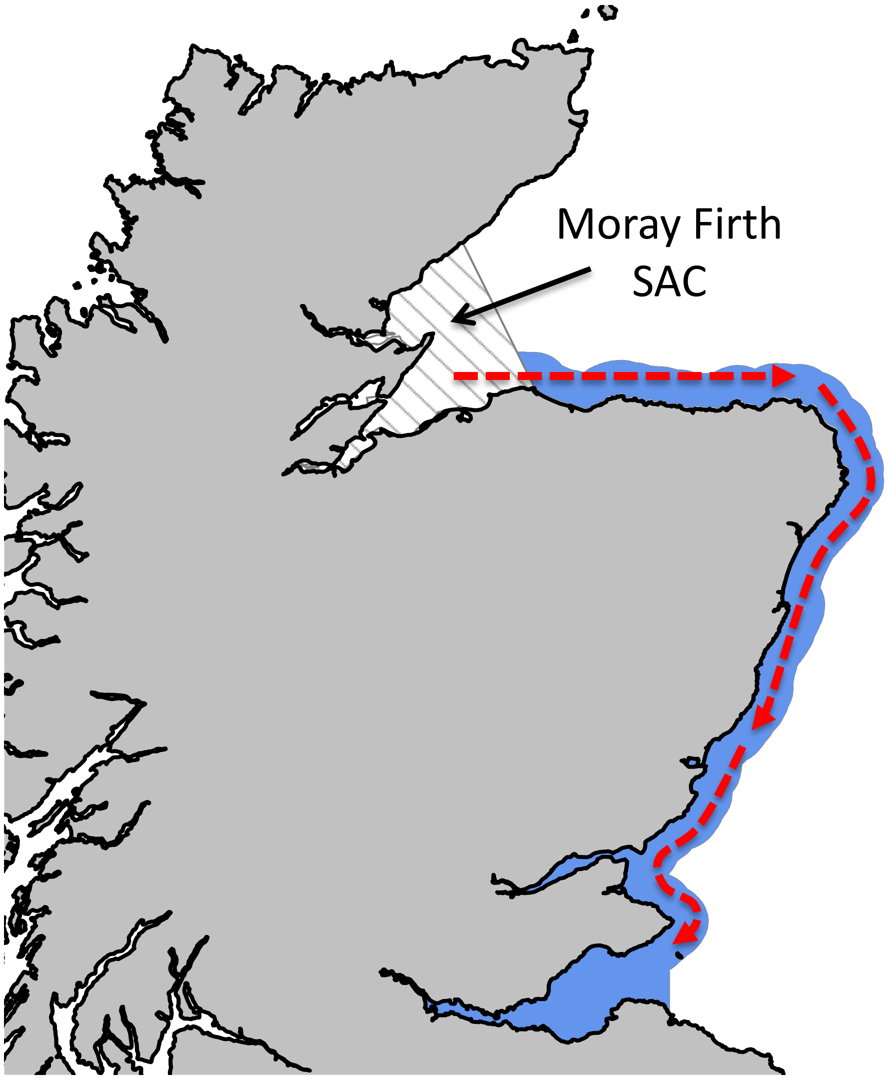


FIG. 1. Map showing the location of the Moray Firth, Scotland, study area. Known distribution of bottlenose dolphins is also shown as heavy shading (regular sightings) and lighter shading (occasional sightings).

Hammond & Thompson (1991)

Wilson *et al.* (1999)

Changes in distribution



- **1996** - Designation of MF cSAC based on data from 1980s to early 1990s
- **2005** – Implementation of MF SAC
- **1990s** - Population's range expansion
  (Wilson *et al.* (2004))
- Current known population range extends from MF to Firth of Forth
- 195 dolphins (95% HPDI: 162-253)
  *(*Cheney *et al.* (2012)*)*
- All animals within the distributional range are considered part of the same population

Trends in population size and use of SAC

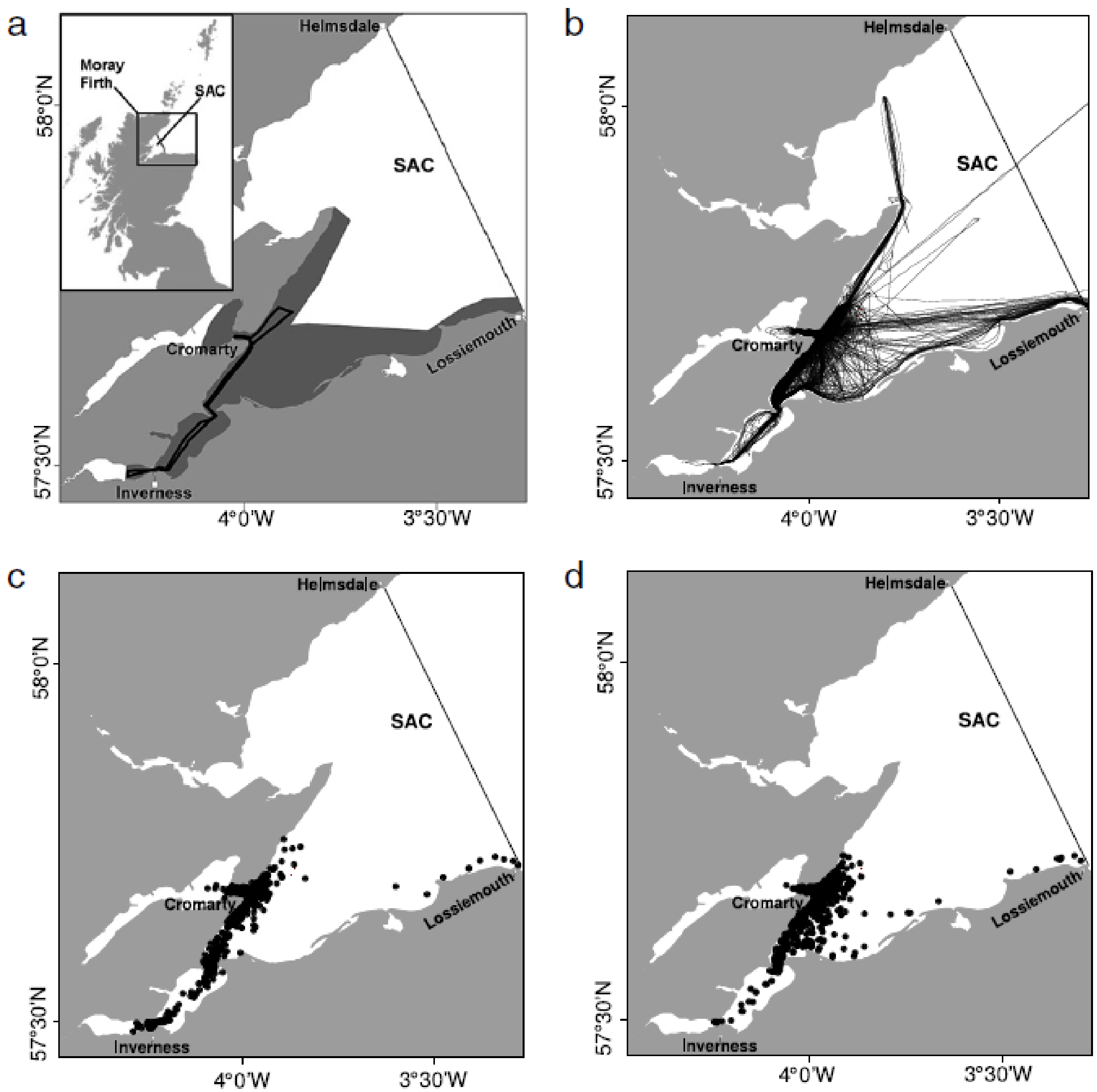
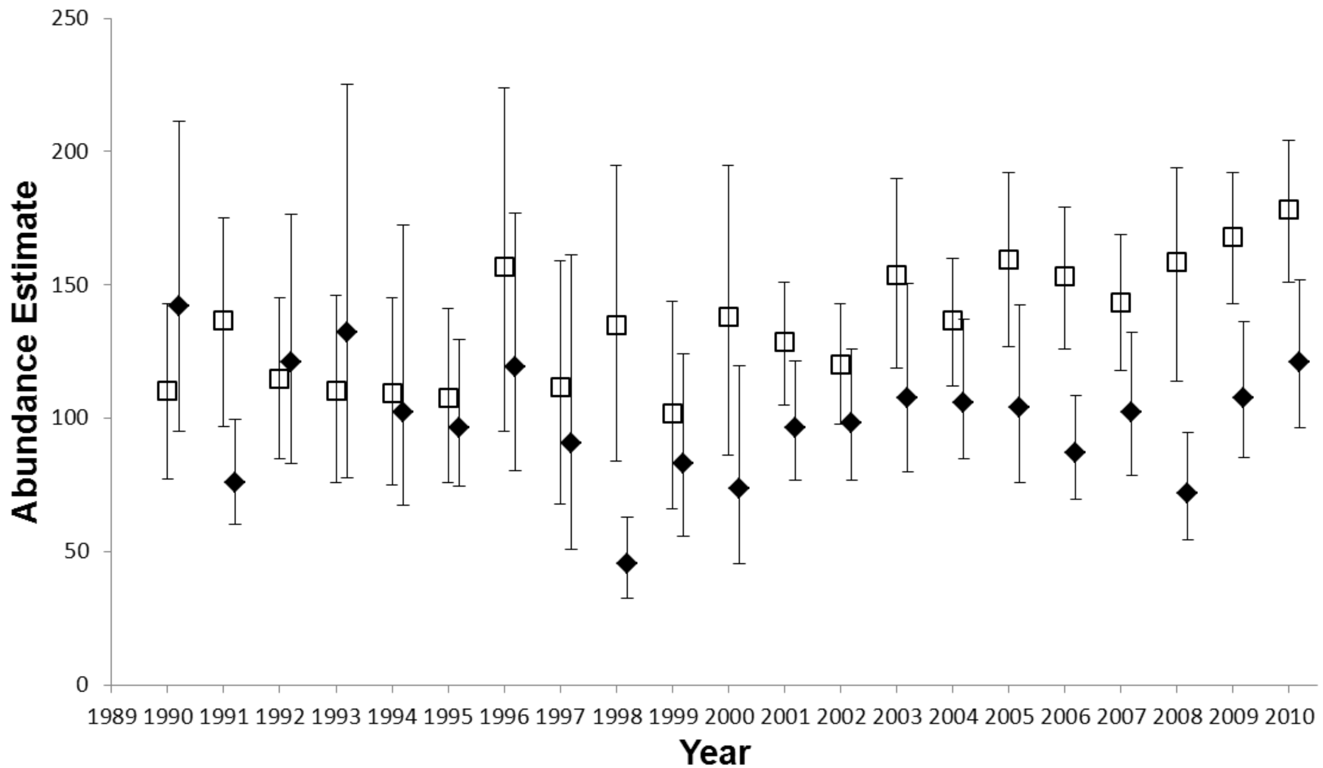
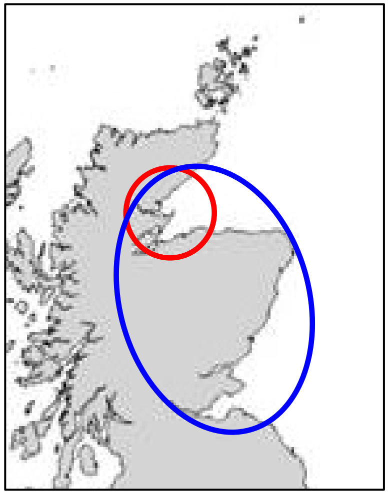


Fig. 1. The Moray Firth Special Area of Conservation (SAC) with photo-identification surveys (a) the fixed survey route for the majority of surveys (>80%) from 1990 to 2000 (black line), with occasional surveys in other areas (grey shading), (b) GPS tracks of flexible surveys from 2001 onward, and the location of all bottlenose dolphin encounters in (c) 1990–2000, and (d) 2001–2010. Inset shows the location of the Moray Firth and the boundary of the SAC.

Cheney *et al* (2014)

Trends in population size and use of SAC



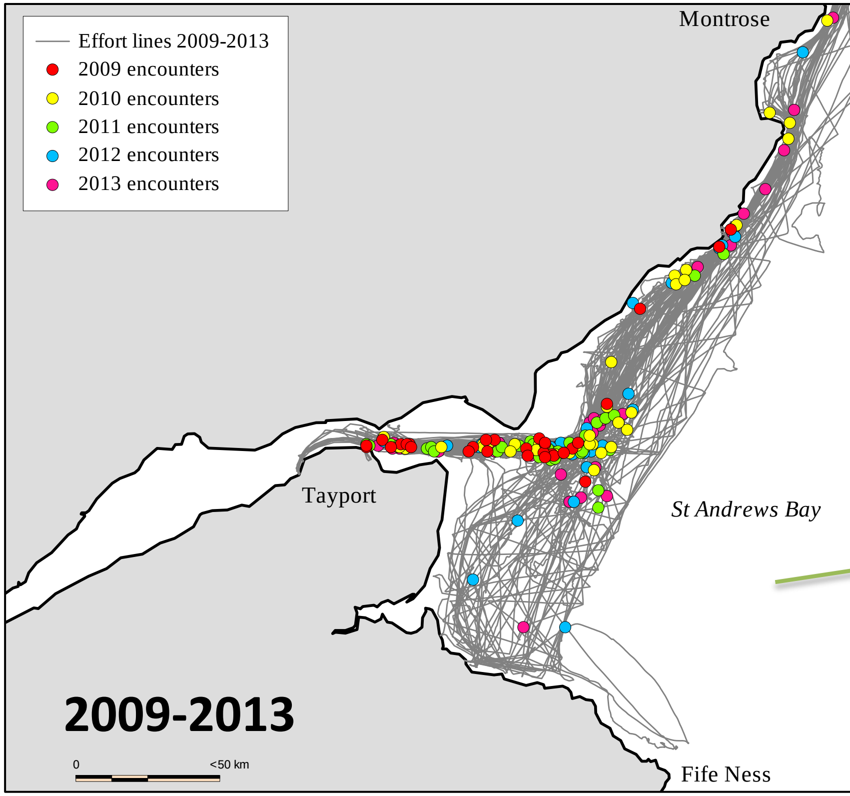


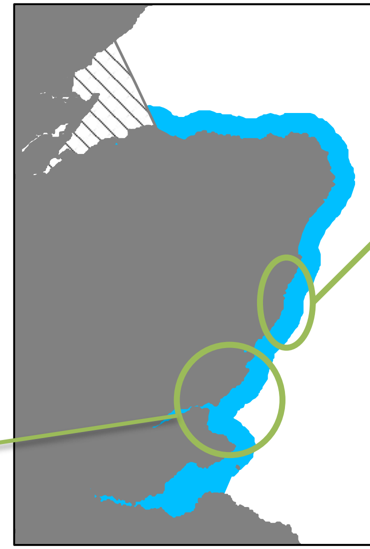
◆ Moray Firth SAC

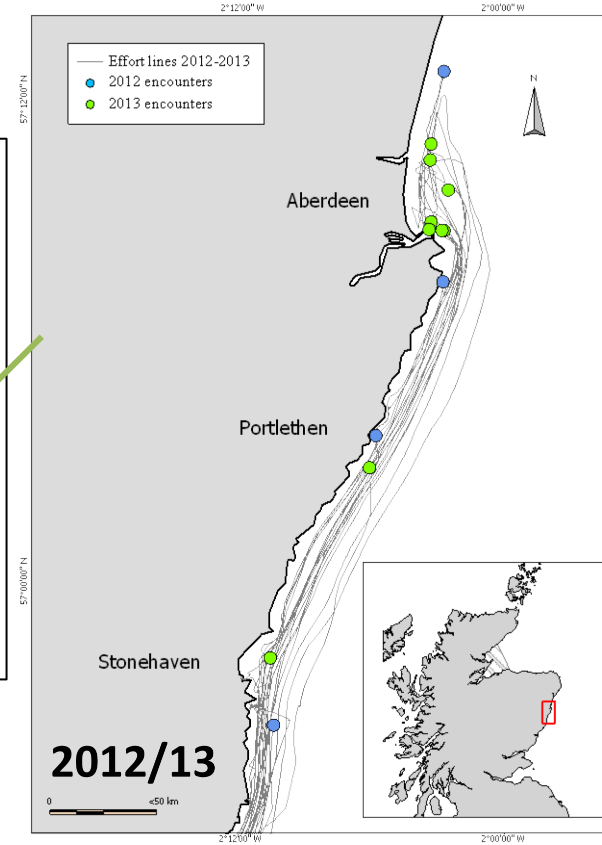
□ East coast Scotland

Cheney *et al* (2014)

St Andrews Bay and Aberdeenshire







2009: 90 (95%CI = 77-106) individuals

2010: 91 (95%CI = 82-100) individuals

2011: 83 (95%CI = 76-91) individuals

2012: 81 (95%CI = 74-90) individuals

2013: 84 (95%CI = 73-96) individuals

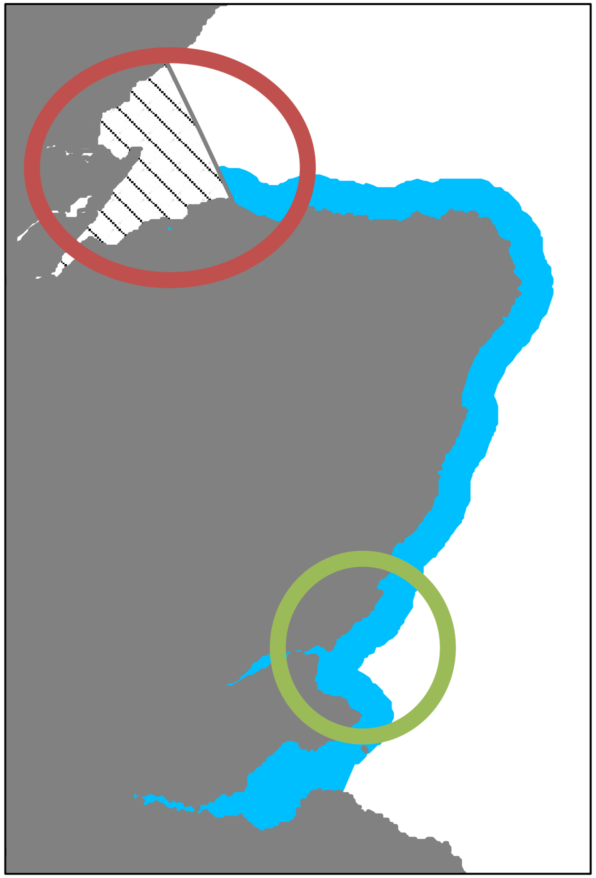
47% total population

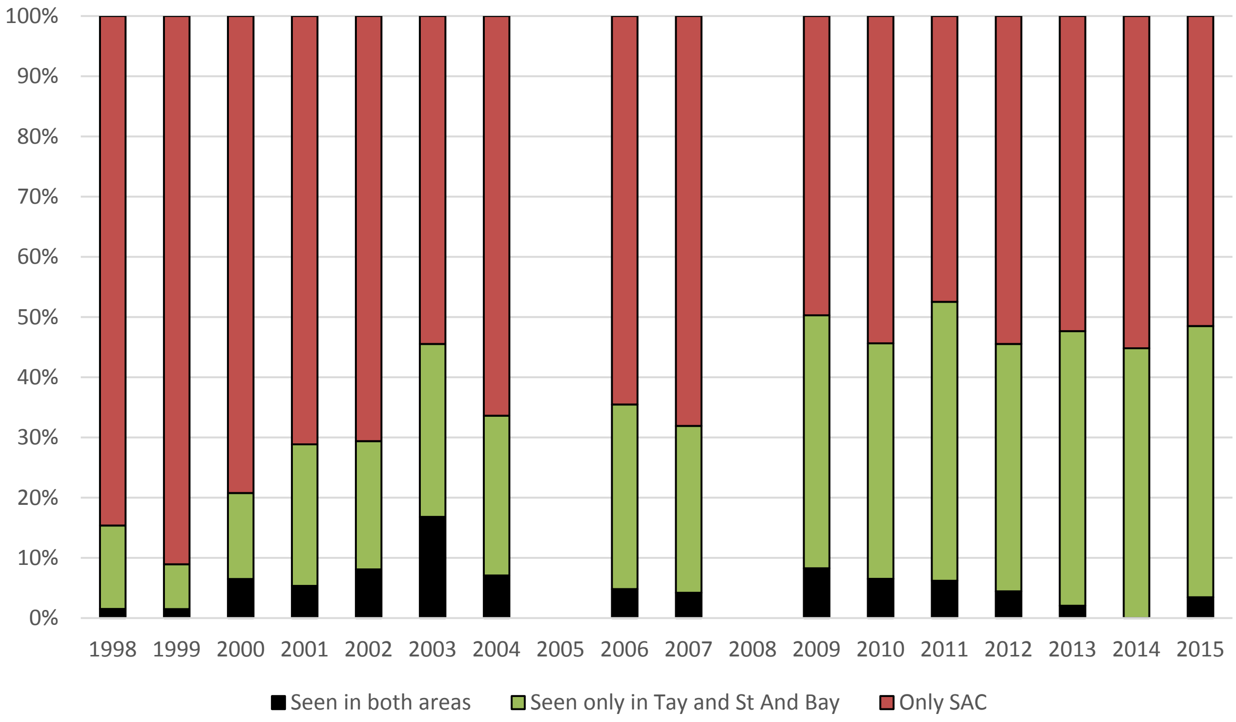
20012-2013: 53 (95% CI = 34-83) individuals

25% total population

Arso Civil (2014) *PhD thesis*

Individual movements across the range





Arso & Hammond (2016) Report to SNH

Seasonal presence of dolphins – CPOD data

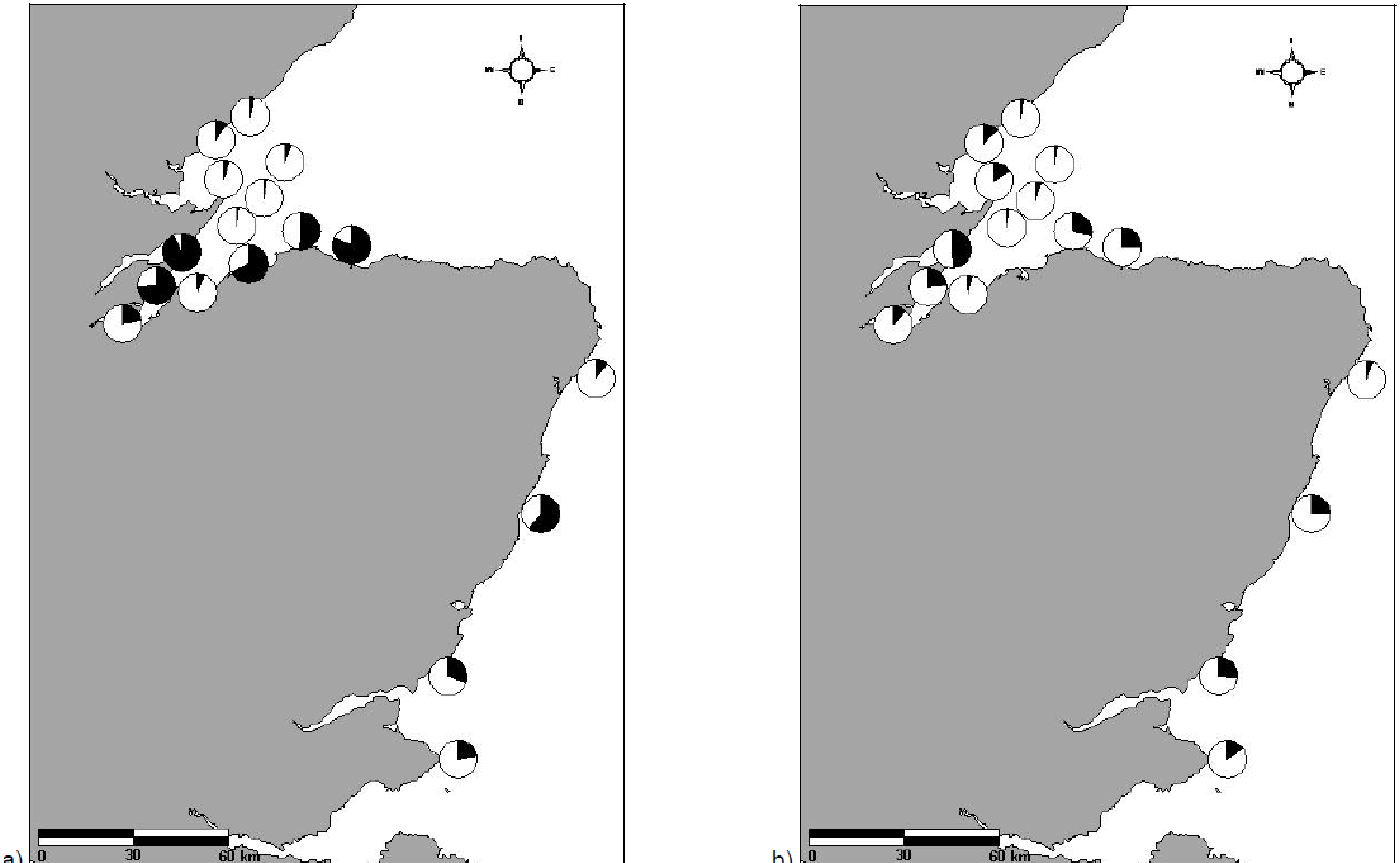
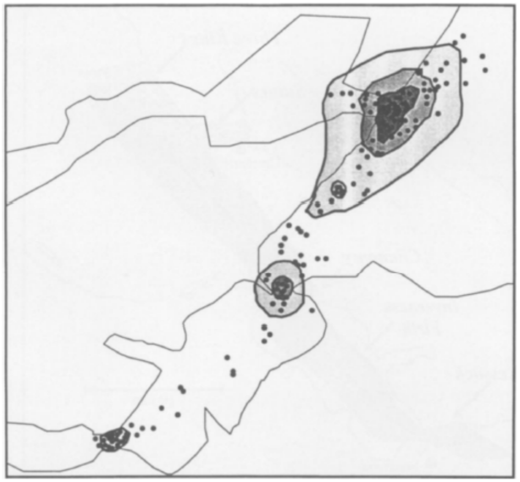
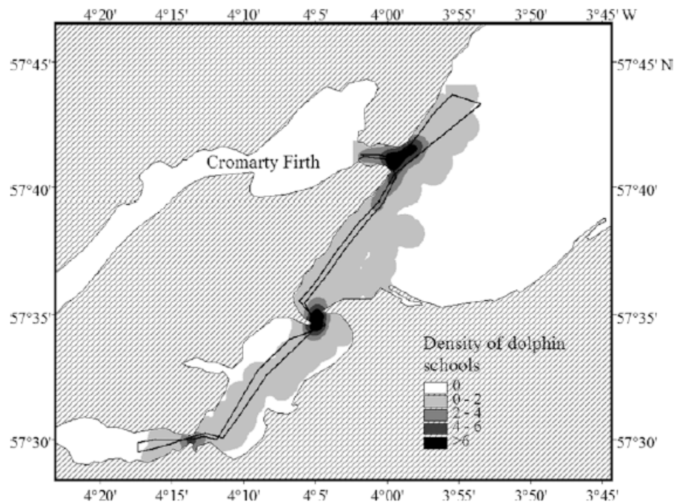


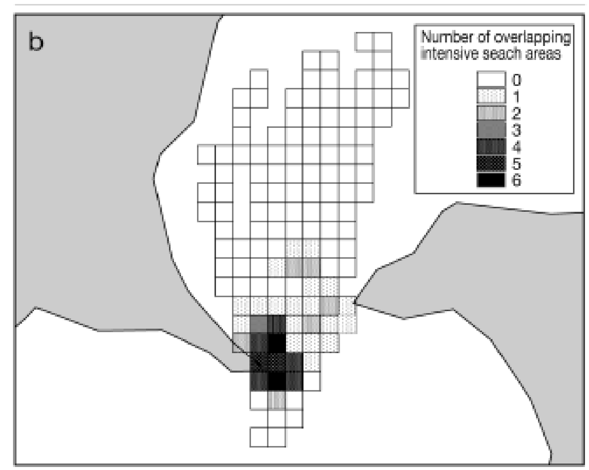
Figure 7.12. Occurrence of bottlenose dolphins around the east coast of Scotland a) in summer and b) in winter of 2008. Pie charts show the proportion of dolphin positive days at a number of key sites around the east coast of Scotland

Thompson *et al* (2011)

Area use – Moray Firth







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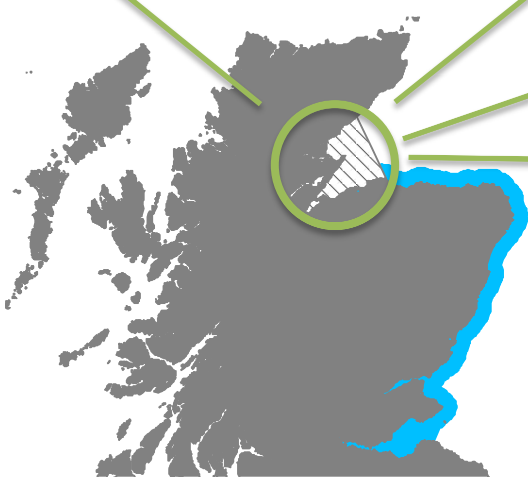
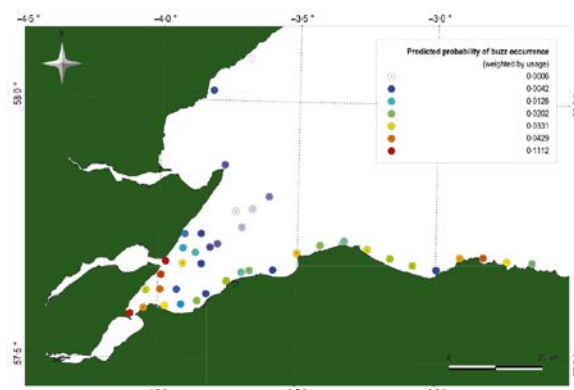
J App Ecol 34: 1365-1374

Hastie *et al*. (2004)
Marine Biology 144: 397-403

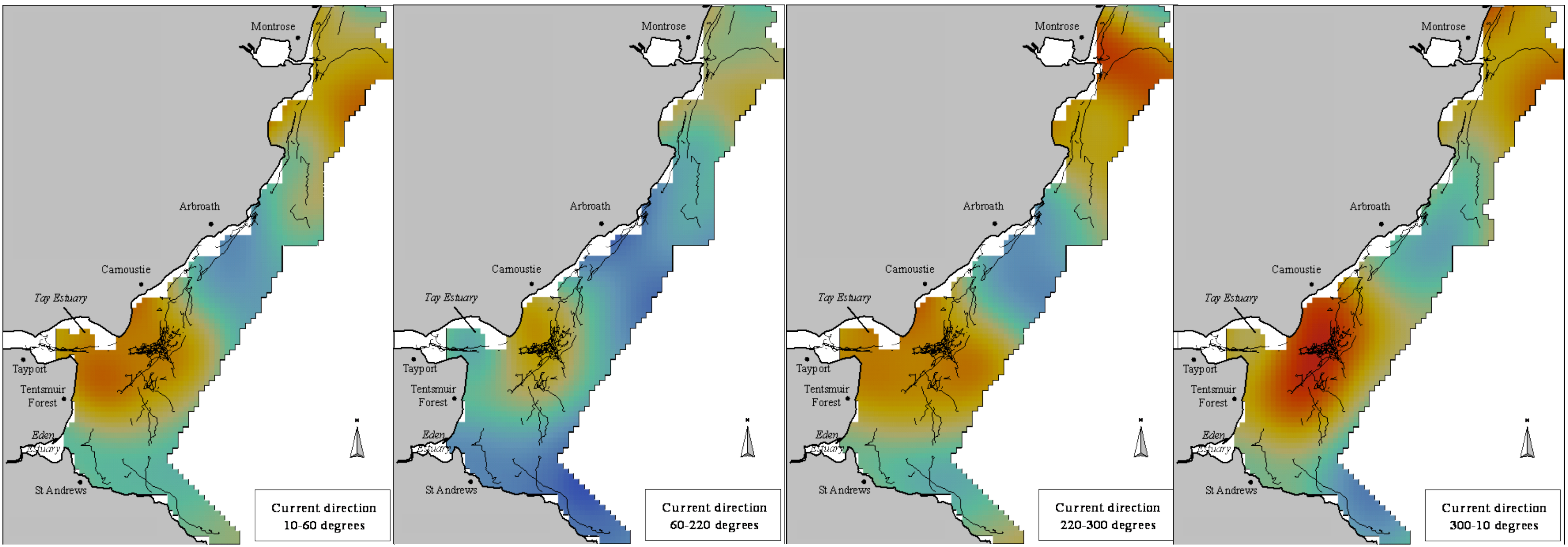
Bailey&Thompson (2010)
Mar Ecol Prog Ser 418:223-233



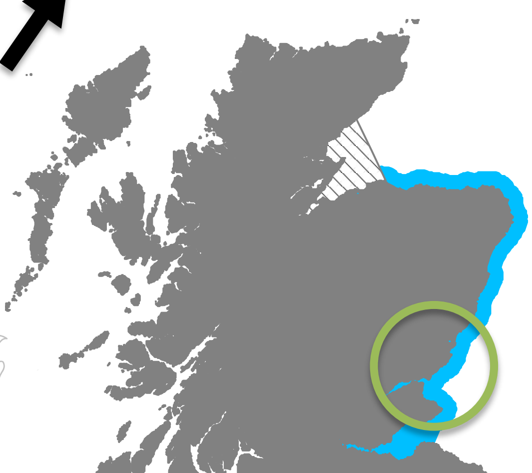


Pirotta *et al.* (2014)
Func Ecol 28:206-217

Area use – St Andrews Bay & Tay estuary



NNE **SSE** **WSW** **NNW**



Predicted probability of presence of dolphins

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

Arso Civil (2014) *PhD thesis*

Demographic parameters

SURVIVAL RATES (Arso Civil (2014) *PhD thesis)*

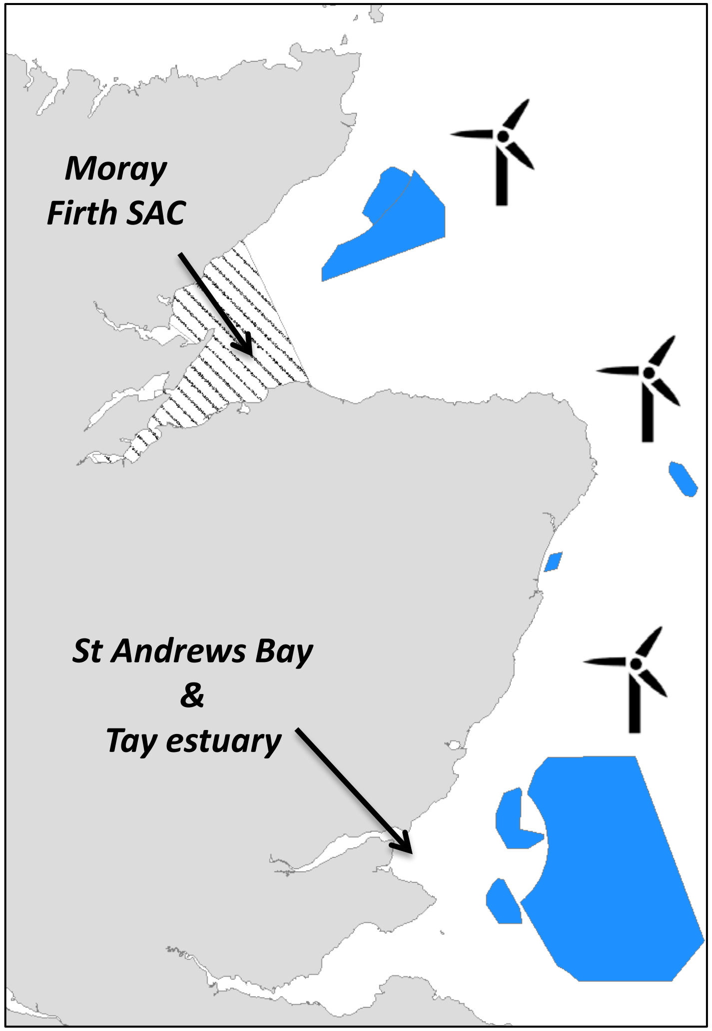
- Probability of apparent survival = 0.946 (0.934 – 0.955)
- Sex-specific apparent survival
  - Females = 0.956 (0.928-0.973)
  - Males = 0.951 (0.918-0.971)
  - Unsexed = 0.939 (0.922-0.952)

FECUNDITY RATE (Arso Civil *et al* (in review))

- Expected inter-birth interval = 4.49 (3.94 - 4.93) years
- Fecundity rate = 22.2% (21.8% – 25.3%)

Potential threats

- Prey depletion
- Coastal development
  - o Displacement from foraging patch due to dredging (*Pirotta et al. 2013*)
- Contaminants (*Jepson et al. 2016*)
- Impacts from oil & gas industry
  - o Ship to Ship Oil Transfers
- Impacts from Marine Renewable Energy Industry
  - o Increased underwater noise
  - o Habitat alteration
  - o Changes in prey resources
  - o Potential displacement from important areas
- Cumulative effects



Current and future research

1. Moray Firth SAC (University of Aberdeen Lighthouse Field Station)

   - **2004-2018:** SAC Site Condition Monitoring for SNH using photo-ID & PAM
   - **2014-2019:** Monitoring vital rates, abundance and distribution as part of as a broader Marine Mammal Monitoring Programme for offshore wind farms in the Moray firth

2. St Andrews Bay (University of St Andrews)

   - **2009-2014**: start of dedicated photo-ID trips in St Andrews Bay (Quick & Hammond). Continued through 2011 and followed by PhD project by Arso Civil (2012-14) (funded by DECC)
   - **2015-2016**: 10 trips per summer season, funded by SNH
   - **2017** potentially continue basic monitoring with SNH funding

Knowledge gaps and future challenges

KNOWLEDGE GAPS

- Distribution and area use outside the summer season (May-September)
- Usage of other areas within distributional range that are not monitored
- Movements outside the known distributional range
- Offshore bottlenose dolphins

FUTURE CHALLENGES

- Funding to ensure continuity of annual surveys
- Importance of monitoring SAC AND areas outside SAC
- Basic monitoring is unlikely to be enough to inform on potential changes in population dynamics
- Conservation plan needed for overall population

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Tursiops on the Scottish west coast: nomads & agoraphobics

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Whereas much is known about the bottlenose dolphin population occupying the Scottish east coast, the dolphins inhabiting waters off west Scotland have received very little dedicated research in comparison. Scotland is increasingly focusing on sustainable energy sources and several marine renewable projects for offshore wind, wave and tidal installations have been proposed for Scottish waters, including off western Scotland. The realisation of these developments has the potential to negatively impact local marine species, including present bottlenose dolphins. To allow assessments of anthropogenic impacts on local dolphins and development of efficient management to mitigate against them (e.g. through time-area management), an increased understanding of their general distribution patterns, residency, and spatial and temporal mobility is required. Therefore, using a variety of research methods (dedicated cetacean surveys and targeted photo-ID trips, acoustic monitoring and the collection of opportunistic photo-ID and sightings data), my study examined local dolphin mobility patterns by investigation of their spatial distribution and temporal occurrence.

Analyses of 26 years of sightings (1989-2014) and 14 years of photo-ID data (2000-2014) considerably extended the long-term monitoring of bottlenose dolphins off western Scotland. Results confirmed findings from previous preliminary studies, supporting the presence of two small communities by providing evidence for a prolonged (at least 2006-2013) social (perhaps also demographical) and geographic isolation between the Sound of Barra (SoB) and Inner Hebrides communities. Furthermore, this study substantiated and extended the duration of the previously described differences in mobility patterns of these segregated communities. The Inner Hebrides community is wide-ranging and occupies the nearshore waters of the Inner Hebrides and mainland coasts. In contrast the SoB community appears to have a much more restricted distribution, inhabiting the SoB and surrounding waters, and dolphins were, with the exception of one female, never photographed away from the area. Despite being fundamentally important to many aspects of spatial management, the factors that drive these seemingly similar communities to have such different ranging patterns remain a mystery.

Inner Hebrides community: Spatio-temporal analyses not only showed the extensive range of the Inner Hebrides community but revealed, for the first time, that dolphins were being sighted *throughout* the Inner Hebrides *each year,* and in most cases during *each month* of the year. Despite a year-round occurrence, most sightings were recorded in the summer, particularly in June-August, most likely reflecting increased observer effort during the summer period. Furthermore, results revealed for the first time the long-term presence of 20 dolphins of the Inner Hebrides community (at least eight years; maximum established was 14 years), with individual temporal occurrence during most if not all months of the year, and individual spatial distributions spanning the entire community range (in contrast to individuals maintaining smaller ranges within a larger community range). Combined, this suggests the presence of a regionally resident community or at least a component thereof.

Throughout this multi-year study new individuals were identified, including adults. These may represent vagrant individuals from neighbouring populations (e.g. eastern Scotland, Ireland, Wales or offshore) or they may be more cryptic individuals. It is possible that other individuals may be present in the region, in particular in more remote areas and locations with limited photo-ID coverage. Photo-ID images revealed the presence of a female and calf, both with an atypical short rostrum. This morphological feature may be an inherited genetic anomaly, although intergeneric hybridisation with a white-beaked dolphin, or in particular with a Risso's dolphin appears a possibility.

Traditional monitoring of low-density communities may be challenging as visual sightings are expected to be rare throughout most of their range. The opportunistic data used here was likely to be spatially and temporally biased, with increased observer effort in summer and in high-use areas. While mindful of these caveats the quantity of collated opportunistic data was markedly higher than that collected during dedicated surveys, indicating that public involvement not only complements and augments systematic surveys, but that it can serve as an effective approach to collect long-term spatio-temporal sightings and photo-ID data covering a large geographic area.

Sound of Barra (SoB) community: This study analysed photo-ID data taken within and in the vicinity of the SoB (1995, 1998, 2006-2013), and revealed that the SoB community has remained a small community (≤15 individuals) for over two decades. Results substantiated the summer site-fidelity previously suggested with a repeated annual presence of ten individuals between 2006 and 2013, four of which were first identified in 1995. Moreover this study is the first to confirm a year-round presence of dolphins in the SoB, with echolocation detected acoustically via C-PODs at one or both monitoring locations (Drover Rocks and Orasaigh) during approximately half of the 591 days monitored between 2010 and 2013; with an increased acoustic presence at Orasaigh and during the summer months. Collectively this indicates not only long-term summer site-fidelity but also year-round residency.

The SoB community appears female-dominated, a result which cannot be attributed to male dispersal or higher male mortality. At least eight calves were born into the community since 2006, yet no other new individuals were identified. Whereas its precise range boundaries remain unclear, based on current knowledge the SoB community could be considered a closed community, showing long-term site-fidelity and residency within a seemingly restricted range, and an apparent lack of association with dolphins from adjacent areas.

Conservation: Although it is possible these communities represent embryonic groups with the potential to grow, it is also plausible that they represent remnants of previously larger groups which have since declined. In any case, given the stochastic effects on small populations and potential Allee effects the presence of relatively few reproducing females in combination with their geographic and social isolation, and their genetic differentiation from other UK bottlenose dolphins, the future resilience, viability and existence of these communities in western Scotland are of concern. Moreover, results presented herein support the view that these communities should be managed as separate conservation units.

Dolphins were observed throughout the entire west coast throughout the year. This insight into their mobility suggests that implementation of time-area management would not be an effective tool in minimising the impacts of industrial activities, as no time periods could be reliably identified when animals are unlikely to be in the vicinity of development areas. Furthermore, the demonstrated predominant presence in areas close to shore suggests that dolphins may be particularly affected by near-shore developments whether for the Marine Renewables industry or otherwise. Limited data are available for the winter and for certain sections within the region, and consequently a lack of confirmed presence should not be interpreted as a confirmation of absence.

Finally, at present the degree of individual and wider genetic mixing between Northeast Atlantic coastal communities/populations and their relevance to true biological populations remain largely unknown, and current results on genetic structuring within the Northeast Atlantic are inconclusive. Inter-regional comparisons between photo-ID catalogues may yet provide matches between areas. This has, however, limited power in detecting rare but reproductively successful movements. Nevertheless such comparisons have already revealed some evidence for movements of dolphins between various localities occupied by bottlenose dolphins in UK and Irish waters, as well as in other areas of northwest Europe. What the consequences of these long-distance movements are with respect to social structure, genetic mixing, population viability and meta-population dynamics, is currently unknown. Given the potential importance of exchanges with neighbouring coastal groups, even if these occurrences are rare, further research is needed to unravel large-scale contemporary genetic structuring, connectivity (including current migration rates), paternity and potential meta-population dynamics.

For further details, see:

van Geel, N.C.F. (2016). *Predator movements in complex geography: Spatial distribution and temporal occurrence of low-density bottlenose dolphin communities off western Scotland*. PhD thesis. University of Aberdeen, Aberdeen, Scotland. 459pp.

Available via: http://digitool.abdn.ac.uk:80/webclient/DeliveryManager?application=DIGITOOL-3&owner=resourcediscovery&custom_att_2=simple_viewer&pid=230551.

University of the Highlands and Islands
Oilthigh na Gàidhealtachd agus nan Eilean

SCOTTISH ASSOCIATION *for* MARINE SCIENCE

Tursiops on the Scottish west coast: nomads & agoraphobics

- Nienke van Geel -

Transnational bottlenose dolphin conservation workshop
Dublin 7th & 8th December 2016

Overview

- Setting the scene: BNDs and MRs off western Scotland
- Inner Hebrides community
  - Coastal distribution
  - Spatio-temporal distribution
  - Site-fidelity
- Sound of Barra community
  - Abundance
  - Temporal presence
- Summary
- Mobility in NW Europe

West coast BNDs – previous knowledge

2 small seemingly isolated communities with contrasting mobility patterns

- Sound of Barra (SoB) & Inner Hebrides communities

Background information available from: Grellier & Wilson, 2003; Mandleberg, 2006; Islas-Villanueva, 2009; Thompson et al., 2011; Robinson et al., 2012; Cheney et al., 2013.

West coast BNDs – previous knowledge

- Sound of Barra (SoB)
  - Photo-ID data: 1995, 1998, 2006 & 2007: ~15 indiv
  - Apparent restricted distributon: SoB & adjacent waters
  - Recaptures indicative of (summer) site-fidelity or residency???
  - High relatedness: values indicative of parent-offspring or full siblings
  - Historic genetic connection with samples from Wales

West coast BNDs – previous knowledge

- Inner Hebrides
  - Photo-ID data 2001-2007: ~30 individuals
  - Wide-ranging throughout Inner Hebrides and mainland coasts
  - Long-distance movements: matches with east coast, Ireland & Cornwall
  - Lack of evidence of full demographic isolation with east coast, but evidence for population differentiation
  - Negative relateness values (but stranding samples); closest relationship with samples from English Channel

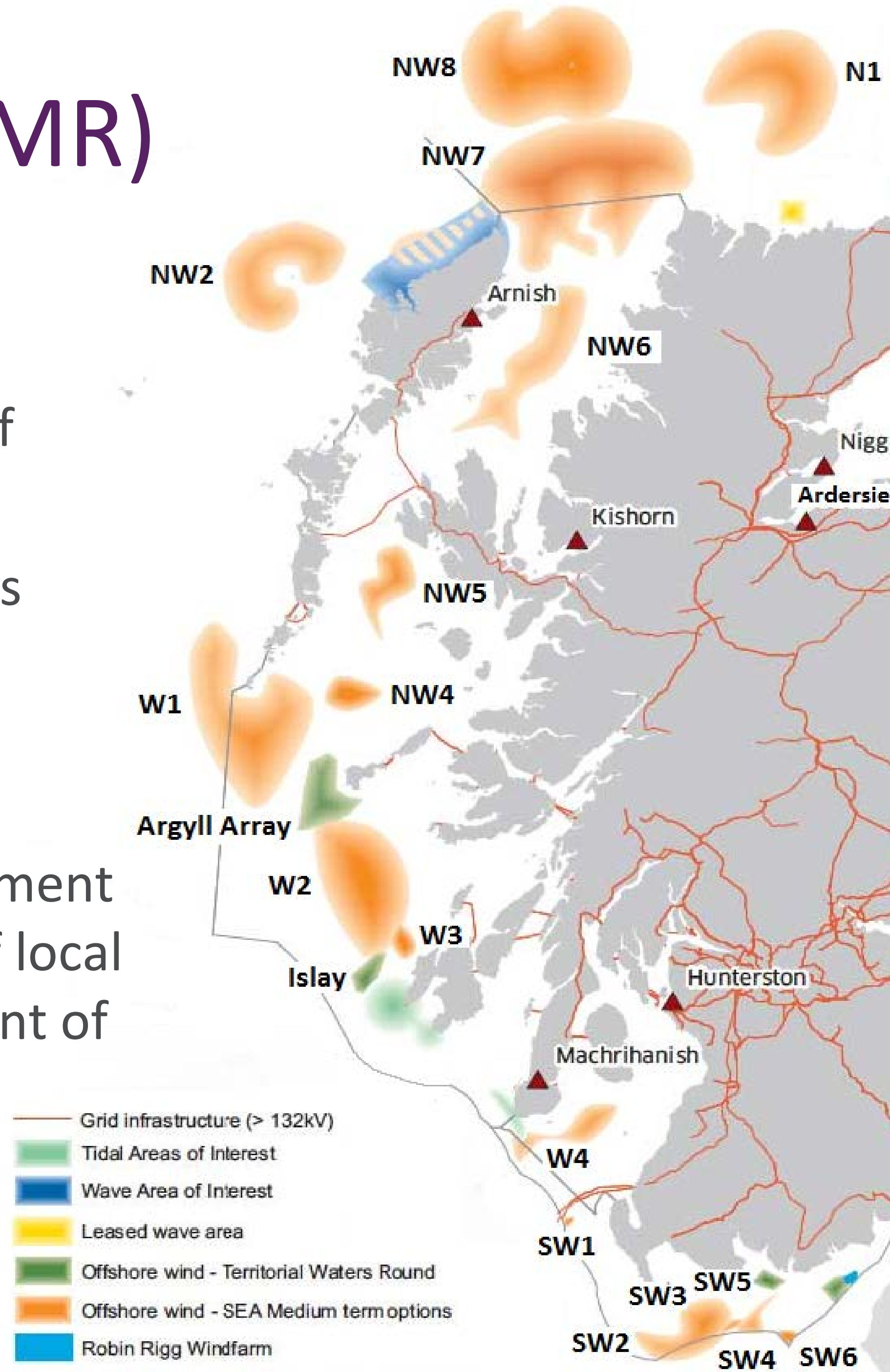
Data gaps

- Spatial and temporal distribution → movement patterns
- Current population size
- Interaction between communities / populations
- Demographics and life history parameters
- Local habitat preferences
- Social structure
- Diet
- Behaviour

→ General lack of baseline information

Marine Renewables (MR)

- Various MR installations proposed off western Scotland
- Spatial overlap with coastal cetaceans raised concerns - impacts & benefits poorly understood
- Ability to assess impacts & the implementation of effective management impeded by limited understanding of local populations, as well as nature & extent of cumulative threats



Proposed area of search sites for MR developments off north & west Scotland. Map © Crown Estate; adapted from Baxter et al., 2011 & Scottish Government, 2011.

Research aim

(van Geel, 2016)

Understanding bottlenose dolphin movements on the west coast of Scotland → can time-area management be used as a mitigation tool?

&

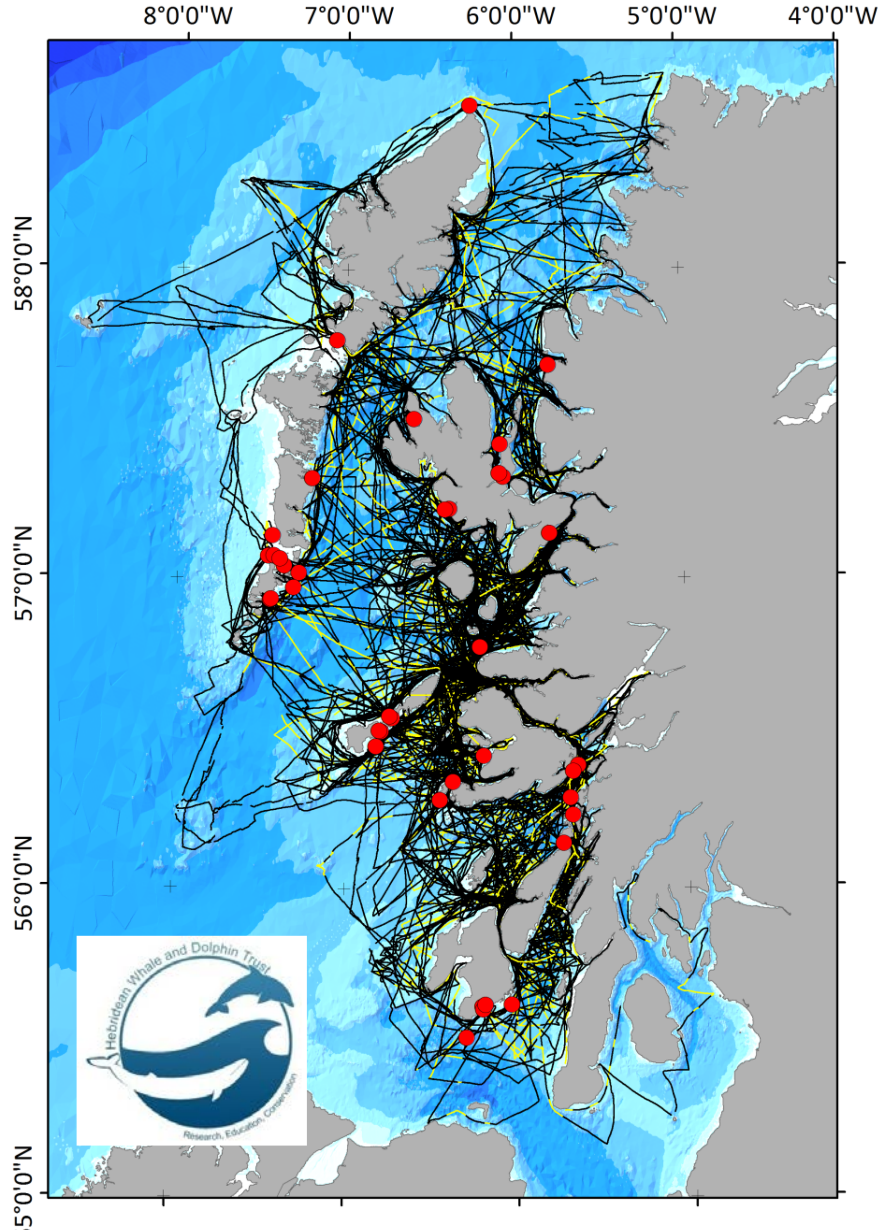
Various MR projects cancelled / postponed
→ Focus on ecology & monitoring methods to investigate low-density communities

Inner Hebrides - Monitoring

- Low-density (wide-ranging small community) through vast complex area → traditional surveys not efficient

- Opportunistic data may provide alternative source, but potentially spatio-temporally biased

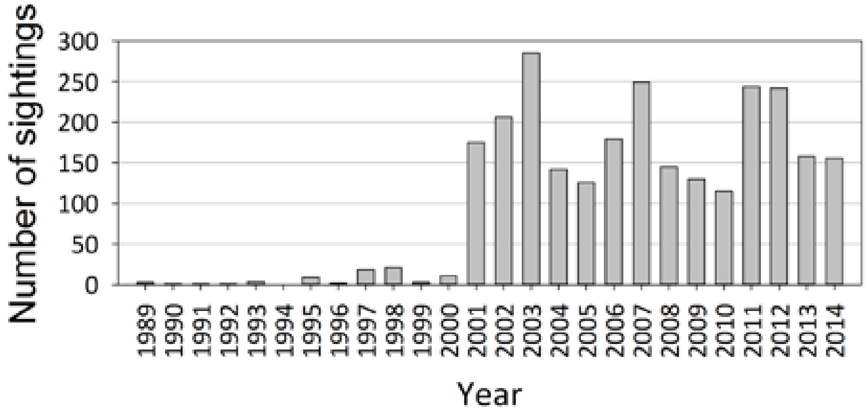
- Assess coastal distribution → implications for monitoring

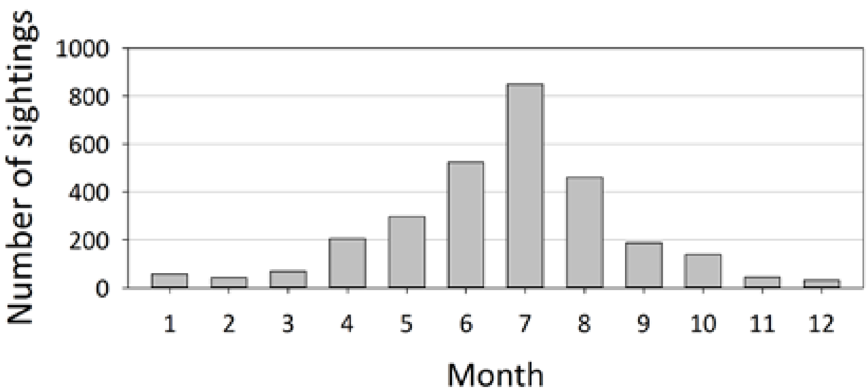


HWDT survey effort 2003-2012: ~60,500km (sea state ≤3 in black; >3 in yellow), and bottlenose dolphin sighting locations (red circles; n=41).

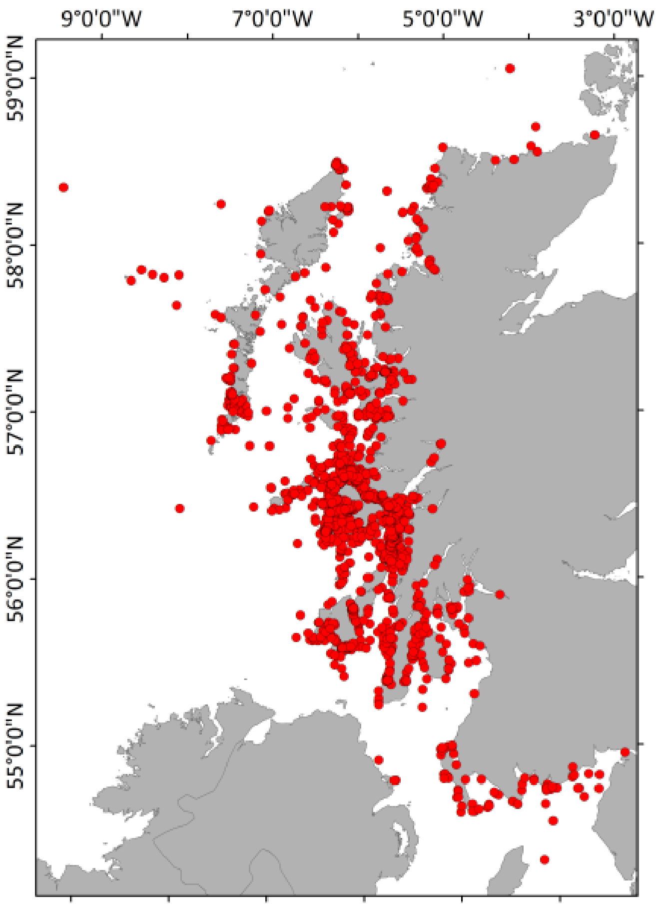
Spatio-temporal distribution (mainly opportunistic data)

1989-2014: 2627 sightings



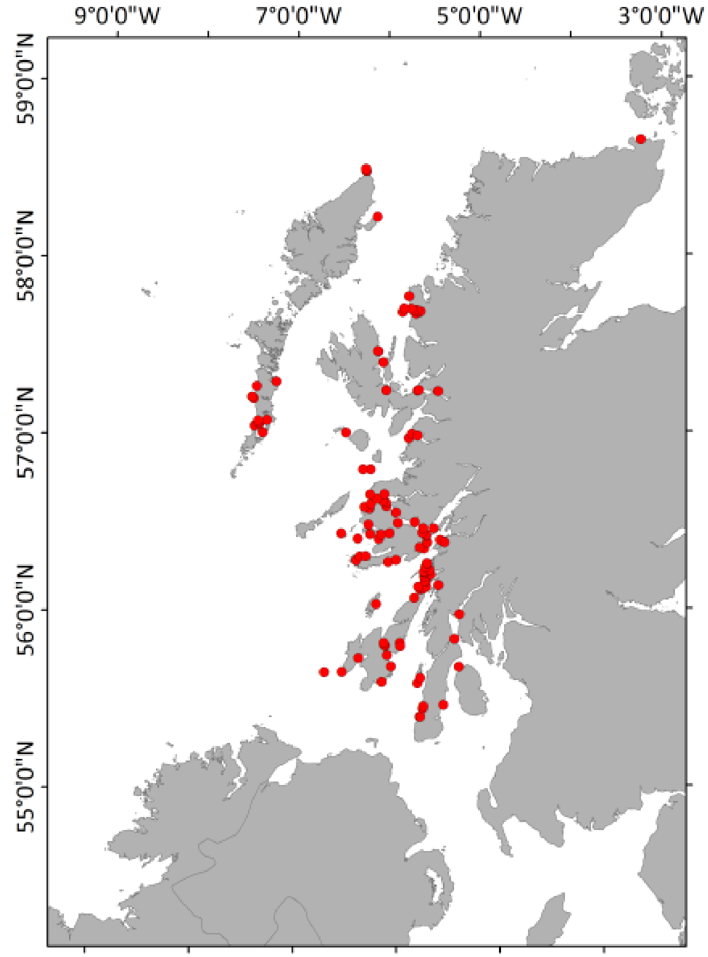


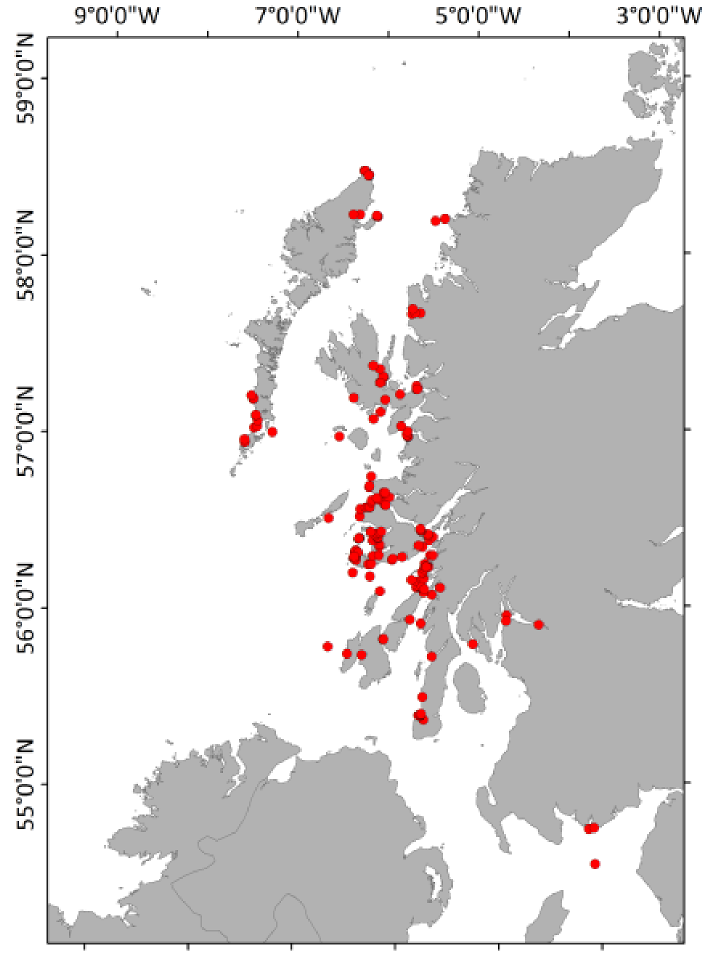
Temporal distribution of bottlenose dolphins sightings off western Scotland 1989-2014. Note: unequal effort assumed among years and throughout the year.



Locations of bottlenose dolphin sightings 1989-2014. Note unequal spatial effort assumed.

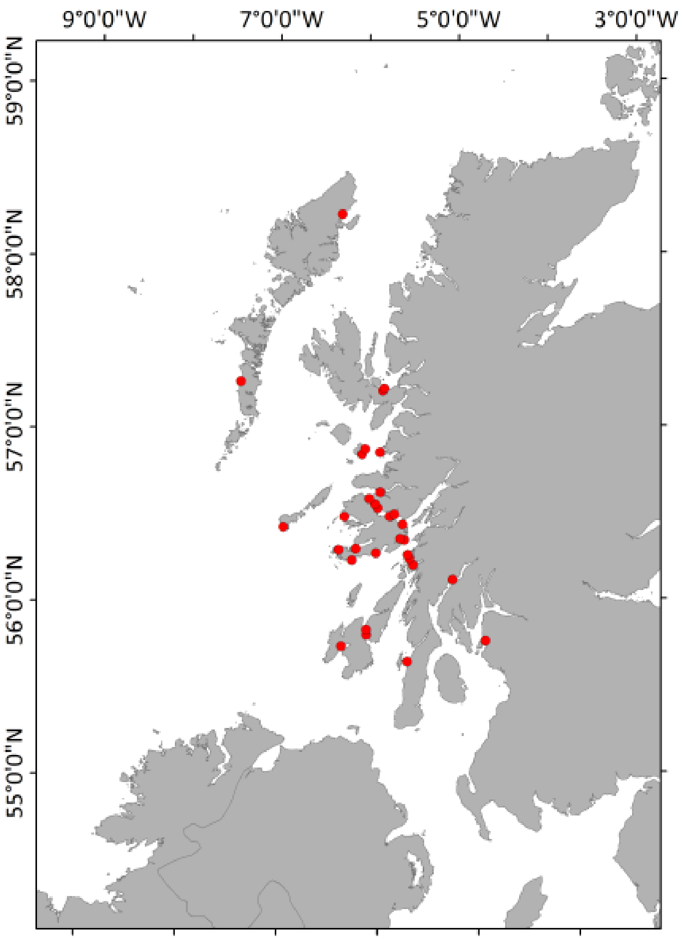
2009 (126) / 2011 (228)



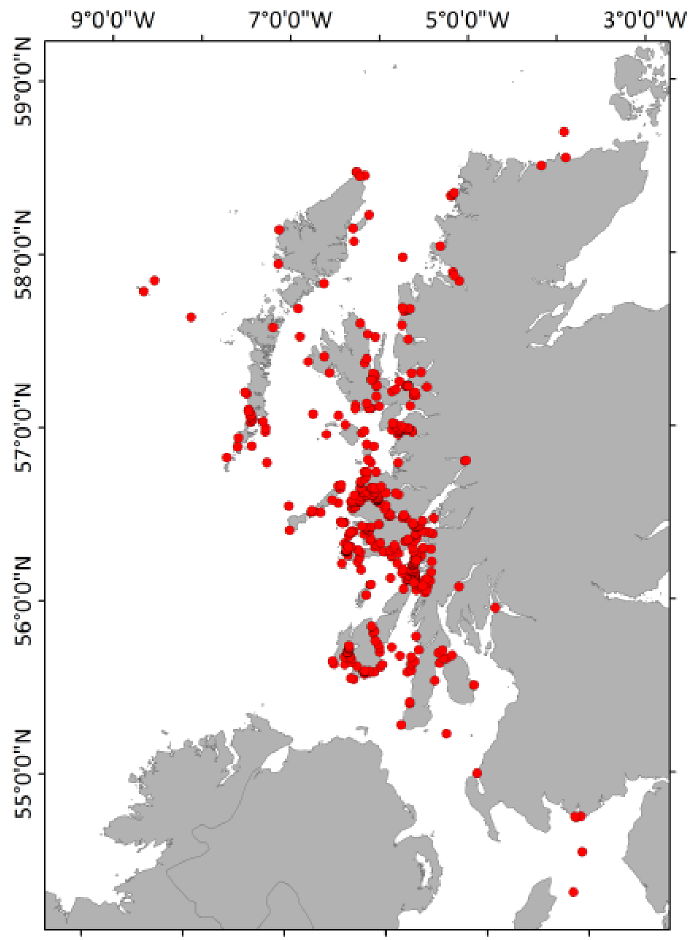


Bottlenose dolphins were observed throughout the research area, independent of year (and number of sightings).

December (32)



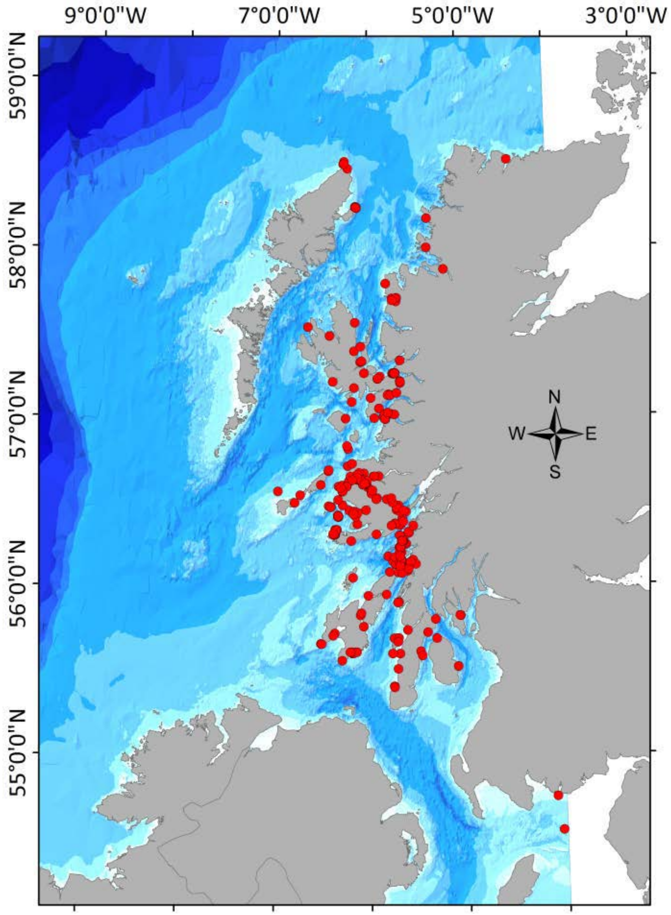
July (538)



Bottlenose dolphins were observed throughout the research area, independent of month of the year (and number of sightings).

Site-fidelity (photo-ID)

2000-2014: 15,439 images of 357 encounters



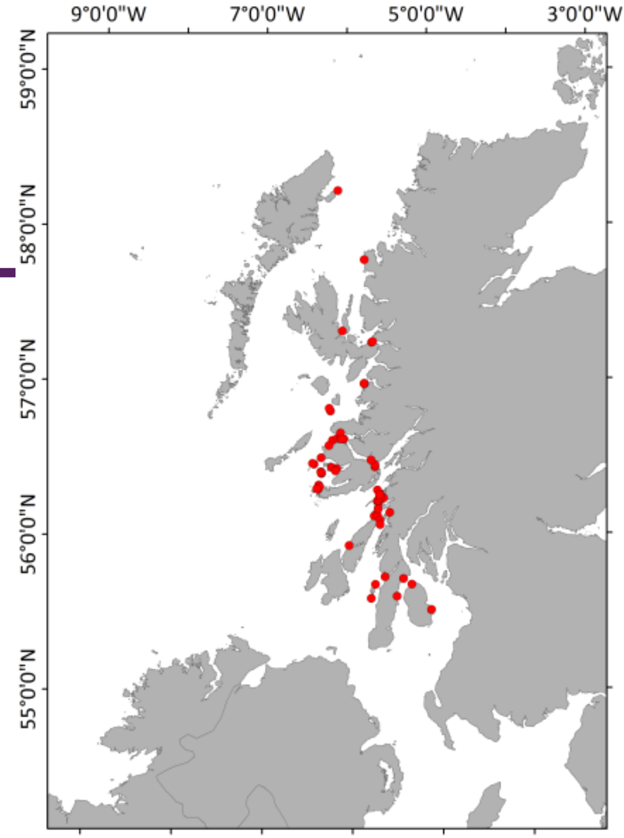
Locations of bottlenose dolphin photo-ID encounters 2000-2014 (SoB excluded).

Site-fidelity (photo-ID)

20 dolphins long-term site-fidelity (identified in ≥ 8 years): 9xM, 8xF, 3xU

Identified throughout the year & research area

e.g. ID 5029: n=63 since born in 2006, all months, throughout area



Sighting locations ID 5029

HOWEVER: In addition to calves, also new adults identified through the years → unknown origin, but frequently together with well-known individuals

Potential for unreported community (Unpublished data)

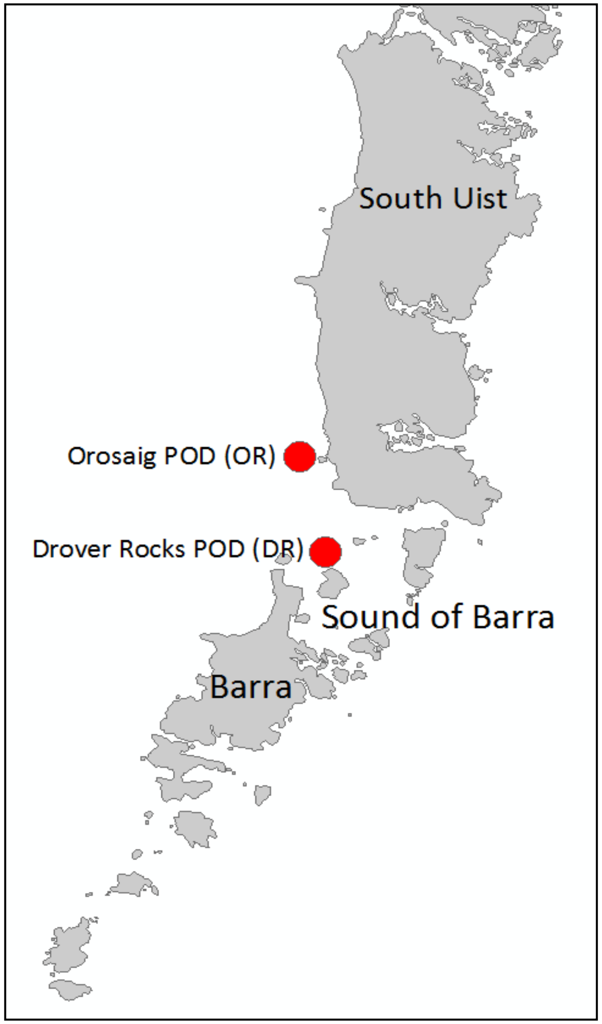
♀ c-pair with a-typical rostrum: genetic anomaly or hybrid?

