

measures as a valuable baseline information on cetacean distribution.

### **Evidence for fission-fusion grouping pattern in narwhal inferred from telemetry data**

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Cetaceans are social animals that live in groups, which has important consequences for the fitness of individuals. Groups vary in stability from permanent groups that last for life, to fission-fusion groups that may only last for a few hours. During the ice-free season, narwhals form mixed sex and age-class clusters of up to 25 narwhals within proximity to one another. These small clusters are part of large herds of several hundred individuals. Although the snap-shot composition of narwhal clusters (i.e. sex and age-class composition) has been examined, the stability of narwhal clusters over time remains unknown. We equipped seven pairs of narwhals from seven different clusters with satellite transmitters to investigate the stability of clusters. During the ice-free season (August - October), pairs of narwhals spent on average 16.7 % (range: 1.1 to 44.4%) of their time within proximity to one another (5km). One pair of narwhals split at least 5 times and spent up to 12 days and 200 km apart before coming back together during the 80 day they were tagged. Another pair of narwhals spent more than a month up to 500 km apart during the fall migration and reunited on their wintering grounds in Davis Strait. This study suggests that narwhals show characteristics of a fission-fusion society in which group formation is highly dynamic, and group size and composition change frequently.

### **Intraspecific variation in social structure in female bottlenose dolphins is driven by a combination of ecological, genetic, and cultural aspects**

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The complexity of dolphin social structure can only be compared to that found in primates including humans. Although many dolphin populations are characterized by a fission fusion system, preferred

associations between individuals can lead to community structure within populations. While male bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia, form persisting social bonds within multi-level alliances, drivers of association in female bottlenose dolphins are not well understood. We investigated association patterns and community structure of female Indo-Pacific Bottlenose Dolphins in the western part of the bay. We assessed the role of kinship, habitat similarity, and shared foraging techniques (culturally transmitted tool use) on female association patterns. Permutation-based Mantel tests suggested that association indices were best explained by individuals sharing the same habitat ( $p < 0.001$ ), the same mtDNA haplotype ( $p < 0.01$ ), and the same foraging technique ( $p < 0.001$ ), suggesting the presence of homophily. We also implemented three different community detection algorithms to assess the underlying female community structure in Western Shark Bay. All three algorithms identified habitat to be an important driver of community structure. Our results indicate that intraspecific variation in social structure in this bottlenose dolphin population is driven by a complex combination of both ecological and genetic aspects, but that also cultural processes appear to shape dolphin social structure, similarly to what has been described in humans.

### **Cetaceans as a potential indicators of micro- and macroplastic impact in the marine environment: Trend topic and emerging gaps.**

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How can 5 mm plastic debris (microplastics) affect filter feeder baleen whales? How can kilograms of plastic debris affect sperm whales? Here, we report the scientific evidence and the emerging gaps of the interaction between the charismatic megafauna (filter feeder baleen whales and deep divers) and micro- and macroplastics studying their impact and their related toxicological effects. We also propose these species as candidate indicators for micro- and macro-plastic pollution, respectively, at global scale. Regarding the interaction between whales and microplastics the first warning was reported for Mediterranean fin whales (*Balaenoptera physalus*) since 2012, and confirmed later (high concentrations of PBTs, plastic additives and specific biomarker responses, detected in skin biopsies) in the same species and for other filter feeders (basking and whale sharks). Filter-feeding megafauna are susceptible to high levels of microplastics ingestion and exposure to associated

toxic compounds due to their feeding strategies and for habitat overlap with microplastic hot spots. For these reasons, this whale species has been proposed as a candidate indicator of microplastics pollution in semi-enclosed basins. On the other hand, deep divers such as the sperm whale and the Cuvier's beaked whale, are exposed to the ingestion of marine litter (ML), including large plastic fragments, due to their feeding in marine canyons. High occurrence of ML (75%) has been reported in Mediterranean sperm whales. This species was recently proposed as a candidate indicator the presence of ML in the Mediterranean (IMAP indicator 24). As these megafauna species are charismatic and iconic indicators that serve as flagship species for marine conservation, this research field became recently a “trend topic”. However, several gaps must be resolved, such as the investigations of new plastic tracers in the tissues and the identification (through omics techniques) of the toxicological effects caused to plastic debris ingestion in these species.

#### **The role of sperm whales as benthopelagic predators.**

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Sperm whales (*Physeter macrocephalus*) produce powerful clicks that allow them to echolocate prey at long ranges in the darkness of the deep ocean. They use information gleaned by echolocation to choose dynamically the foraging habitat targeted in each dive. At high latitudes they exploit epi-, meso-, and benthopelagic prey with highly variable diving patterns. This contrasts with their stereotyped diving behavior at low latitudes, where whales do not feed on epipelagic prey and maintain a typical maximum dive depth of 600-800 m. These differences have been interpreted as behavioural adaptations to geographical variation in prey resources rather than as sex-driven choice of foraging strategies. Here we aim to uncover how the dependence of benthic resources of sperm whales in low latitudes differ between two areas where this species has genetically distinct populations: the Gulf of Mexico (GOM) and the Mediterranean Sea (Med). We used data gathered with sound and movement recording DTAGs from

16 sperm whales (8 GOM, 8 Med) summing some 117 deep dives in 125 tag-hours. Clicks were identified with a supervised automatic detector and echograms were formed to locate seafloor echoes generated by the clicks. All sperm whales fed within the mesopelagic realm, but approximately 50% of deep dives entered the Benthic Boundary Layer (BBL, 0-200 m altitude above the seafloor). Sperm whales have an important role as top-predators in offshore waters, where they consume a large biomass and contribute to the recirculation of nutrients, and potentially pollutants, from deep to shallow waters. Understanding their trophic ecology and their dependence on different niches is essential for trophic web modeling and to assess the vulnerability of the species to human resource exploitation.

#### **Bottlenose dolphin social sounds during interaction with bottom-trawl fishery in the Mediterranean Sea**

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Acoustic communication signals play an important role in mediating different relations in social animals. Bottlenose dolphins (*Tursiops truncatus*) produce whistles as social sounds, and each individual develops its own distinctive signature whistle encoding identity information. We assessed social sounds by bottlenose dolphins while interacting with bottom-trawl fishery in the central Tyrrhenian Sea and in the Sicily Channel (Italy). Both stationary and towed hydrophones were used to collect acoustic data by group of dolphins following trawling vessels to exploit anthropogenic food patches. The frequencies of different whistle types (upsweep, down sweep, concave, convex, flat, modulated), as well as their acoustic parameters (initial, final, maximum and minimum frequencies; number of steps and inflection points; duration) were measured. We found a varied whistle repertoire when animals interact with