Reviewed ethograms for cetacean species in the Mediterranean Sea: an updated approach to ethological analysis

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WHY THE BEHAVIOUR ?

Cetaceans' behaviours are a fundamental part of their physiological repertoire and, therefore, the collection and **analysis of behavioural data are necessary to understand the dynamics of the populations**. For example, behavioural patterns can be used to identify feeding and mating grounds and understand social interactions and structures.

WHAT IS AN ETHOGRAM ?

The study of behavioural patterns in natural conditions and their social and ecological purposes is known as ethology. **The ethogram is a catalogue including the standardised description of a species' behaviours** intended to facilitate the comparison of behavioural patterns across species and, for the same species, across locations and time.

WHY THE MEDITERRANEAN ?

The Mediterranean Sea is a fitting example of the lack of standardised and comprehensive ethograms for cetaceans. **Ethological research is still limited and standardised protocols do not currently exist.** Yet, the Mediterranean Sea is a hotspot for cetacean biodiversity, counting eight resident species whose conservation status is concerning.
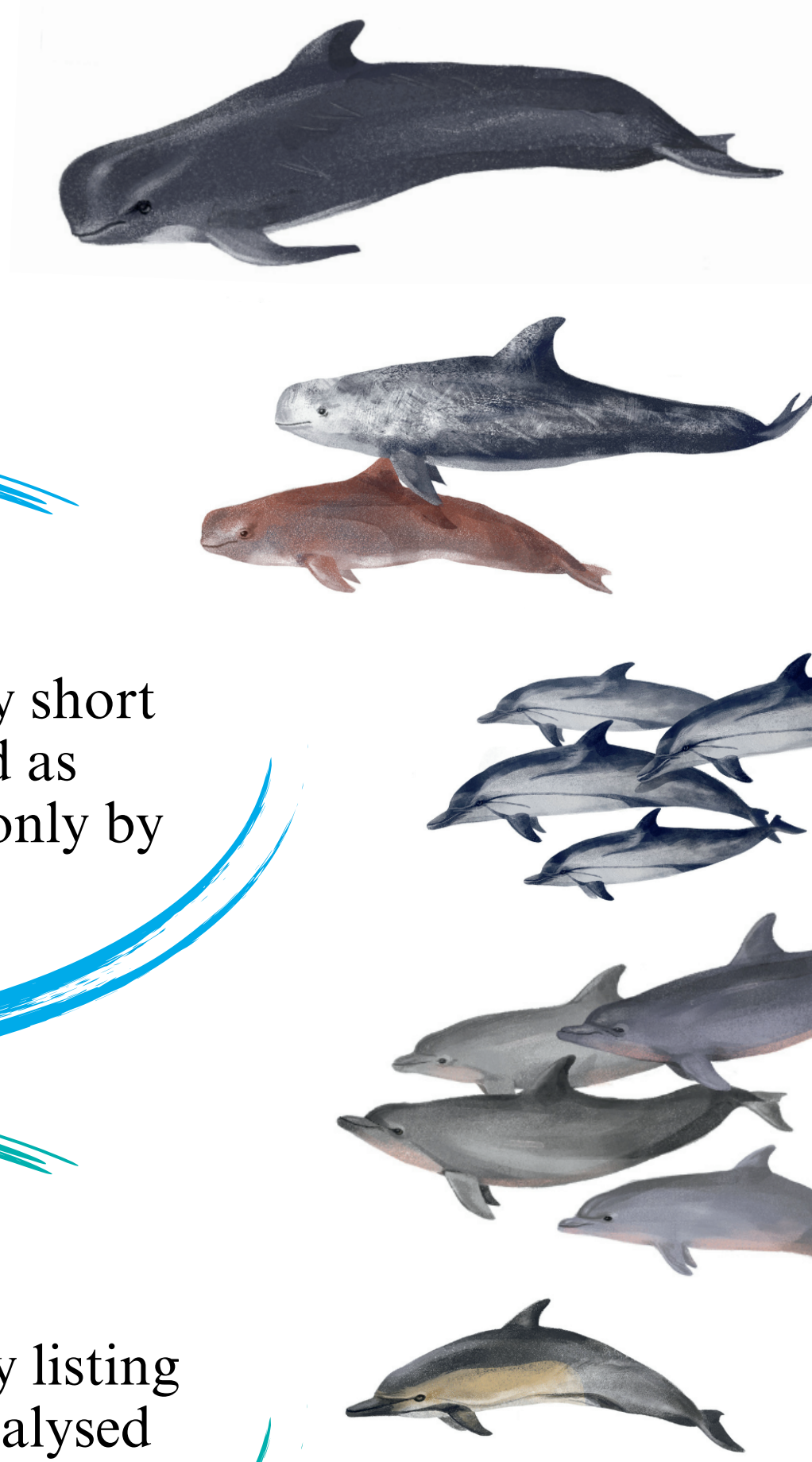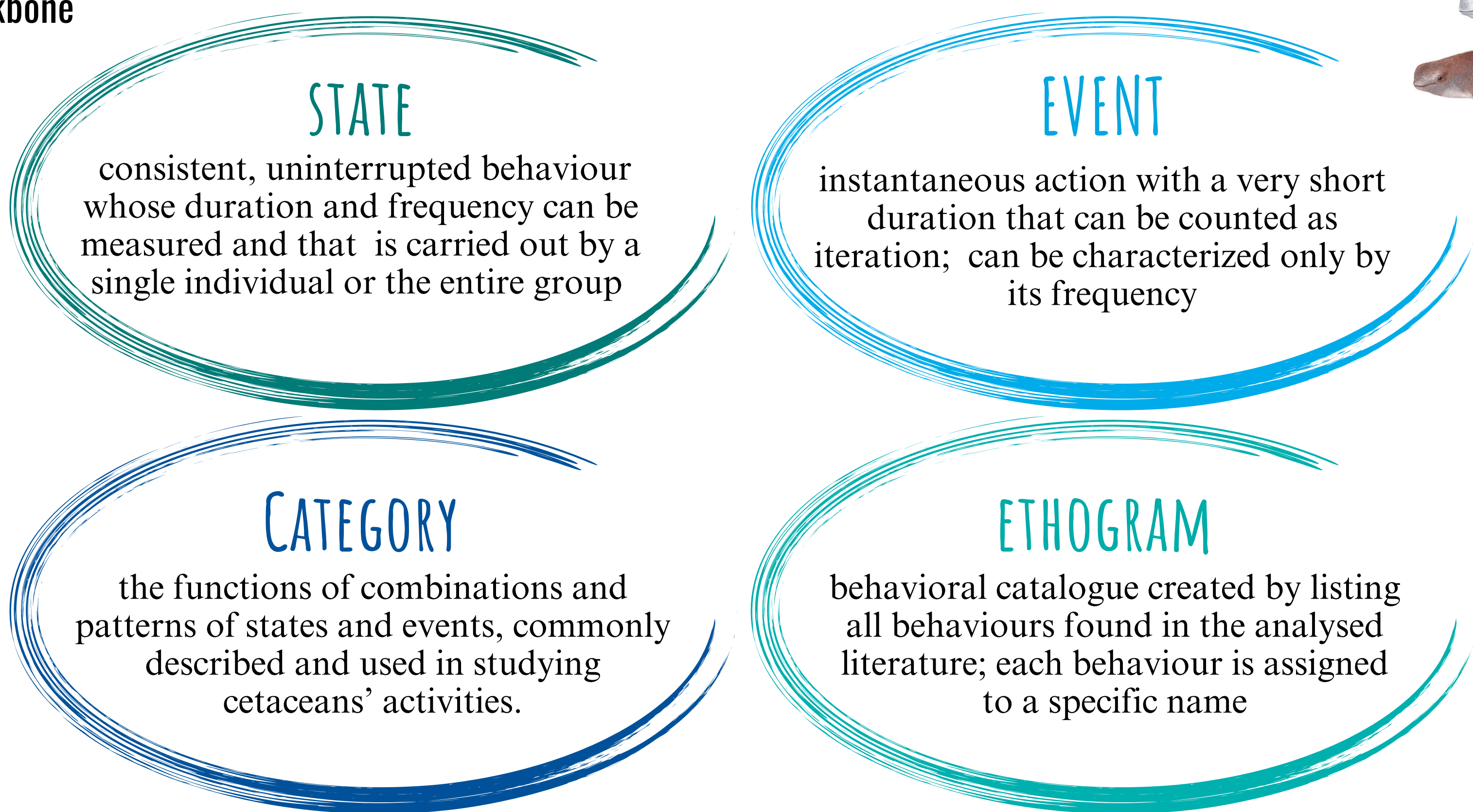
GOALS