Sound of Barra

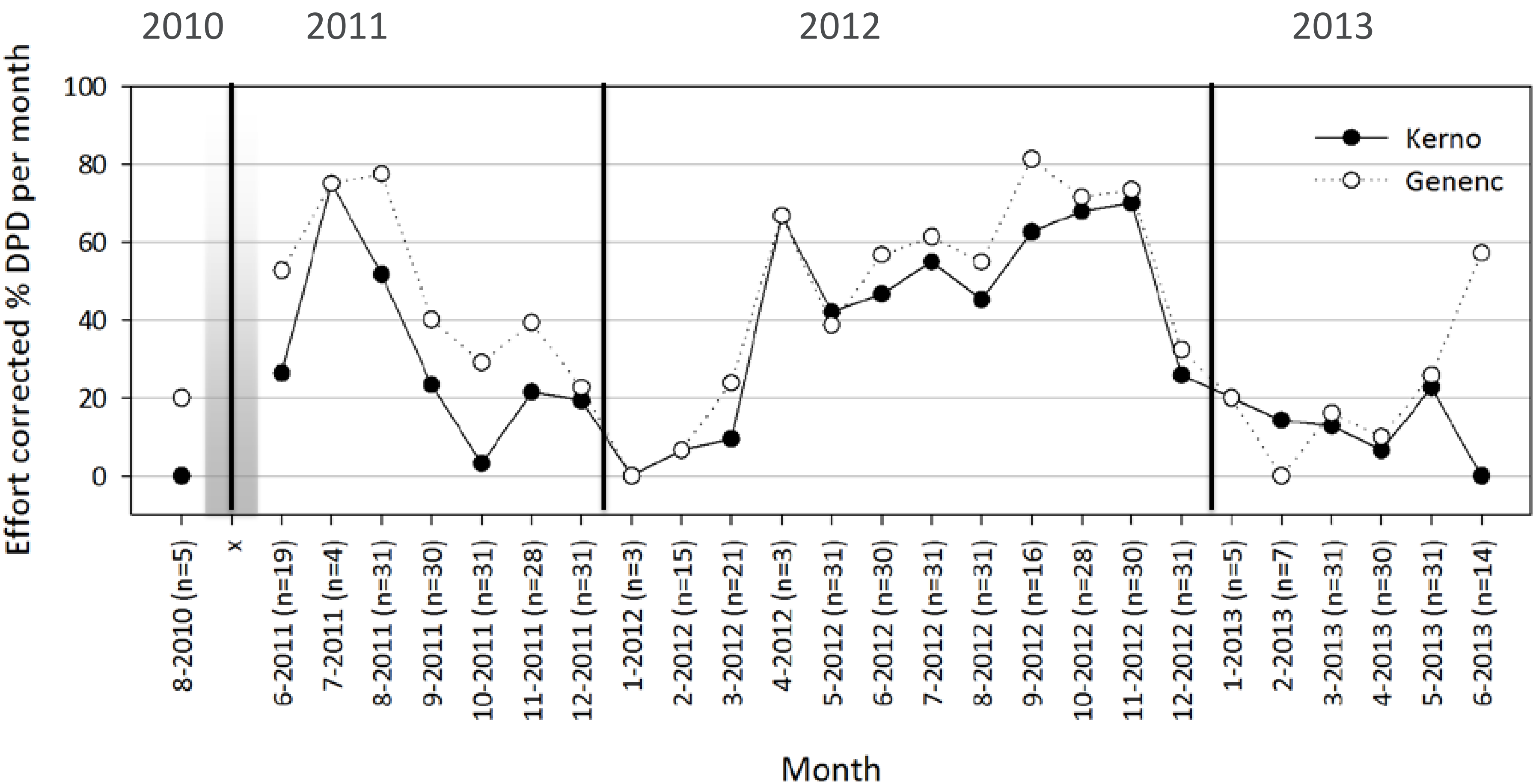
- Photo-ID data: 2006-2013 → 13,934 pictures
- Annually 12-15 individuals
- Gender for 13/18 indiv: 10xF & 3xM
- 8 calves born from 3 females; no other new individuals
- Long-term site-fidelity: 4 since 1995
- 1 ♀ identified outside SoB (solitary) in 2004 - same matriline as other SoB sampled *(Islas-Villanueva, 2009)* - annually back in SoB since 2006

Temporal presence

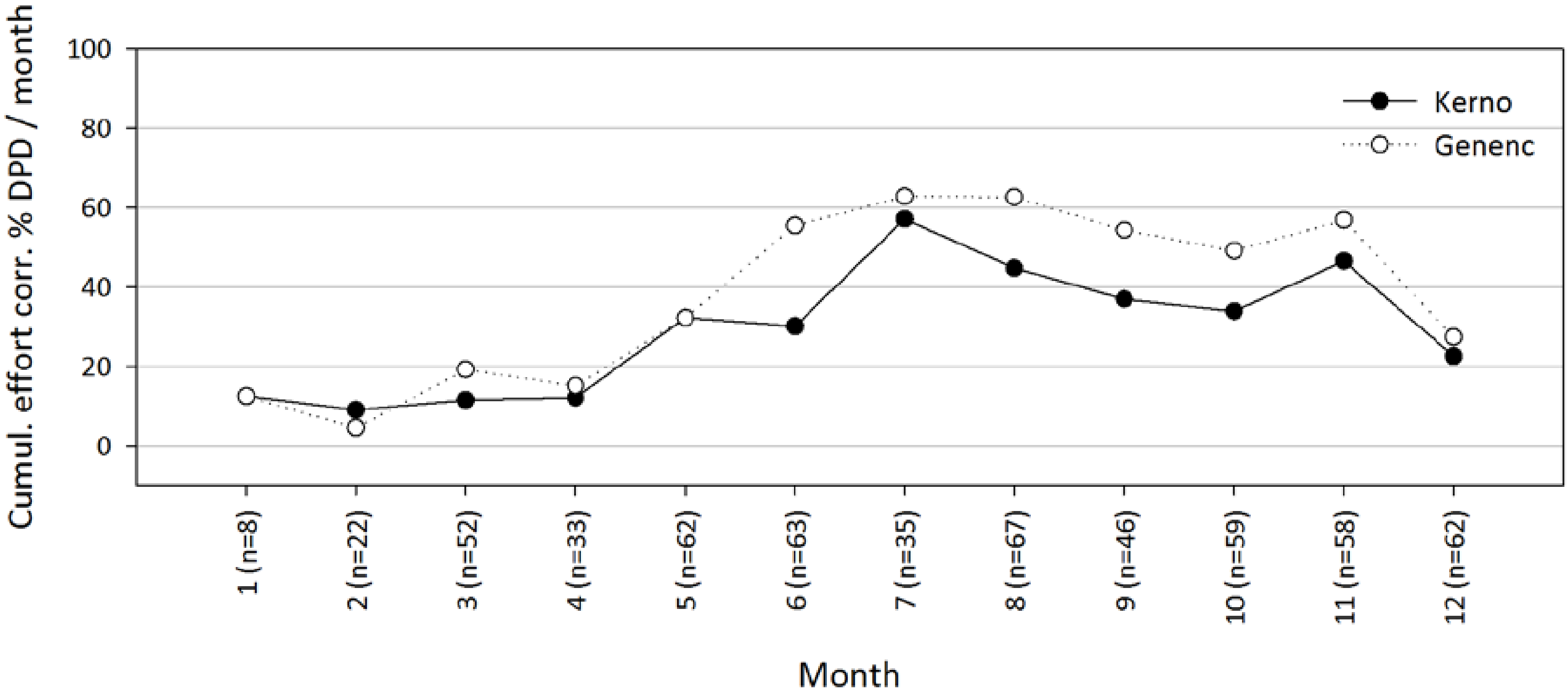
- C-POD monitoring @ 2 locations
- 2010-2013 (non-continuous)



Temporal presence (DR site)

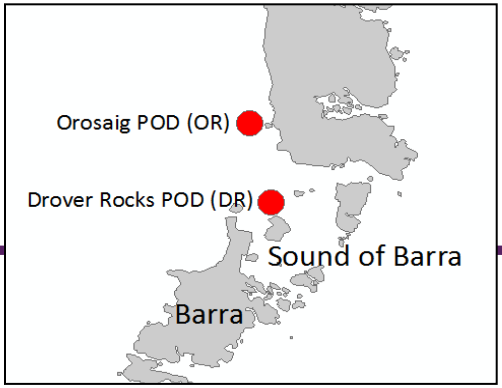


Temporal presence (DR)



→ First evidence for year-round presence

(Despite decreased acoustic presence in winter)



	DR	OR
Total effort (min)	807,409	293,612
DPM (‰)	1,406 (1.74)	2,449 (8.34)
Effort (days)	567	207
DPD (%)	240 (42.3)	142 (68.6)
Jun-Aug effort (days)	165	178
Jun-Aug DPD (%)	99 (59.3)	130 (73.0)
Mean DPM/day (for days BND detected)	5.9 (SD=6.6, range 1-30, n=240)	17.2 (SD=20.1, range 1-91, n=142)

Conclusions

Results confirmed presence of 2 small geographical and socially (perhaps also demographically) isolated communities & study substantiated and extended the duration of previously indicated differences in mobility patterns

Dolphins showed nearshore distribution → collection of opportunistic data useful & efficient approach to collect long-term spatio-temporal data covering wide geographic area

Conclusions

- Inner Hebrides community

26 years of sightings & 14 years of photo-ID data

- Year-round presence, most sightings in summer (potentially reflecting increased observer effort)
- BNDs range ***throughout*** research area ***each year*** and during ***each month*** → ***TIME-AREA MANAGEMENT NOT SUITABLE***
- Long-term presence (>8 years) of 20 individuals with presence during most (or all) months & distribution spanning entire community range

→ Resident component in community

Conclusions

- Sound of Barra community
  - Photo-ID data 1995-2013: small community (≤15 individuals) showing summer site-fidelity & appears female dominated
  - Acoustic monitoring 2010-2013: year-round presence with increased detections during spring & summer

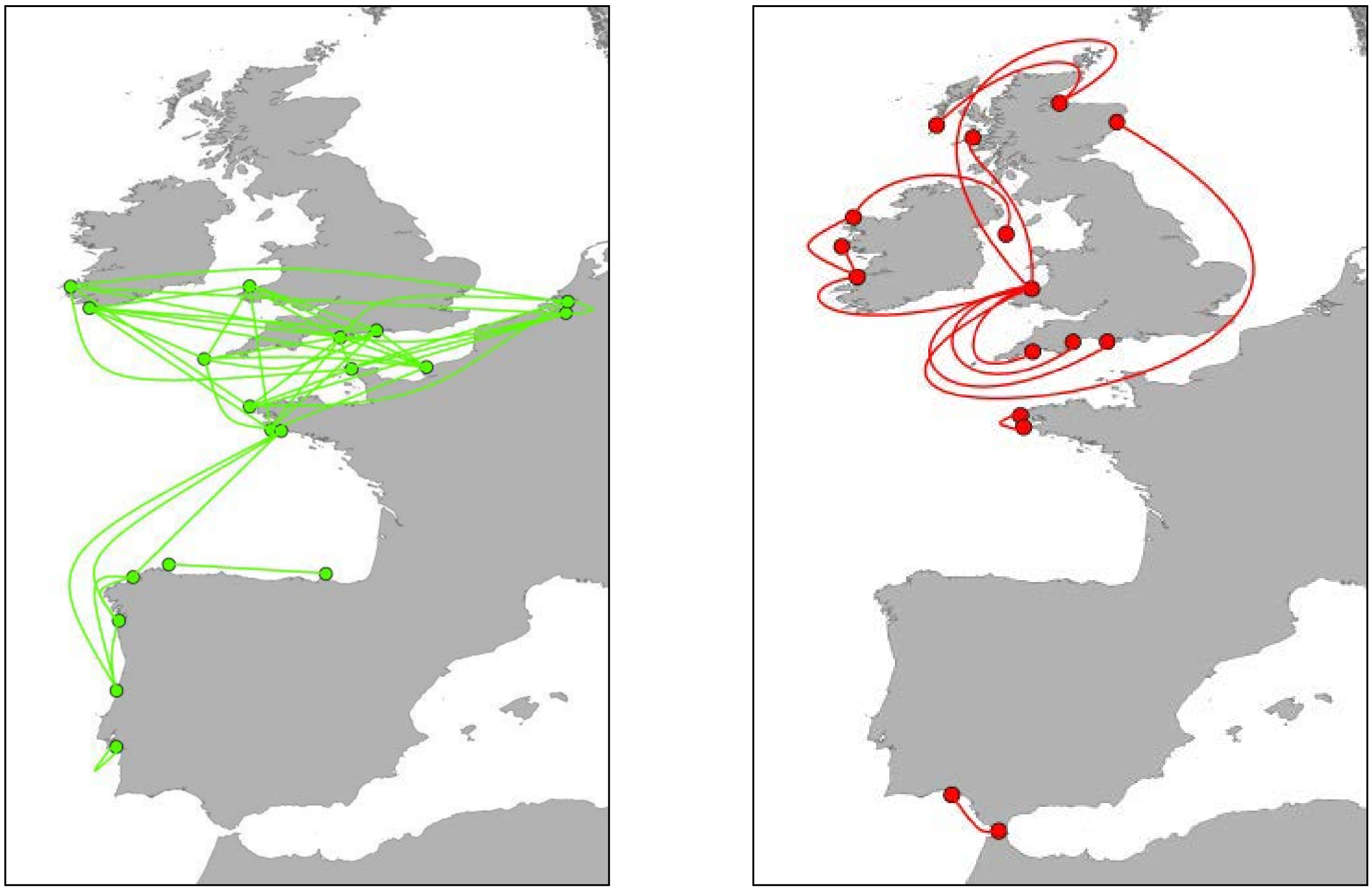
→ Resident community

Mobility in NW Europe

Typically site-specific photo-ID research throughout global range
→ limited knowledge about population connectivity

Exercise: mapping photo-ID matches (including solitary individuals) & reported lack of matches globally

Mobility in NW Europe



Left: Reported matches (mainly solitary individuals); Right: reported lack of matches between communities/populations. See PhD Thesis for associated references.

Mobility in NW Europe

Reported matches between communities/populations. See PhD Thesis for associated references.

Acknowledgements

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Status of bottlenose dolphins in Wales: Approaches to monitoring and conservation

Tom Stringell[1], Charlie Lindenbaum[1] and Peter Evans[2]

[1] *Natural Resources Wales,* [2] *Sea Watch Foundation*

Monitoring populations of bottlenose dolphins is critical if we are to manage them effectively, report on their status and underpin conservation and marine planning decisions. With all cetaceans being European Protected Species (EPS) and bottlenose dolphins requiring Special Areas of Conservation (SACs) under the EU Habitats Directive, there is high level of legal (societal) protection in European waters. In Wales, there are two large SACs for coastal bottlenose dolphins in Cardigan Bay: Cardigan Bay and Pen Llyn a'r Sarnau SACs. SACs have conservation objectives which consider population size and structure, natural range, and supporting habitat; SACs contribute to achieving favourable conservation status.

For about 20 years the bottlenose dolphin population of Cardigan Bay, the largest population in the UK, has been monitored more or less annually. Principally, it is population size and range/distribution that is routinely monitored and reported but other aspects, such as population dynamics and health status (e.g. body condition) provide valuable insights into population status. In Wales, we conduct line transect surveys (using distance sampling with independent observers) and PhotoID surveys to derive abundance estimates. Line transect derived estimates indicate a relatively stable population with CVs of approximately 0.3 varying from year to year. PhotoID data are analysed with closed and open population models and, as before, they indicate a stable population over the survey period (2001-2015) although the abundance trajectory is hump-shaped and it peaked in 2008.

The population of bottlenose dolphins is best described as a combination of residents, occasional visitors and transients as defined by the number of recaptures and the size of home ranges/distances travelled. Comparisons with other PhotoID catalogues in Europe has not revealed any matches suggesting the population might be distinct to the Irish Sea. As such, this led to defining the Interagency Marine Mammal Working Group Irish Sea Management Unit for the species and the Coastal Wales assessment unit by the ICES Working Group on Marine Mammal Ecology.

Seasonality in dolphin abundance has been observed both through visual observations and acoustic detections. The population of dolphins associated with Cardigan Bay SAC appear to be most abundant in the summer months and many move to the North Wales coast and further afield during winter.

Birth rates and calf mortality appear to be relatively representative of other well-studied populations. Health status is not routinely reported but *ad hoc* observations of skin lesions, body condition etc are recorded. Additionally the national strandings programme (Cetacean Strandings Investigation Programme) provides valuable information on biology (e.g. diet) and ongoing pressures and threats (e.g. bycatch, pollution).

Threats and pressures are not adequately monitored or centrally recorded in the Irish Sea or most of the UK. This is a major gap in our knowledge which compromises our understanding of cumulative effects. Current main threats and pressures in Wales consist of harassment/disturbance, vessel strikes, pollution (chemicals & pathogens) and noise disturbance (from marine industry). Potential future threats include possible collision with renewable energy devices. Incidental capture in fishing gear (bycatch) is less of a threat than for other cetacean species such as harbour porpoise and common dolphin.

In conclusion, we consider the conservation status of bottlenose dolphins in Wales as favourable. However, to be able to draw that conclusion we need to monitor and manage human impacts on bottlenose dolphins and to maintain monitoring efforts to track population health.

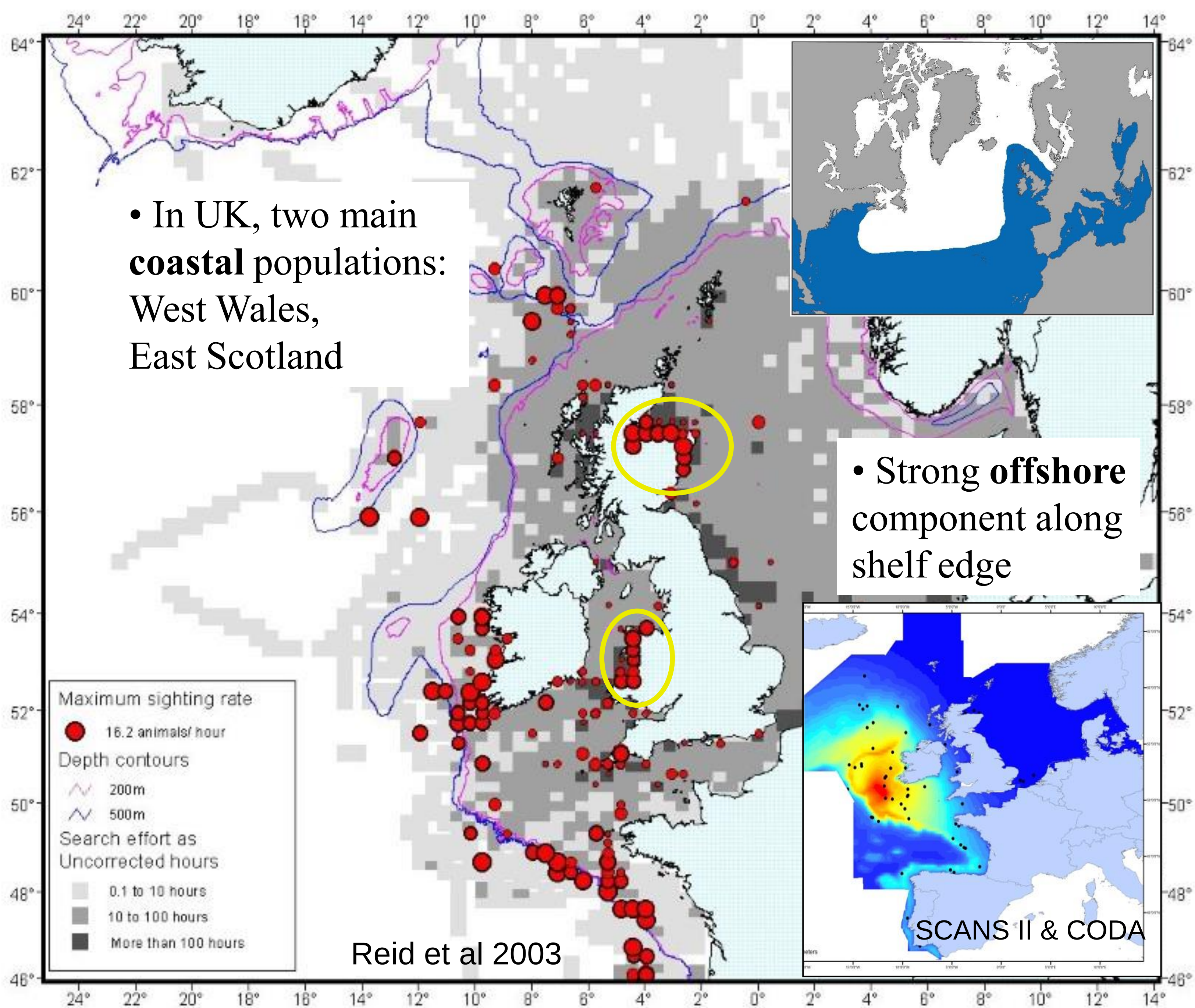
Status of bottlenose dolphins in Wales: approaches to monitoring

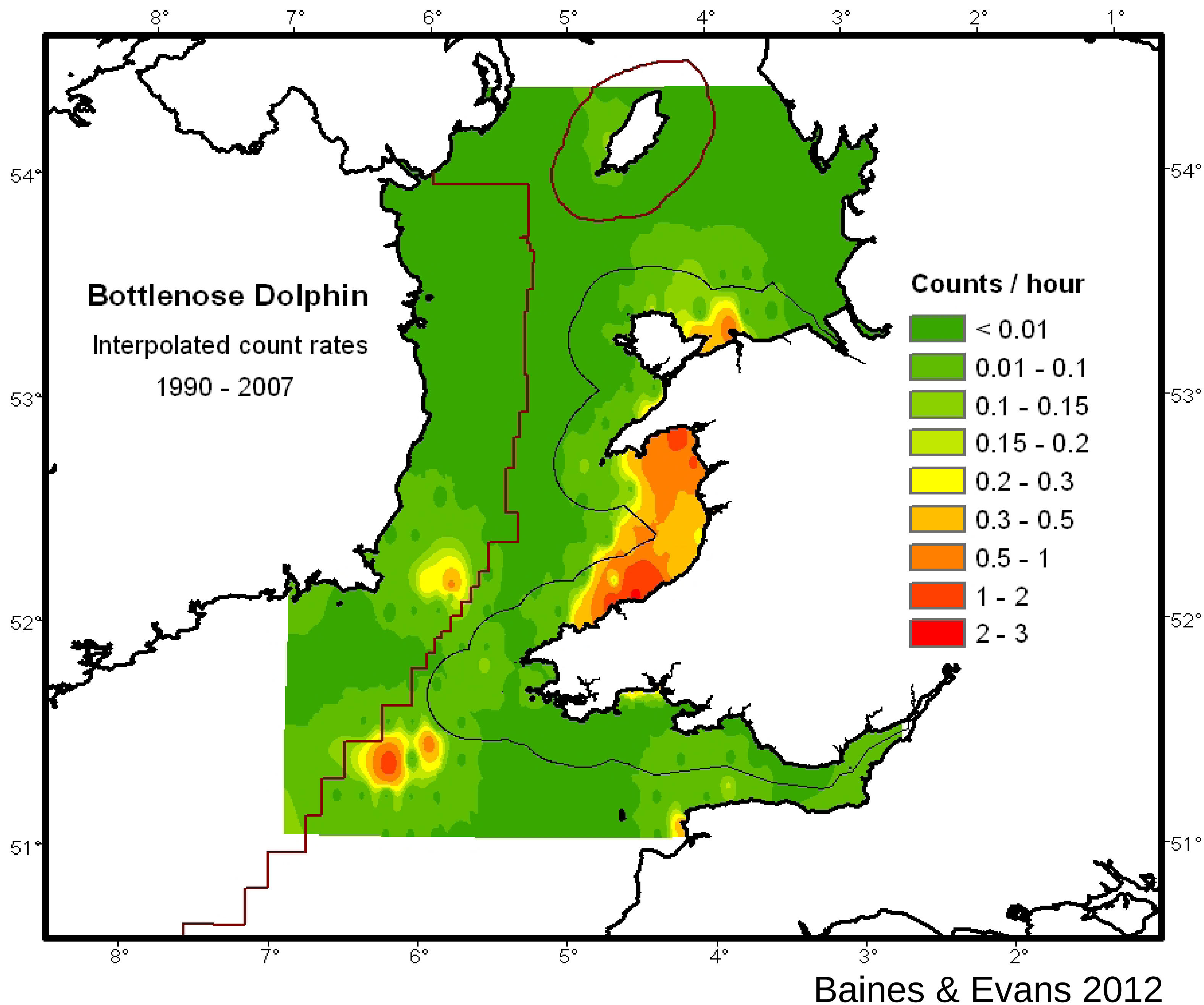
Tom Stringell[1], Charlie Lindenbaum[1] & Peter Evans[2]

[1]Natural Resources Wales [2]Sea Watch Foundation

Cyfoeth Naturiol Cymru Natural Resources Wales

sea watch FOUNDATION

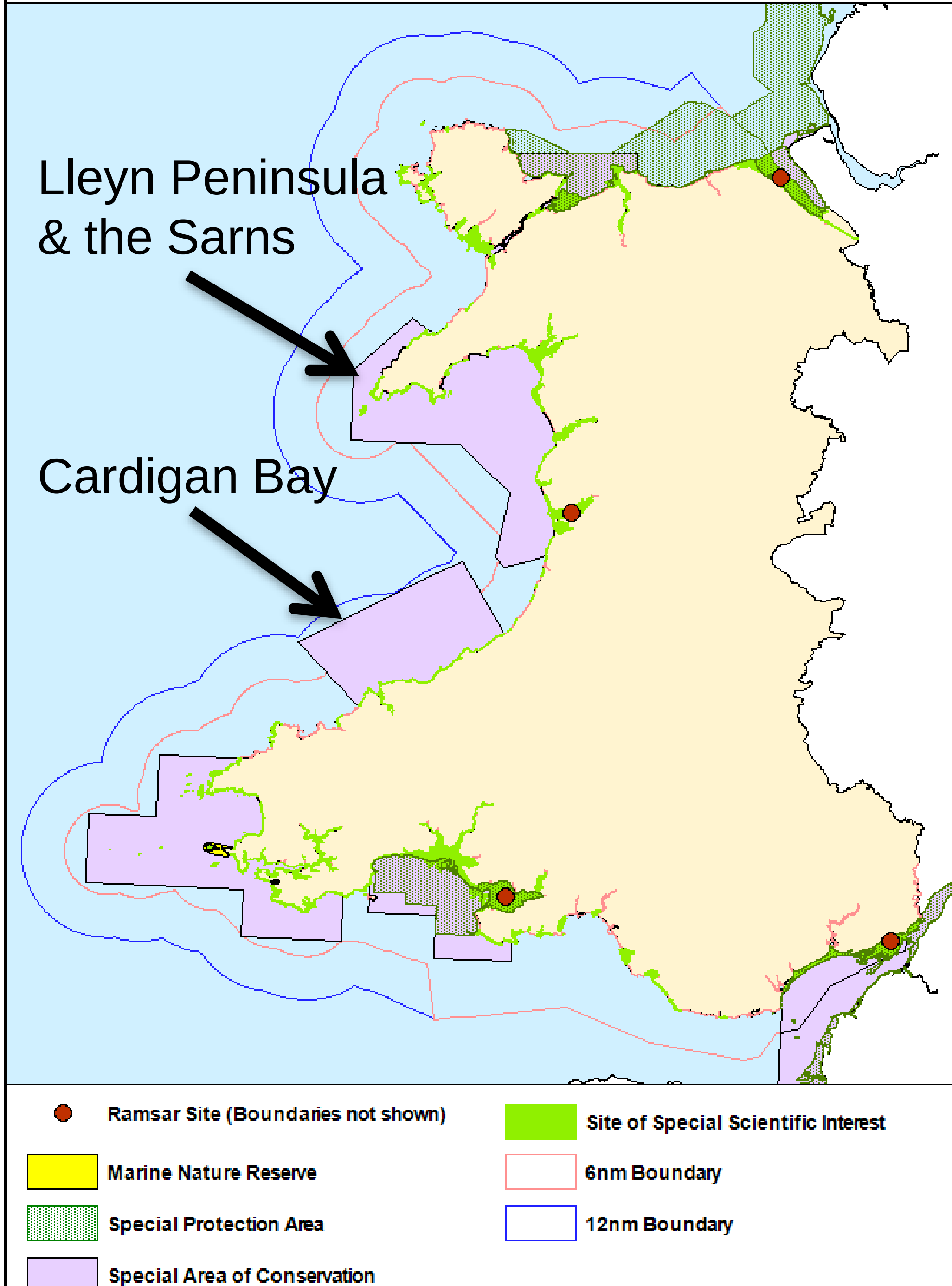

• In UK, two main **coastal** populations: West Wales, East Scotland
• Strong **offshore** component along shelf edge
Maximum sighting rate
16.2 animals/ hour
Depth contours
200m
500m
Search effort as Uncorrected hours
0.1 to 10 hours
10 to 100 hours
More than 100 hours
Reid et al 2003
SCANS II & CODA



Bottlenose Dolphin
Interpolated count rates
1990 - 2007
Counts / hour
< 0.01
0.01 - 0.1
0.1 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
1 - 2
2 - 3
8°
7°
6°
5°
4°
3°
2°
1°
54°
53°
52°
51°
Baines & Evans 2012

SACs in Wales: bottlenose dolphins

- Annex II EC Habitats Directive



SAC Conservation Objective(s)

To achieve favourable conservation status the following must be maintained in the long-term:

- **<u>Population</u> is a viable component of the site**
  - Population Size, Reproductive Success
  - Population Structure, Physiological Health (contaminants)

- **Natural <u>Range</u> is not reduced**

- **<u>Habitat</u> is sufficient to maintain/increase population**
  - Distribution and Extent
  - Structure, Function and Quality, Prey availability





SAC Conservation Objective(s)

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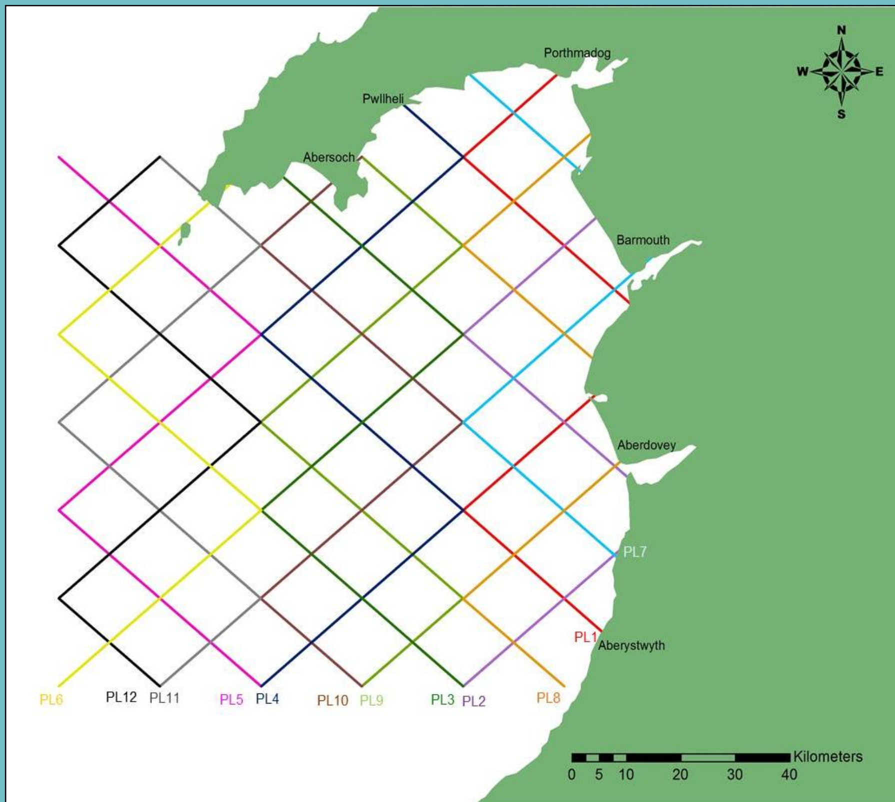
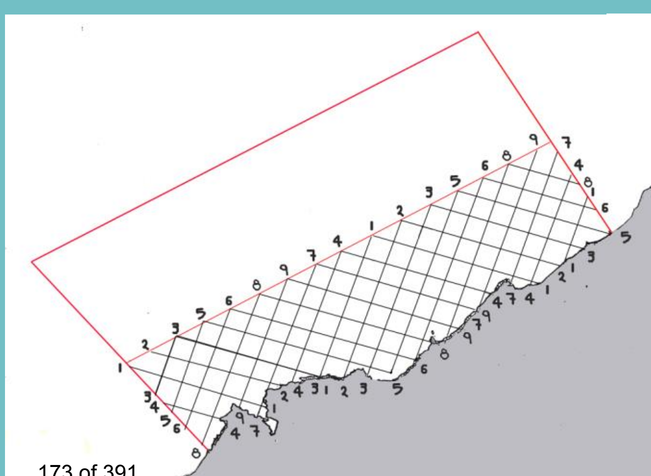
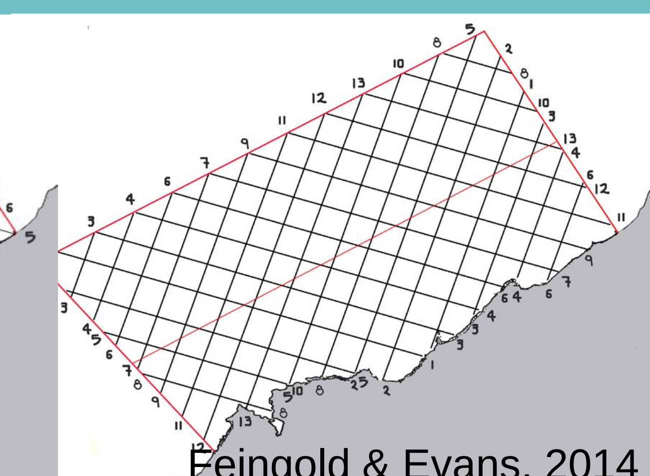
  Distribution and Extent

  Structure, Function and Quality, Prey availability

Line-transect design for abundance & distribution



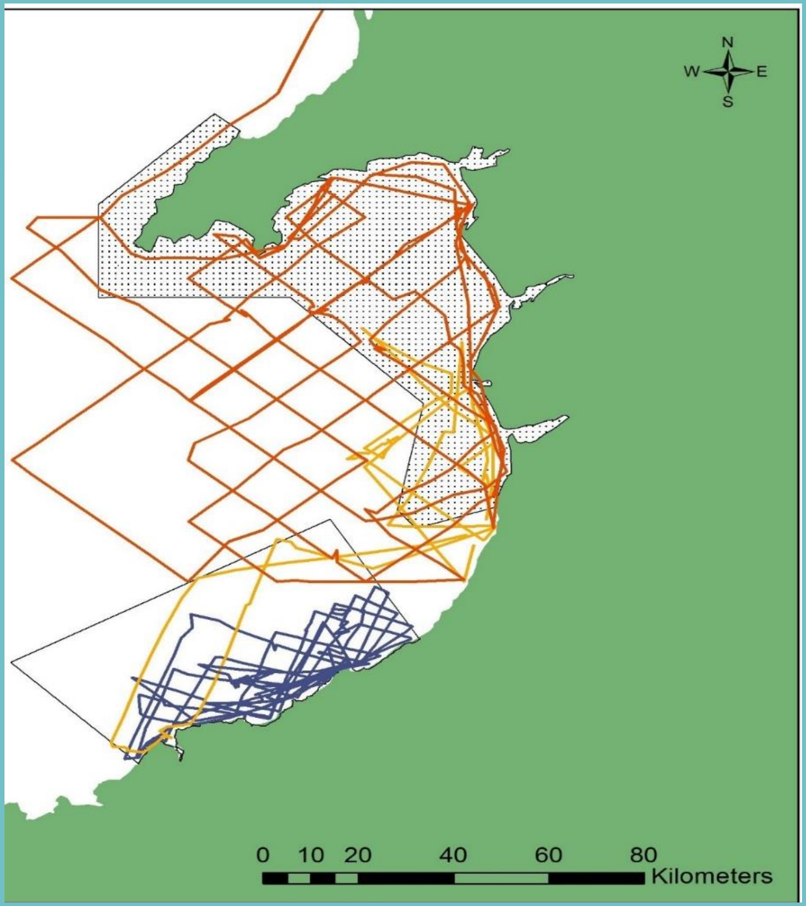


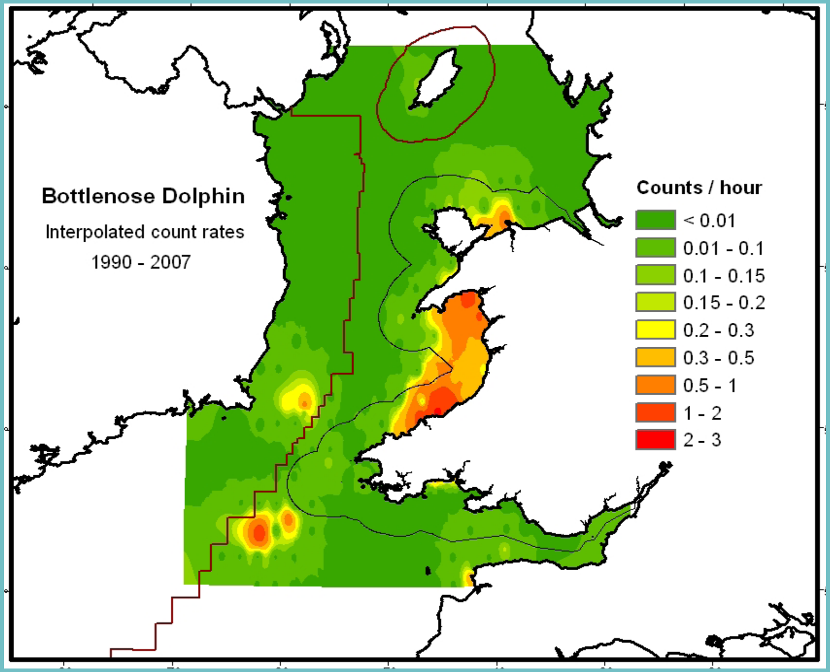


Feingold & Evans, 2014

- Vary survey effort between areas – *design / weather / boat / staff*
- Select transects at random.
- Repeated annually
- ~£30k pa

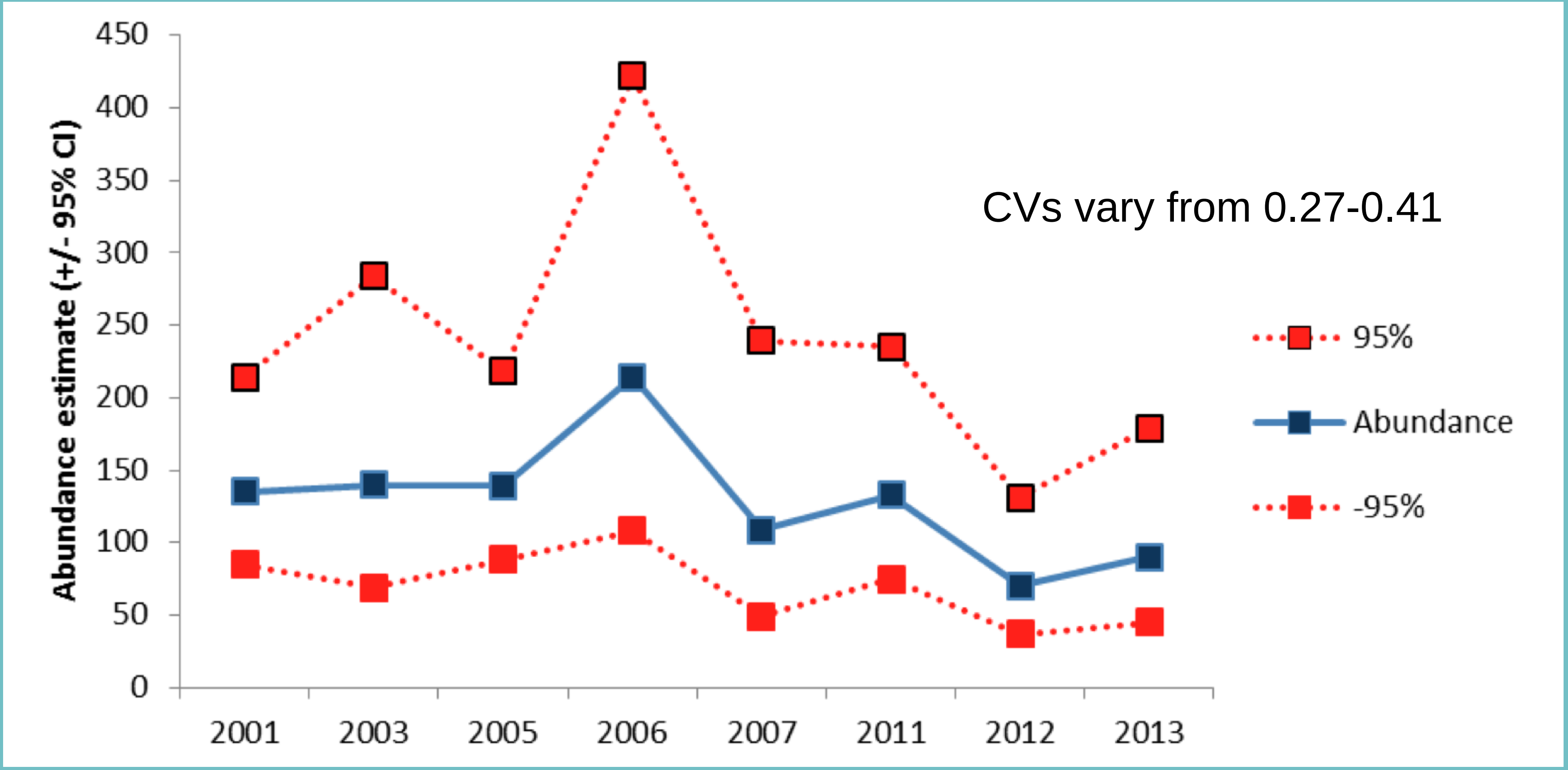
Line-transect surveys: Distribution & abundance in Cardigan Bay





Baines & Evans 2012

Line-transect surveys:
Trends in abundance in Cardigan Bay SAC

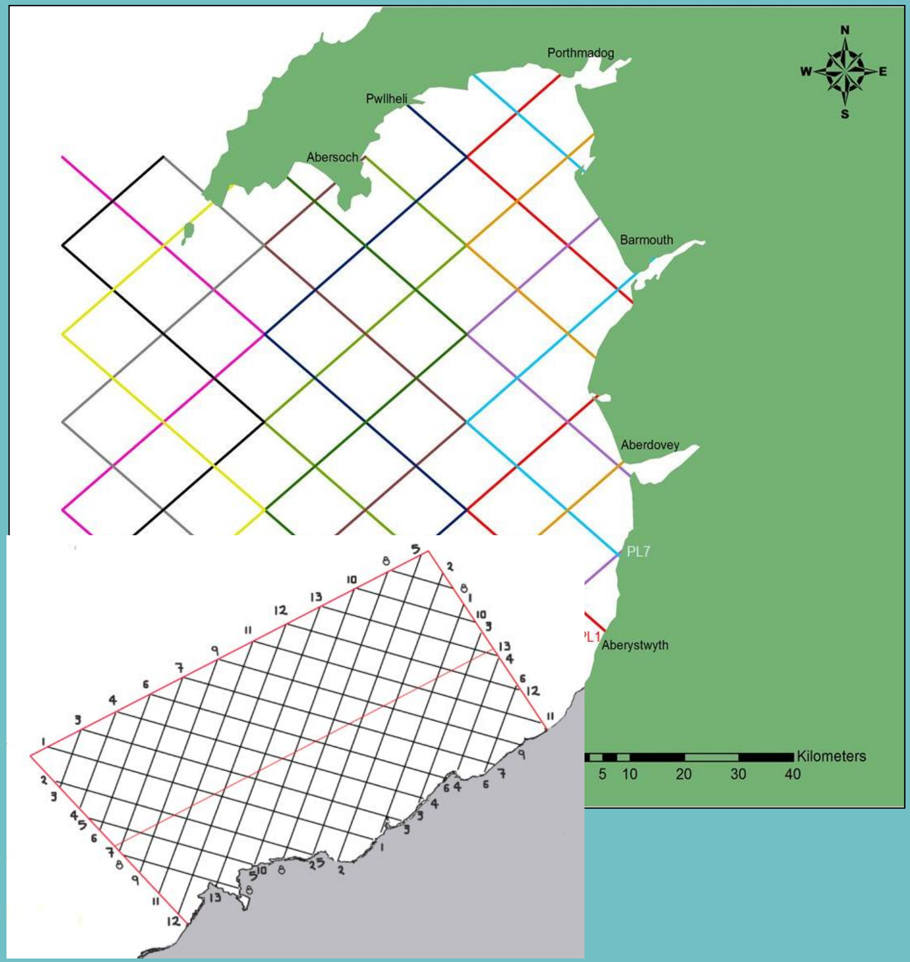


Source: Veneruso & Evans, 2012; Feingold & Evans, 2014

Photo ID: Identifying individuals

- Movements (years) and connectivity/range
- Survival and demographic parameters
- Abundance estimation – Mark Recapture

Line-transect design for Photo-ID



- Uses line transect design for coverage
- Effort varies by design / weather / boat / staff
- Select transects at random
- Repeated annually

~ £30k pa

Disturbance:
under licence

Welsh Bottlenose Dolphin Photo-ID Catalogue, 2015

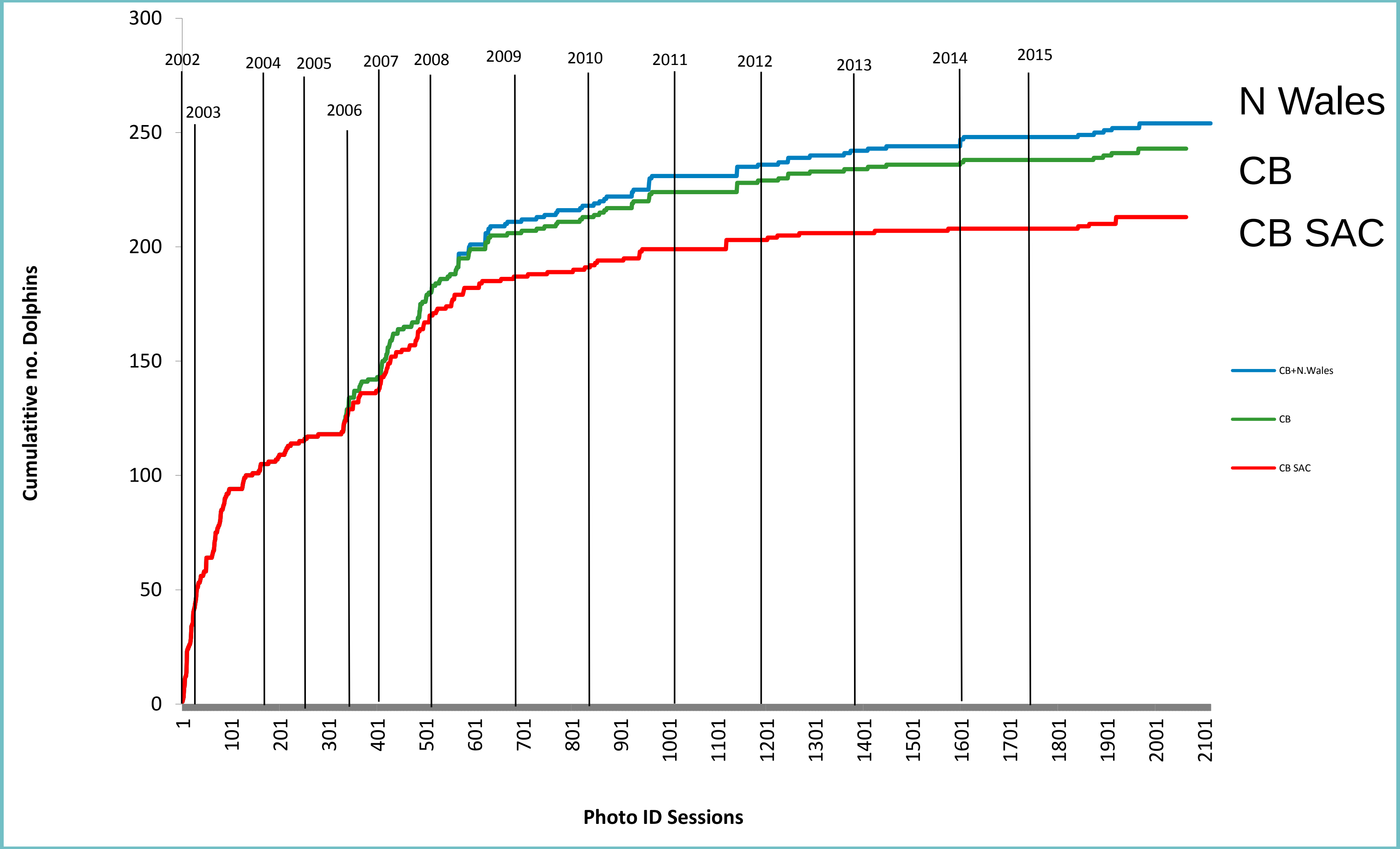
248 marked
(105 well and 143 slightly)

132 right
(unmarked)

131 left
(unmarked)

At least 380 dolphins in the catalogue

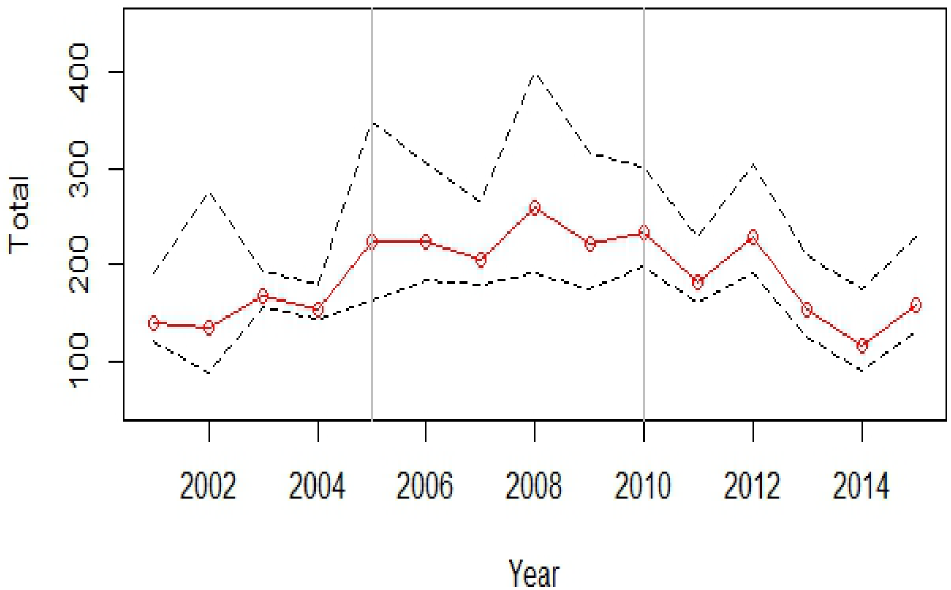
Welsh Bottlenose Dolphin Photo-ID Discovery Curve



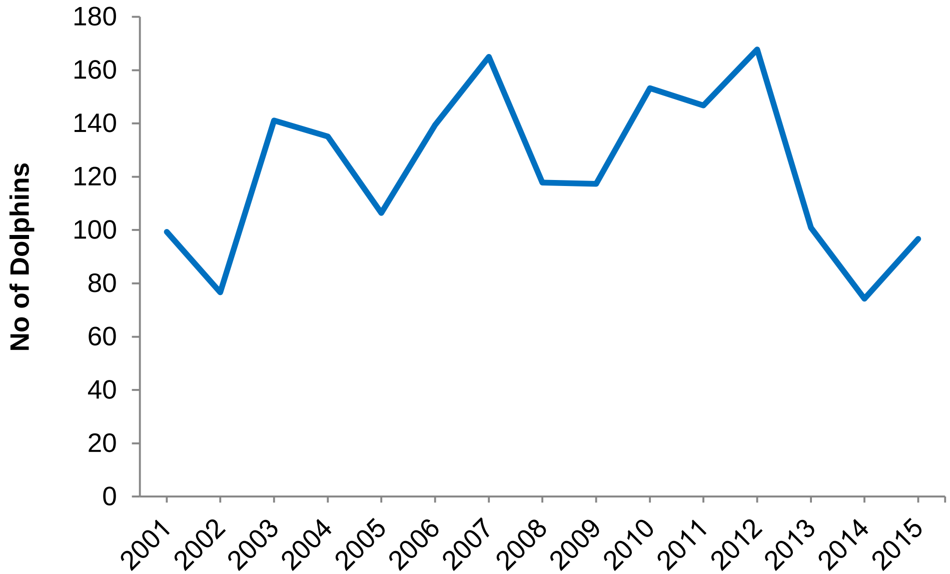
• catalogue size flattening off only since 2009

Bottlenose dolphin population trends in Cardigan Bay SAC, 2001-15 (Photo-ID MR)

a) Closed Population model

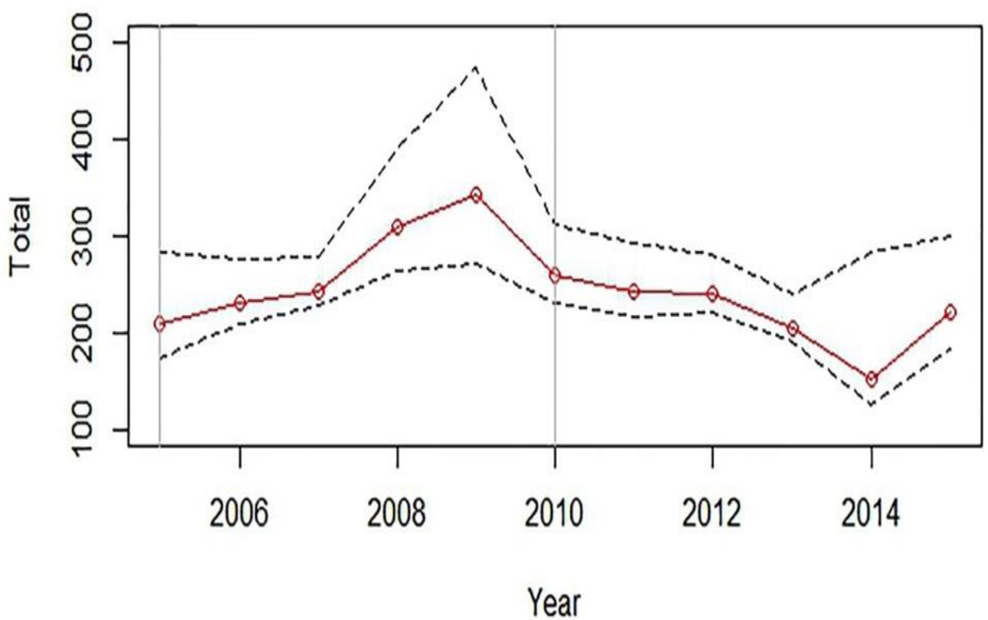


b) Open Population model

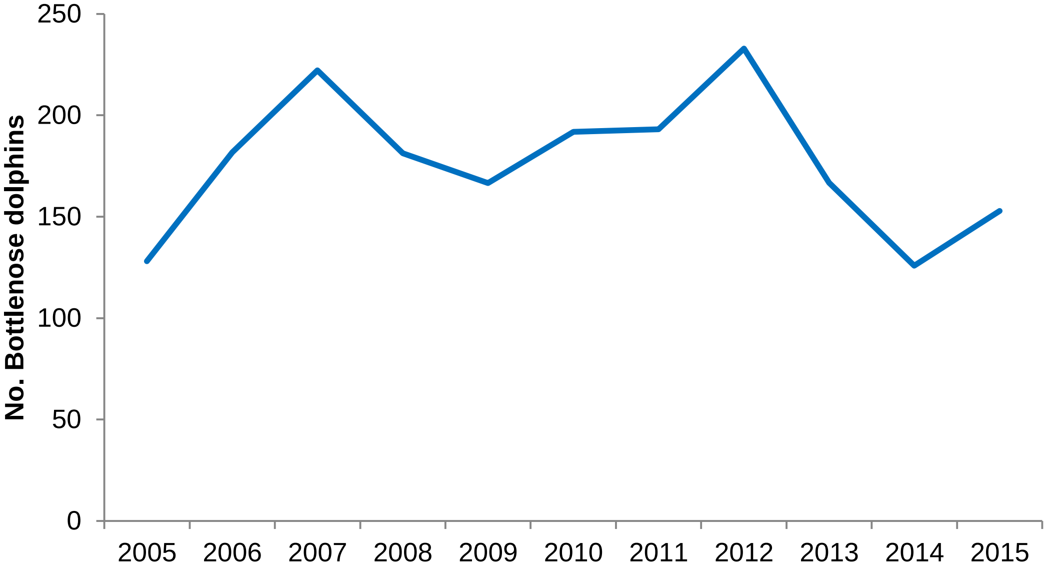


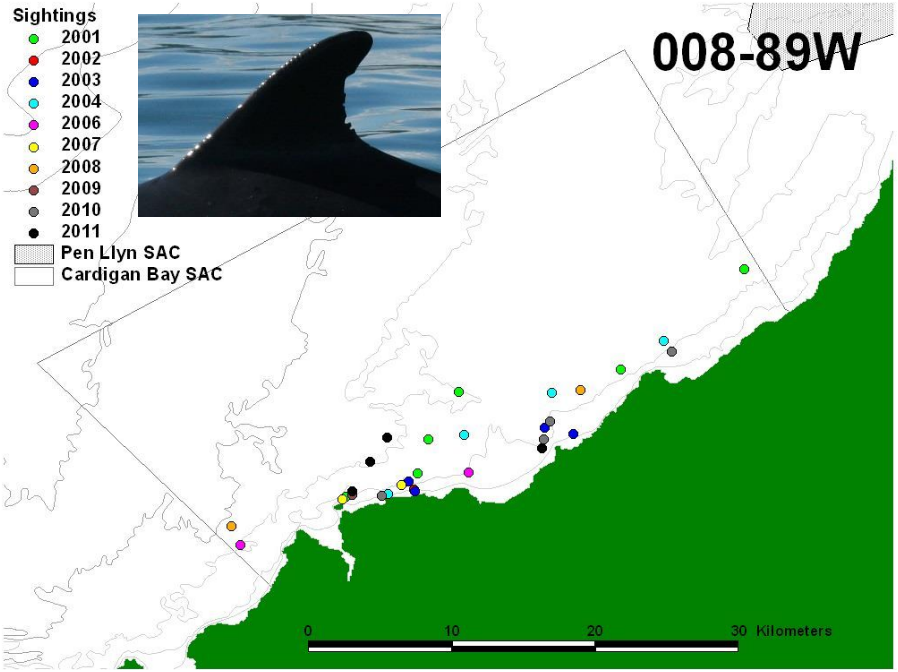
Bottlenose dolphin population trends in wider Cardigan Bay, 2005-15 (Photo-ID MR)

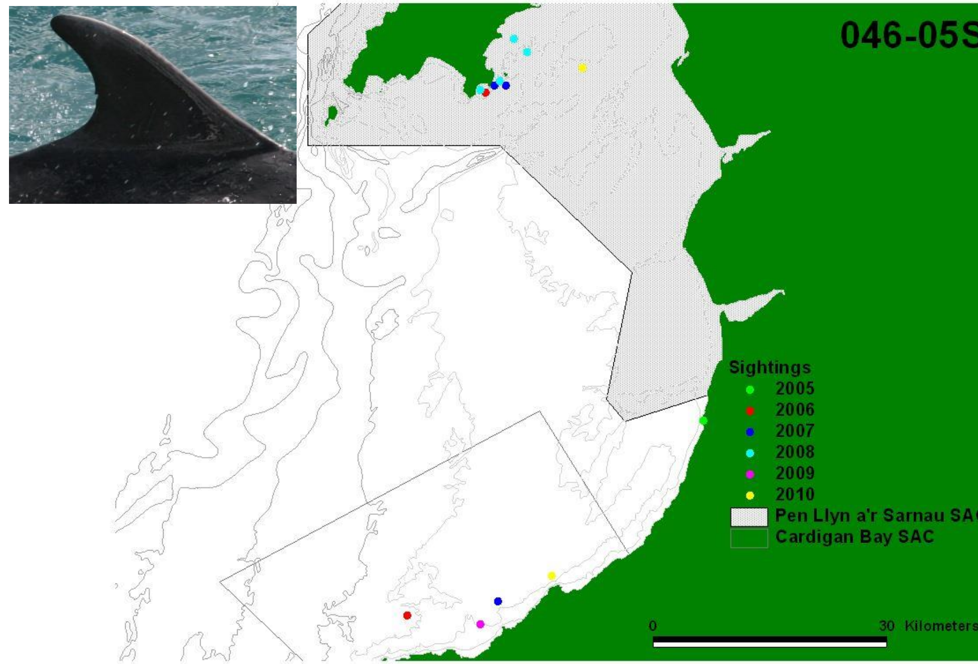
a) Closed Population model



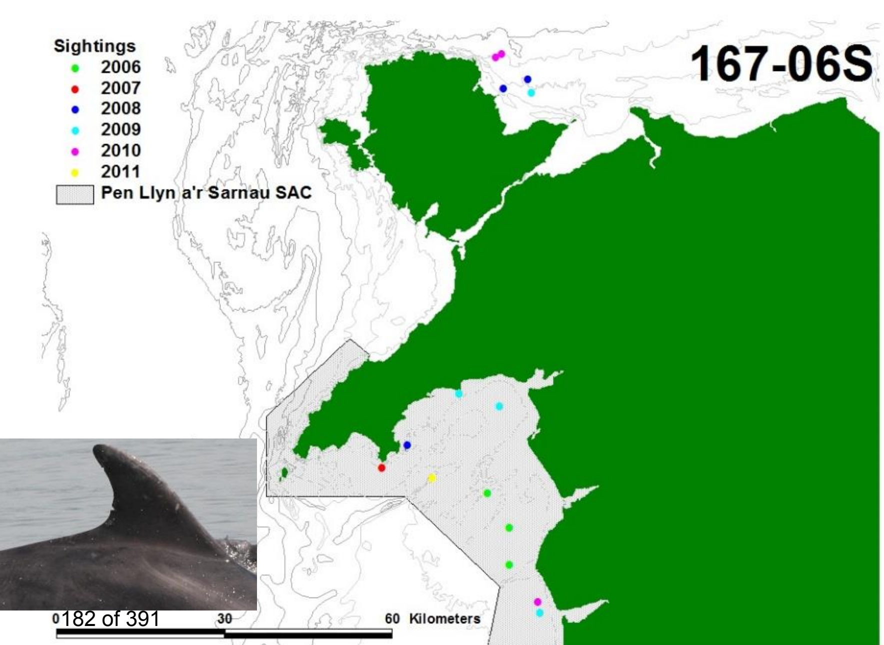
b) Open Population model

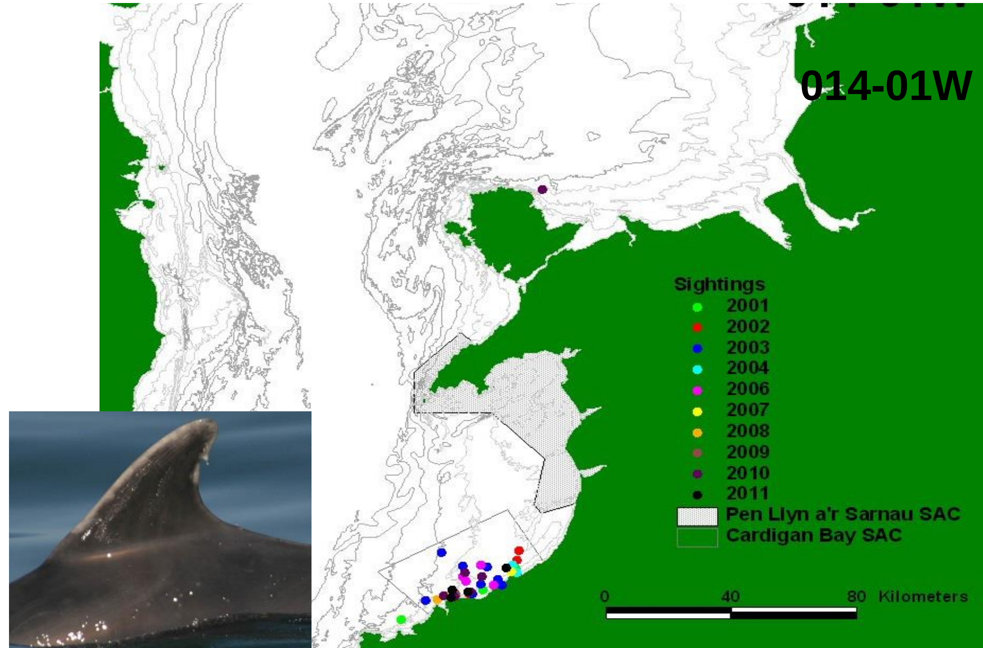



008-89W
Sightings
2001
2002
2003
2004
2006
2007
2008
2009
2010
2011
Pen Llyn SAC
Cardigan Bay SAC
0
10
20
30 Kilometers


046-05S
Sightings
2005
2006
2007
2008
2009
2010
Pen Llyn a'r Sarnau SAC
Cardigan Bay SAC
0
30 Kilometers

Home ranges


167-06S
Sightings
2006
2007
2008
2009
2010
2011
Pen Llyn a'r Sarnau SAC
0
30
60 Kilometers


014-01W
Sightings
2001
2002
2003
2004
2006
2007
2008
2009
2010
2011
Pen Llyn a'r Sarnau SAC
Cardigan Bay SAC
0
40
80 Kilometers

Cardigan Bay Bottlenose Dolphin Population Structure

Best described as a combination of:

More recaptures

Smaller home ranges / distances travelled

- **Residents**

  56% seen > 12 times
  49% seen ≥ 6 years
  small home ranges, travel shorter distances

- **Occasional visitors**

  26% seen between 4 to11 times
  25% seen between 3-5 years
  large home range, many km travelled

- **Transients**

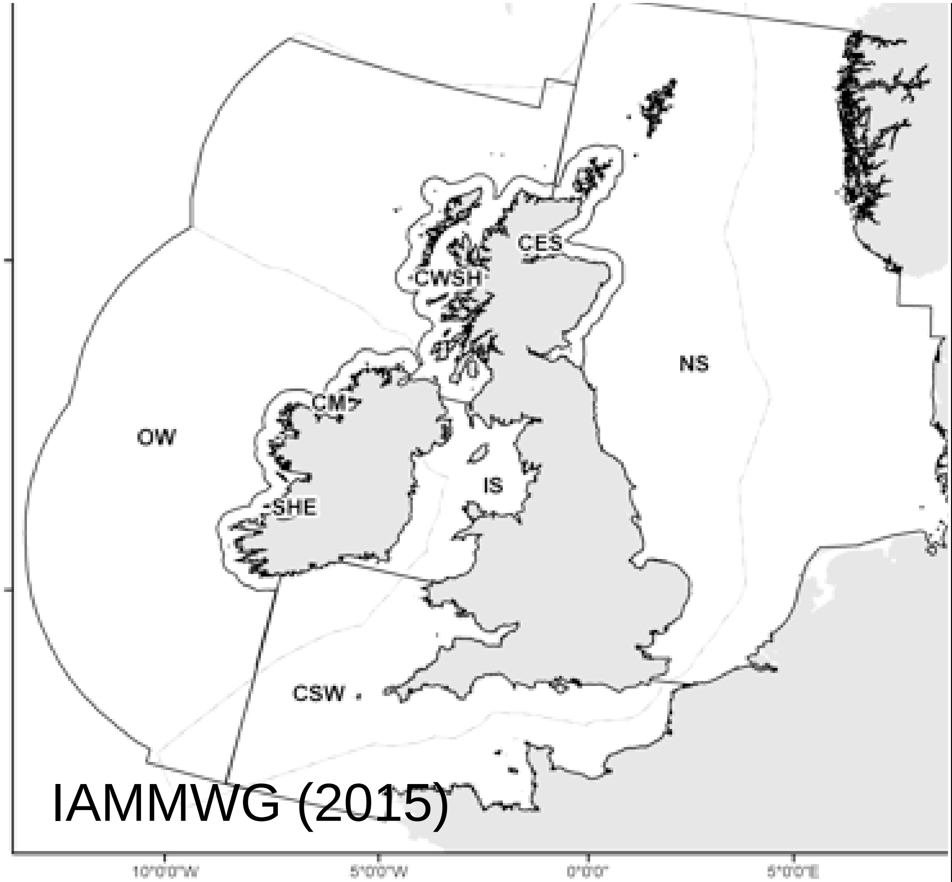
  17% seen between 1 to 3 times
  21% seen between 1 to 2 of the 12 years of data
  little information on range

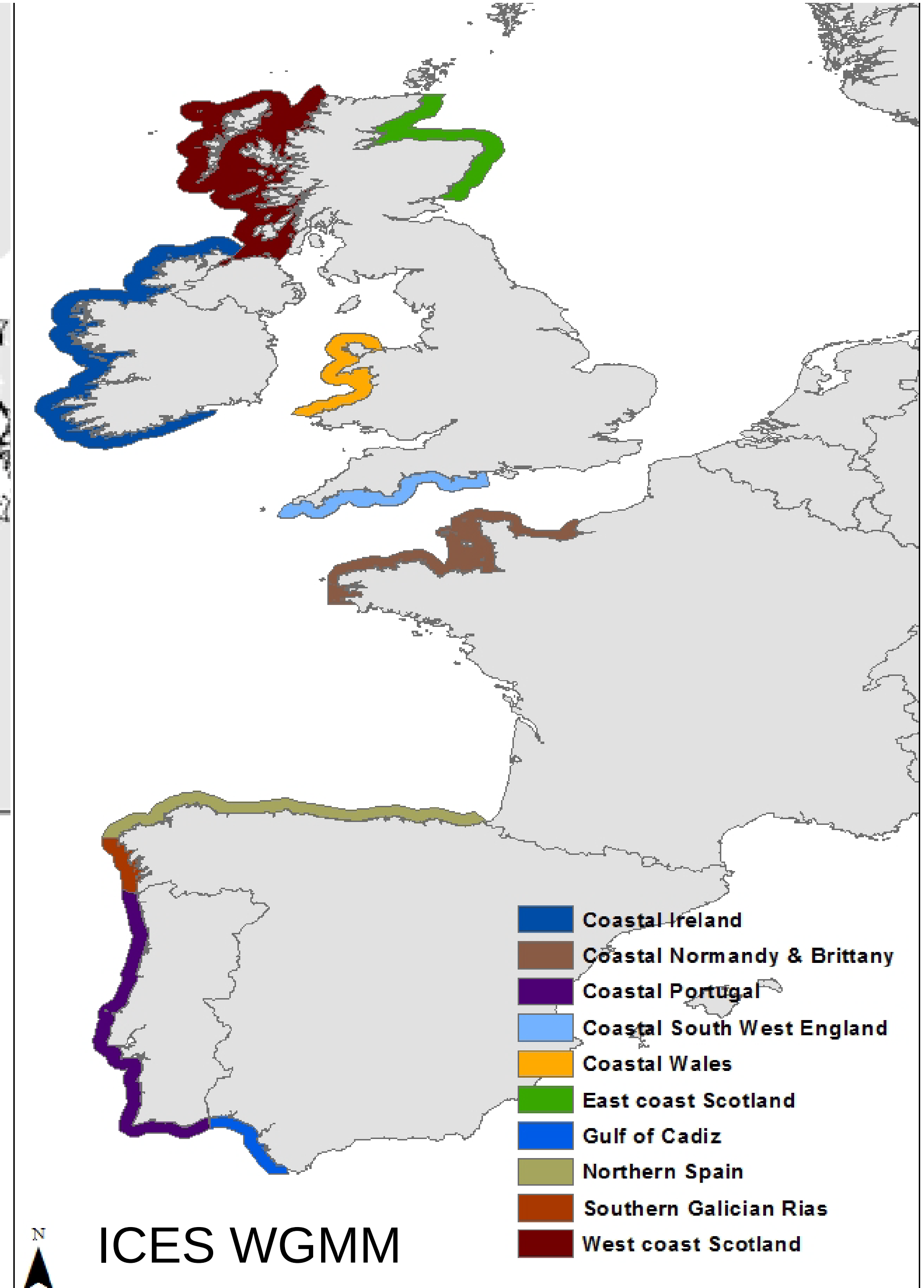
Other bottlenose dolphin ID catalogues

	# of pictures analysed	Matches
South-East Ireland	46	0
Cornwall	17	0
South Devon	21	0
Dorset	106	0
Aberdeen	55	0
North Grampian	151	0
Moray Firth	412	0
Inner Hebrides	27	0
Shannon Estuary	328	0
Total	**1163**	**0**

Irish Sea population
(coastal)

Management / Assessment units for bottlenose dolphin in UK waters



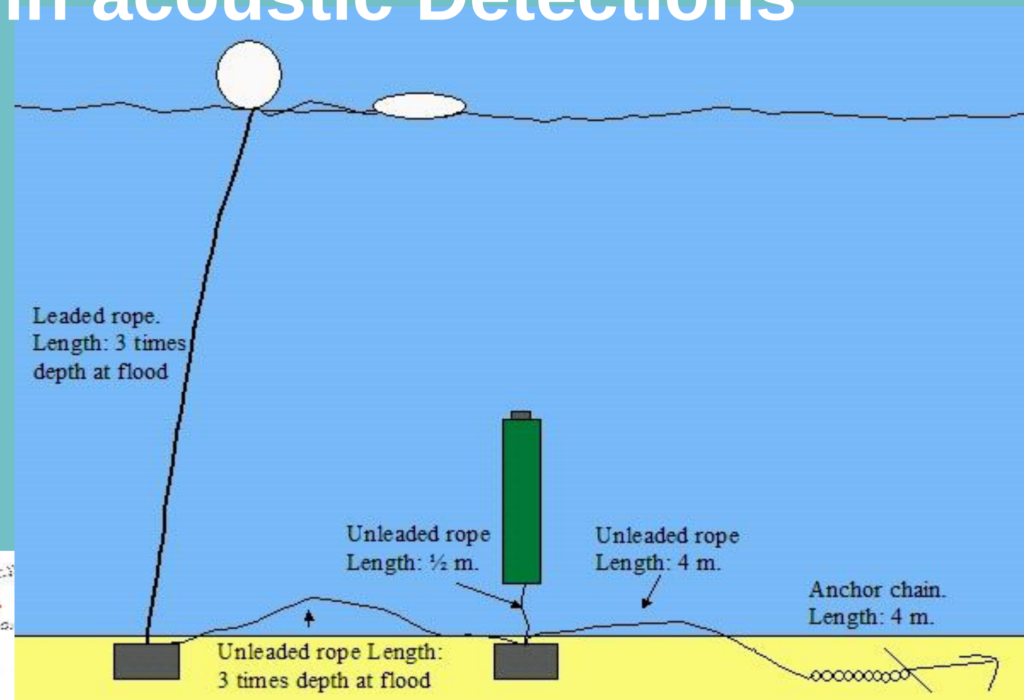


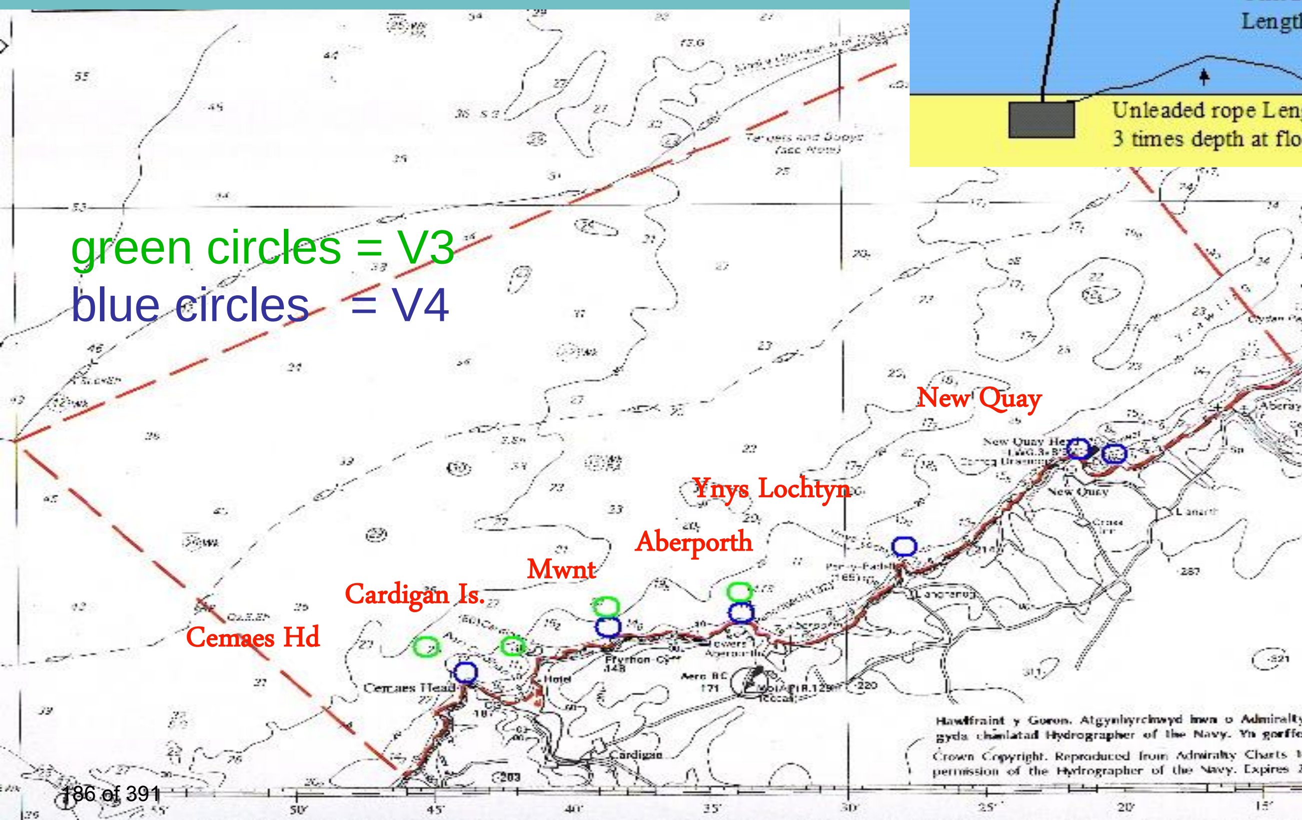
"A group of individuals for which there are different lines of complementary evidence suggesting reduced exchange (migration / dispersal) rates over an extended period (low tens of years)"

