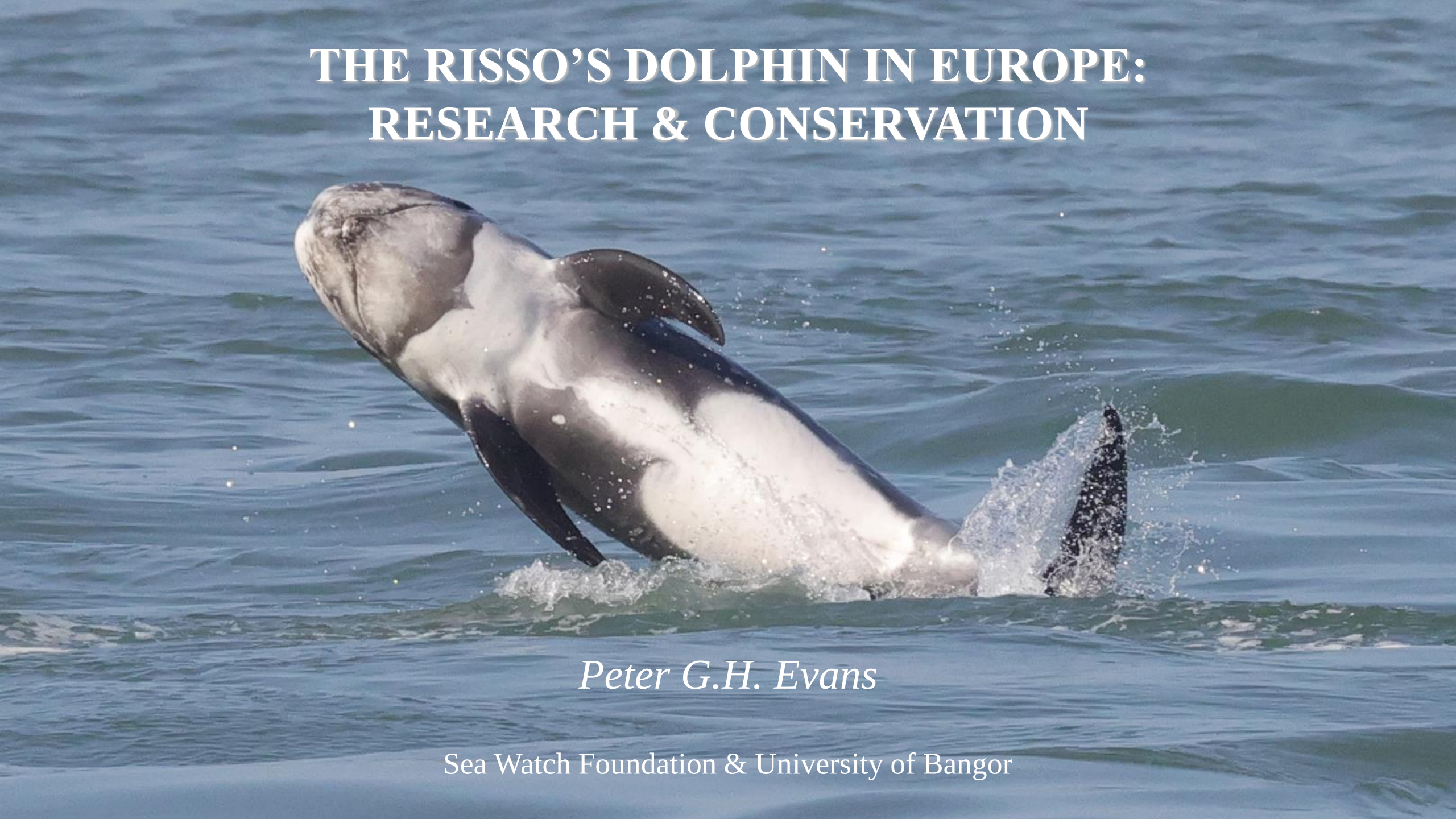
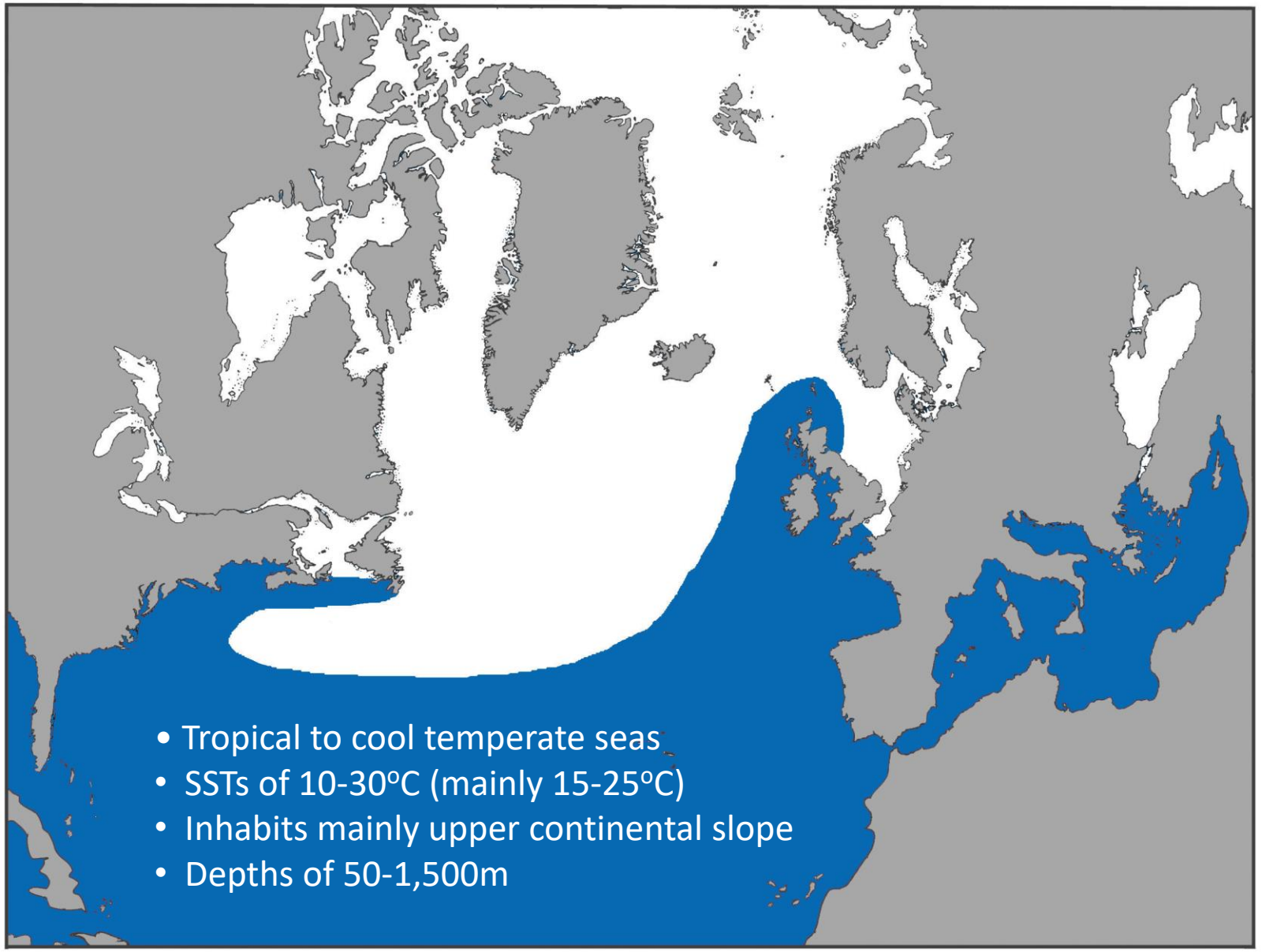
# THE RISSO'S DOLPHIN IN EUROPE: RESEARCH & CONSERVATION



