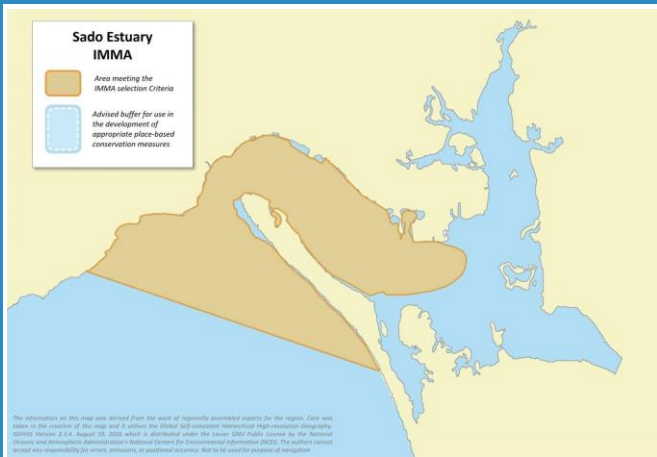


# Sado Estuary IMMA

## Description:

The habitat of bottlenose dolphins in the Sado Estuary, Portugal, encompasses a dynamic ecosystem influenced by tidal currents and the mixing of freshwater and seawater, with high levels of primary productivity. The Sado Estuary is a coastal plain estuary with a total area of 212.4 km<sup>2</sup> and it is considered the second largest estuary in the country (Caeiro et al., 2003). Based on depth and current dynamics, the estuary is divided into three areas. The North Channel, located near the city of Setubal, is characterized by a maximum depth of 15 m, weak currents, and receives most of the urban and industrial effluent discharge, resulting in lower water quality compared to the South Channel. This area is a crucial feeding area for dolphins, especially in spring (Gaspar, 2003). The intermediate zone consists of intertidal sandbanks that are exposed only during low tide. This area is not as used by dolphins as the other two and is mainly used as a corridor (Gaspar, 2003). The South Channel, running along the Troia Peninsula, has a maximum depth of 35 m and exhibits high hydrodynamics with stronger currents. It is also considered a crucial feeding area. A delta-like sandbank extends around the Sado's mouth, producing a vast shallow water area (around 5 m deep), which is crossed by an artificial channel 10 m deep. Further south, the coast of Troia is characterised by a smooth gradient of the seabed, resulting from the deposition of sand carried by the Sado River.



## Area Size

104 km<sup>2</sup>

## Qualifying Species and Criteria

Common bottlenose dolphin – *Tursiops truncatus*  
Criterion B (1); D (1)

## Summary

The IMMA is located in the Sado Estuary, Portugal, and adjacent waters, including the Natural Reserve of Sado Estuary and part of the Professor Saldanha Marine Park. The IMMA is particularly important for a resident population of bottlenose dolphins (*Tursiops truncatus*) that is present year-round and which is highly dependent on the region for activities vital to survival, such as feeding, resting, and nursing of young. The individuals of this small population have distinctive genetics and behavioural traits. At the national level, the population is listed as threatened in the Red Book of Vertebrates, as it has been declining in the last decades, and is an aging population with high infant/juvenile mortality. Furthermore, the population is impacted by human activities (e.g. waste disposal [resulting in chemical pollution], dredging, boat traffic, and dolphin watching), which have been increasing in the estuary in recent years.

## Criterion B: Distribution and Abundance

### Sub-criterion B1: Small and Resident Populations

The first abundance estimate for this population was 40 animals in 1981 (dos Santos & Lacerda, 1987). Except for a small increase in 1997, the population has declined between the period of 1986-2015, with an unsustainable trend of 30% decrease (ICES, 2016). Presently, the Sado population comprises only 25 individuals (Ferreira et al., 2023), of which 10 are males, eight are females and seven are of unknown sex. The long-term steady decline, an aging population, high calf/juvenile mortality, and low levels of immigration (dos Santos & Lacerda, 1987; Gaspar, 2004; Augusto et al., 2011; Martinho, 2012;

Carvalho et al., 2016; Lacey, 2015) collectively contribute to the bottlenose dolphin population inhabiting the Sado Estuary region (Portugal) being one of the smallest resident populations of this species in Europe. Six individuals in the population are more than 40 years old. These dolphins are year-round residents in the estuary and are consistently observed each month (Gaspar, 2003; Martinho, 2012; Lacey, 2015), with regular monthly monitoring conducted by the national conservation institute. The resident dolphins primarily inhabit the shallow waters near the estuary entrance and the south channel (Gaspar, 2003; Martinho, 2012; Harzen, 1998; Grilo, 2010), but they also utilize other available habitats, excluding the upper estuary shallows.