Evans & Teilmann, 2009

Seasonality: Dolphin acoustic Detections

10 T-PODs deployed in Cardigan Bay SAC, 2005-07

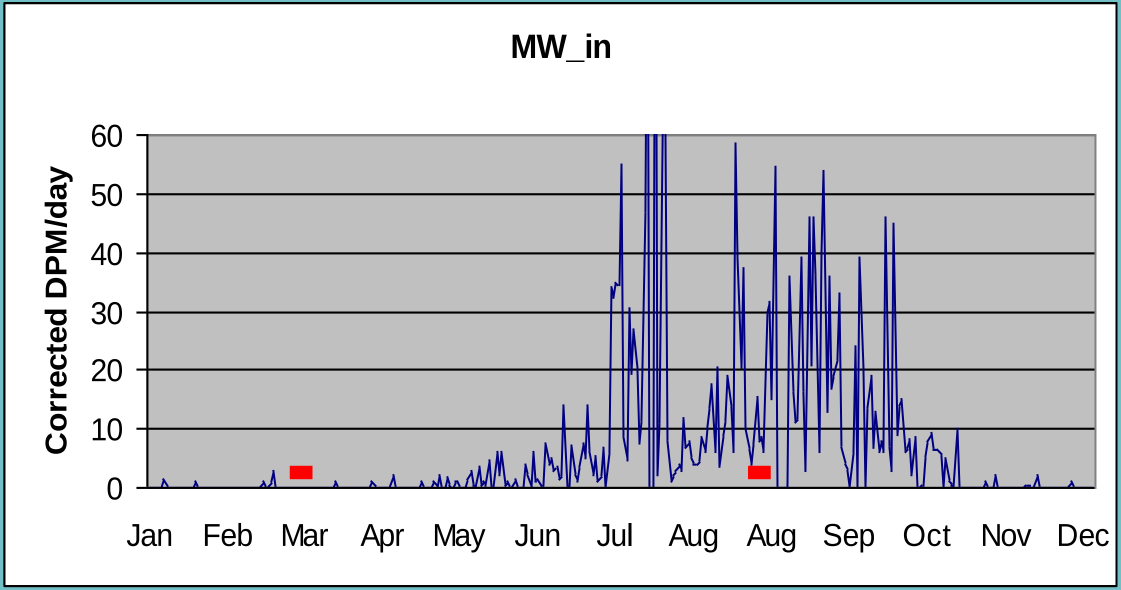


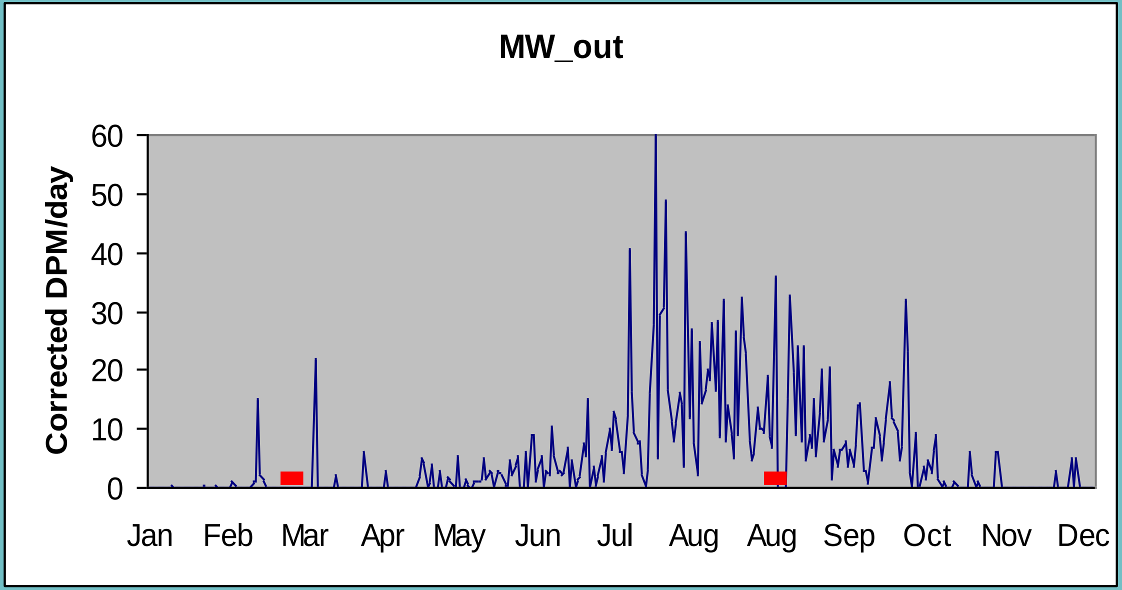


Seasonality: Dolphin acoustic Detections

Mwnt

periods not logged
by the TPOD



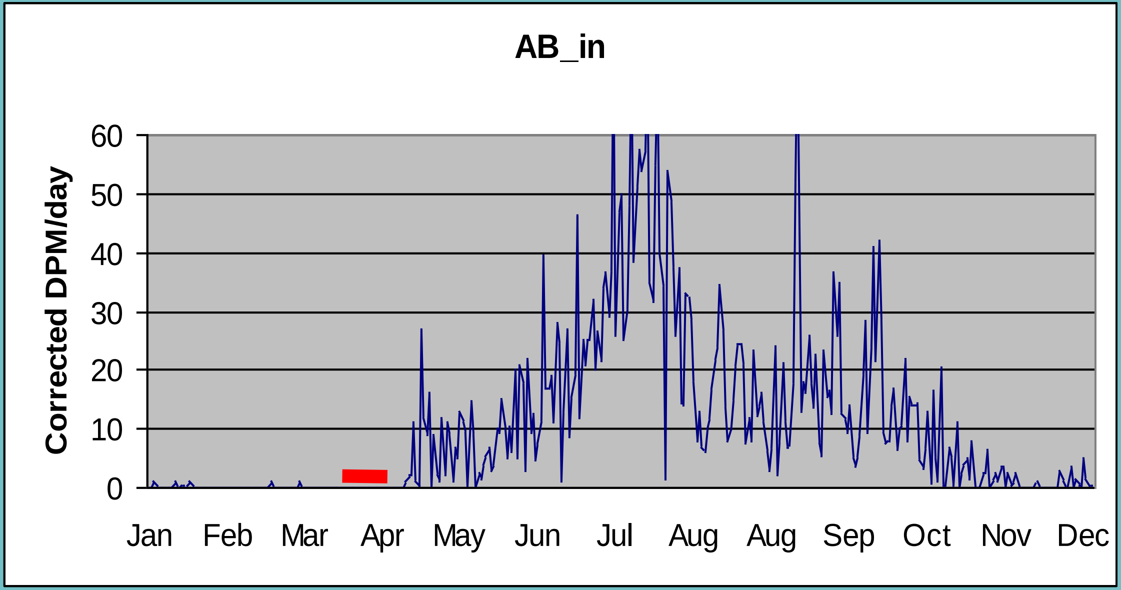


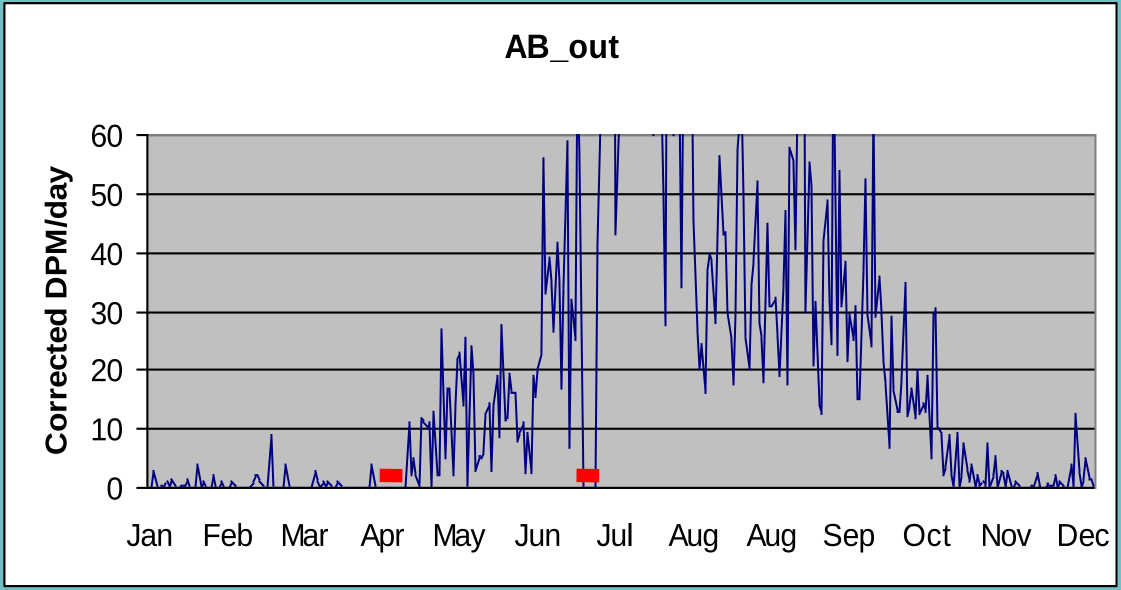
Source: Sea Watch Foundation

Seasonality: Dolphin acoustic Detections

Aberporth

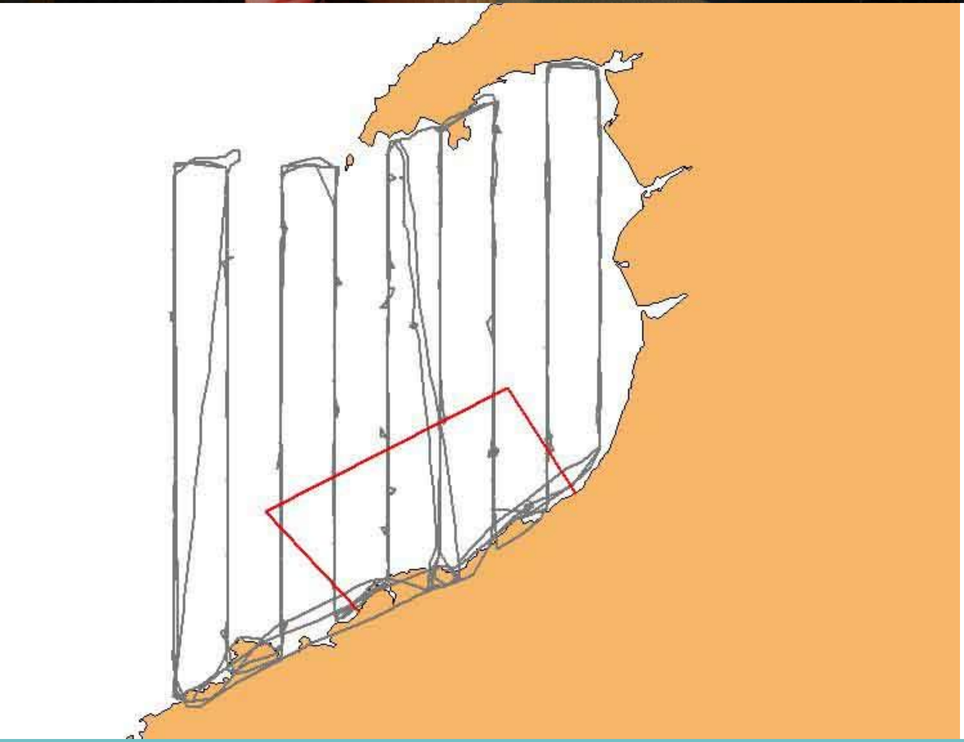
periods not logged
by the TPOD

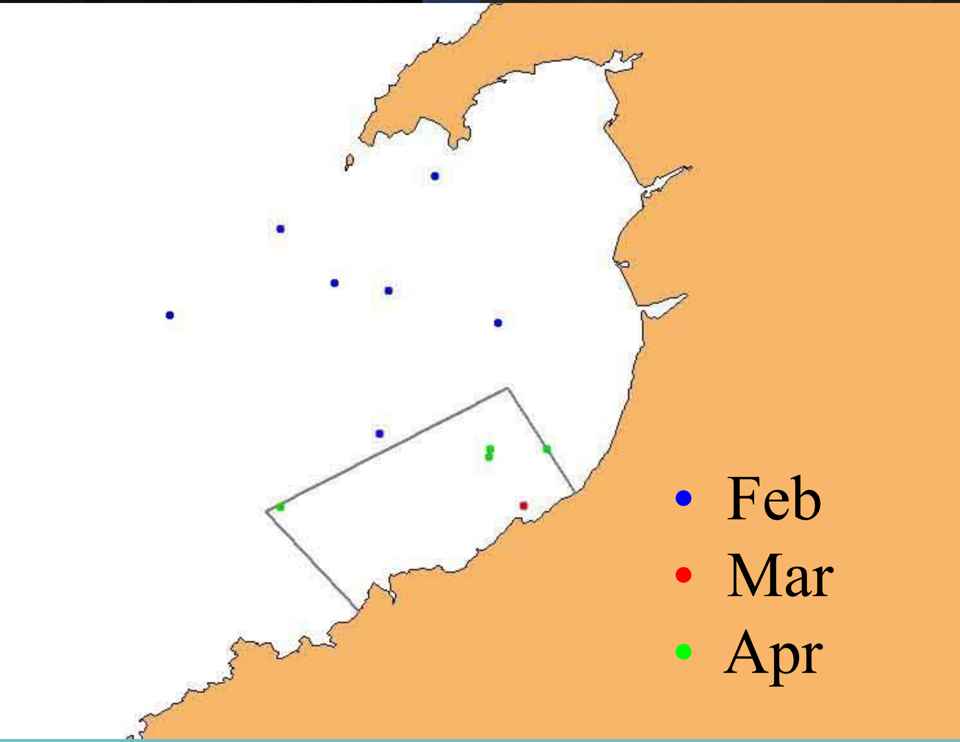




Source: Sea Watch Foundation

Winter Aerial Surveys of Cardigan Bay

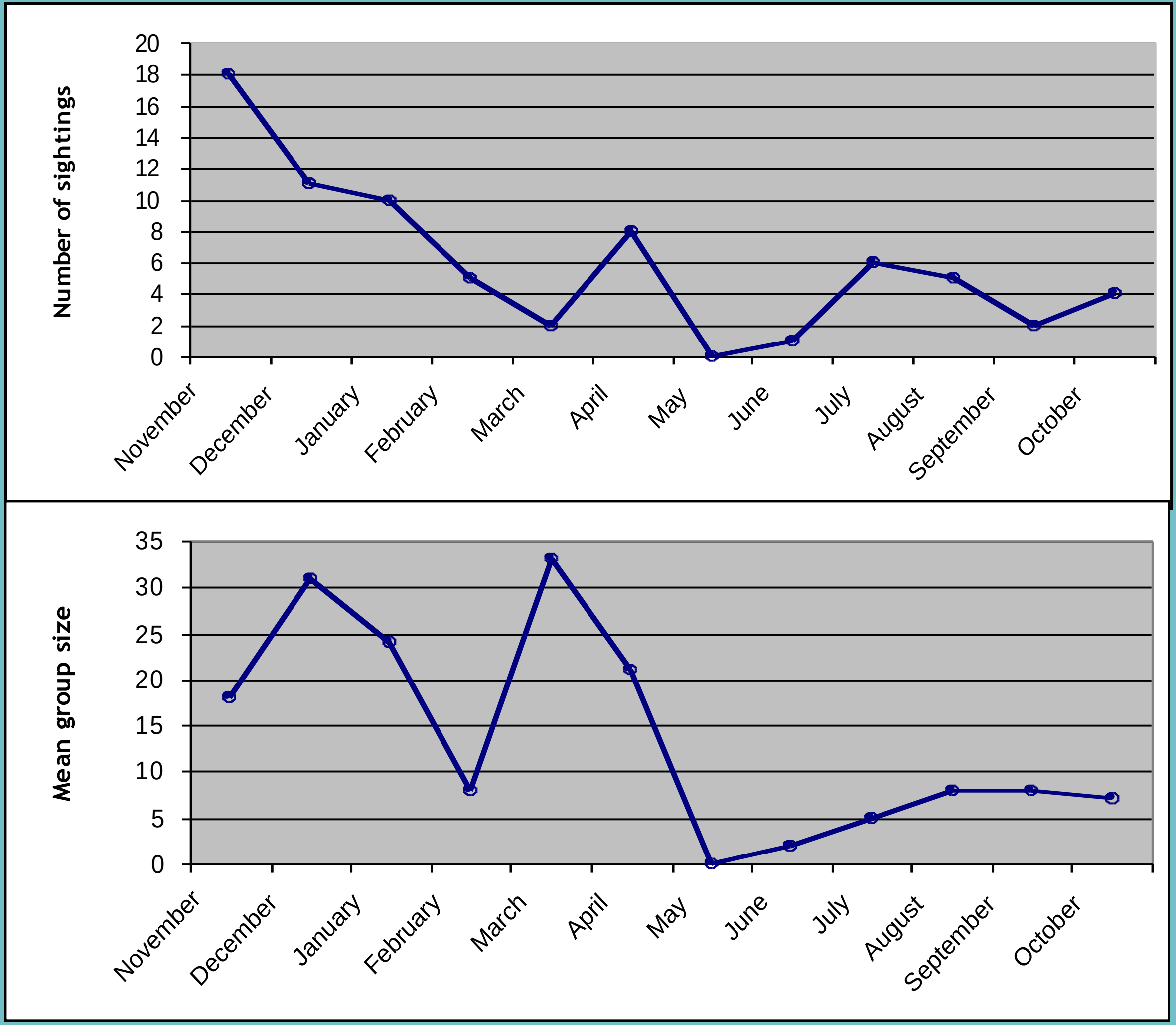




- late winter surveys suggest wide dispersion, largely outside the SACs

Shore watches off Anglesey:

Bottlenose more common in winter



Source: Dave Powell, MANW/SWF

Population demographics: Birth rates

CB	2005	2006	2007	2008	2009	2010	2011	2012	Mean
Birth rate (closed)%	8.24	8.29	6.34	4.81	4.06	7.44	11.00	7.03	7.15
Birth rate (open)%	11.63	10.11	7.21	7.33	5.63	11.54	12.37	9.36	9.40

CB SAC	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Mean
Birth rate (closed)%	5.54	4.82	6.67	8.39	6.06	5.68	4.44	1.92	1.46	6.14	8.77	4.10	5.33
Birth rate (open)%	7.07	10.39	7.41	9.52	11.43	9.03	6.02	4.00	0.54	9.21	11.36	7.14	7.76

Location	Crude birth rate
Eastern Australia	1.2
North Adriatic, Croatia	4.9
Cardigan Bay SAC (closed)	**5.3**
Sado Estuary, Portugal	5.4
Sarasota Bay, Florida	5.5
Moray Firth, Scotland	6.0
Doubtful Sound, New Zealand	6.6
Cardigan Bay, Wales (closed)	**7.15**
Southern California	7.2
Northern Gulf of Mexico	7.7
Cardigan Bay SAC, Wales (open)	**7.76**
Florida	8.2
Cardigan Bay, Wales (open)	**9.4**
Argentina, South Atlantic Coast	9.6
Tampa Bay, Florida	9.7

Population demographics: Calf mortality

60% (n=38) of calves survive to juvenile age (>3 years)

Welsh population: first year 15%(n=11), second year 17%(n=12), third year 7%(n=5)

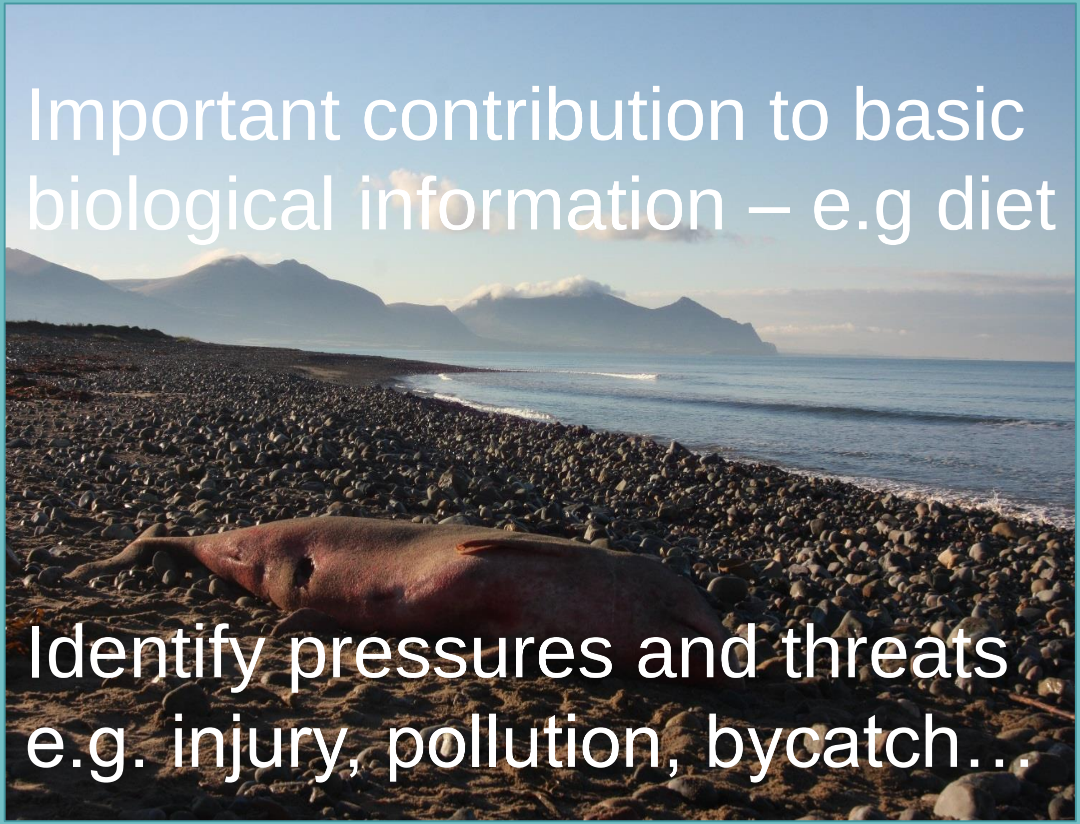
Place	First Year	Second Year	Third Year
North Carolina, USA	11%	---	---
Indian and Banana rivers, Florida, USA	11%	---	---
Sarasota Bay, Florida, USA	19%	---	---
Doubtful Sound, New Zealand	20%	---	---
Natal, South Africa	22%	---	---
Shark Bay, Australia	29%	18%	3%

Difficult to establish because calves have unmarked fins and can only be identified when in association with the mother

Monitoring health status

- Visual observations
- Skin lesions
- Necropsies for pathology
- Biomarkers (stress hormones)

Strandings (Cetacean Strandings Investigation Programme)



Monitoring Threats & Pressures

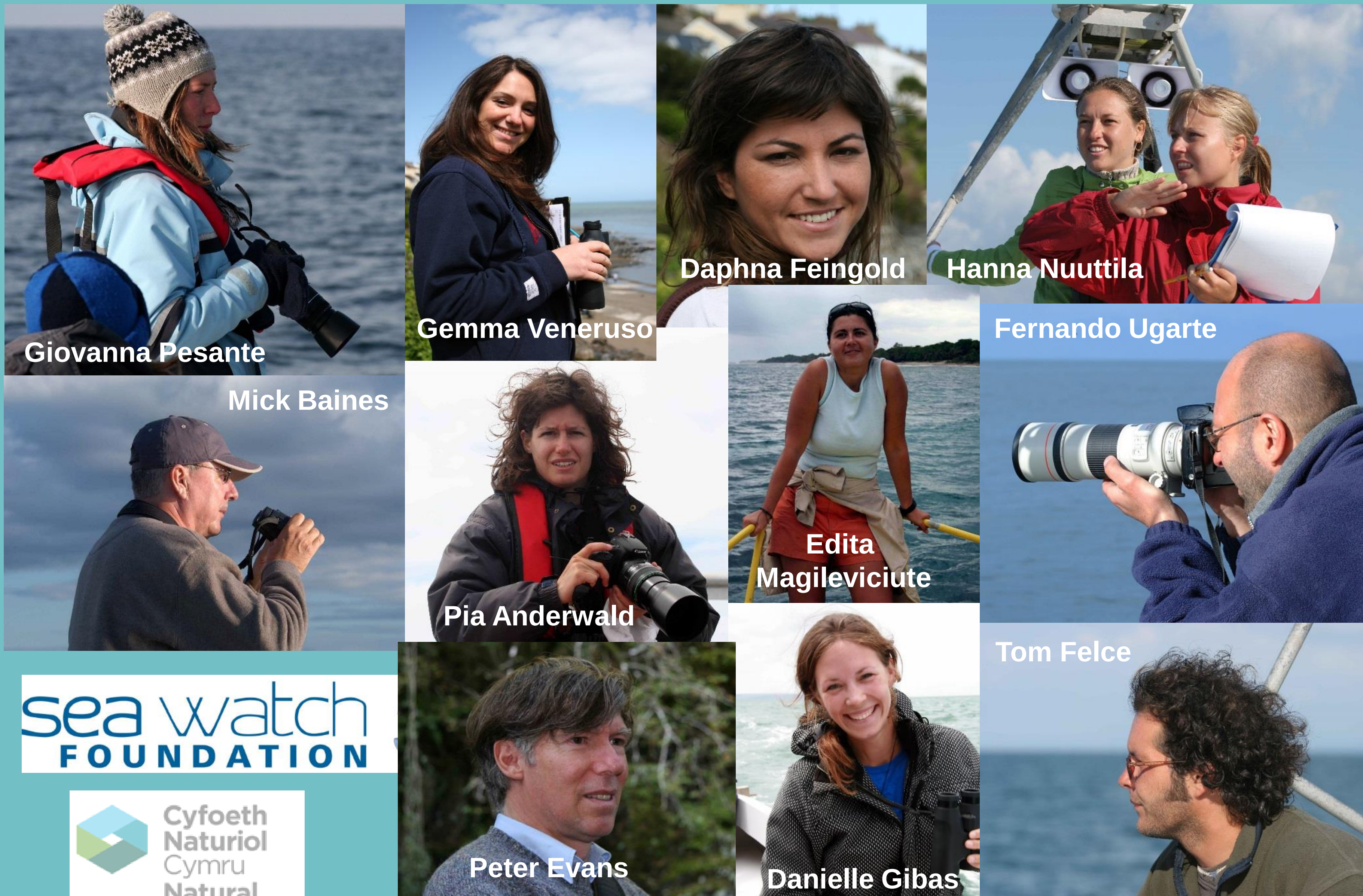
Threats & Pressures in Wales

- Harassment/disturbance & vessel strikes
- Pollution (chemicals & pathogens)
- Noise disturbance (marine industry)
- *Collision with renewable energy devices*
- *Incidental capture in fishing gear*

Current conservation status

- Bottlenose dolphins in Wales are considered to be favourable

- Keep monitoring and tracking population health.
- Monitor and manage human impacts



sea watch FOUNDATION

Cyfoeth Naturiol Cymru
Natural Resources Wales

www.naturalresourceswales.gov.uk

@NatResWales
@tomstringell

Cyfoeth Naturiol Cymru
Natural Resources Wales

Diolch - Thank You

The Shannon Population: Status and Situation Management

Simon Berrow, Joanne O'Brien and Isabel Baker

Shannon Dolphin and Wildlife Foundation, Kilrush, Co Clare

The Shannon Estuary is home to a unique population of bottlenose dolphins and one of the longest running dolphin field studies in Europe. The dolphins have been studied since 1993 when a pilot photo-id study was carried out and this has been ongoing over the past 25 years. The population has been shown to be small, with estimates ranging from 140±12 in 2007 to 107±12 in 2010 but it is considered stable over the past 20 years. The Shannon population is genetically isolated from adjacent coastal populations. It was designated as an SAC with bottlenose dolphins as a qualifying interest in 1999.

The dolphins' use of the estuary is not uniform with sightings concentrated in discrete areas, termed critical habitats, especially when foraging. These foraging sites are characterised by having greatest benthic slope and depth, leading to high tidal flows. These occur where the estuary is constricted such as between Kilcredaun and Kilconly Points in the outer estuary and Tarbert and Killimer in the mid-estuary. Sites which may be important for other activities such as socialising or resting have not been identified.

Since 1993 standardised transects have been carried out along a consistent route between Tarbert/Killimer and Kilcloher Head and Ballybunnion in the outer estuary. The route is based on the first transects in 1993 which used fixed marks in the estuary such as navigation buoys and headlands to determine location due to the lack of handheld GPS or onboard navigation systems. This current transect route only covers around one-third of the 684km^2 area of the designated SAC, with no coverage in the inner estuary, east of Tarbert. There is also very little coverage outside the summer period (June to September). Transects were surveyed during the 2006-2007 winter period along the same summer transect route and although they located dolphins in similar sites to the summer, dolphin abundance was lower. Winter transects were carried out between November and March, including into the inner estuary. Dolphins were recorded on 70% of transects which was similar to that during summer transects but the encounter rate was lower (0.17 dolphins per km compared to 0.80 dolphins per km). A static acoustic study using CPODs during 2011-2012 showed dolphins were regularly detected up river as far as Shannon Airport, but with decreasing frequency. Dolphins were detected on 80% of days off Moneypoint, 40% off Foynes, 31% off Aughinish and 21% off Shannon Airport, though mean Detection Positive Minutes per day and feeding buzzes were higher off the Airport compared to Aughinish, suggesting this area was used more for foraging. Season had a significant explanatory effect off Moneypoint, Foynes and Aughinish with more detections during winter but not off Shannon Airport. Clearly the current limited transects in the SAC are not providing sufficient spatial or seasonal coverage to understand how the dolphins use the estuary and this may also impact on long-term population monitoring if the dolphins' distribution changes for example with changes in prey distribution or other factors.

Although the Shannon dolphins do spend considerable time in the estuary they are known to range outside the SAC boundary. Shannon dolphins were recorded off north Kerry 20km west of the SAC in 2009 and a putative Shannon dolphin was identified off Donegal in 2015 while the IWDG recorded also one off Co Cork. A small group of dolphins recorded in outer Cork Harbour from 2006 to 2013 were attributed genetically to the Shannon population. Are these Shannon dolphins ranging long distances from the Shannon or individuals from the coastal population visiting the Shannon but not breeding with the Shannon population? A recent study of the Shannon dolphins outside the estuary showed that 95% of the 70 individual dolphins photographed in Brandon and Tralee Bays between 2008 and 2016 were from the Shannon population, with 37 of these being recorded more than 10 times in the estuary. Clearly these bays in northwest Kerry provide very important habitats for the Shannon population and more effort is required to determine how far Shannon dolphins range outside the estuary to identify other important habitats which should be protected to maintain this discrete population.

In order to explore population status, especially in the event of population changes, information on life-history traits such as calving rates and survival and longevity are essential. These data are hard to obtain and the current long-term monitoring programme with surveys every three years, and aiming to estimate abundance using photo-id and mark-recapture models, are not sufficient. A power analysis and population viability analysis was carried out to explore the ability of the current sampling strategy to detect population change, and to simulate a number of management scenarios. They showed the importance of low CVs in abundance estimates and suggested the current triennial strategy could detect change of 5% per annum after four reporting cycles (12 years), by which time the population would have declined from 140 to 76 individuals. The PVA suggested this small population is vulnerable where only one catastrophic event, which resulted in a 25% population decline in survival in 1% of years during a 250 year simulation, could lead to population extinction.

These analyses used reproductive parameters from Florida, USA as no data were available from Ireland or Europe. Since 2012, Baker (unpublished data) has increased photo-id effort in the Shannon each year and has shown around 8 calves are born annually on average (range 5-12) with inter-calf intervals of around 2-3 years. Mortality rates of adults are harder to determine but bottlenose dolphin strandings increased in 2002-2009 with a cluster reported around the Shannon Estuary. If stranded bottlenose dolphins are assigned to a population through genetic techniques a minimum mortality rate could be calculated. If the population is considered stable, mortality must equal birth rates assuming no immigration or emigration. Clearly more data is required to provide better estimates of important life-history parameters but the current triennial sampling strategy cannot provide this information.

The diet and foraging ecology is a significant gap in our knowledge of the ecology of the Shannon dolphins. The only data on the diet of bottlenose dolphins in Ireland is from Hernandez-Milan *et al*. (2015) who included one individual (classified as a Shannon dolphin using genetics) in their sample of 12 stranded individuals. Fish accounted for 90% of the diet (99% by weight) with cephalopods occurring in 67% of stomachs but attributed only a small proportion of the weight consumed. Most fish were gadoids (whiting, pollock, saithe, haddock) with dogfish, conger eels and mackerel also present. Salmon was considered to be under-represented. How fish availability and abundance changes seasonally in the estuary and the effect on dolphin foraging and health status is not known but it is a very important management issue. Species such as salmon, herring and mackerel are only seasonally abundant so what do Shannon dolphins feed on during winter?

The Shannon dolphins face a number of potential threats. The estuary is the second busiest waterway in Ireland with significant plans for development. Increased vessel use of the estuary could lead to increased disturbance and habitat degradation especially through increased noise levels. One study modelled the sound from the Shannon Ferry between Killimer, Co Clare and Tarbert, Co Kerry while simultaneously monitoring dolphin occurrence and this showed that a higher Inter-Click-Interval occurred in the presence of vessel activity at the Tarbert site. Noise disturbance may also occur from point sources such as from vessels on anchor in the estuary and from site investigations and dredging. The Shannon has been identified as having potential for creation and support of renewable energy with its tidal energy resource currently under investigation. These developments have the potential to degrade the dolphins' habitat unless the appropriate information is available to contribute to impact and environmental assessments.

The Shannon dolphin population supports a well-established marine tourism industry, largely based in west Clare. Dolphin-watching has the potential to impact negatively as tour boats are targeting dolphins which may increase disturbance especially during critical periods or behaviours (e.g. mating/foraging). Dolphin-watching peaked in the estuary in the early 2000s and has shown a steady but consistent decline in recent years. Tour boats are monitored annually by the Shannon Dolphin and Wildlife Foundation and there is no evidence of a negative impact on the dolphins at the individual or population level. Indeed dolphin-watching has been shown to have a positive influence on the population's conservation status through increased awareness and consideration in development plans as well as providing economic benefits to coastal communities in west Clare in particular.

A significant long term threat is the impact of persistent pollutants. Although the Shannon dolphins had the lowest concentrations of PCBs in bottlenose dolphins in Europe from those sampled as part a European study, concentrations were still well above the toxic threshold. The impacts of high PCB concentrations on reproductive rates in mammals has been well studied but it is not known if this is currently impacting on the viability of the Shannon dolphins through reduced calving rates and survival. While an extremely difficult threat to manage, ongoing vigilance to minimise inputs of persistent pollutants into the Shannon catchment should be paramount as well as engagement with relevant European initiatives and ongoing monitoring.

A more immediate potential threat is the periodic removal of pelagic prey, especially sprat from the estuary in the autumn and its effects on predators such as dolphins as well as other fish species. Although sprat fishing in the estuary is not carried out every year, hundreds of tonnes of sprat may be removed in some years at a time when dolphins have been shown to respond positively to the availability of pelagic prey. An Appropriate Assessment of the effects of fishing in marine SACs is currently underway in Ireland and the precautionary principle should apply in the absence of good data on the Shannon dolphins' diet and predator-prey dynamics.

In summary, the bottlenose dolphins in the Shannon Estuary are a small, genetically discrete and important population. Knowledge gaps include ranging behaviour outside the designated SAC and information on life-history including births, survival and longevity and diet and predator-prey dynamics. As the estuary is one of Ireland's busiest waterways it is essential to collect the appropriate data to inform managers and developers and to ensure impacts are minimised and have no significant effects on the population in the short or long-term.

The Shannon Population: Status and Situation Management

Simon Berrow, Joanne O'Brien and Isabel Baker

Shannon Dolphin and Wildlife Foundation, Kilrush, Co Clare
Irish Whale and Dolphin Group, Kilrush, Co Clare
Galway-Mayo Institute of Technology, Galway

Saoirse na Sionna
shannon Dolphin
freedom of the shannon

IWDG www.iwdg.ie
Irish Whale and Dolphin Group
"Dedicated to the conservation of whales, dolphins and porpoises in Irish waters"

GMIT
GALWAY-MAYO INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA NA GAILLIMHE-MAIGH EO

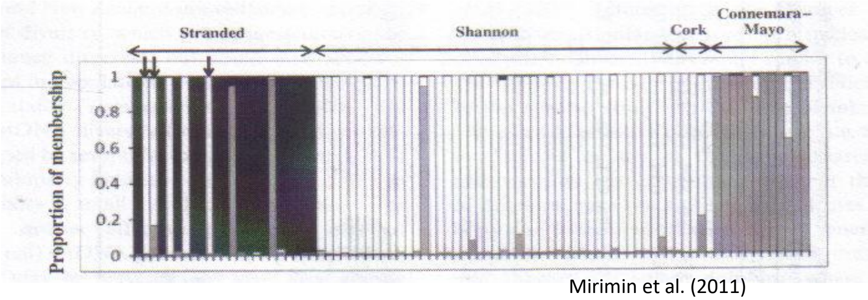
Shannon Dolphins: a unique population

Studied since 1993: one of the longest data-sets in Europe

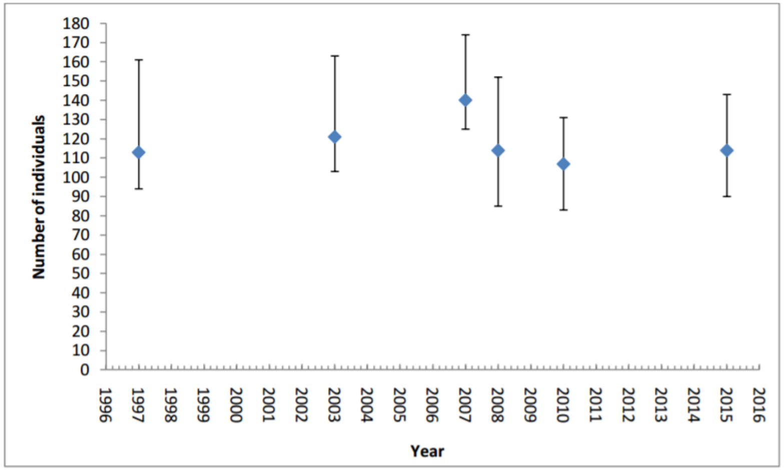
Restricted range

Small but stable population

Genetically discrete



Mirimin et al. (2011)



Rogan et al. (2015)

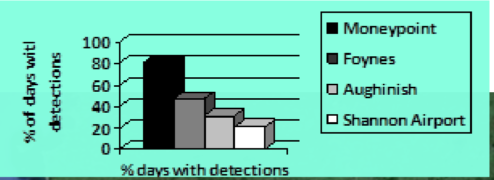
Habitat Use

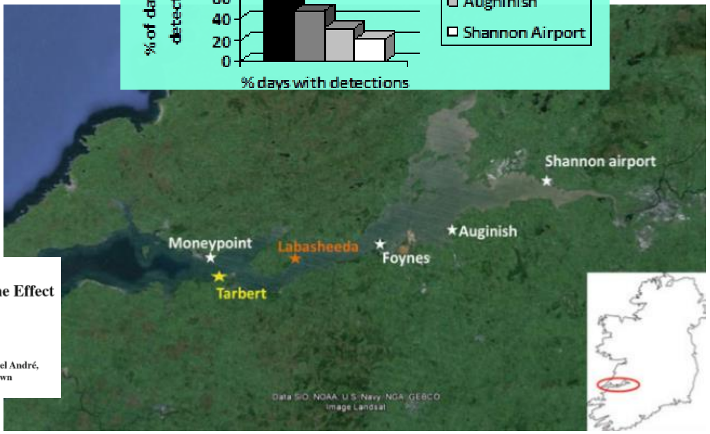
Management Gap

Coverage within estuary

Critical habitats

- foraging
- socialising/breeding/resting ?
- coverage .....



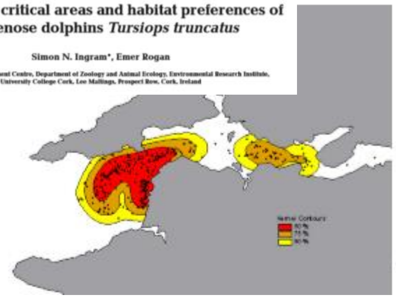


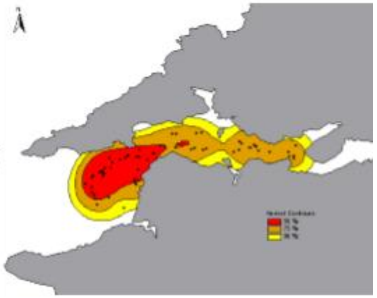
Vol. 244: 247–255, 2002 MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser Published November 29

Identifying critical areas and habitat preferences of bottlenose dolphins *Tursiops truncatus*

Simon N. Ingram*, Emer Rogan

Aquaculture Development Centre, Department of Zoology and Animal Ecology, Environmental Research Institute, University College Cork, Lee Maltings, Prospect Row, Cork, Ireland





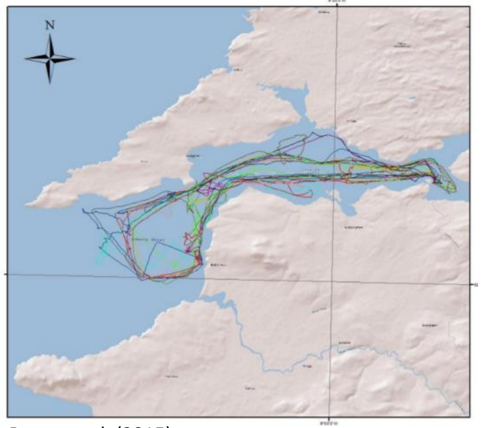
Chapter 95
The Use of Deep Water Berths and the Effect of Noise on Bottlenose Dolphins in the Shannon Estuary cSAC

Joanne M. O'Brien, Suzanne Beck, Simon D. Berrow, Michel André, Mike van der Schaar, Ian O'Connor, and Eugene P. McKeown

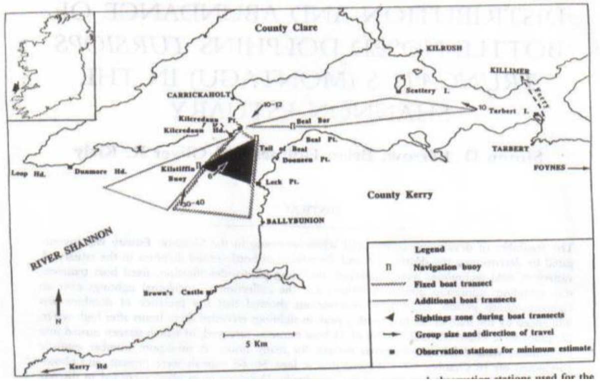
DISTRIBUTION AND ABUNDANCE OF BOTTLE-NOSED DOLPHINS *TURSIOPS TRUNCATUS* (MONTAGU) IN THE SHANNON ESTUARY

Simon D. Berrow, Brian Holmes and Oliver R. Kiely

Englund et al. (2008)



Rogan et al. (2015)



Winter distribution of Bottle-nosed Dolphins (*Tursiops truncatus* (Montagu)) in the inner Shannon Estuary

Simon D. Berrow

Shannon Dolphin and Wildlife Foundation, Merchants Quay, Kilrush, Co. Clare

Life-history

Knowledge Gaps

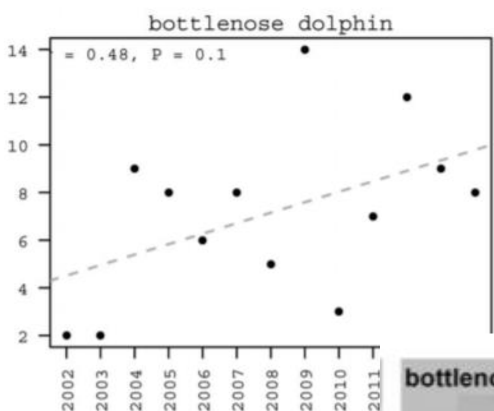
Life-history parameters

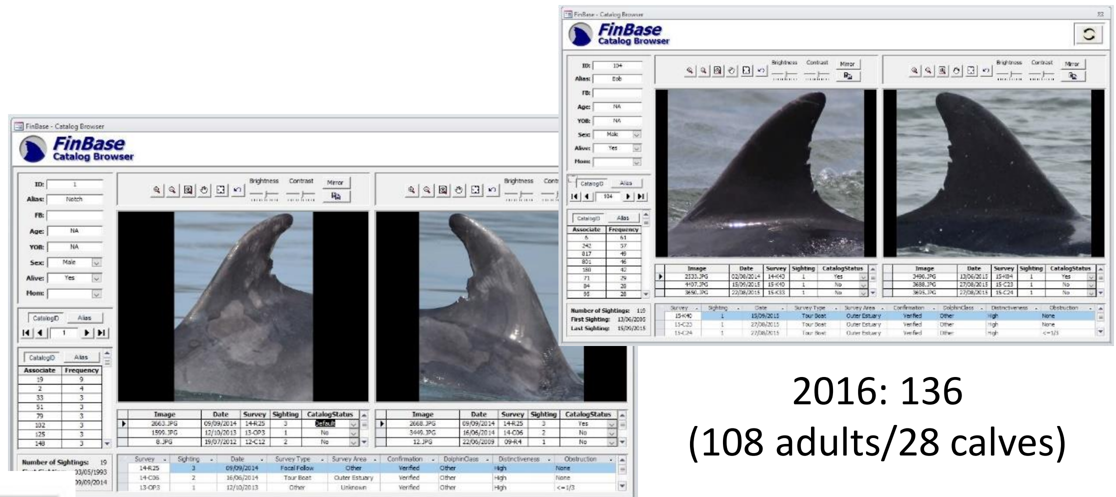
(calving rates and survival)

Longevity/Mortality

Population status and viability

- PVA (vulnerable)
- Births and deaths
  - 1993-2016





2016: 136
(108 adults/28 calves)

8 individuals still alive were recorded in 1993/94 (7% of current population)

5 births in 2016 (mean = 8 over the last 5 years (ranging from 5-12)

When is a dolphin considered dead ? How many years without recording

Temporal and spatial trends in stranding records of cetaceans on the Irish coast, 2002–2014

BARRY MCGOVERN, ROSS M. CULLOCH, MICHAEL O'CONNELL AND SIMON BERROW

Movements

Knowledge Gap

Range outside estuary

Range outside SAC boundary

- Ryan and Berrow (2013) Brandon Bay/Sauce Creek
- Donegal (Rogan et al. 2015)
- Youghal (IWDG/SDWF)
- “coastal” Scattery-Moneypoint in 2015

Are these “Shannon” dolphins or the “coastal” population visiting the Shannon ?

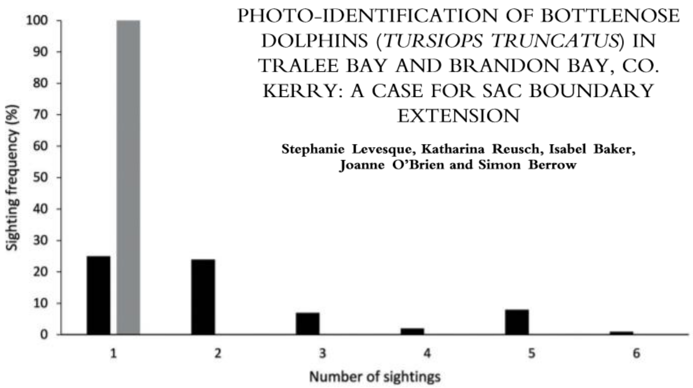


PHOTO-IDENTIFICATION OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN TRALEE BAY AND BRANDON BAY, CO. KERRY: A CASE FOR SAC BOUNDARY EXTENSION

Stephanie Levesque, Katharina Reusch, Isabel Baker, Joanne O’Brien and Simon Berrow

Fig. 3—Sighting frequency (1–6 number of sightings) of individual bottlenose dolphins from the Shannon population (n = 67) and Brandon unknown dolphins (n = 3) during 11 surveys carried out between 2008 and 2016.

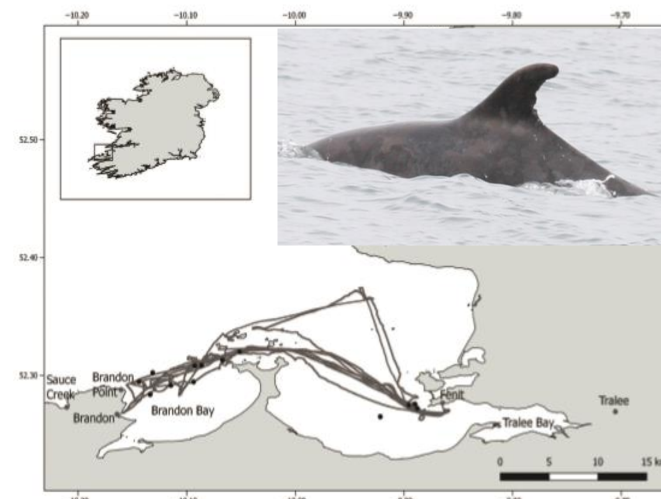


Fig. 1—Bottlenose dolphins are seen regularly from Doonbeg Bay, Kilkee Bay and Lahinch Bay, although no studies have been done to discern which population they are from. Some individuals seen in Brandon/Tralee were also observed as far east as Labasheeda Bay; a distance of 100–120km. Study area is shown with group sightings (black points) and survey tracklines. The black line between Loop Head and Kerry Head represents the boundary of the Lower River Shannon SAC.

Ecology

Diet ......

Knowledge Gaps

Diet,

prey availability

- one from Shannon population

Fish - gadoids (whiting, Pollock, saithe, haddock)

dogfish, conger, mackerel and horse mackerel

Cephalopods – oceanic Teuthowenia, Gonatus and Eledone

Aquatic Mammals 2015, *41*(2), 226-239, DOI 10.1578/AM.41.2.2015.226

Insights into the Trophic Ecology of Bottlenose Dolphins (*Tursiops truncatus*) in Irish Waters

Gema Hernandez-Milian,[1] Simon Berrow,[2]
M. Begoña Santos,[3] David Reid,[4] and Emer Rogan[1]

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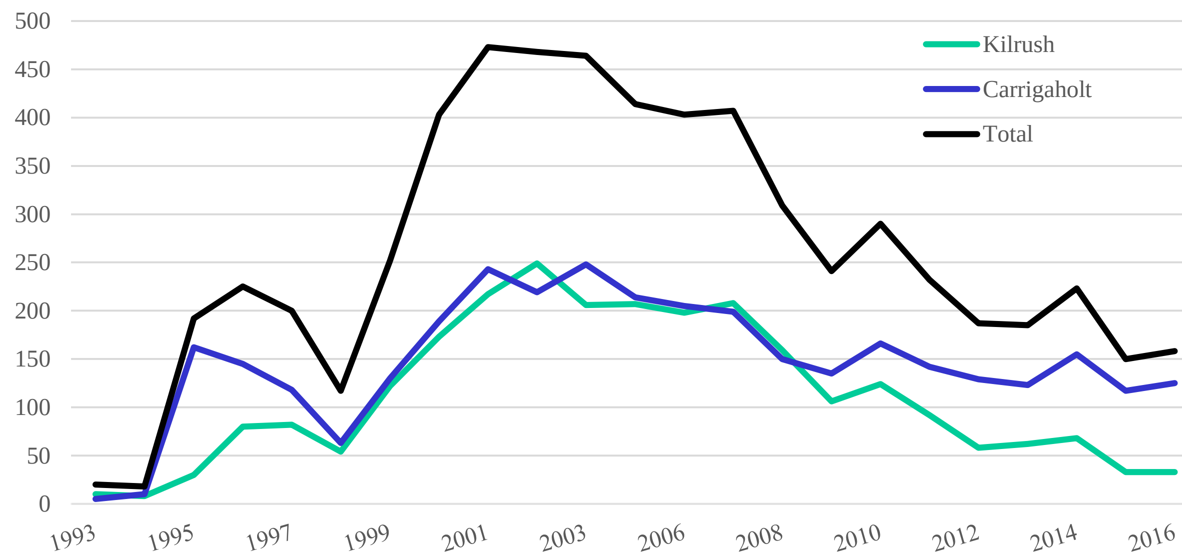
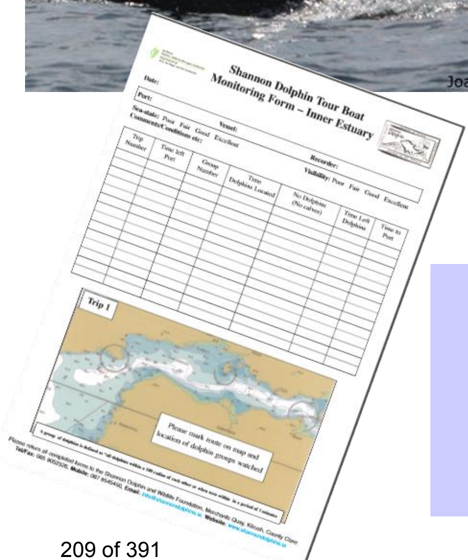
E-mail: g.hernandezmilian@ucc.ie
[2]*Irish Whale Dolphin Group (IWDG), Merchants Quay, Kilrush, Co. Clare, Ireland*
[3]*Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Apdo. 1552, E-36200 Vigo, Spain*
[4]*Marine Institute, Rinville, Oranmore, Co. Galway, Ireland*

Summer/Autumn - salmon, mackerel, herring, sprat ?
Winter ?

Shannon Dolphins: Potential threats

Dolphin-watching tourism





Measuring the Performance of Partnerships: Why, What, How, When?

Claire Kelly*

niversity of Plymouth

<u>Management Gaps</u>

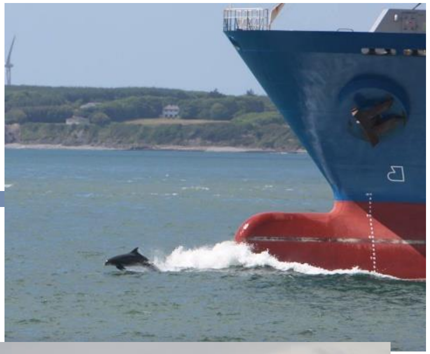
Notifiable Action

Conservation Plan

AL AND SPATIAL VARIATION IN
IZE OF BOTTLENOSE DOLPHINS
SIOPS TRUNCATUS) IN THE
NNON ESTUARY, IRELAND

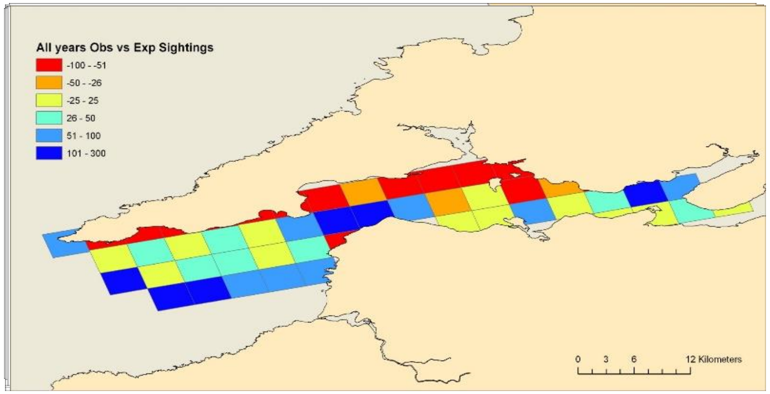
Joanna Barker and Simon Berrow

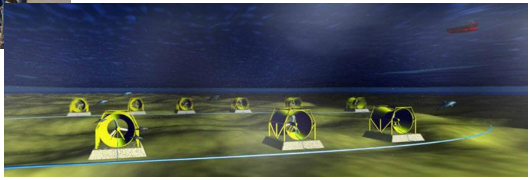
Shannon Dolphins: Potential threats



Disturbance and Habitat degradation

- Shannon Estuary busy waterway (SIFP)





Chapter 95
The Use of Deep Water Berths and the Effect of Noise on Bottlenose Dolphins in the Shannon Estuary cSAC

Joanne M. O'Brien, Suzanne Beck, Simon D. Berrow, Michel André, Mike van der Schaar, Ian O'Connor, and Eugene P. McKeown

<u>Management Gaps</u>

Disturbance

Ambient noise trends

Point sources

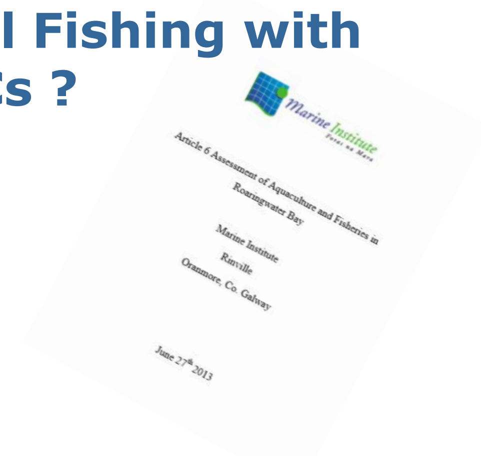
Shannon Dolphins: Potential threats

Persistent pollutants

- 2001 biopsy study (not of great concern)
- revisited 2016 (Jepson et al.), of concern
- more samples
- re-sample 2001 individuals ?

Periodic removal of pelagic prey (sprat and herring)

Appropriate Assessment of Commercial Fishing with Marine SACs ?



Marine Institute
Foras na Mara

Article 6 Assessment of Aquaculture and Fisheries in Roaringwater Bay

Marine Institute
Rinville
Oranmore, Co. Galway

June 27th 2013

<u>Knowledge Gaps</u>

Pollution ?

Predator-prey dynamics

Summary

Vulnerable population (small and genetically discrete)

Limited spatial distribution

Knowledge Gaps:

- **Better understanding of life-history (births and deaths)**
- **Habitat Use and movements (especially outside SAC)**
- **Diet and prey availability**

Management Gaps:

- **Survey Coverage**
- **Dolphin-watching as a Notifiable Activity**
- **Effects of persistent pollutants**
- **Disturbance and habitat effects**
- **Ambient and point noise sources and trends**
- **Predator-prey dynamics**
- **Conservation Plan for Lower River Shannon cSAC**

Who or what killed Flipper? Investigating bottlenose dolphin strandings around the UK coast over the last 100 years (1913-2015)

Rob Deaville

Cetacean Strandings Investigation Programme, The Zoological Society of London, Regent's Park, London, UK
Author Contact Information: rob.deaville@ioz.ac.uk (+ 44 207 449 6672)

Strandings are commonly defined as *where "a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea*" (Geraci and Lounsbury, 2005). Investigation of such stranding events through systematic post-mortem examination not only allows a cause of death to be established, from which more can be learnt about the threats these species face, but also facilitates a wide range of multi-disciplinary research that can shed light on the lives of species that may be otherwise difficult to study.

Between 1913 and 2015 16,748 cetaceans were reported stranded in the UK, comprising *Phocoenidae* (n=7550), *Delphinidae* (n=5835), *Balaenopteridae* (n=605), *Ziphiidae* (n=338), *Physeteridae* (n=220), *Kogiidae* (n=13), *Monodontidae* (n=2) and cetaceans of indeterminate identity (n=2185). Routine recording of stranded cetaceans in the UK began in 1913 under the aegis of the Natural History Museum (http://www.nhm.ac.uk/take-part/citizen-science/uk-whale-and-dolphin-strandings.html). Routine and systematic necropsies of stranded cetaceans were initiated in the UK in 1990, under the aegis of the collaborative Cetacean Strandings Investigation Programme (CSIP, www.ukstrandings.org). A significant increase in strandings reporting effort occurred after the inception of the CSIP with 74% of the total strandings in this 103-year dataset recorded after 1990.

The sixth most common species recorded stranded in the UK during this period was the bottlenose dolphin (*Tursiops truncatus*, 428 strandings). Of these, 223 were recorded in England, 101 in Scotland, 96 in Wales and eight in Northern Ireland. The strandings were largely single stranding events (n=412) with a small number of double stranding events (n=8), illustrating the relatively rare occurrence of mass strandings. A seasonal peak was noted with strandings occurring most frequently over the summer months, and with the most pronounced effect noted in Wales.

The long-term nature of this dataset demonstrates changes in spatial and temporal distribution of strandings around the UK coast. Strandings of bottlenose dolphins used to be recorded in UK regions where they are no longer found, primarily in the southern North Sea region, and in and around Morecambe Bay. This suggests a range contraction in coastal populations of bottlenose dolphins has occurred in the UK over the last century. The apparent range contraction in the North Sea region is also mirrored within another historical dataset, the Netherlands strandings database held by *Naturalis* (http://www.walvisstrandingen.nl)

During the period of the modern strandings programme (1990-extant) 80 stranded bottlenose dolphins were recovered for systematic necropsy, using standardised protocols (Kuiken and Hartmann, 1991). Causes of mortality were: infectious disease (n=12), live stranding (n=8), accidental entrapment in fishing gear (n=5), intraspecific aggression (n=5, e.g. Patterson *et al.,* 1998), starvation (n=4, including one neonatal starvation case), neonatal death (n=3), physical trauma of unknown cause (n=2) and a range of other causes of mortality (n=9). A cause of death was not determined in 32 individuals.

The large proportion of 'Not Established' cases was to some extent a function of decomposition in these cases (20/32 were in advanced decomposition) but also reflects a lack of significant underlying pathology. Few direct/physical anthropogenic drivers of mortality were noted, with no ship-strike cases and relatively low levels of by-catch (~6%) compared to other UK-stranded delphinid species (e.g. 45% in UK stranded common dolphins). Finally, recently published research (Jepson *et al.,* 2016) has found elevated mean levels of polychlorinated biphenyls (PCBs) in many European stranded bottlenose dolphins that markedly exceed all known marine mammal PCB toxicity thresholds.

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Geraci, J.R., Lounsbury, V.R. (2005). *Marine Mammals Ashore: A Field Guide for Strandings (2nd Edition)*. National Aquarium in Baltimore, Baltimore, MD. 305 pp.

Jepson, P.D., Deaville, R., Barber, J.L., Aguilar, À., Borrell, A., Murphy, S., Barry, J., Brownlow, A., Barnett, J., Berrow, S., Cunningham, A.A., Davison, N., ten Doeschate, M., Esteban, R., Ferreira, M., Foote, A.D., Genov, T., Giménez, J., Loveridge, J., Llavona, Á., Martin, V., Maxwell, D.L., Papachlimitzou, A., Penrose, R., Perkins, M.W., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A., Law, R.J. (2016). PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Scientific Reports* **6:** 18573 doi:10.1038/srep18573.

Kuiken, T., Garcia Hartmann, M. (Eds.) (1991). *Proceedings of the first European Cetacean Society workshop on cetacean pathology: dissection techniques and tissue sampling*. ECS newsletter 17, Special issue. 39pp.

Patterson, I.A.P, Reid, R.J., Wilson, B., Grellier, K., Ross, H.M., Thompson, P.M. (1998). Evidence for infanticide in bottlenose dolphins: An explanation for violent interactions with harbour porpoises? *Proceedings of The Royal Society of London Series B-Biological Sciences* **265:** 1167-1170.

Who or what killed Flipper? Investigating bottlenose dolphin strandings around the UK coast over the last 100 years (1913-2015)

ZSL

Institute of Zoology

CSIP

UK CETACEAN STRANDINGS INVESTIGATION PROGRAMME

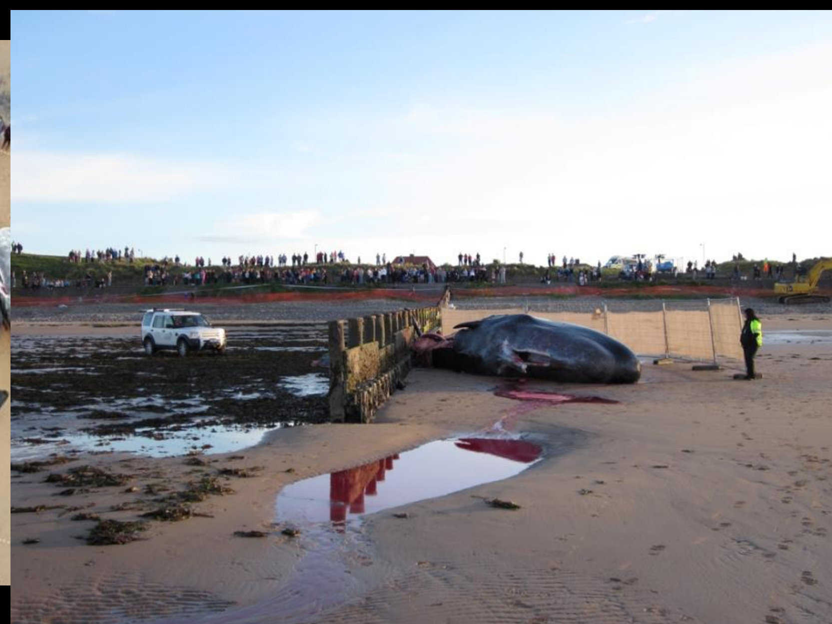
LIVING CONSERVATION

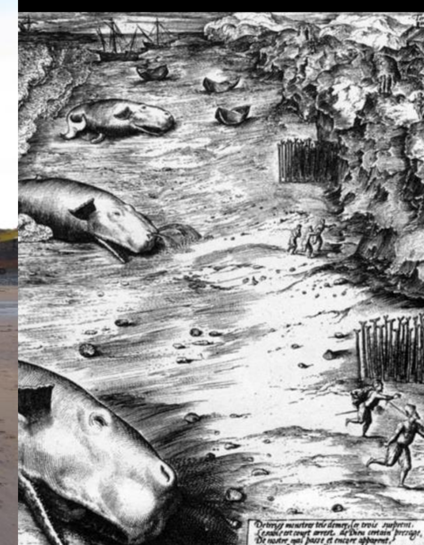
CSIP

Strandings

ZSL

- Strandings are commonly defined as "*when "a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea*"*
- May occur individually or in groups (mass strandings) and have occurred throughout recorded history
- Many possible reasons, both 'natural' and anthropogenic

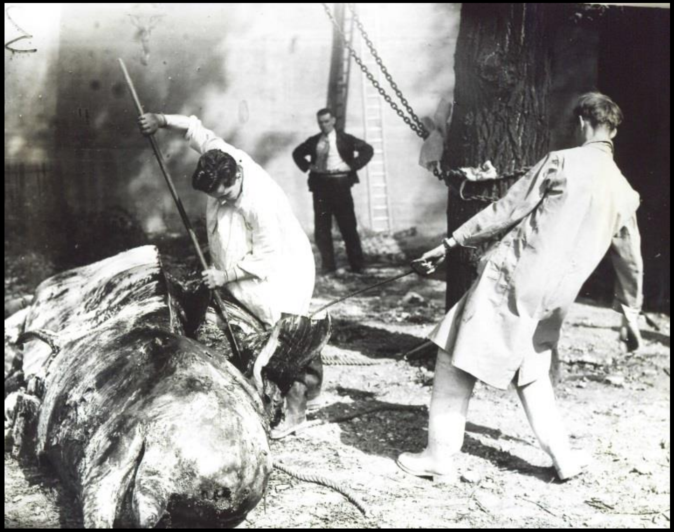


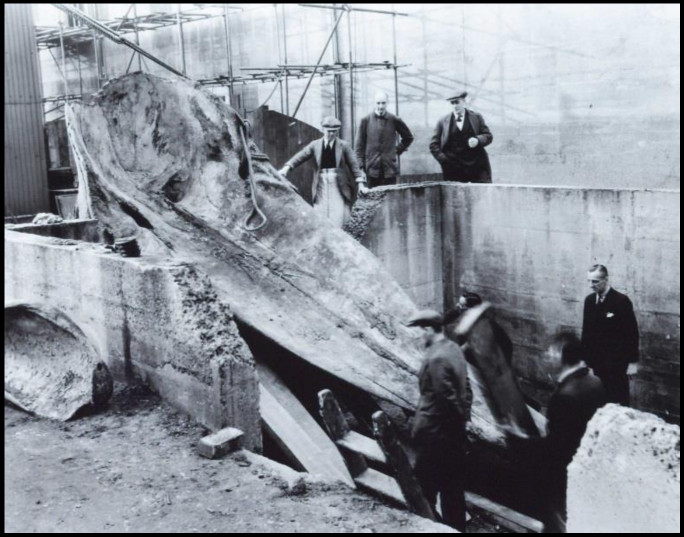


* Geraci, J. R. and Lounsbury, V.R. Marine Mammals Ashore: A Field Guide for Strandings, 2nd Edition. *National Aquarium in Baltimore, Baltimore, MD*, 305 pp. (2005)

UK strandings- history and background

- 'Royal Fish'- 1324
  - Statute Prerogative Regis, 17 Edward II (AD 1324) states that although the Crown has sovereign dominion over the sea around the British Isles, it has no general property in the fish and marine mammals in it except for cetaceans and sturgeon. These are 'Royal Fish' and belong to the Crown. An exception to this is if they become stranded or their bodies are washed ashore within the limits of a Manor, such as the Duchy of Cornwall, in which case title passes to the Lord of the Manor.
- 1911- mass stranding of c. 50 pilot whales in Penzance, Cornwall
- 1913- NHM begin to routinely record strandings data
- Over next 80 years data collected on 3949 strandings and recovery of bodies (largely for skeletal material)
- Modern UK stranding programme began in 1990





CSIP

UK strandings programme (1990→)

ZSL

Department for Environment Food & Rural Affairs

Llywodraeth Cymru Welsh Government

The Scottish Government

JNCC Joint Nature Conservation Committee

marinescotland

mca

Cornwall Wildlife Trust

University of Exeter

British Divers Marine Life Rescue

SMRU

Cefas

Moredun

University of Aberdeen

National Museums Scotland

RSPCA

Natural England

Scottish Natural Heritage All of nature for all of Scotland

Cyfoeth Naturiol Cymru Natural Resources Wales

ZSL Living Conservation

SRUC

Natural History Museum

Marine Environmental Monitoring

WDC Whale and Dolphin Conservation

Humane Society International

Cetacean Research & Rescue Unit

Sea Watch Foundation

Strandings 1913-2015

Species	Strandings
Harbour porpoise	
Short beaked common dolphin	
Long-finned pilot whale	
White beaked dolphin	
Minke whale	
Bottlenose dolphin	
Atlantic white-sided dolphin	
Risso's dolphin	
Striped dolphin	
False killer whale	
Sperm whale	
Northern bottlenose whale	
Sowerby's beaked whale	
Cuvier's beaked whale	
Killer whale	
Fin whale	
Humpback whale	
Pygmy sperm whale	
Sei whale	
Blue whale	
Narwhal	
Beluga whale	
Blainville's beaked whale	
Fraser's dolphin	
Melon headed whale	
Dwarf sperm whale	
Unknown cetacean	
TOTAL	16748

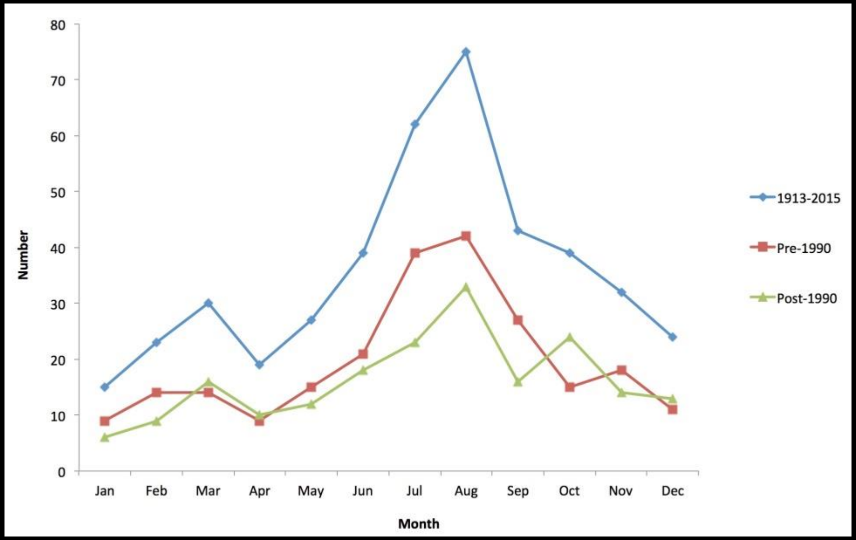




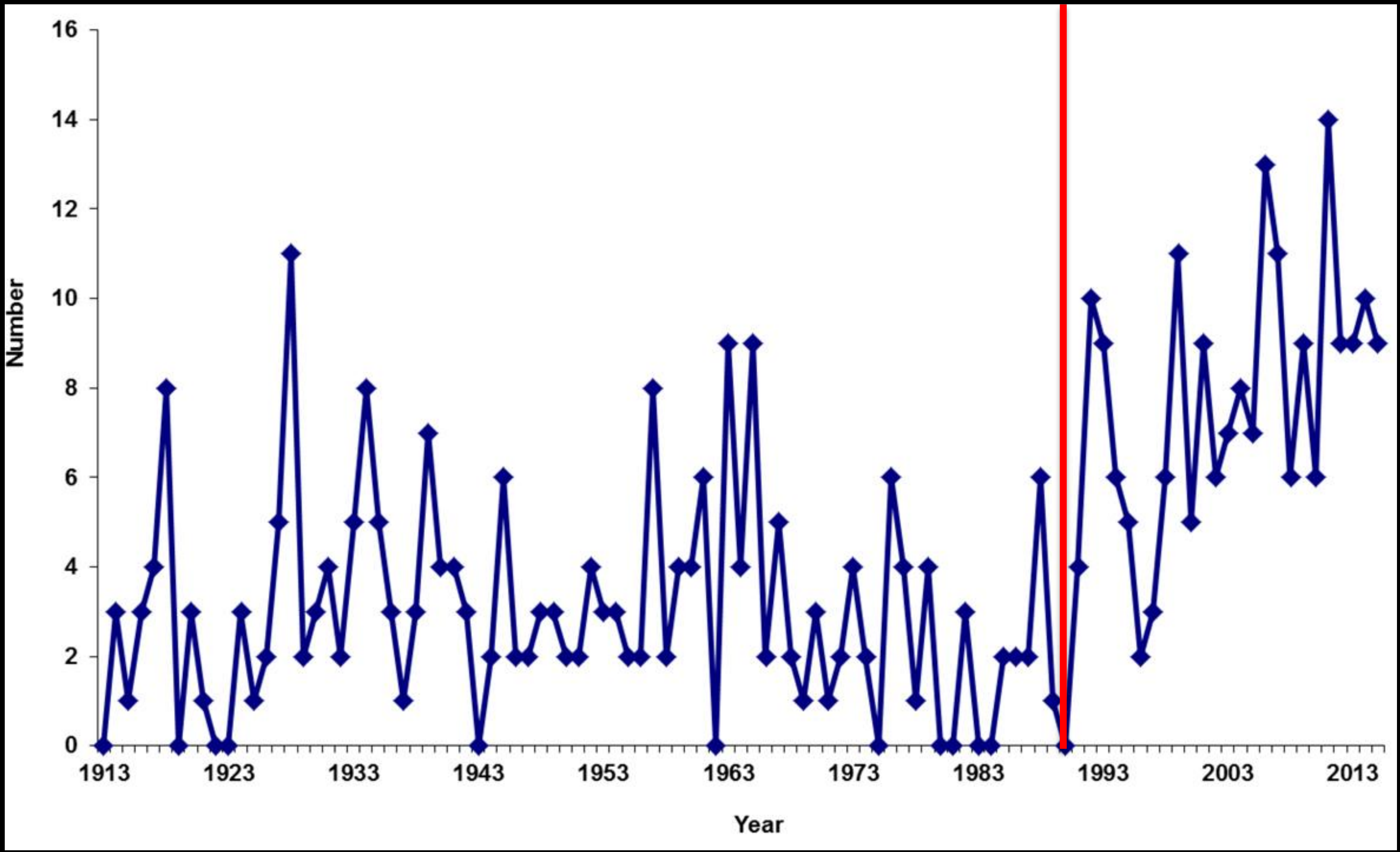
At least 26 species
1913-1989: 3949 strandings (NHM)
1990-2015: 12799 strandings (CSIP)

UK BND strandings (1913-2015)

- Sixth most common stranded species in the UK
- M (n=116), F (n=84), U (n=218)
- 412 single stranding events; Eight MSE’s (all n=2). Poss mother-calf pairs. ↓mass stranding risk
- England (n=223), Scotland (n=101), Wales (n=96) and Northern Ireland (n=8)
- Summer peak in strandings (most pronounced in Wales)



Bottlenose dolphin strandings (UK, 1913-2015)