*Peter G.H. Evans*

Sea Watch Foundation & University of Bangor

# Risso's Dolphin distribution in N. Atlantic & Mediterranean



# POPULATION ESTIMATES IN THE NORTH ATLANTIC

**Western North Atlantic**

- Eastern United States: 35,215
- Northern Gulf of Mexico: 1,974

**Source:** NOAA, 2021, 2022

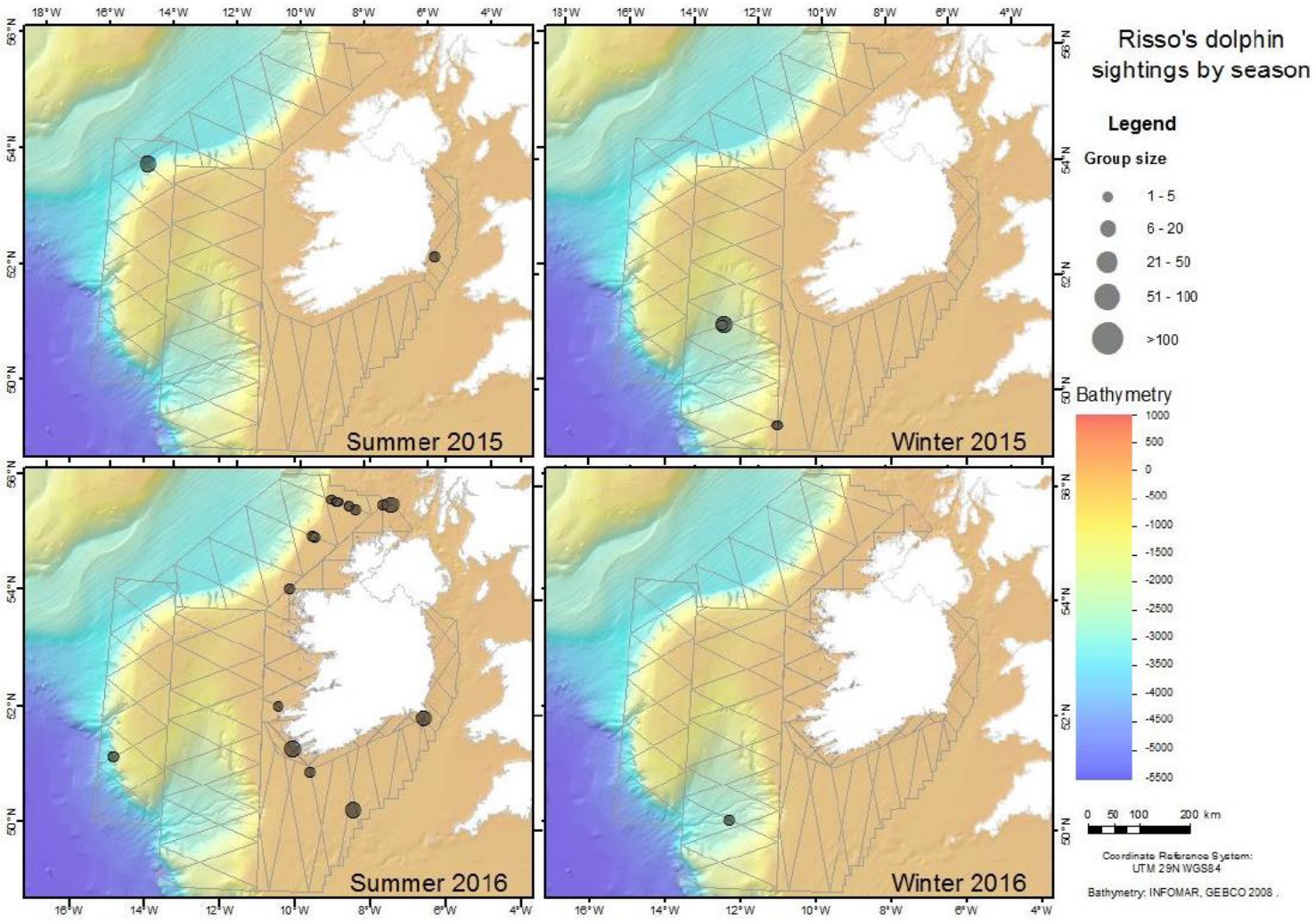
**Eastern North Atlantic**

- ASCOBANS Agreement Area: 13,584
  - Irish EEZ: 2,630

**Source**: Rogan *et al*., 2017; Hammond *et al*., 2021

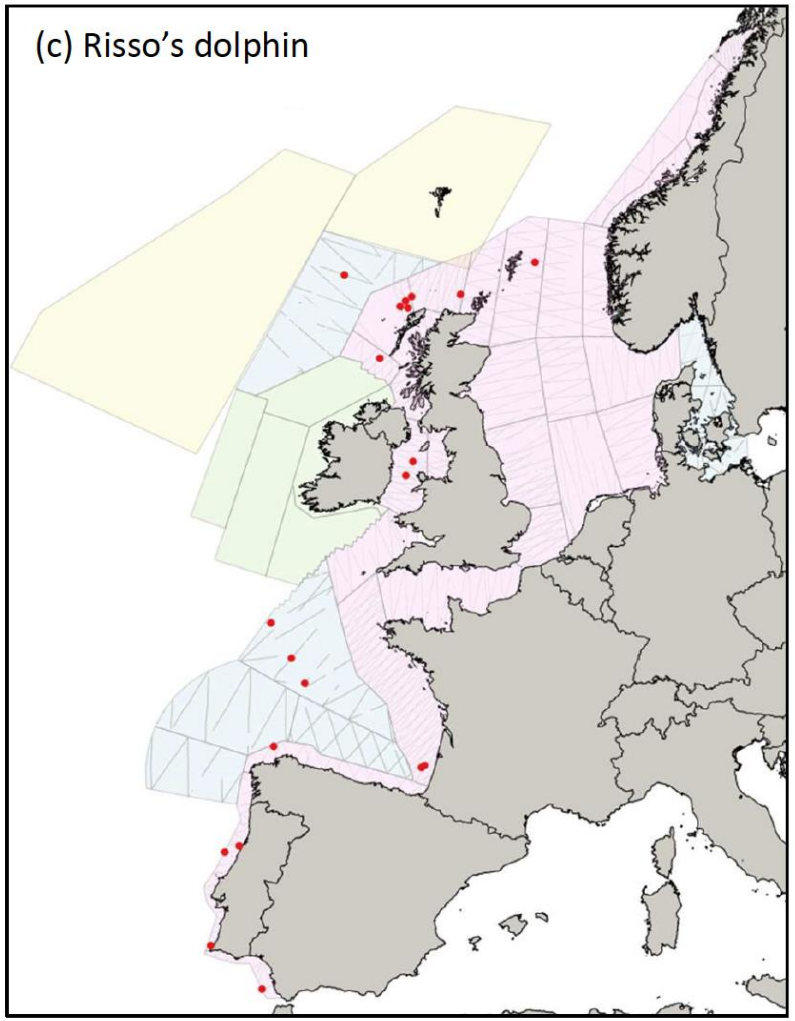
# RISSO'S DOLPHIN SIGHTINGS DURING LARGE-SCALE SURVEYS

Irish ObSERVE Surveys, Summer & Winter 2015-16



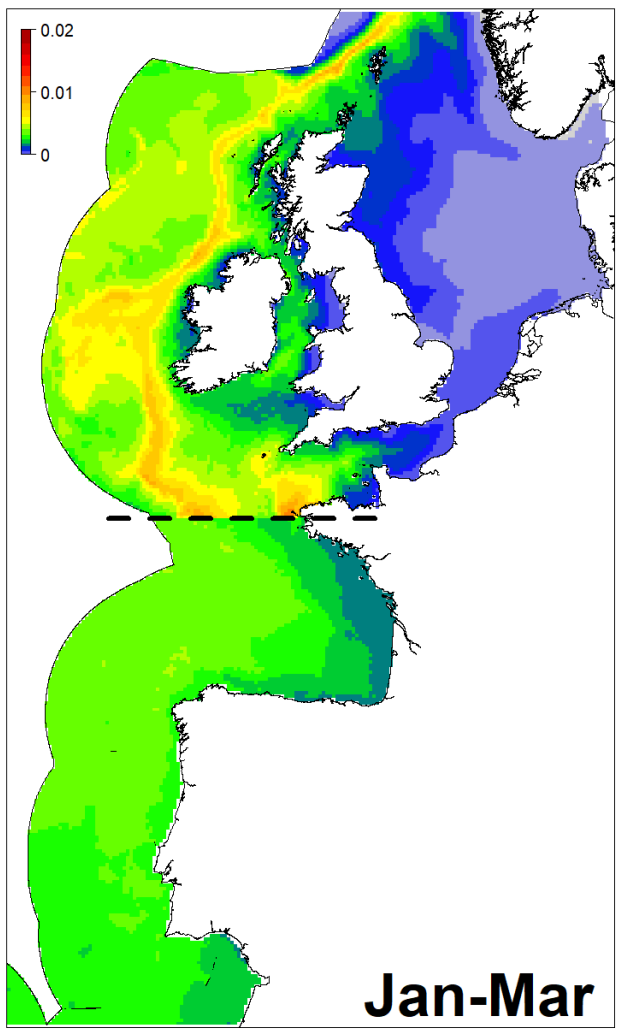

**Source:** Rogan *et al*., 2017

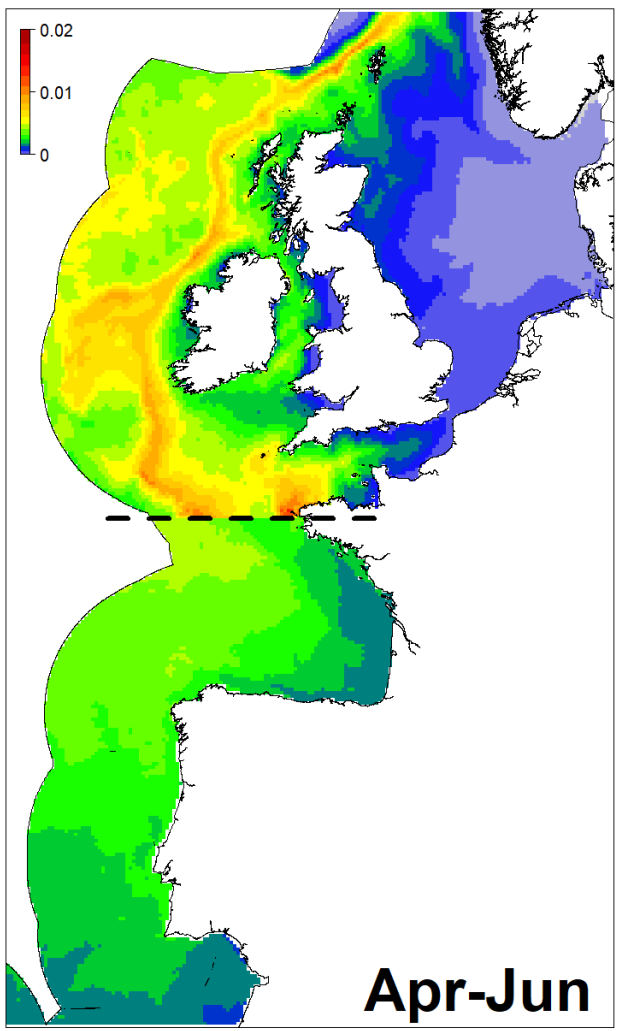
SCANS-III Survey, July 2016

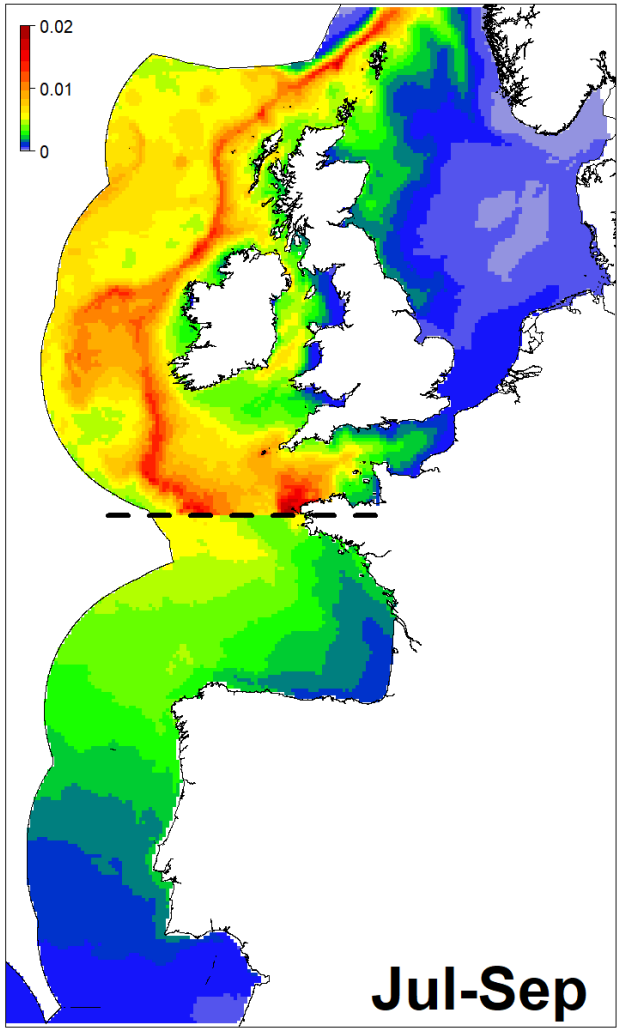


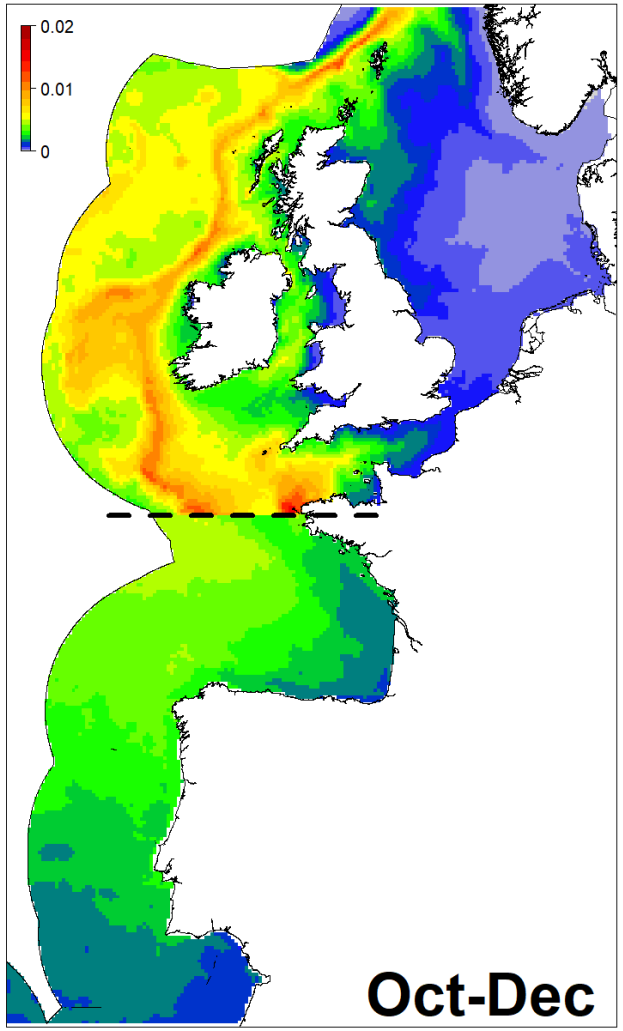

**Source:** Hammond *et al*., 2021

# Risso's Dolphin density distributions by season



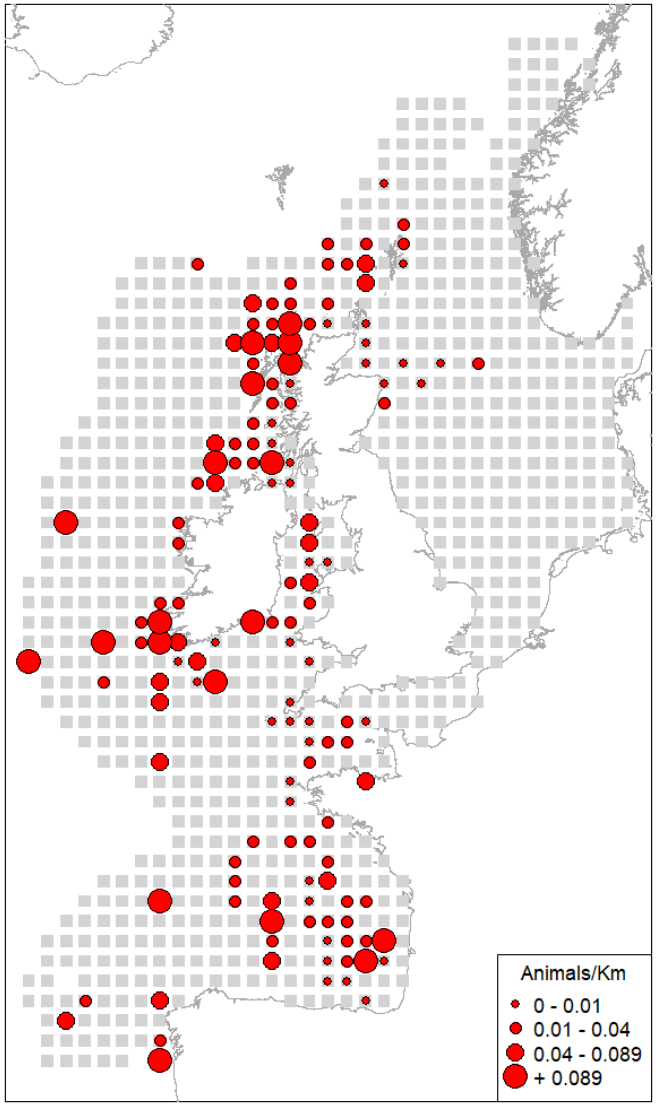



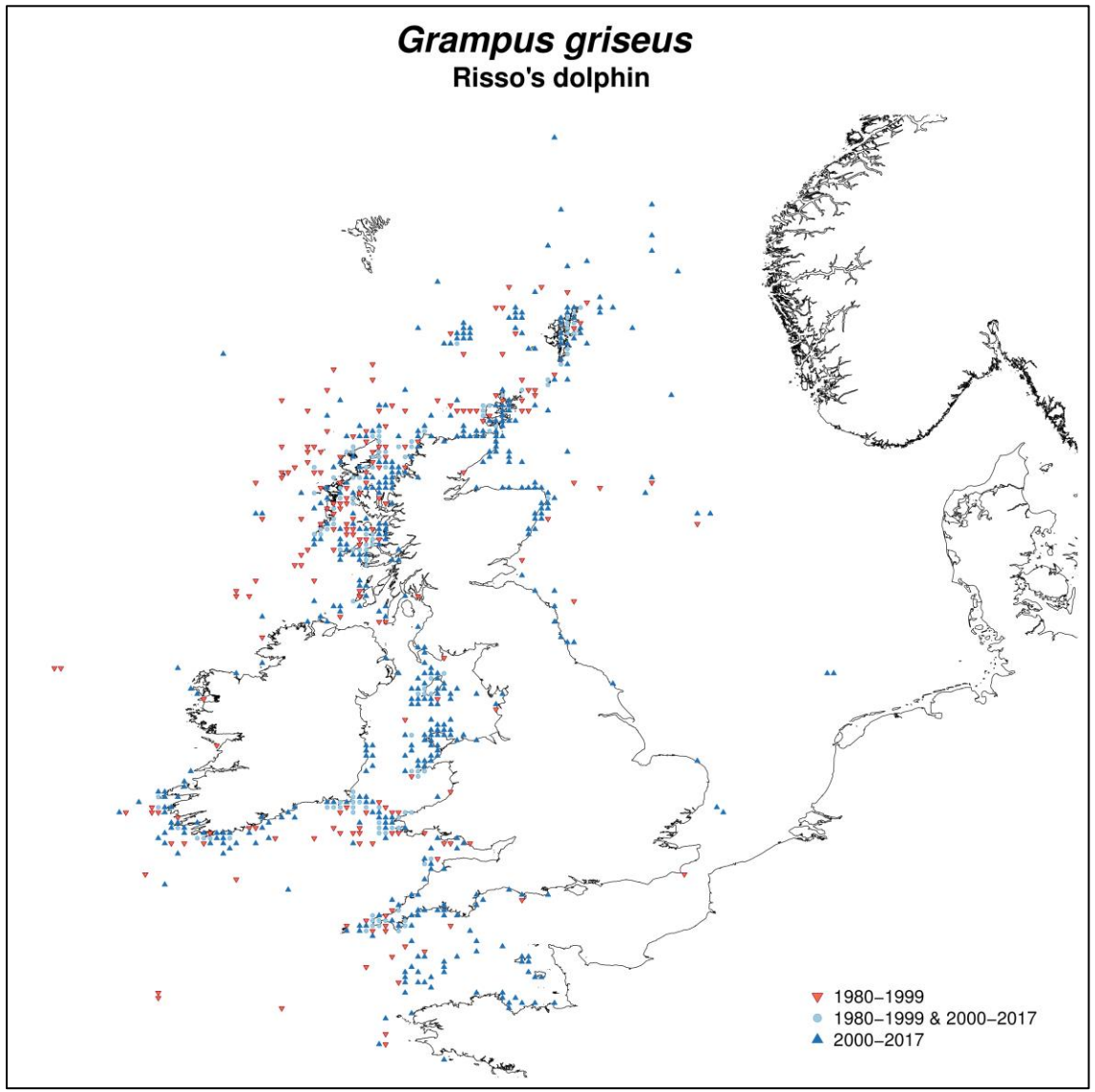




**Source**: J. Waggitt & P.G.H. Evans, Marine Ecosystems Research Programme

# SIGHTINGS AROUND THE BRITISH ISLES

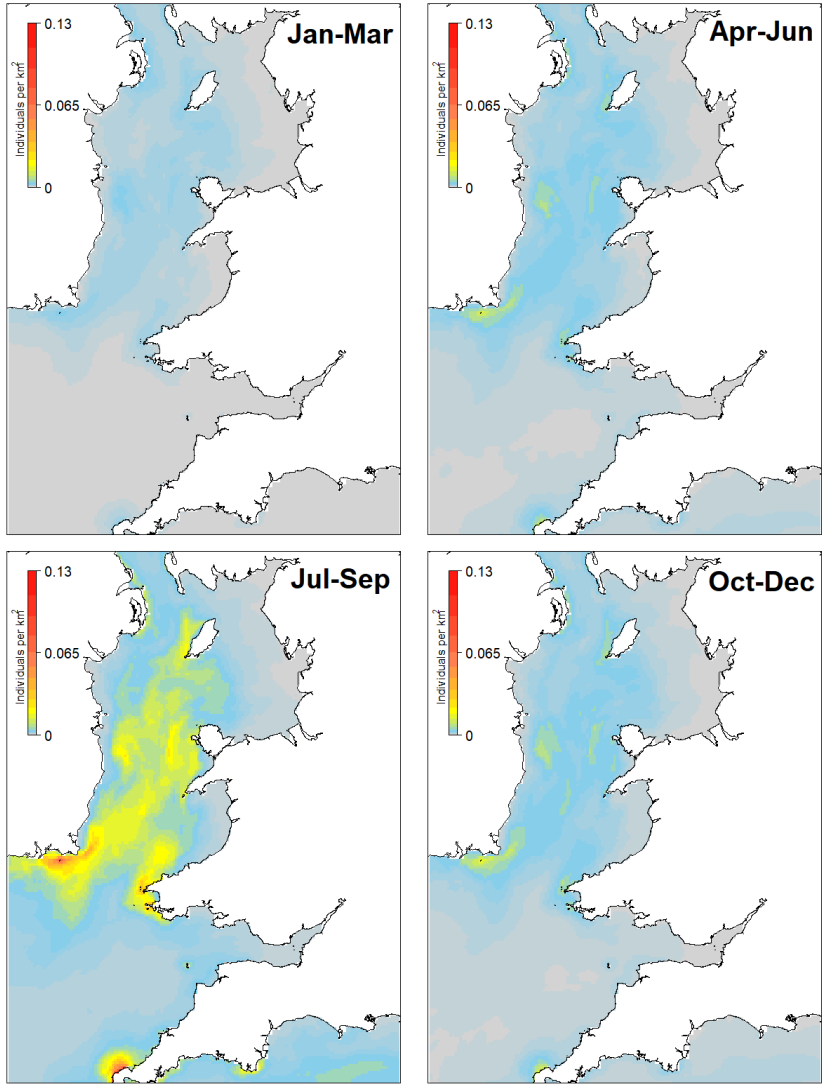


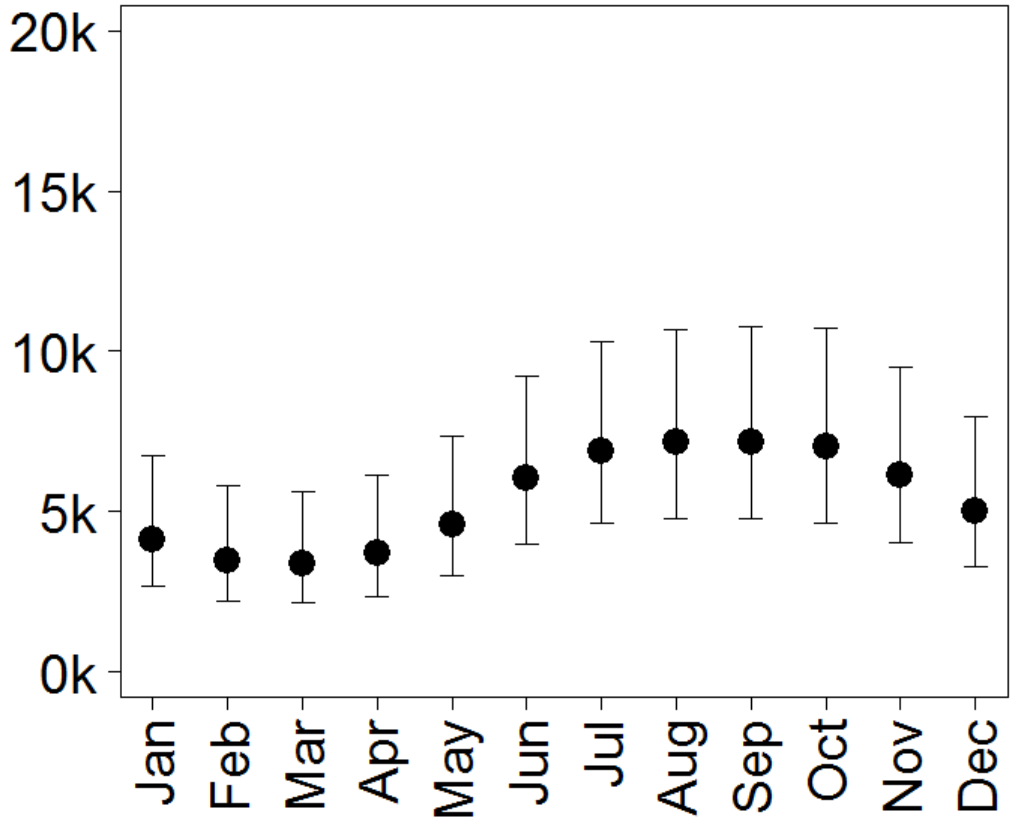

**Source**: Waggitt *et al.,* 2020; Evans & Waggitt, 2020

# SEASONAL OCCURRENCE IN RISSO'S DOLPHINS

a) Irish Sea

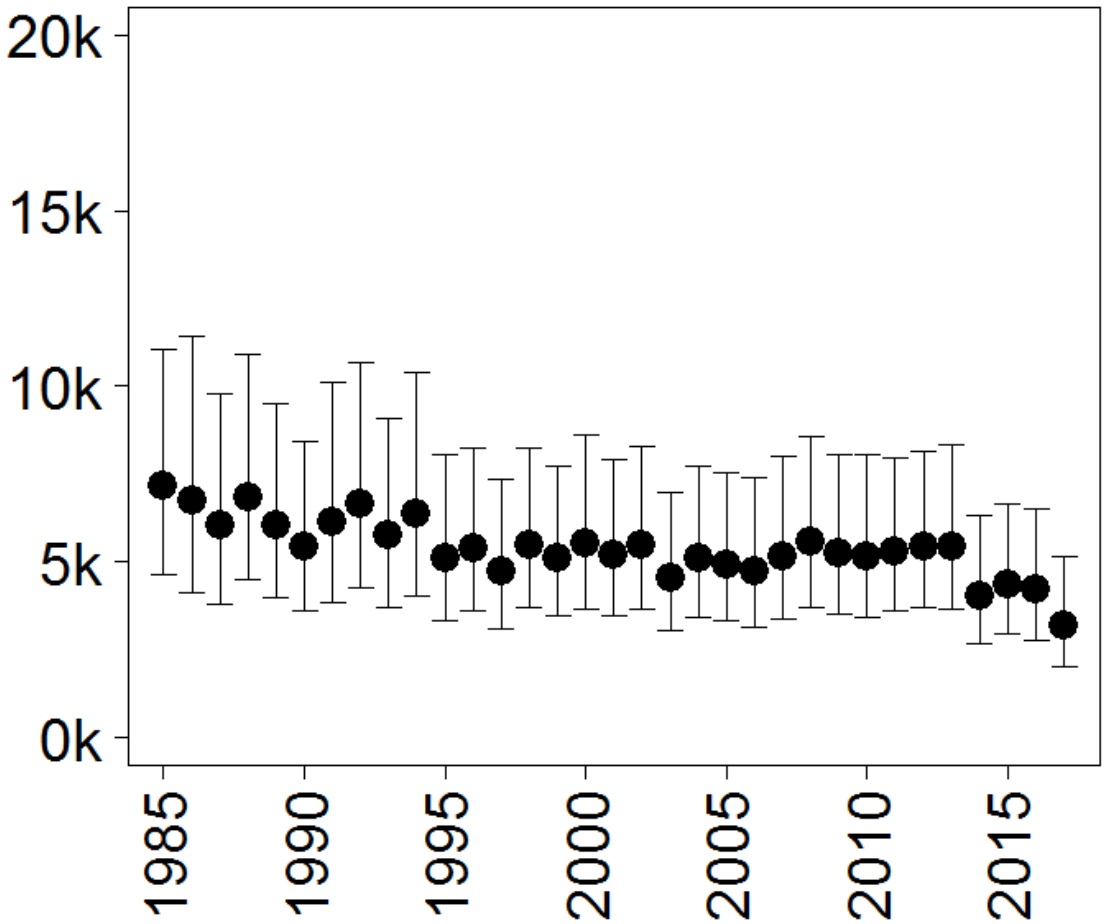



b) North-west Europe