This study aims to develop and share a codified ethogram for each resident cetacean species of the Mediterranean Sea focused on behaviours that can be observed from the surface in order to:

- compile an up-to-date review of known species-specific behaviours;
- standardize ethological research on cetaceans of the Mediterranean Sea to further support informed conservation measures.

METHODS
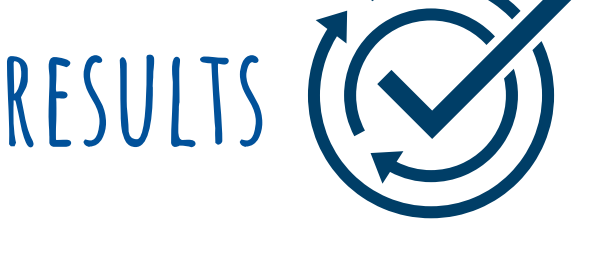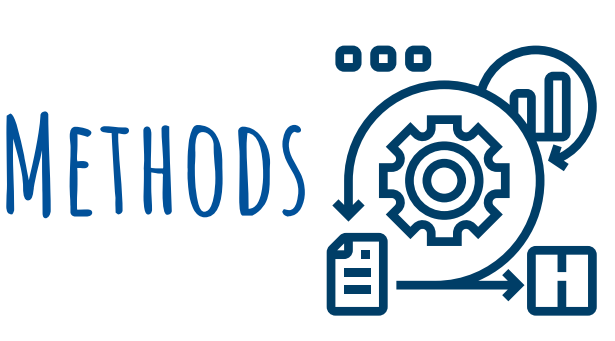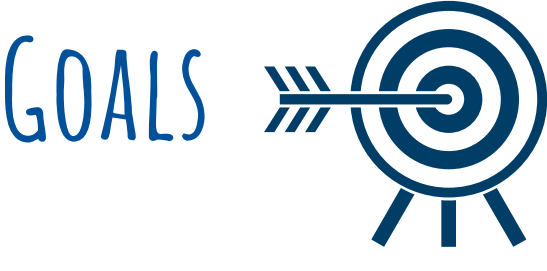
Literature review to extract the behavioural displays that served as the backbone for developing the updated specie-specific ethograms.