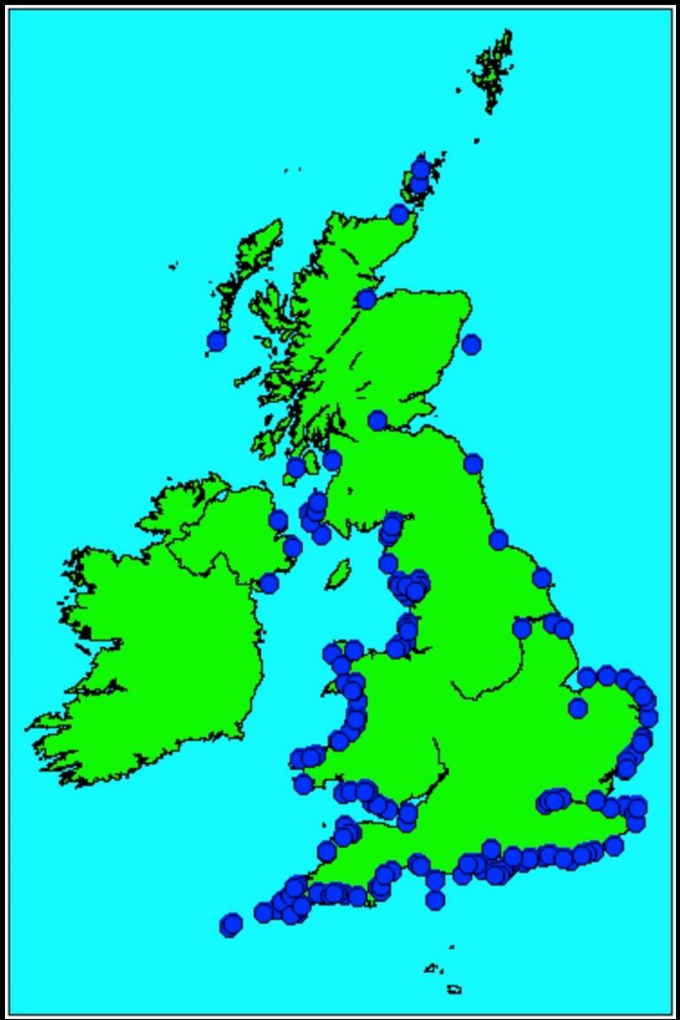


Data- NHM strandings dataset 1913-1989 and CSIP dataset 1990-2015

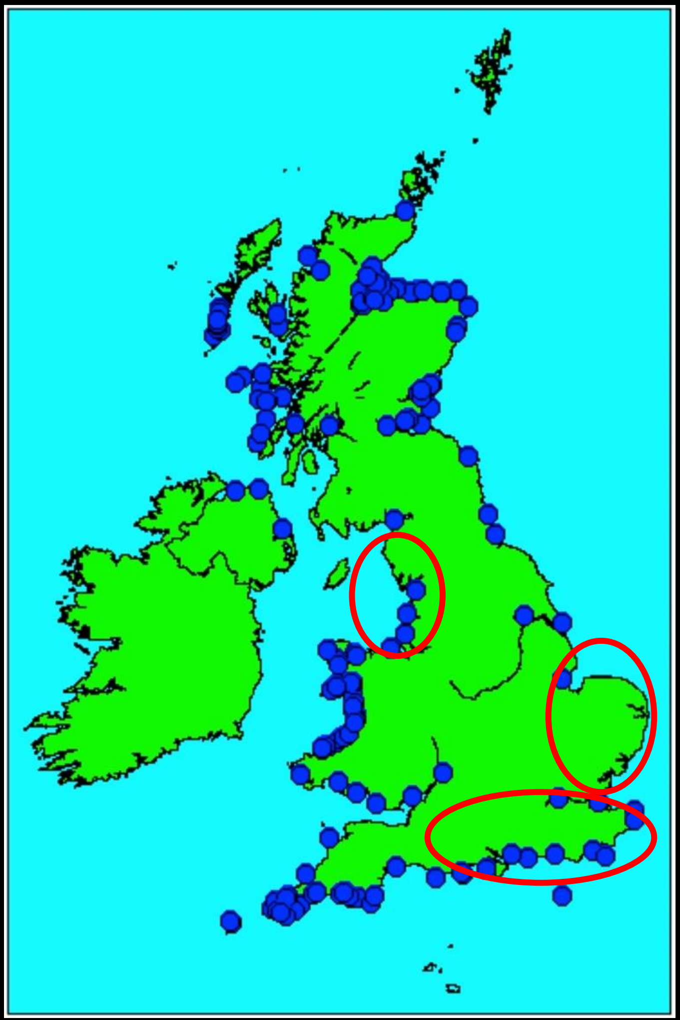
1913-1989 mean 3/year
1990-2015 mean 8/year

1913-1989 mean 38/year
1990-2015 mean 520/year

Bottlenose dolphin strandings 1913-2015

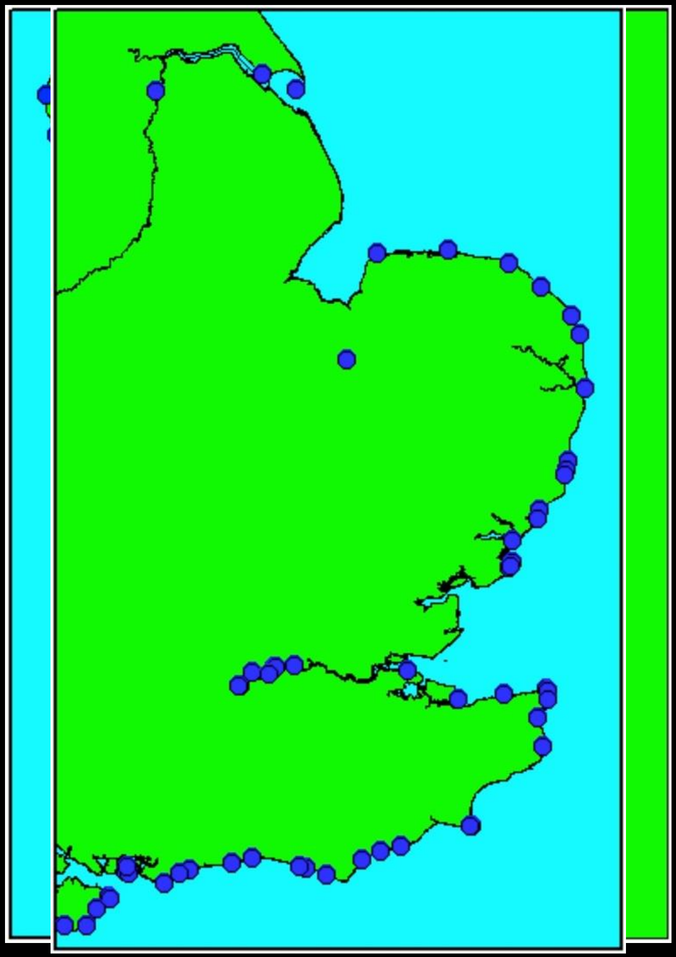


1913-1989
n=234

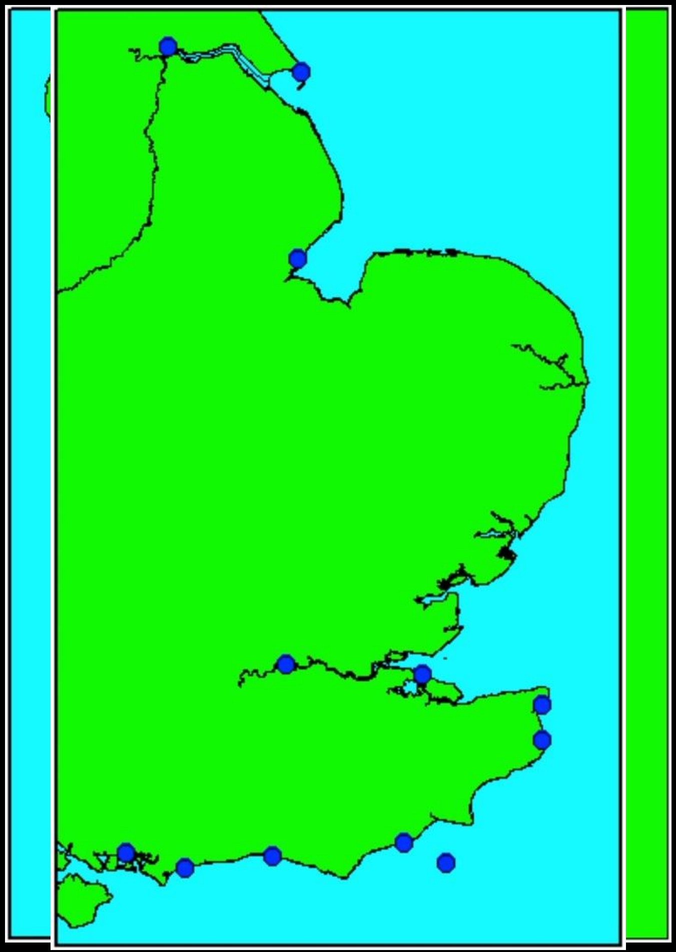


1990-2015
n=194

Morecambe Bay, North Sea/S. England

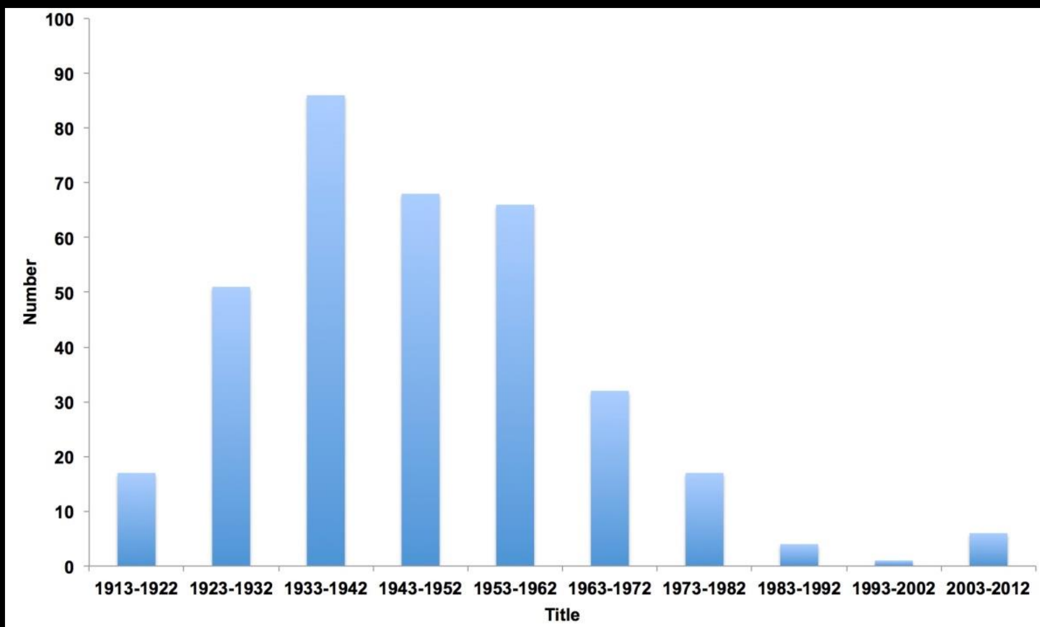


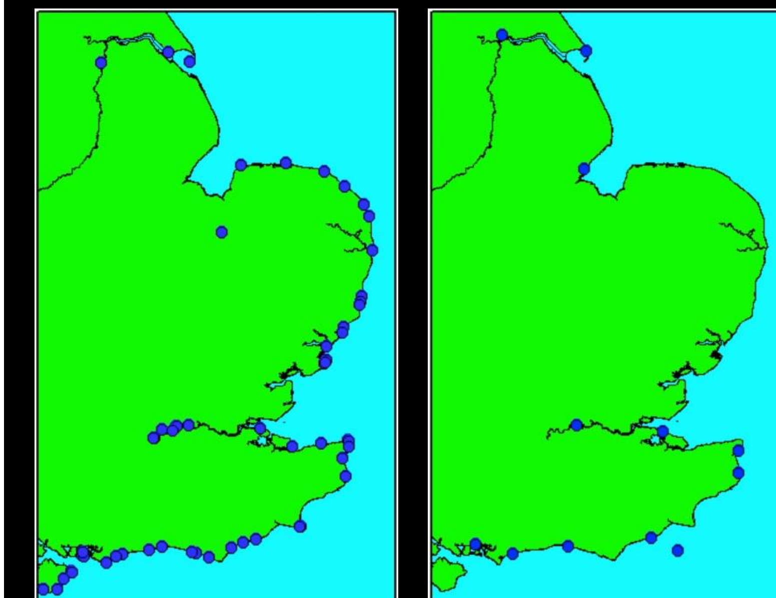
1913-1989



1990-2015

North Sea BND strandings 1913-2015
Dutch historical dataset





1913-1989 1990-2015

Range contraction? Possible drivers?

http://www.walvisstrandingen.nl

Necropsies (1990-2015)

- 3630 conducted on 19 species
- Forensic and standardised necropsy protocol (ex. ECS)
  - External assessment and morphometrics
  - Digital imagery
  - Bacteriology and virology samples
  - Organ examination and sampling (lesions, parasites etc)
  - Sample collection (skin, blubber, liver, teeth, stomach contents, gonads etc)
  - Histopathology
- Generation of a cause of death by a pathologist

Kuiken, T. and Garcia Hartmann, M. (eds.) (1991) Proceedings of the first European Cetacean Society workshop on cetacean pathology: dissection techniques and tissue sampling. ECS newsletter 17, Special issue: 39pp

Causes of Death
UK stranded BNDs 1990-2015

Cause of Death	No.
Infectious disease	12
Others	9
Live stranding	8
Bycatch	5
Intraspecific aggression	5
Starvation (in. one neonate)	4
Neonatal death	3
Physical trauma (others)	2
Not established	32
TOTAL	**80**

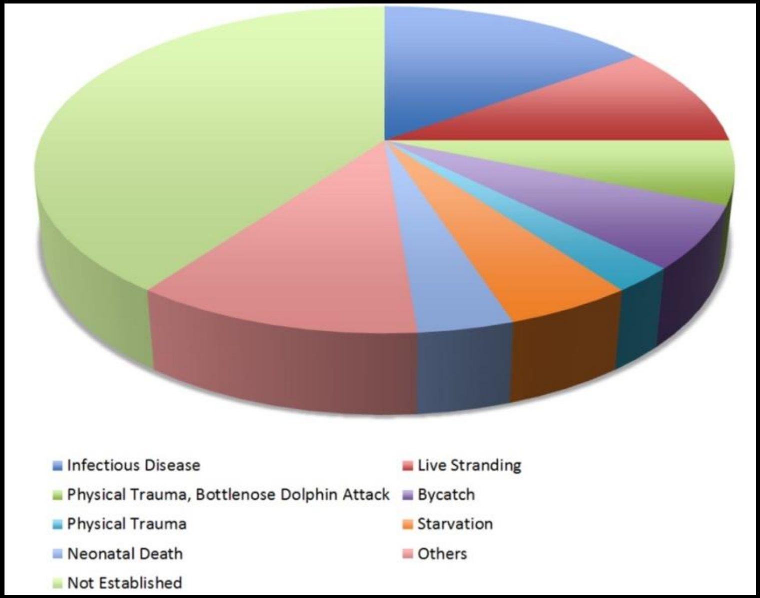
80/194 strandings necropsied (~41%)

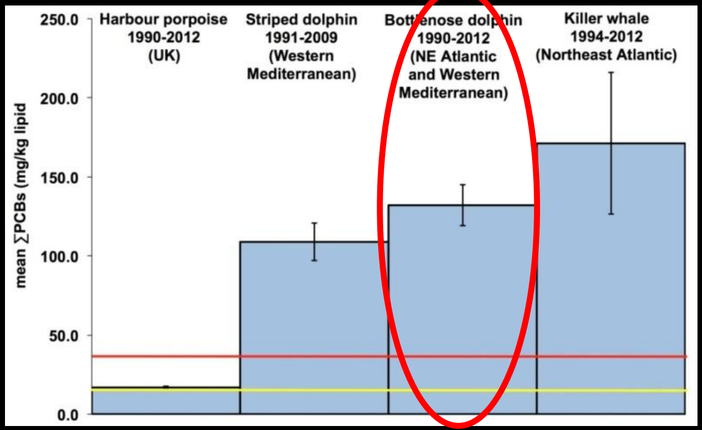
NB Excludes known by-caught animals (n=1)

Patterson, IAP *et al.* (1998) Evidence for infanticide in bottlenose dolphins: An explanation for violent interactions with harbour porpoises? *Proceedings of The Royal Society of London Series B-Biological Sciences* **265**, 1167-1170

BND causes of death (1990-2015)

- Large proportion 'Not Established'. Function of DCC (20/32 code 4+), but also lack of significant underlying pathology
- Few direct/physical anthropogenic drivers of mortality. No ship-strike, debris ingestion/entanglement etc. Relatively low levels of by-catch (~6%) compared to other delphinid species (e.g. 45% in UK stranded CDs)
- High levels of contaminants (PCBs)- Paul's talk…





Summary

- Strandings research is an opportunistic method of sampling. <u>But</u> can facilitate use of necropsy as a powerful research tool to investigate causes of mortality
- 428 BND strandings (1913-1989)
- Bottlenose dolphins not recorded stranded in regions where historical strandings- range contraction?
- Comparable data in other historical dataset (Netherlands- North Sea). Benefit of greater integration of both historical and modern strandings datasets across Europe
- 81 necropsies (1990-2015) Main drivers of mortality infectious disease; low anthropogenic trauma; high not established; high contaminants…
- Samples and data feed into collaborative research
- Strandings data are useful guide to presence/absence of species within a region- where we don't see strandings that we may have greatest cause for conservation concern

Louis, M. *et al.* (2014) Habitat-driven population structure of bottlenose dolphins (*Tursiops truncatus*) in the NE Atlantic. *Molecular Ecology* **23**, 857-874
Dawson C.E. *et al.* (2006) Isolation of *Brucella* from a bottlenose dolphin (*Tursiops truncatus) Veterinary Record* 158:831-832
Santos, M.B. *et al*. (2001) Stomach contents of bottlenose dolphins (*Tursiops truncatus*) in Scottish waters. *Jou. Mar. Bio. Ass. UK* **81**, 873-878
Jepson, P.D. *et al.* (2016) PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Scientific Reports* **6**: 18573

Acknowledgments

- **Funders-** Department for Environment, Food and Rural Affairs (Defra). Scottish Government (Marine Scotland). Welsh Assembly Government.
- **Contract manager-** Joint Nature Conservation Committee.
- **CSIP partner organisations-** Institute of Zoology, Scottish Agricultural College (Inverness), Natural History Museum, Marine Environmental Monitoring
- **Cornwall-** Cornwall Wildlife Trust Marine Strandings Network (and other wildlife trusts) and Veterinary Laboratory Agency (Truro)
- **Live strandings-** British Divers Marine Life Rescue (BDMLR)
- **Collaborators-** Sea Mammal Research Unit, CEFAS Burnham laboratory, Mordeun Institute, University of Aberdeen, National Museum of Scotland
- **Statutory Authorities-** Maritime and Coastguard Agency/Receiver of Wreck. Natural England, Scottish Natural Heritage and Countryside Council for Wales
- **NGO's-** WDCS, Seawatch Foundation and CRRU

The Iroise Marine Nature Park:

A case study of coastal dolphins and our efforts to conserve them

Philippe Le Niliot[1] and Benjamin Guichard[2]

[1] *Assistant Director of Iroise Marine Nature Park, French Agency for Biodiversity*

[2] *Policy officer for marine mammals and marine turtles, French Agency for Biodiversity*

This presentation describes how bottlenose dolphins are monitored in the Iroise Marine Nature Park (PNMI). The aim of this monitoring is to ascertain the use of different sites frequented by bottlenose dolphins, in order to protect the habitat potential of these sites for cetaceans. This objective is part of PNMI's management plan which considers these actions as priorities. Simultaneously, measures are being taken to limit the pressures that may be exerted on these sites and threaten the presence or conservation status of groups of coastal bottlenose dolphins.

On the PNMI's map, areas in purple are where conservation efforts need to be strengthened, and where most marine mammals are observed. This map also shows the archipelago of Molène and Sein island (Île de Sein) that each host a group of resident bottlenose dolphins whilst only being 22 nautical miles apart. These two groups do not seem to interact, as no individual has ever been observed in both groups.

Various protection statuses cover these areas. As part of the marine nature park they can be subject to management systems elaborated within PNMI, which is on the IUCN green list of best-managed protected areas since 2014. They are also Special Areas of Conservation under the Habitats Directive and a biosphere reserve under UNESCO's Man & the Biosphere Programme. Moreover, bottlenose dolphin populations are protected in France by a Decree of the Ministry of Environment that prohibits disturbance but also habitat modification.

There are two groups of bottlenose dolphins in the Iroise sea, one of 70 individuals in Molène archipelago and one of 30, west of Sein island. These two groups are distinct and very coastal, never being seen in waters more than 20 metres deep. Both groups have very small home ranges, where they hunt and have social interactions. With only a few square kilometres in home range, the Sein island group is considered one of the smallest known in the world. They live in very similar habitats: kelp forests, where they spend almost 80% of their time. These immense fields of *Laminaria* are very productive environments where they find prey in abundance. They do not use the whole area covered by this habitat, which is close to 200 square kilometers. Monitoring operations are carried out to understand how dolphins use their habitat, as PNMI's objective is to preserve the functionalities of these marine mammal habitats.

Since PNMI was created in 2007, park teams have been monitoring bottlenose dolphin coastal populations. Observations suggest that home ranges are reducing, particularly for bottlenose dolphins of the Molène archipelago. This group is now confined to a very small part of the archipelago where it spends nearly 80% of its time. The park teams set up a photo-ID catalogue in order to understand the dynamics of these coastal groups. Even if the home range is reduced, the dynamics seem favorable with a constant number of births observed every year (3 to 4 calves per year).

Since the 2000s, however, a diminution of the home range of Molène archipelago group has been observed. Nowadays the dolphins are concentrated in a small area, south of the archipelago and actions have been taken to understand how they use and evolve in this specific area. In 2010 three hydrophones (AURALS type) were deployed for six months in the middle of their home range. Dolphins were present during more than 20% of the recording time and more than half of this presence time was recorded during summer, suggesting that this particular area is mainly frequented during that time of the year. Unfortunately it is very difficult to access this site in winter and monitoring activities are thus limited during this time of year.

Observations and knowledge acquired on Iroise bottlenose dolphins are used to inform a PNMI indicator on the status of bottlenose dolphin coastal populations. It is thus possible to determine whether the situation is improving or deteriorating, according to trends observed from year to year. Although the Molène group's home range seems to be reducing, the population dynamics remain favorable. Therefore there is a doubt on the status of this group. It would be interesting to compare the data collected in Iroise with what has been done in other sites where coastal dolphins are observed and monitored.

Pressure indicators are also integrated, but activities are quickly evolving. Tourist activities have dramatically increased in the last 10 years, which bring up ethical, health and security issues: e.g. swimming with dolphins, dolphin-watching with speed-boats, jet skis, etc. The majority of these tourist activities did not exist before the natural marine park was created. A number of rules were thus implemented following the Decree protecting bottlenose dolphin in France. For example, jet-ski activities have been prohibited and ways to regulate and better manage dolphin-watching related activities are being tested within the marine park.

Today there are a dozen service providers offering dolphin-watching excursions, sometimes several times a day in summer. Some providers even propose snorkeling with marine mammals. Whilst the Decree prohibiting disturbance of dolphins facilitates the control of these activities, in the field it is very difficult to characterise disturbance as dolphins often spontaneously interact with ships and sometimes even with swimmers.

These activities generate important local economic gains, but are legally considered as maritime passenger transport. In spite of several attempts to modify regulations, dolphin-watching activities, which rely on the utilisation of natural heritage and remarkable areas, are still not subject to formal authorisation. Exchanges with other European MPA managers experiencing similar issues with dolphin-watching activities would be highly beneficial for PNMI.

In the absence of a legal control of dolphin-watching activities, a charter of good practices and educational materials were elaborated by the park and offered to all operators. Some operators never adopted the charter and some did without respecting its provisions, which illustrates the limitations of such measures.

Finally, an increase in kelp harvesting over the last fifteen years also raises concerns about its consequences on bottlenose dolphin coastal groups. As a matter of fact this activity now exploits new seaweed species and harvesting technologies, increasing the harvested areas and the noise generated. After three years of discussions with kelp harvesters, no-harvesting areas were set up as silence zones for bottlenose dolphins, one of which is located in the middle of their home range. In order to assess this complex management system, kelp-harvesting ships are geo-located to monitor their movement and to ensure no-harvesting zones are respected.

PNMI staff also regularly control kelp harvesting ships, but there are still doubts on the appropriate size and efficiency of silence zones, and exchanges with colleagues with experience on such matters would be highly appreciated.

The Iroise Marine Nature Park : A case study of coastal dolphins and our efforts to conserve them

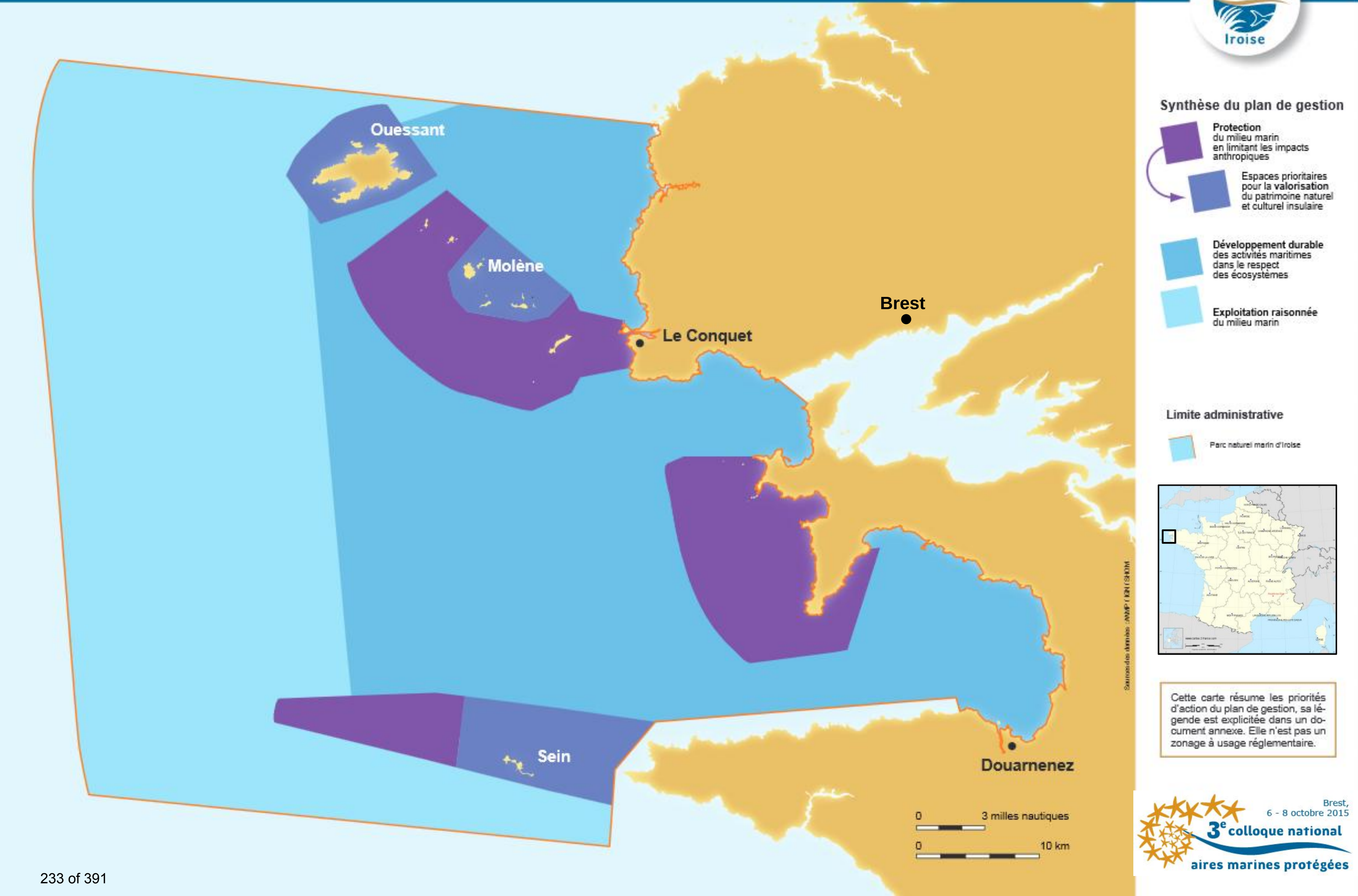
Philippe Le Niliot, assistant director of Iroise Marine Nature Park

Benjamin Guichard, policy officer for marine natural heritage

French Agency for Marine Protected Areas

Transnational bottlenose dolphin conservation workshop,
Dublin, 7-8 December 2016

Parc naturel marin d'Iroise ▪ Carte des vocations



Several protection status

Bottlenose dolphins (*Tursiops truncatus*) in Iroise sea

- a population of approximately 100 individuals (dispatched in 2 distinct groups)
- year-round residents, highly coastal (< 20 m), near islands or islets,
- very small home range

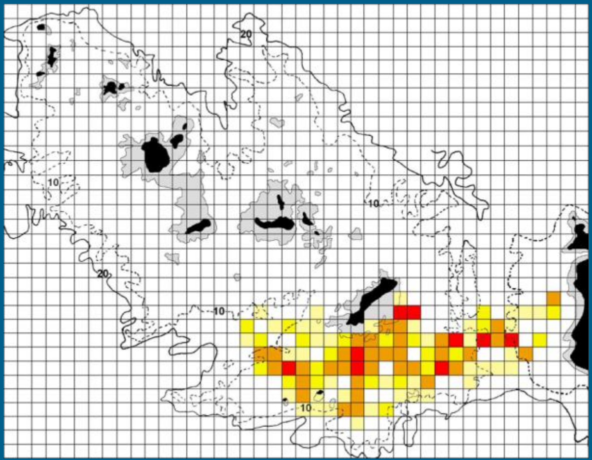

Bottlenose dolphins (*Tursiops truncatus*) in Iroise sea

- habitat = rocky bottom covered with macro-algae (kelp forest)

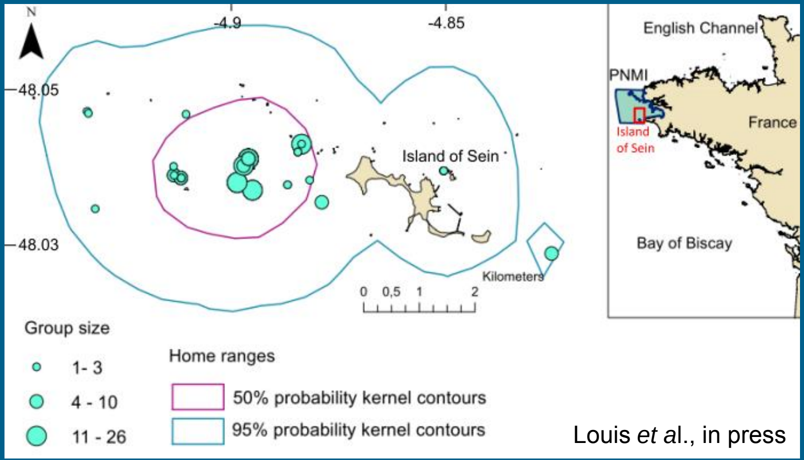
- cold-water areas with strong currents

Monitoring the home range of Iroise bottlenose dolphins

Molène archipelago



Sein island



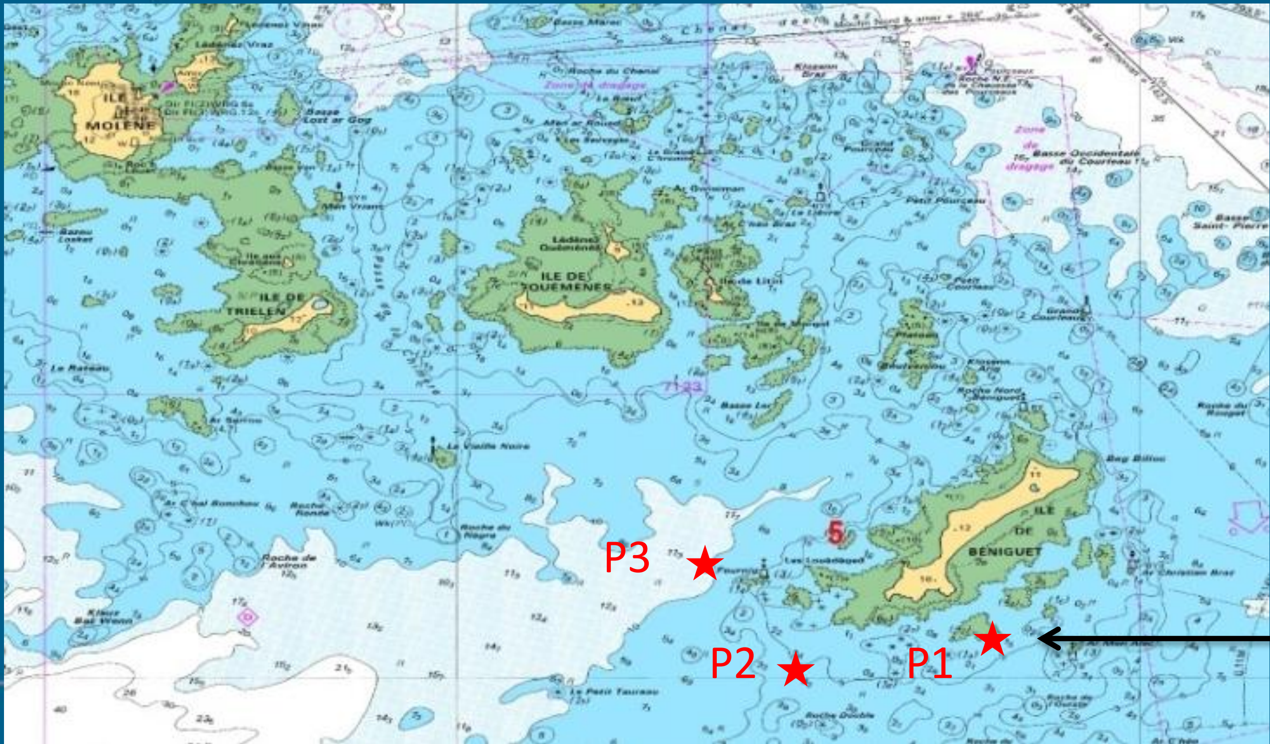
Louis *et al.*, in press

Photo-ID

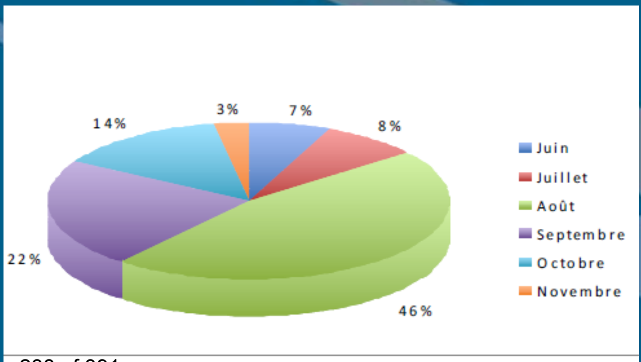
Photo-ID catalogue

Agence des aires marines protégées

Acoustic monitoring program



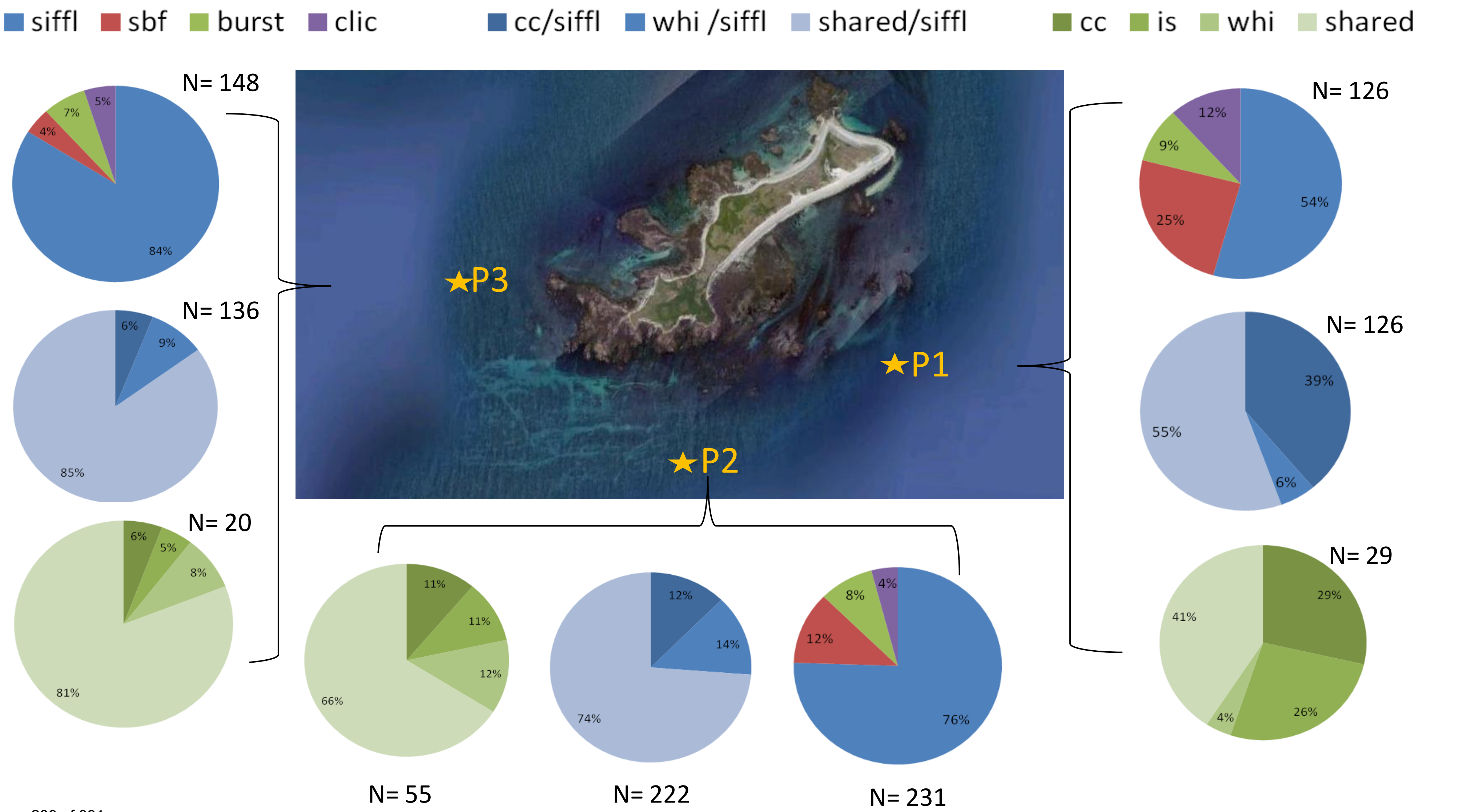
Autonomous recorder



Multi-parameters probe

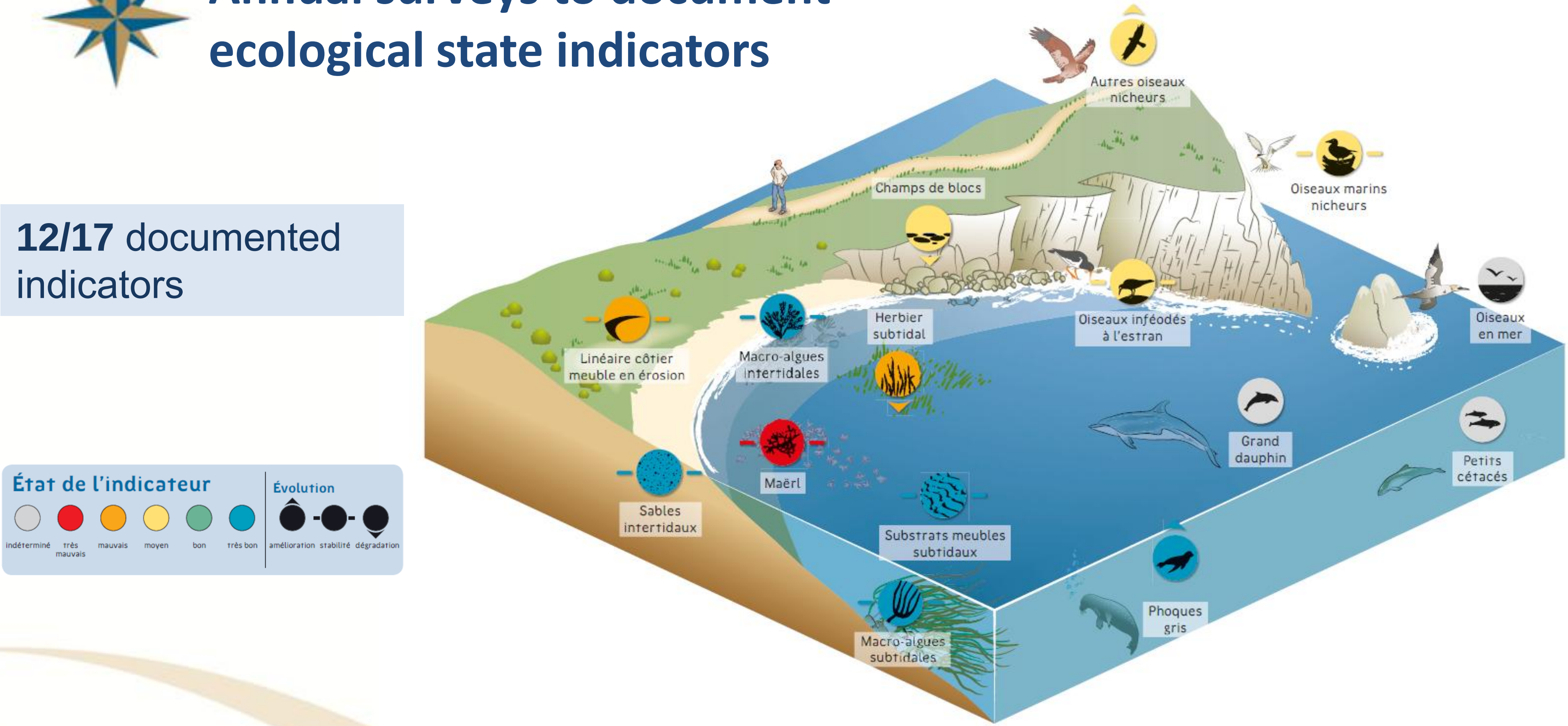
Agence des aires marines protégées

Functionnal use of the three monitored sites



Annual surveys to document ecological state indicators

12/17 documented indicators

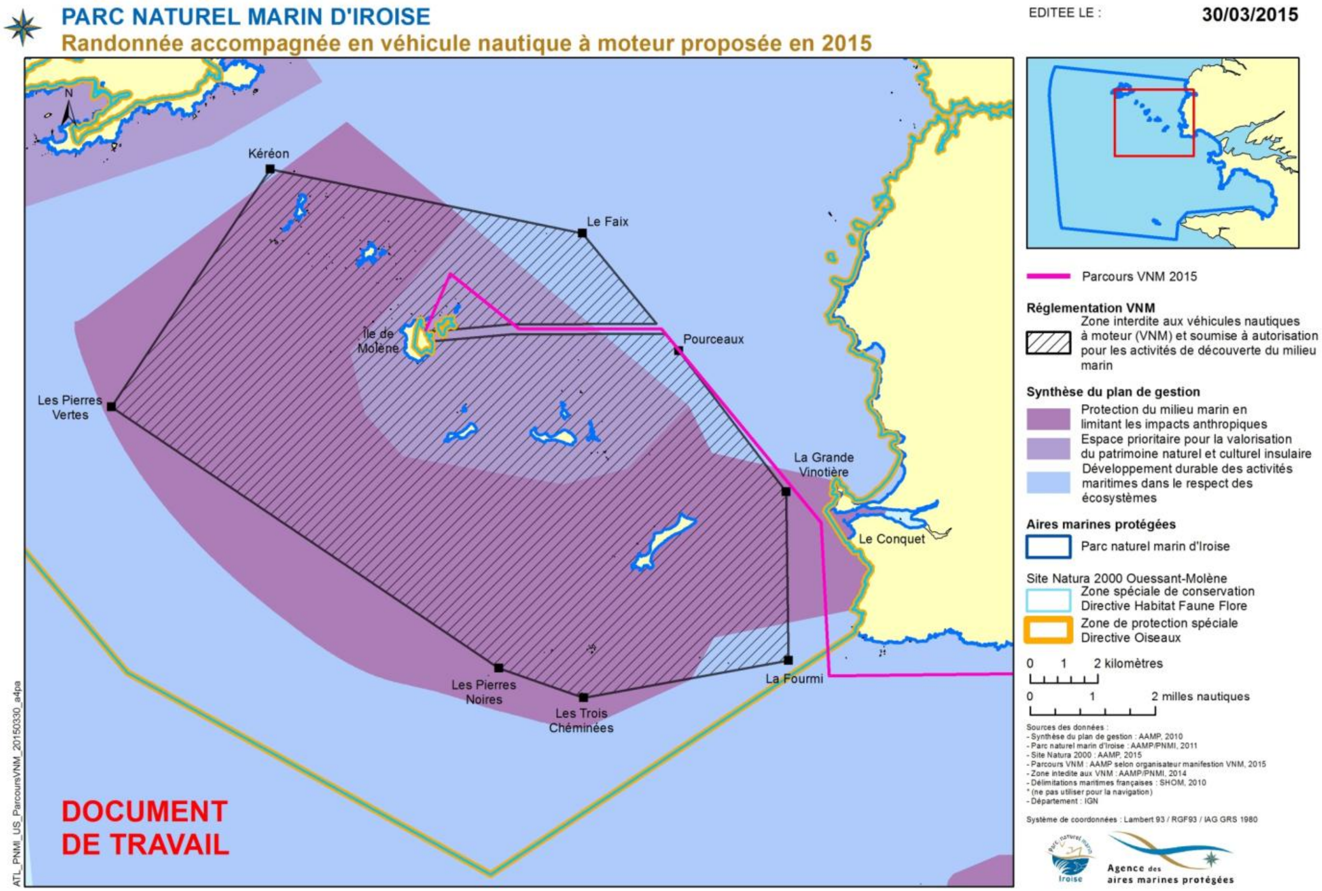


Iroise Marine Nature Park has a dashboard with a "bottlenose dolphin" indicator.

Agence des aires marines protégées

Increasing pressures

Specific regulation to forbid personal water crafts from Molène archipelago



A fast-growing activity

About ten speed boat companies are working in Molène archipelago (sea tours and snorkeling).

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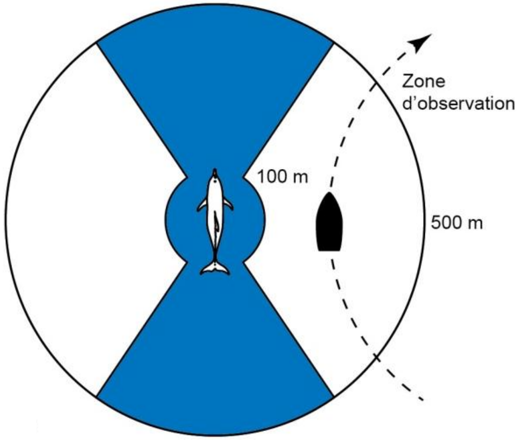
An activity relying on natural heritage

= populations and groups of coastal cetaceans.

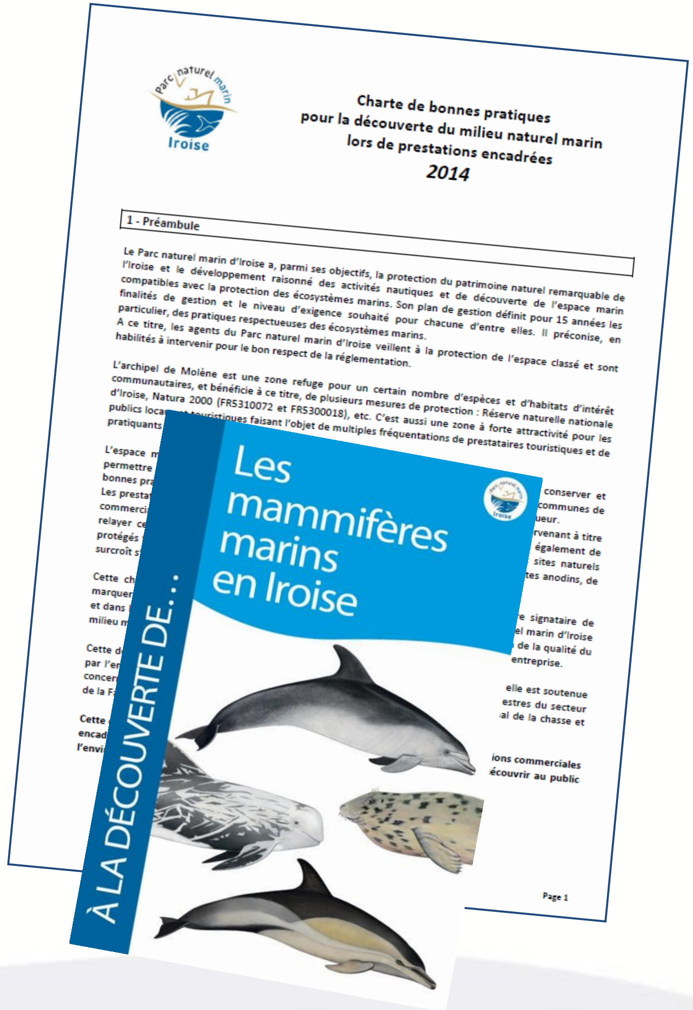
120 to 150 tours/year/company (10 to 15 000 passengers/year/company).
90% encounter rate with cetaceans.

An activity requiring setting up a code of good practices



Code of good practices established in 2011 for boat tours in Molène archipelago

Companies accepting the code become partners of Iroise Marine Nature Park, with special trainings and relationships with its teams.



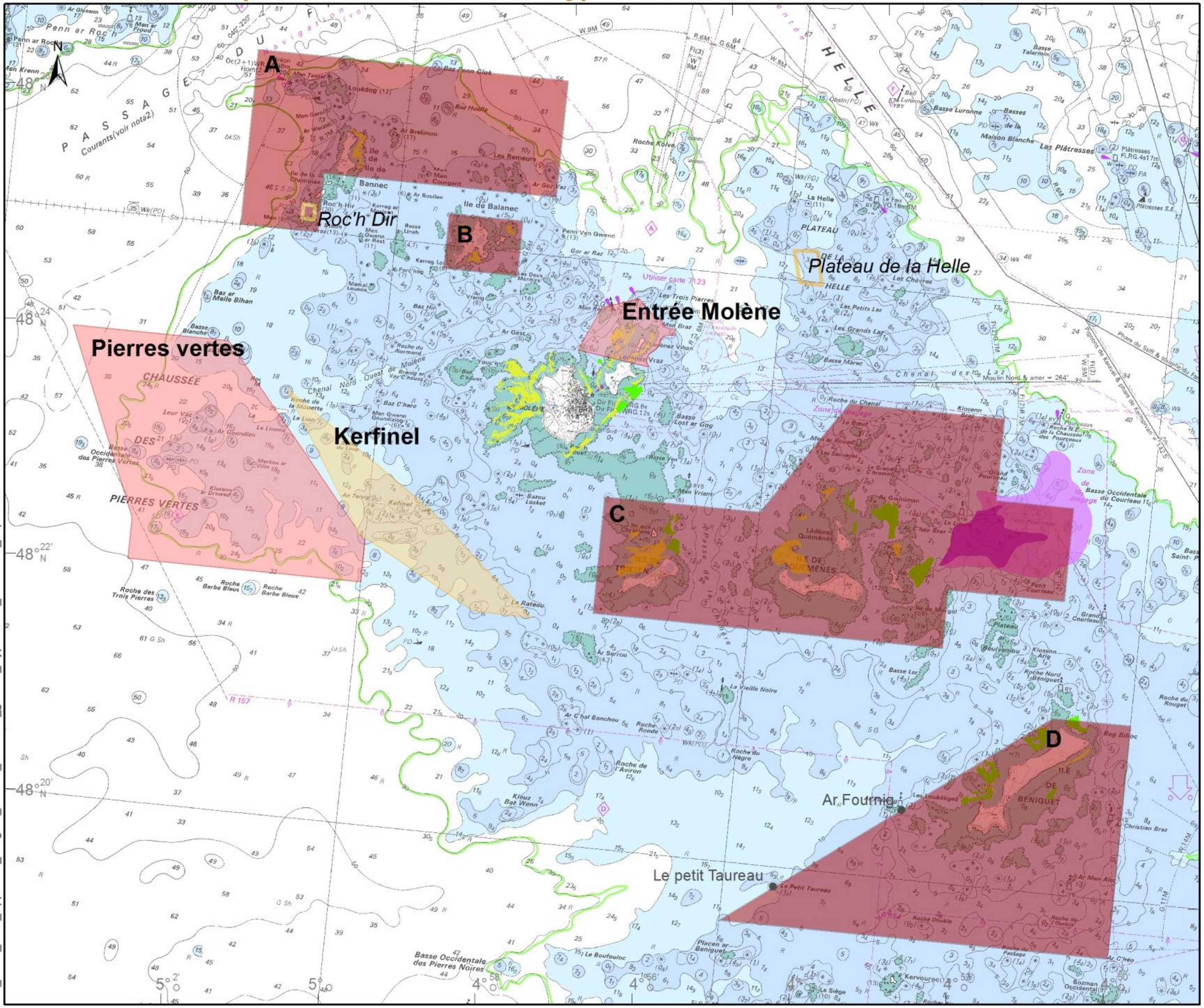
Agence des aires marines protégées

New fishing engines used to harvest kelps

PARC NATUREL MARIN D'IROISE

Gestion de l'exploitation de *Laminaria hyperborea*

EDITEE LE : **18/06/2014**



Gestion de l'exploitation de *Laminaria hyperborea*

- Zone témoin suivi scientifique
- Zone fermée du 15 avril au 31 aout
- Zone fermée jusqu'à nouvel ordre
- Zone fermée toute l'année

Habitat

- Champs de blocs intertidaux
- Herbiers à *Zostera marina*

Banc de maërl

- Banc de maërl mort
- Banc de maërl vivant

0 1 2 kilomètres

0 0,5 1 mille nautique

Sources des données :
- Zones de gestion : AAMP/PNMI, 12/2013
- Projet de grille d'exploitation de *Laminaria hyperborea* : AAMP, 09/2013
- Délimitations maritimes françaises : SHOM, 2010
* (ne pas utiliser pour la navigation)
- Fond de carte scan littoral : SHOM/IGN, 2011
- Champ de blocs : LEMAR/PNMI, 2010
- Herbiers : LEMAR/PNMI, 2010
- Maërl : multisource REBENT, 2009
- Laminaria hyperborea : IFREMER/PNMI, 06/2013

Système de coordonnées : Lambert 93 / RGF93 / IAG GRS 1980

Parc naturel marin Iroise

Agence des aires marines protégées

ATL_PNMI_GES_Approche_integree_Molene_ARRETE_gestion_Hyperborea_20140618_a4pa.mxd


THANK YOU FOR YOUR ATTENTION

The effects of anthropogenic disturbance on bottlenose dolphins along the east coast of Scotland: Existing evidence and research challenges

Enrico Pirotta, John Harwood, Paul M. Thompson, Leslie New, Barbara Cheney, Monica Arso, Philip S. Hammond, Carl Donovan, David Lusseau

Human activities in the marine environment are rapidly expanding and diversifying. In the waters off the east coast of Scotland (UK) industrial developments have been proposed which involve increased boat traffic and coastal development. A small population of bottlenose dolphins (*Tursiops truncatus*) lives along this coast with some individuals consistently using the inner Moray Firth, which is designated as a Special Area of Conservation (SAC) for the species under the European Habitats Directive. Proposed activities could therefore compromise the population's "favourable conservation status", a regulatory target for the UK to maintain under European legislation.

Anthropogenic disturbances do not necessarily remove individuals from populations. They may also non-lethally change their behaviour, with unknown long-term effects on population dynamics. Given our current regulatory targets, such behavioural changes might therefore be irrelevant for management and conservation. This has driven interest in developing analytical tools that predict the population consequences of short-term individual responses. Recent research has shown that modelling behavioural dynamics arising from underlying motivations is an effective way to simulate the processes affecting individuals' decision-making and to predict any effect on their vital rates. However, there are relatively few examples where this was done using a robust evidence base. Our study combined empirical information on the ecology of the population of bottlenose dolphins ranging along the east coast of Scotland to evaluate the effects of the proposed developments on the animals' vital rates.

First, we used passive acoustic data to quantify the effect of boat traffic on dolphin foraging activity and found that foraging declined with increasing number of boats, although this effect was short-term and depended on several contextual factors (e.g. location, time of the year, behaviour of the boat). We also collected visual data in the harbour of Aberdeen to assess responses to coastal dredging and showed that both maintenance and extraordinary dredging activities led the animals to spend less time in this foraging patch. By means of an array of underwater acoustic loggers we investigated which characteristics of the environment drive dolphins' foraging activity and mapped their foraging areas in space and time. Based on existing long-term photo-identification information, we then examined how individual dolphins use their habitat and how this influences their spatially-explicit exposure to boat traffic. Finally, these results were combined in an individual-based model. The model simulates individuals moving within their home range over the summer season, driven by their motivational states and an underlying spatial structure. Boat traffic is assumed to affect the animals' motivational states, while dredging is assumed to displace them. The model returns the exposure and motivational states of each individual at the end of each summer.

We ran the model for six baseline summers (2006-2011). We then considered three proposed developments in the area and used the framework to simulate their potential effects during both construction and operation. No detrimental effect was predicted during the construction phase, although our model did not incorporate the effects of pile driving and disposal of dredged material. In contrast, increases in traffic during the operational phase could cause a detectable change in the motivational states of the individuals (i.e. individuals were hungrier at the end of the simulated summer).

For such results to be relevant for management, the effects on individuals' vital rates need to be quantified. These are mediated by the animals' ability to maintain their condition. However, it remains challenging to measure changes in an individual's condition in the field. Alternatively, we investigated whether the relationship between an individual's exposure and reproductive success could be directly estimated. Calves spend at least three years in association with their mother, and their survival can be tracked using photo-identification. We tested whether the exposure or motivational state of the mother affected the probability of the calf to transition between successive development stages using a Bayesian multi-stage model for calf survival history. We carried out a simulation study to assess any bias, as well as the sample size and effect size required to detect an effect. The results suggest that this approach could only detect significant relationships in large, closely-studied populations, but any effect is likely small.

We highlighted the critical data gaps and research challenges for the population under analysis. The long-term dataset available for this population was instrumental for the development of the model, and monitoring efforts should be continued across the entire range to refine our knowledge of the population's demography and movements. In terms of the behavioural responses to different sources of disturbance, information on the effects of pile driving and disposal of dredged material is required for the correct assessment of the effects of construction activities. More data about the stressors, their distribution in space and time and their synergy is necessary to extend the model outside the Moray Firth. Finally, we lack a robust measure of individuals' condition, which represents the critical link between behaviour and vital rates. Photogrammetry or telemetry techniques could be used to collect such data, or, alternatively, a bioenergetic model could be developed.

The outlined framework has a series of strengths: 1) By modelling behavioural dynamics at an individual level, it allows characterising the variability around any effect. This is critical because the contribution of different individuals to the demography of the population might be unbalanced; 2) It is spatially-explicit. Effective management measures are intrinsically grounded in space, since the effect of any human activity will depend on where it occurs in relation to the affected animals' distribution; 3) It integrates various stressors, i.e. it can model the cumulative effects of different disturbances and could be extended to others (e.g. pile driving); 4) It could be adapted to other small cetacean populations where similar information is available.

Our work can be used to guide management decisions, reduce uncertainty associated with meeting wildlife regulatory targets in the consenting process for coastal and offshore industrial developments, and direct targeted monitoring and new data collection.

The effects of anthropogenic disturbance on bottlenose dolphins along the East coast of Scotland: existing evidence and research challenges

Enrico Pirotta

John Harwood, Paul Thompson, Leslie New, Barbara Cheney

Monica Arso, Philip Hammond, Carl Donovan, David Lusseau

Bottlenose dolphin workshop

Dublin, Ireland

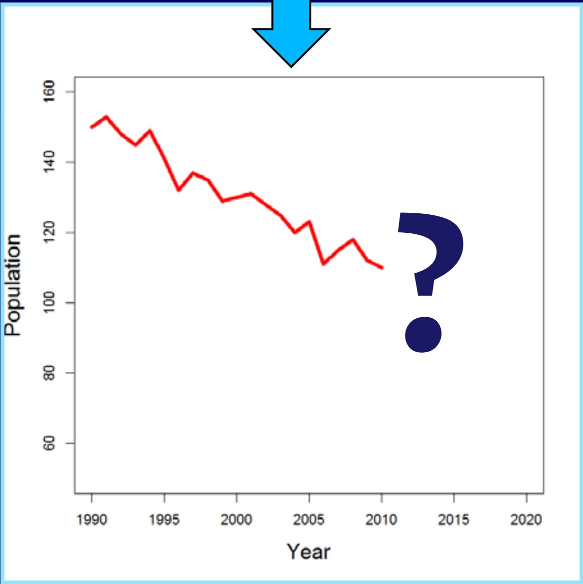
8 December 2016

Background

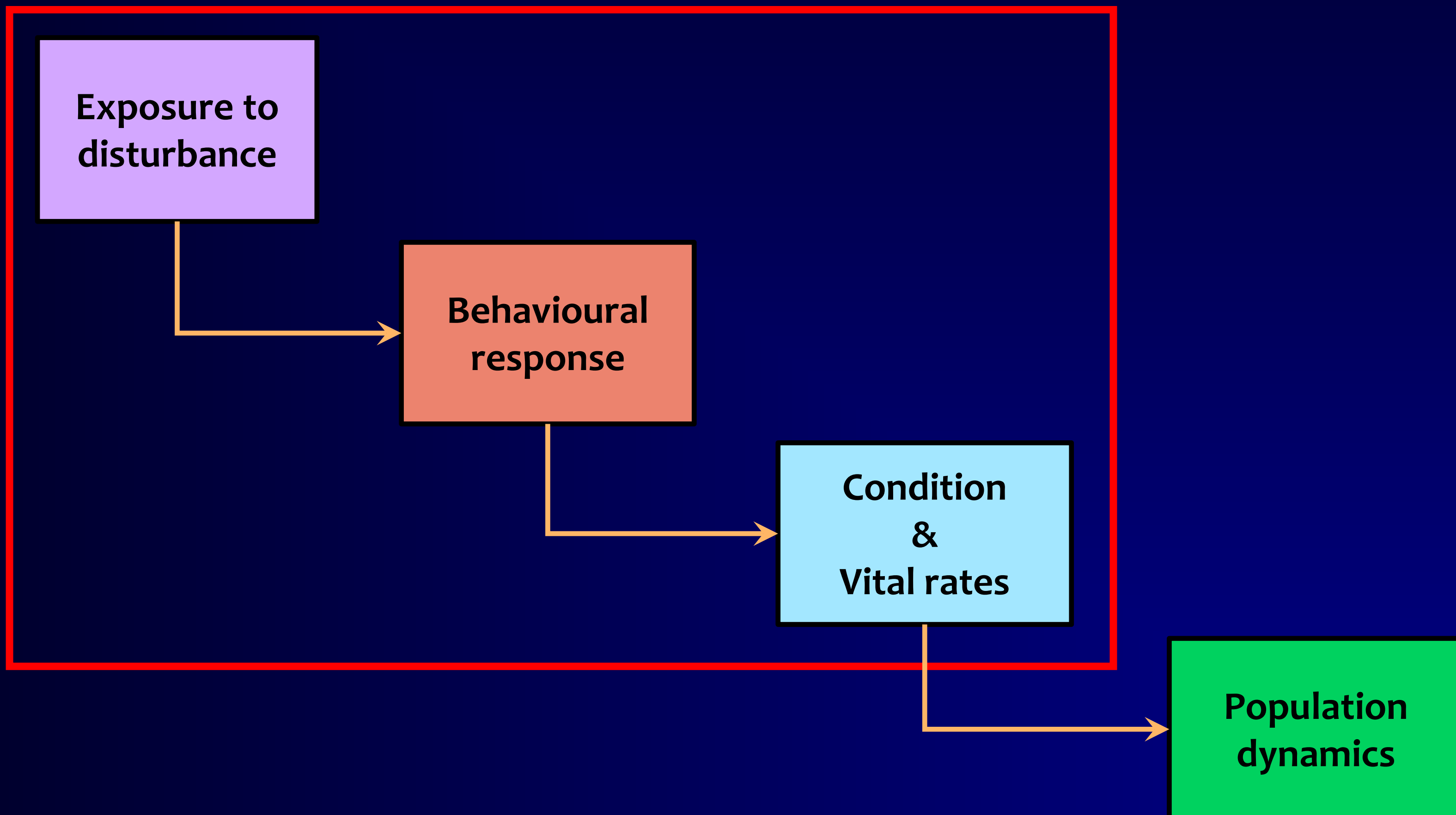
Overall approach

- *Applied objective* - robust predictions to:
  - Maintain **favourable conservation status**
  - speed up the **consenting process**
- Effects of disturbance can be observed at the **individual** level