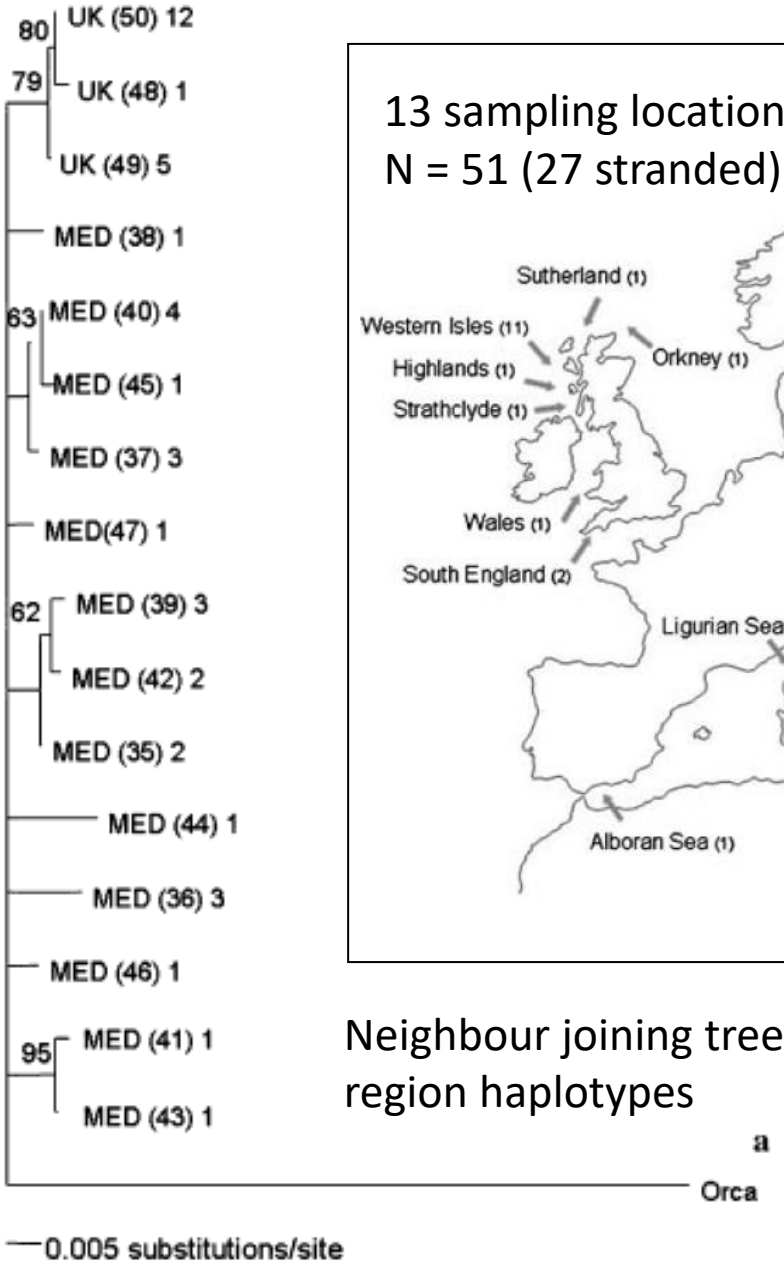

**Sources:** Waggitt *et al.*, 2020; Evans & Waggitt, 2023

# LONGER-TERM TRENDS IN RISSO'S DOLPHIN ABUNDANCE IN NW EUROPE

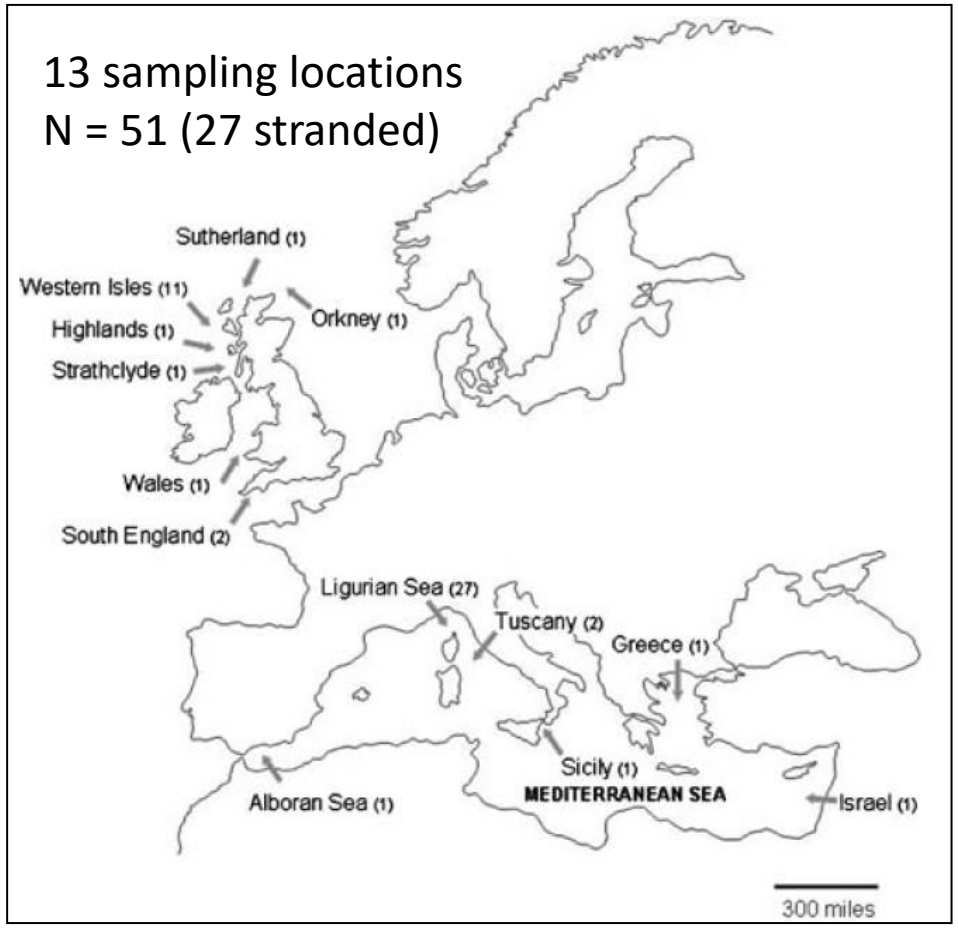


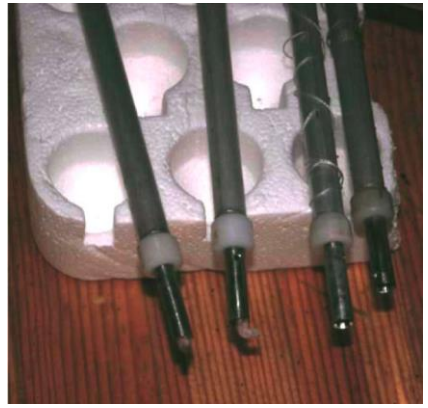

**Source**: Waggitt *et al.*, 2020

# GENETIC VARIATION




Neighbour joining tree based on mtDNA control region haplotypes



Samples taken from both stranded animals and by biopsy dart from free-living dolphins

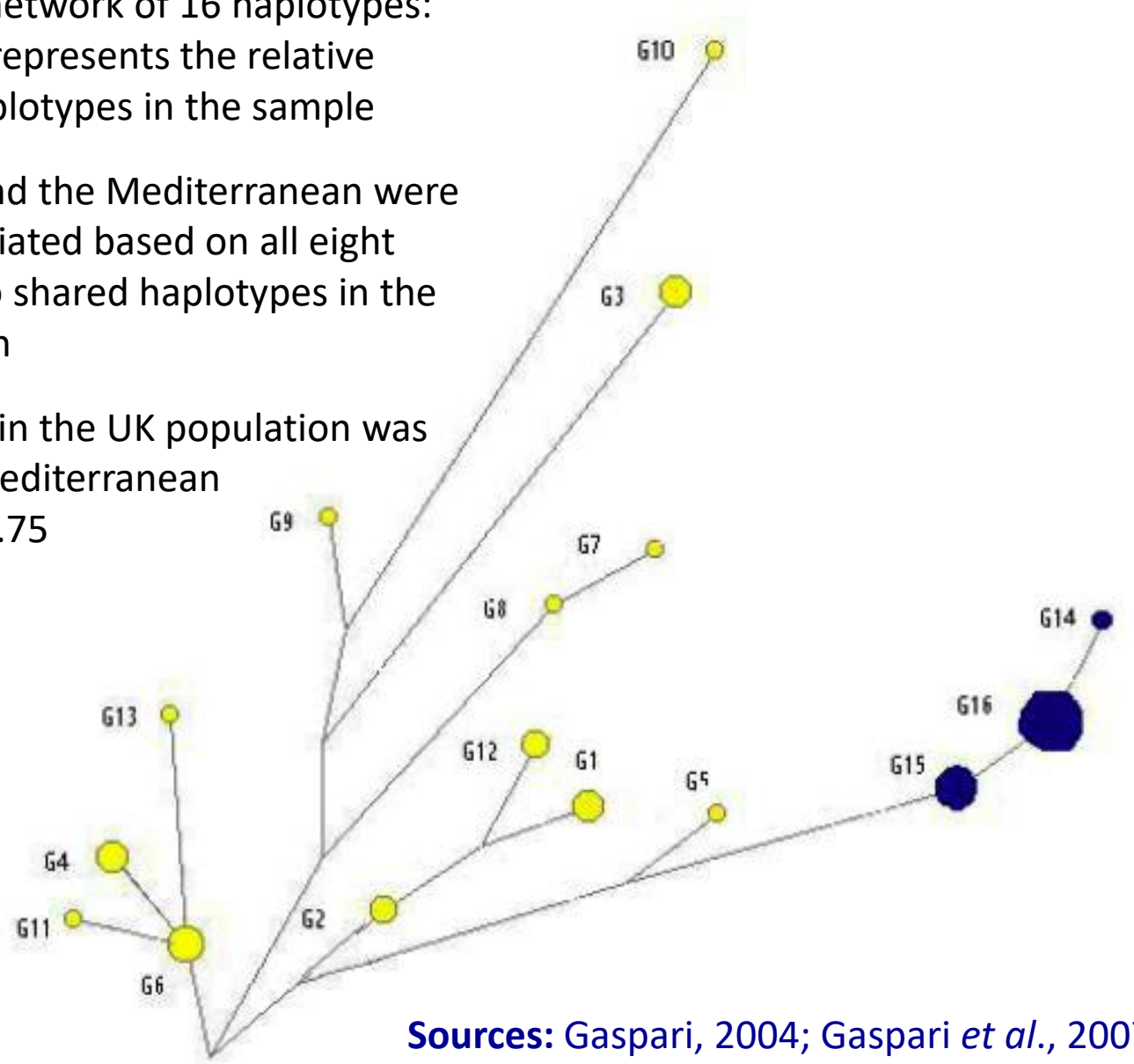
**Sources:** Gaspari, 2004; Gaspari *et al*., 2007

# GENETIC VARIATION

Minimum-spanning network of 16 haplotypes: the size of the circle represents the relative proportion of the haplotypes in the sample

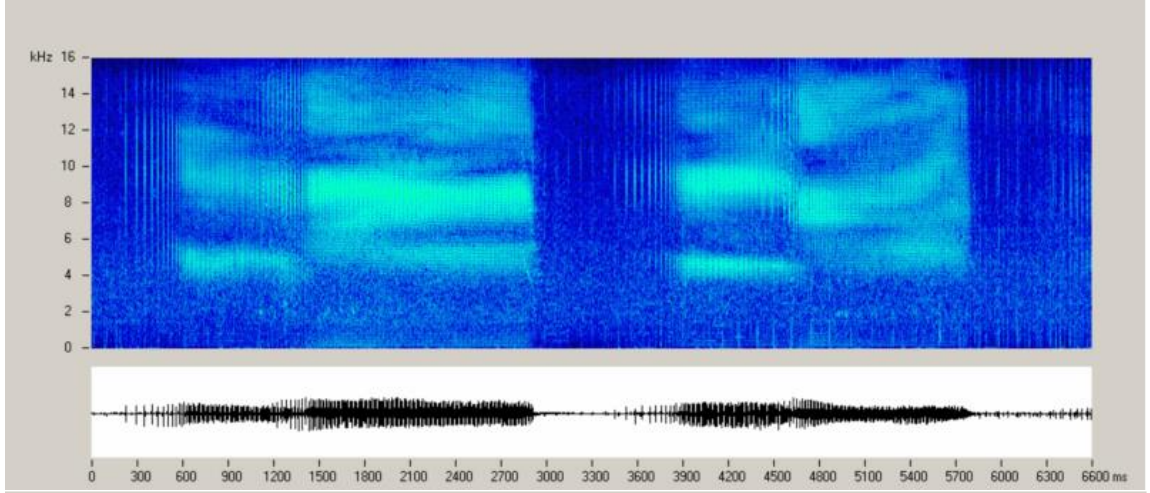
- Samples from UK and the Mediterranean were significantly differentiated based on all eight microsatellite loci; no shared haplotypes in the mtDNA control region

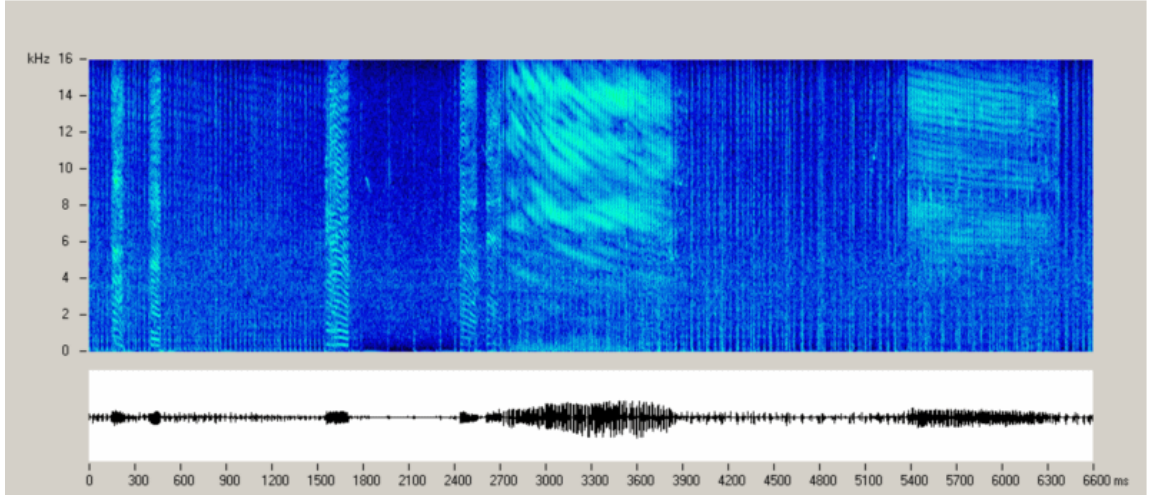
- Haplotype richness in the UK population was 3.0 whereas in the Mediterranean population, it was 10.75

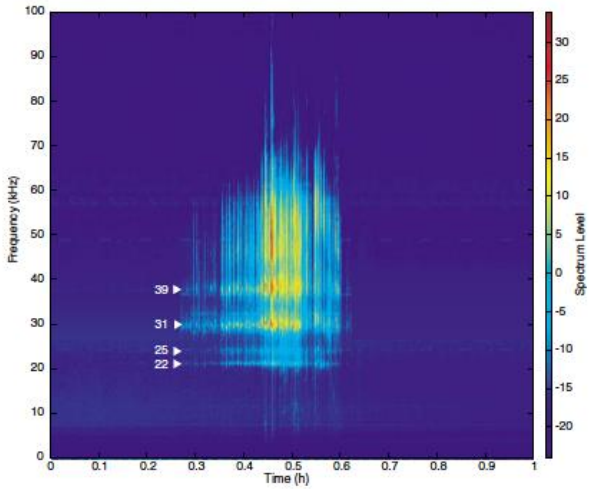



**Sources:** Gaspari, 2004; Gaspari *et al*., 2007

# VOCALISATIONS



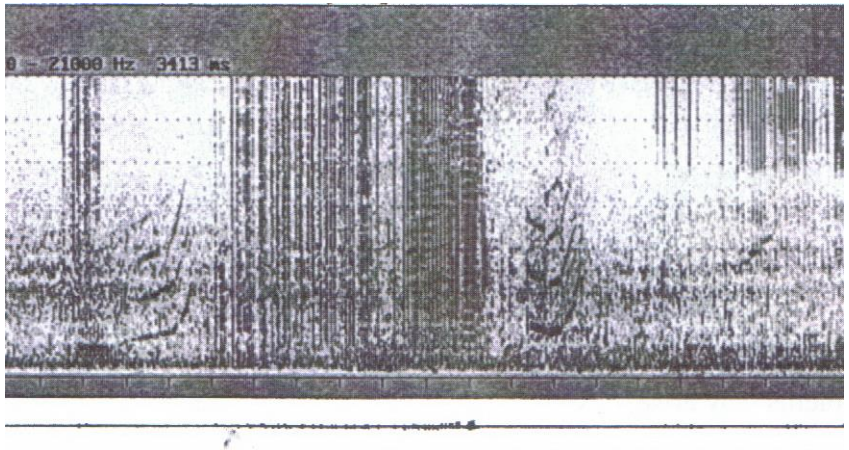




• Clicks – 0.2->200 kHz (peak 65 kHz), av. duration 40-100 µs, max. SL 192 dB re 1µPa Repetition rates of 4-200/s with click bursts lasting 0.2-1.5 s, forming buzzes, squeaks, squeals & moans

