REPORT OF THE ECS WORKSHOP ON "ADVANCING KNOWLEDGE ON FIN WHALES IN THE MEDITERRANEAN SEA"

Issue: Conservation Management Plans

Background

To date, four ACCOBAMS "Species Conservation Management Plans" (CMPs) are under development for fin whales, Risso's dolphins, common dolphins and bottlenose dolphins.
In April 2024, ACCOBAMS supported a full-day expert workshop aimed at enhancing knowledge about fin whales in the Mediterranean Sea. This event took place prior to the 35th Conference of the European Cetacean Society, held in Catania, Sicily.
The objective of the expert workshop was to review the most recent research (post-2019) on Mediterranean fin whales so to ensure that the scientific basis of the draft CMP could be updated if necessary, facilitating potential revisions to the proposed actions before the stakeholder workshop. The primary focus of the workshop was on population structure and movements, seasonal distribution and abundance, and important knowledge gaps.

ECS Workshop Report

Advancing knowledge on fin whales in the Mediterranean Sea

Organisers: Pauline Gauffier, Simone Panigada, Anna Schleimer, Greg Donovan

Held ahead of the European Cetacean Society Conference, Catania, 2024
Convened at Aula Linneo, University of Catania, Catania, Sicily, Italy
on Tuesday 9 April 2024 08:30 to 17:00.

The workshop was partially funded by ACCOBAMS.

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1. Context

For several years, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) and the International Whaling Commission (IWC) have stressed the importance of, and worked on developing, a Conservation Management Plan (CMP) for Mediterranean Sea fin whales (*Balaenoptera physalus*). This included the holding of a drafting workshop in December 2019 and subsequent refinements. The IWC/ACCOBAMS guidelines for the adoption of CMPs include the need for a dedicated stakeholder workshop, to review and finalise any CMP. Primarily due to the effects of COVID, such a workshop has been delayed.

On 8 April 2024, we held a full-day expert workshop ahead of the 35th European Cetacean Society conference in Catania, Sicily. The workshop focussed on reviewing recent studies (after 2019) on Mediterranean Sea fin whales and was attended by 38 participants, with 6 researchers presenting online. A full list of participants is provided in Appendix 1. The programme consisted of 20 5-minute presentations from the participants and subsequent discussions on knowledge gaps and future directions.

The objective of this new expert workshop was not to revise the draft CMP but rather to review the most recent (post-2019) research on Mediterranean fin whales to ensure that, if necessary, IWC/ACCOBAMS can update the scientific background to the draft CMP and any consequential amendments to proposed actions before the stakeholder workshop. The primary focus of the workshop was on population structure and movements, seasonal distribution and abundance, and important knowledge gaps.

2. Presentation summaries

2.1 Population structure, distribution, and movement

During the first section of the workshop, we discussed recent findings relating to the population structure, distribution, and movement. This topic is of high importance because significant knowledge gaps remain concerning the relationship between Mediterranean and Atlantic fin whales in terms of spatio-temporal overlaps and genetic connectivity. Participants presented their results from studies using various methodologies to address these questions, notably acoustics, visual sightings, telemetry, and genetic sampling.

ACOUSTICS

- *Presenter: Andreia Pereira, University of Lisbon, Portugal*

Fin whale acoustic presence and song characteristics in seas to the southwest of Portugal

Through 11 months of acoustic data from 2007-2008, two fin whale song patterns were detected in southwestern Portugal, relating to both Mediterranean Sea (Pattern 1) and North Atlantic Ocean (NENA) (Pattern 2) fin whales. Pattern 2 was most common and was dominant in winter, while Pattern 1, indicating sporadic Mediterranean whale presence, was less common and appeared mainly in September–December, February, and April. Occasional

simultaneous recordings of both patterns suggest potential mixing between populations. These findings thus provide an extension of spatial and temporal overlap between Mediterranean and North Atlantic acoustic groups off southwestern Portugal. It was also pointed out that a recent study by Papale et al. (2023) reported acoustic signatures (INIs) associated with Mediterranean characteristics as far north as Svalbard. Satellite-tracked animals from Svalbard are known to visit the waters off Portugal (Lydersen et al. 2020), leading to two hypotheses: given the overlap of NENA and Mediterranean animals, NENA fin whales might learn the Mediterranean song and reproduce it in Svalbard or different acoustic populations visit Svalbard. The recent paper by Romagosa et al. (2024) was highlighted as it provided evidence of vocal learning in fin whales with songs changing over four singing seasons and hybrid songs; an aspect that needs to be considered when using acoustic signatures to make inferences about population structure.