BUT interested in effects on **population**



PCoD framework



Building blocks

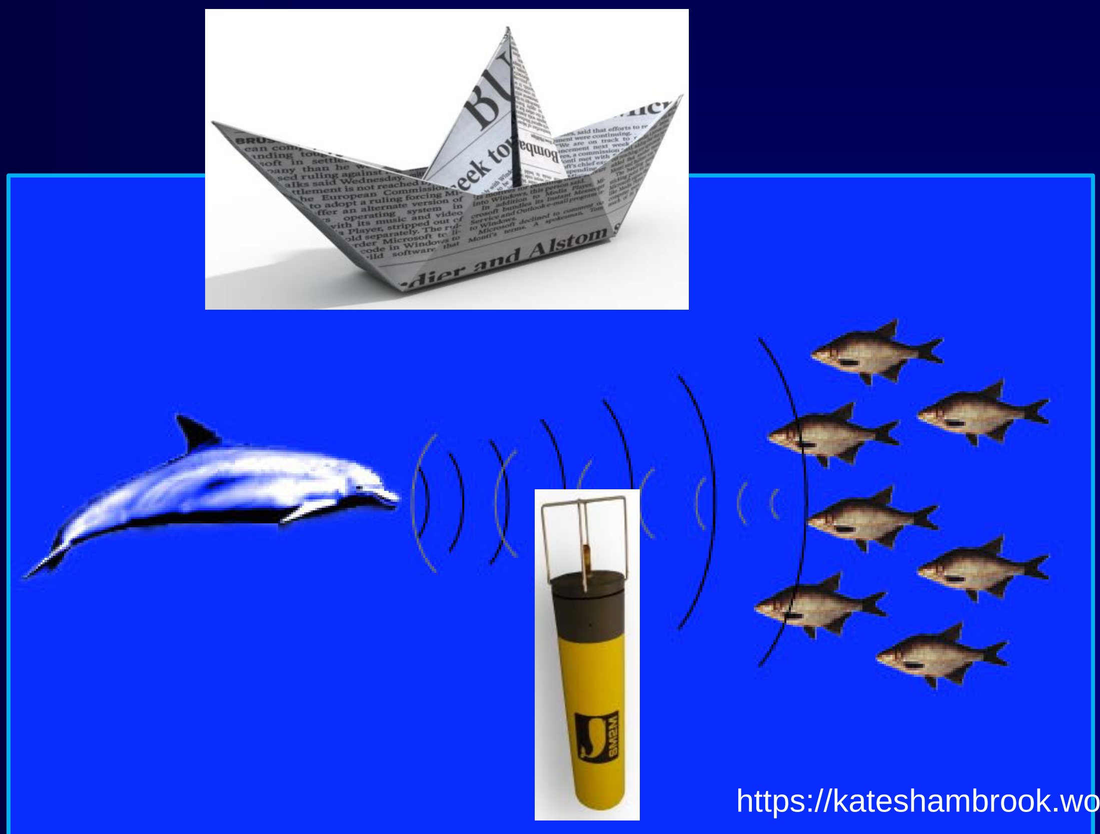
Exposure to disturbance

Behavioural response

Condition & Vital rates

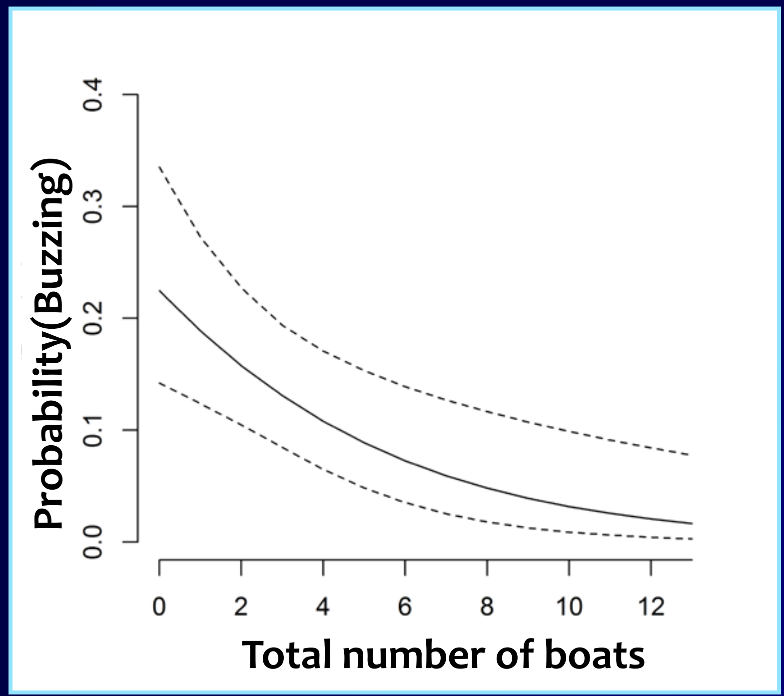
Response to boats

→ Passive acoustic techniques



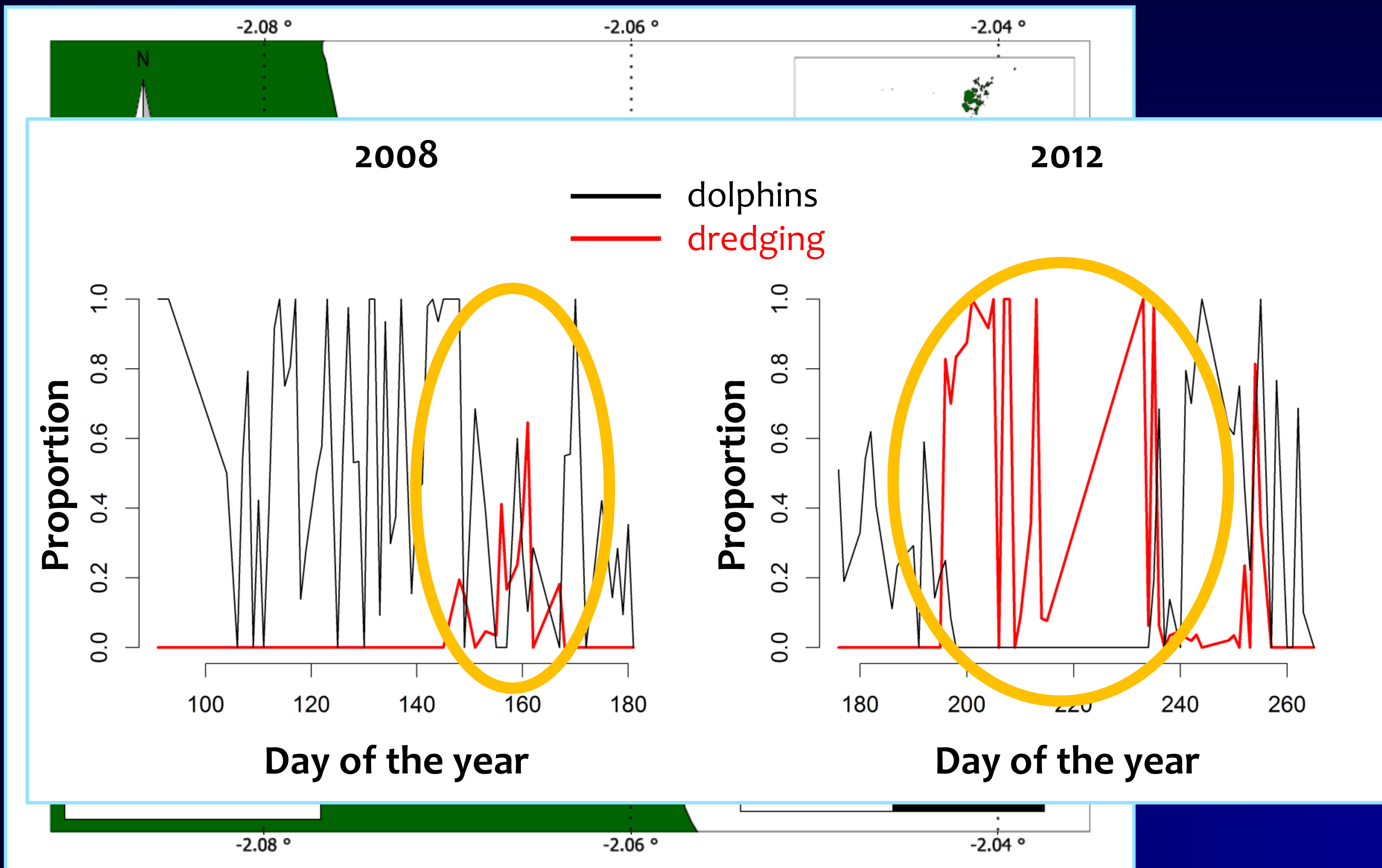
https://kateshambrook.wordpress.com/

Response to boats

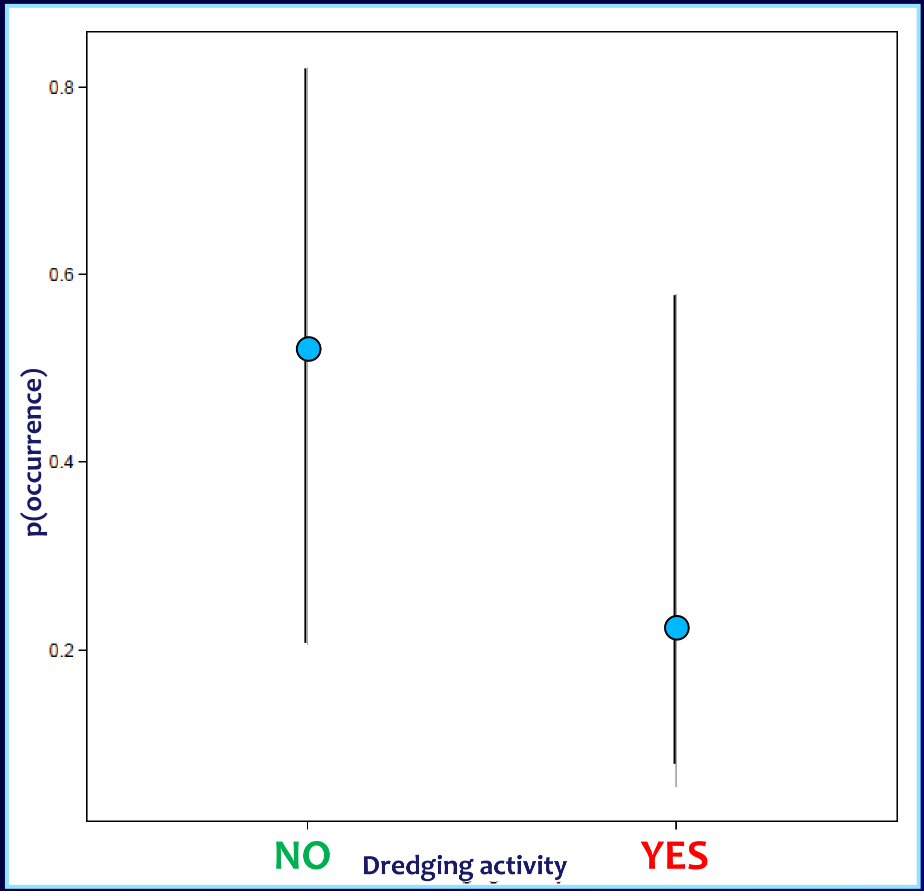


Pirotta et al. 2015 Biological Conservation

Response to dredging

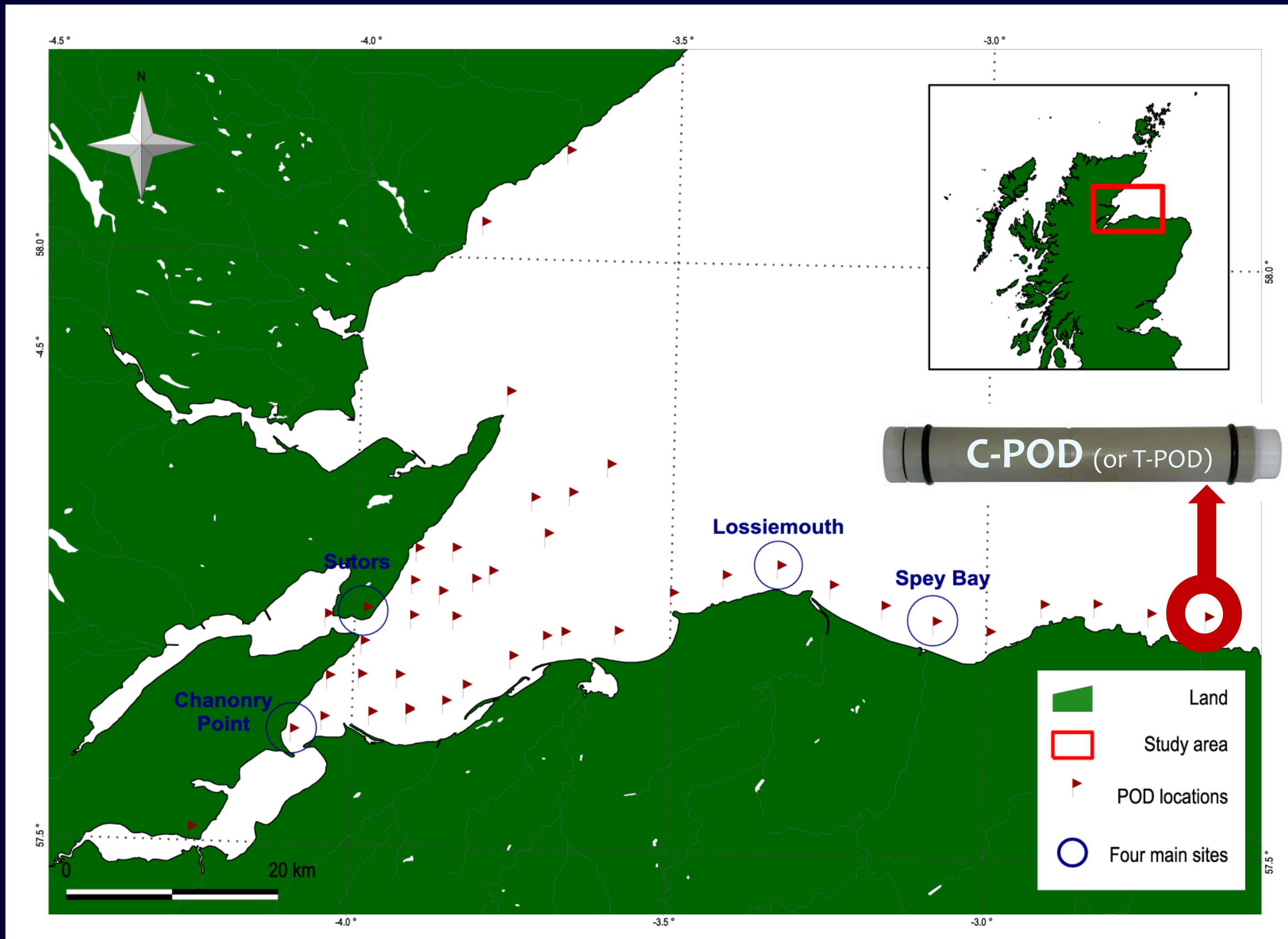


Response to dredging

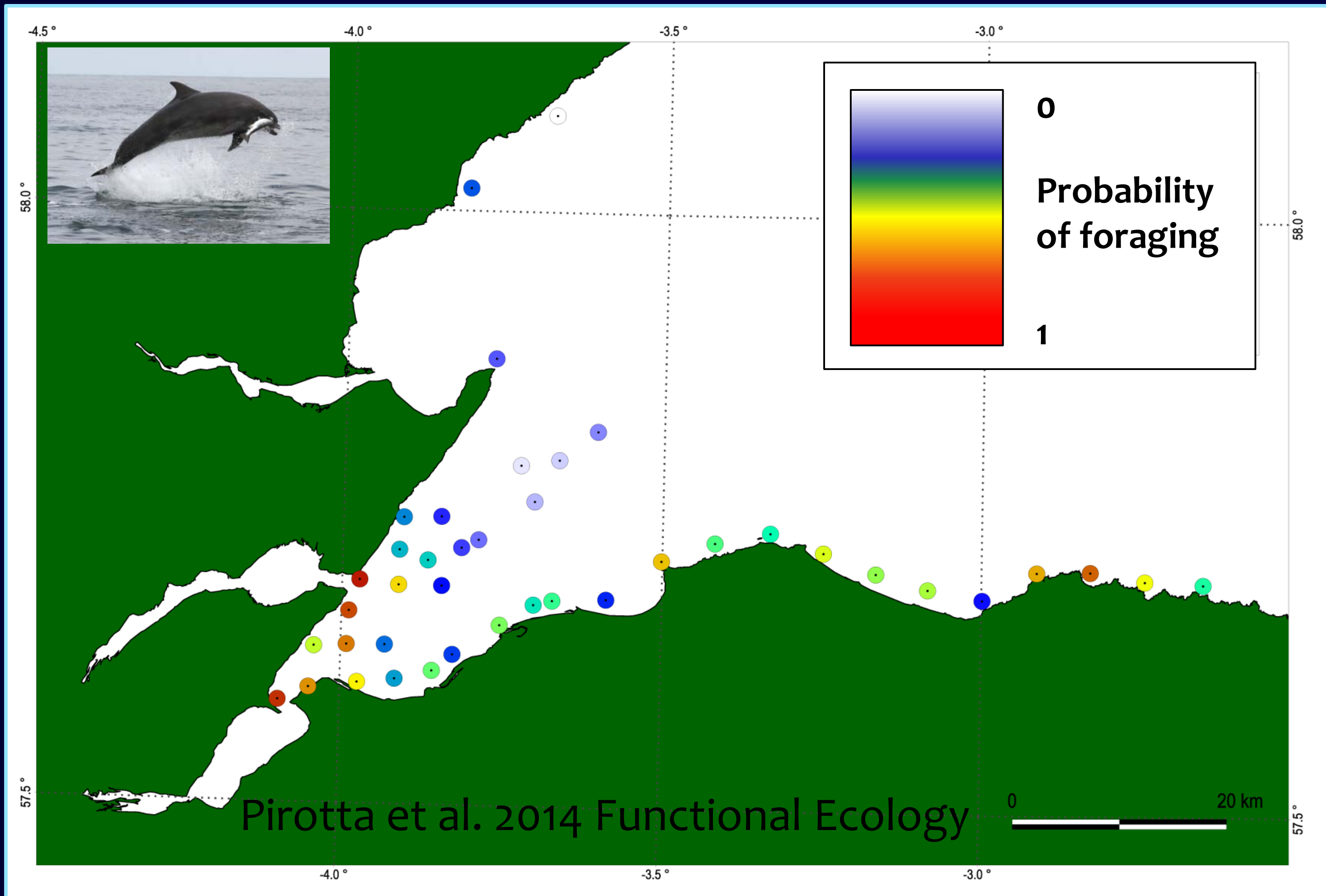


Pirotta et al. 2013 Marine Pollution Bulletin

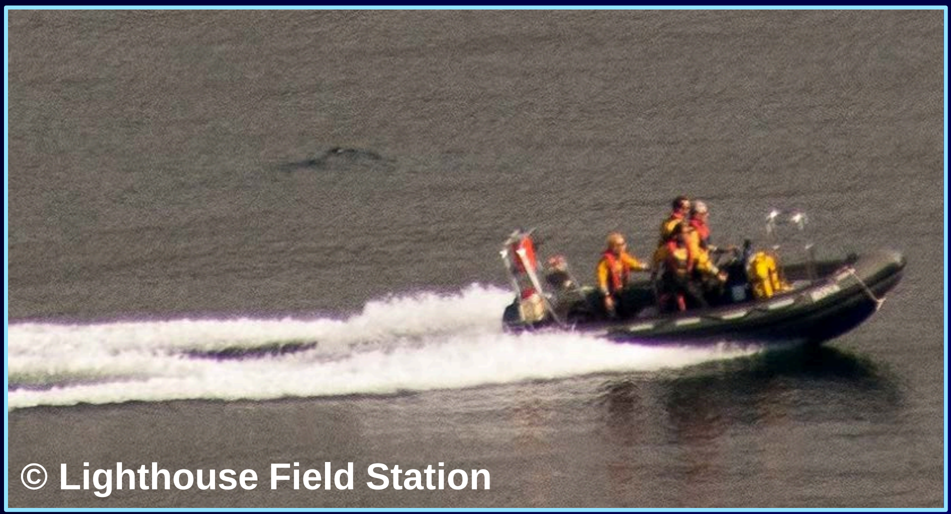
Foraging distribution



Foraging distribution



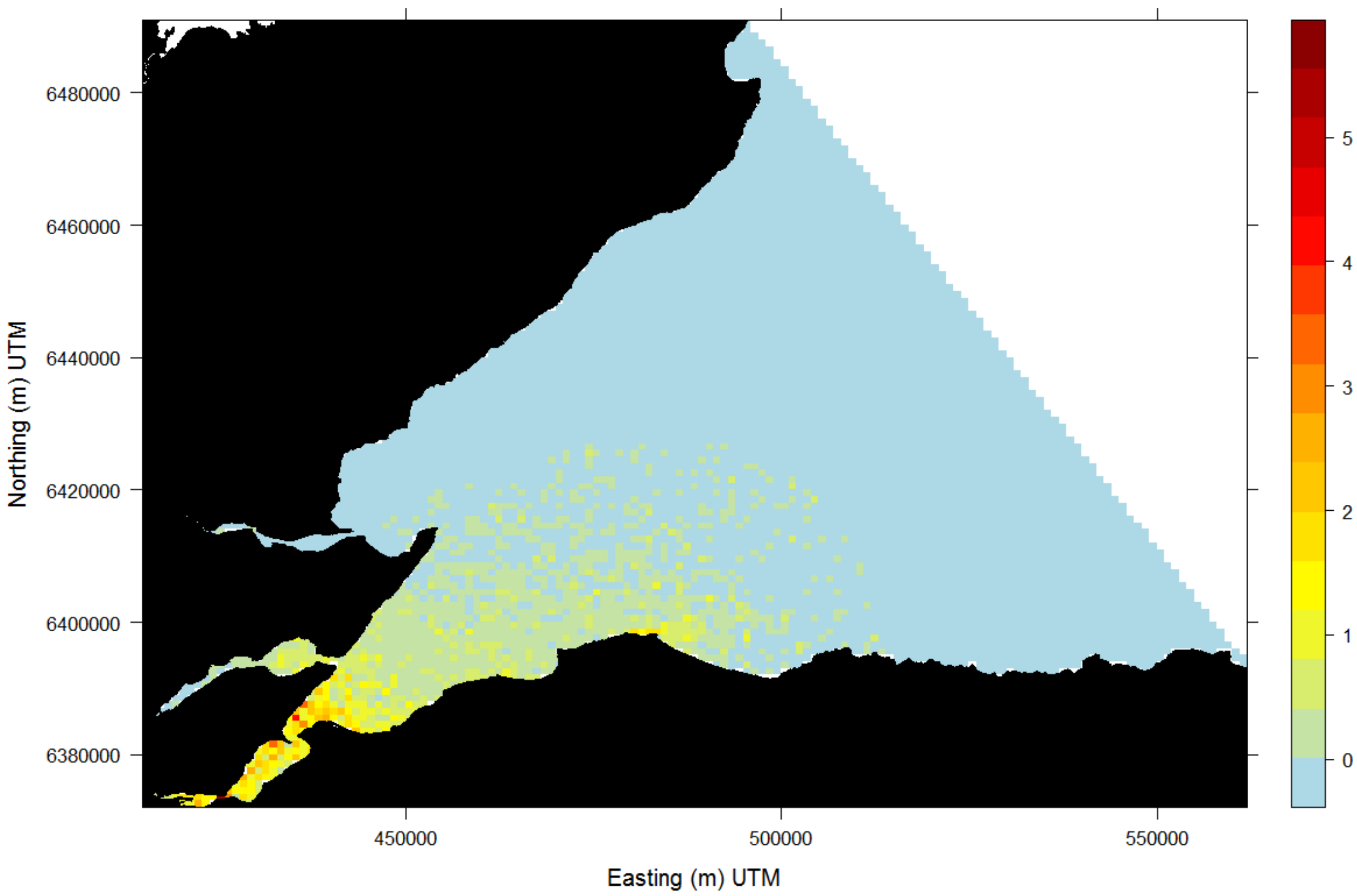
Exposure



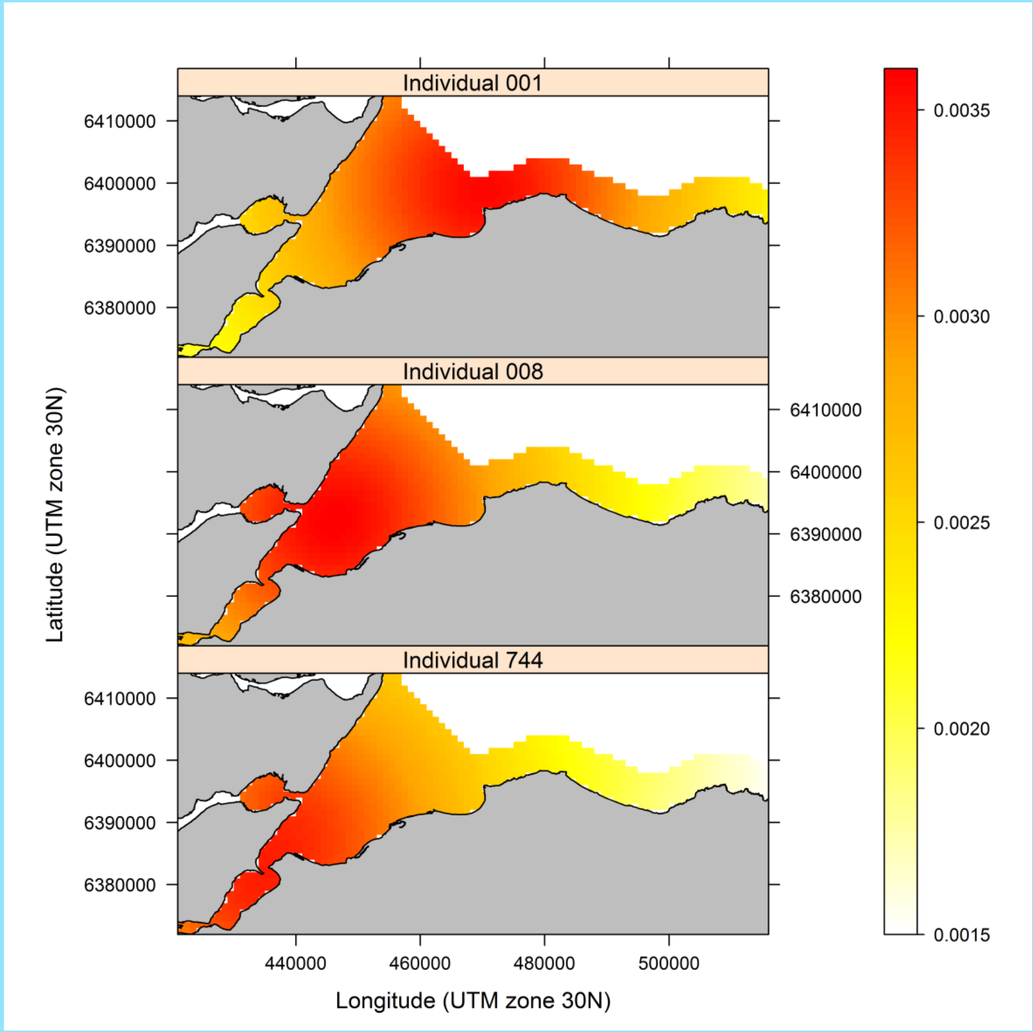
- **Photo-identification** of individual dolphins
- Capture histories **with spatial information** on captures (SECR)

Exposure

Distribution of boat traffic



Exposure


Individual 001
Individual 008
Individual 744
6410000
6400000
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6380000
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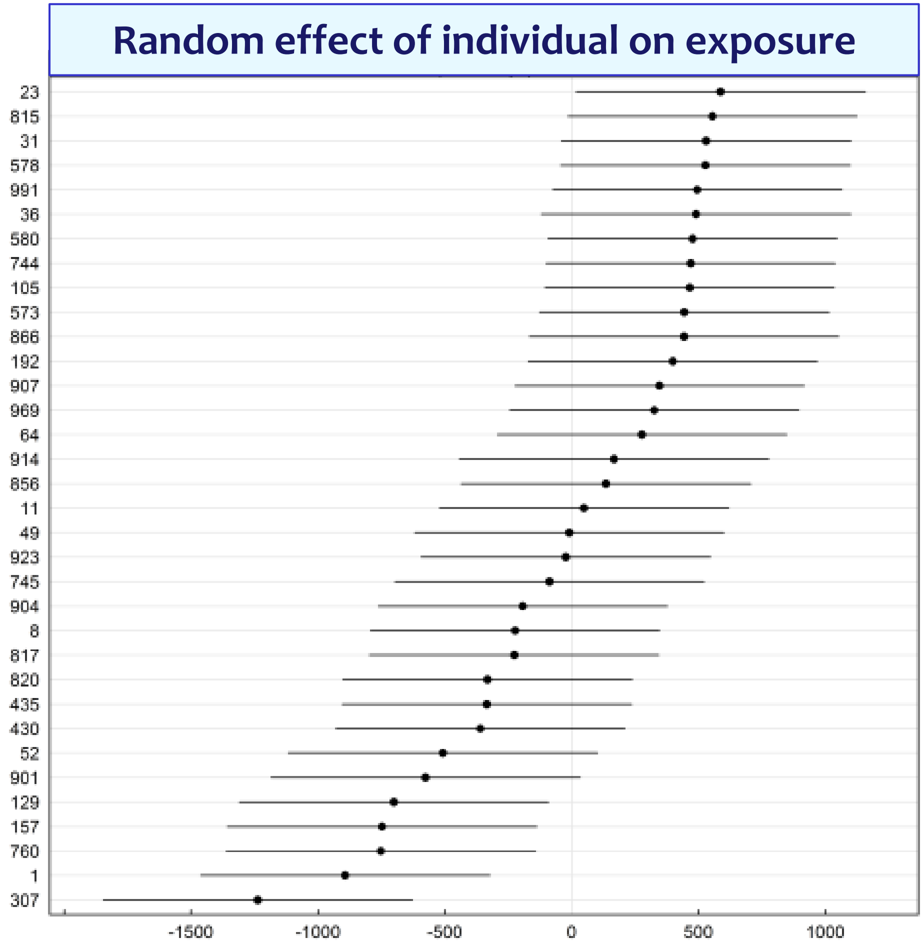
Latitude (UTM zone 30N)
Longitude (UTM zone 30N)

Exposure

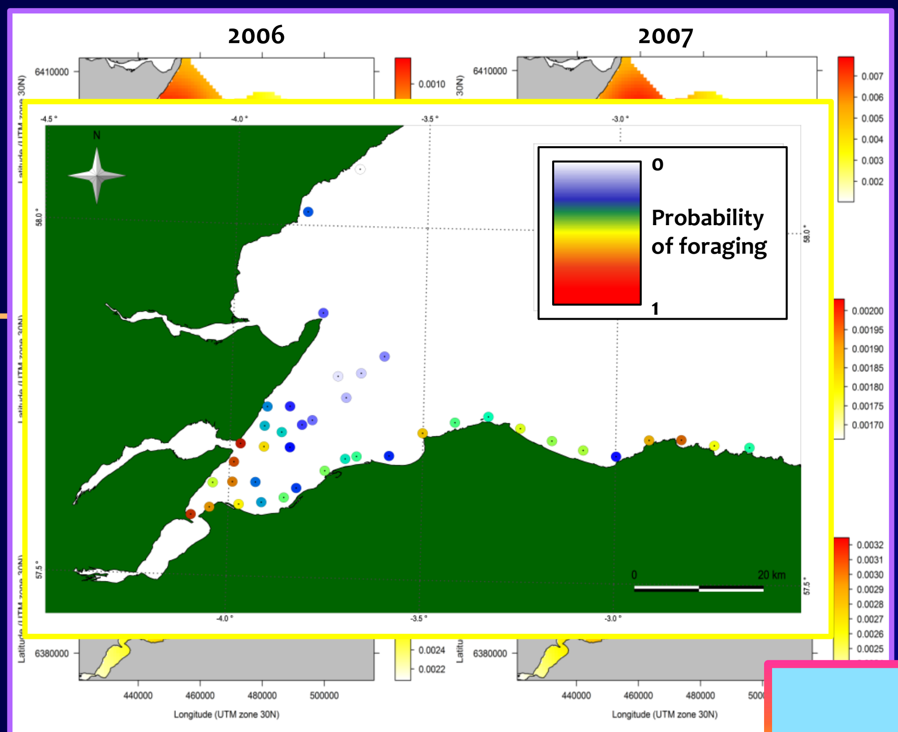


Pirotta et al. 2015 Animal Conservation

IBM – Introduction

Distribution of disturbance

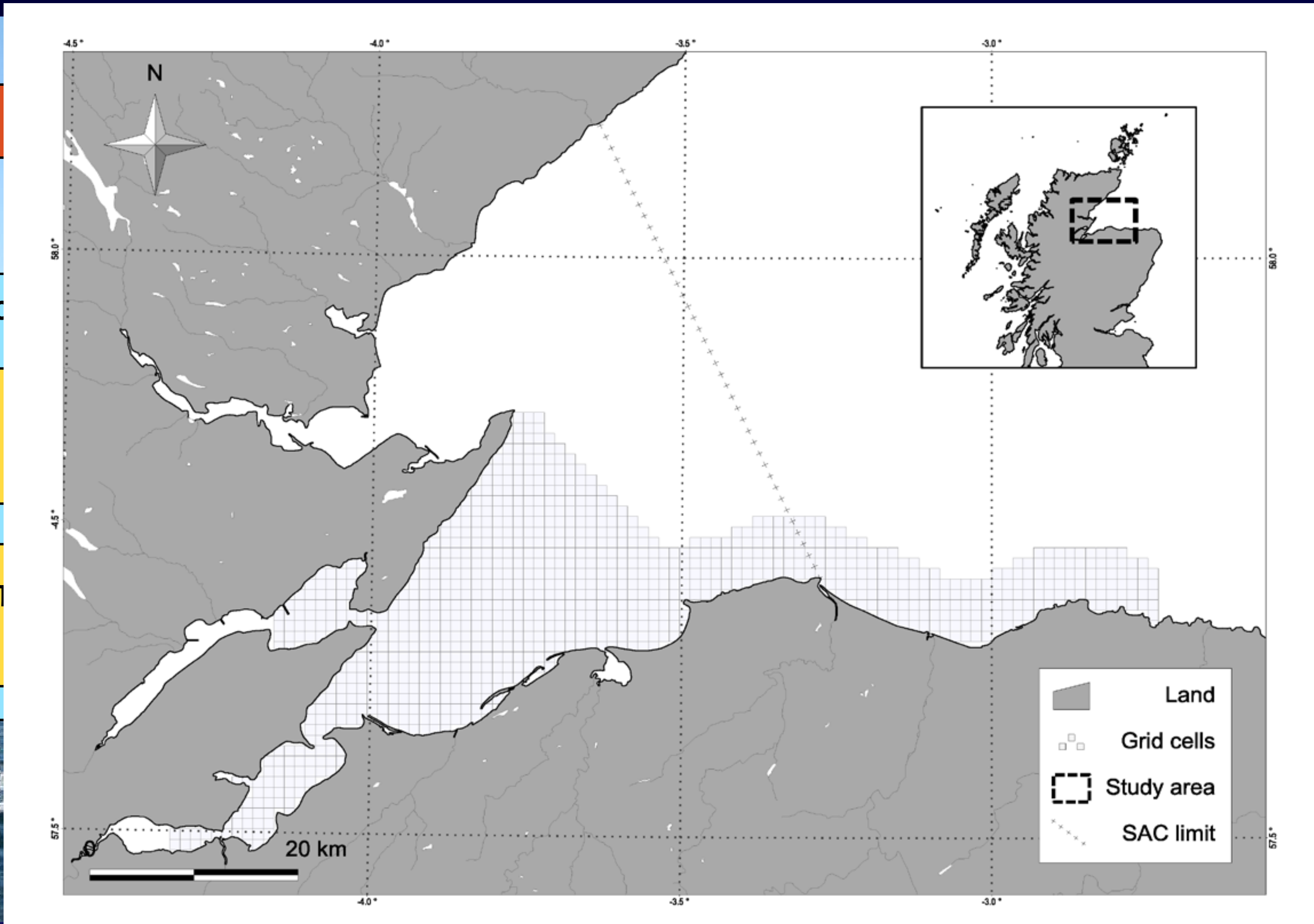
Use of area by individuals



foraging

IBM

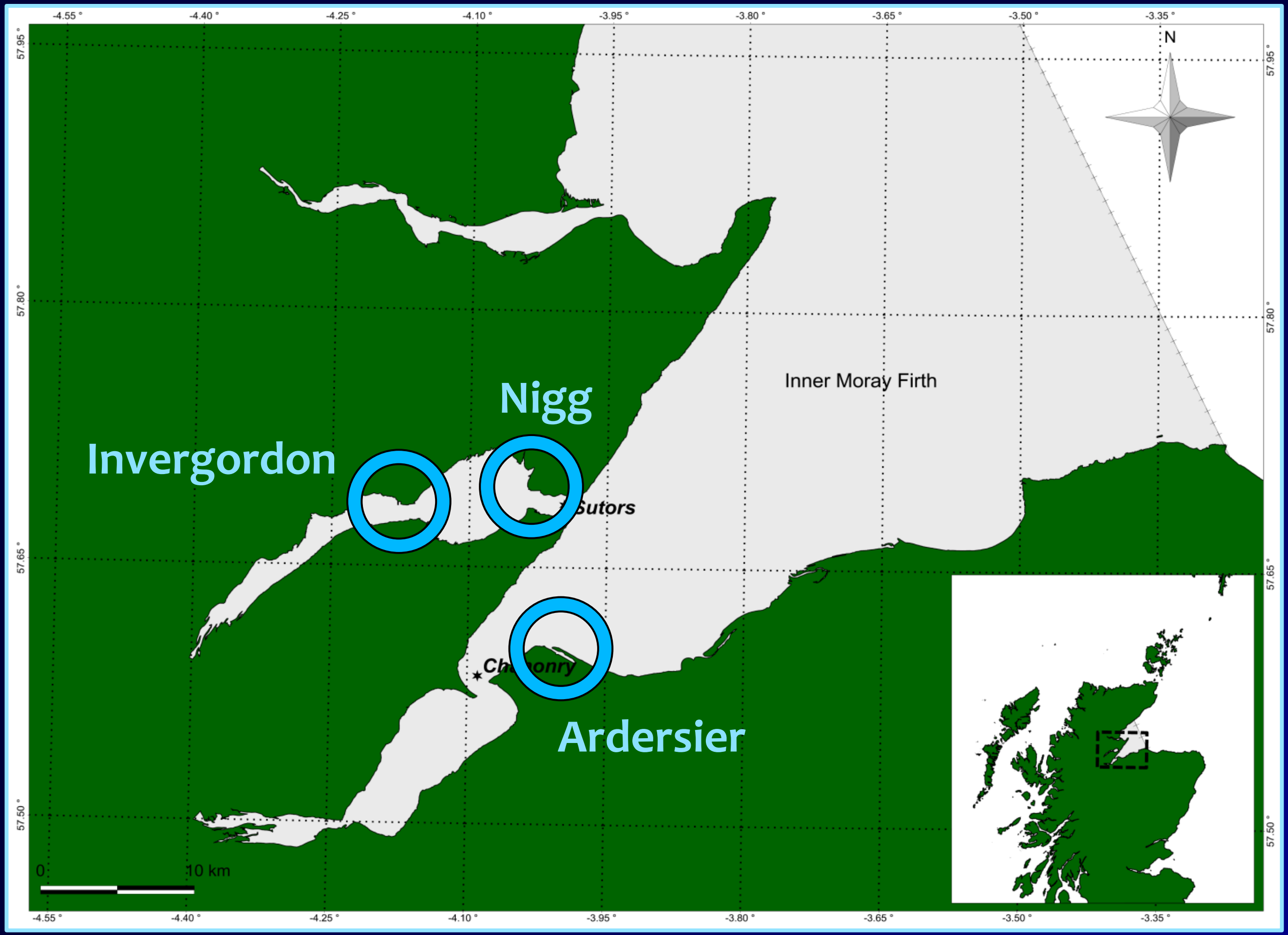
IBM – Methods



IBM – Methods

- 6 baseline years
- Simulation of 3 proposed developments

IBM – Methods


Nigg
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0
10 km
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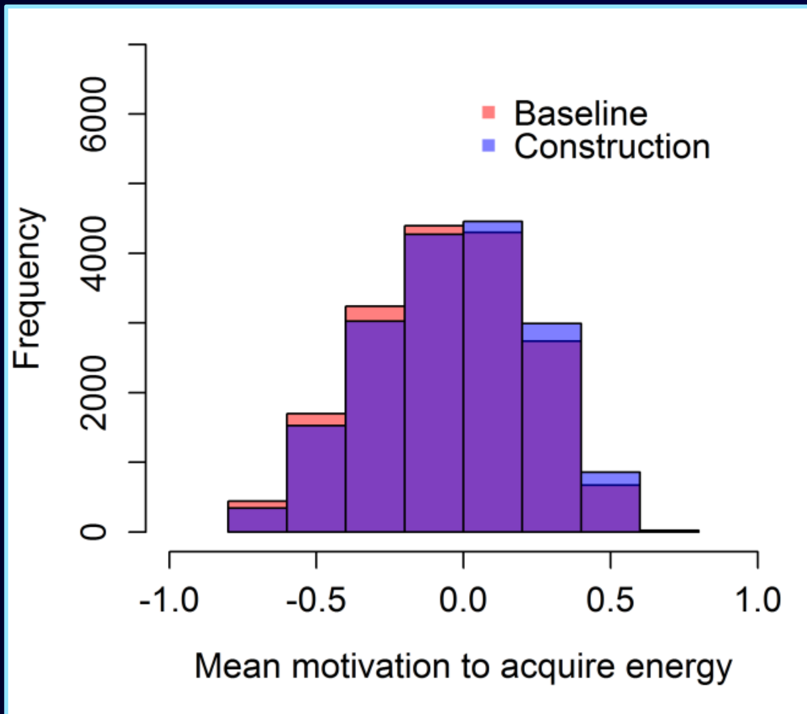
-4.40 °
-4.25 °
-4.10 °
-3.95 °
-3.80 °
-3.65 °
-3.50 °
-3.35 °
57.95 °
57.80 °
57.65 °
57.50 °

IBM – Methods

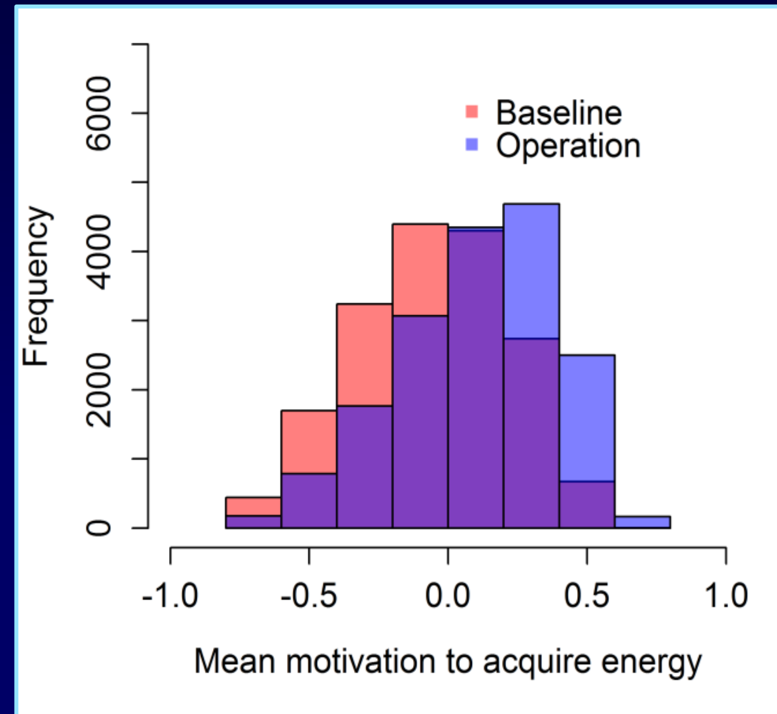
Dolphin exposure to traffic <-> reproductive success?

→ Calf survival history in association with mothers' exposure and motivational states

IBM – Results



vs.



BUT no detected effect of exposure on calf survival

→ **We need larger sample size but effect is likely small**

Conclusions

Modelling framework using a robust evidence base

Individual based, spatially explicit, cumulative effects

Unlikely consequences on reproductive success

Identified gaps and data needs

Data gaps and challenges

Parameter	Scale	Required data	(*Interim*) alternative	Monitoring and data collection needs
Behavioural responses to disturbance	Individual-level	Dose-response curves (different stressors , different contexts)	Meta-analysis of existing evidence by functional group	Responses to piling and disposal of dredged material

Data gaps and challenges

Parameter	Scale	Required data	(*Interim*) alternative	Monitoring and data collection needs
Condition	Individual-level and temporal variation	Accelerometry, photogrammetry, or photographic evidence of health	Bioenergetic modelling	Growth of calves (photogrammetry), individual condition (tagging or photogrammetry), bioenergetic model, diet analysis, variability in prey distribution and abundance

Data gaps and challenges

Parameter	Scale	Required data	(*Interim*) alternative	Monitoring and data collection needs
Vital rates	Population-level and individual variation	Long-term population studies	Expert elicitation, extrapolation from comparable species or populations	Extend available dataset (movements?)

Data gaps and challenges

Parameter	Scale	Required data	(*Interim*) alternative	Monitoring and data collection needs
Exposure rates	Population-level and individual variation	Animal distribution and habitat use (depending on activity and on individual or class preferences). Socio-economic surveys and analysis of the distribution of human activities	Simulation studies (for the distribution of anthropogenic stressors in space and time)	Variability in boat traffic between years, noise propagation modelling, anthropogenic disturbance outside the Moray Firth, exposure rates to dolphin-watching boats, synergy between stressors

THANK YOU!

More in Pirotta *et al.* 2015 *Proc Roy Soc B*

THANKS TO:

My co-authors, MASTS, Washington State University, UCC Nathan Merchant, Laura Ceyrac, James Robbins, Tim Barton, Marianne Marcoux, Barbara Laesser, Isla Graham, Kate Brookes, Peter Miller, Andrea Powell, Len Thomas, Beth Scott, Luke Rendell, Doug Gillespie, Thomas Cornulier, Alex Douglas, Rebecca Hewitt, Rachel Plunkett, Cecilia Pinto, Derek Murphy, Conor Murphy, …

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Persistent Pollutants, Persistent Effects:

PCBs remain a global threat to orcas and other marine apex predators

Paul D. Jepson[1] *et al*.

[1] *The Zoological Society of London, Regent's Park, London, UK*

Author Contact Information: paul.jepson@ioz.ac.uk (+ 44 207 449 6691)

Abstract

Persistent organic pollutants (POPs) are chemical substances that persist in the environment and can bioaccumulate in food webs. Organochlorine (OC) pesticides and the more persistent polychlorinated biphenyls (PCBs) have well-established dose-dependent toxicities to birds, fish and mammals in experimental studies but the actual impact of OC pollutants on marine top predators is not fully understood. In this study we show that several cetacean species in Europe have very high mean blubber PCB concentrations likely to cause population declines and suppress population recovery. In a large pan-European meta-analysis of stranded (n=929) or biopsied (n=152) cetaceans, three out of four species:- bottlenose dolphins (BNDs), striped dolphins (SDs) and killer whales (KWs) had mean PCB levels that markedly exceeded all known marine mammal PCB toxicity thresholds. Some locations (e.g. western Mediterranean Sea, south-west Iberian Peninsula) are global PCB "hotspots" for marine mammals. Blubber PCB concentrations initially declined following a mid-1980s EU ban, but have since stabilised in UK harbour porpoises and SDs in the western Mediterranean Sea. Some small or declining populations of BNDs and KWs in the North-East Atlantic were associated with low recruitment, consistent with PCB-induced reproductive toxicity. Despite regulations and mitigation measures to reduce PCB pollution their biomagnification in marine food webs continues to cause very severe impacts among cetacean top predators in European waters. Ultimately, there is an urgent need to review current methods of PCB mitigation in the marine environment—both in Europe and elsewhere, including full compliance with the Stockholm Convention.

Persistent Pollutants, Persistent Effects: PCBs remain a global threat to orcas and other marine apex predators

Paul D. Jepson *et al.*

Cefas

Universitat de Barcelona

defra
Department for Environment Food and Rural Affairs

Marine Environmental Monitoring

SRUC

ZSL
LIVING CONSERVATION

Institute of Zoology

defra
Department for Environment Food and Rural Affairs

CSIP

NATURAL HISTORY MUSEUM

Facultad de Veterinaria
Universidad de Las Palmas de Gran Canaria

JNCC
Joint Nature Conservation Committee

The Scottish Government

Chemical pollutants: Organochlorines

- **PCBs, DDTs, dieldrin, dioxins, etc.**
- synthesized from mid-1940s for industrial and agricultural uses
- highly **lipophilic**
- environmentally **persistent**
- **bioaccumulate** within trophic level/**biomagnify** between trophic levels
- banned in developed countries (1970s/1980s)
- highest global exposure occurs in marine mammals
- range of toxicities in experimental animals/humans
  - **immunosuppression (**e.g. increased infectious disease susceptibility)
  - **reproductive impairment** (e.g. reduced female fecundity)
  - **neurological (cognitive) deficits** (e.g. lowered IQ scores - humans)
  - **cancer** - primary carcinogens in humans/animals (Lancet 2013)

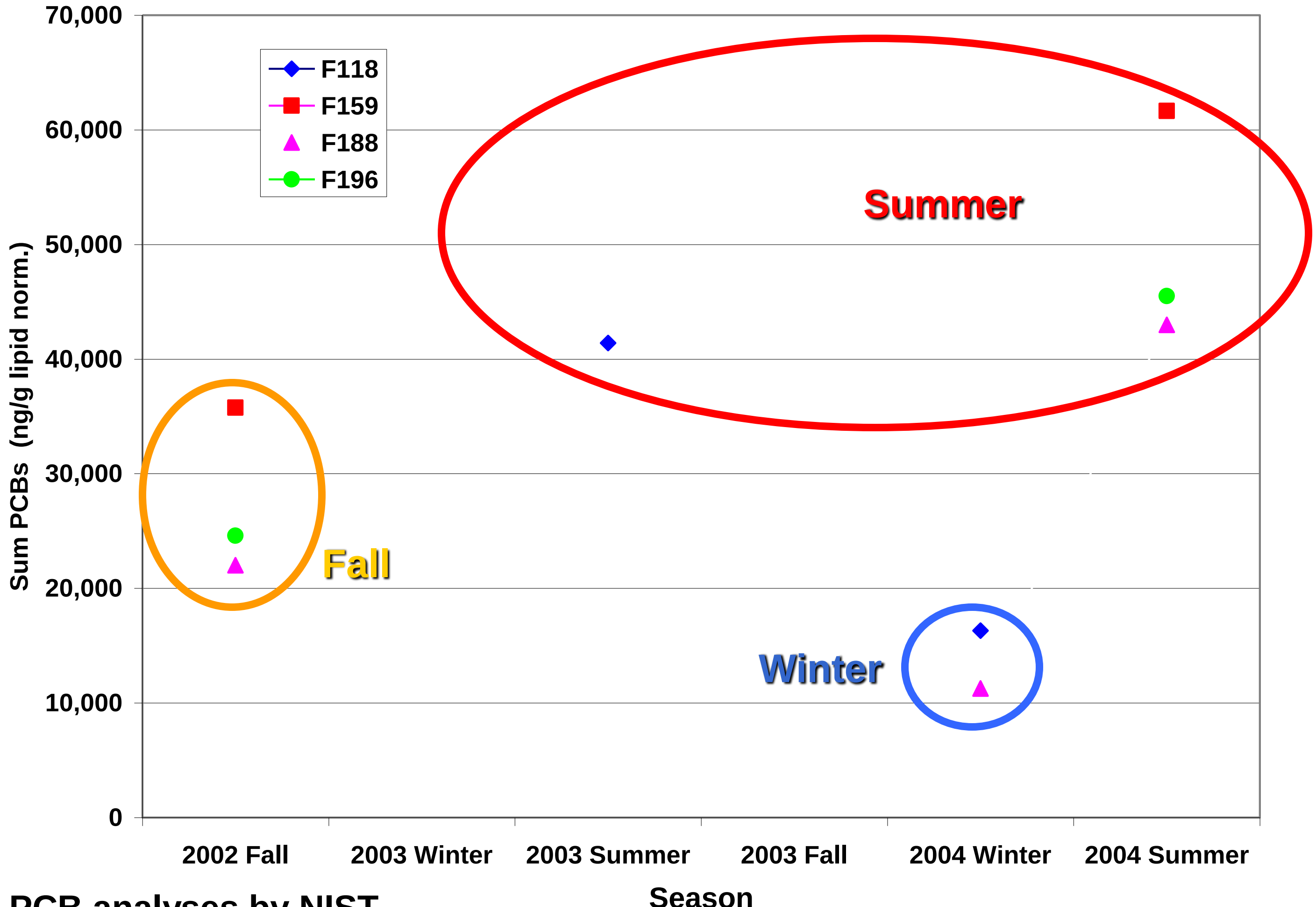
Periodic Health Assessments since 1988

Provide information from a sample of the community members on:

1. Health and body condition, including immune function
2. Environmental contaminant concentrations
3. Biotoxin concentrations
4. New and emerging diseases
5. Life history
6. Hearing abilities
7. Genetics
8. Whistle communication

Preliminary Data Indicate Increase in Circulating PCBs in Summer

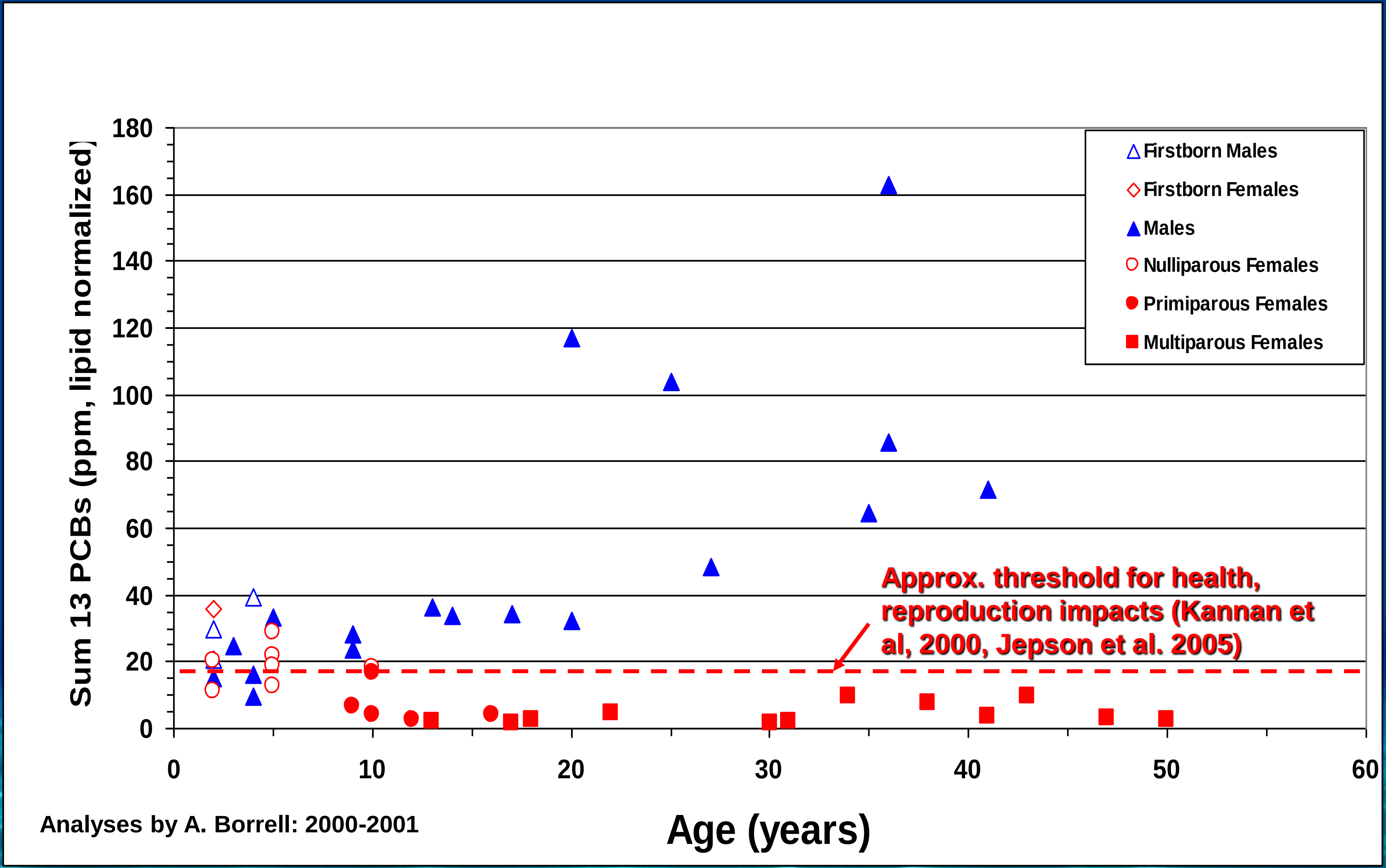
Mobilization of POPs from blubber and concomitant increase in contaminants in blood suggest cetaceans with reduced blubber lipid may be at a greater risk for contaminant-associated health effects (Yordy 2009)



PCB analyses by NIST

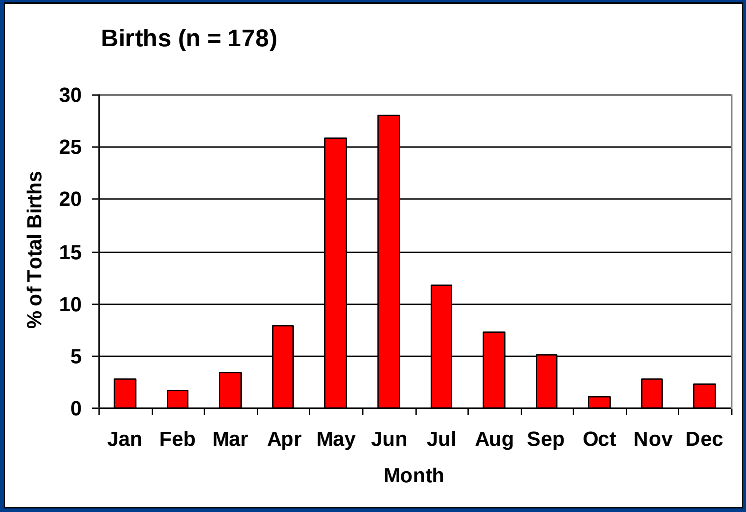
Yordy, J.E. 2009. Persistent Organic Pollutant (POP) mixtures in wild bottlenose dolphins: the influences of life history, dietary exposure, physiology and their potential for endocrine disruption. PhD Dissertation. Medical U. of S. Carolina.

How will warmer waters affect the exposure of dolphins to toxic pollutants previously sequestered and released seasonally?

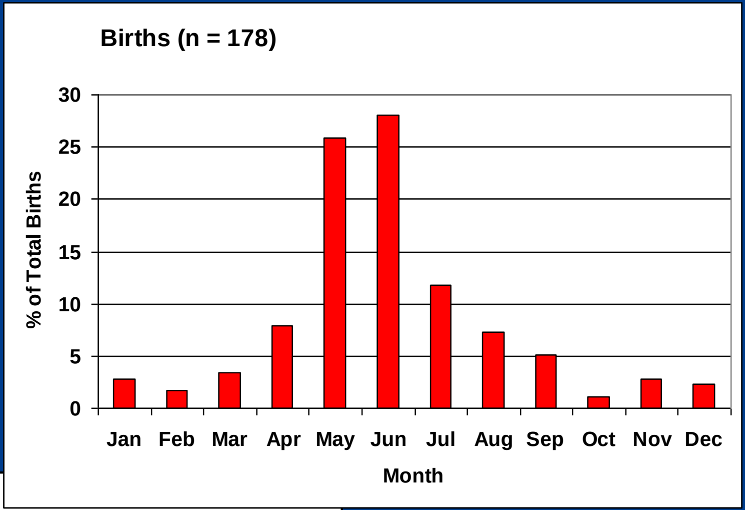


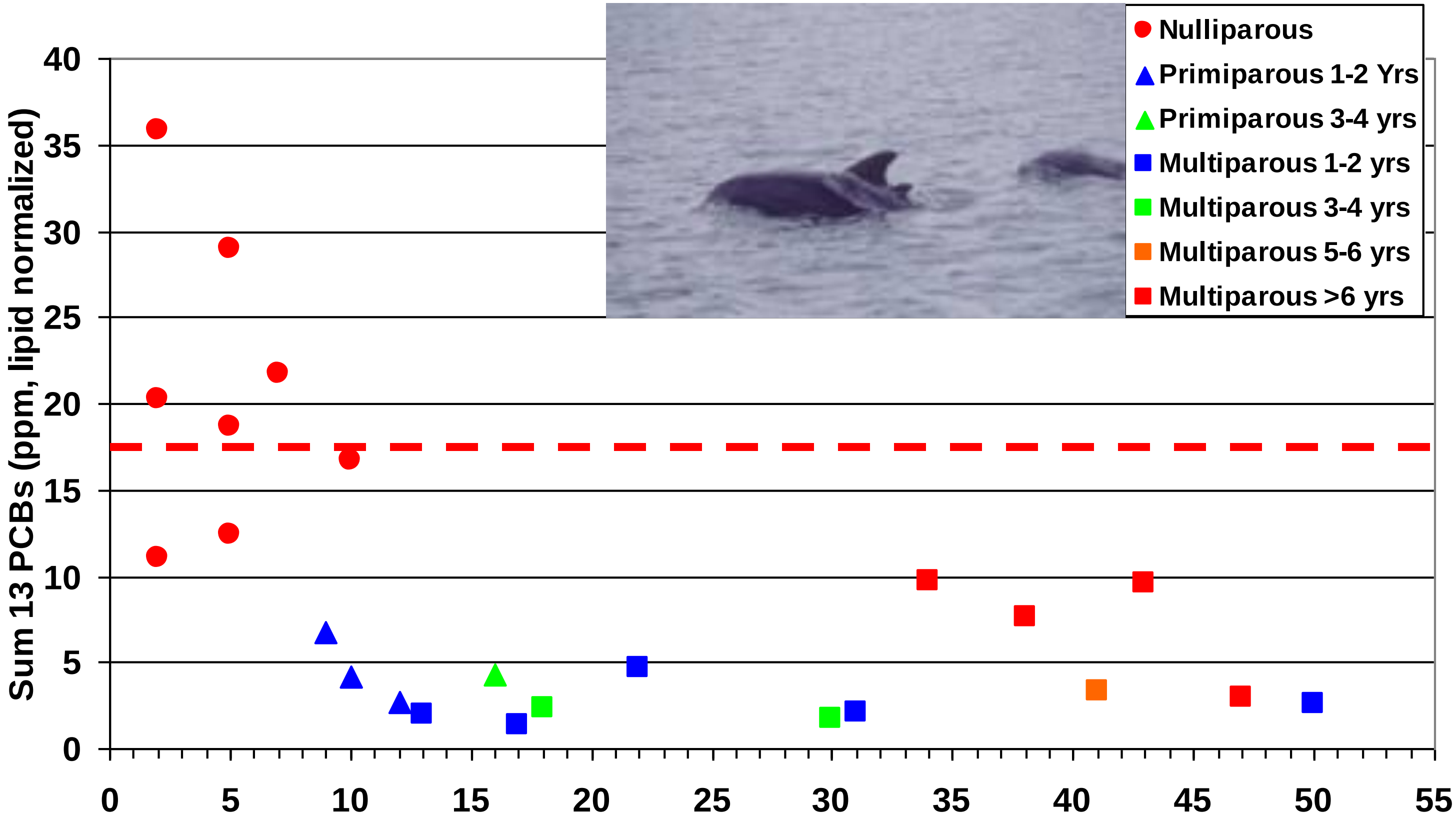
Wells, R.S., V. Tornero, A. Borrell, A. Aguilar, T.K. Rowles, H.L. Rhinehart, S. Hofmann, W.M. Jarman, A.A. Hohn, and J.C. Sweeney. 2005. Integrating life history and reproductive success data to examine potential relationships with organochlorine compounds for bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. Science of the Total Environment 349:106-119.

Most births occur in late spring/summer



Most births occur in late spring/summer, when circulating contaminant concentrations would have the greatest potential impact through depuration

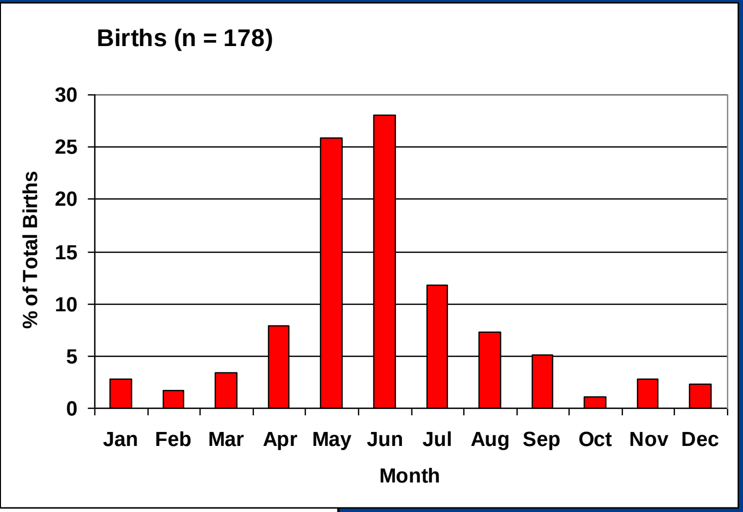


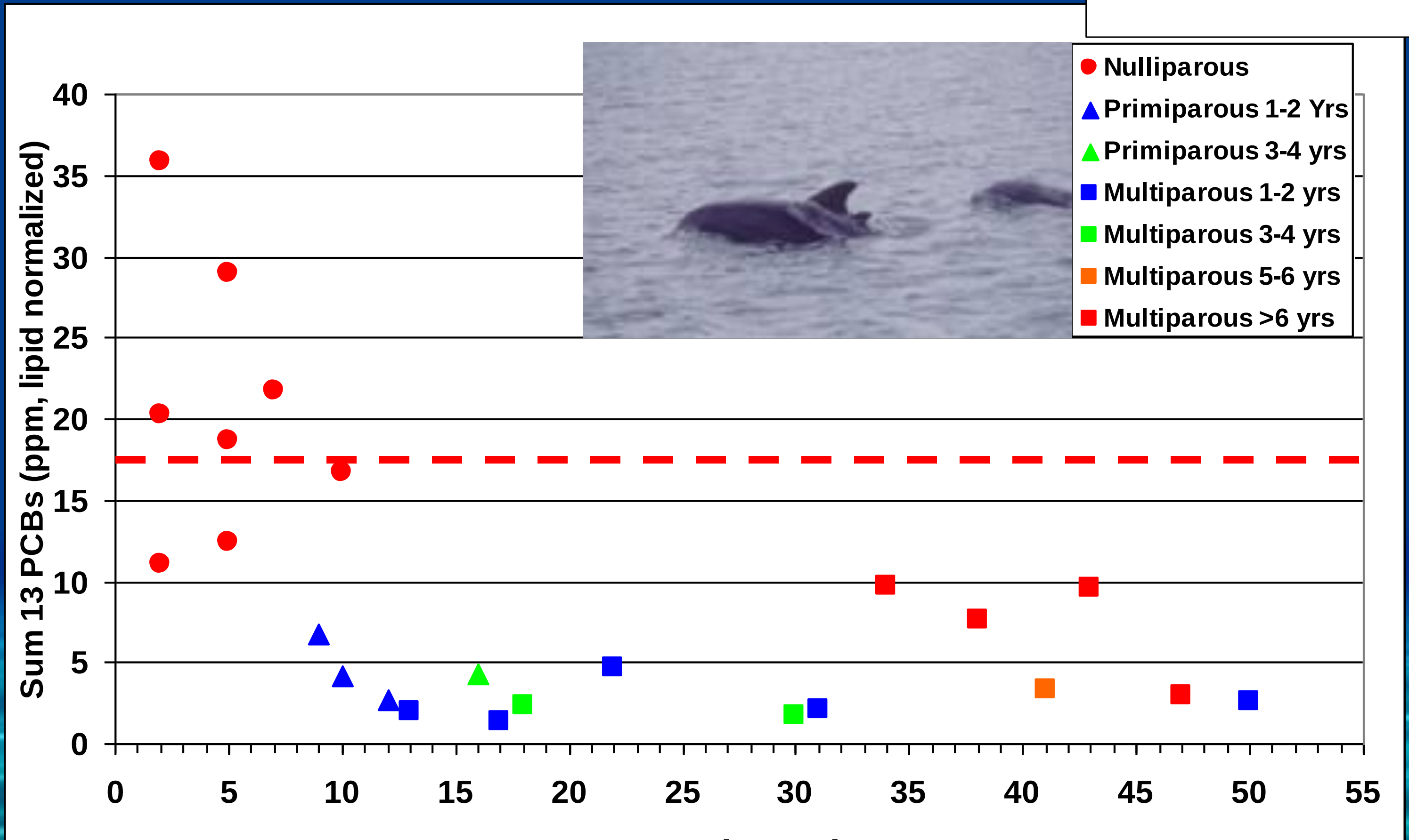


PCB analyses by A. Borrell

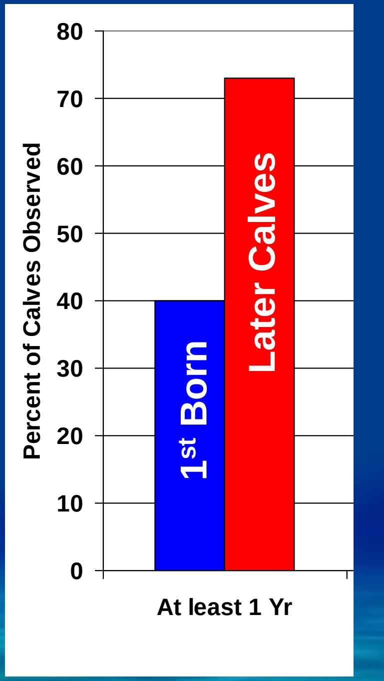
Most births occur in late spring/summer, when circulating contaminant concentrations would have the greatest potential impact through depuration

May contribute to high first-born mortality

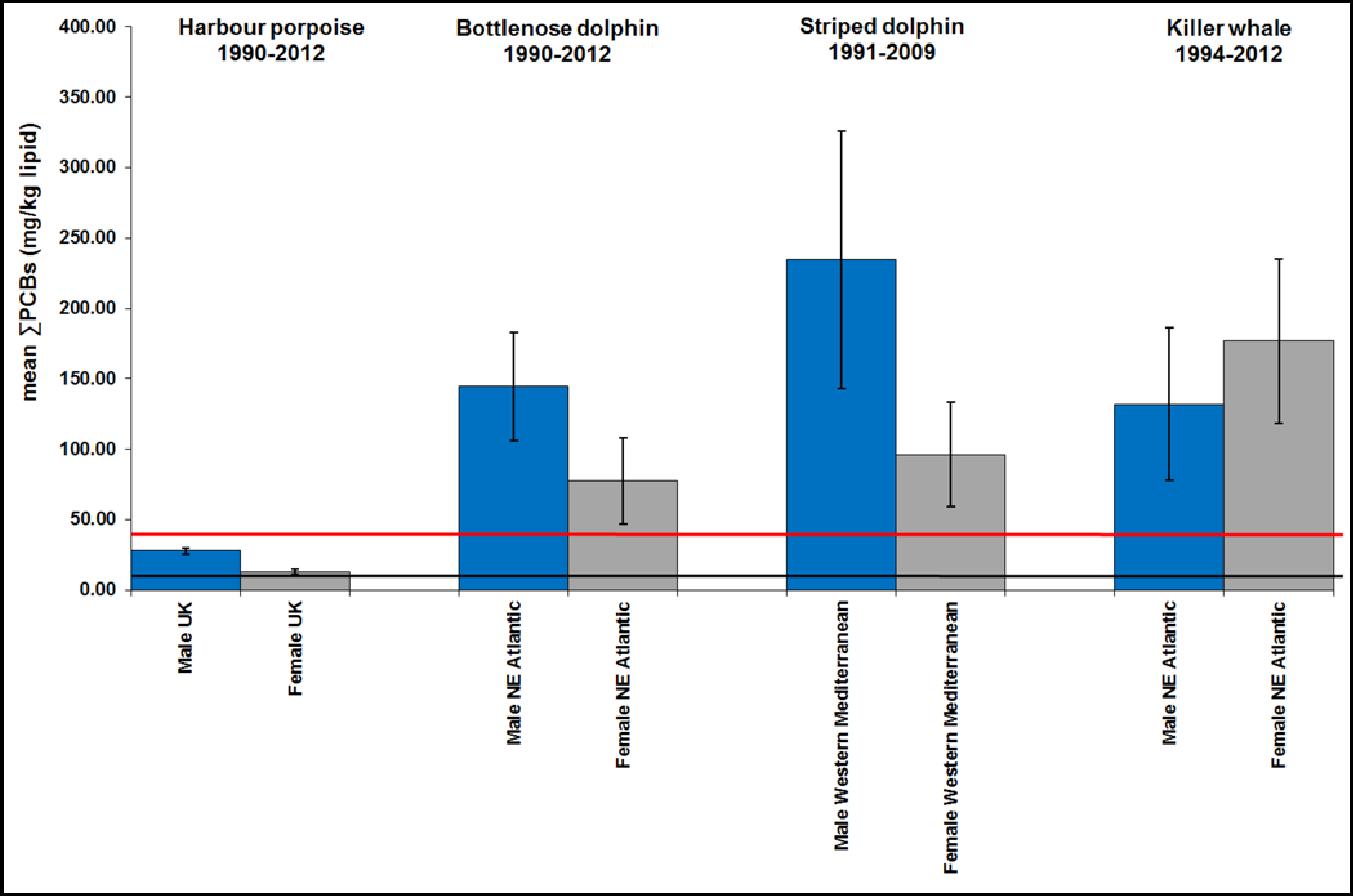




PCB analyses by A. Borrell

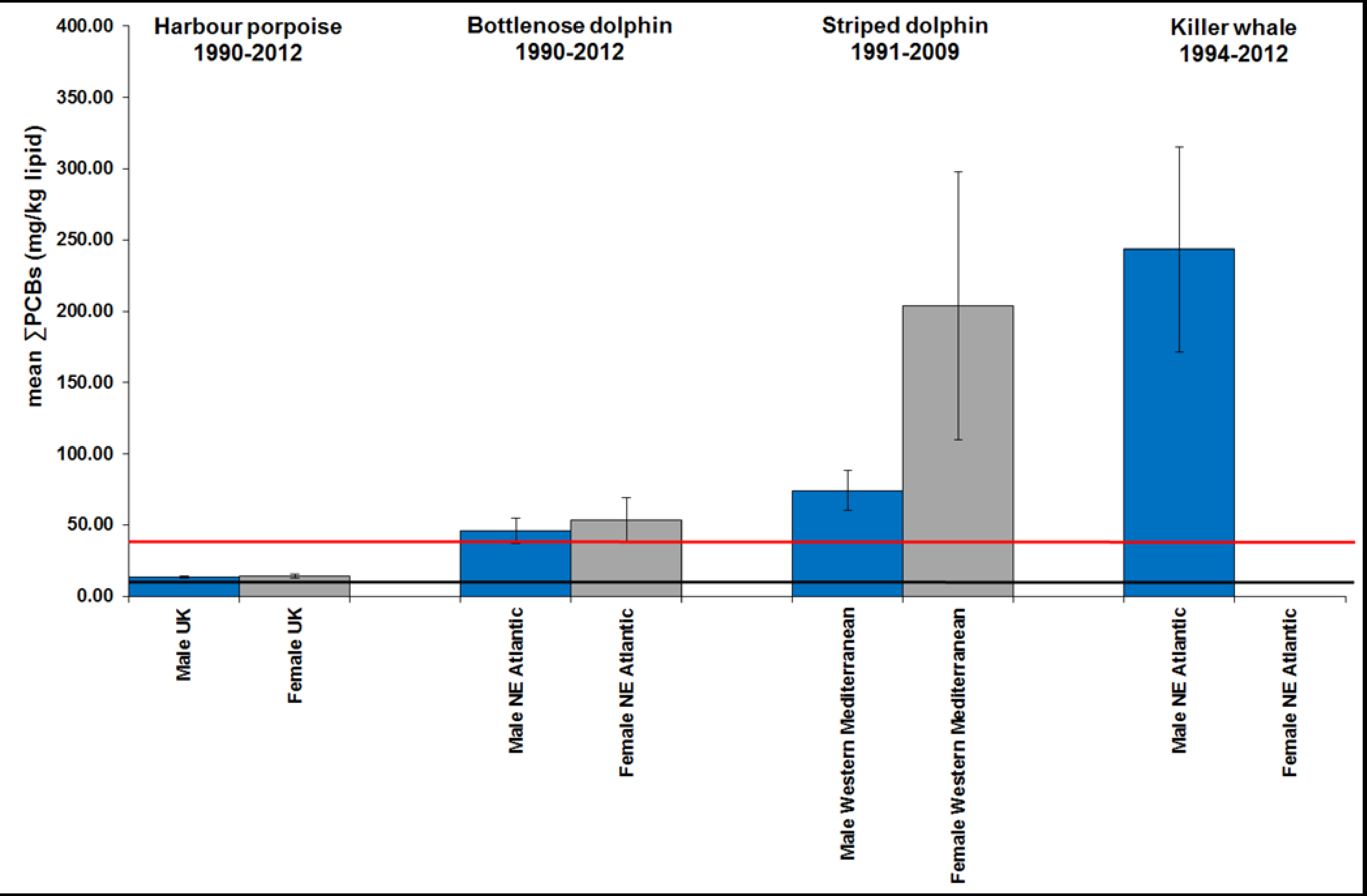


Mean PCB exposure: ADULTS only
by sex and PCB toxicity thresholds (marine mammals)



Jepson P.D. et al. (2016) *Scientific Reports*

Mean PCB exposure: IMMATURES only
by sex and PCB toxicity thresholds (marine mammals)



Jepson P.D. et al. (2016) *Scientific Reports*

Mean PCB exposure: kernal smoothing PCB distribution maps (1996-2012) – HP/BND/SD/KW

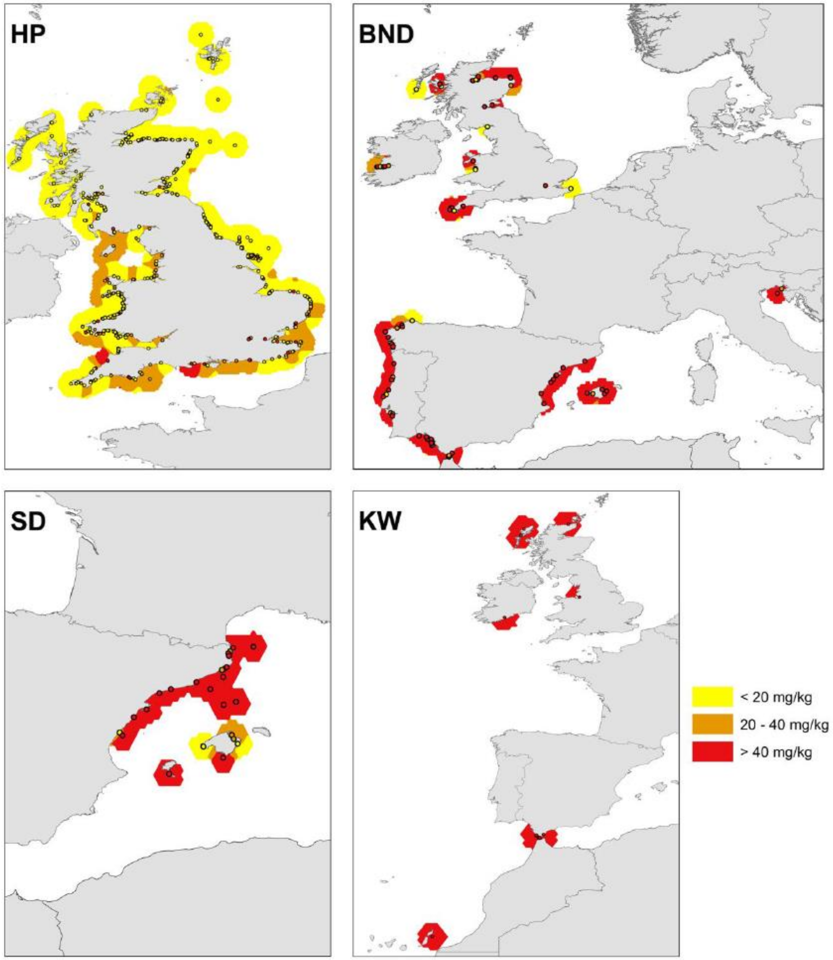


Figure 3A-D: Kernel smoothed estimates of mean PCB levels for all four species (A) - HPs; (B) - BNDs; (C) - SDs; (D) - KWs sampled between 1996 and 2013.

Jepson P.D. et al. (2016) *Scientific Reports*

Population Dynamics

- **remaining coastal killer whale (KW) populations are:- <u>close to extinction</u> in industrialised regions of Europe**
- **marked/historic <u>contraction of range</u> (KWs & BNDs)**
  - stranding records (UK; North Sea; France; Iberia)
- **remaining resident populations of BNDs and KWs in the NE Atlantic/Med.** (long-term photo-ID studies: IUCN)
  - associated with low/zero calf recruitment
  - consistent with PCB-induced reproductive toxicity
- **HIGH PCBs** in **adult Fs (esp. KWs) – consistent with reproductive FAILURE**
- **all dolphin populations suffering long-term declines** (Mediterranean and Black Seas) **(*IUCN Red Lists*)**

Jepson P.D. et al. (2016) *Scientific Reports*

SUMMARY (Jepson P.D. *et al*., 2016)

- **Large cetacean PCB dataset (n=1,081) – 4 species**
- **VERY HIGH mean (+median) PCBs conc. (mean = 50-350 mg/kg lipid) in orca/BNDs (NE Atlantic) and BNDs/SDs (Med.)**
  - **~1.2-6 X > Southern Resident KWs (~ 55.6 mg/kg lipid)**
- **Time trends (PCBs in HPs/SDs) have now stabilised**
- **Low (BNDs) or very low (KWs) bycatch rates (Europe)**
- **Highly PCB-exposed coastal/resident orca/BND populations:-**
  - **small/fragmented/contraction of historic range**
  - **show clear evidence of low/zero fecundity (adult F)**

ZSL Science & Conservation meeting (PCBs and orcas) Feb 2016

- Chair – Rob Deaville (IoZ)
- 3 speakers:-
  - Robin Law (Cefas)
  - Paul Jepson (IoZ)
  - Richard Moxon (Head of Contaminants - Defra)
- Closing address – Prof Ian Boyd (Chief Scientist to Defra)
- media coverage including **BBC Newsnight** (featuring Ian Boyd and Paul Jepson)

Global review PCB risk in marine apex predators (incl. seabirds)

CSIP

ZSL

INSIGHTS

PERSPECTIVES

MARINE ENVIRONMENT

Persistent pollutants, persistent threats

Polychlorinated biphenyls remain a major threat to marine apex predators such as orcas

By Paul D. Jepson[1] *and* Robin J. Law[1,2]

Persistent organic pollutants (POPs) are chemical substances that persist in the environment, accumulate in the food web, and pose a risk of adverse effects in humans and wildlife (*1*). Rachel Carson first identified the potentially devastating effect of POPs on wildlife in the early 1960s (*2*). In the late 1960s, polychlorinated biphenyls (PCBs) were detected in high concentrations in wildlife in Sweden (*3*). After PCB use and manufacture were banned in 1979 (US), 1981 (UK), and 1987 (EU), levels started to decline slowly in all biota around the world (*4–6*). In 2004, the Stockholm Convention committed more than 90 signatory countries to phasing out or eliminating large stocks or other sources of POPs, including PCBs (*1*). Yet, PCBs continue to threaten the survival of marine predators. Concerted efforts are thus still needed to mitigate PCB pollution.

Since legislative restrictions on different POPs have been introduced, tissue concentrations of POPs, including PCBs and DDT-related compounds (DDTs), have declined, and many wildlife populations have recovered. For example, populations and reproductive indices of grey seal, otter, and white-tailed sea eagle recovered in Sweden during the 1980s as tissue PCB and DDT concentrations fell substantially from the 1960s and 1970s to 2010 (*5*, *7*). Most avian marine apex predators, including herons, gulls, ospreys, petrels, and skuas, are no longer listed as threatened on the International Union for Conservation of Nature (IUCN) Red List, although half of the remaining sea eagle species are still threatened with extinction due to a range of threats, potentially including PCBs (*8*). Among pinnipeds, only the Hawaiian and Mediterranean monk seals and several spe-

[1]Institute of Zoology, Zoological Society of London, Regent's Park, London NW1 4RY, UK. [2]Centre for Environment, Fisheries and Aquaculture Science (Lowestoft Laboratory), Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK. Email: paul.jepson@ioz.ac.uk

PHOTO: PAUL NICKLEN/NATIONAL GEOGRAPHIC CREATIVE

Published by AAAS

- PCBs remain a major global threat to marine apex predators
- killer whales (orcas) = most PCB-polluted species globally
- other species probably still impacted by PCBs (based on *IUCN Red Lists*):-
  - false killer whales; bottlenose dolphins (resident/coastal)
  - river dolphins/porpoises (S.E. Asia)
  - polar bears (Arctic)
  - great white/tiger/bull/short-fin mako/hammerhead sharks

Jepson P.D. and Law R.J. (2016) *Science* **352**: 1388-1389. **doi**: 10.1126/science.aaf9075

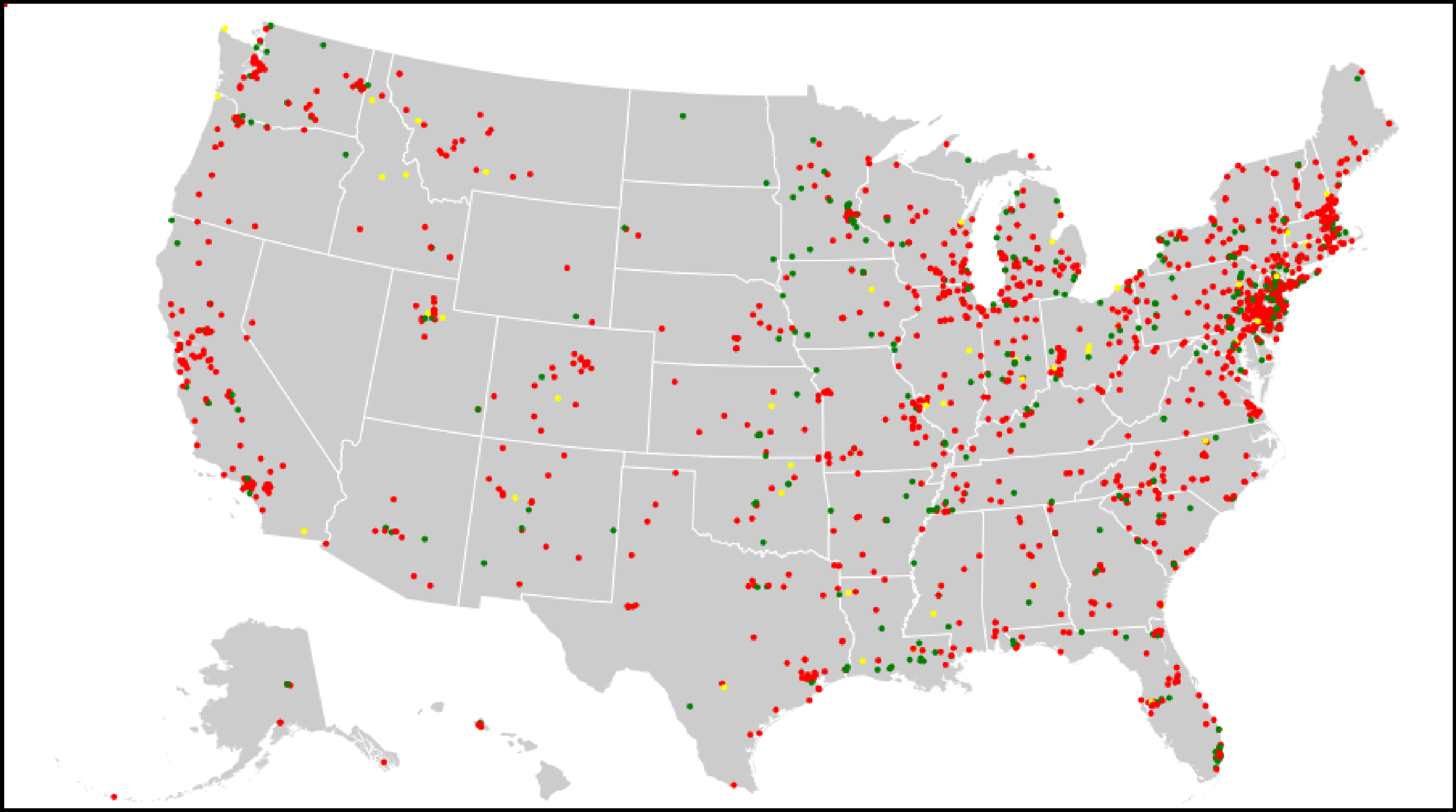
What can we do to mitigate PCBs?