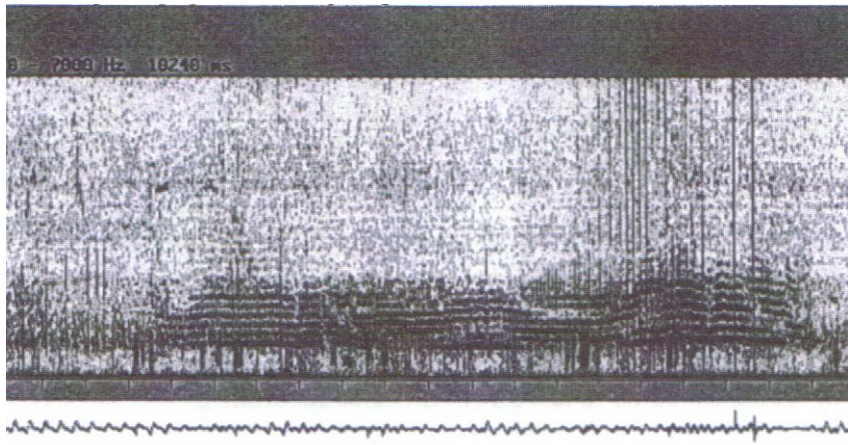
• Whistles – 2.5-20 kHz (usually 8-12 kHz), av. duration 0.67 s, max. SL 170 dB re 1µPa

**Sources**: Au, 1993; Benoldi *et al*., 1997, 1998; Madsen *et al*., 2004; Soldevilla *et al*., 2008, 2010

# GEOGRAPHIC VARIATION IN VOCALISATIONS



a) Clicks in discrete series (Creaks) & Whistle



b) Fast series of pulsed sounds (Moans)

| WHISTLE | | Min. freq. Hz | Max. freq. Hz | Start freq. Hz | End freq. Hz | duration ms |
|---|---|---|---|---|---|---|
| Hebrides | Mean | 9003.6 | 13241.4 | 12047.1 | 11128.7 | 565.5 |
| | st. dev. | 2626.1 | 2328.7 | 2714.3 | 6267.6 | 259.6 |
| | | | | | | |
| Med. | Mean | 7449.2 | 11813.4 | 9625.6 | 8736.1 | 394.5 |
| | st. dev. | 3630.4 | 4134 | 3849.9 | 4230 | 278.3 |

Comparing whistles between the Hebrides and Western Mediterranean

**Source:** Benoldi *et al.*, 1997, 1998

# GEOGRAPHIC VARIATION IN VOCALISATIONS: Statistical Results

| Duration ms | CREAK | BUZZ | SQUEAK | SQUEAL |
|---|---|---|---|---|
| F test | F = 0.2<br>P> 0.05 | F = 3.7<br>P< 0.05 | F = 1.1<br>P> 0.05 | F = 8.4<br>P> 0.05 |
| t test | t = 9.2<br>P< 0.01 | | t = 0.08<br>P< 0.01 | t = 2.6<br>P< 0.01 |
| z test | | z = 22.5<br>P< 0.01 | | |

| WHISTLE | Duration ms | Hz min. | Hz max. | Hz start | Hz end |
|---|---|---|---|---|---|
| F test | F = 0.9<br>P< 0.05 | F = 0.5<br>P> 0.05 | F = 0.3<br>P> 0.05 | F = 0.5<br>P> 0.05 | F = 0.5<br>P> 0.05 |
| t test | t = 3.7<br>P< 0.01 | t= 3.0<br>P< 0.01 | t = 2.8<br>P< 0.01 | t = 4.5<br>P< 0.01 | t = 3.4<br>P< 0.01 |

Duration, Pulse Rate and Frequency Range were all significantly different for similar sounds made by Risso's Dolphins in the Hebrides compared with the Western Mediterranean

**Source:** Benoldi *et al*., 1997, 1998

# GROUP SIZES & BEHAVIOUR

- Group sizes range from 1 to 4,000 but are typically between 10 and 40 individuals
- Travel speeds generally 6-8 km/h; spurts may reach speeds of 20-25 km/h
- Usually surface every 7 secs; most dives 2-4 mins  max. possibly to 30 mins
- Behaviours include breaches, lob-tailing, spy-hops, tail & flipper slaps

**Sources**: White & Norris, 1978; Clarke, 1986; Kruse, 1989; Kruse *et al*., 1999; Gaspari, 2004; Evans, 2008; Hartman et al., 2008; Wells *et al*., 2009; de Boer *et al*., 2012

# HABITAT PREFERENCES OF RISSO'S DOLPHINS IN THE SHELF SEAS OF WESTERN UK

- Areas with depths of 20-40 m and slightly shelving slopes favoured (Outer Hebrides, Bardsey Island & north Anglesey)
- Areas with tidal eddies favoured (e.g. off Bardsey Island & in north Anglesey)
- LW & ebb tides favoured at Bardsey, whereas HW & flood tides favoured in north Anglesey
- Higher occurrence in late afternoon off Bardsey Island whereas in north Anglesey, no particular diurnal pattern was observed

**Sources:** Gill *et al.,* 1997; Anderwald, 2002; de Boer *et al*., 2013, 2014; Stevens, 2014; Mandlik, 2020; Evans, 2021

# PHOTO-IDENTIFICATION

• Nicks in trailing edge of the dorsal fin – best feature

• Pale markings on fin & back – can be used when distinct

• But rake marks can change over time, coalescing to form larger areas, and whitening with age

# PHOTO-ID MATCHES IN WESTERN UK

a)

b)

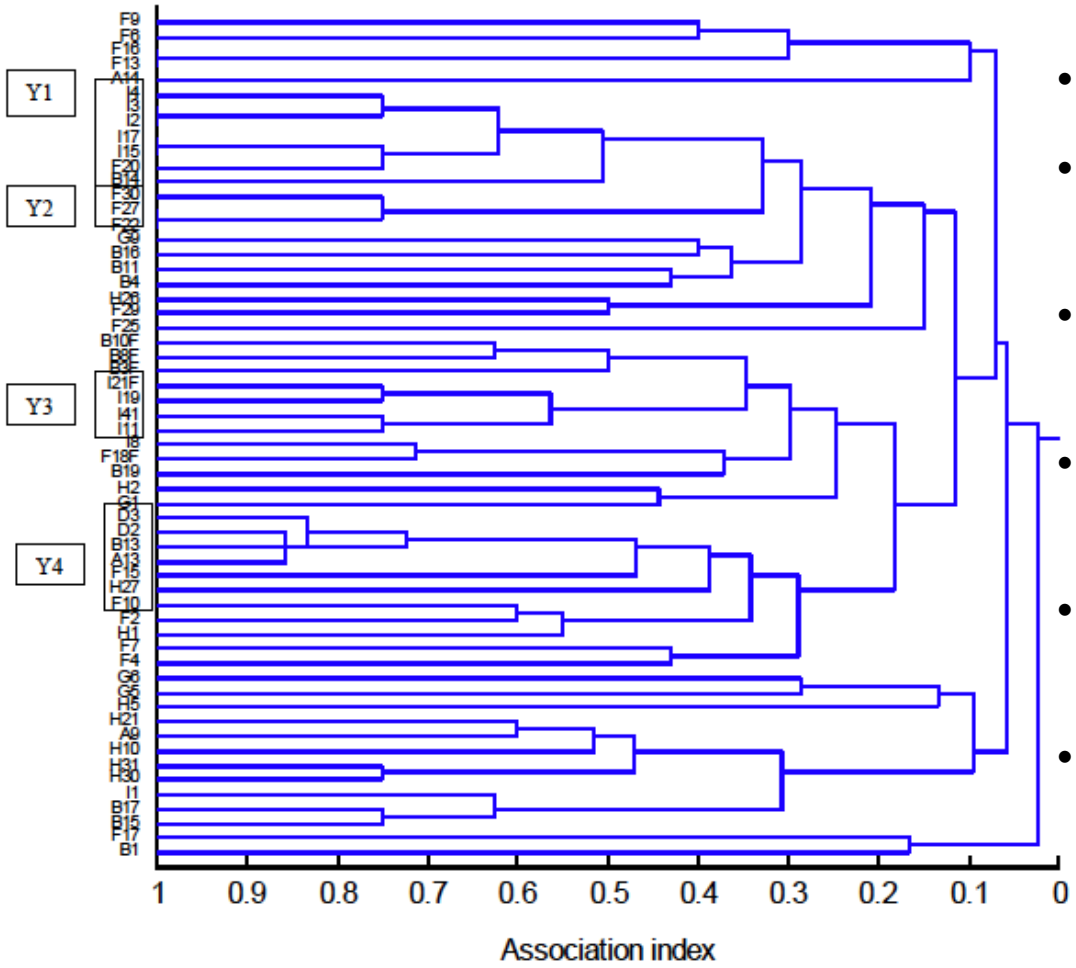
Risso's dolphin probable female (no. *21AN20*) photographed off north Anglesey in Oct 2015 (top), and re-sighted in April 2021 in Cornwall (bottom). It was also sighted in the Isle of Man in 2005.

**Sources:** de Boer *et al*., 2013; Stevens, 2014; Mandlik, 2020;

# SOCIAL STRUCTURE

## a) Ligurian Sea

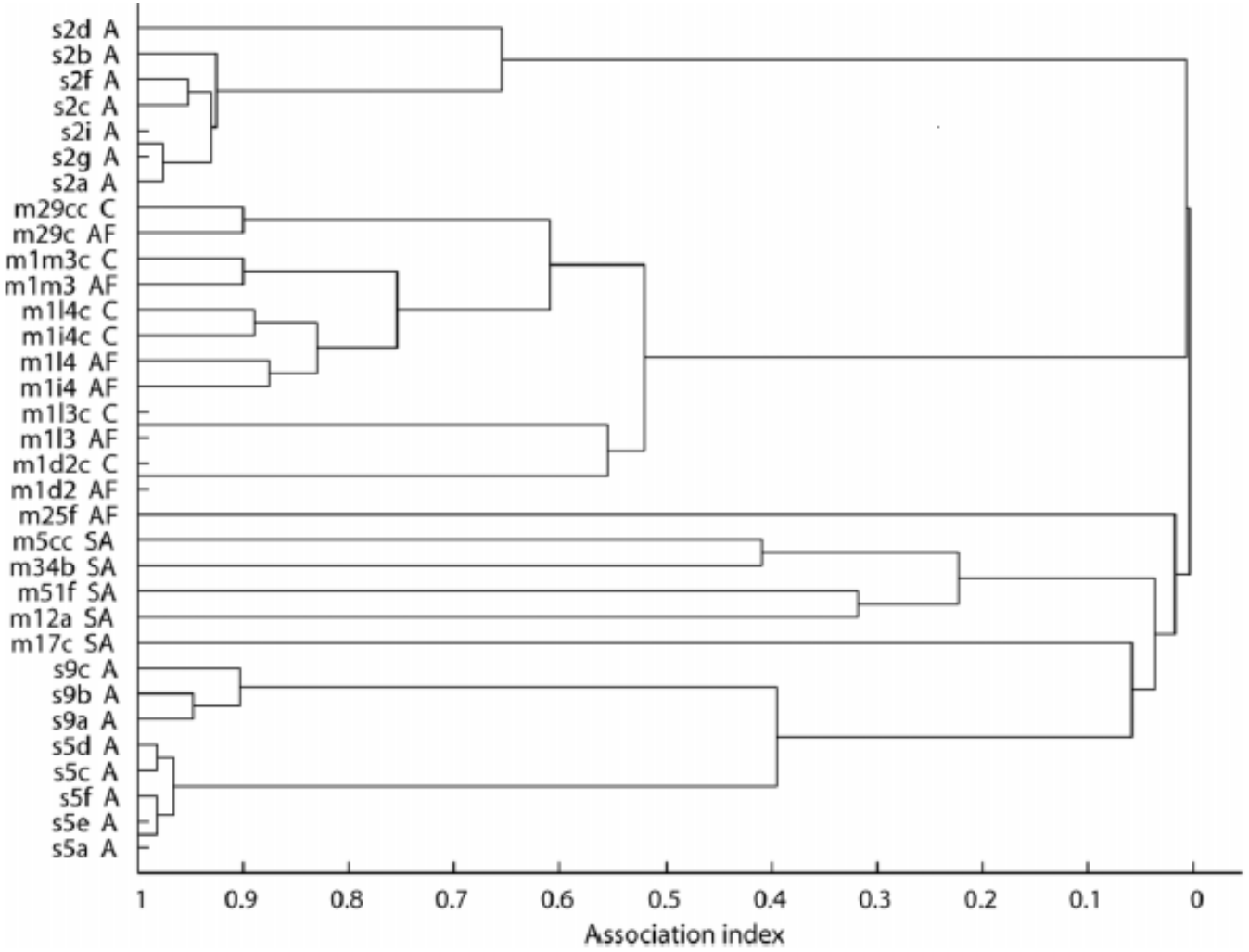
Dendrogram of associations between individual Risso's dolphins: average linkage cluster analysis of association matrix of 58 photo-identified individuals




- Cluster analysis indicates four groups
- Cluster Y1 comprised 6 individuals, 4 of which were always sighted together
- Cluster Y2 comprised 3 individuals, with high individual fidelity
- Cluster Y3 comprised 4 individuals, with moderate individual fidelity
- Cluster Y4 comprised 4 individuals, with moderate individual fidelity
- Strong preference for specific indivs. to associate with each other

**Source:** Gaspari, 2004

# SOCIAL STRUCTURE

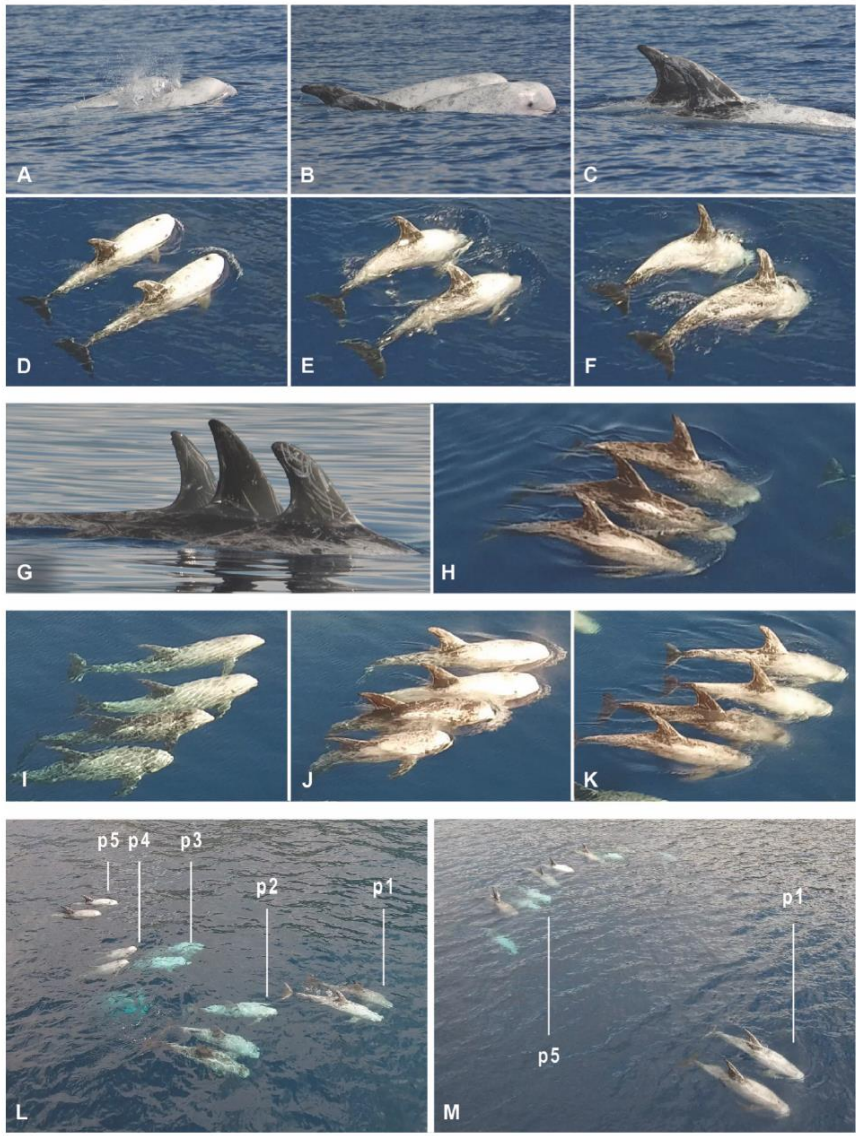



**b) Azores**

- Individuals form stable long-term bonds in pairs or clusters of 3-12 individuals
- Strong associations between adult males and between adult females

**Source:** Hartman *et al.*, 2008

# Continuous focal group follows using aerial drones




- Data based upon focal follows of 13 male Risso's dolphins in the Azores
- 21 separate UAV flights during 7 surveys in July-August 2017, recording 2,886 breathing events and 571 synchronous dyads
- Results showed strong differences in sociality between individuals: two strongly associated pairs, one strongly associated trio, and six less associated individuals within the group
- Provides a better understanding of individual associations, group structure & dynamics

**Source:** Hartman *et al*., 2020

**FIGURE 2 |** Examples of individual identification and group compositions used for scoring relative positions of individuals. **(A–C)** Photo identification of a synchronized pair using conventional photo identification methods. **(D–F)** Same pair, captured by the UAV. **(G)** Photo identification of a synchronized triplet. **(H)** Same triplet, captured by the UAV. **(I–K)** Photo identification of a synchronized quartet, captured by the UAV. **(L)** The IKB group organized in 5 rows, using a relative classification for individual positions categorized as: front row (p1), row behind the front (p2), center (p3), row before the rear (p4), or rear row (p5). **(M)** The IKB group organized in 2 rows: front (p1) and rear (p5).