- Closely related species outside the Mediterranean were considered when scarce or incomplete information was present;
- Pieces of literature describing both surface and acoustic/deep behaviours were included, but only surface behaviours were incorporated in the ethograms.

For each behaviour (state and event) and for each category, a unique name was selected and associated with an explanatory description and related bibliography

STATE
consistent, uninterrupted behaviour whose duration and frequency can be measured and that is carried out by a single individual or the entire group

EVENT
instantaneous action with a very short duration that can be counted as iteration; can be characterized only by its frequency

CATEGORY
the functions of combinations and patterns of states and events, commonly described and used in studying cetaceans' activities.

ETHOGRAM
behavioral catalogue created by listing all behaviours found in the analysed literature; each behaviour is assigned to a specific name

RESULTS

5 CATEGORIES: Travelling, Socialising, Milling, Feeding, Resting

51 DIFFERENT BEHAVIORS were recognised from the analysis of the literature: 11 states and 40 events

5 ETHOGRAMS: 1 valid for bottlenose, striped and common dolphin, 1 for Risso's dolphin, 1 for pilot whale, 1 for sperm whale, 1 for fin whale, 1 for Couvier's beaked whale

Examples of some *Delphinidae* behaviors listed in an ethogram: State, Event, and Category				
Swim normal	S	The focal individual/group swims in a consistent direction at a constant speed. **Modifiers:** Slow (S): the individual/the group swims at low speed (species-specific minimum speed) Medium (M): the individual/the group swims at medium speed (included between the species-specific minimum and maximum speed) Fast (F): the individual/the group swims at high speed (species-specific maximum speed)	Azzolin et al., 2019; Baker et al., 2017; ; Bearzi et al., 1999; Berrow et al., 2008; Constantine et al., 2004; Lusseau, 2006; Mann& Smuts, 1998, 1999; Muller at al., 1998; Nimak-Wood et al., 2011; Pilleri & Knuckey, 1969; Schaffar-Delaney, 2004; Shane, 1990; Steiner, 2011; Waples, 1995	
Leap	E	The focal individual jumps out of the water, covering a distance of at least one body length and with limited height. The individual re-enters the water, with limited or no water splash. **Modifiers:** Forward: the individual falls back into the water with the head first Inverted: the individual falls back into the water with the back Lateral: the individual falls back into the water in a lateral position	Angradi et al., 1993; Azzolin et al., 2019; Baker et al., 2017; Bearzi et al. 1998, 1999; Carwardine, 2020; Constantine et al., 2004; Lusseau, 2006; Mann & Smuts, 1998; Muller at al., 1998; Neumann, 2001; Nimak-Wood et al., 2011; Pilleri & Knuckey, 1969; Schaffar-Delaney, 2004; Shane, 1990; Smultea & Lomac- MacNair, 2016; Steiner, 2011; Weaver, 1987	
Travelling	C	The focal group, or individual, moves in a consistent direction with short and relatively regular diving intervals; the animals can move at different speed.	Baird et al., 2002; Baker et al., 2017; Bearzi et al., 1998, 1999; Cioffi, 2020; Cipriano et al., 2022; Constantine et al., 2004; ; Gero & Whitehead, 2007; Goold, 1999; Hartman et al., 2020; Isojunno et al., 2017; Lafortuna et al., 2003; Lusseau, 2006; Mann & Smuts, 1998, 1999; Neumann, 2001; Nimak-Wood et al., 2011; Pereira,2008; Roden, 1998; Saintignan et al., 2020; Schaffar-Delaney, 2004; Schuler et al., 2019; Shane, 1990, 1995; Smultea et al., 2018; Smultea, 2016; Steiner, 2011; Visser et al., 2011.	

FUTURE STEPS

The standardisation of behavioural data achieved through the use of the compiled ethograms is a crucial instrument to improve cetacean studies and conservation, allowing not only the comparison of data across locations, but also over time.

An improved conservation status of cetacean species, and the implementation or advancement of spatial conservation measures (MPAs, IMMAs) is dependent upon an increased accuracy in behavioural research.

Accordingly, ethology should be considered a conservation tool, and these ethograms should be disseminated and incorporated into methodological guidelines.