- **mitigation** must involve **<u>full implementation</u>** of the **Stockholm Convention** (all EU/non-EU member states)
  - cease using PCB-containing equipment by **2025**
  - perform PCB waste by management by **2028**
- **disposal of large stocks of PCBs (industrial/other sources)**
- **reduce PCBs leaking out of old landfill sites into rivers**
- **limit dredging of PCBs in marine sediments**
- **excavate or cap PCBs in contaminated rivers**
- **regulate PCBs added to joint sealants – used in many tower-blocks built in the 1950s-80s**

Global PCB manufacture and environmental mitigation (UNEP 2015)

- **United States (US)** made **476,000-648,000** tonnes (total)
  - US banned PCBs in 1979
  - conducts very active PCB mitigation (e.g. "**Superfund**" sites)
  - PCB levels declining slowly (decades)
- **Europe 299,000-585,000** tonnes (total)
  - EU banned PCBs in 1987
  - EU member states should have destroyed large stocks PCBs by 2010 (not happened – **UNEP 2015**)
  - EU PCB levels stable & highest on earth (Jepson et al 2016)
- **Rest of the world** approx. **100,000-300,000** tonnes (total)
  - mostly **China/Russia**
  - lower PCB levels (but still a risk to **killer whales**)

Map of Superfund sites (US)
(October 2013)



- Red = currently on **final National Priority List**; Yellow = proposed site, green = deleted (usually having been cleaned up).

Future research requirements

- international collaborative studies to better assess the **global impact of PCBs on wildlife**
  - particularly marine and riverine (industrial) environments
- **Killer whales** - “canary in the coal mine” (sentinel species)
  - most PCB-contaminated mammalian species on earth
  - need global PCB risk assessment
- further work to document the pathways of environmental PCB exposure/effects in other species (e.g. **BNDs; sharks**)
- ongoing research documenting PCB exposure and effects on **human health/reproduction**
- find better (more innovative) ways to mitigate or destroy PCBs to comply with *Stockholm Convention*

“Lulu”

Acknowledgments

- **Funders-** Department for Environment, Food and Rural Affairs (Defra). Scottish Government (Marine Scotland). Welsh Government.
- **Contract manager-** Joint Nature Conservation Committee.
- **CSIP partner organisations-** Institute of Zoology, Scottish Agricultural College (Inverness), Natural History Museum, Marine Environmental Monitoring
- **Cornwall**- Cornwall Wildlife Trust Marine Strandings Network (and other wildlife trusts) and University of Exeter
- **Live strandings**- British Divers Marine Life Rescue (BDMLR)
- **Collaborators**- Sea Mammal Research Unit, CEFAS, Mordeun Institute, University of Aberdeen, National Museum of Scotland
- **Statutory Authorities-** Maritime and Coastguard Agency/Receiver of Wreck. Natural England, Scottish Natural Heritage and Natural Resources Wales
- **NGO's**- WDC, Seawatch Foundation, CRRU and HSI

Bottlenose Dolphin Conservation Strategies

Peter G.H. Evans

Sea Watch Foundation and University of Wales, Bangor

Marine species protection in Europe is enshrined in two EU legislative instruments, the Habitats Directive (HD) and the Marine Strategy Framework Directive (MSFD), which strive for animals and their habitats to be at Favourable Conservation Status and Good Environmental Status, respectively. Although the HD has tended to focus upon area-based conservation measures through its Natura 2000 network, there are situations where issue-based measures may be more appropriate. Each approach has both benefits and limitations and these should be carefully weighed up. There is a tendency for opinion to be polarised towards one of these to the exclusion of the other. Currently, within the EU there are 321 Natura 2000 sites in which bottlenose dolphin is said to occur, 73 in the Atlantic biogeographic region. However only ten sites are classified in the top category: A, four of which are in the Atlantic. Around 80% of sites are ascribed category C or below, illustrating the deficiency of the Natura 2000 network in affording site protection for the species where populations are concentrated.

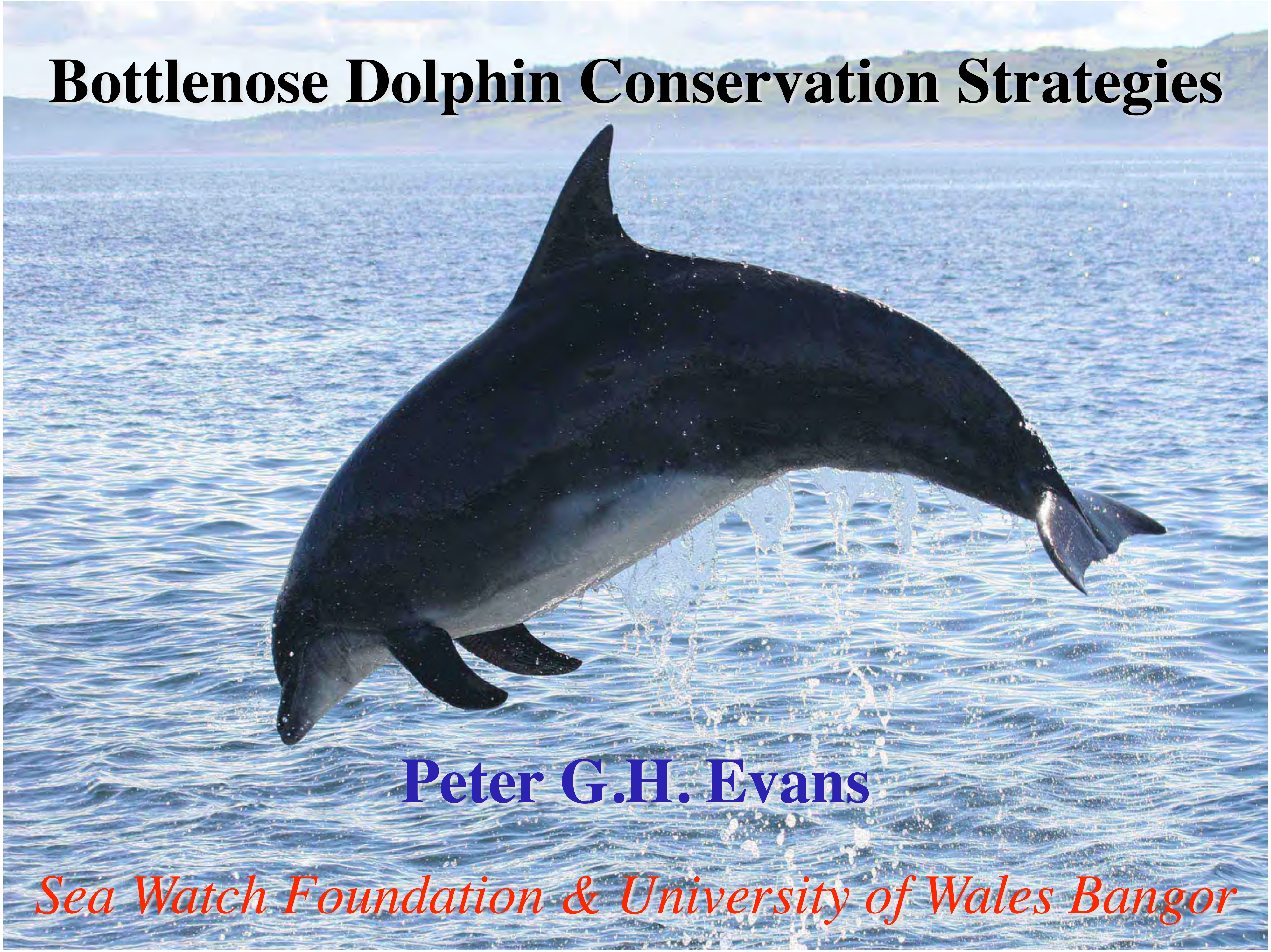
SAC conservation objectives are to maintain (or restore) the habitat and species features, as a whole at (or to) Favourable Conservation Status within the site. To achieve that, one must ensure there is a viable population (which means establishing population structure, and monitoring population size, reproductive success and health status), ensuring the range is not reduced, that the habitat (and prey resources within it) is sufficient to maintain or increase the population, and to manage human activities and operations to achieve this. It is not sufficient simply to aim for the latter without collecting the evidence base to test whether management is having the desired effect.

At present we only have measures of trends in population size, with at least four sampling years over a ten-year period, for six sites in the Atlantic region. For coastal populations at least, there is scope to supplement these with trends in relative abundance from land-based systematic surveys.

Monitoring of human pressures remains a large gap in many parts of Europe, and an even greater gap is adequate studies to link cause and effect for observed population changes.

Bottlenose dolphin populations typically exist as two main ecotypes: a large offshore population that may be wide-ranging and therefore panmictic in terms of gene flow; and several smaller coastal populations showing stronger site fidelity. These are best described as Management Units (MUs), defined as demographically independent populations. So far in the Atlantic region we recognize one offshore and ten coastal Management Units, although it is likely that this number should be increased. In the eastern United States seven MUs were initially recognized, but ten years later with further study this had expanded to seventeen. Increasingly we have evidence for a complex population structure for coastal bottlenose dolphins in Europe. At this point it is worth considering the underlying mechanisms that may lead to population structure. These very likely depend upon the carrying capacity of particular sites and their habitats, determined by the abundance, dispersion and ecology of particular prey resources. Prey species that are largely sedentary may provide sufficient food to sustain a small coastal or estuarine resident population of dolphins. A better understanding of bottlenose dolphin diet and how it varies in space and time is clearly needed. In Atlantic Europe, there are a number of coastal/estuarine populations that once existed but have now largely disappeared (in and around the North Sea, mainly in the late nineteenth century). Although the causes are not known, pollution is likely to have played a role either indirectly by negatively affecting their prey or more directly by reducing dolphin reproductive success or even causing mortality.

Finally, there is value in not considering bottlenose dolphins in isolation but attempting to get a better understanding at the level of the ecosystem, identifying hot spots for all top predators as a functional group as well as through lower trophic levels, and to determine what are the major environmental drivers for the patterns in distribution and abundance that we observe in space and time. This is what we are attempting to do currently as part of the NERC-Defra funded Marine Ecosystem Research Programme.


Bottlenose Dolphin Conservation Strategies
Peter G.H. Evans
Sea Watch Foundation & University of Wales Bangor

European Commission

The Habitats Directive

- EU law providing common framework for the conservation and sustainable use of biodiversity to fulfil CBD commitments
- Overall objective is to ensure that these species and habitat types are maintained at, or restored to, a *"favourable conservation status"*
- A strong instrument for integration of biodiversity requirements into other EU policy areas, including fisheries

Site protection and management
- Annex I Habitat types
- Annex II species

Species protection & management
- Annex IV species
- Annex V species

Phocoena phocoena
Tursiops truncatus

All cetaceans

Source: *European Commission*

Area-based vs Issue-based Conservation Measures

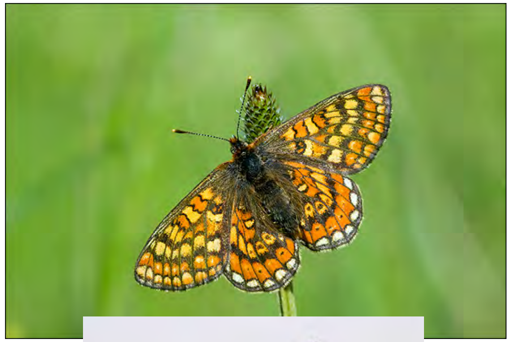
ISSUE-BASED CONSERVATION MEASURES

PROS	CONS
Can be designed to target particular human pressures wherever they occur	Conservation measures can be expensive; so with limited resources, often a need to target areas where potential conflict will be greatest
Provides greater focus upon issue-based mitigation measures, e.g. net modifications, bubble curtains	The most effective management measure may simply be to ensure that cetaceans and the conflicting activity are separated in space & time
Since fisheries move around as do their target prey, it is difficult to regulate within the confines of a particular area whereas measures can be introduced throughout a fishery	The establishment of some safe havens for fish may not only benefit top predators like cetaceans and seabirds that feed upon them but also help local fish stocks to recover
Although pollutant point sources can effectively be managed spatially, pollutants disperse over wide areas and so are not easily controlled by area-based measures	Most regions identified as highly polluted are enclosed areas of sea where ocean circulation is reduced, for which area-based measures can be applied

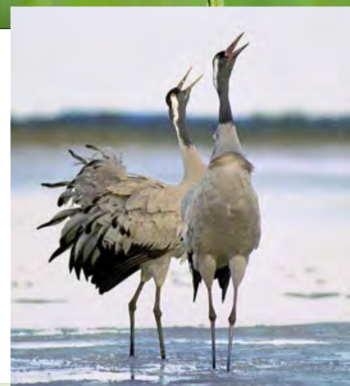
AREA-BASED CONSERVATION MEASURES

PROS	CONS
Provides focus to areas/habitats that are of particular importance for the species	Those important areas may change over time; requires adaptive management
Some features of the ocean (e.g. bathymetry, high energy sites) are stable over time, thus affording favourable conditions which may be applicable to a variety of species	If environmental conditions do vary, area-based legislation traditionally takes time to respond
Many human activities (e.g. recreation, seismic, offshore renewables) are area-based	Fishing activities in particular tend to move around
Encourages developers to conduct fuller HRAs / EIAs before starting activities	Boundaries have to be meaningful
Encourages development of a management plan involving all users	Can lead to conflicts between users & regulators/ conservation groups
Raises public awareness & conservation focus for the species in that area	If the species occurs significantly outside that area, those regions may receive less attention

Key principles of Natura 2000



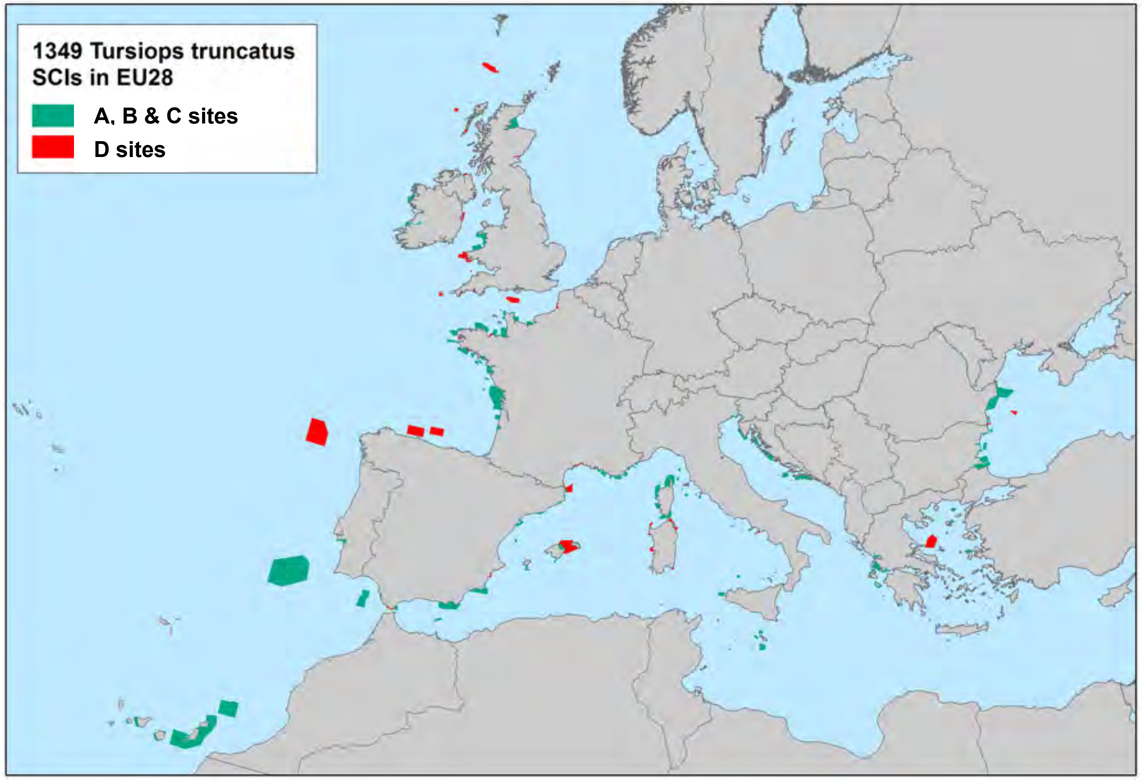
- Conservation of species & habitats across entire natural range in EU - irrespective of political boundaries
- Site selection is exclusively scientific
- Sites have strong legal protection
- Not a system of nature reserves – management in collaboration with stakeholders
- Promotes sustainable development : new activities or development affecting Natura 2000 sites are not automatically excluded

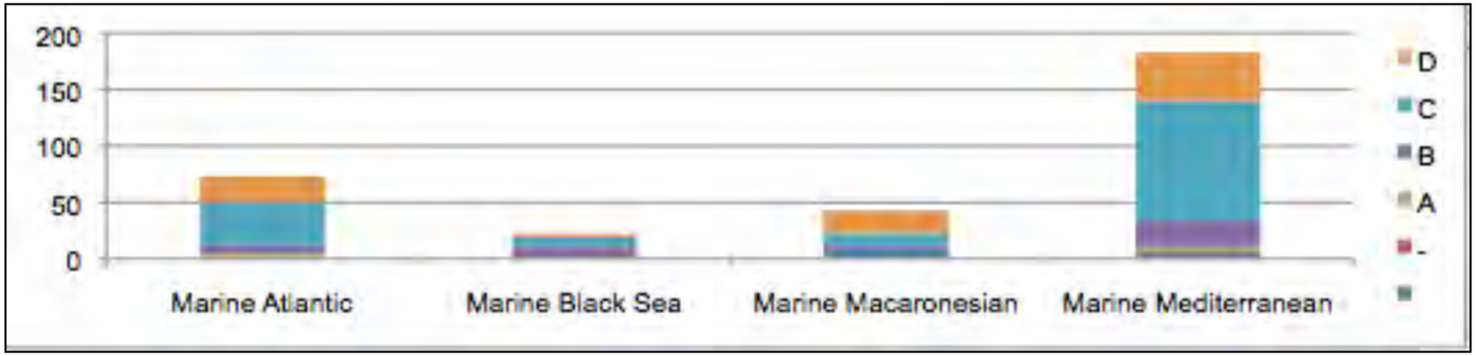


Source: *European Commission*

Natura 2000 sites hosting Bottlenose Dolphin *Tursiops truncatus*

321 sites in twelve Member States:-
A: 10 (4 Atlantic)
B: 43 (8)
C: 162 (37)
D: 89 (23)
Unspecified: 17 (1)





Source:
European Commission (Dec 2016)

SAC Conservation Objectives

To maintain (or restore) the habitat and species features, as a whole, at (or to) Favourable Conservation Status within the site

For species such as bottlenose dolphin:

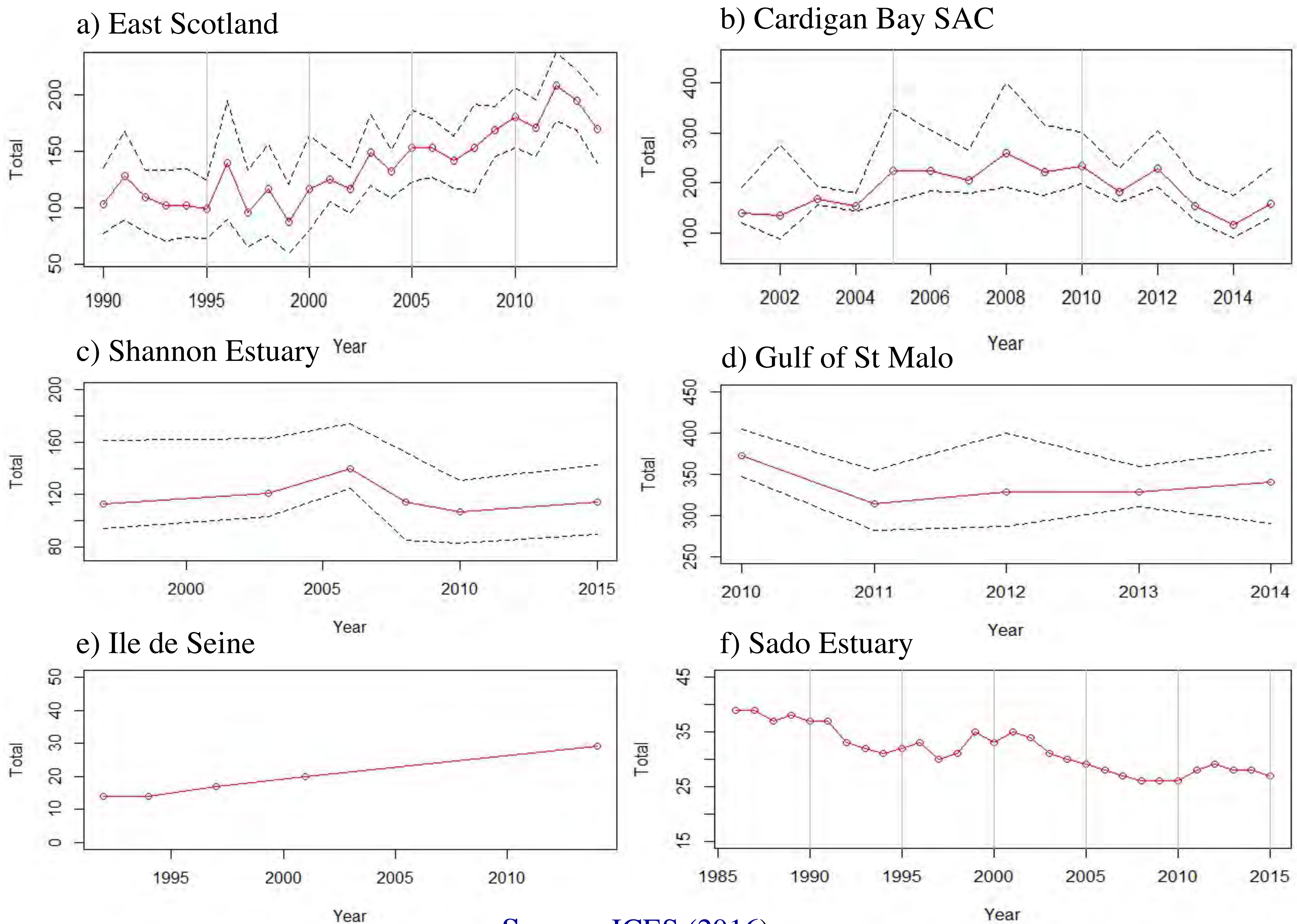
- **Ensure a Viable Population**
  - Population Size
  - Reproductive Success
  - Population Structure
  - Physiological Health
- **Ensure Range is not reduced**
- **Ensure Habitat is sufficient to maintain or increase Population**
  - Distribution and Extent
  - Structure, Function and Quality
  - Prey Availability
- **Management of Activities and Operations to achieve above**





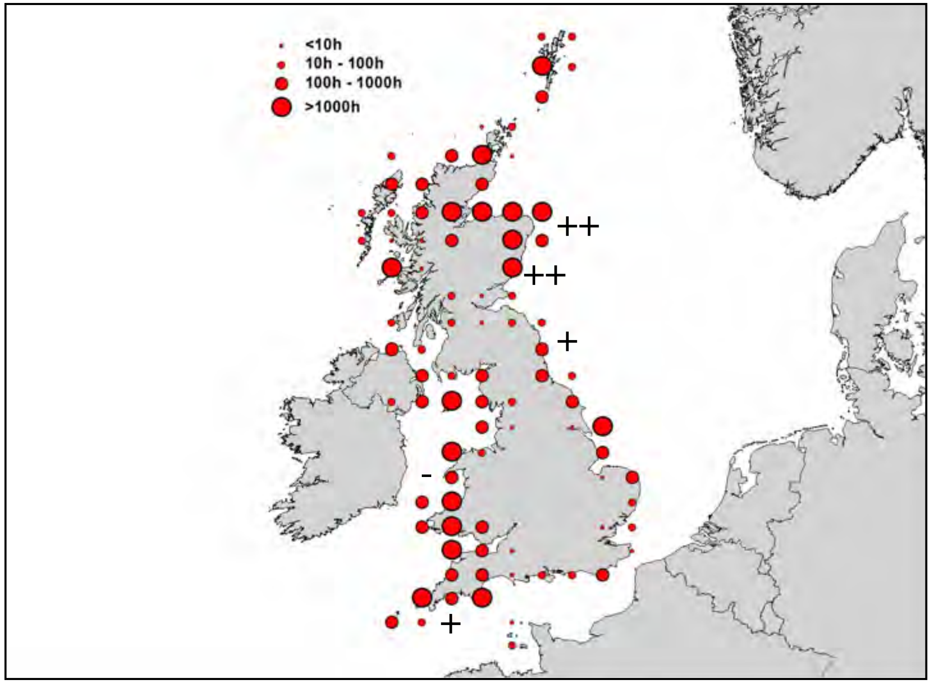

Monitoring Population Change

BOTTLENOSE DOLPHIN POPULATION TRENDS

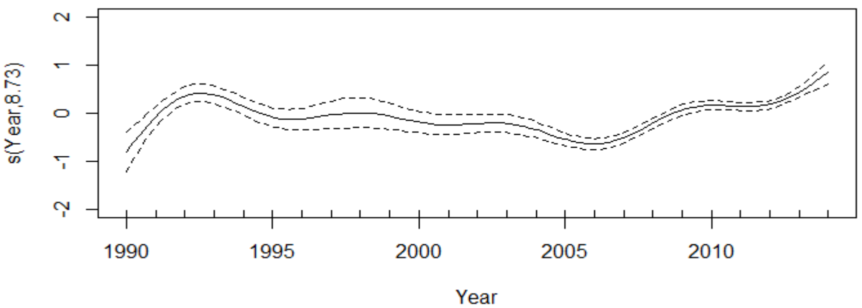


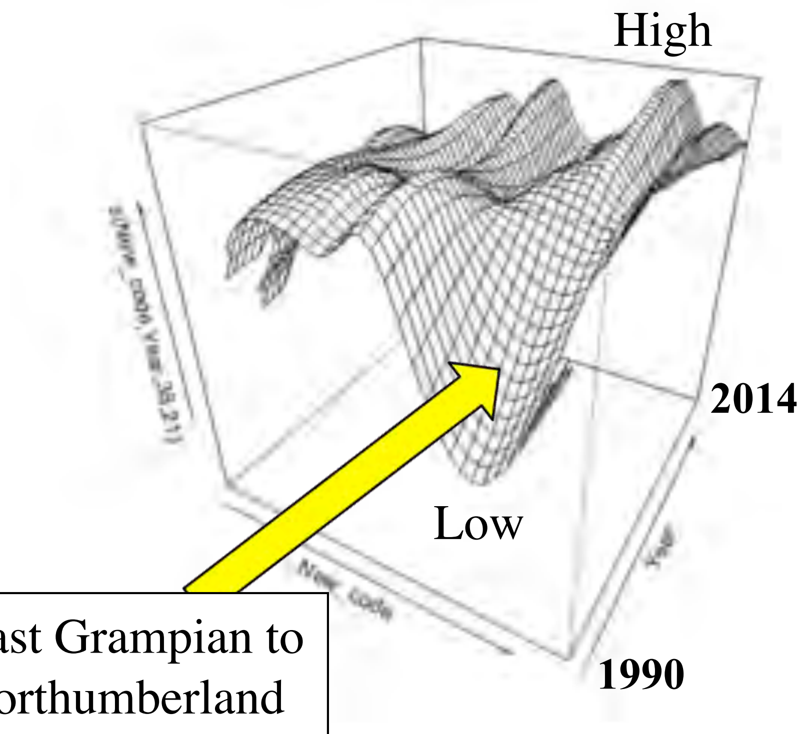
Source: ICES (2016)

REGIONAL LONG-TERM TRENDS IN PRESENCE OF BOTTLENOSE DOLPHIN AROUND THE UK



- >145,000 effort records
- c. 84,000 hours of effort
- 50-year time period: 1965-present
- Number of sites: 732
- c. 27,000 bottlenose dolphin records



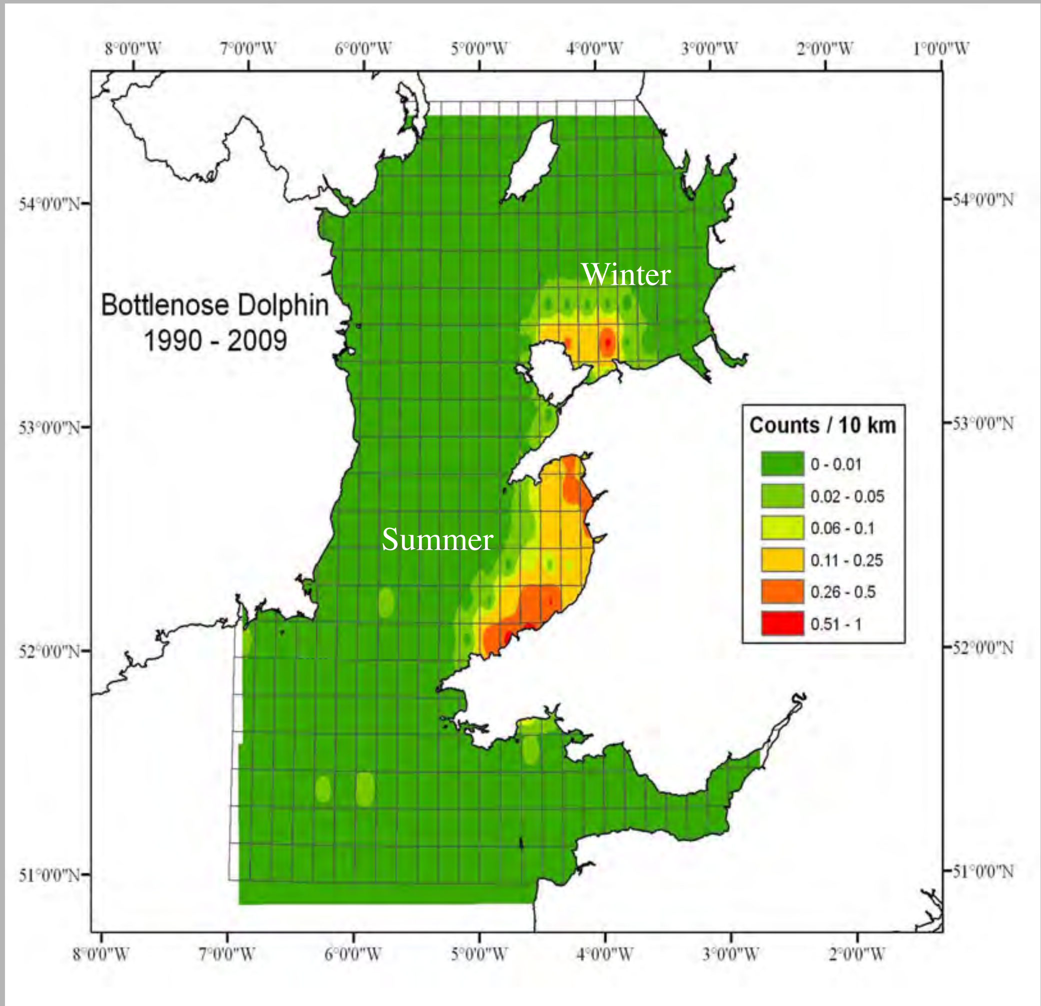


East Grampian to Northumberland
N = 56 sites

Source: Evans *et al*., 2015

Monitoring Human Pressures

BOTTLENOSE DOLPHIN DISTRIBUTION IN THE IRISH SEA



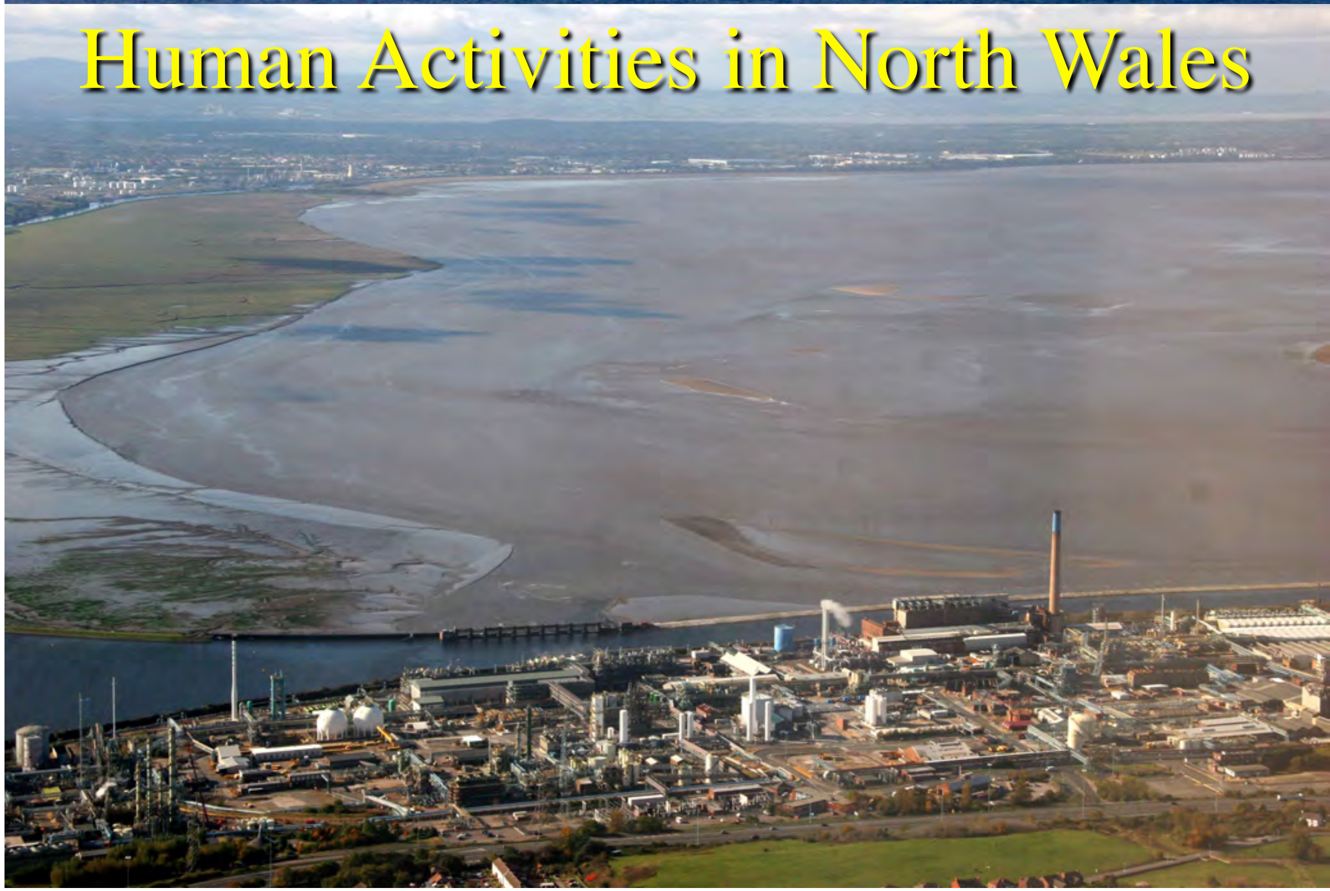
- locally distributed, mainly coastal, particularly in summer
- main summer concentrations are in Cardigan Bay & in winter, N Wales

Source: Baines & Evans (2012) *Atlas of Marine Mammals of Wales*

Human Activities in Cardigan Bay

• Potting • Scallop Dredging • Sailing • Water Sports • Dolphin Watching

Human Activities in North Wales

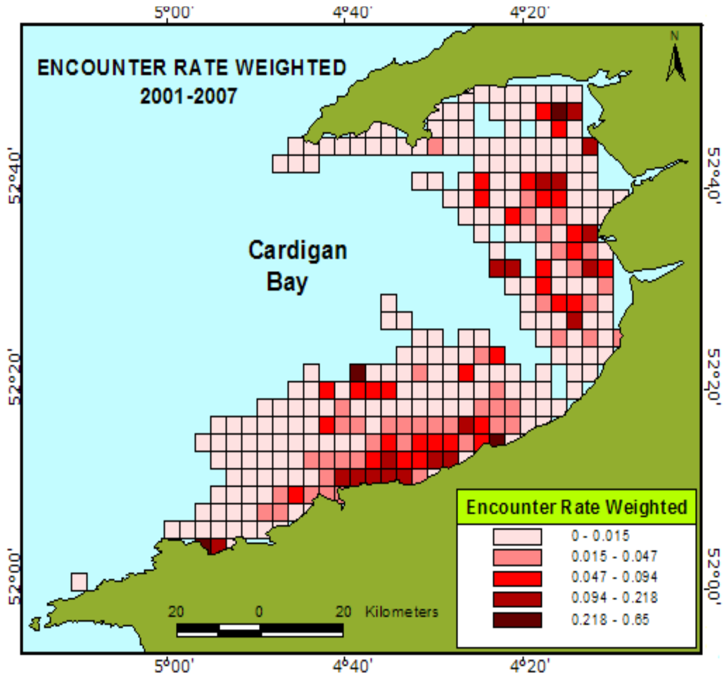


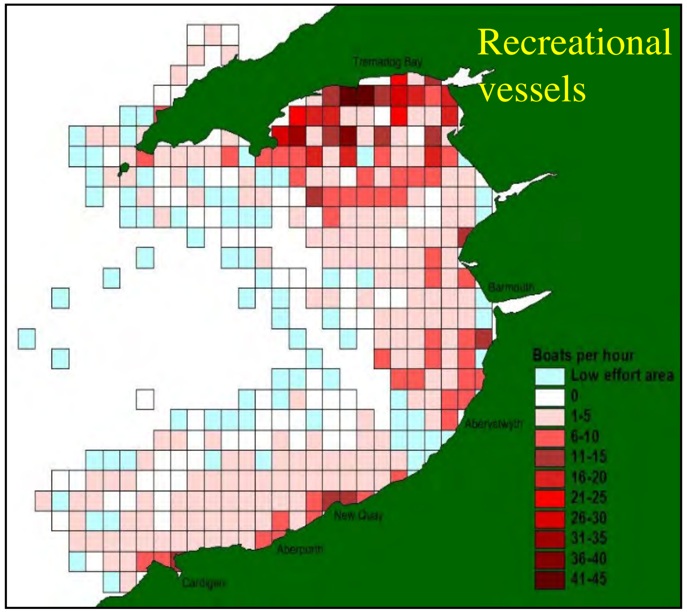
Wind farm construction - disturbance from pile driving

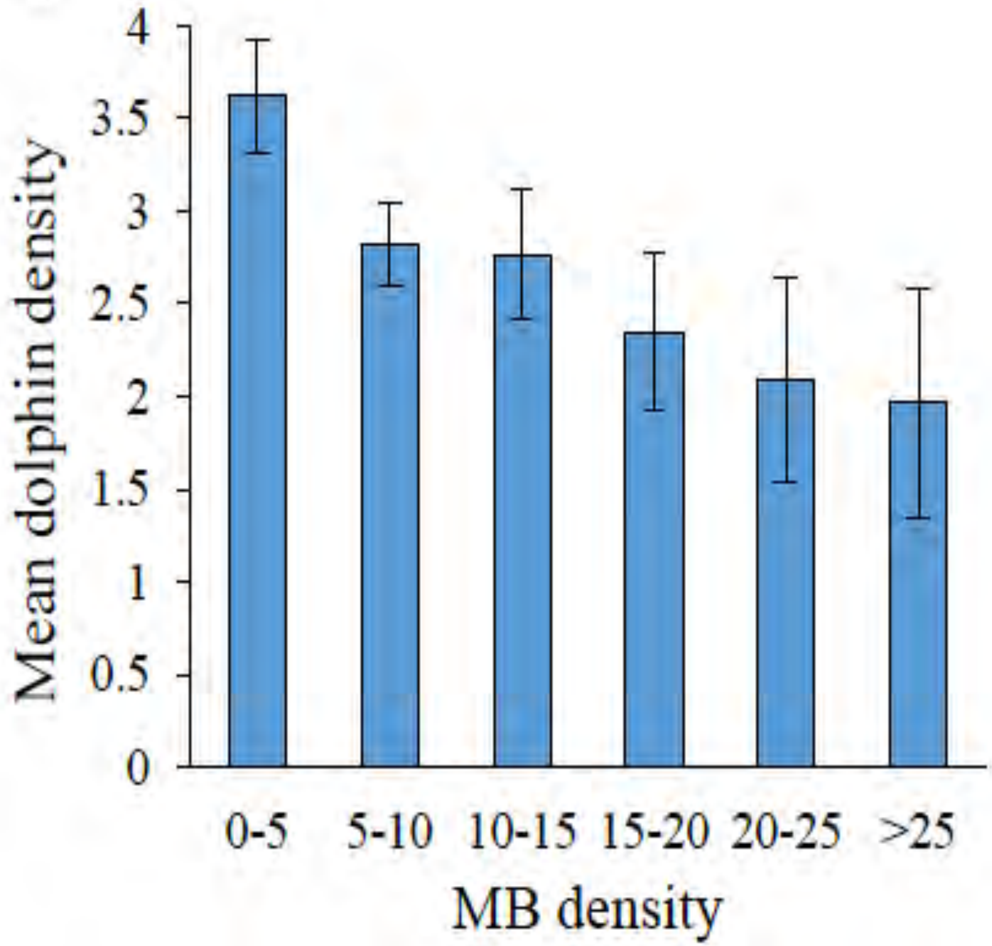
Industrial activities in Liverpool Bay - high levels of PCBs, mercury and lead

Linking Cause with Effect

BOTTLENOSE DOLPHIN ENCOUNTER RATES IN RELATION TO RECREATIONAL ACTIVITY IN CARDIGAN BAY, WALES



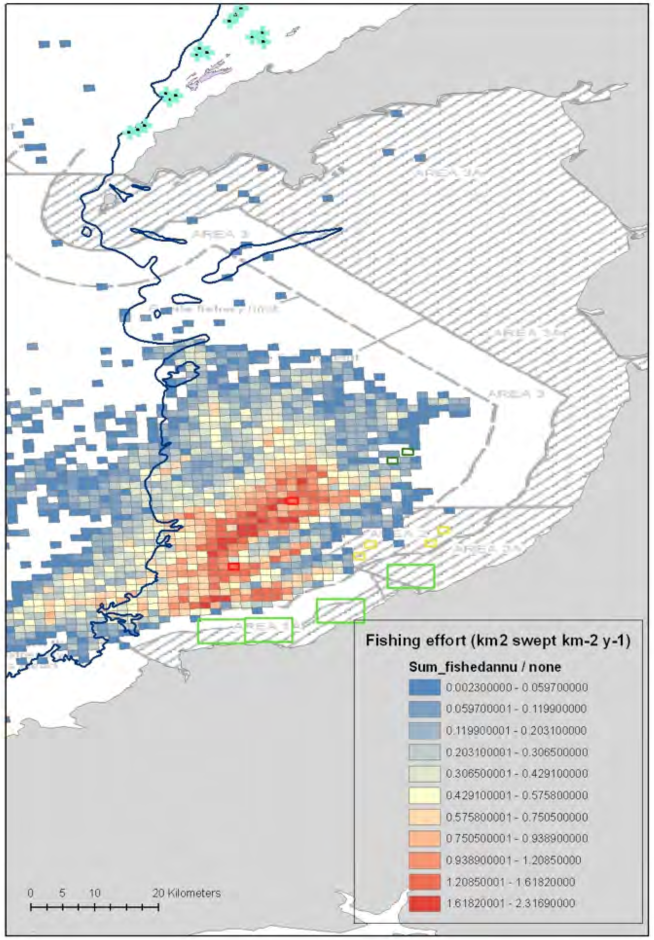




• Bottlenose dolphin densities show an inverse relationship to motor boat (MB) densities which is not observed with yachts or non-powered vessels

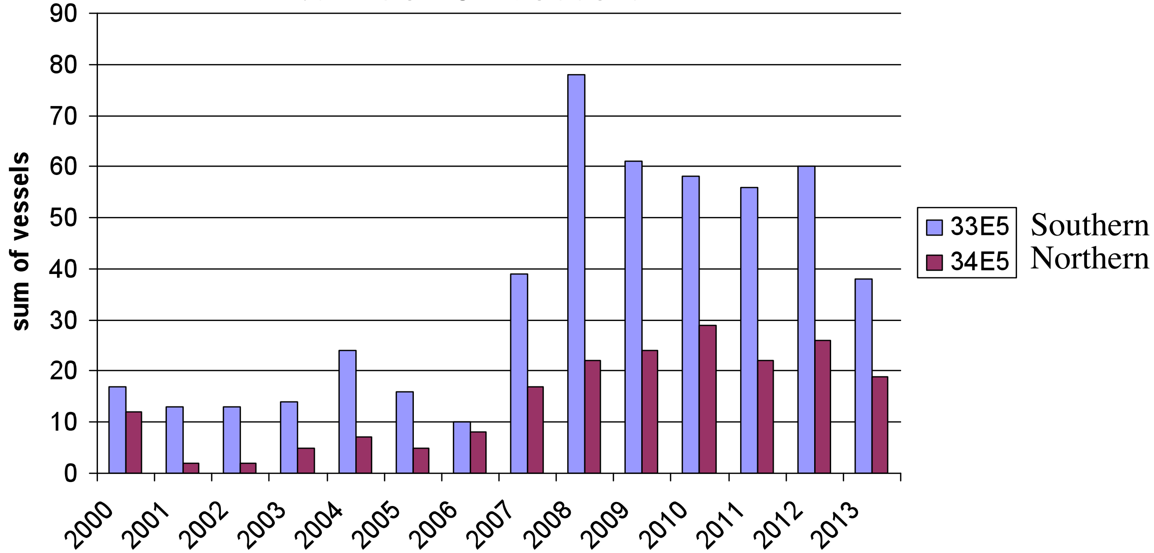
TRENDS IN SCALLOP DREDGING EFFORT, 2000-13

Scallop dredging, 2008

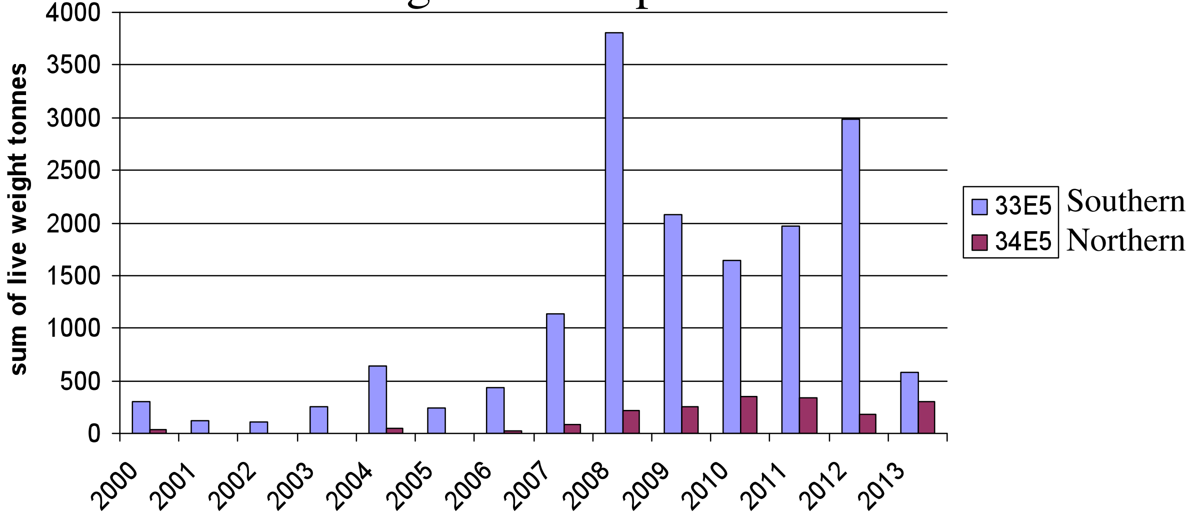


Source: School of Ocean Sciences, Bangor University

Number of vessels



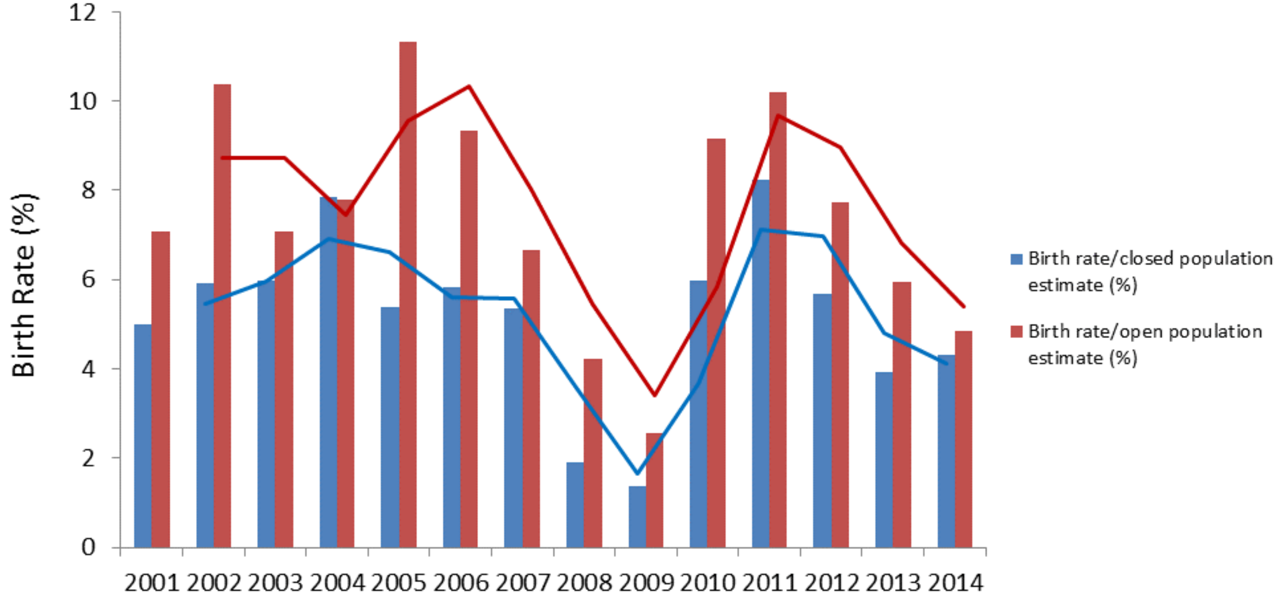
Tonnage of scallops



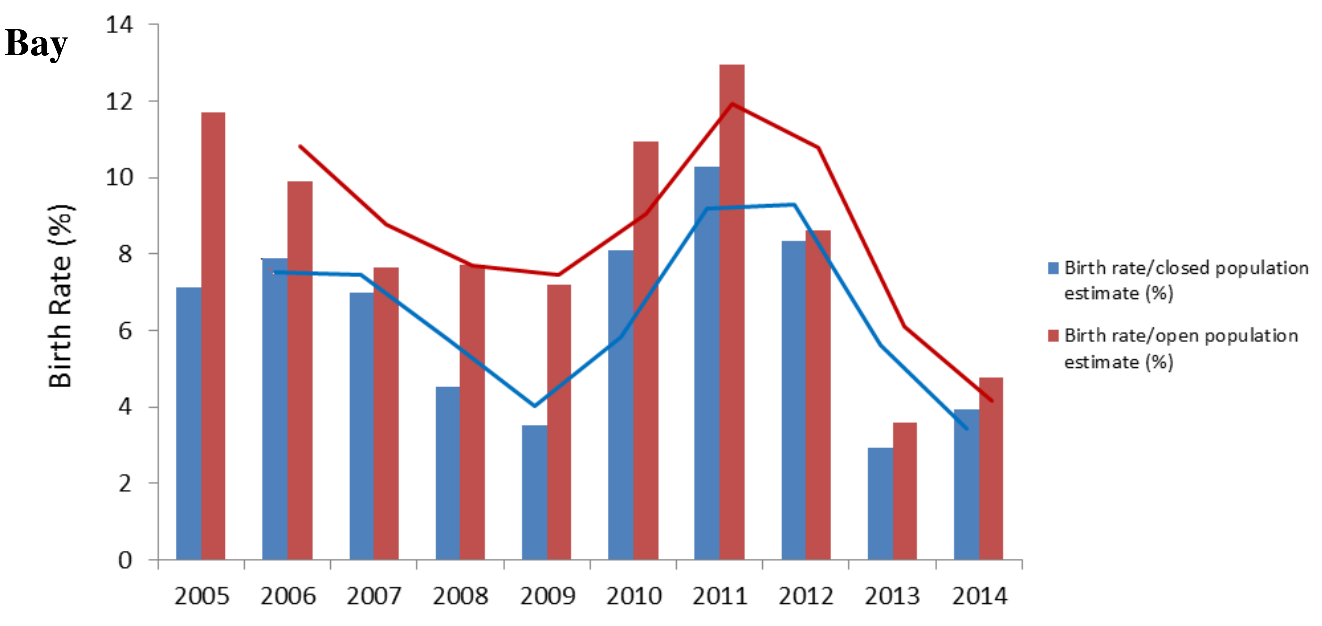
Source: Marine Management Organisation

BIRTH RATES IN CARDIGAN BAY SAC (top) AND WIDER CARDIGAN BAY (bottom), 2001-14

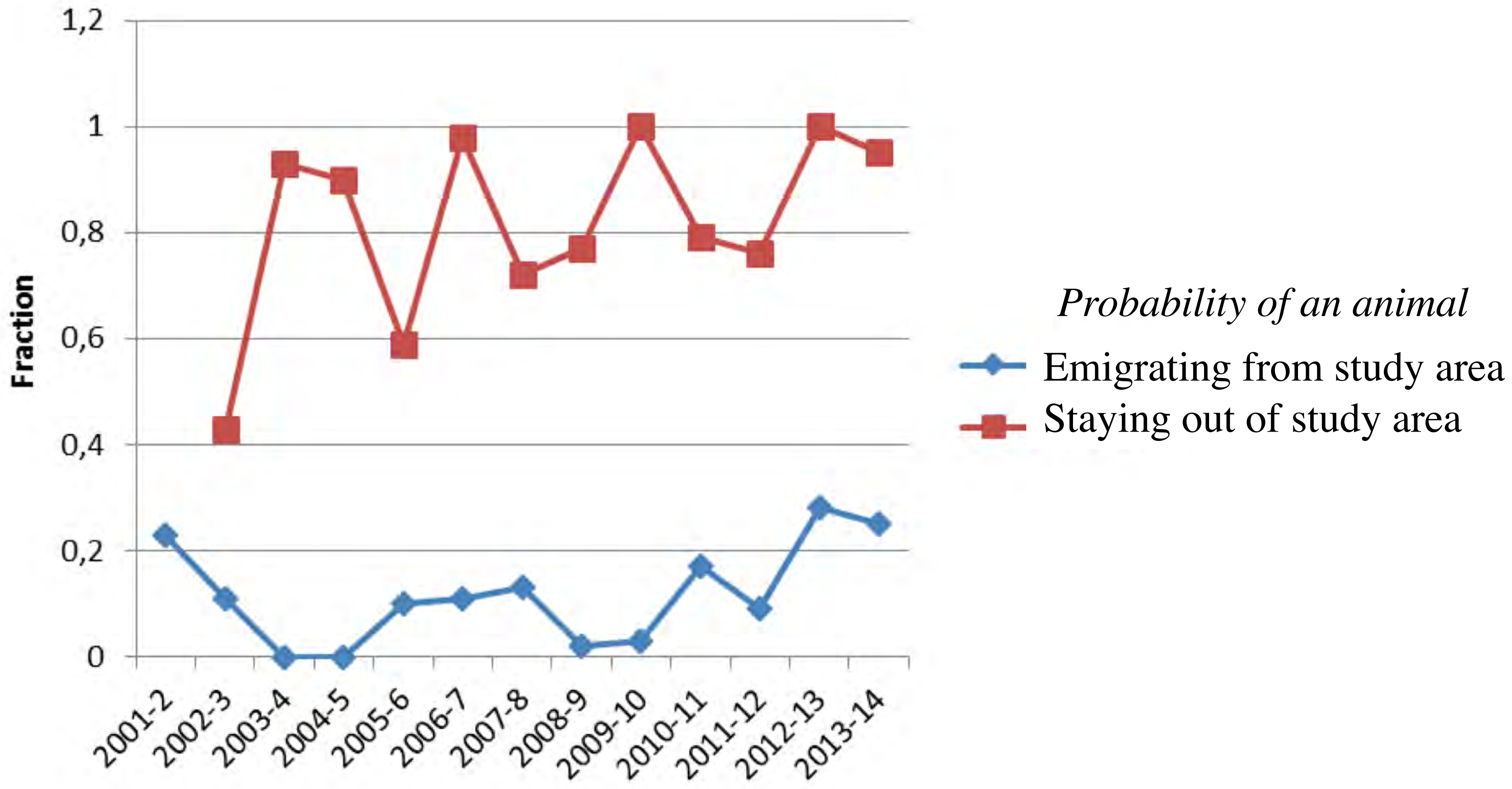
a) Cardigan Bay SAC



b) Entire Cardigan Bay

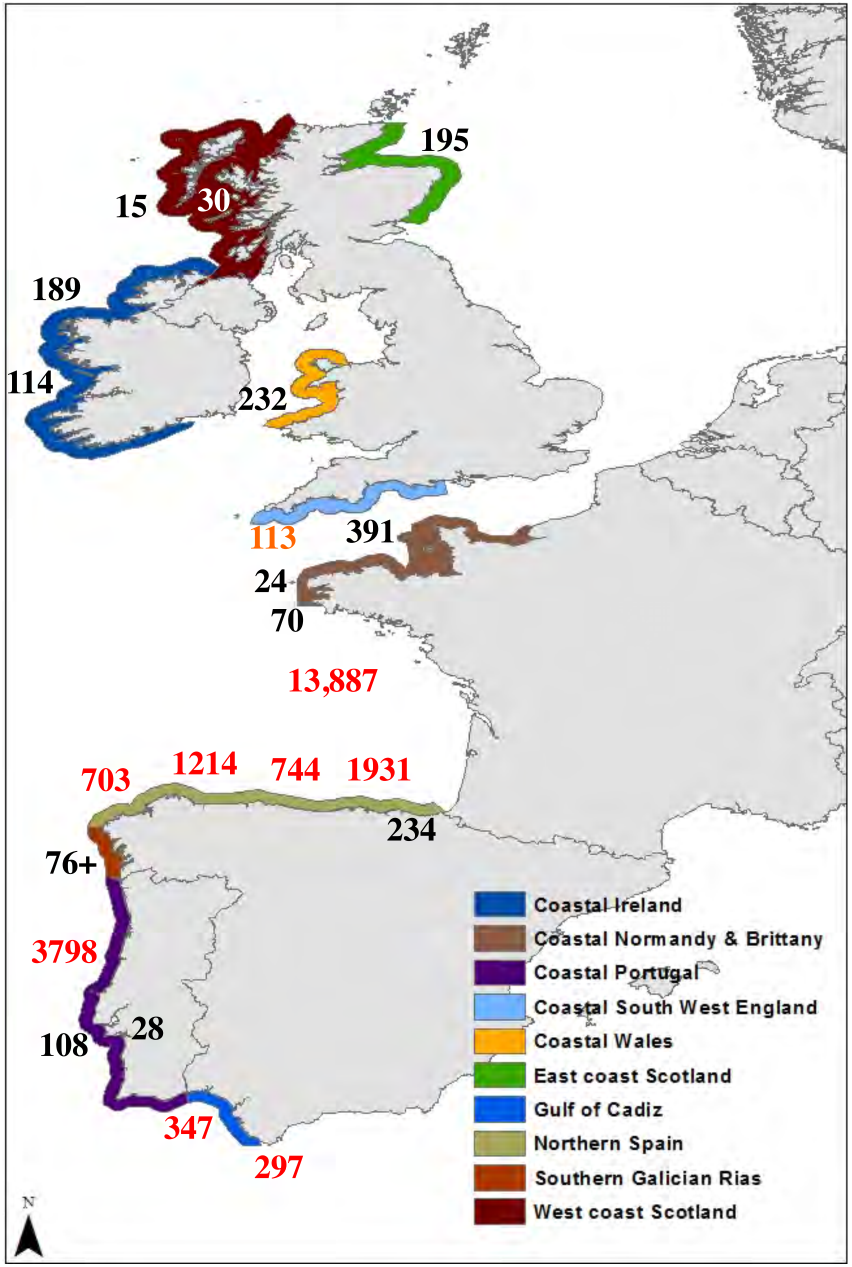


BOTTLENOSE DOLPHIN RESIDENCY RATES IN CARDIGAN BAY SAC (from open population models)




Defining Management Units

POSSIBLE MANAGEMENT UNITS FOR COASTAL BOTTLENOSE DOLPHINS IN ATLANTIC EUROPE



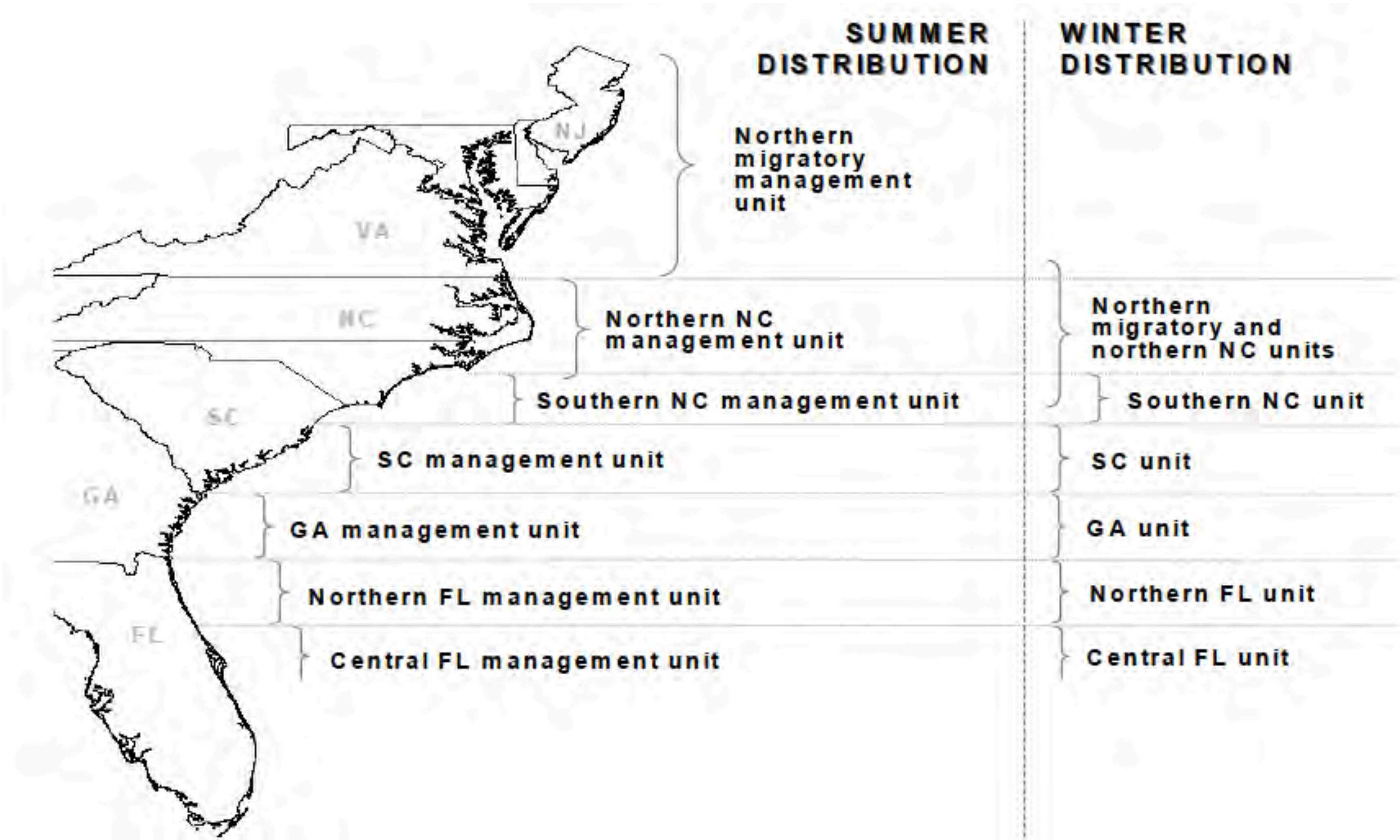
Definition of a Management Unit:

"A group of individuals for which there are different lines of complementary evidence suggesting reduced exchange rates (migration / dispersal) over an extended period (low tens of years)"

Lines of Evidence:

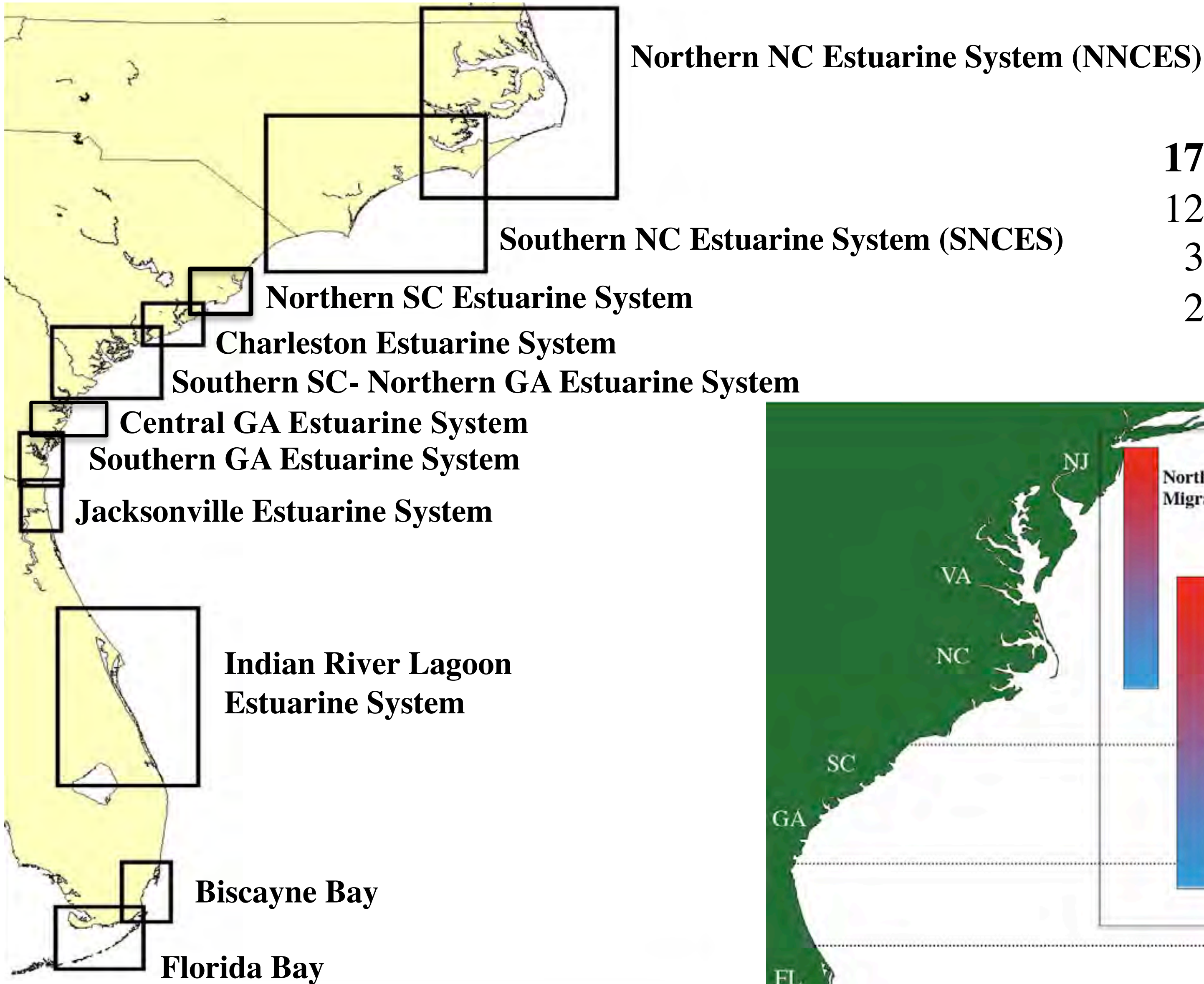
- **Distributions**
- **Photo-ID**
- **DNA analyses**
- **Stable isotopes**
- **Contaminants**
- **Morphometrics**

MANAGEMENT UNITS FOR BOTTLENOSE DOLPHINS IN ATLANTIC UNITED STATES



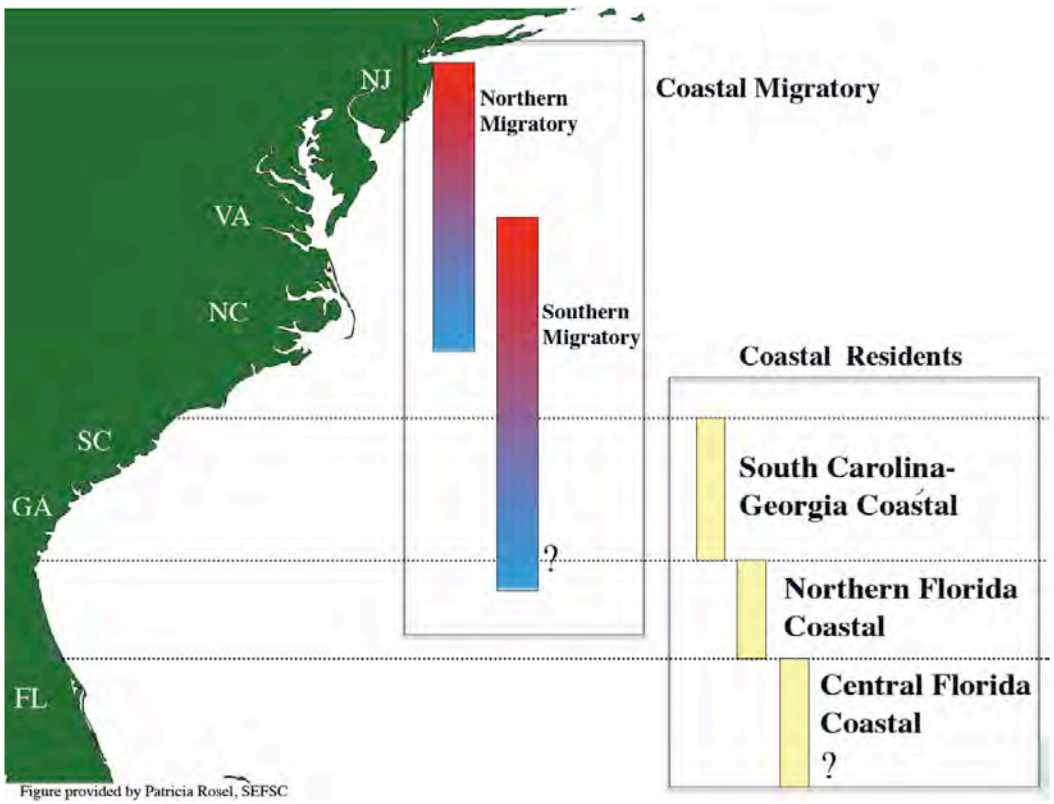
Source: NOAA (2002)

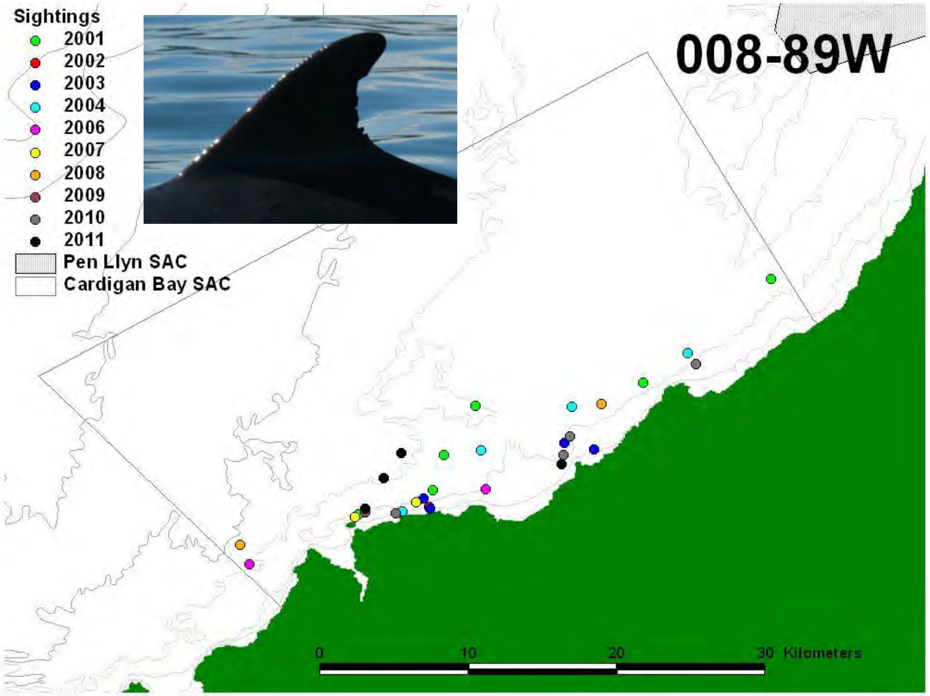
MANAGEMENT UNITS FOR BOTTLENOSE DOLPHINS IN ATLANTIC UNITED STATES

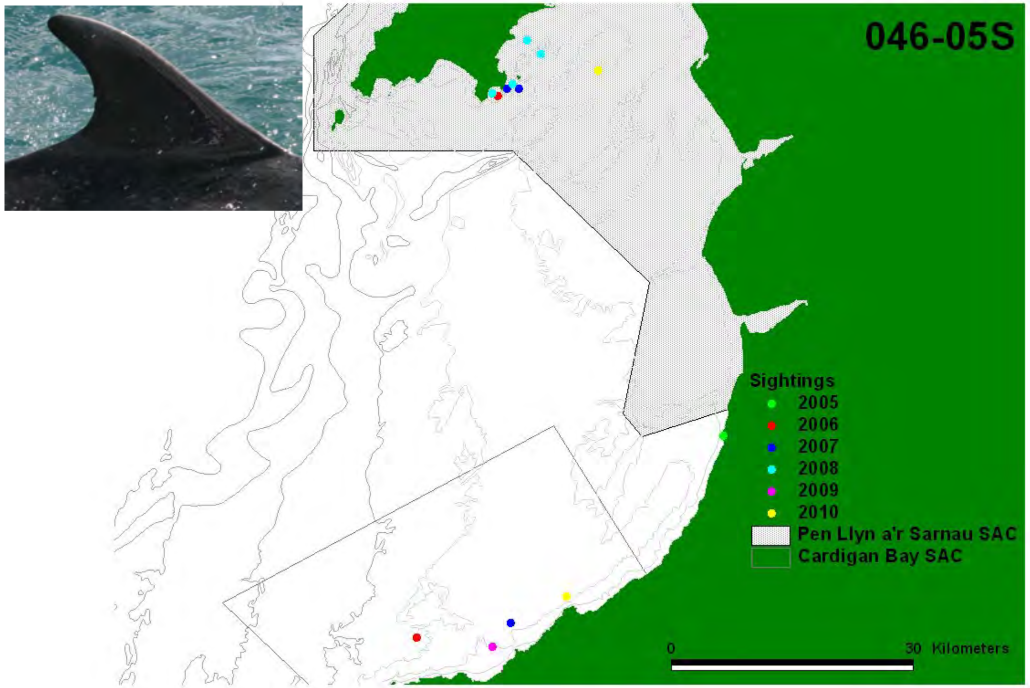


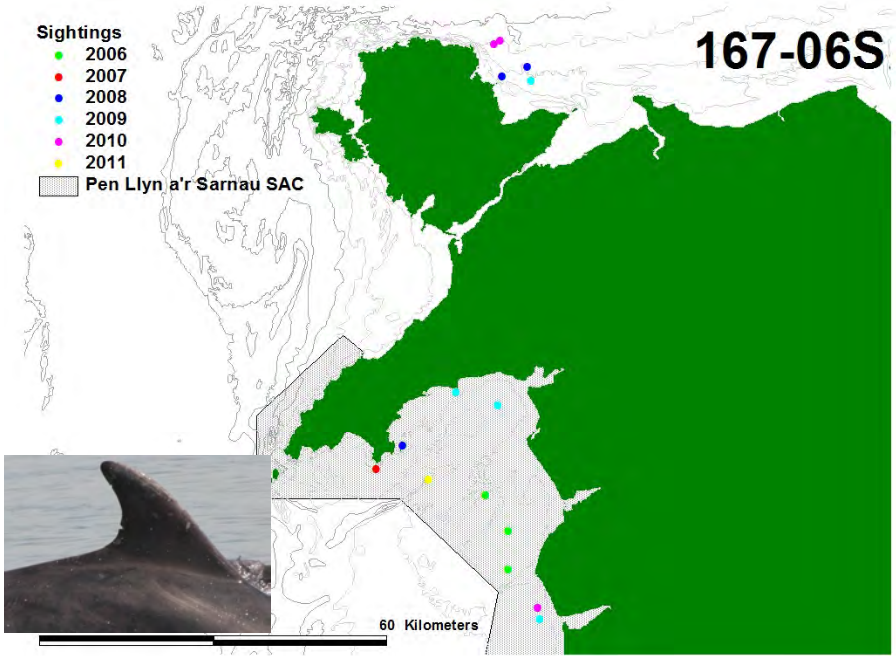
Courtesy of Aleta Hohn, NOAA

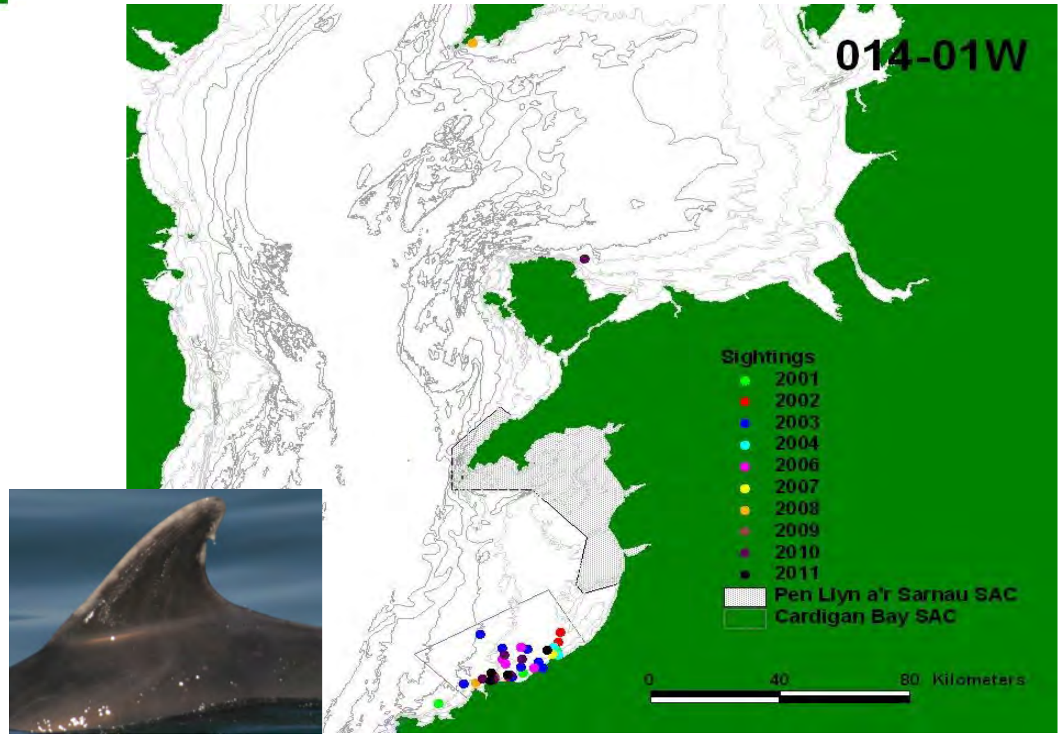
17 separate stocks:
12 Estuarine Residents
3 Coastal Residents
2 Coastal Migrants