# FEEDING ECOLOGY

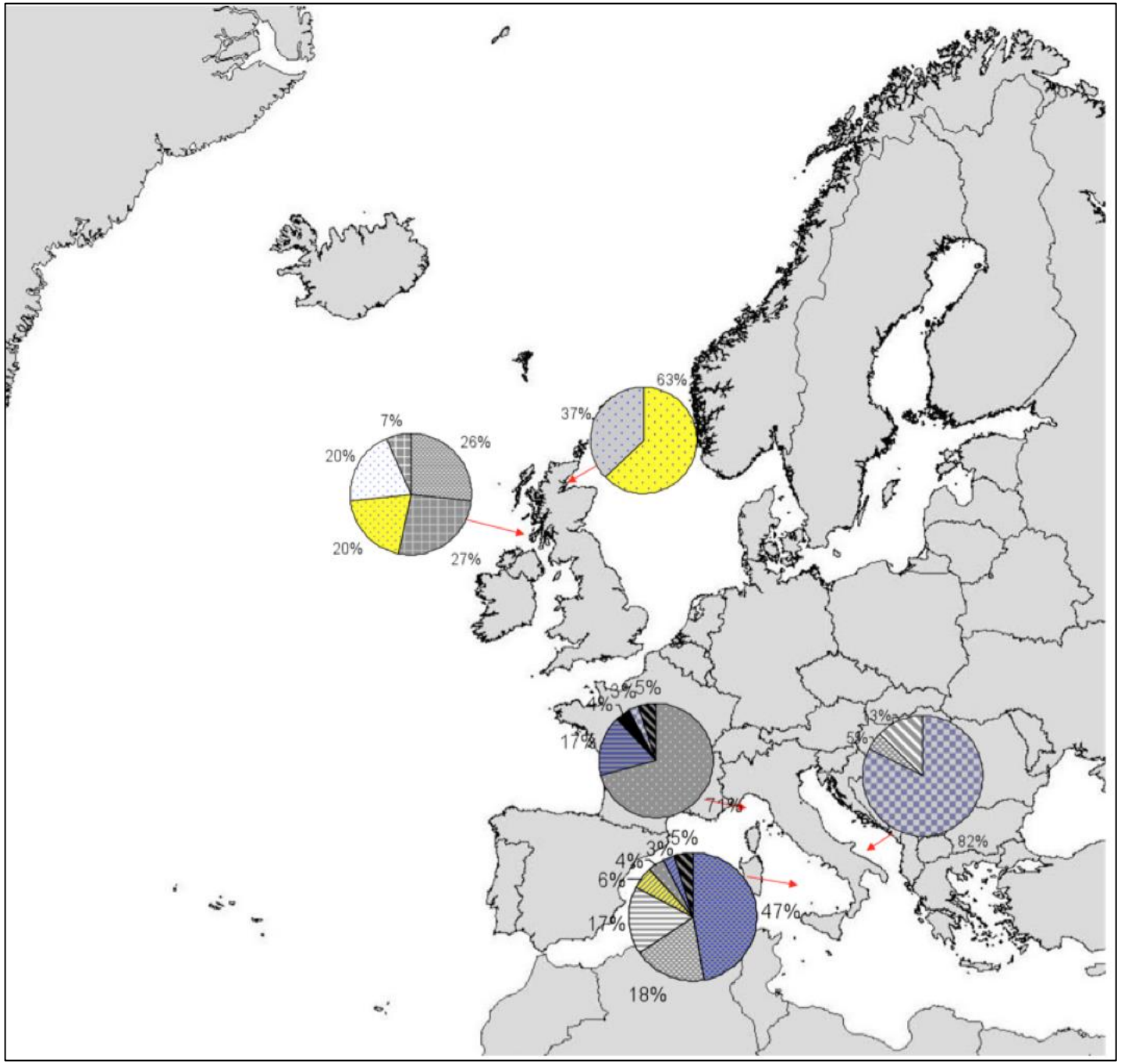
**Mesopelagic squid**

- Octopus (*Eledone*)
- Cuttlefish (*Sepia*)
- *Loligo forbesi*
- *Loligo vulgaris*
- *Todarodes sagittatus*
- *Gonatus spp.*
- *Histioteuthis reversa*
- *Histioteuthis bonnelli*

**Sources:**

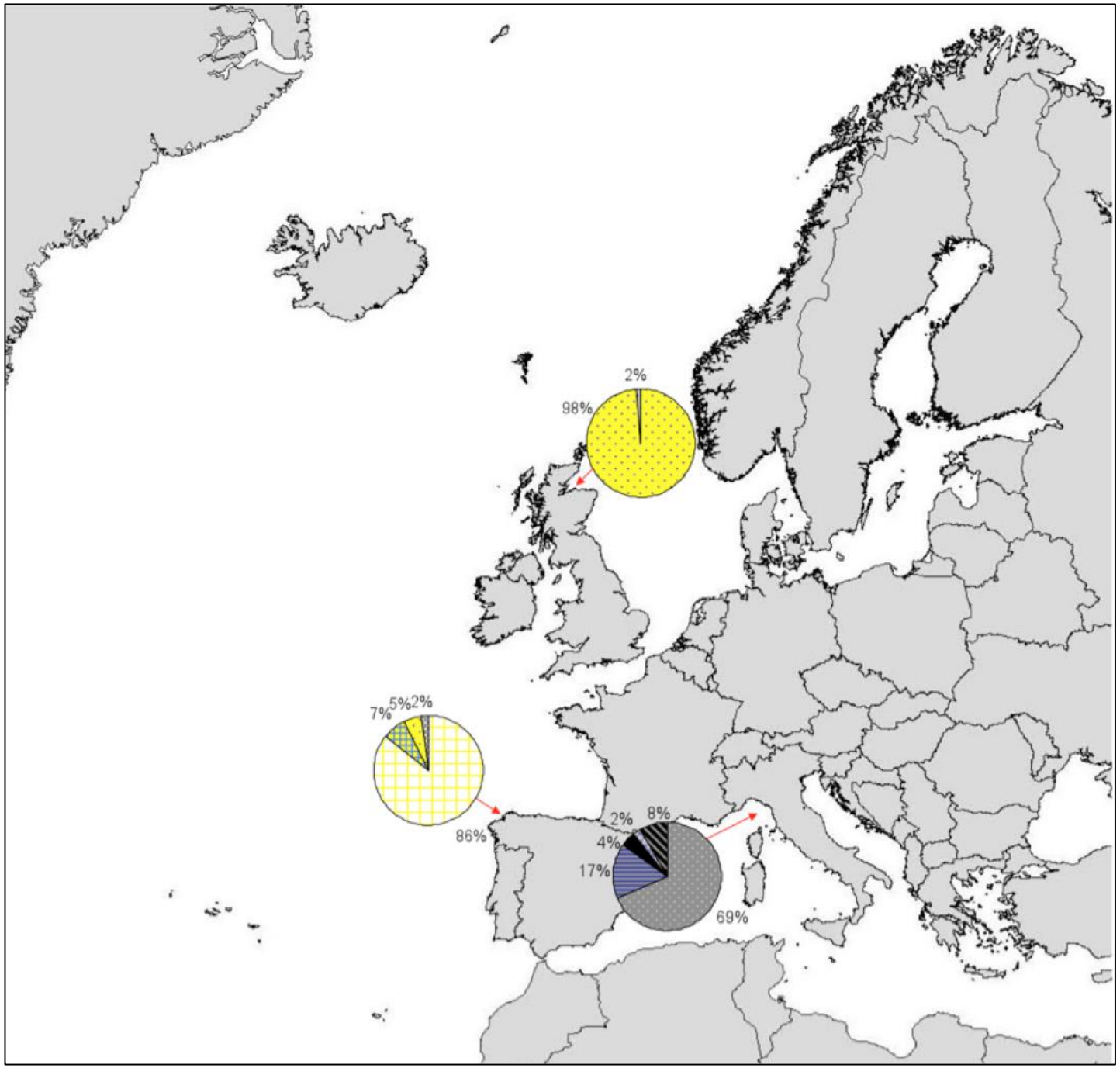
Clarke & Pascoe, 1985;
Desportes, 1985; Clarke, 1986;
Zonfrillo *et al*., 1988;
Bello & Pulcini, 1989;
Podesta & Meotti, 1991;
Carlini *et al*., 1992;
Wurtz *et al*., 1992, Bloch *et al*., 2012

# DIET - % by number



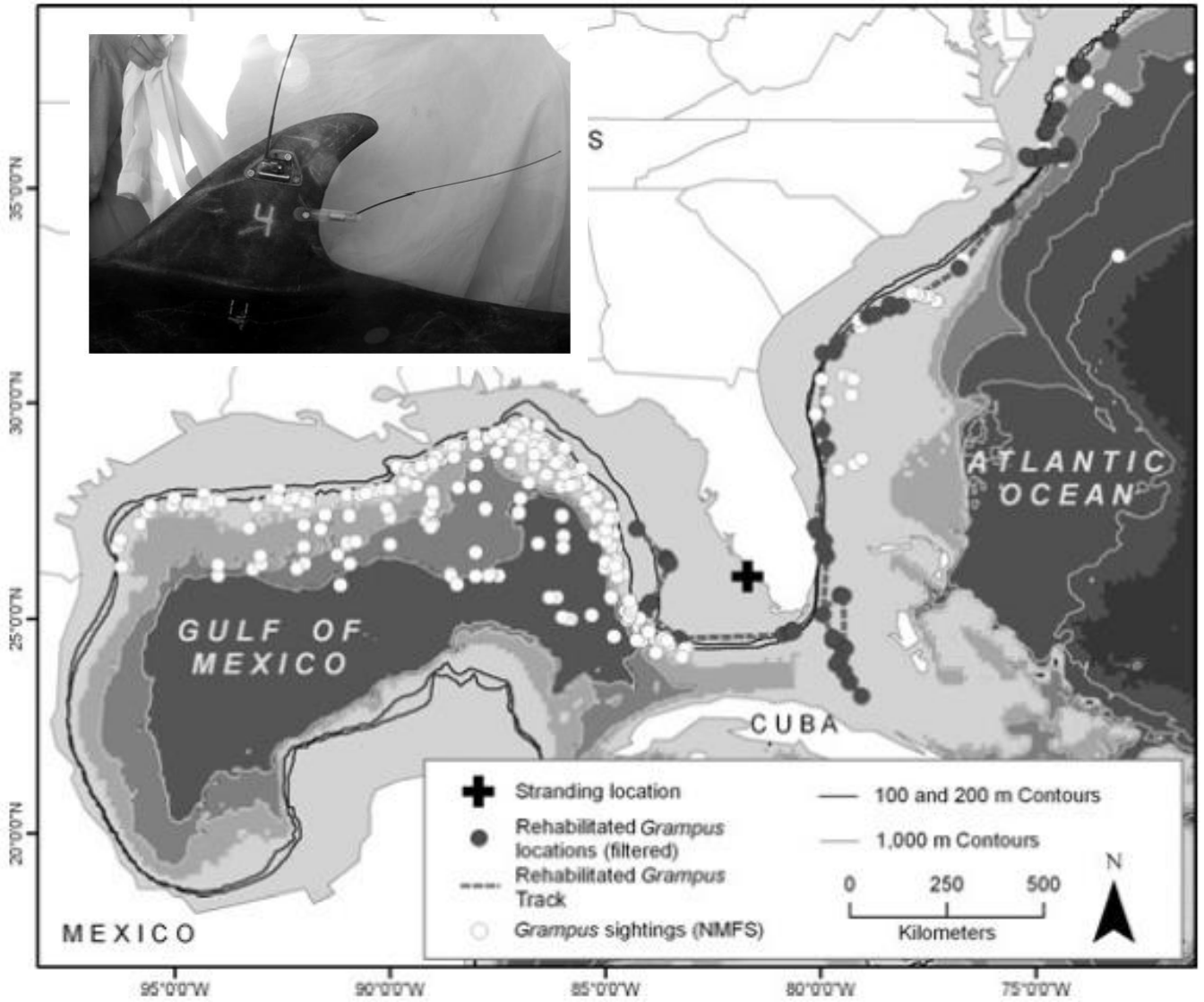

- Eledone cirrhosa
- Ocythoe tuberculata
- Loligo forbesi
- Rossia macrosoma
- Sepietta oweniana
- Histioteuthis reversa
- Loligo vulgaris
- Illex coindetti
- Gonatus steenstrupi
- Cranchiidae
- Todarodes sagittatus
- Ancistroteuthis lichtensteinii
- Histioteuthis sp.
- Other squid

# DIET - % by weight

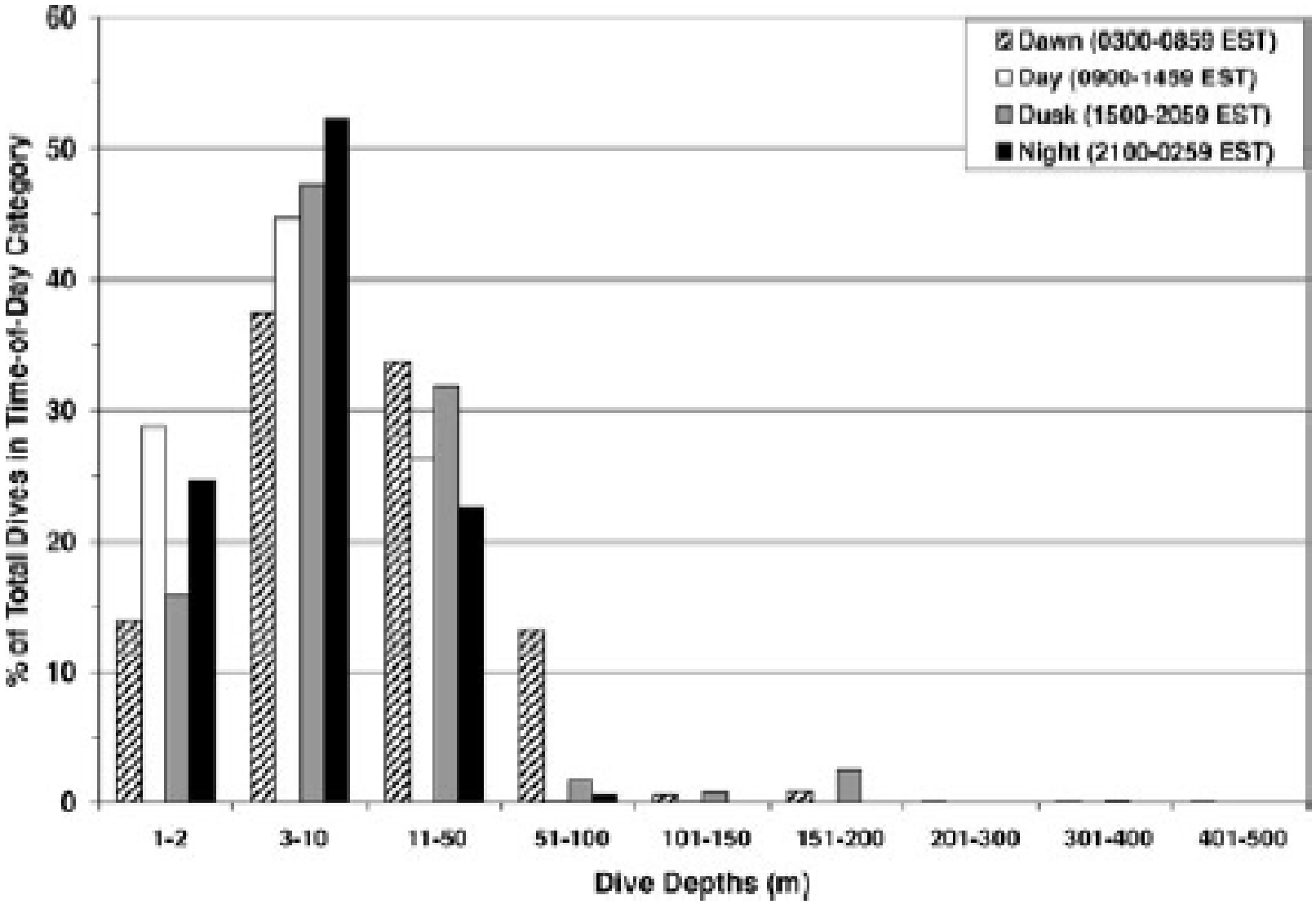



| | |
|---|---|
| | Eledone cirrhosa |
| | Ocythoe tuberculata |
| | Loligo forbesi |
| | Cranchiidae |
| | Todarodes sagittatus |
| | Ancistroteuthis lichtensteinii |
| | Histioteuthis sp. |
| | Octopus vulgaris |
| | Sepiolo atlantica |
| | Histioteuthis bonnelli |
| | Other squid |

