THE RISSO’S DOLPHIN IN EUROPE: RESEARCH & CONSERVATION

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Risso’s Dolphin distribution in N. Atlantic & Mediterranean

- Tropical to cool temperate seas
- SSTs of 10-30°C (mainly 15-25°C)
- Inhabits mainly upper continental slope
- Depths of 50-1,500m
POPULATION ESTIMATES IN THE NORTH ATLANTIC

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

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

Source: NOAA, 2021, 2022

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

13 sampling locations
N = 51 (27 stranded)

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

Neighbour joining tree based on mtDNA control region haplotypes

Sources: Gaspari, 2004; Gaspari et al., 2007
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
• 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)

Comparing whistles between the Hebrides and Western Mediterranean

<table>
<thead>
<tr>
<th>WHISTLE</th>
<th>Min. freq. Hz</th>
<th>Max. freq. Hz</th>
<th>Start freq. Hz</th>
<th>End freq. Hz</th>
<th>duration ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hebrides</td>
<td>Mean 9003.6</td>
<td>13241.4</td>
<td>12047.1</td>
<td>11128.7</td>
<td>565.5</td>
</tr>
<tr>
<td></td>
<td>st. dev. 2626.1</td>
<td>2328.7</td>
<td>2714.3</td>
<td>6267.6</td>
<td>259.6</td>
</tr>
<tr>
<td>Med.</td>
<td>Mean 7449.2</td>
<td>11813.4</td>
<td>9625.6</td>
<td>8736.1</td>
<td>394.5</td>
</tr>
<tr>
<td></td>
<td>st. dev. 3630.4</td>
<td>4134</td>
<td>3849.9</td>
<td>4230</td>
<td>278.3</td>
</tr>
</tbody>
</table>

Source: Benoldi et al., 1997, 1998
GEOGRAPHIC VARIATION IN VOCALISATIONS: Statistical Results

<table>
<thead>
<tr>
<th></th>
<th>CREAK</th>
<th>BUZZ</th>
<th>SQUEAK</th>
<th>SQUEAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F test</strong></td>
<td>F = 0.2</td>
<td>F = 3.7</td>
<td>F = 1.1</td>
<td>F = 8.4</td>
</tr>
<tr>
<td></td>
<td>P &gt; 0.05</td>
<td>P &lt; 0.05</td>
<td>P &gt; 0.05</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td><strong>t test</strong></td>
<td>t = 9.2</td>
<td>t = 0.08</td>
<td>t = 2.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P &lt; 0.01</td>
<td>P &lt; 0.01</td>
<td>P &lt; 0.01</td>
<td></td>
</tr>
<tr>
<td><strong>z test</strong></td>
<td></td>
<td>z = 22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P &lt; 0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WHISTLE</th>
<th>Duration ms</th>
<th>Hz min.</th>
<th>Hz max.</th>
<th>Hz start</th>
<th>Hz end</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F test</strong></td>
<td>F = 0.9</td>
<td>F = 0.5</td>
<td>F = 0.3</td>
<td>F = 0.5</td>
<td>F = 0.5</td>
</tr>
<tr>
<td></td>
<td>P &lt; 0.05</td>
<td>P &gt; 0.05</td>
<td>P &gt; 0.05</td>
<td>P &gt; 0.05</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td><strong>t test</strong></td>
<td>t = 3.7</td>
<td>t = 3.0</td>
<td>t = 2.8</td>
<td>t = 4.5</td>
<td>t = 3.4</td>
</tr>
<tr>
<td></td>
<td>P &lt; 0.01</td>
<td>P &lt; 0.01</td>
<td>P &lt; 0.01</td>
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</tr>
</tbody>
</table>

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
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

• 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
FEEDING ECOLOGY

Mesopelagic squid

• Octopus (Eledone)
• Cuttlefish (Sepia)
• Loligo forbesi
• Loligo vulgaris
• Todarodes sagittatus
• Gonatus spp.
• Histiotethis reversa
• Histiotethis 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
Sepiella 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
- Histiotethis sp.
- Octopus vulgaris
- Sepiolo atlantica
- Histiotethis 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.
>99% of dives lasted <6 min (mainly 2-4 min) for 2,245 dives that exceeded 30 sec; longest dive lasted 9-10 min
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 Rissos'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 (m/s).

Source: Arranz et al., 2019
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
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 DOLPHIN 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
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