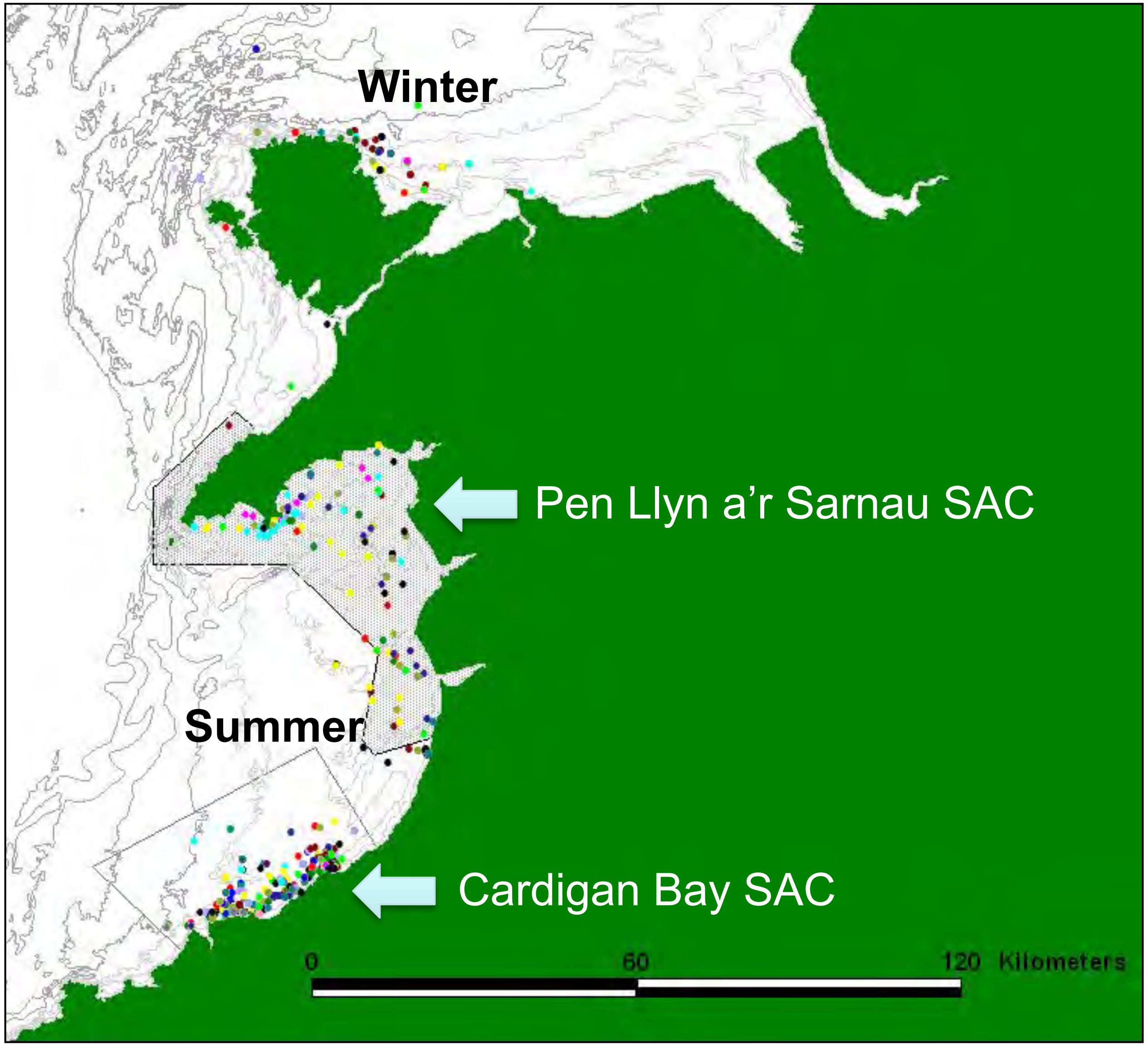

008-89W
Sightings
2001
2002
2003
2004
2006
2007
2008
2009
2010
2011
Pen Llyn SAC
Cardigan Bay SAC
0
10
20
30 Kilometers


046-05S
Sightings
2005
2006
2007
2008
2009
2010
Pen Llyn a'r Sarnau SAC
Cardigan Bay SAC
0
30 Kilometers


167-06S
Sightings
2006
2007
2008
2009
2010
2011
Pen Llyn a'r Sarnau SAC
60 Kilometers


014-01W
Sightings
2001
2002
2003
2004
2006
2007
2008
2009
2010
2011
Pen Llyn a'r Sarnau SAC
Cardigan Bay SAC
0
40
80 Kilometers

HOME RANGES OF BOTTLENOSE DOLPHINS



Bottlenose Dolphin Photo-ID in Wales

- 64% (141/221) of individuals recorded in both Cardigan Bay SAC and North Wales
- 78% (172/221) of individuals recorded in one or both SACs also occurred in North Wales
- 15% (33/221) of individuals recorded only in Cardigan Bay SAC

Source: Veneruso & Evans, 2012

Cardigan Bay Bottlenose Dolphin Population Structure

Best described as a combination of:

- **Residents**

  58% seen > 25 times
  49% seen ≥ 10 years
  small home ranges and travel relatively short distances

- **Occasional visitors**

  26% seen between 11 to 25 times
  27% seen between 4-8 years
  large home range, many km travelled

- **Transients**

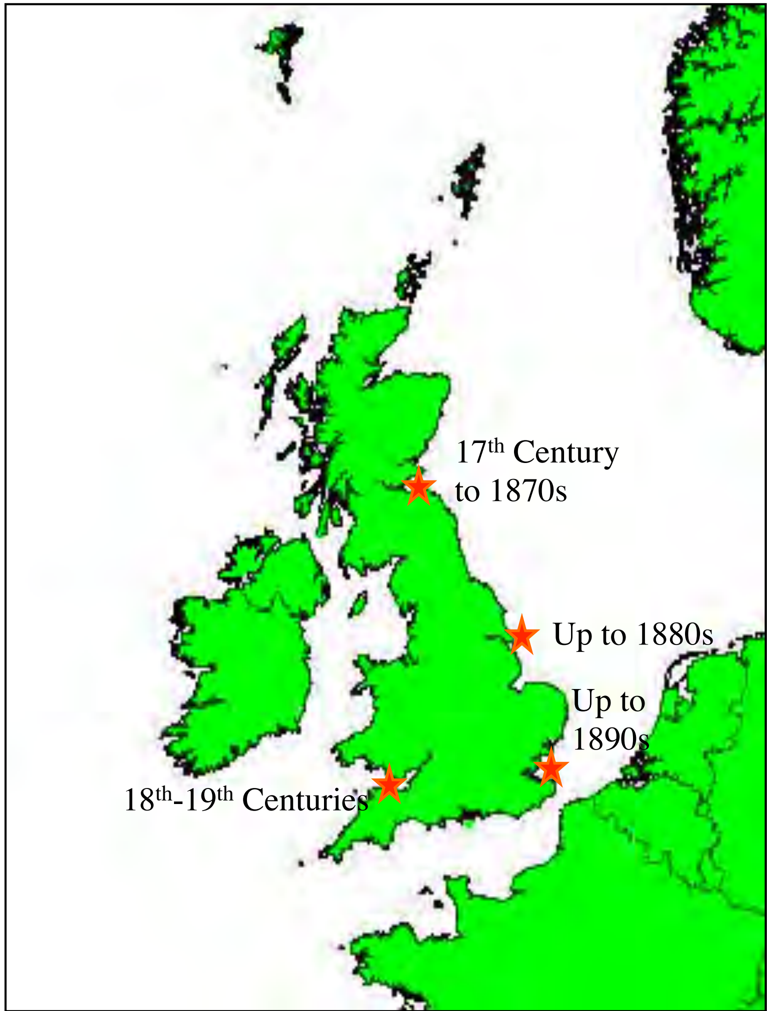
  16% seen between 1 to 5 times
  24% seen between 1 to 2 of the 15 years of data collection
  little information on km travelled or area covered

Considering the Underlying Ecology

POSSIBLE SCHEMATIC TO DESCRIBE BOTTLENOSE DOLPHIN POPULATIONS

Trait	Offshore	Coastal	Estuarine
Home Range	Large	Medium - Large	Small
Prey resources	Mobile pelagic / semi-pelagic fish, e.g. blue whiting, horse mackerel, mackerel, saithe	Benthic / demersal fish, e.g. sole, dab, haddock, whiting + Pelagic fish, e.g. herring, sea bass	Benthic / demersal fish, e.g. sole, dab, + Riverine species, e.g. eel, salmon, trout
Movements	Migratory	Semi-Resident	Resident
Typical group size	Large	Variable	Small
Carrying capacity	Large, in thousands	Medium, in hundreds	Small, in tens

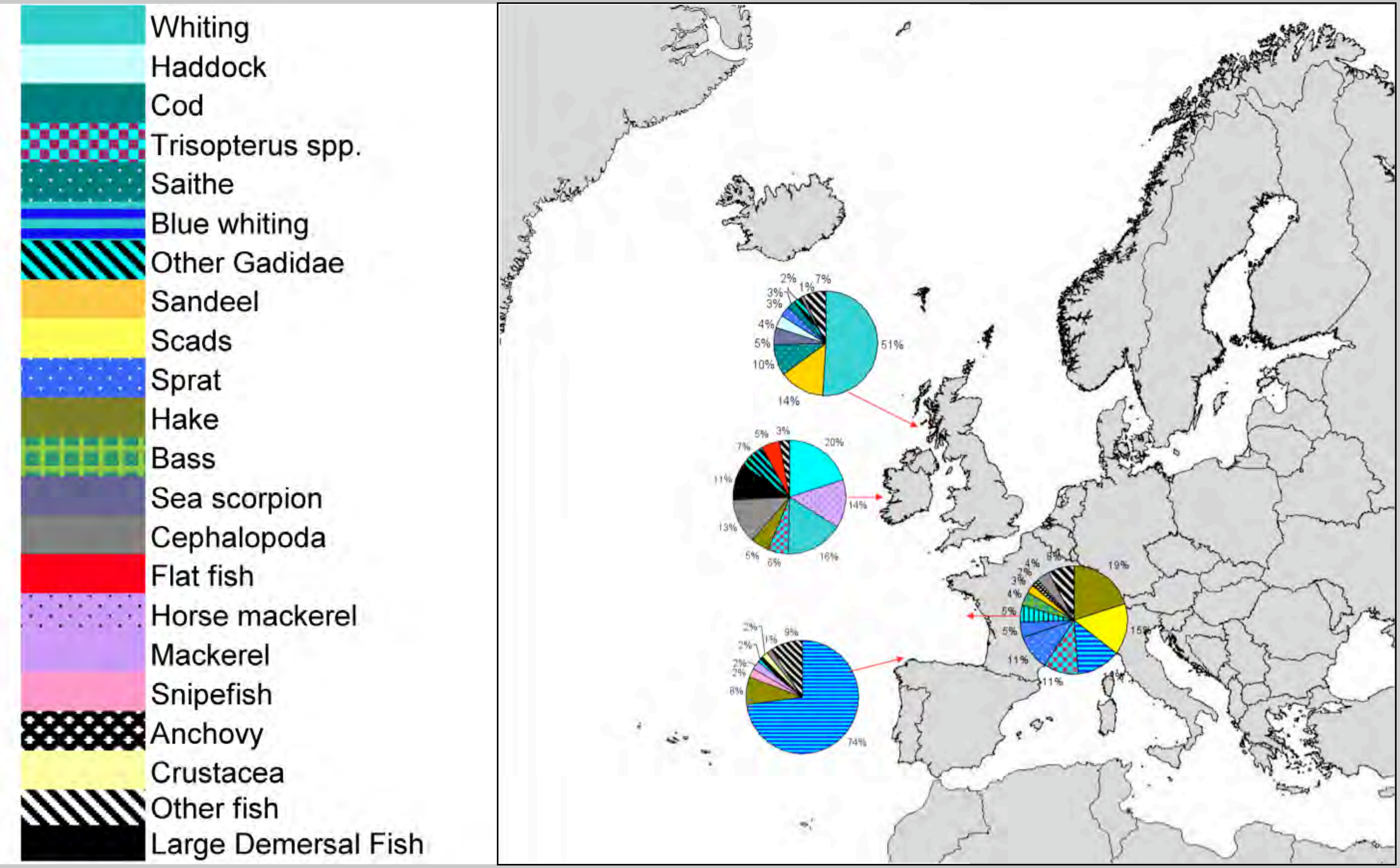
HISTORICAL DISTRIBUTION OF BOTTLENOSE DOLPHINS



Derived from: Evans & Scanlan, 1990

★ = Localities where bottlenose dolphins formerly occurred regularly

BOTTLENOSE DOLPHIN DIET IN NW EUROPE (BY NUMBER)



Source: Santos *et al*., 2001, 2007; Spitz *et al*., 2006; Hernandez-Milian *et al*., 2015

BOTTLENOSE DOLPHINS CAPTURING FISH

BOTTLENOSE DOLPHIN DIET

Species recorded taken in Welsh coastal waters:

Riverine
- Atlantic salmon
- Trout
- Eel

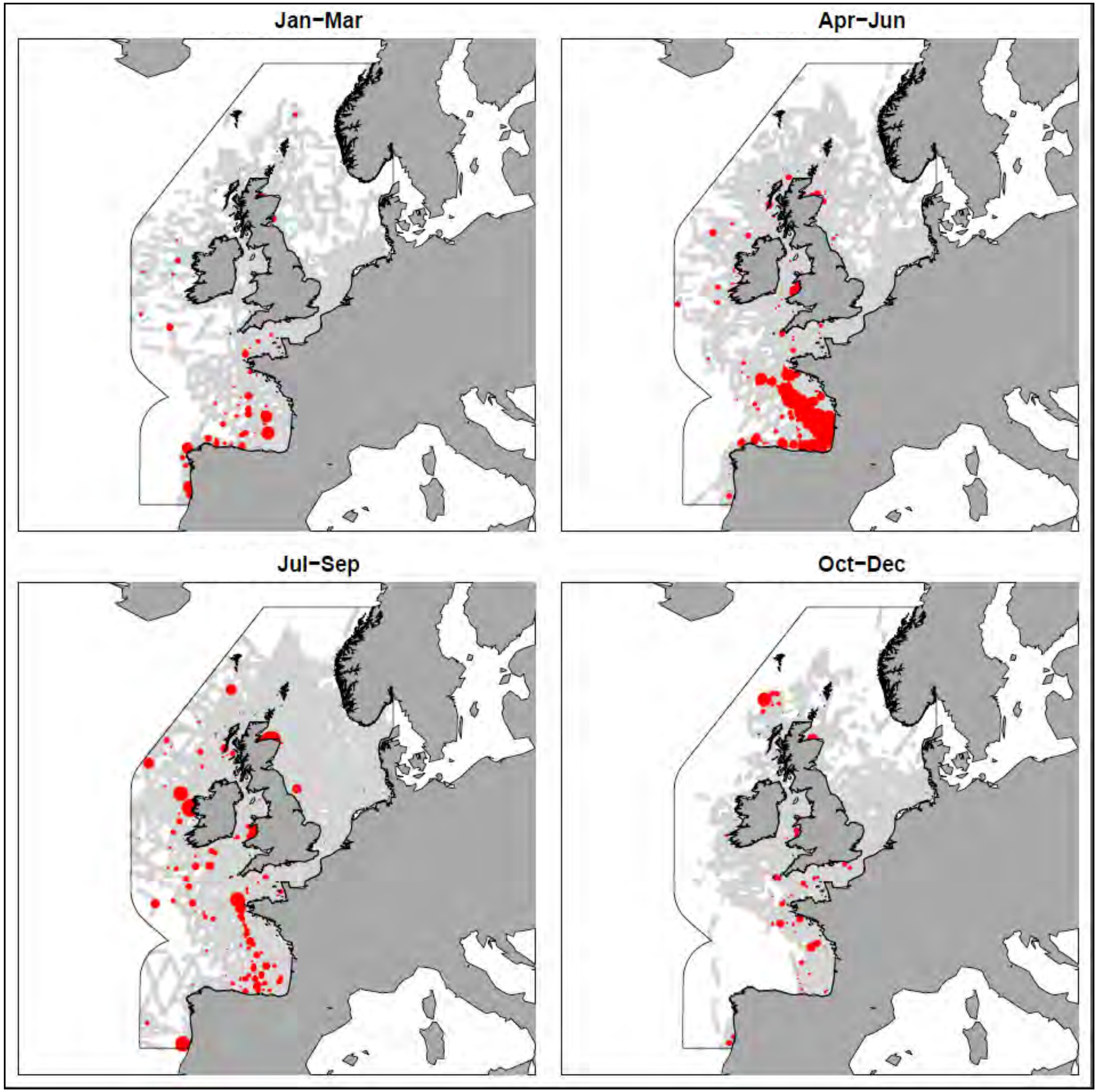
Benthic
- Sole
- Brill

Bentho-pelagic
- Sandeel

Demersal (Pelagic in 1st 2-3 mo)
- Whiting

Shallow pelagic
- Sea bass
- Garfish
- Smooth-hound

BOTTLENOSE DOLPHIN DISTRIBUTIONS



based currently upon

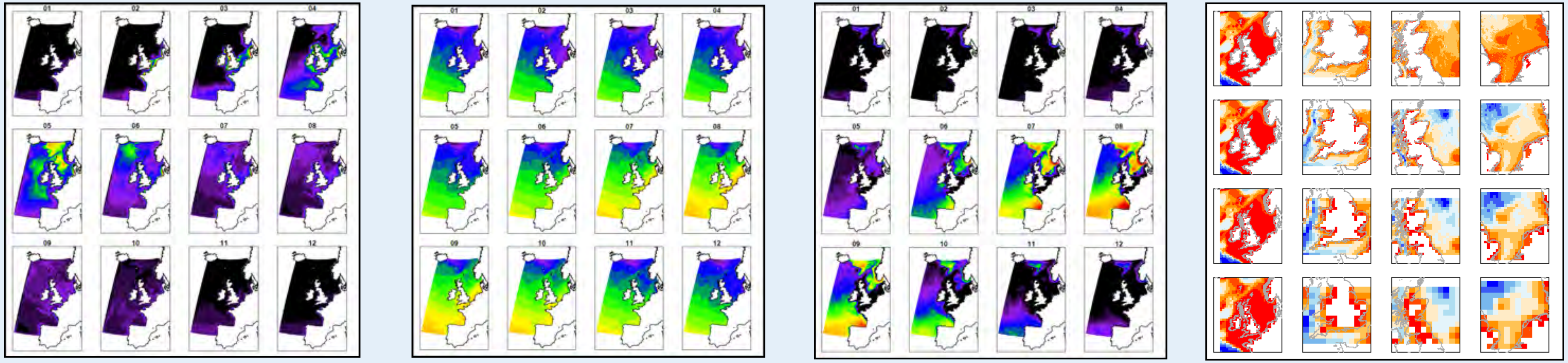
1.8 million km of survey effort from c 50 research groups, mainly from between 1990-2015

Marine Ecosystems Research Programme

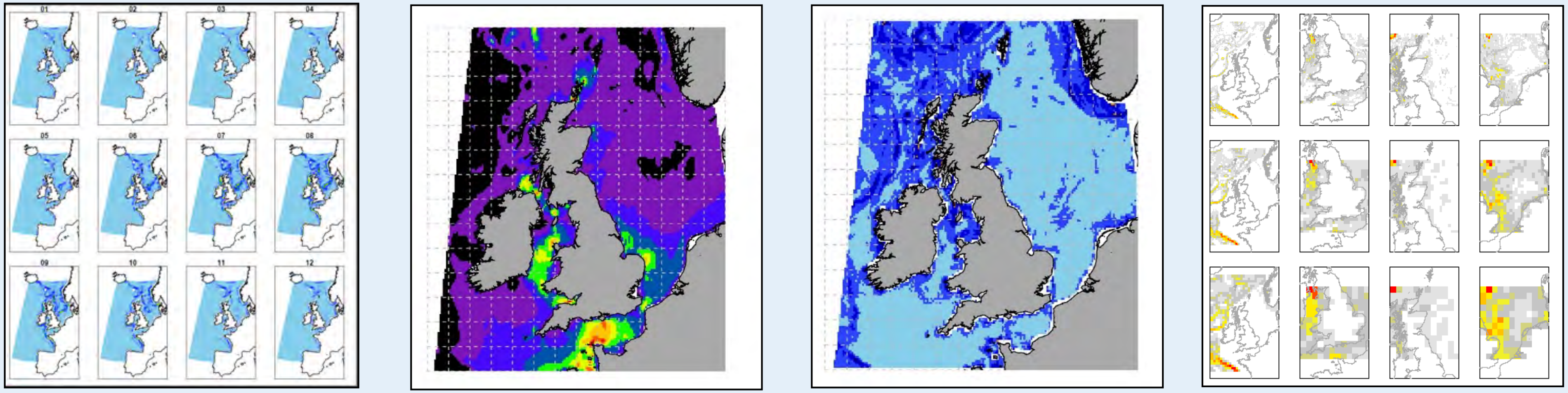
NERC SCIENCE OF THE ENVIRONMENT

Department for Environment Food & Rural Affairs

Collating Environmental Data

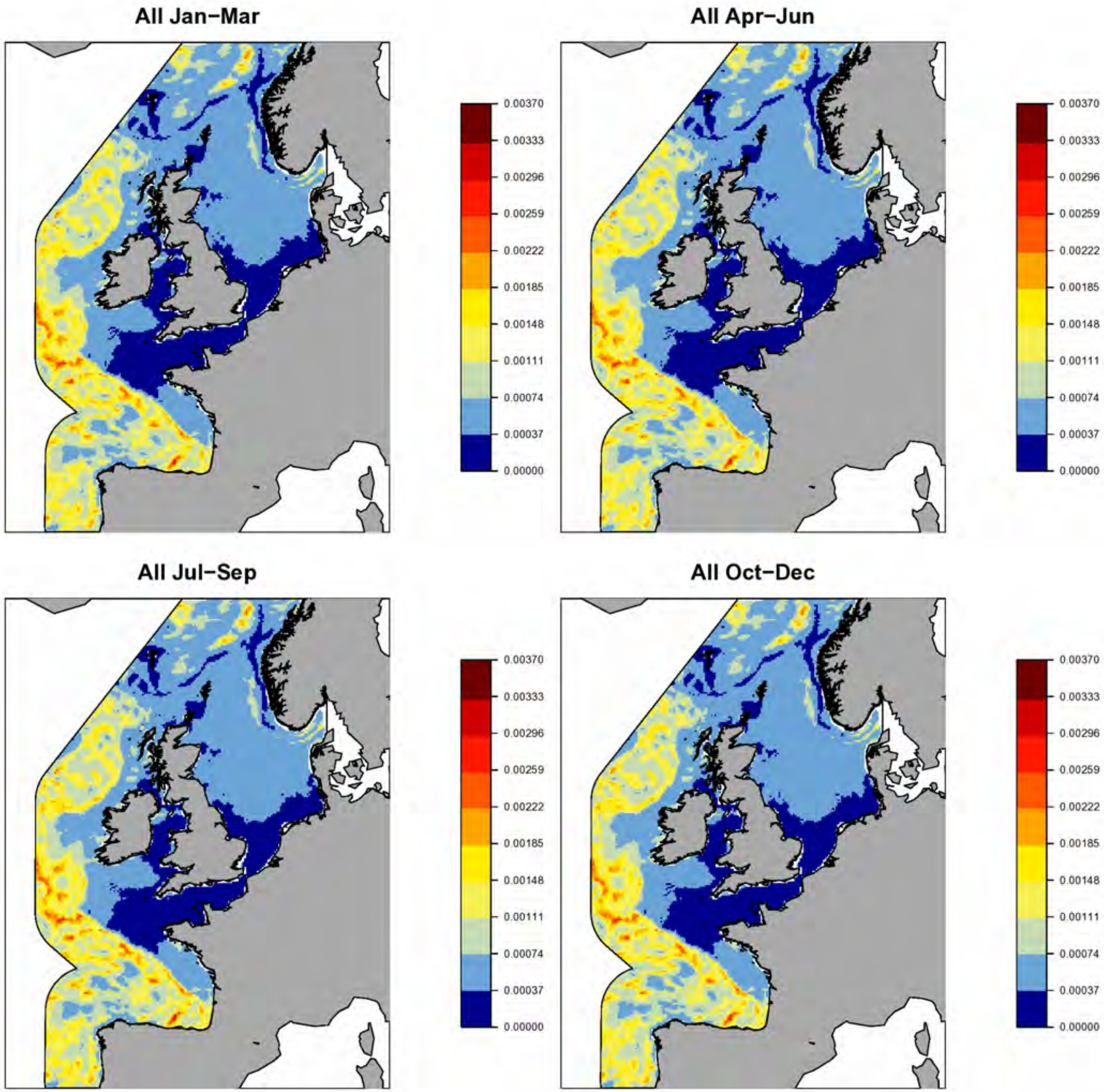


Coarse-scale processes likely to influence prey communities and abundances
(Left to Right: Primary Productivity, Temperature, Stratification and Depth)



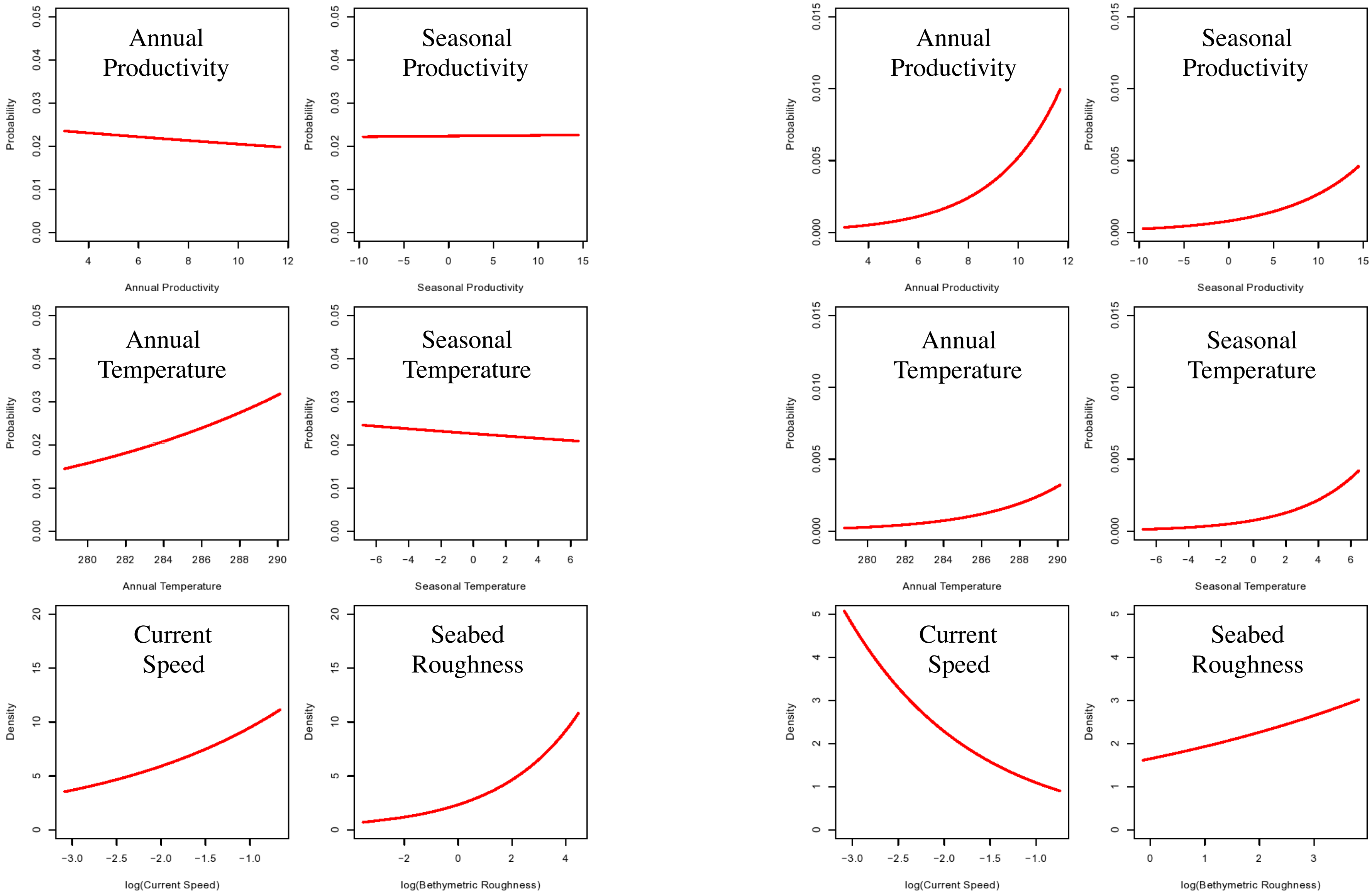
Finer-scale processes likely to influence prey availability
(Left to Right: Tidal Fronts, Current Speed, Eddy Potential and Seabed Roughness)

PREDICTED DISTRIBUTIONS

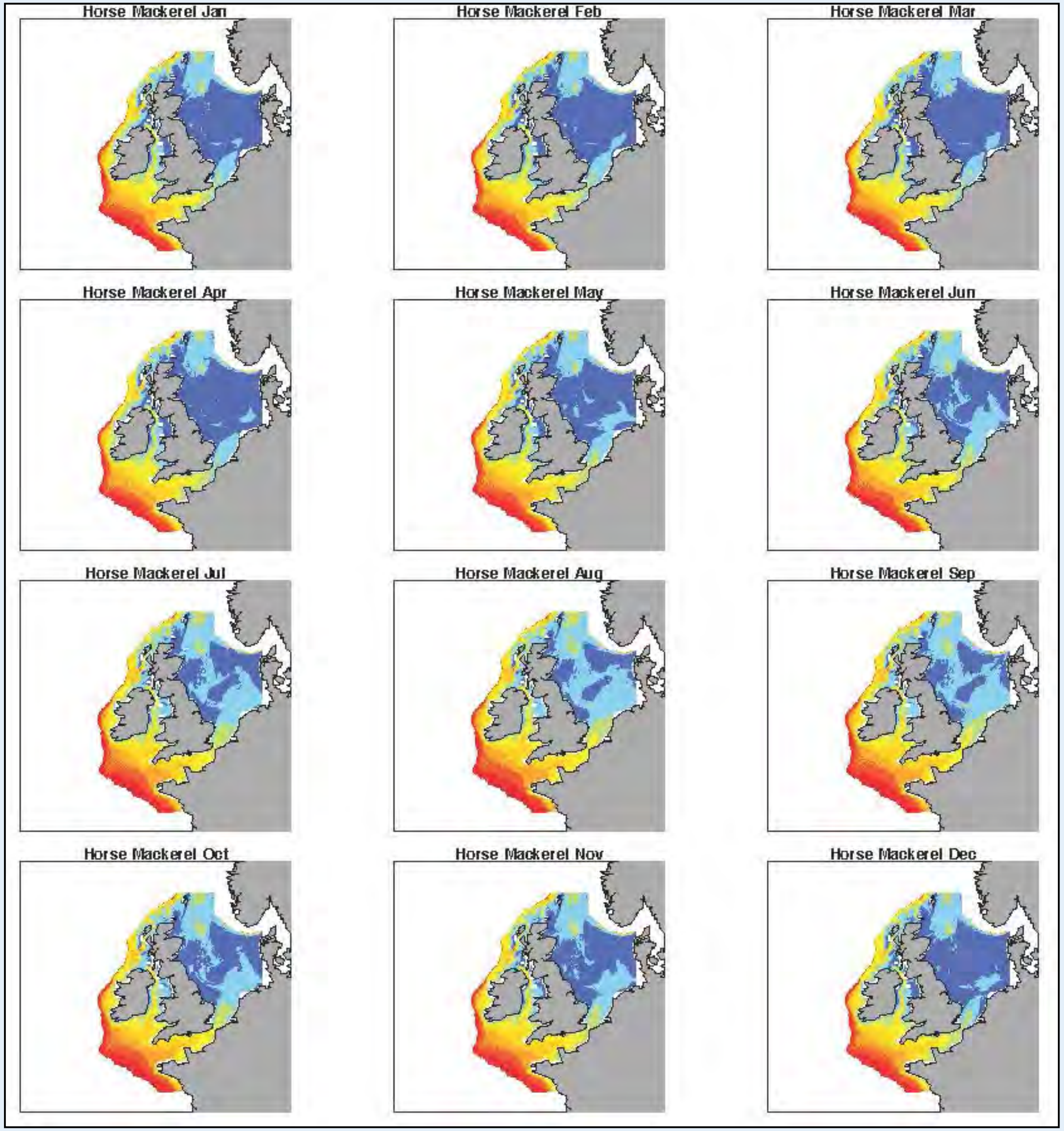


ENVIRONMENTAL RELATIONSHIPS TO BOTTLENOSE DOLPHIN DISTRIBUTIONS

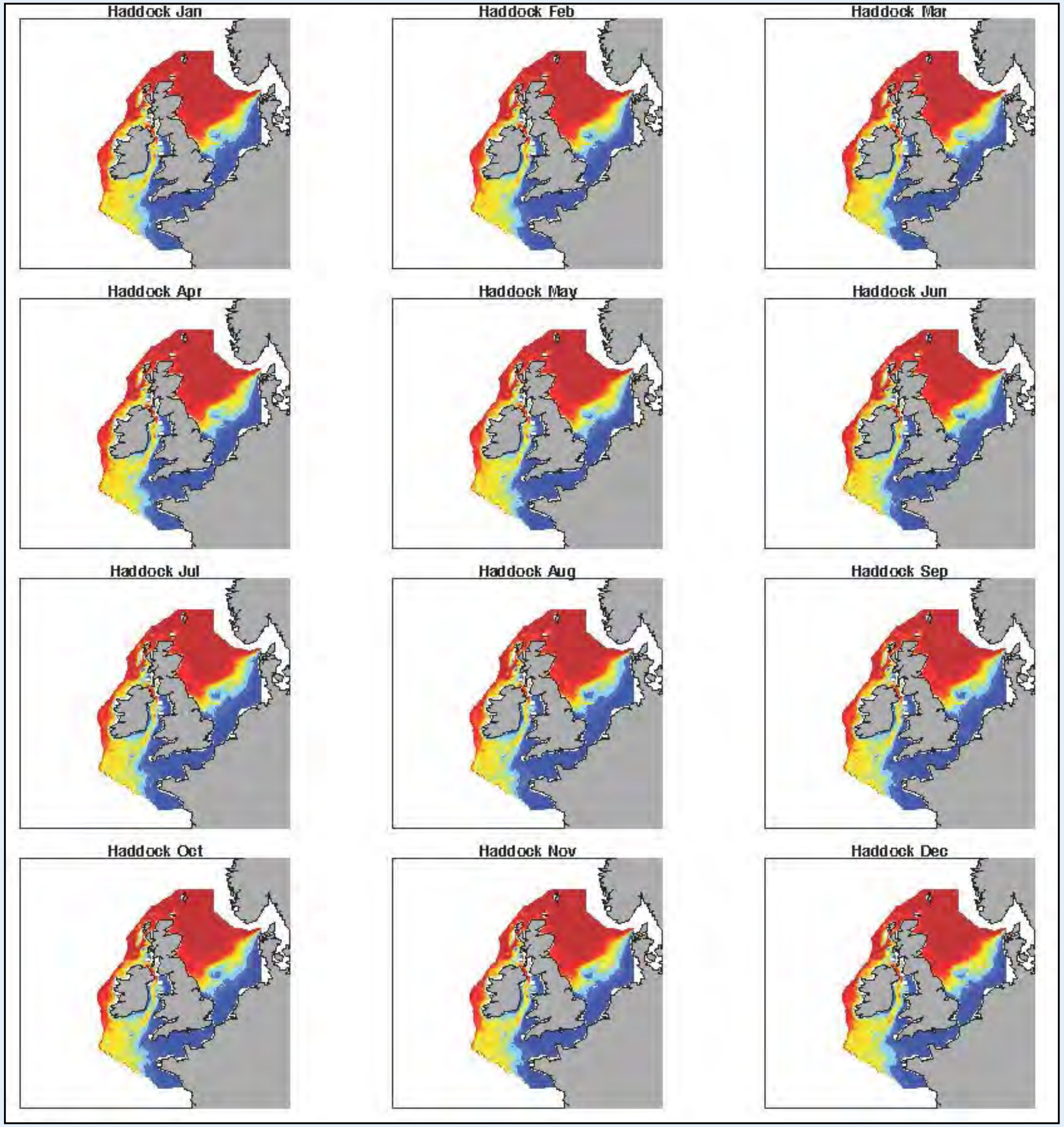
a) Offshore b) Coastal



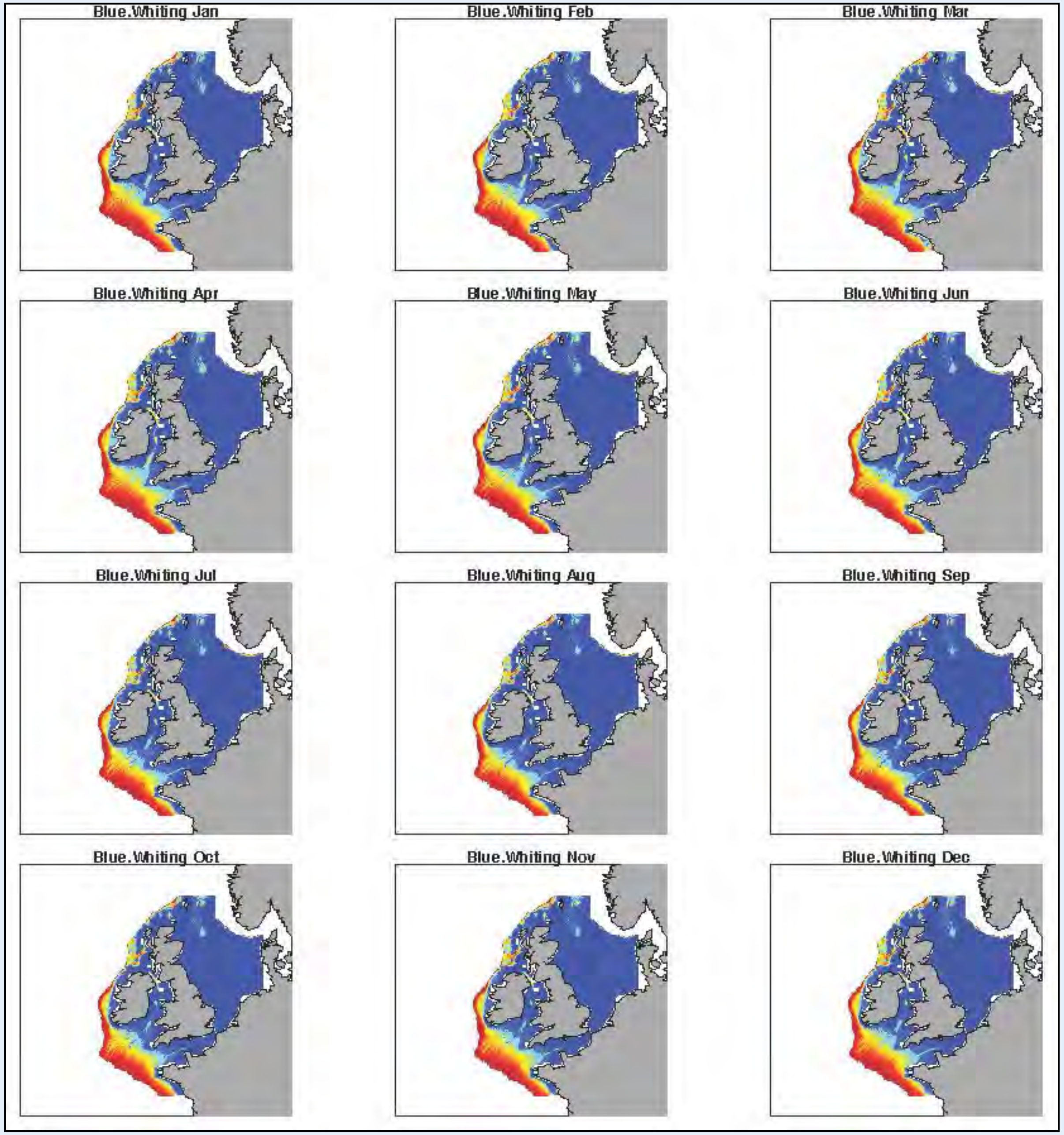
Modelling Monthly Prey Distributions: Horse Mackerel



Modelling Monthly Prey Distributions: Haddock



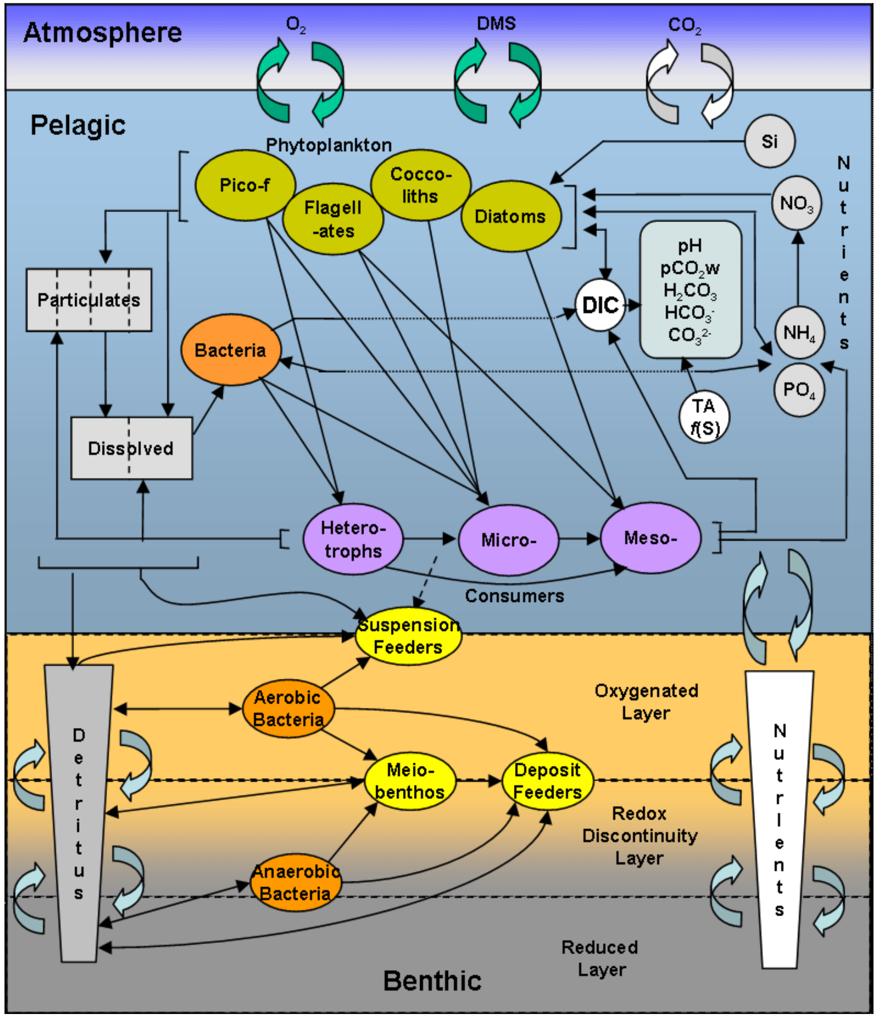
Modelling Monthly Prey Distributions: Blue Whiting



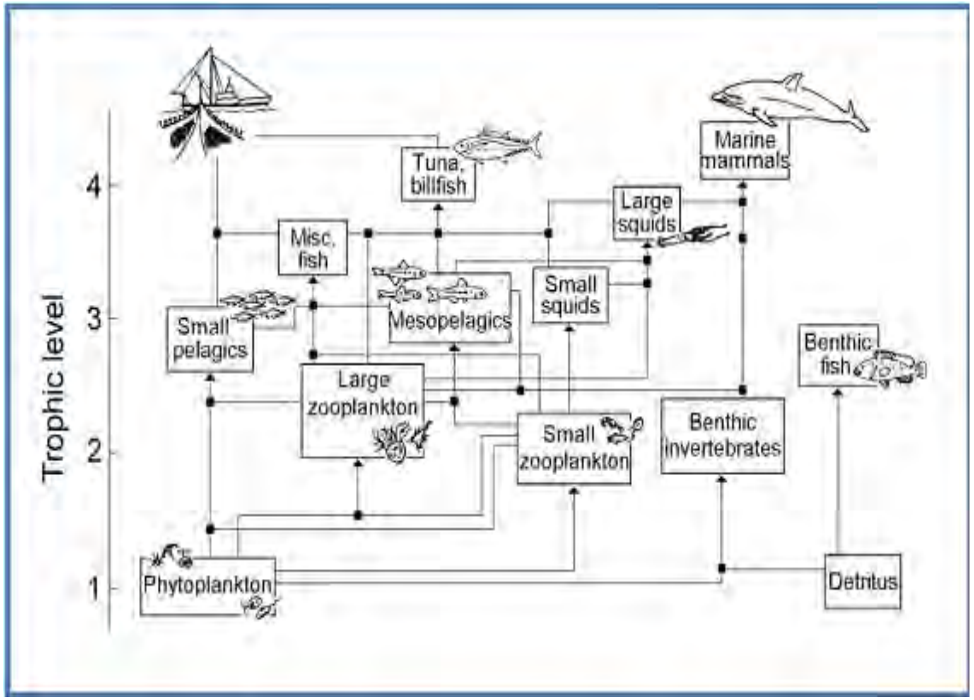
Bottlenose Dolphins in the Wider Ecosystem

MARINE ECOSYSTEMS RESEARCH PROGRAMME

a) Trophic structure of the European Regional Seas Ecosystem Model (ERSEM)



b) Schematic illustration of a food web, produced with the Ecopath ecosystem modelling software



NERC
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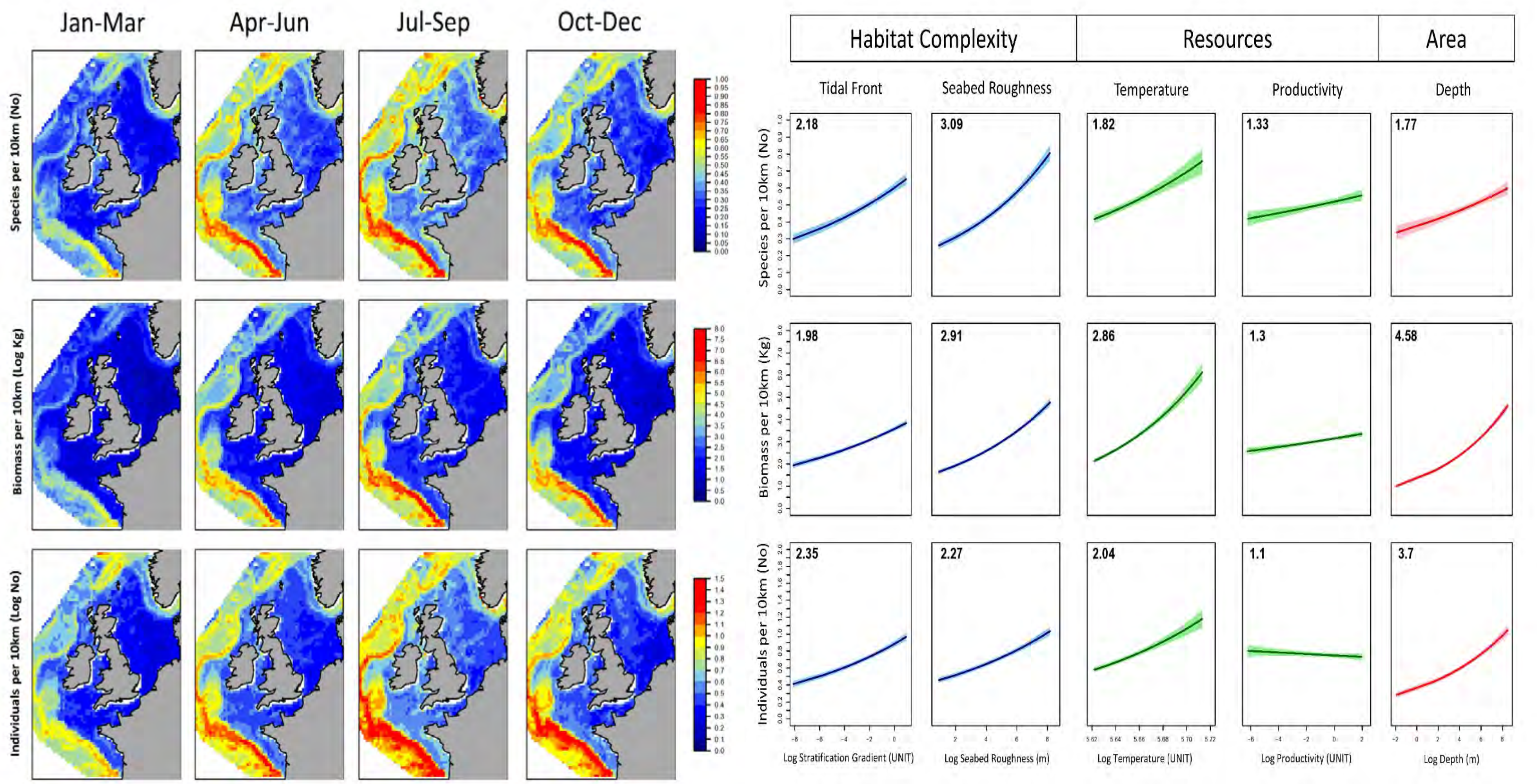
Marine Ecosystems Research Programme

Department for Environment Food & Rural Affairs

Cetacean Species Diversity, Biomass & Abundance

a) Seasonal modelled relationships for cetacean communities

b) physical & oceanographic features, prey resources




Thank You for Listening

Conserving bottlenose dolphins effectively in large EEZs:

The UK experience for now and the future

Eunice Pinn

Joint Nature Conservation Committee (JNCC)

The UK EEZ comprises approximately 774,000km^2 excluding overseas territories. This is considerably larger than any other EEZ within European waters. The total UK population of bottlenose dolphin is estimated to be approximately 7,000 individuals. The vast majority of these are wide ranging offshore animals, with approximately 700 of these constituting four coastal populations: East Coast Scotland, Coastal Wales, West Coast Scotland and Coastal Southwest England. For the purposes of management, the UK's EEZ has been divided into a number of management units[1]. The UK also has 3 SACs with bottlenose dolphin as a qualifying feature and an additional 11 with non-qualifying presence. There is no evidence of persistent areas found in offshore waters.

For the wider ranging offshore animals, a good understanding of abundance and distribution is ascertained through large scale population surveys such as SCANS and CODA, as well as through the collation of more localised surveys through the Joint Cetacean Protocol[2] (JCP). The JCP developed to bring together spatially and temporally disparate datasets. It includes over 1 million km of survey effort with data from 1970s through 2010, from 545 distinct effort-related surveys from ships and aircraft. For the coastal populations, photo ID and inshore line transect surveys are more important. These inshore surveys also provide an opportunity to undertake more detailed work such as activity and behaviour studies, investigating birth rates, etc.

Management of human activities takes a risk based approach. There is a UK wide strandings scheme which monitors different causes of death. Key observed causes of death include bycatch, live strandings, physical trauma and the PCB issue. There is also a separate bycatch monitoring scheme using independent onboard observers. To date c. 17,000 static nets hauls have been observed and c. 2,500 pelagic and demersal trawls have been observed. The management units provide an indication of spatial scale for the assessment of plans and projects (alone, cumulatively and in-combination). The UK has produced protocols on minimising risk of injury to marine mammals from the use of explosives[3], seismic surveys[4] and piling operations[5] that should be followed during any licensable activity. New projects/developments must also demonstrate that they will not commit an Injury offence which affects the ability of the species to survive, breed, rear or nurture its young, or affect its hibernation or migration patterns, or commit a Disturbance offence where the local distribution or abundance of the protected species is affected. For SACs, the Habitats Regulations Appraisal looks at the effect a proposed activity may have on SAC integrity.

Key knowledge gaps include identification of fine-scale population structure (i.e. presence of parapatric coastal and offshore populations), to quantify and explore reasons for changes in distribution (i.e. if recovery of range is possible?) and the consequences of human activities, particularly habitat deterioration (including pollutants) and disturbance from recreational activities (including commercial dolphin watching), on our coastal populations.

[1] http://jncc.defra.gov.uk/page-6943
[2] http://jncc.defra.gov.uk/page-5657
[3] http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Explosives%20Guidelines_August%202010.pdf
[4] http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Seismic%20Guidelines_Aug%202010.pdf
[5] http://jncc.defra.gov.uk/pdf/jncc_guidelines_piling%20protocol_august%202010.pdf

Conserving bottlenose dolphins effectively in large EEZs – the UK experience for now and the future

Eunice Pinn

Monitoring and Management

Joint Nature Conservation Committee

Abundance and distribution

- SCANS, CODA and the Joint Cetacean Protocol
- Photo ID and inshore surveys

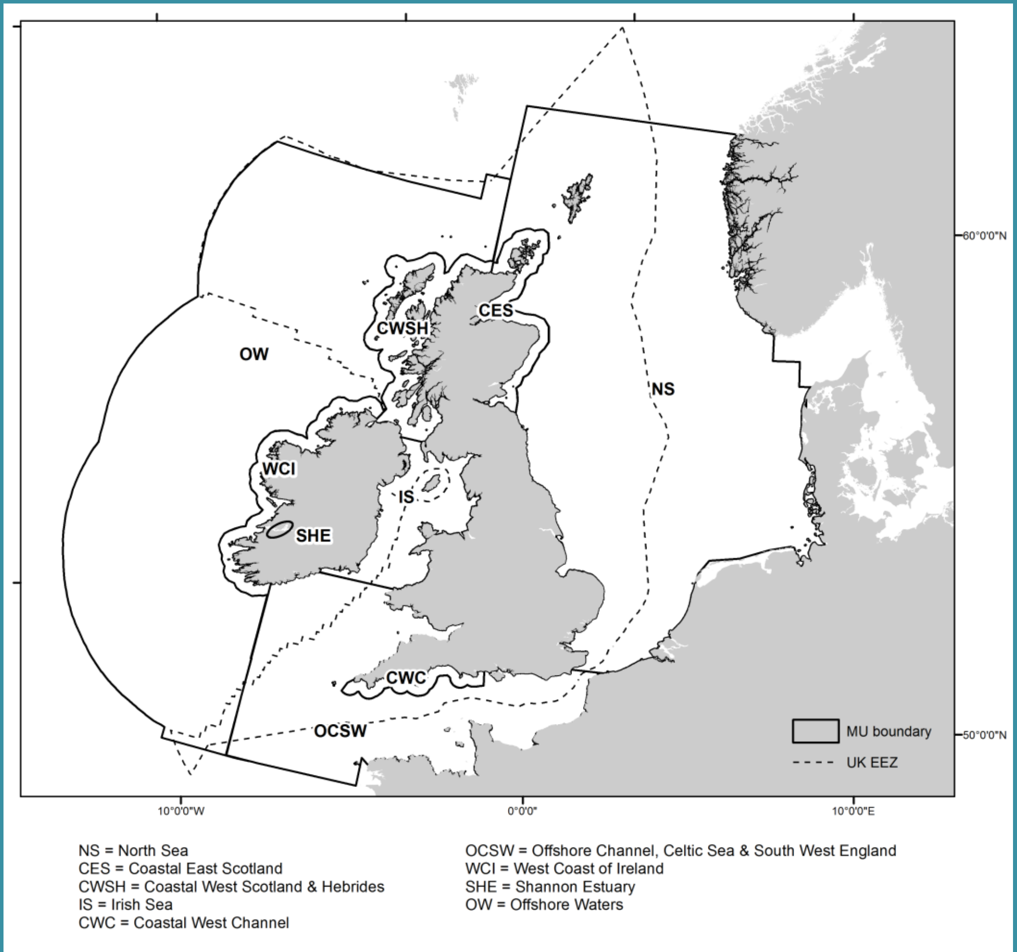
Protected Areas

Risk based approach to activities:

- UK CSIP
- Bycatch monitoring
- Guidelines for Seismic surveys, Pile Driving and Use of Explosives
- EPS licensing

Management Units

Joint Nature Conservation Committee



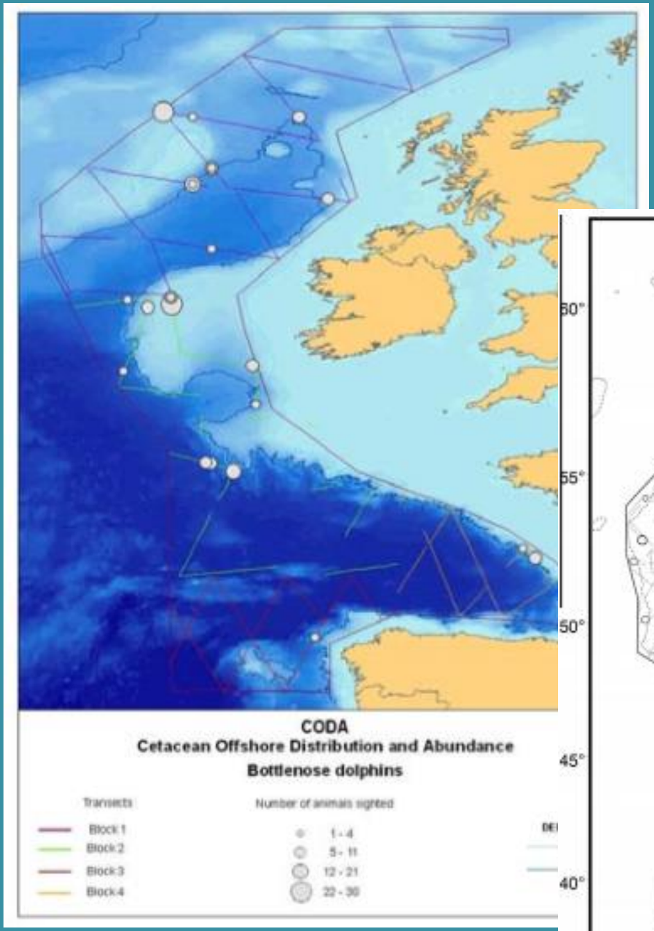
Provides an indication of spatial scale for the assessment of plans and projects (alone, cumulatively and in-combination)

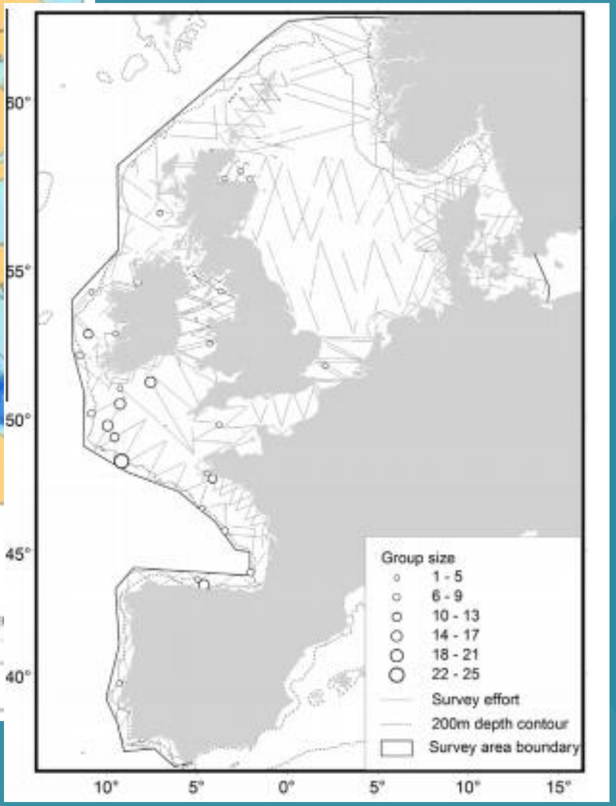
Update anticipated 2019

IAMMWG. 2015. Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, JNCC Peterborough

SCANS and CODA surveys

Joint Nature Conservation Committee



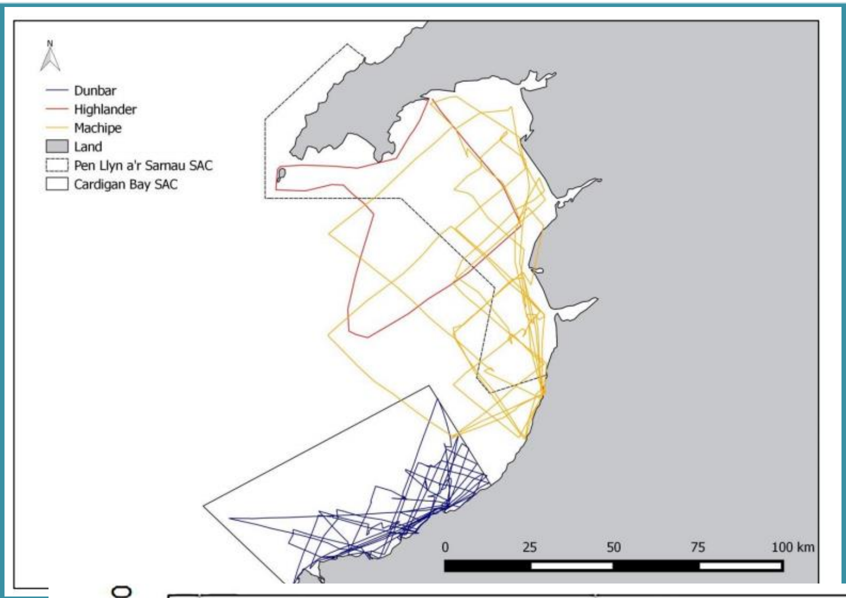


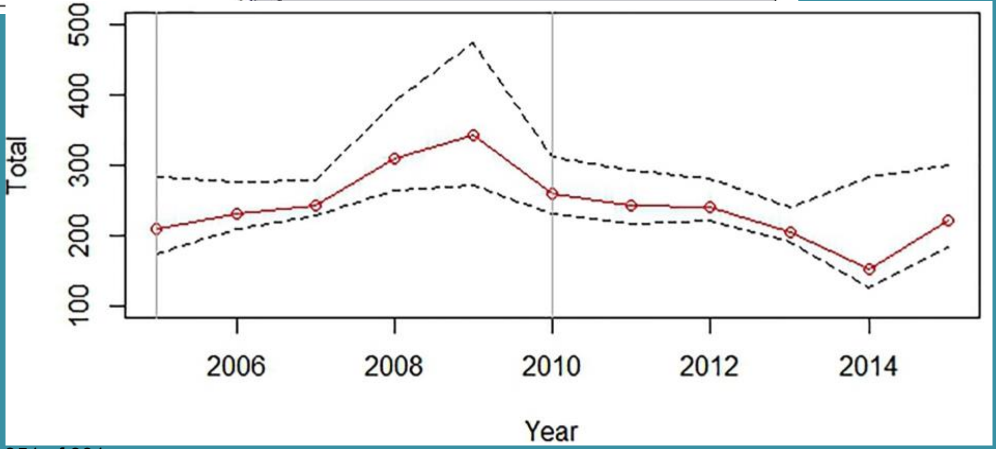
Significant supporter of the SCANS and CODA surveys

Valuable for robust population estimates: the offshore ‘UK’ population (c. 6200)

Inshore surveys

Joint Nature Conservation Committee



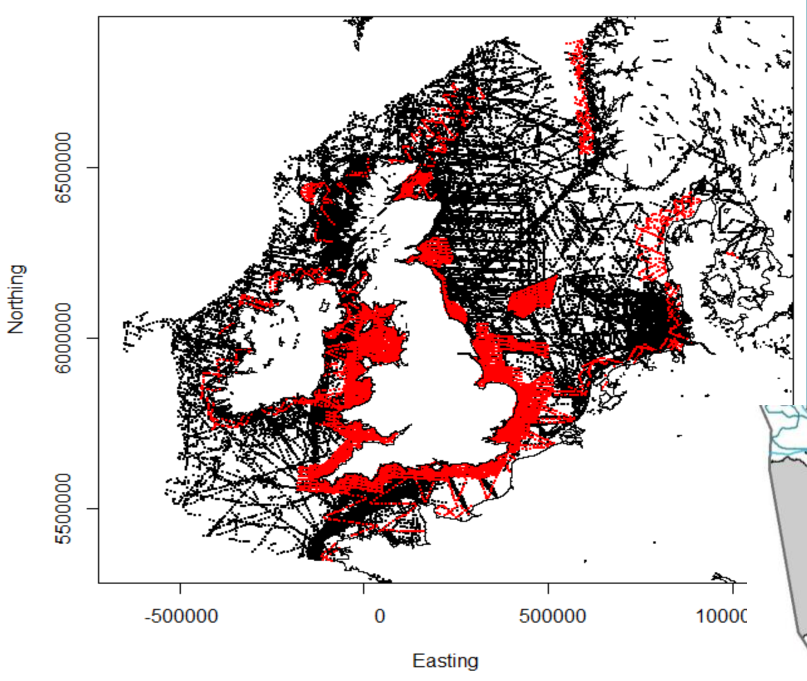


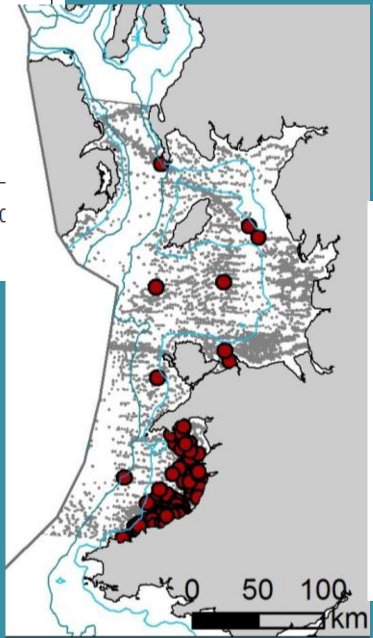
Coastal population estimates come from Photo ID and localised surveys:
 NE Scotland - 195 [95% CI: 162-253]
UK part of Irish Sea – 397 [95% CI: 362-414])

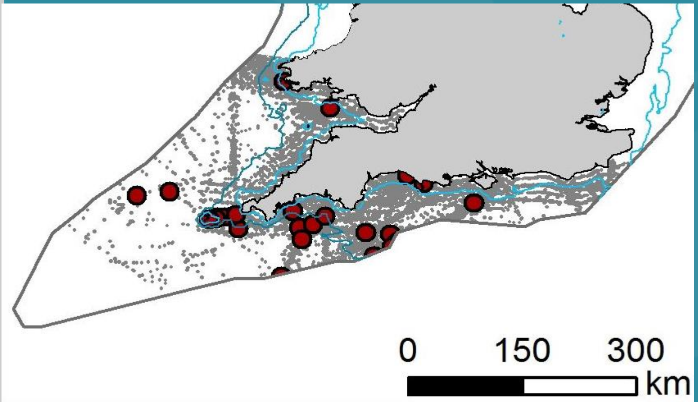
Opportunity to undertake more detailed work – activity/behaviour, birth rates etc

Joint Cetacean Protocol

JCP developed to bring together spatially and temporally disparate data
Data from 1970s through 2010
545 distinct effort-related surveys from ships and aircraft
Over 1 million km of survey effort







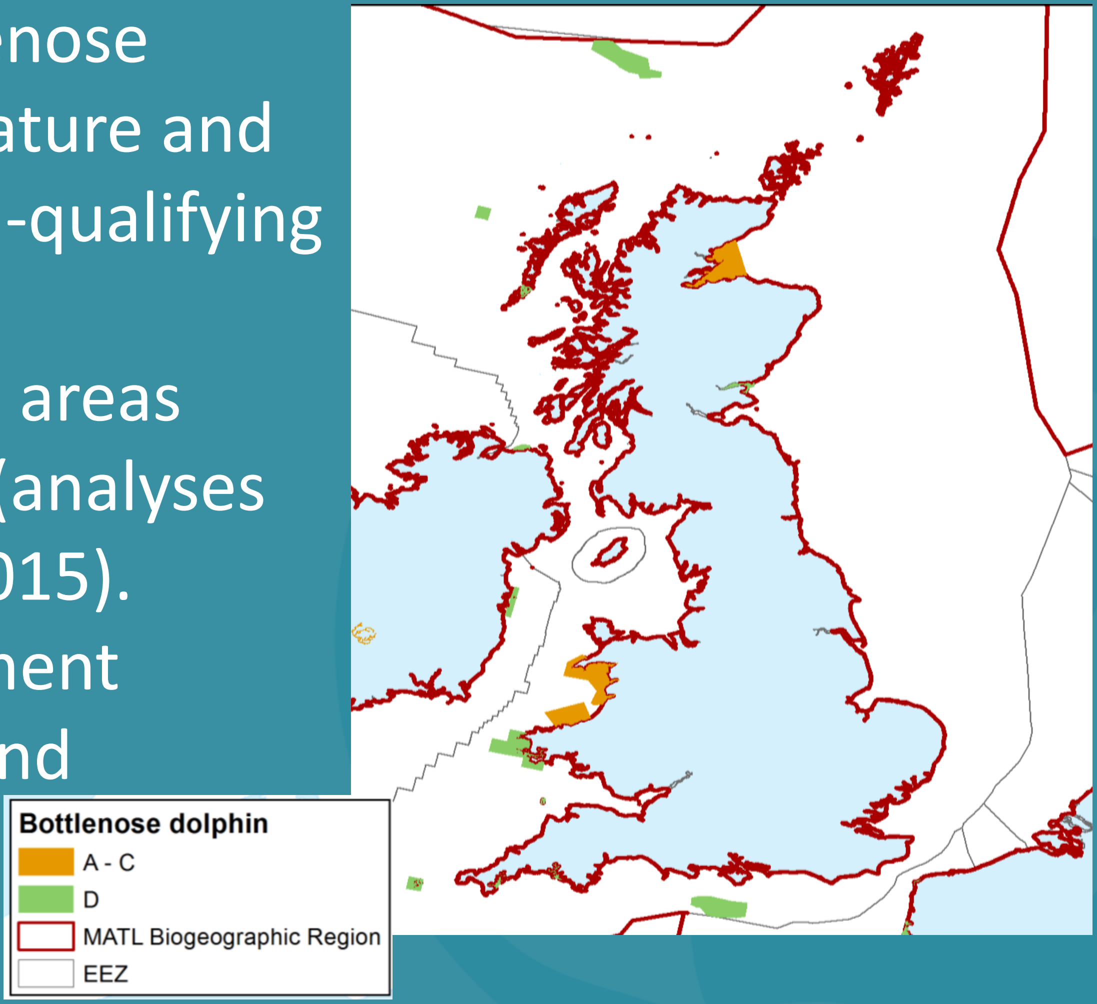
Example transects and bottlenose dolphin sightings data for 2006-2010 in JCP

Protected Areas

UK has 3 SACs with bottlenose dolphin as a qualifying feature and an additional 11 with non-qualifying presence.

No evidence of persistent areas found in offshore waters (analyses conducted in 2005 and 2015).