# TELEMETRY STUDIES OF A REHABILITATED RISSO'S DOLPHIN (Wells *et al*., 2009)

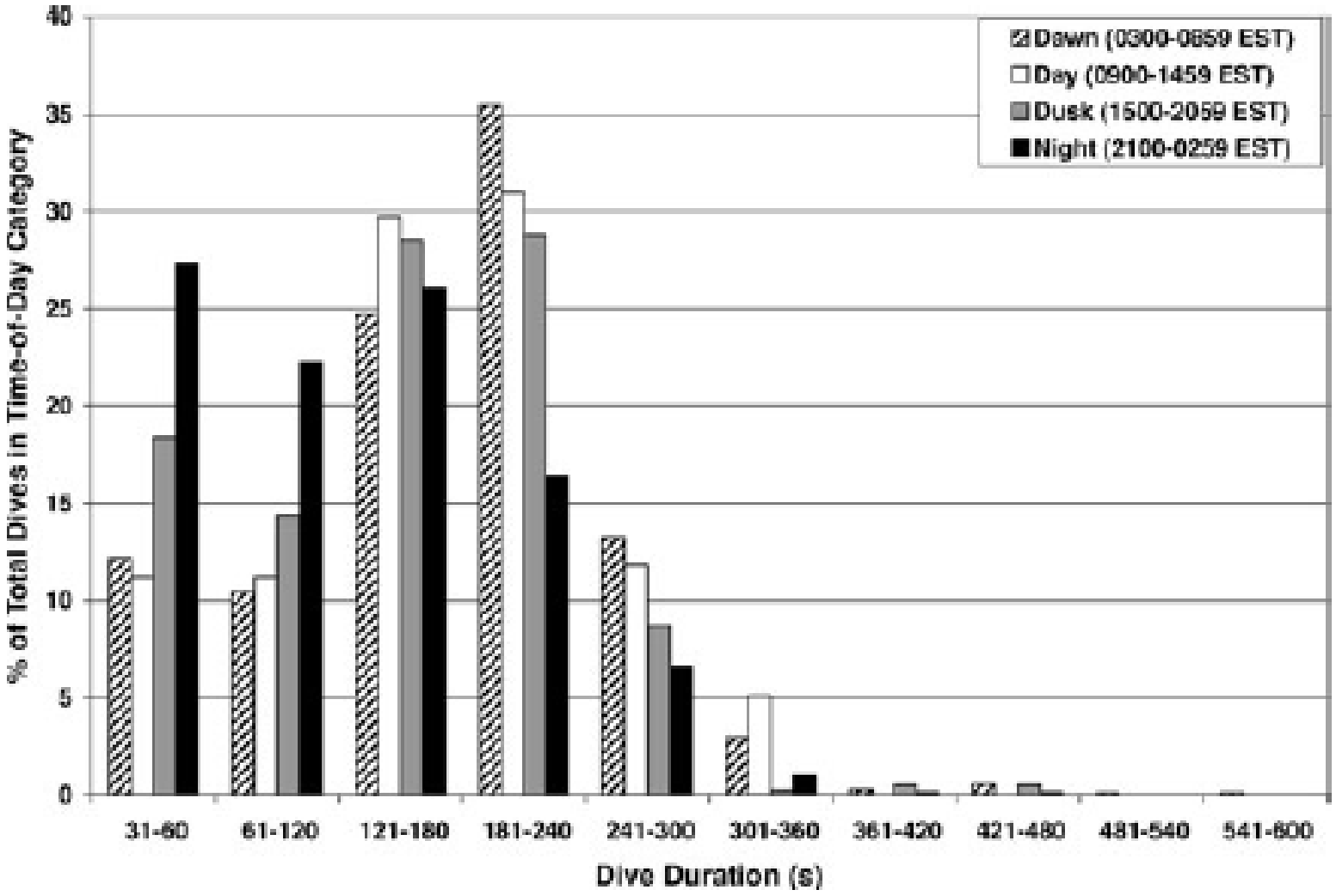


# DIVE DEPTH PROFILES RELATIVE TO TIME OF DAY



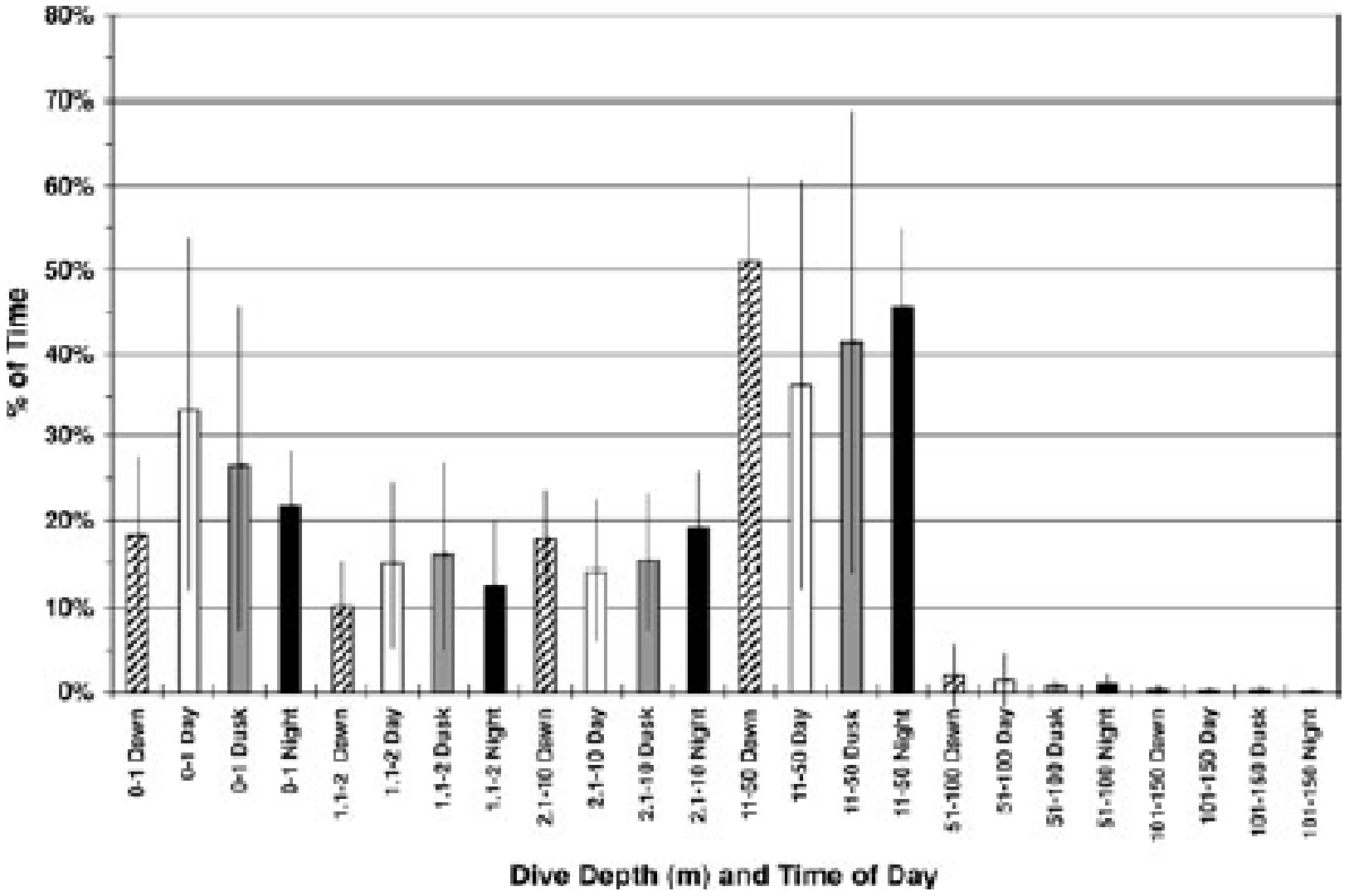

>95% of 6,048 dives were within 50 m of the surface; deepest dive was 400-500 m; majority of dives >50 m were during dawn and dusk

# DIVE DURATION PROFILES RELATIVE TO TIME OF DAY



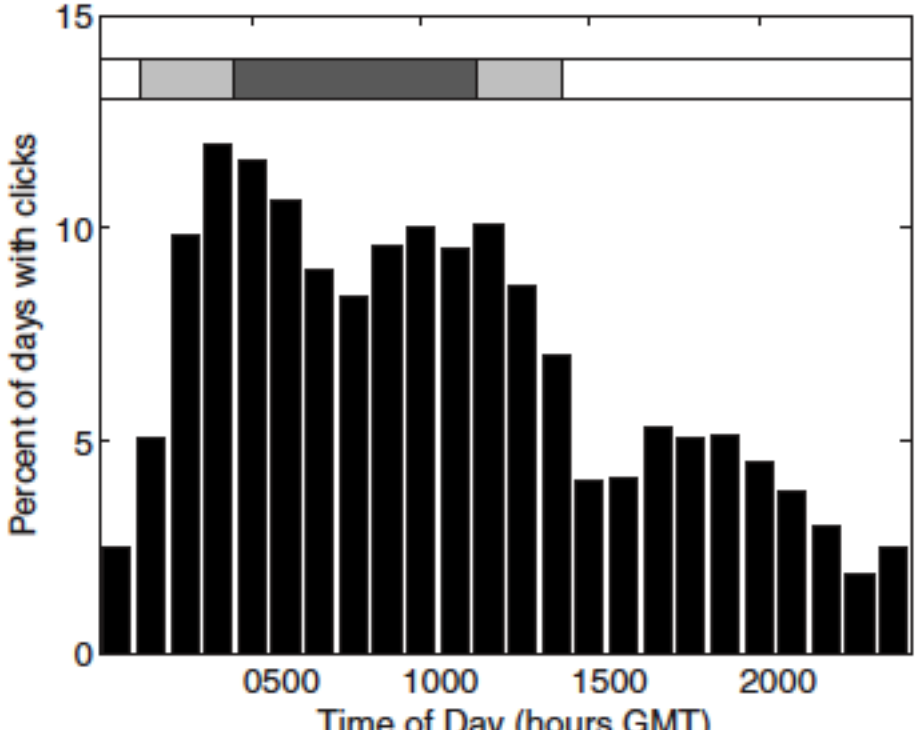

>99% of dives lasted <6 min (mainly 2-4 min) for 2,245 dives that exceeded 30 sec; longest dive lasted 9-10 min

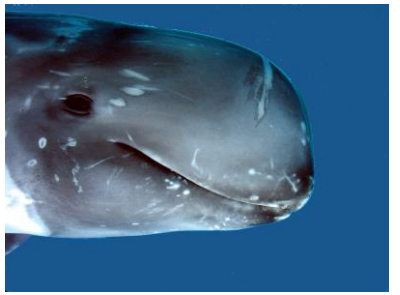
# AVERAGE % TIME SPENT AT DIFFERENT DEPTHS RELATIVE TO TIME OF DAY



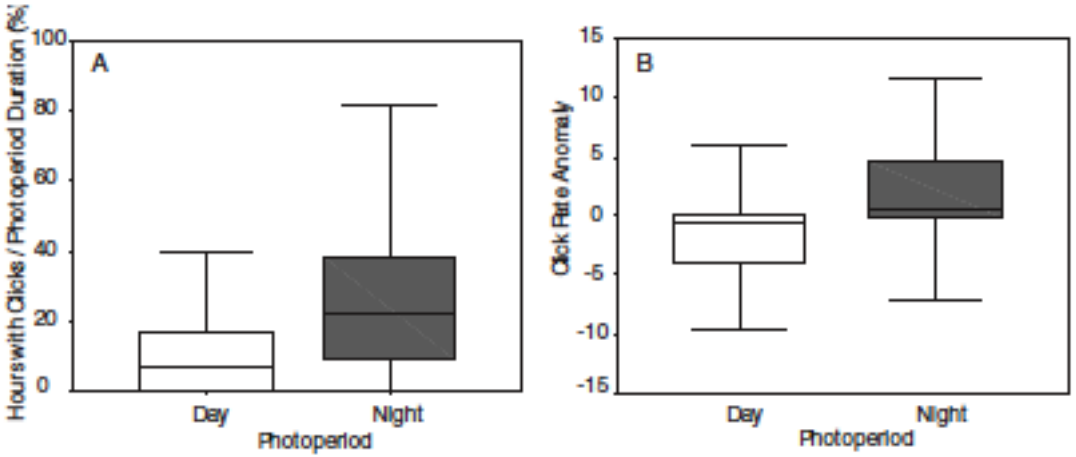

99% spent within 50 m of the surface, in the top 10% of the water column;
The animal was 10-50 m below the surface for 36-51%, and within 1 m for 18-33% of the time

# DIEL PATTERN OF ECHOLOCATION CLICK BOUTS



- Marked increase in clicks during early part of the night, slight decrease in the middle of the night followed by another increase before sunrise
- Sharp decrease after sunrise but with moderate peak in late morning




- Click bouts occurred significantly more often at night
- Click rates were significantly higher at night

**Source:** Soldevilla *et al.*, 2010

# DIVE PROFILES FROM TWO RISSO'S DOLPHINS WITH A) THE LONGEST PERIOD OF TIME WITH CONSISTENT DEEP DIVES, AND B) THE LONGEST NIGHT-TIME FORAGING PERIOD RECORDED

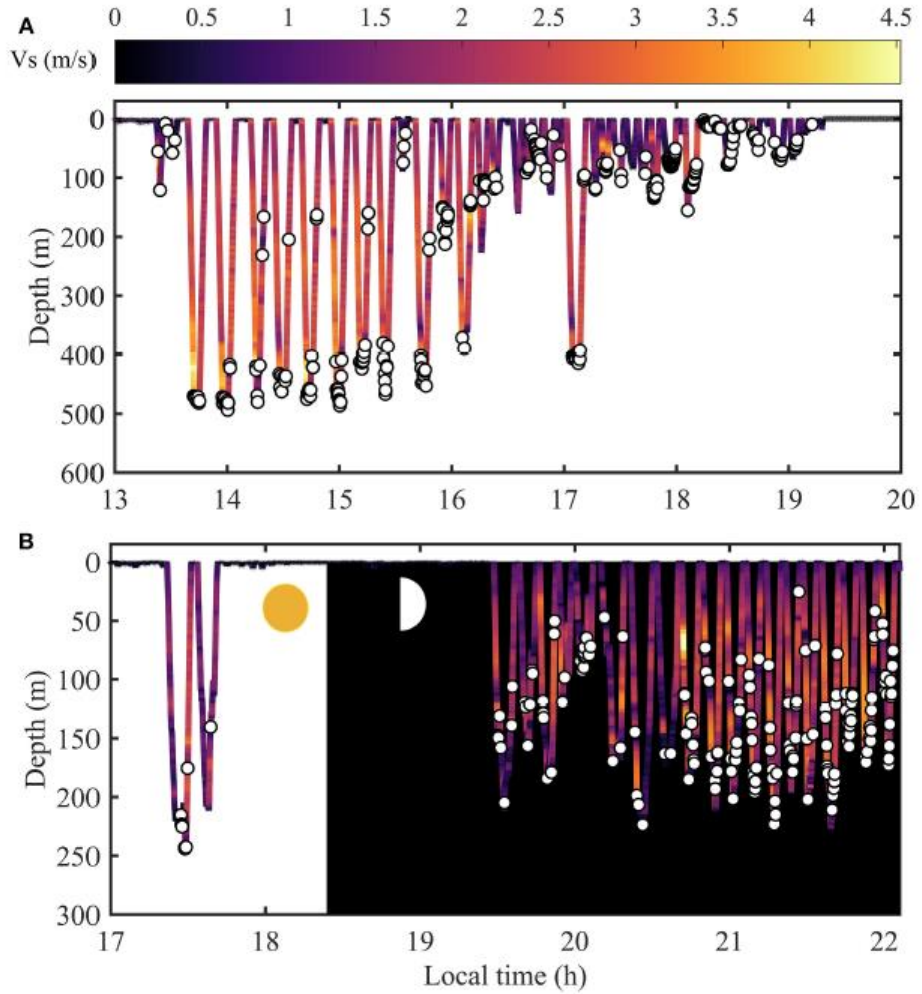
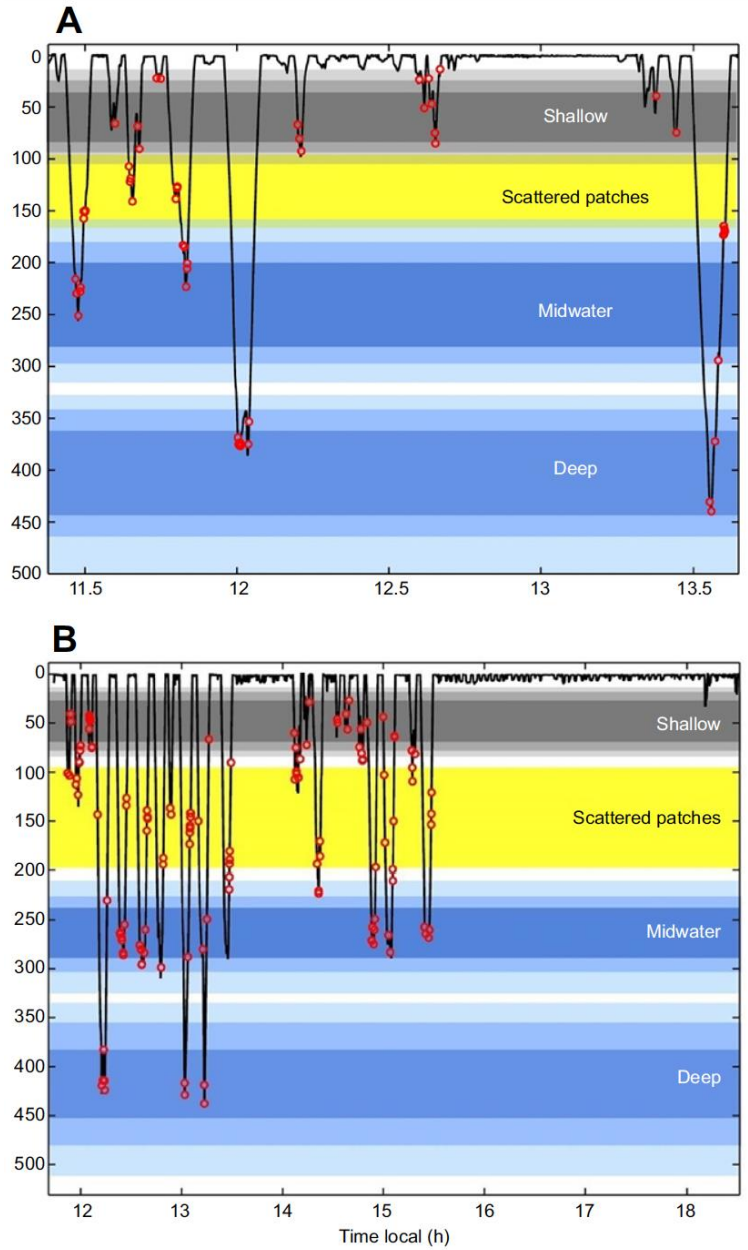
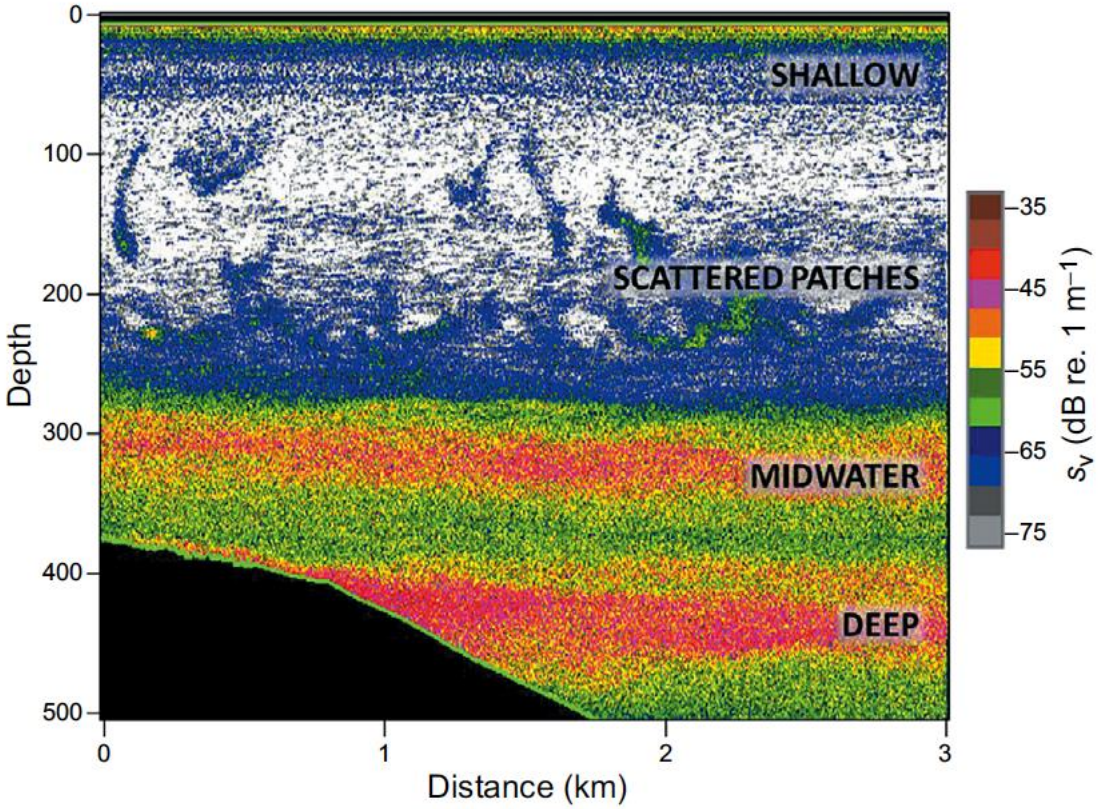



**FIGURE 1** | Dive profiles from two Risso's dolphins with **(A)** the longest period of time with consistent deep dives and **(B)** the longest night time foraging period recorded, among 33 tagged individuals. Prey capture attempts are represented by white circles. Dive profile is colored according to vertical swim speed (Vs).