Relevant references:

Pereira, A., Harris, D., Tyack, P., & Matias, L. (2020). Fin whale acoustic presence and song characteristics in seas to the southwest of Portugal. *The Journal of the Acoustical Society of America*, *147*(4), 2235-2249. https://doi.org/10.1121/10.0001066

Papale, E., Pelagatti, M., Pedrazzi, G., & Buscaino, G. (2023). Occurrence and patterns of fin whale songs reveal alternative migration strategies in Svalbard Islands, Norway. *Scientific Reports*, *13*(1), 4436. https://doi.org/10.1038/s41598-023-31665-x

Romagosa, M., Nieukirk, S., Cascão, I., Marques, T. A., Dziak, R., Royer, J. Y., ... & Silva, M. A. (2024). Fin whale song evolution in the North Atlantic. *Elife*, *13*, e83750. https://doi.org/10.7554/eLife.83750

- *Presenter: Virginia Sciacca, Institute of Polar Sciences – National Research Council, CNR-ISP, Messina, Italy*

Acoustic Studies of Fin Whale Occurrence and Behavior in the Central Mediterranean Sea

The results of the first investigation into fin whale songs from 2012-2013 recordings in the Ionian Sea were discussed. These findings currently represent the sole published study on songs in the Central-Eastern Mediterranean. Four primary song patterns were identified, consistent with those observed in the Western Mediterranean. These findings revealed potential recurring features in the songs of this population and possibly a frequency shift but more data are required to assess whether this shift is permanent.

It was also mentioned that the analysis of acoustic data from the Ionian Sea from 2017 and 2018 is ongoing. The presented acoustic signatures were not yet compared to those from Castellote et al. 2012 and Perreira et al. 2020 but they will in the future. The project PRIN 2022 PNRR, titled “KNOWhale: Knowledge Improvement for the Conservation of Endangered Mediterranean Fin Whales in Southern Italy'' was also presented. The project consists of different work packages relating to the acoustic behaviour of fin whales, the acoustic communication space and impact of noise, as well as fin whale distribution and hotspots in southern Italy. It was noted that this initiative fits within the actions of the CMP and that a coordinated approach to fin whale conservation should be undertaken to create synergies where possible.

Relevant reference:

Sciacca, V., Morello, G., Beranzoli, L., Embriaco, D., Filiciotto, F., Marinaro, G., ... & Viola, S. (2023). Song Notes and Patterns of the Mediterranean Fin Whale (*Balaenoptera physalus*) in the Ionian Sea. *Journal of Marine Science and Engineering*, *11*(11), 2057. https://doi.org/10.3390/jmse11112057

SIGHTINGS

- *Presenter: Paola Tepsich, CIMA Research Foundation, Italy*

Fin whale presence and trend in NW-Mediterranean: updates from the long-term monitoring data by the FLTMedMon-Network

Long-term monitoring data collected by the FLTMEdNEtwork shows a strong interannual variability in fin whale presence and distribution (number of sightings, but also group size and aggregation pattern), correlated with pelagic ecosystem productivity and climate change scenarios. In the last 4 years (2019-2023) an anomalous distribution has been evidenced, with an increase in the presence of groups (more than 3 individuals), a shift to more coastal areas, and longer aggregation periods. Winter surveys have confirmed the constant presence of the species in the NW basin, and a seasonal-multiscale habitat analysis evidences different habitat uses within the basin during winter.

Overall, these results highlighted that differences in fin whale habitat use occur over the years.

Relevant reference:
Tepsich, P., Schettino, I., Atzori, F., Azzolin, M., Campana, I., Carosso, L., ... & Arcangeli, A. (2020). Trends in summer presence of fin whales in the Western Mediterranean Sea Region: new insights from a long-term monitoring program. *PeerJ*, *8*, e10544. https://doi.org/10.7717/peerj.10544

- *Presenter: Aurélie Moulins, CIMA Research Foundation, Italy*

Insights from the opportunistic data collection obtained from whale-watching off Genoa: changes of fin whale's encounter rate over the period 2019-23

Data from two whale-watching companies getting out from the Genoa port were pooled over the period 2019-2023 to analyze the distribution and encounter rate of fin whales. In total, during the 5 years, the two companies conducted 426 surveys over Genoa's submarine canyon. They encountered fin whales 102 times with variability over years, with the typical habitat being at 1000m depth, close to the coast. For both companies, the year with less sightings was 2021 while the year with more sightings was 2023. Considering that the area covered by both companies over the year is quite regular we also analyzed where the sightings are and if any habitat parameters change over time. It was noted that the whale-watching boats stay within 20nm from the coast and that there had been a shift in target species to Cuvier's beaked whales. These observations exemplified that encounter rates can vary dramatically over years when monitoring small areas.

- *Presenter: Beatriu Tort, EDMAKTUB*

Fin whales on the Catalan coast, northwestern Spanish Mediterranean. A spring feeding ground. Updating a ten-year project.