Monitoring and management focused on NE Scotland and Cardigan Bay Area

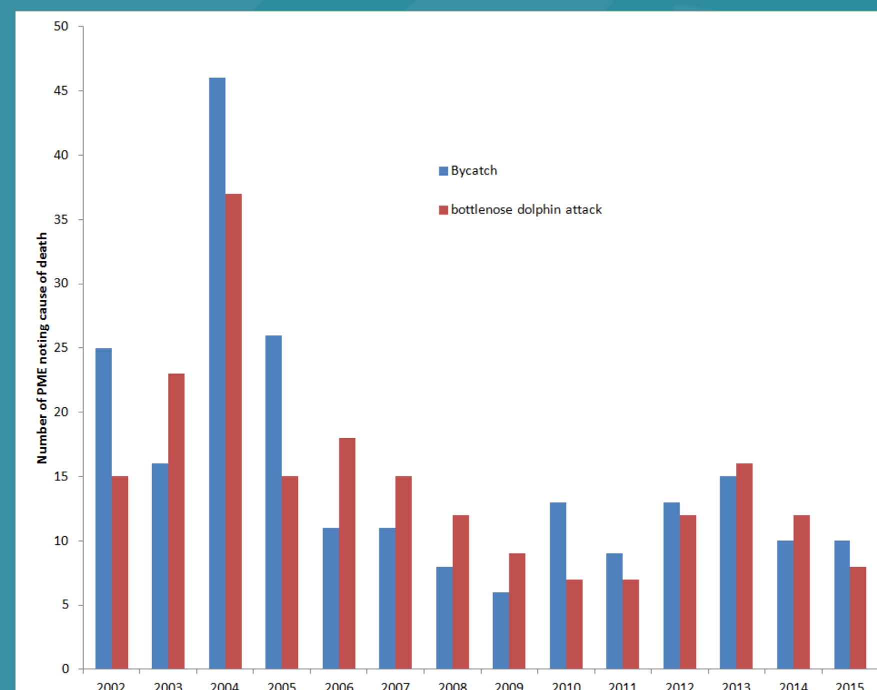


Risk based approach: UK CSIP

Joint Nature Conservation Committee

Identification of key causes of death: bycatch, live strandings and physical trauma plus the PCB issue

Based on PME statistics: Bottlenose dolphin kill as many harbour porpoise as we do through bycatch (mean number harbour porpoise PME per annum = 85±33)



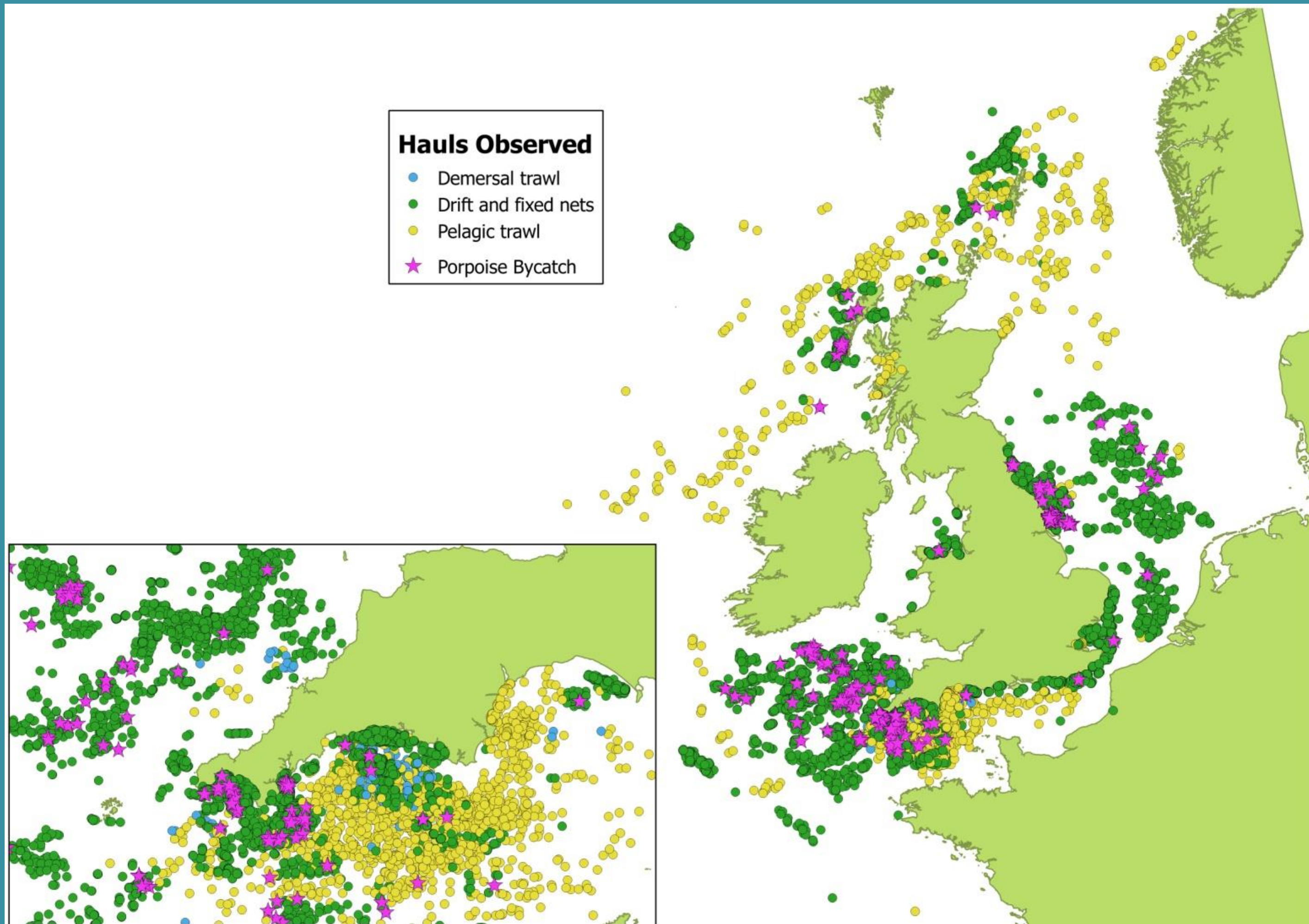
Bycatch Monitoring

Joint Nature Conservation Committee

CSIP provides an indication of where additional monitoring might be required.
1996 bycatch research projects were set up resulting in formal introduction of UK Bycatch Monitoring Strategy in 2003 .

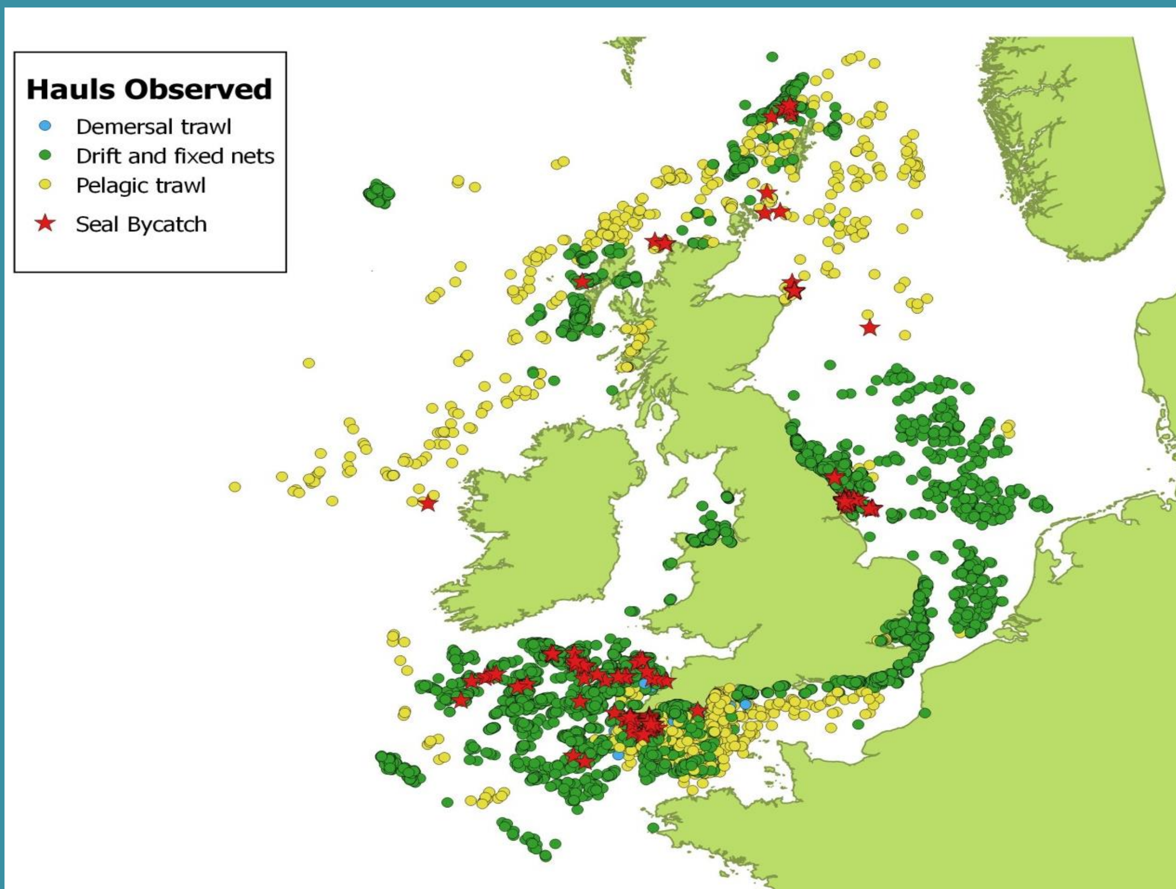
Covers all protected species: cetaceans, seals, seabirds
Independent onboard observers
Static nets hauls observed: c. 17,000; of which c. 300 were drift nets
Pelagic and demersal trawls observed: c. 2,500

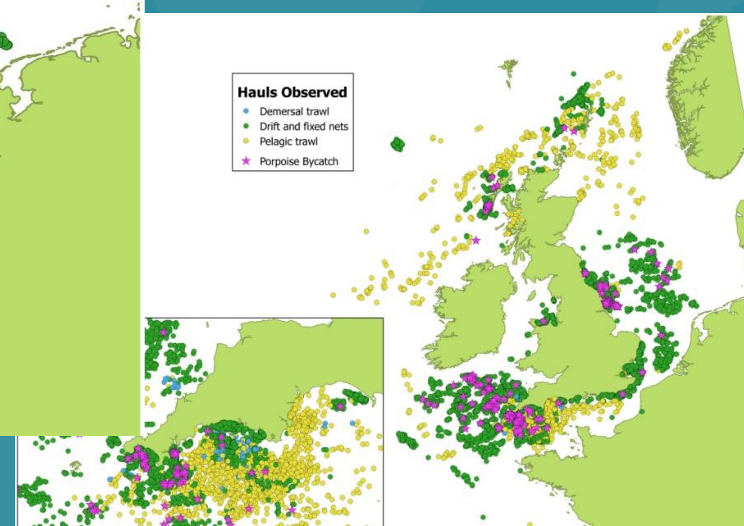
Harbour porpoise bycatch



Seal bycatch

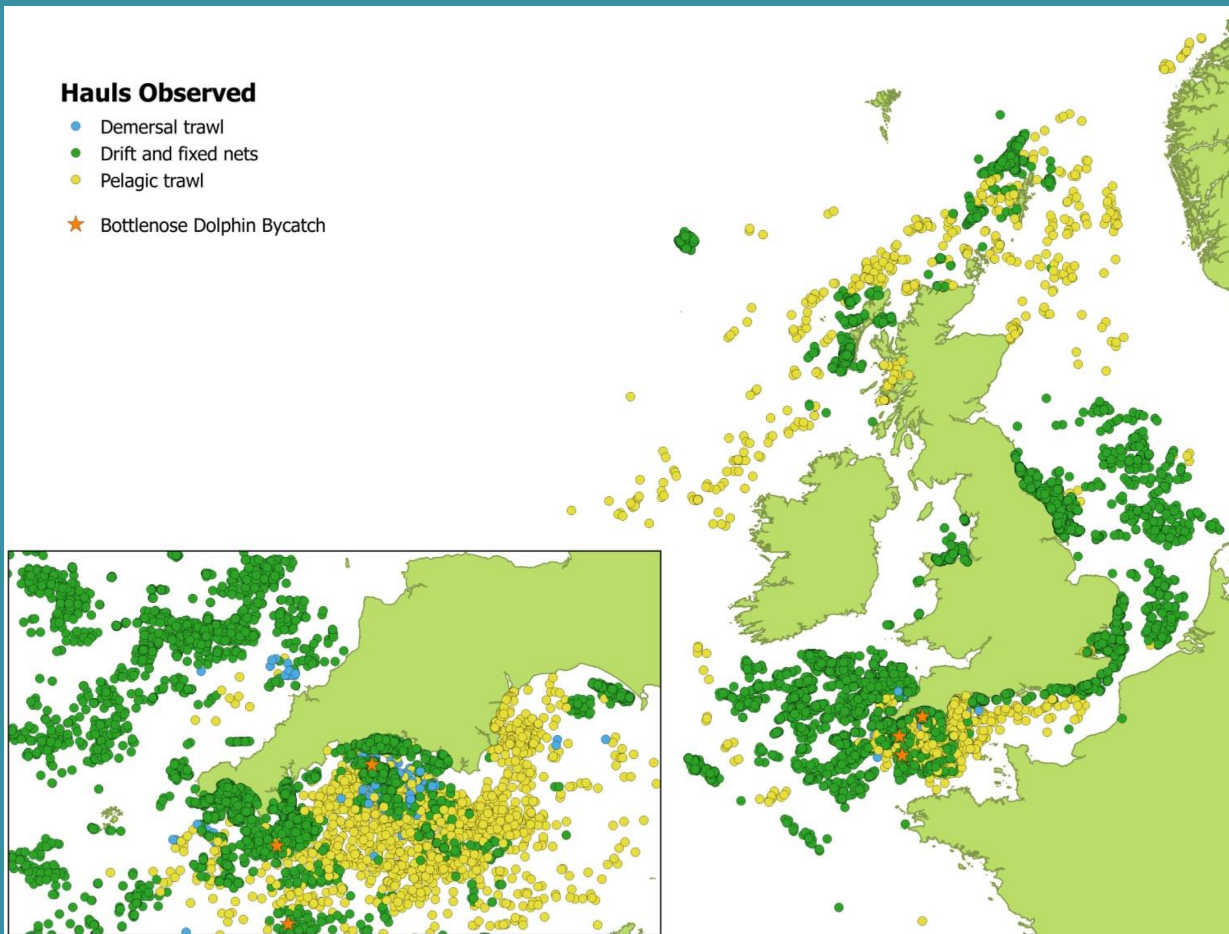
JNCC
Joint Nature Conservation Committee

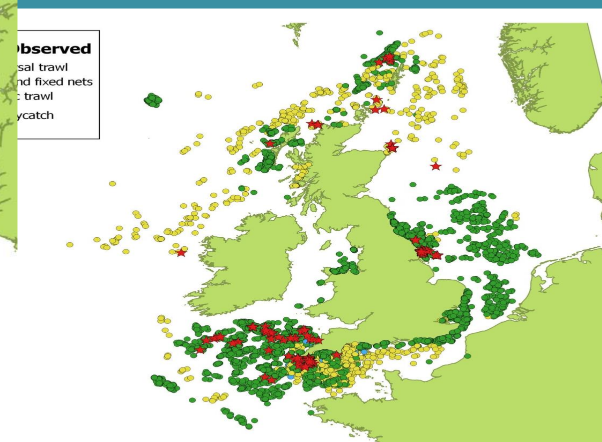


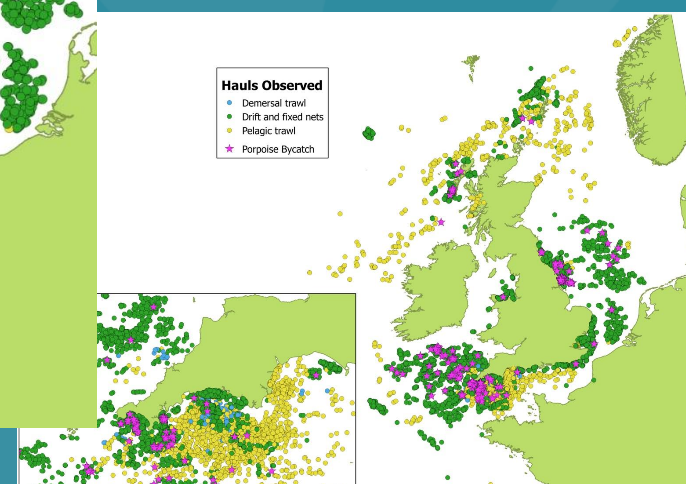


Bottlenose dolphin Bycatch

JNCC
Joint Nature Conservation Committee







European Protected Species

Devolved responsibility: England and Wales, Scotland and Northern Ireland plus offshore

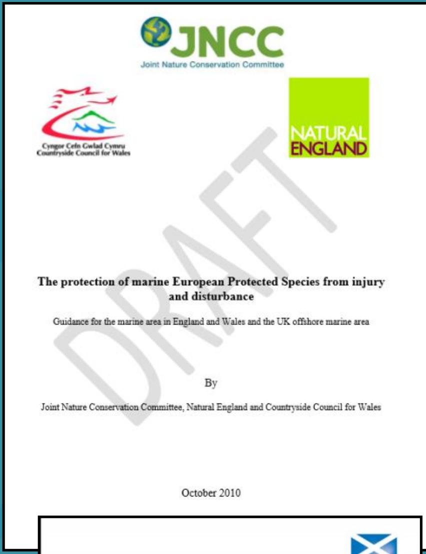
New projects/developments must demonstrate that they will not significantly disturb an EPS.
Injury offence: affects the ability of the species to survive, breed, rear or nurture its young or affect its hibernation or migration patterns
Disturbance offence: the local distribution or abundance of any protected species is effected.

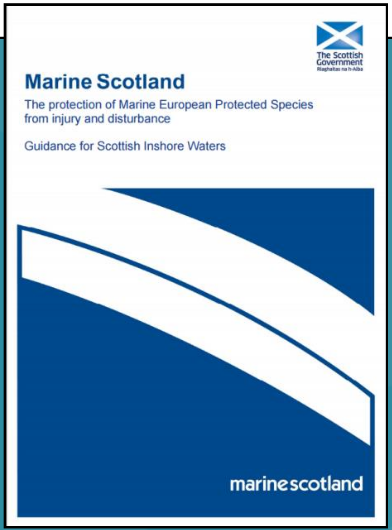
Habitats Regulations Appraisal (HRA): effect of a proposed activity on SAC integrity . MU role: Moray Firth SAC Ξ Coastal East Scotland MU.

European Protected Species

JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys (first published 1995, updated 2010, currently consulting on updated version for 2017: http://jncc.defra.gov.uk/page-7339)
Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (2010)
JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (2010)

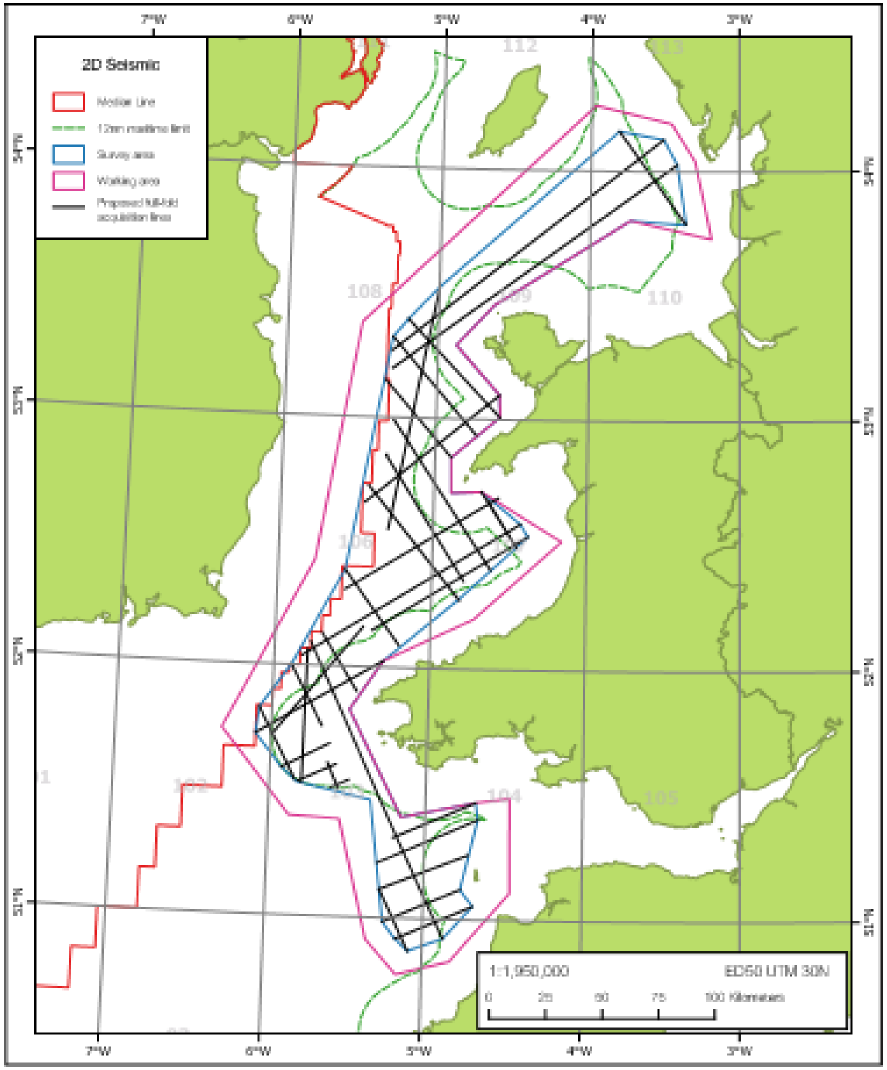
JNCC/CCW/NE Guidance on Marine European Protected Species Disturbance Assessment: produced in 2010 and available on request from JNCC.
Scottish EPS Guidance published in 2014: http://www.gov.scot/Resource/0044/00446679.pdf





EPS Casework

Joint Nature Conservation Committee



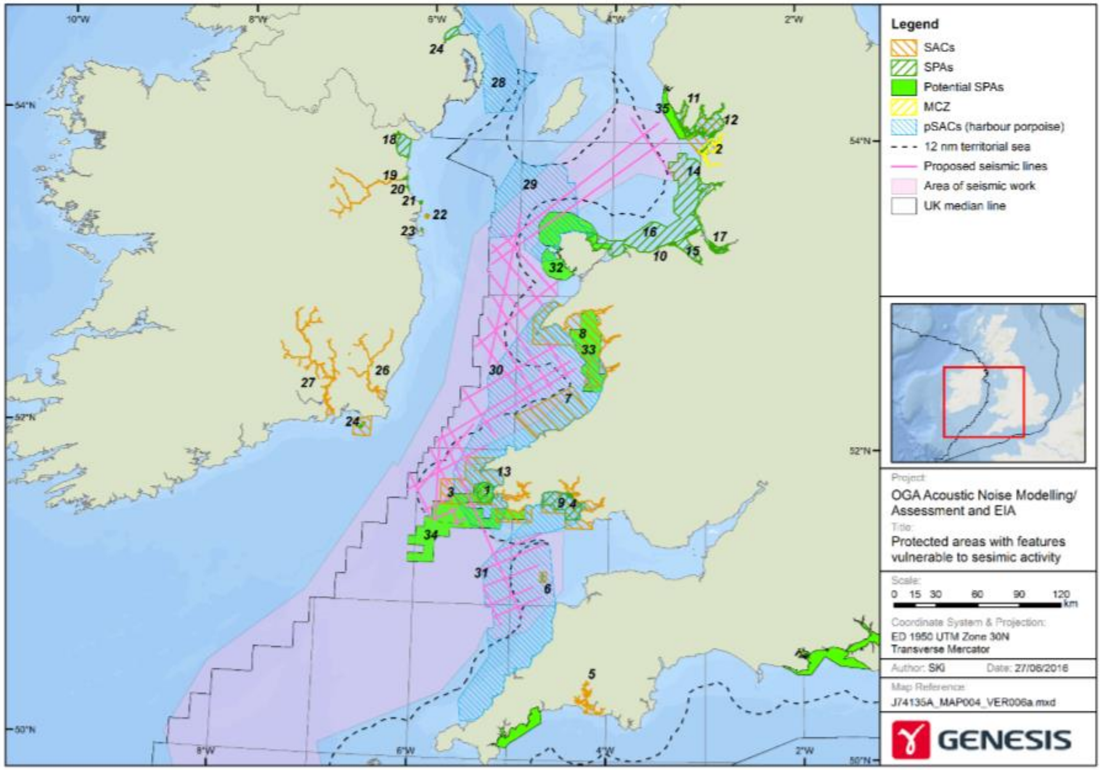
2D Seismic Survey covering 16,088km^2 (greater area including turns was 24,862km^2)

Took 35 days between 1 Sept and 30 Nov 2016

2 MMOs and PAM operators on board, soft start procedures employed as required by seismic guidelines

EPS Casework

JNCC
Joint Nature Conservation Committee



Considered 37 SAC/SPA sites within 40km of the operation.

Operators felt the impact on cetaceans would be relatively minor except for bottlenose dolphin within the Irish Sea MU, particularly in relation to Cardigan Bay.

JNCC , NRW and NE advised that an EPS license was required due to the scale which may result in the risk of committing a deliberate disturbance offence due to the potential for a significant effect at both an individual and population level. The potential requirement for Habitats Regulations Appraisal (HRA) in relation to the bottlenose dolphin SACs was also highlighted (and subsequently undertaken).

Knowledge Gaps

Identification of fine-scale population structure - presence of parapatric coastal and offshore populations

Quantify and explore reasons for changes in distribution - is recovery of range is possible?

Consequences of human activities, particularly habitat deterioration (including pollutants), and disturbance from recreational activities (including commercial dolphin watching) on our coastal populations

What about the Future?

Joint Nature Conservation Committee

Drivers Post-Brexit

1. Bern Convention [currently implemented through Habitats Directive] (FCS, prevent disturbance and killing)
2. CMS and ASCOBANS (FCS, reduce bycatch, noise)
3. CITES (trade)
4. CBD (sustainable development, MPAs)
5. OSPAR (regional implementation for MSFD)
6. Stockholm Convention (PCB pollution)

Any Questions?

Joint Nature Conservation Committee

Thank you for listening

Acknowledgements:
Thanks to Peter Evans for some of the photos!

We can only manage ourselves not the animals or the environment we are seeking to protect

Conserving bottlenose dolphins effectively in large EEZs (part 2): The French experience for now and the future

Benjamin Guichard

Policy officer for marine mammals and marine turtles, French Agency for Biodiversity

The French EEZ covers 10.3 million km² in all five oceans, 97% of which is overseas (mainly in French Polynesia, New Caledonia and Austral Ocean Islands) and 334 604 km² which corresponds to the mainland's EEZ.

The French Agency for Marine Protected Areas (AAMP) was created in 2006 and it had 200 employees in 15 sites in 2016, with its headquarters based in Brest (Brittany). Its main assignments were to:

- Create and manage ten marine nature parks, in order to cover French waters with 20% of Marine Protected Areas (MPAs) by 2020;
- Support marine protection public policies: MPAs, Natura 2000, Marine Strategy Framework Directive (MSFD);
- Drive the French MPA network and actively participate in international MPA networks.

On the 1st of January 2017, AAMP became part of the newly-created French agency for biodiversity (L'Agence Française pour la Biodiversité, AFB).

Bottlenose dolphins in French Atlantic waters

The largest resident population dwells in the Normandy-Brittany Gulf (including around the Channel Islands). It is made of 400-500 individuals, subdivided in 3 groups: North, middle and South. There are two smaller groups in the Iroise Sea (west of Finistère in Brittany): one group of 60-80 in Molène archipelago and one of 24 around Sein island (Île de Sein). A small group of around 20 animals has also been reported settling in Morbihan (south Brittany) but it is not monitored for the moment.

Habitat modeling from SAMM aerial surveys in winter 2011-12 and summer 2012 shows that bottlenose dolphins are mainly distributed along the continental slope and in the opening of western Channel, with a north-south gradient in winter. During the SCANS-III survey in July 2016, most observations were made over the continental slope (via ship) and the continental shelf (via aeroplane).

624 bottlenose dolphin strandings were recorded in the Channel and Bay of Biscay since 1969, with no seasonal pattern. Causes of death are generally unknown; the main known causes are by-catches and collisions. A contaminant study was performed in 2010-2016 by the *Groupe d'Étude des Cétacés du Cotentin* (GECC) on 121 bottlenose dolphin samples from the Normandy-Brittany Gulf. It showed very high levels of PCBs (higher in males, increasing with age), high levels of mercury and significant levels of phthalates, both increasing with age.

MSFD monitoring programme for bottlenose dolphins

The first MSFD six-year cycle started in 2010 with the definition of Good Environmental Status, followed by the Initial evaluation and adoption of Environmental objectives (2012). A Monitoring Programme (2015 $\rightarrow$ 2021) and a Programme of Measures (2016) were then elaborated by each relevant EU Member State.

The French MSFD monitoring programme is made up of 13 themes, with one dedicated to marine mammals and marine turtles. Each programme theme has a scientific pilot and a thematic coordinator. For marine mammals these are Jérôme Spitz (PELAGIS, Université de la Rochelle) and Benjamin Guichard (AFB) respectively. The marine mammal monitoring programme has four sub-programmes including actions for bottlenose dolphins:

SP1 = coastal cetaceans:

Iroise Sea groups of bottlenose dolphin will be monitored by the Iroise Marine Nature Park, the Normandy-Brittany Gulf group by GECC.

Development of a common photo-ID catalogue, dedicated iPad application for small-boat transect surveys to be developed by GECC in 2016-2017.

SP3 = offshore marine mammals and turtles:

Aerial surveys: SAMM 2012 / SCANS-III 2016

Annual ship surveys on IFREMER fisheries campaigns: PELGAS (Bay of Biscay, spring), EVHOE (Bay of Biscay-Celtic Sea, autumn), CGFS (Channel), IBTS (North Sea).

SP4 = strandings of marine mammals and turtles:

Improvement of the diagnosis of the causes of death, with more autopsies of fresh stranded bottlenose dolphins.

Contaminant monitoring will be done by PELAGIS.

SP5 = interactions with human activities:

PEACAD project (Université de la Rochelle) on interactions between fishermen and small cetaceans (2016-2018). Next step: set up rapid by-catch assessment surveys (PELAGIS).

Threats & protection

Coastal populations are threatened by the rapid development of marine renewable energies in French waters (numerous projects involving wind farms and hydro-turbines) and by the increasing pressure of dolphin-watching in the Iroise Sea and Normandy-Brittany Gulf. Fisheries could be a cause for the increased number of bottlenose dolphins standings over the past 30 years. Traffic noise could also have an impact on offshore populations.

The Iroise Marine Nature Park (PNMI) was created in 2007; an additional marine nature park is planned in the Normandy-Brittany Gulf.

Natura 2000: 43 out of 53 Atlantic coastal Special Areas of Conservation (SACs) on the French Atlantic coast were appointed for bottlenose dolphins. Only a few concern resident groups and they will see fisheries-risk assessments in the coming years.

The 2009 Marine Biogeographic Seminar in Galway concluded that the protection of offshore marine mammals by Natura 2000 site designation was insufficient in France. This led AAMP and the National Museum of Natural History to propose seven large offshore SACs for marine mammals and birds: 2 in the west Channel tide fronts and 5 along the Bay of Biscay continental slope. These offshore SACs should be designated in 2017. Threats identified are mainly by-catches, collisions and oil spills. Protective measures will be defined after risk evaluation and testing.

Conserving bottlenose dolphins effectively in large EEZs (part 2)
The French experience for now and the future

Benjamin Guichard, policy officer for marine natural heritage

French Agency for Marine Protected Areas

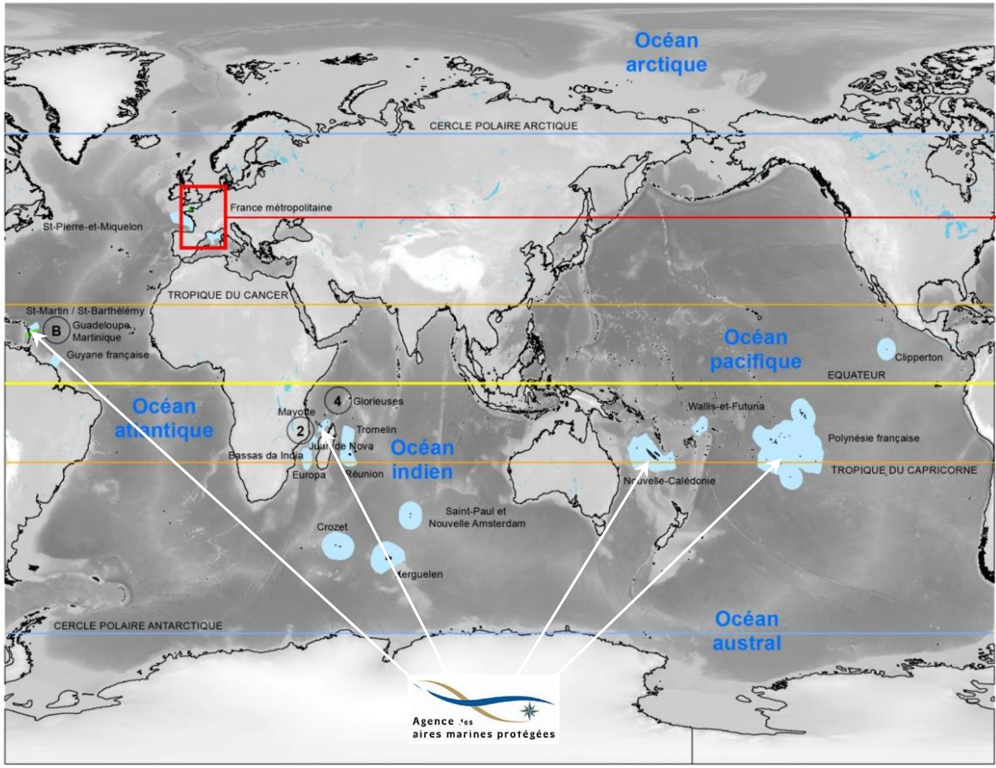
Transnational bottlenose dolphin conservation workshop,
Dublin, 7-8 December 2016

Agence des aires marines protégées

Introduction

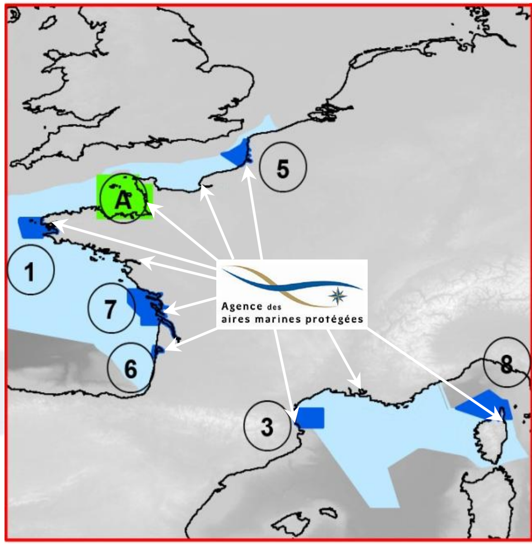
French EEZ = 10.3 Mkm².
Mainland EEZ = 334 604 km².

French agency for MPAs (AAMP) created in 2006.
200 employees in 15 sites, head-quarters in Brest (Brittany).



Main roles :

- Create and manage 10 marine nature parks, to cover French waters with 20% of MPAs by 2020
- Support marine protection public policies (Natura 2000, Marine Strategy Framework Directive…)
- Drive the French MPAs network and actively participate to international MPAs networks



AAMP → French Agency for Biodiversity in 2017.

Plan of the presentation

1. Bottlenose dolphins in French Atlantic waters

2. MSFD's monitoring program for bottlenose dolphin

3. Threats & protection

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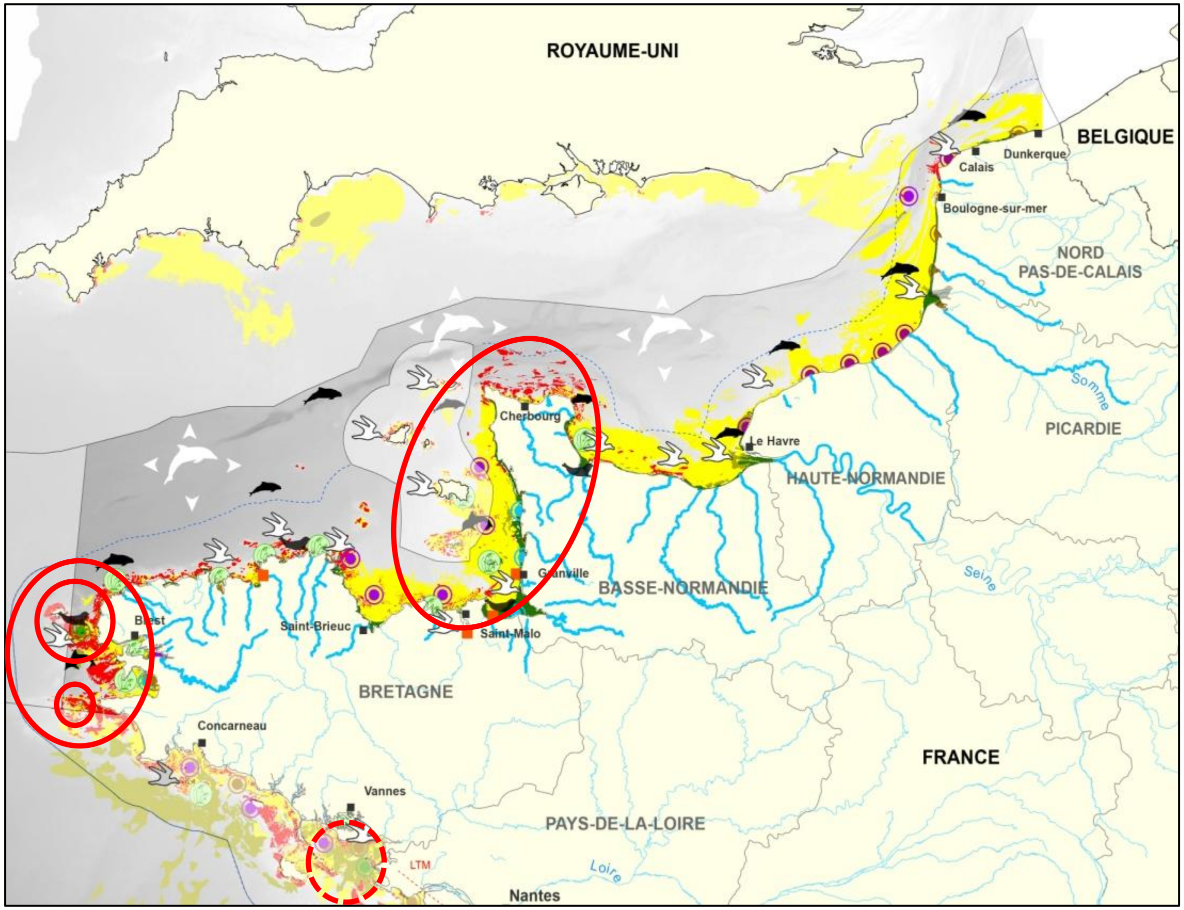
1. Bottlenose dolphin in French Atlantic waters (1)

Resident populations :

Normandy-Brittany Gulf : 400-500 individuals, subdivided in 3 groups : North, middle and South. Also around Channel islands.

Iroise Sea : 1 group of 60-80 in Molène archipelago + 1 group of 24 around Sein island.



Possibly a small group of around 20 animals settling in Morbihan (South Brittany).

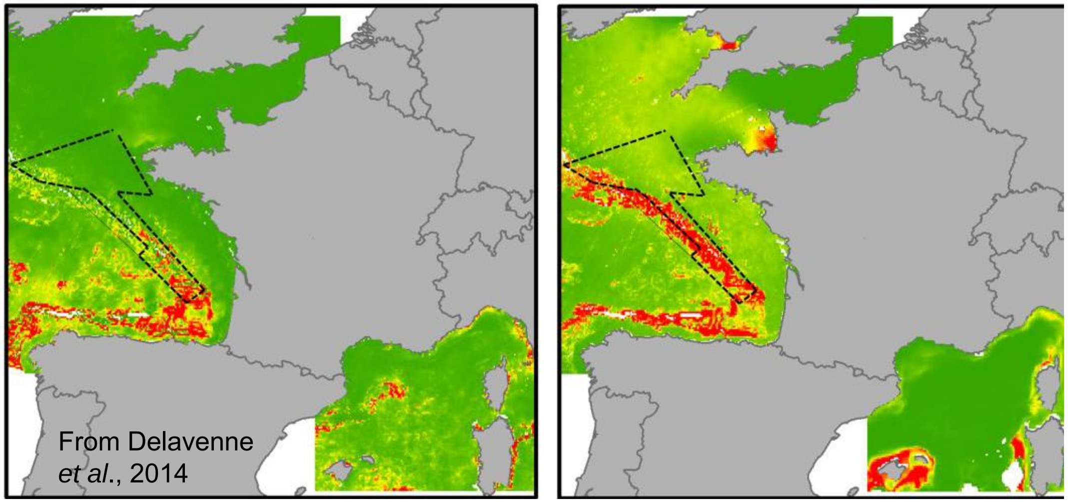
1. Bottlenose dolphin in French Atlantic waters (2)

Offshore population :

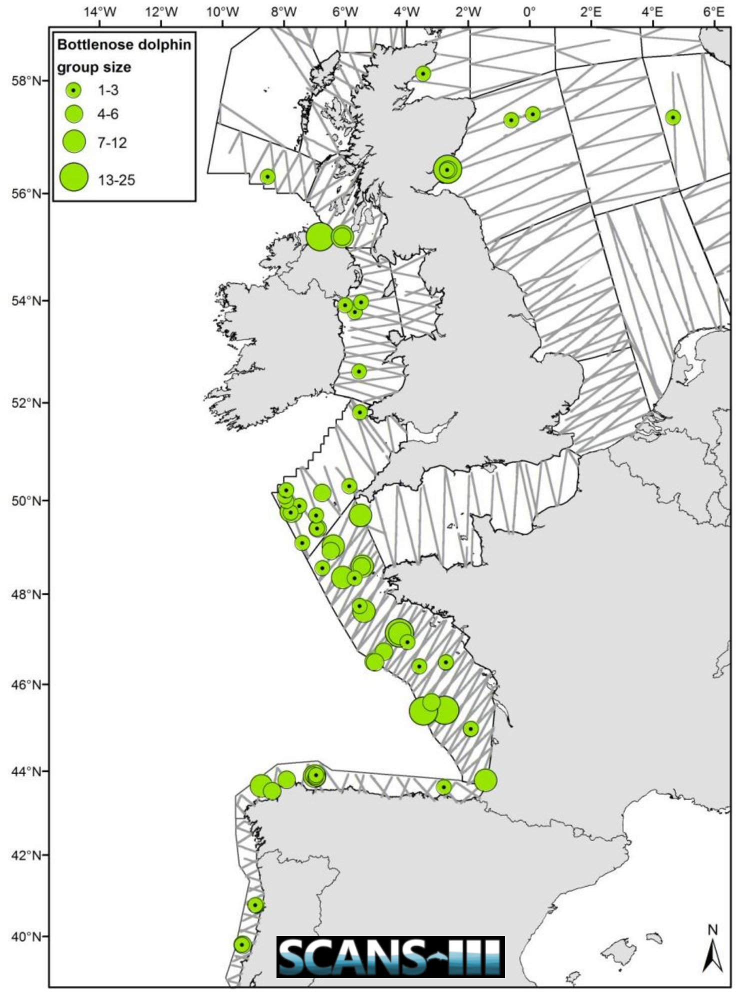
SAMM aerial surveys in winter 2011-12 and summer 2012.

Habitat modelling → BD mainly along the continental slope + opening of West Channel, with a N-S gradient in winter.

SCANS-III July 2016 : observations on the slope (boat) and the shelf (planes).



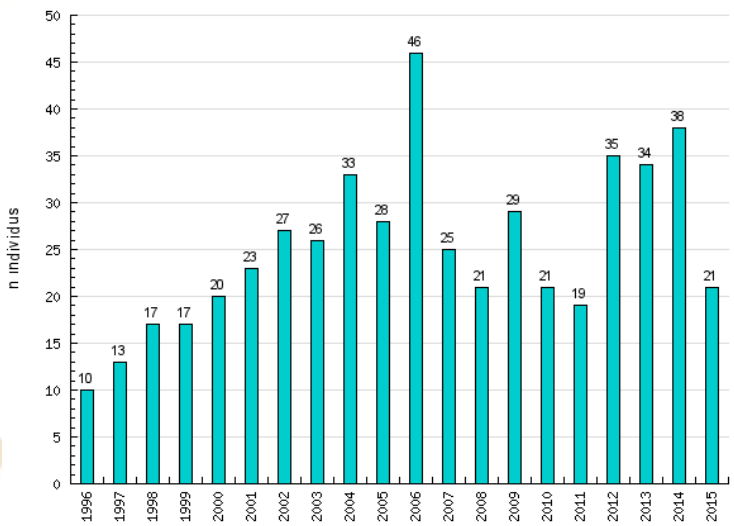
Winter Summer



1. Bottlenose dolphin in French Atlantic waters (3)

Strandings :

624 strandings in the Channel and bay of Biscaye since 1969, no seasonal pattern.



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Causes : unknown > bycatch > collisions.

Contaminant study in Normandy-Brittany Gulf (121 samples) → PCBs +++ (♂, age), Hg ++ (age), phtalates + (age).

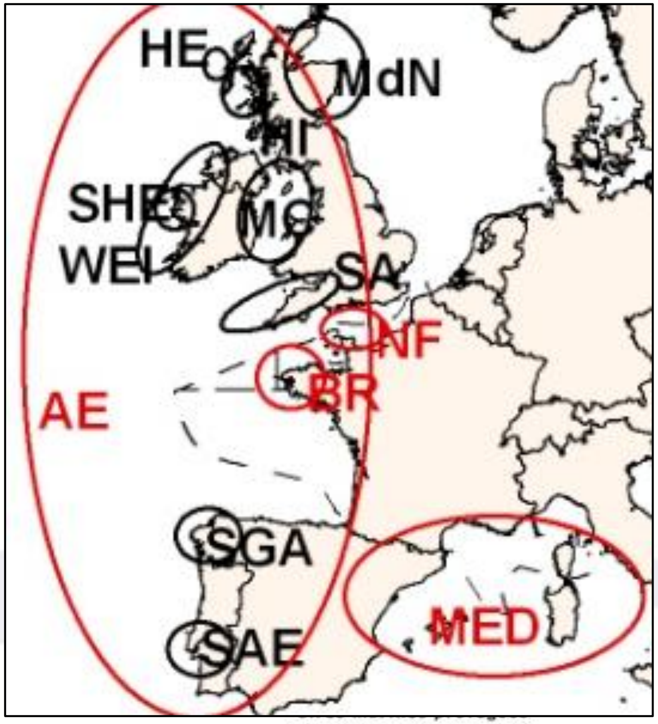
2. MSFD's monitoring program for bottlenose dolphin (1)

MSFD 1st cycle : Good Ecological State (2010) / Initial Evaluation (2012) / Environmental objectives (2012) / **Monitoring programme (2015→2021)** / Programme of measures (2016).

Monitoring programme : 11 themes, among which one dedicated to **marine mammals and marine turtles** → scientific pilot = PELAGIS (J. Spitz) Technical coordination = AAMP (B. Guichard).

Marine mammals/turtles French monitoring program divided in 5 sub-programmes :

- SP1 = coastal cetaceans
- SP2 = pinnipeds
- SP3 = offshore marine mammals & turtles
- SP4 = strandings of marine mammals & turtles
- SP5 = interactions with human activities



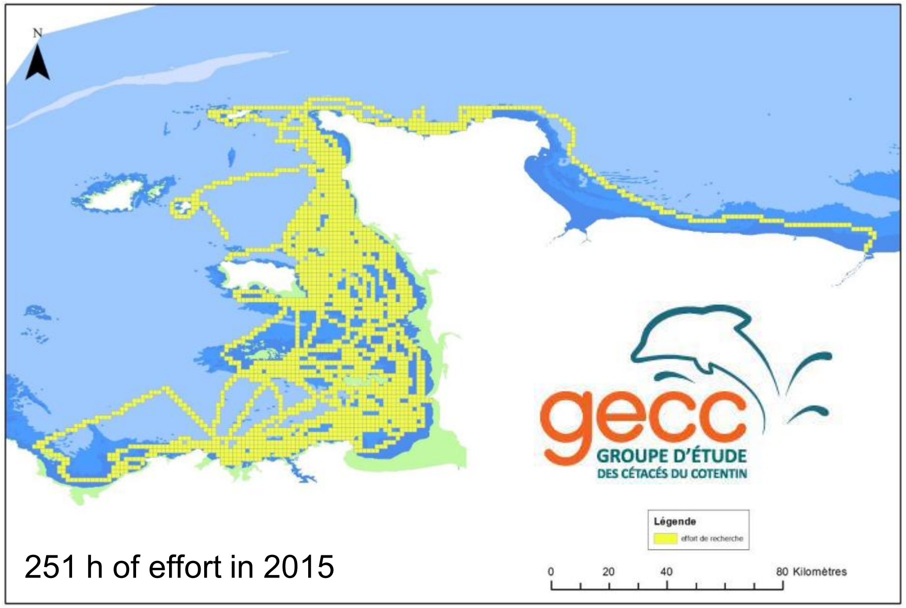
BD management units recommended by ASCOBANS/OSPAR (MSFD Initial Evaluation, 2012)

2. MSFD's monitoring program for bottlenose dolphin (2)

Sub-programme 1 : monitoring of BD resident populations

Iroise Sea : Iroise marine nature park

Normandy-Brittany Gulf : Groupe d'Étude des Cétacés du Cotentin (GECC)



Common photo-ID catalogue, dedicated ipad application developped by GECC in 2016-2017.

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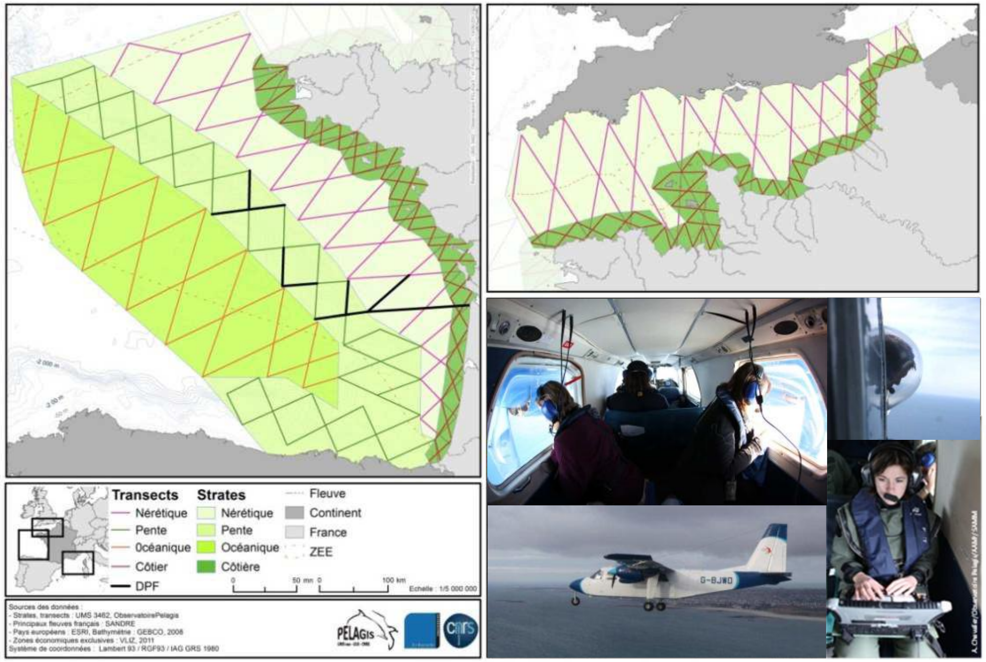
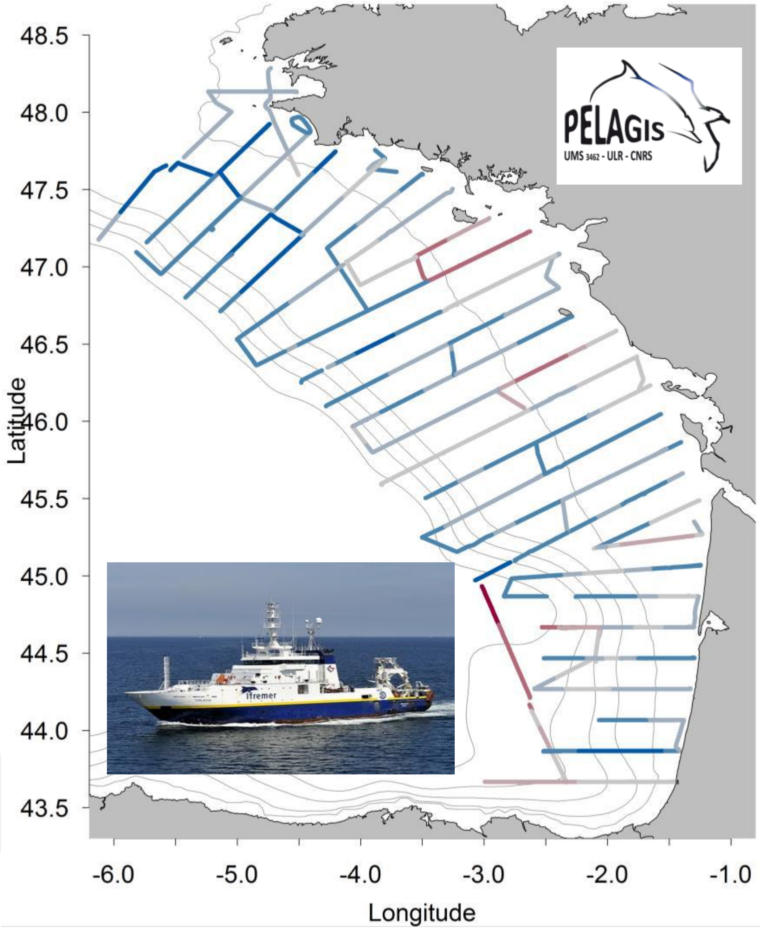
2. MSFD’s monitoring program for bottlenose dolphin (3)

Sub-programme 3 : offshore bottlenose dolphins population

Aerial surveys : SAMM 2012 / SCANS-III 2016 → SAMM2 2020 ?



Annuals boat surveys : PELGAS (Bay of Biscaye, spring), EVHOE (BoB-Celtic Sea, autumn), CGFS (Channel), IBTS (North Sea).



2. MSFD's monitoring program for bottlenose dolphin (4)

Sub-programme 4 : strandings of bottlenose dolphins

Goal for 1st cycle = improve diagnosis of the causes of death → more autopsies of fresh stranded bottlenose dolphins.

Contaminants monitoring → PELAGIS, GECC + DolphinSEAS Interreg project ?

Sub-programme 5 : interactions with human activities

PEACAD project (Université de la Rochelle) on interactions between fishermen and small cetaceans.

Next step : set up rapid bycatch assesment surveys (PELAGIS).

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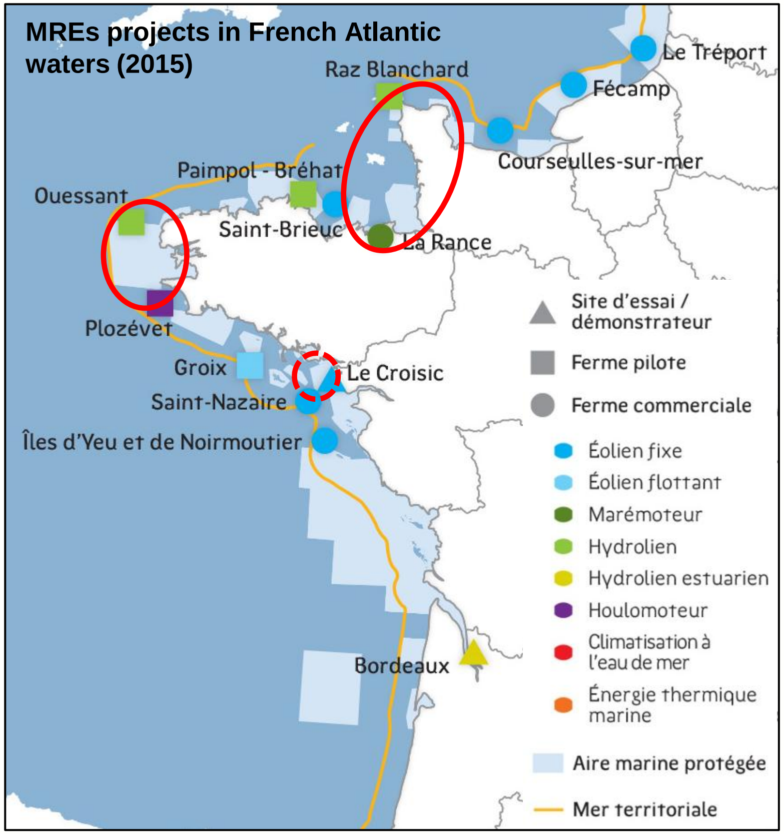
3. Threats & protection (1)

Pressures & threats :

Marine renewables energies : numerous projects of wind farms and hydro-turbines → threats mainly for coastal populations

Dolphin watching : increasing pressure in Iroise and Normandy-Brittany Gulf.



Fisheries : could be a cause for the increased number of bottlenose dolphins standings over the past 30 years.

Traffic noise : impact on offshore populations ?

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3. Threats & protection (2)

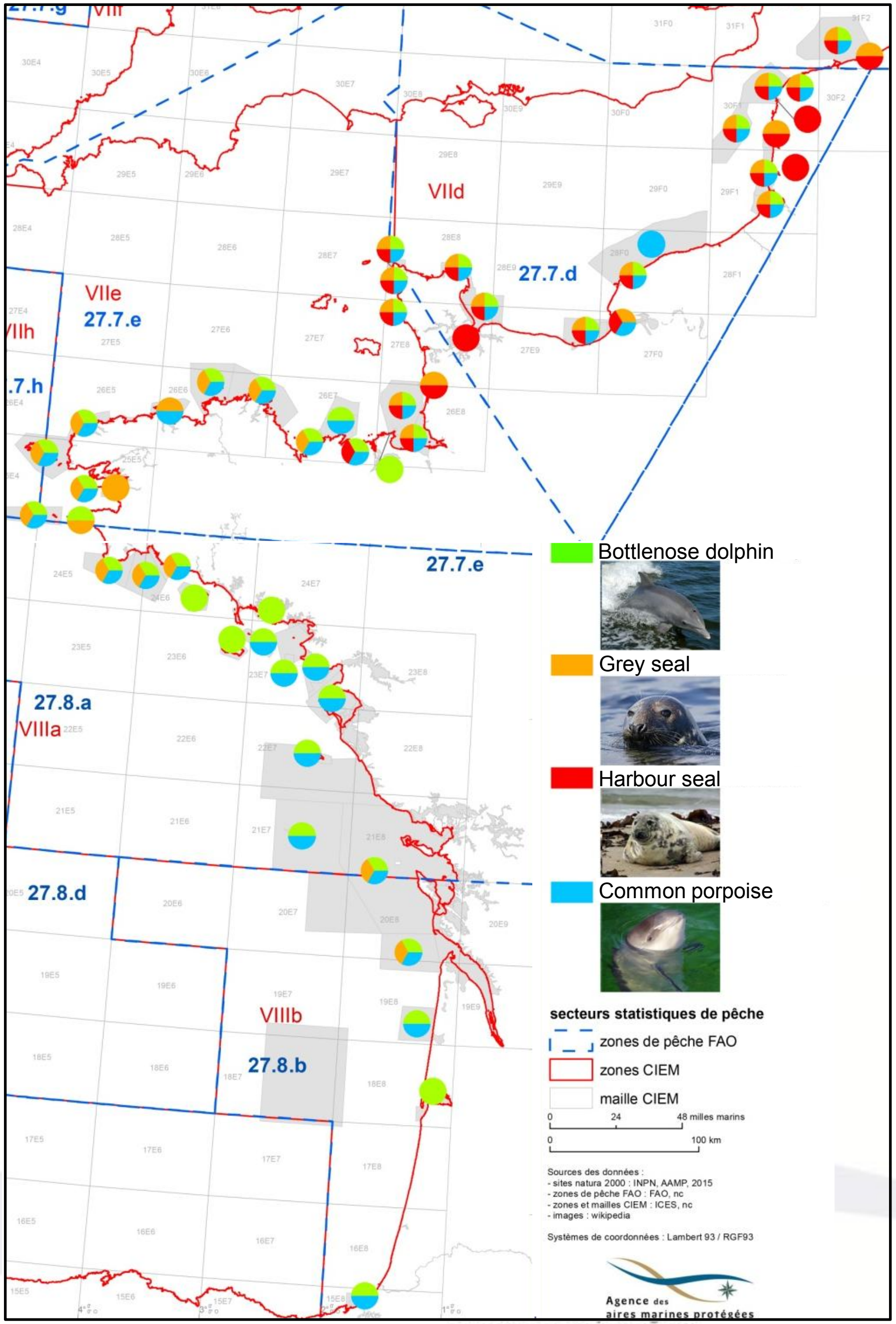
Protection measures :

Marine nature parks : Iroise + project in Normandy-Brittany Gulf.

Natura 2000 :

43 out of 53 Atlantic coastal SACs on French Atlantic shore were appointed for BD.
Only a dozen concern resident BD and will carry on fisheries-risk analysis in the following years.

2009 biogeographic seminar in Galway
→ lack of offshore protection for marine mammals and deep reefs
→ MNHN/AAMP proposals for offshore SACS.



3. Threats & protection (3)

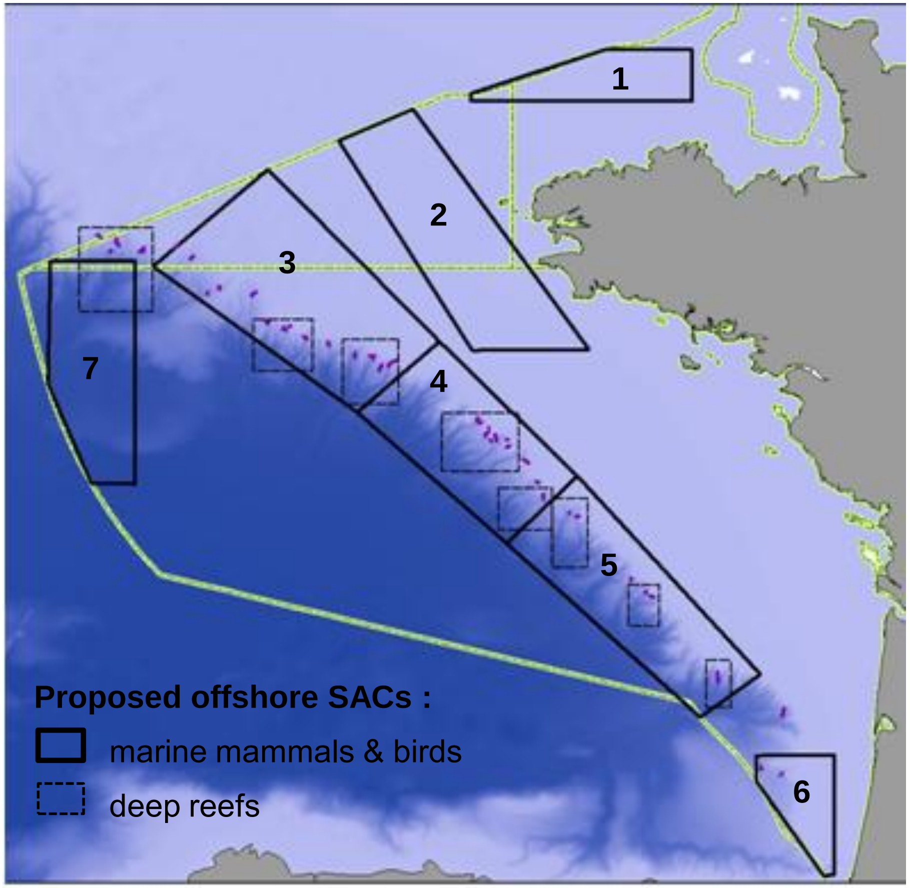
7 large offshore zones proposed for marine mammals & birds :

- West Channel tide fronts : 1-2
- Upwelling/slope : 3 to 7 (3-4-5 could be designated as a single site).

Cap Ferret canyon (zone 6) is only proposed as SPA but is important for BD and should also be a SAC.

Threats : bycatch (mainly porpoises in zone 1), collisions and oil spills.

Measures to be defined after evaluation and test.



These offshore SACs should be designated in 2017.

Agence des aires marines protégées


THANK YOU FOR YOUR ATTENTION

Integrating efforts for better protection

Simon N. Ingram

University of Plymouth

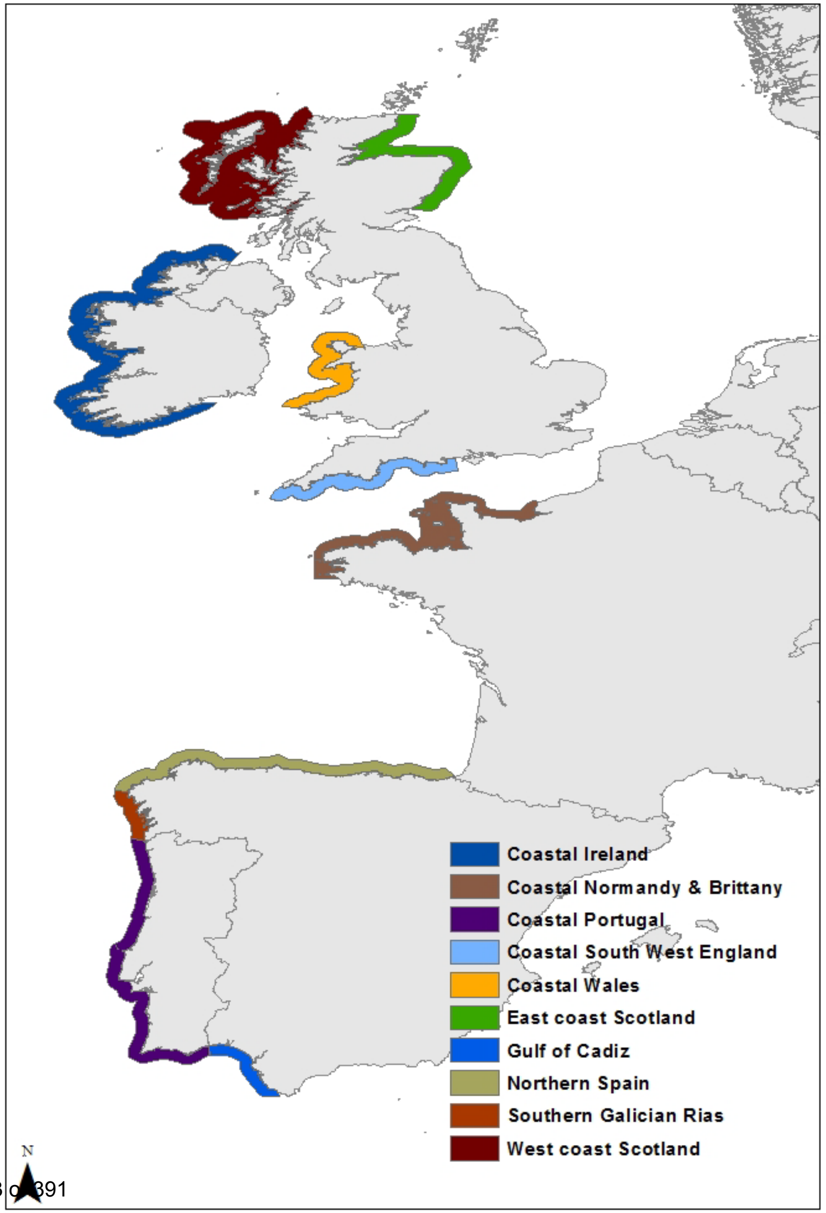
Much progress has been made in the previous two decades on understanding the distribution, abundance and population structure of bottlenose dolphins throughout the North-East Atlantic region. Mostly, these efforts have been conducted via independent research projects at a local or national scale. These efforts have led to a detailed patchwork of understanding of the species throughout the coastal and offshore waters of NW Europe. Mostly, and especially in coastal areas, effort has been concentrated in sites with statutory protection and specifically within Special Areas of Conservation (SACs) designated in accordance with the Habitats Directive.

Together with broad-scale surveys in offshore waters this work has yielded detailed knowledge at specific but isolated coastal sites with a broad-brush understanding of distribution and abundance in pelagic waters. With changes in the policy landscape such as the use of coastal bottlenose dolphins as an indicator of Environmental Status for the Marine Strategy Framework Directive and an increasing pressure on integrating inshore planning and management, the current challenge is to integrate our current knowledge into a broader context. Neighbouring countries face a shared challenge in managing transnational mobile populations. Effective monitoring requires an understanding of population dynamics and movements at scales larger than most current research efforts and the identification of relevant benchmarks for monitoring and measuring change.

At present there are spatial and temporal gaps in research effort, a lack of integrated management and a lack of understanding of cumulative impacts experienced by mobile coastal populations. In order to develop a more coherent and integrated approach to management a more complete understanding of population structure, abundance and movements is needed in order to assess the status, resilience and vulnerability of the species throughout international waters in the NE Atlantic. An integrated approach would enable national statutory authorities to be proactive rather than reactive to bottlenose dolphin conservation challenges and enable more flexible and informed management.

In order to achieve this, survey effort and sampling needs to be extended spatially with an emphasis on transnational collaboration, using a mixture of research techniques, shared best practice, increased public engagement and the development of robust scientific advice.

Integrating efforts for better protection.



Simon Ingram, University of Plymouth

Where we are

- Lots of progress
- Developing a patchwork of understanding throughout the Atlantic Area (need to fill in the gaps between these better studied sites)
- Most effort has concentrated on areas with higher numbers and more resident populations
- Need to get a large scale integrated perspective

Common challenges

- Policy drivers, (Habitats Directive, MSFD…but what's over the horizon?)
- Managing and understanding threats
- Managing mobile populations in an increasingly integrated marine planning paradigm
- Understanding benchmarks and moving baselines (wrt population sizes, distributions) . What would we expect to see in a restoration scenario?

Common risks

- Data deficit and incomplete knowledge
- Manage at national scales rather than at the biological scale
- Lack of detailed understanding of threats wrt distribution
- Lack of understanding of cumulative impacts
- Lack of joined up management
- Lack of future proofing

What do we do next

- Fill in the gaps (surveys, biopsy samples)
- Gain a more complete understanding of population structure
- Investigate movements and ranging behaviour
- Gain a better understanding of status, resilience and vulnerability
- Develop a more flexible, mixed approach to protection
- Be proactive rather than reactive

How do we achieve this?

- Increase surveys and sampling effort, spatially and temporally
- Share best practice
- Develop shared protocols
- Collaborate
- Use a mixture of techniques
- Develop management tools
- Incorporate citizen science

APPENDIX 1 ROUND-TABLE DISCUSSION - THEME I: Key research gaps (G) and research issues (I) to be addressed, as identified by 27 participants from six countries. [Note: The top three Gaps and Issues identified and voted on by Workshop participants are shaded in blue and red respectively. Score = the percentage of all participants voting for an Item]

	Item	Gap/Issue	England	France	Ireland	N. Ireland	Scotland	Wales	*VOTES*	SCORE (%)
1	Spatial gaps in the knowledge of dolphin occurrence	G	✓	✓	✓	✓	✓	✓	*10*	37
2	Temporal gaps in the knowledge of dolphin occurrence	G	✓	✓	✓	✓	✓	✓	*10*	37
3	Long term life history studies and their value	I	✓	✓	✓	✓	✓	✓	*16*	59
4	Knowledge of vital rates, reproductive success, mortality	G	✓	✓	✓	✓	✓	✓	*16*	59
5	Funding mechanism(s) required for long-term studies	I	✓	✓	✓	✓	✓	✓	*18*	67
6	Condition status/Health status of dolphin communities	G	✓	✓	✓	✓	✓	✓	*15*	56
7	Population viability analyses based on existing data	G	✓	✓	✓	✓	✓	✓	*2*	7
8	Pollutant sampling & its value as a research tool	I	✓	✓	✓	✓	✓	✓	*11*	41
9	Better sharing of Bottlenose dolphin ID catalogues	I	✓	✓	✓	✓	✓	✓	*3*	11
10	How to share Photo-ID data & best practice in this	G	✓	✓	✓	✓	✓	✓	*0*	0
11	Improved understanding of Diet and Resource utilisation	G	✓	✓	✓	✓	✓	✓	*18*	67
12	Understanding of the drivers of change/displacement	G	✓	✓	✓	✓	✓	✓	*10*	37
13	Improved understanding of Habitat utilisation	G	✓	✓	✓	✓	✓	✓	*8*	30
14	Major knowledge gaps in behavioural research	G	✓	✓	✓	✓	✓	✓	*3*	11
15	Population structure & connectivity between populations	G	✓	✓	✓	✓	✓	✓	*22*	81
16	Growth of human marine activity & its potential impacts	I	✓	✓	✓	✓	✓	✓	*16*	59
17	Knowledge of offshore populations/communities	G	✓	✓	✓	✓	✓	✓	*10*	37
18	Knowledge of Climate Change and its effects on dolphins	G	✓	✓	✓	✓	✓	✓	*0*	0
19	Knowledge of individual movement & ranging behaviour	G	✓	✓	✓	✓	✓	✓	*2*	7
20	Knowledge of meta-population dynamics, colonisation	G	✓	✓	✓	✓	✓	✓	*6*	22
21	Genetic resilience and inbreeding, including risk analysis	G	✓	✓	✓	✓	✓	✓	*10*	37

APPENDIX 2 ROUND-TABLE DISCUSSION - THEME II: Key management/policy gaps (G) and issues (I) to be addressed, as identified by 27 participants from six countries. [Note: The top three Gaps and Issues identified and voted on by Workshop participants are shaded in blue and red respectively. Score = the percentage of all participants voting for an Item]

	Item	Gap/Issue	England	France	Ireland	N. Ireland	Scotland	Wales	*VOTES*	SCORE (%)
1	Potential impacts of marine renewable energy development and associated human activities	G	✓	✓	✓	✓	✓	✓	*11*	**41**
2	Site-based Management Plans for Bottlenose dolphin	G	✓	✓	✓	✓	✓	✓	*2*	**7**
3	Inadequate transnational approaches or integration of management to improve the species' conservation	I	✓	✓	✓	✓	✓	✓	*13*	**48**
4	Gaps in the Consent/Licensing process	G	✓	✓	✓	✓	✓	✓	*1*	**4**
5	Regulation and management of eco-tourism	I	✓	✓	✓	✓	✓	✓	*11*	**41**
6	Adaptive management for designated SAC and MPA sites	I	✓	✓	✓	✓	✓	✓	*3*	**11**
7	Effective communication with Stakeholders for SAC sites	I	✓	✓	✓	✓	✓	✓	*3*	**11**
8	Interactions with fisheries & improved risk assessments	G	✓	✓	✓	✓	✓	✓	*16*	**59**
9	Definition & efficacy of Management Units proposed for use under the Marine Strategy Framework Directive	I	✓	✓	✓	✓	✓	✓	*9*	**33**
10	Determining the threats faced by the species coastally & offshore, and the provision of funding for this issue	I	✓	✓	✓	✓	✓	✓	*24*	**89**
11	Implementation of the Stockholm Convention on Persistent Organic Pollutants, effective from 2004	I	✓	✓	✓	✓	✓	✓	*16*	**59**
12	Implementation of management measures that will benefit the conservation of Bottlenose dolphins	G	✓	✓	✓	✓	✓	✓	*0*	**0**
13	Reviewing the efficacy and updating of national or international Guidelines/Codes of Practice	I	✓	✓	✓	✓	✓	✓	*3*	**11**
14	Sharing of Guidelines & transnational consistency therein	I	✓	✓	✓	✓	✓	✓	*5*	**19**
15	National legislation for Bottlenose dolphin protection	G	✓	✓	✓	✓	✓	✓	*0*	**0**
16	Proposed use of coastal Bottlenose dolphin as an Indicator grouping for MSFD Descriptor 1 (Biodiversity)	I	✓	✓	✓	✓	✓	✓	*1*	**4**
17	Transnational integration of approaches in implementing the MSFD and associated monitoring/measures	G	✓	✓	✓	✓	✓	✓	*16*	**59**
18	Understanding human activity threshold levels prompting management action to conserve the species	G	✓	✓	✓	✓	✓	✓	*21*	**78**

<u>APPENDIX 3 ROUND-TABLE DISCUSSION - THEME III:</u> Transnational collaborative actions to improve and enhance Bottlenose dolphin conservation, as identified and encouraged by Workshop participants from six countries.

	Action	England	France	Ireland	N. Ireland	Scotland	Wales
1	**Finalisation and submission of an integrated multi-national proposal for EU funding** ***(Interreg Atlantic Area Transnational Cooperation Programme 2014-2020)***	✓	✓	✓	✓	✓	✓
2	**Trialling and collaborative undertaking of a transboundary status assessment for *T.truncatus*** ***(e.g., for Habitats Directive Article 17 or MSFD reporting)***	✓	✓	✓	✓	✓	✓
3	**Development and implementation of Data Sharing protocols between international partners**	✓	✓	✓	✓	✓	✓
4	**Sharing of Photo-ID catalogues between groups involved in Bottlenose dolphin research and monitoring**	✓	✓	✓	✓	✓	✓
5	**Sharing of national Guidelines/Codes of Practice of relevance to Bottlenose dolphin conservation**	✓	✓	✓	✓	✓	✓
6	**Development and establishment of international standards for Life History and Vital Rate assessment**	✓	✓	✓	✓	✓	✓
7	**Sharing of dolphin population genetic markers and data between groups/countries**	✓	✓	✓	✓	✓	✓
8	**Sharing of information regarding the approaches taken in Regulatory assessments**	✓	✓	✓	✓	✓	✓
9	**Sharing of effort-logged and vessel-based survey data**	✓	✓	✓	✓	✓	✓
10	**Collaborative notification of effort-based surveys due to take place or completed**	✓	✓	✓	✓	✓	✓
11	**Collaborative sharing of Bycatch data from Member State fleets undergoing monitoring**	✓	✓	✓	✓	✓	✓
12	**Greater integration of data and sample sharing from Stranding and Post-Mortem programmes**	✓	✓	✓	✓	✓	✓
13	**Greater and wider input to ASCOBANS/ACCOBAMS national reporting from Regulatory bodies and the research community**	✓	✓	✓	✓	✓	✓