**Source:** Arranz *et al.*, 2019

# FORAGING ACTIVITY OF RISSO'S DOLPHINS AND SYNCHRONOUS TIME-DEPTH DISTRIBUTION OF PREY AGGREGATIONS, CALIFORNIA, USA

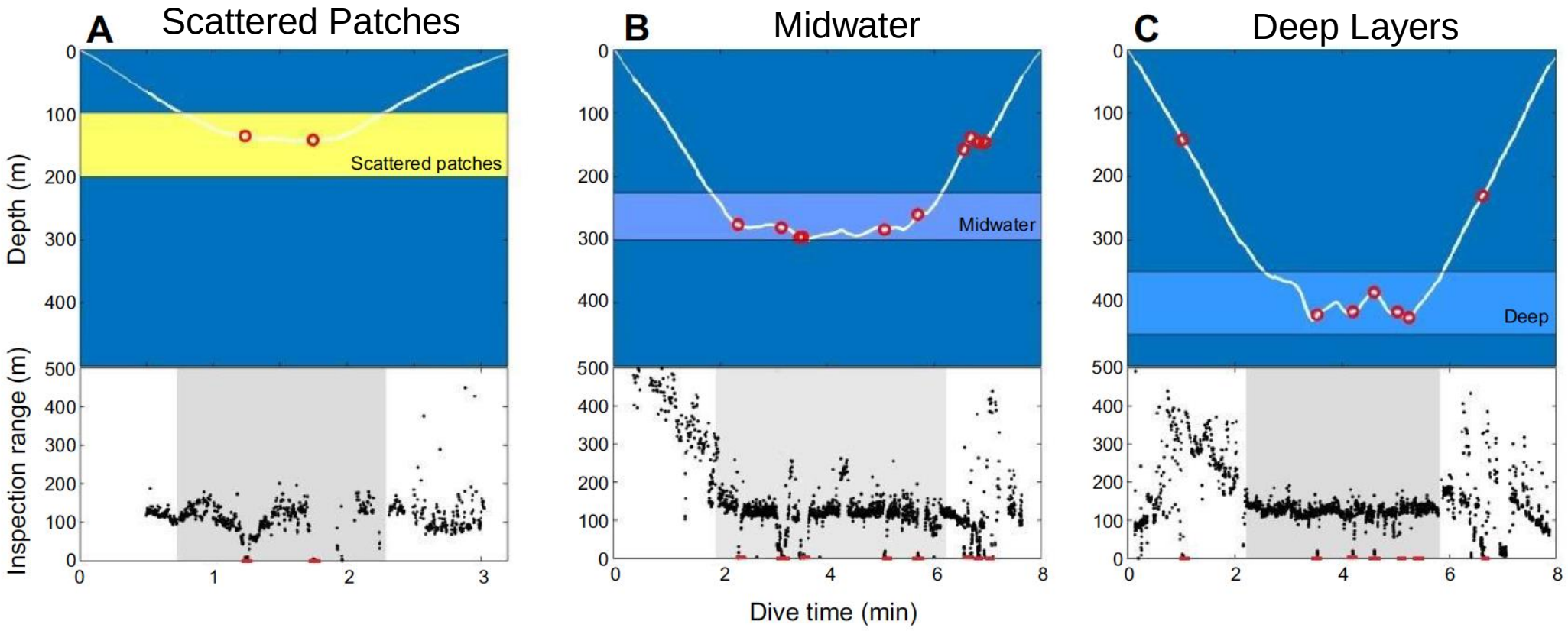



- Three sound-scattering layers revealing patches of high prey biomass: 'shallow' – 30-90m depth, 'midwater' – 200-300 m depth, migrating vertically in 24-hr cycles, 'deep' – 350-450 m depth, no diurnal migration

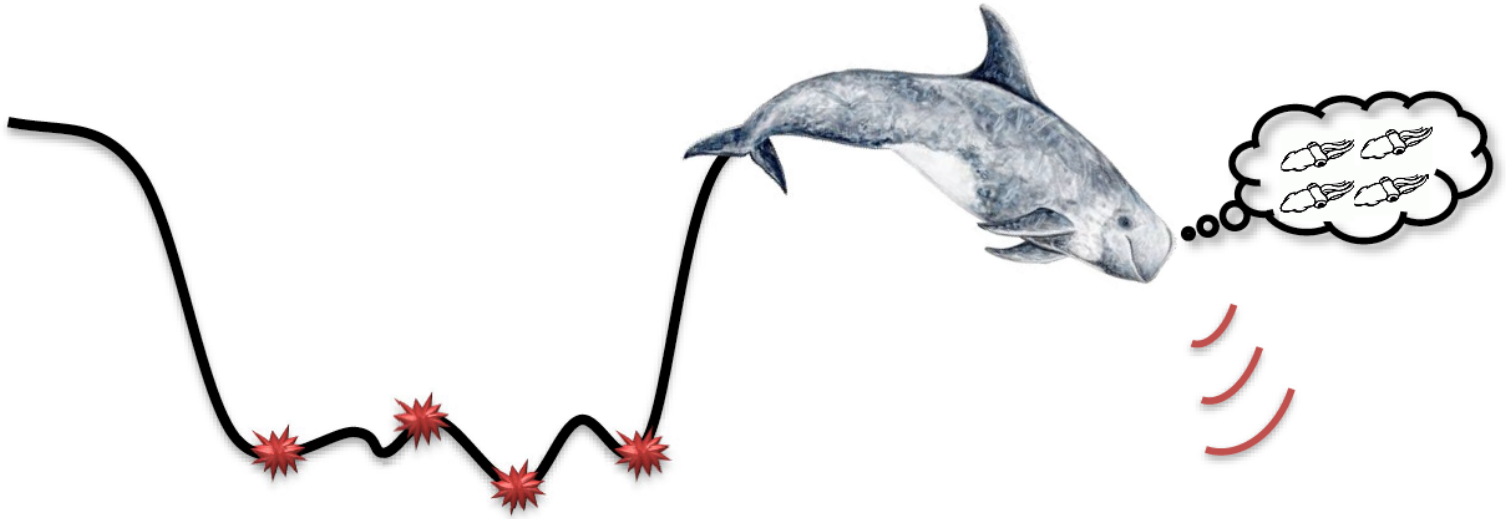
**Source:** Arranz *et al.*, 2018

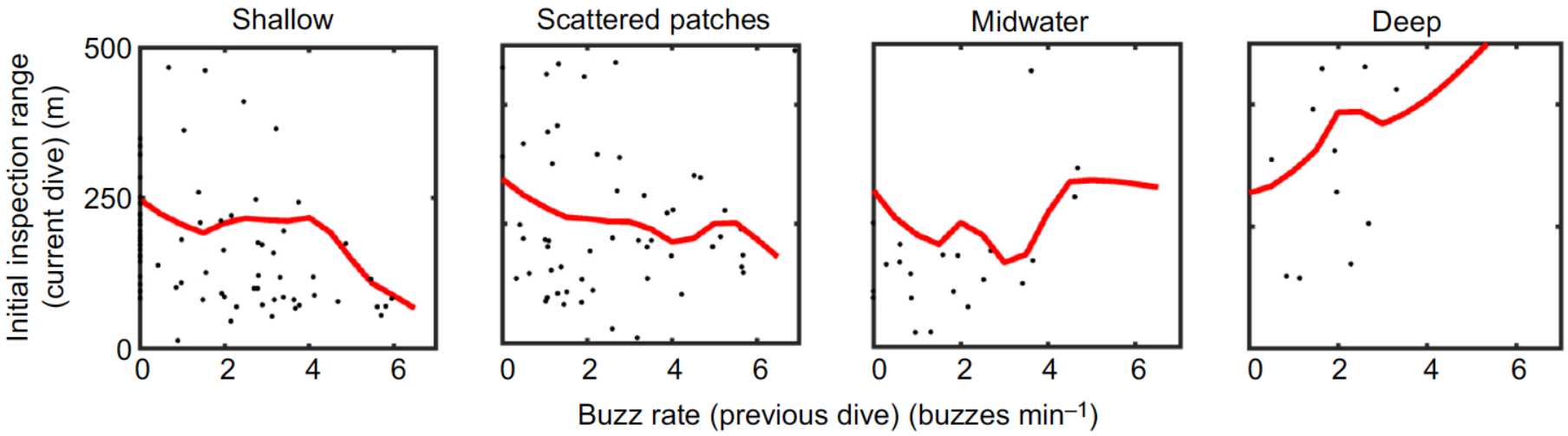
# EXAMPLES OF THE SAMPLING STRATEGIES OF RISSO'S DOLPHINS AND SYNCHRONOUS TIME-DEPTH DISTRIBUTION OF PREY AGGREGATIONS, CALIFORNIA, USA




**Source:** Arranz *et al*., 2018

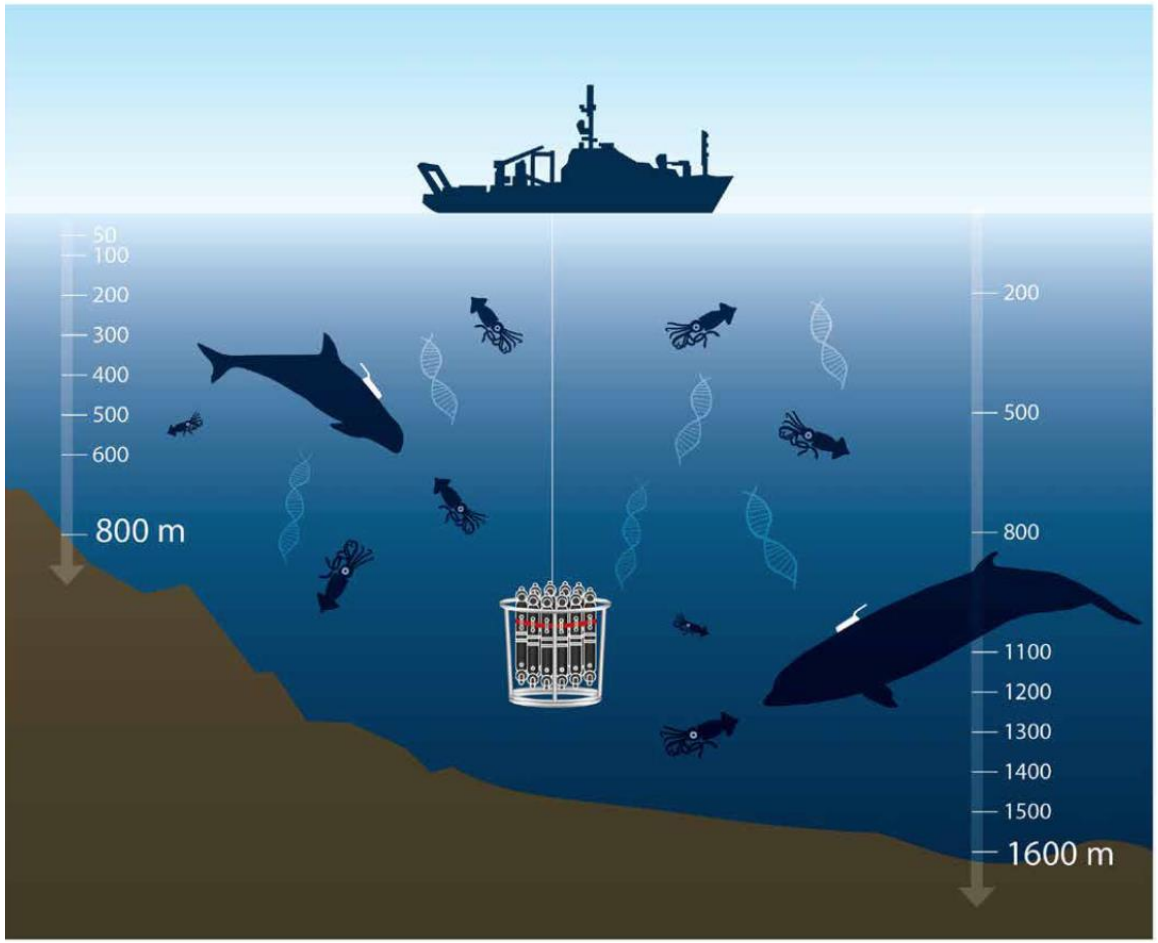
# INITIAL INSPECTION RANGE ADAPTED TO THE BEST FORAGING DEPTH ENCOUNTERED ON THE PREVIOUS DIVE FROM 174 DIVES BY 28 RISSO'S DOLPHINS