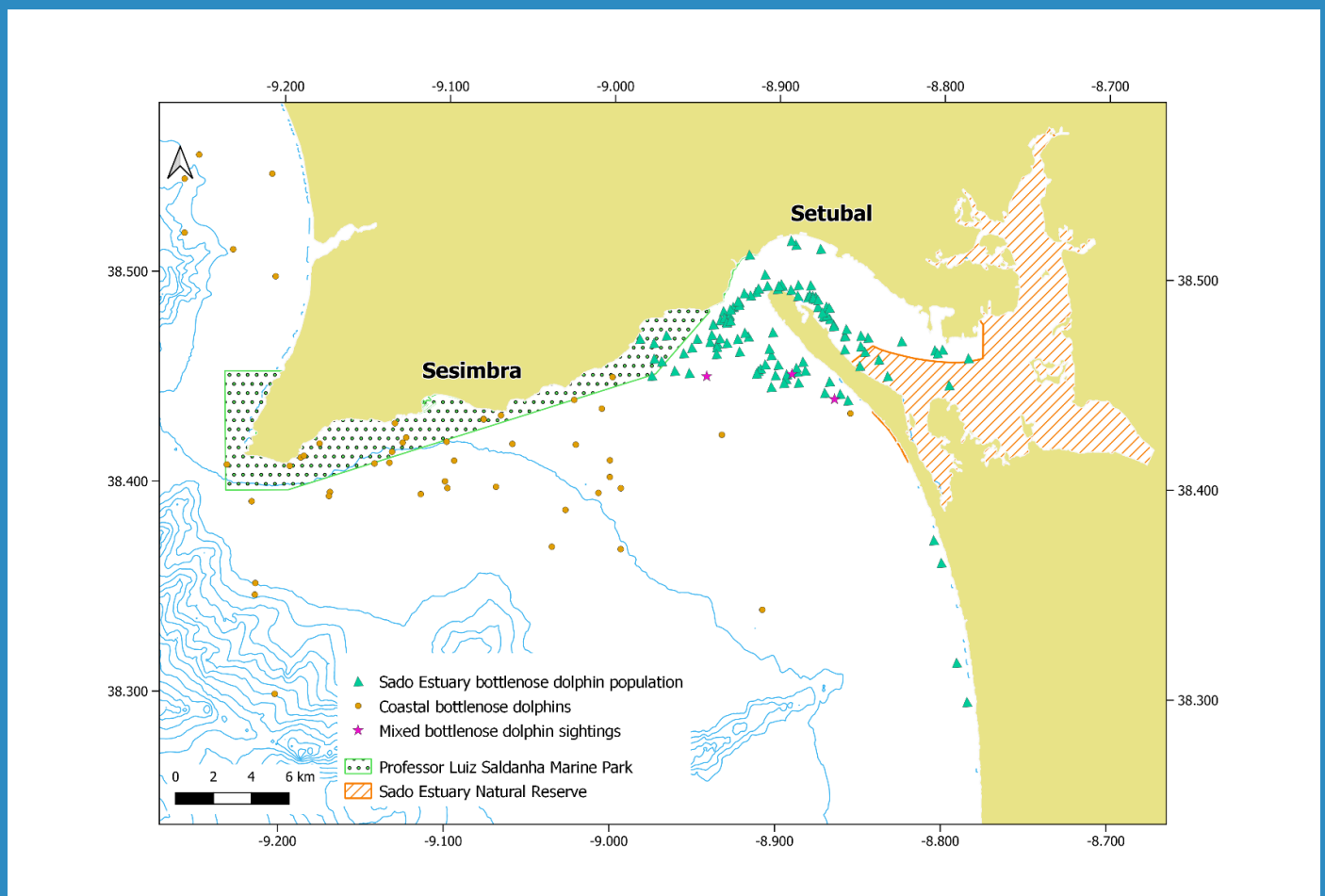


Figure 1: Sightings of Sado Estuary bottlenose dolphin population. Excerpt from Instituto Gulbenkian de Ciência.



Figure 2: Bottlenose dolphin (*Tursiops truncatus*) eating a flatfish. The Sado estuary is an important feeding area for this population. Photo credit: Andreia Pereira



Figure 3: Group of Sado bottlenose dolphins (*Tursiops truncatus*) entering the estuary. Photo credit: Inês Carvalho



Figure 4: The Sado population inhabits an estuary characterized by increasing anthropogenic pressures, including multiple sources of contamination. Photo credit: Francisco Martinho

Calving and other reproduction-related behaviour is observed mostly during the spring and summer months (Gaspar, 2003; Augusto et al., 2011; Martinho, 2012), coinciding with increased levels of boat traffic in the region (Sequeira et al., 2009; Luís et al., 2014). Behaviour linked to reproduction occurs throughout the estuary and adjacent marine areas (Luís, 2008; Rocha, 2012). Inter-birth intervals range from three to 11 years (Gaspar, 2003). Feeding has been observed in various parts of the estuary, encompassing both deep (Nunes, 2001) and shallow waters (Gaspar, 2003; Martinho, 2012; Nunes, 2001; dos Santos et al., 2007). In shallower areas, animals can spend a longer time foraging in the substrate for bottom prey (dos Santos et al., 2007). Mostly during springtime, when some of the prey enter the estuary to reproduce, the bottlenose dolphins follow them towards the interior of the estuary (Gaspar, 2003).

## **Criterion D: Special Attributes**

### **Sub-criterion D1: Distinctiveness**

Recent genetic data (based on microsatellite markers, mitochondrial DNA and Single Nucleotide Polymorphisms) have shown that the dolphins of the Sado estuary are genetically differentiated from the surrounding Iberian populations (Carvalho et al., 2016; Afonso et al., 2022). Low levels of genetic diversity, remarkably high incidence of inbreeding and the presence of unique haplotypes suggest an isolation of this population. The long-term site fidelity and the strong residency patterns, indicative of limited movements, in conjunction with low immigration rates and genetic uniqueness of the Sado estuary bottlenose dolphins, serve as clear indicators of limited connectivity and gene flow with neighbouring populations.

## Supporting Information

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## Acknowledgements

We would like to thank the participants of the 2023 IMMA Regional Expert Workshop for the identification of IMMAs in the North East Atlantic Ocean. Funding for the identification of this IMMA was provided by the Water Revolution Foundation. Other sponsors for the workshop included OceanCare and ORCA (orca.org.uk), and substantial administrative support to the IMMA Secretariat was provided by the Tethys Research Institute and Whale and Dolphin Conservation.