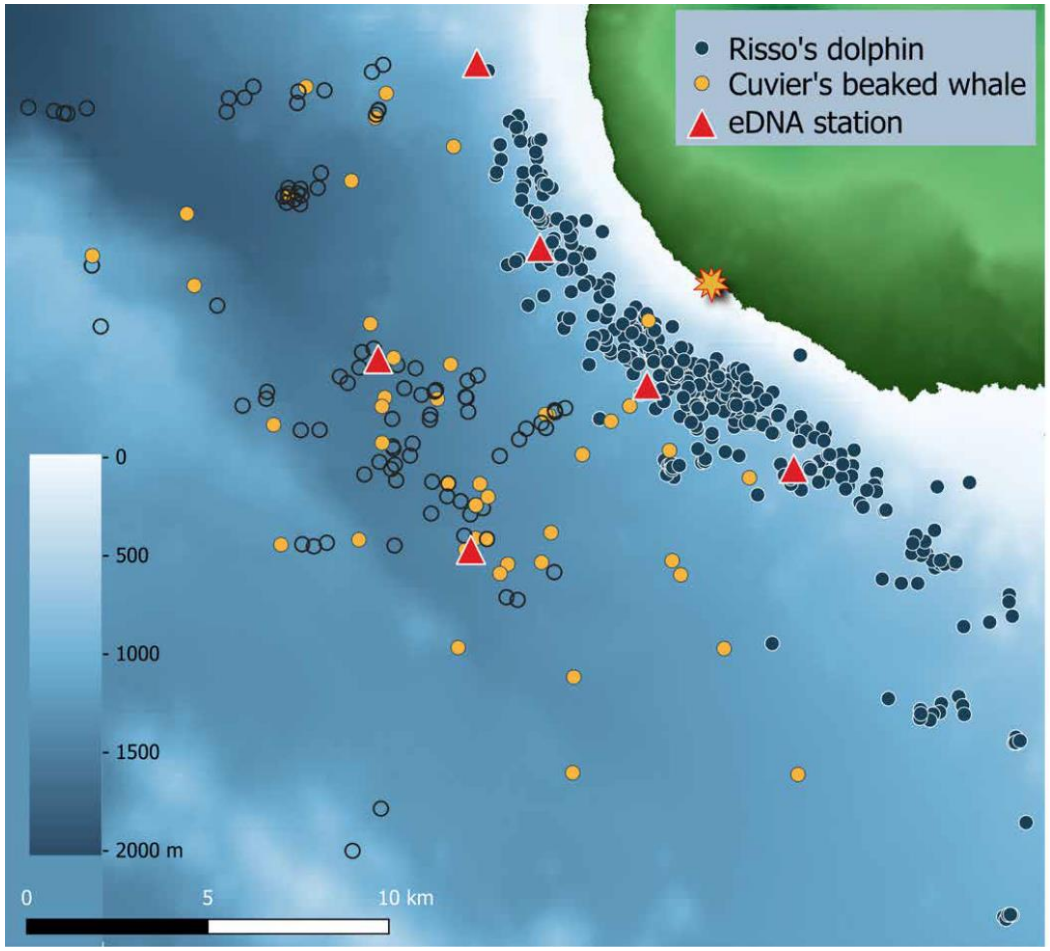





**Source:** Arranz *et al.*, 2018

# STUDIES OF NICHE SEGREGATION BETWEEN RISSO'S DOLPHIN & CUVIER'S BEAKED WHALE



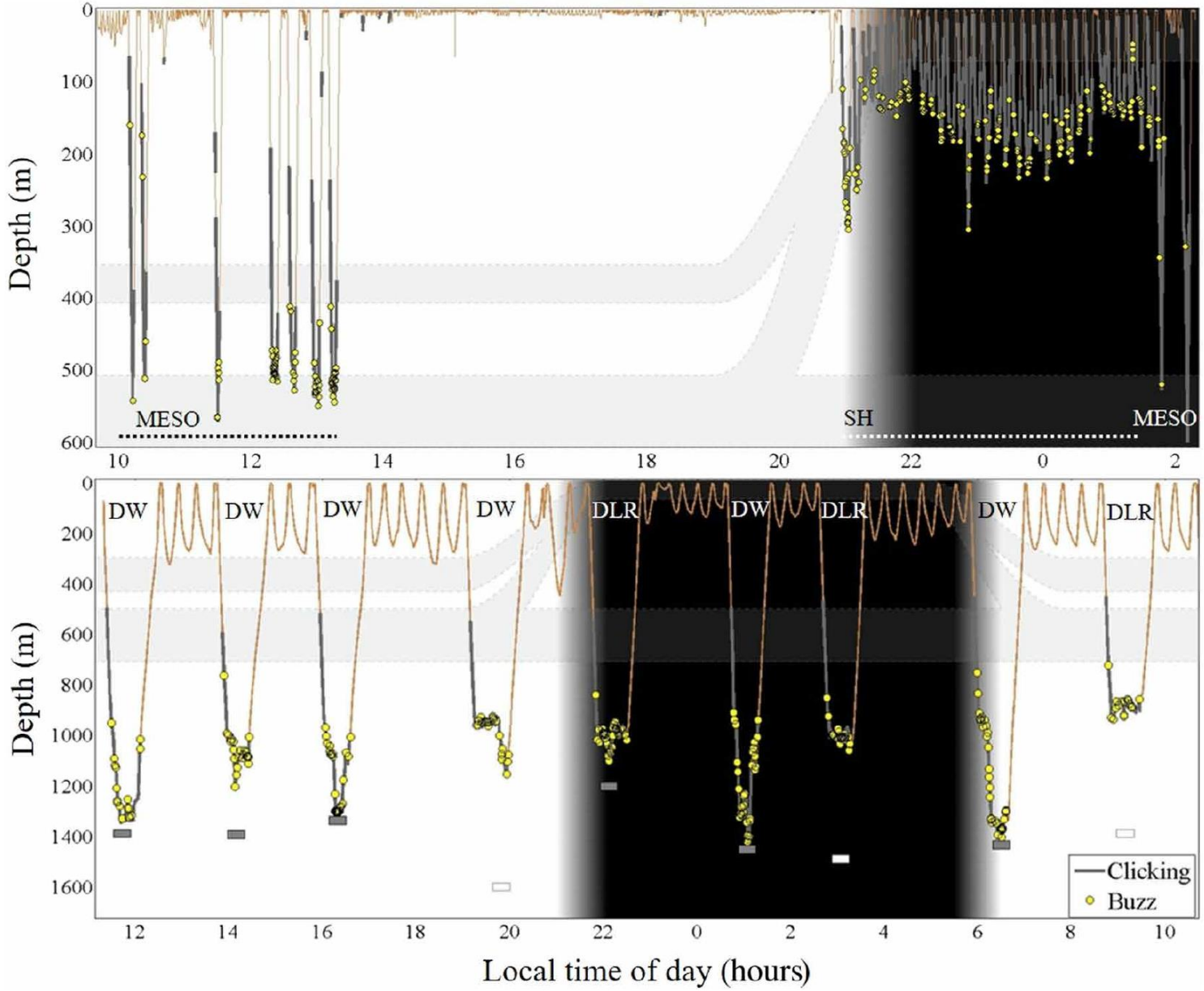




**Source:** Visser *et al*., 2021

# FORAGING BEHAVIOUR OF RISSO'S DOLPHIN & CUVIER'S BEAKED WHALE IN AZORES

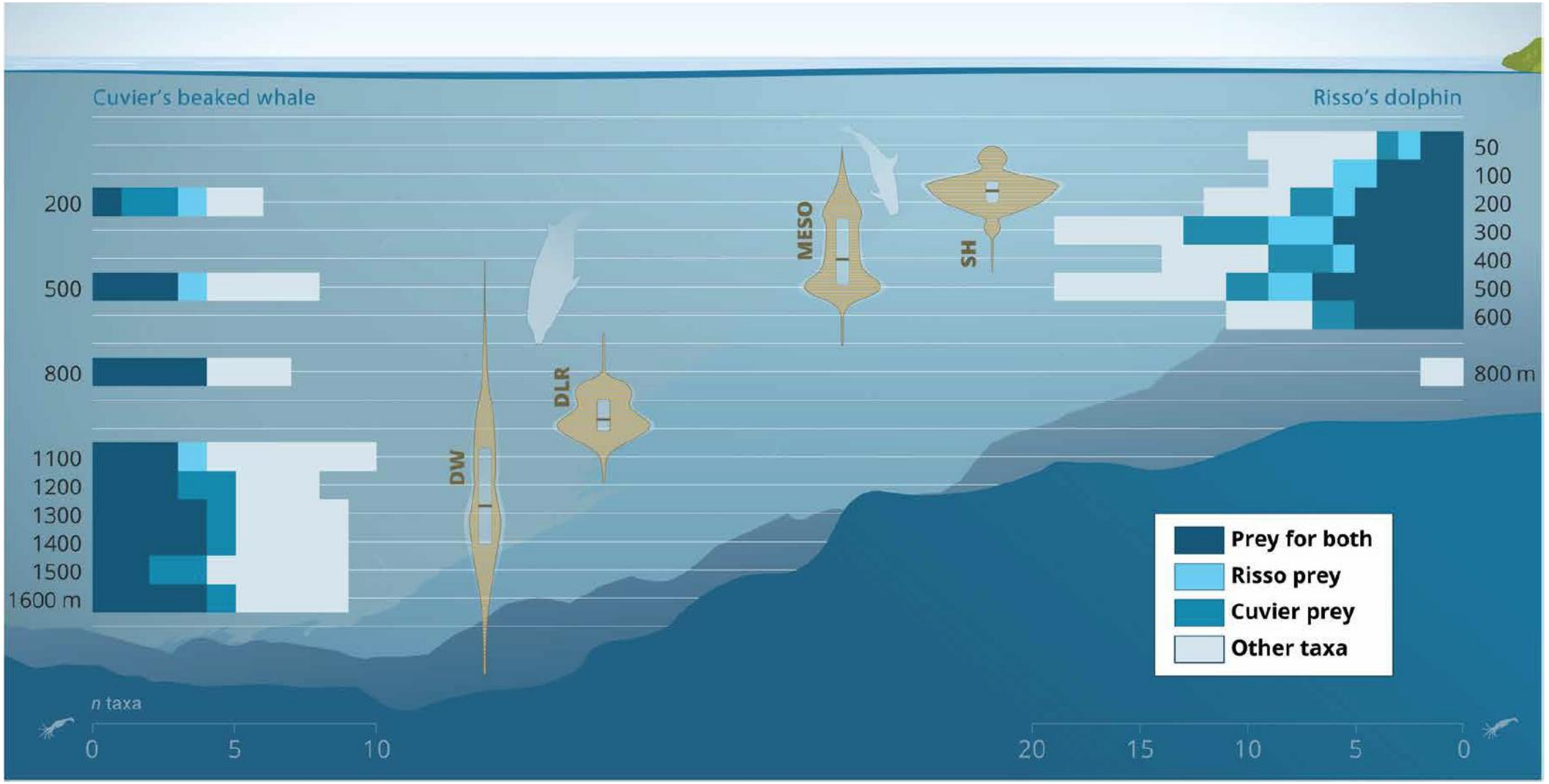
a) Risso's dolphin

b) Cuvier's beaked whale



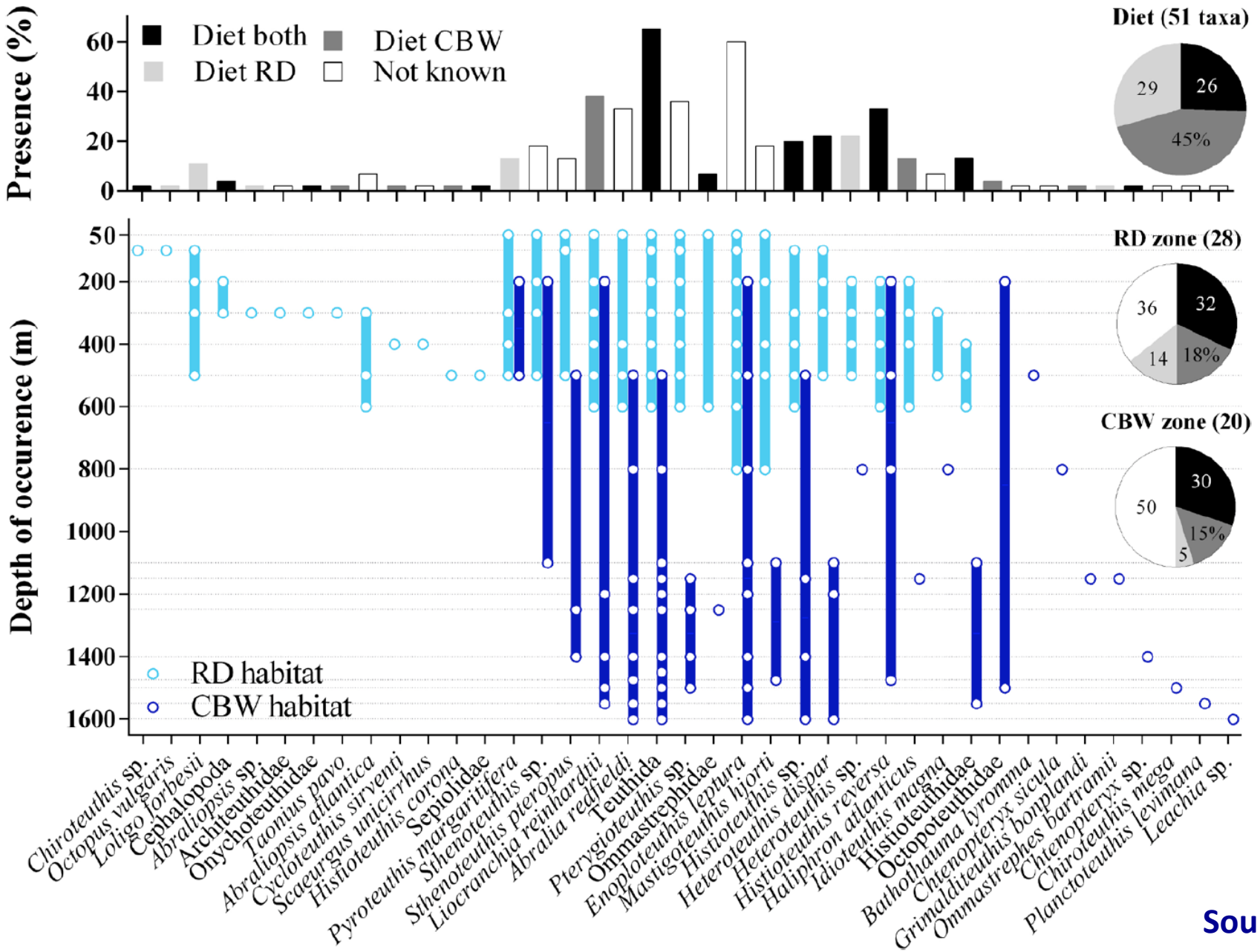

**Source:** Visser *et al.*, 2021

# DEEP SEA NICHE DIFFERENTIATION BETWEEN RISSO'S DOLPHIN & CUVIER'S BEAKED WHALE IN AZORES



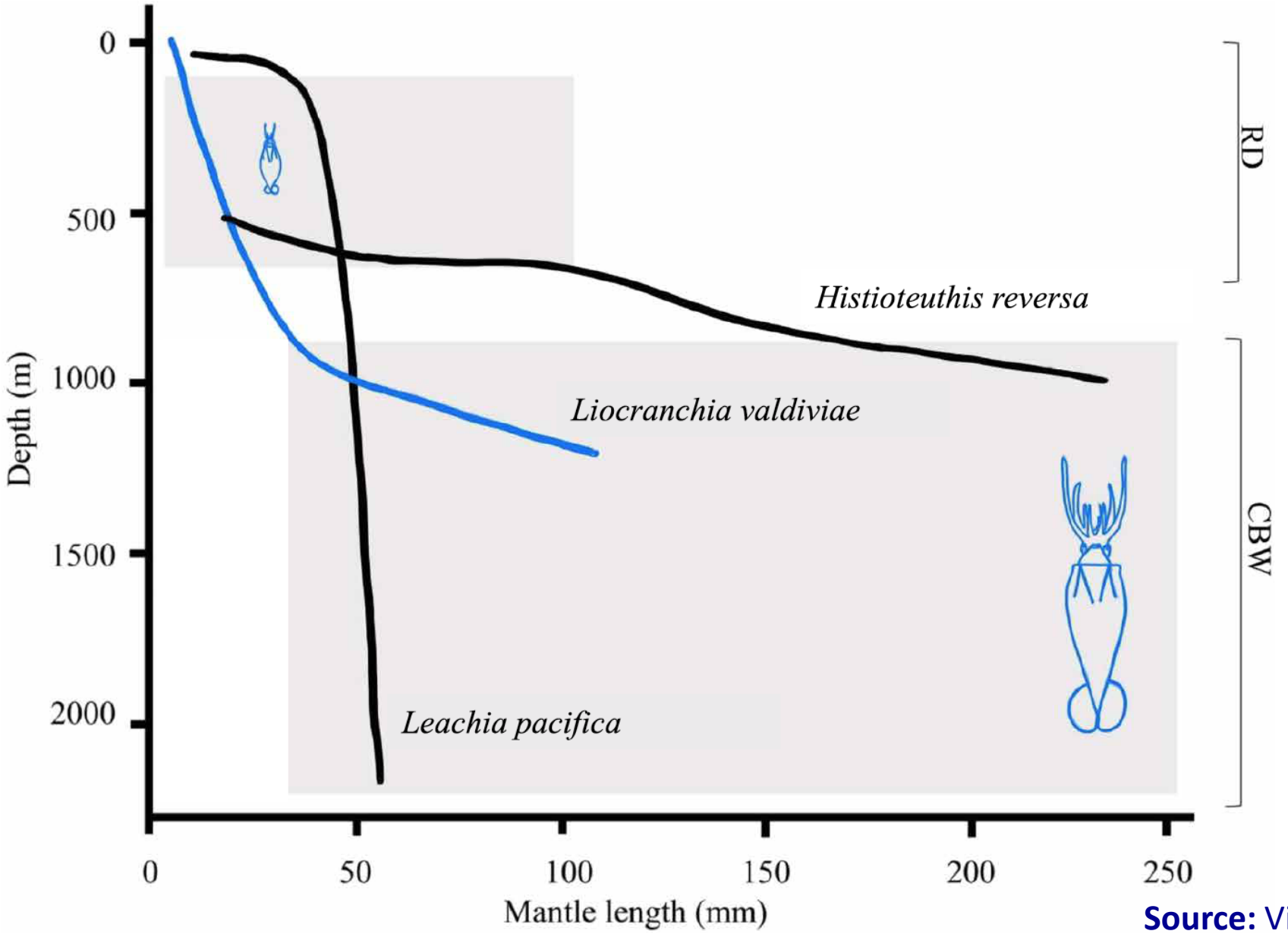

**Source:** Visser *et al*., 2021

# CEPHALOPOD SPECIES COMMUNITY AND DEPTH DISTRIBUTION FROM eDNA IN AZORES




**Source:** Visser *et al.*, 2021

# DEEPER WATERS OFFER LARGER, MORE MATURE CEPHALOPOD PREY




**Source:** Visser *et al.*, 2021

# REPRODUCTIVE & LIFE HISTORY PARAMETERS

• Births in most months, but appears to be mainly between Feb & July

• Gestation c. 13-14 (av. 13.9) months

• Lactation period unknown

• Calving interval 2-3 (av. 2.4) years

• Age at sexual maturity 8-10 years (females), 7-12 years (males)

• Life span 45-50 years

**Sources**: Kruse *et al*., 1999; Amano and Miyazaki, 2004; Evans, 2008; Baird, 2009, Bloch *et al*., 2012, Plön *et al*., 2020

# CAUSES OF MORTALITY IN RISSO'S DOLPHINS

In the UK, between 1995 & 2018, 45 strandings have had PMEs:
8 live strandings, 5 gas embolism, 4 (meningo)encephalitis, 4 infectious disease, 2 others,
4 by-catch, 4 starvation, 2 neonatal death, 2 dystocia, 2 gastritis/enteritis, 2 physical trauma, (boat/ship strike), 1 physical trauma (unidentified cause), 5 not established

**Sources:** Bennett *et al*., 2000; SAC, 2000; Jepson, 2005; Deaville & Jepson, 2011, 2018, Deaville, 2019

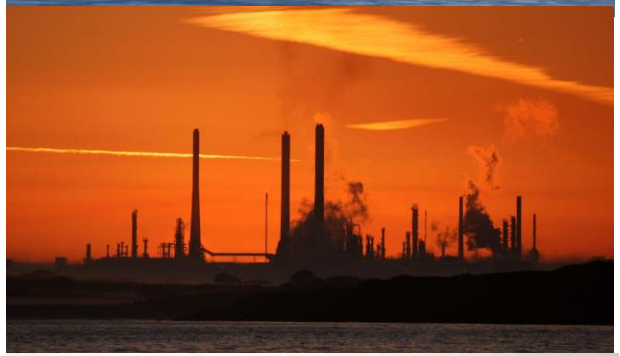
# STRANDED RISSO'S DOLPHIIN WITH GAS EMBOLISM

- male stranded at Cemlyn, Anglesey on 17 Sept 2009

- identified swimming off north coast a few days earlier, and the previous year

- massively enlarged spleen

- diffuse and severe gas cavitation




# IMPACTS UPON RISSO'S DOLPHINS

**Fisheries Conflicts:** squid fisheries, long-lining, gill netting, seine netting, driftnets

**Pollution:** PCBs, flame retardants, tributyl tins, mercury, cadmium, plastic debris

**Sound Disturbance:** active sonar, seismic surveys, detonations, shipping

**General Disturbance:** whale watching, water sports, coastal developments

# RECOMMENDATIONS

- Systematic surveys & habitat modelling to identify hotspots, particularly offshore

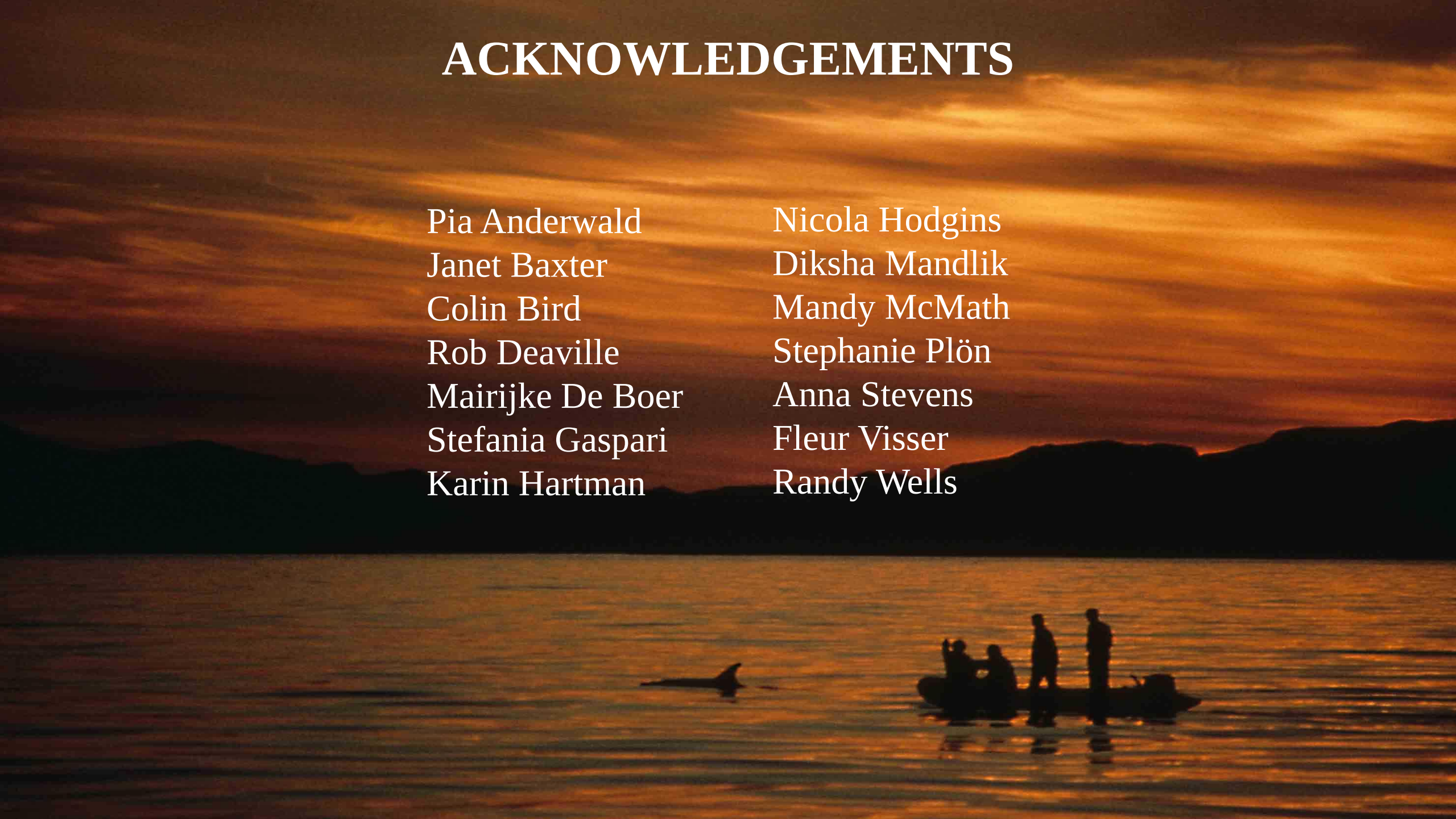
- Population estimates from photo-ID and line-transects

- Wide-scale surveys of genetic variation throughout N. Atlantic & Mediterranean Sea, and better understand population structure using complementary techniques such as acoustics & stable isotopes

- Long-term collaborative studies using photo-ID to investigate home ranges, movements, social structure, and life history parameters

- Examine further geographical & seasonal variations in diet using stomach contents, fatty acid & stable isotope analysis, eDNA, etc

- Better assess relative importance of different conservation threats on a geographical basis



# ACKNOWLEDGEMENTS


Pia Anderwald
Janet Baxter
Colin Bird
Rob Deaville
Mairijke De Boer
Stefania Gaspari
Karin Hartman
Nicola Hodgins
Diksha Mandlik
Mandy McMath
Stephanie Plön
Anna Stevens
Fleur Visser
Randy Wells