The Fin Whale project has studied the occurrence of fin whales off the Catalan coast every spring for the past 10 years. In these studies, data were collected on presence, behaviour, identification, drone recordings, plankton and water samples, as well as biological samples: skin and faeces. Meteorological and oceanographic conditions as well as maritime traffic data were also analysed. As a result, it has so far been possible to define the area as a coastal feeding ground with 72% of fin whales being observed foraging in the area. They also collaborate with fishermen who report sightings to them. Fin whale occurrence is strongly linked to patterns of precipitation/river run-off and in years without rain there are very few

sightings. The annual encounter rates contrast those reported for the Genoa canyon (few sightings in 2019 and 2023, high numbers in 2021 and 2022). Their photo-identification catalogue based on drone imagery counts more than 400 individuals with 15% of inter-annual recaptures. It is also an area with a serious risk of collisions given the marine traffic and highly affected by changes in climate. It was noted that the SPAMI Mediterranean corridor does not cover the coastal sightings, but this area is covered by the PSSA. The canyon area is important to the fin whales and should be covered by the protected areas.

Relevant reference:
Tort Castro B, Prieto González R, O'Callaghan SA, Dominguez Rein-Loring P and Degollada Bastos E (2022) Ship Strike Risk for Fin Whales (Balaenoptera physalus) Off the Garraf coast, Northwest Mediterranean Sea. Front. Mar. Sci. 9:867287. https://www.frontiersin.org/articles/10.3389/fmars.2022.867287/full

- *Presenter: Pauline Gauffier, Madeira Whale Museum, Portugal*

Insights on fin whales from Madeira

The archipelago of Madeira is located in the neighbouring Atlantic Ocean outside the ACCOBAMS area. In Madeira, fin whales are not commonly observed, representing <2% of all species sightings with an overall encounter rate of 0.05 animals/100 km for the period of 2001-2017. These observations mostly occurred during the spring months, with a peak in March and April. Their relative rareness and the concurrent presence of other (more common) baleen whale species in the archipelago are sometimes challenging to get definite species identification. Efforts have been made towards creating photo-identification catalogues based on ca. 4,000 pictures provided mainly by whale-watching companies. Twenty marked animals have been added to the catalogue, without any recaptures thus far. Some animals are severely scarred by cookie cutter shark bits, which could indicate that these animals originate from more southern areas. No further information on fin whale origin/destination is available. Future research plans include collecting samples and deploying satellite tags if the opportunity arises, but are limited by the scarcity of observations. Hybrid blue-fin whales have not been observed and there were also no noticeable changes in encounter rates since 2016 as opposed to patterns in the Azores.

SATELLITE TAGGING

- *Presenter: Mónica A. Silva, Azores Whale Lab, Azores, Portugal*

Migration ecology of fin whales: a mid-Atlantic perspective

This presentation included a brief synthesis on the current knowledge on the movements and behaviour of fin whales during their spring migration through the Azores, with a focus on the acoustic and foraging behaviour, and environmental correlates of movement. Based on the satellite tracks of 15 fin whales, it was shown that migratory movements were strongly influenced by sea surface temperature and zooplankton biomass. The SEAPOD model (Copernicus) was employed to make hindcast predictions about zooplankton biomass. Some fin whales also carried time-depth recorders showing dive patterns typical for foraging ground behaviours and following diurnal vertical migration (i.e. deeper dives during day, shallower at night). Most fin whale sightings were recorded from week 6 -17, but the timing varied between years. Animals followed the northward progression of biomass. Fin whale behaviour was thus

likened to surfing resource waves as the timing of migration varied among years, generally lagging two weeks behind the peak in prey biomass. Sei and blue whales, in contrast, timed migrations closer to biomass peaks. Surfing varied along the migration route, with whales being closer or behind the peak at mid-latitudes but moving ahead of the peak at higher latitudes. It was noted the fin whales are observed feeding on mesopelagic fish, with a more generalist diet than blue whales. Timing of migration did not differ significantly between sexes, but there is no data on reproductive status/hormones.

- *Presenter: Viola Panigada,Tethys Research Institute*

Targeting fin whale conservation in the North-Western Mediterranean Sea: insights on movements and behaviour from biologging and habitat modelling

Recent results on the fin whale movement in the North-Western Mediterranean Sea were presented. Using satellite telemetry, the authors investigated foraging behaviour and habitat preferences related to chlorophyll-a productivity fronts. Tracking Mediterranean fin whales during their spring-summer feeding aggregation in 2021-2023, they found that whales mostly foraged outside of currently protected areas. There was a <30% overlap with the SPAMI Migration corridor and only 2 tagged individuals were observed in the Pelagos Sanctuary, but a 100% overlap with PSSA, >80% with IMMA. These results highlight the urgency to address anthropogenic threats, such as ship strikes and noise disturbance, in a region marked by exceptionally high maritime traffic. Enhanced time- and place-based conservation actions are crucial to protect core habitats and safeguard the well-being of this endangered species. It was noted that animals were never closer than the 200m isobath and that the SPAMI, being a Spanish initiative, is defined by political borders and does not cover the French coast.
Relating to this paper, the tracks of a fin whale tagged in the Gulf of Lyon in June were presented briefly by Simone Panigada. The animal was observed feeding in the Ligurian Sea, then travelled to the Atlantic and was tracked until the Bay of Biscay where the animal was feeding in August.

Relevant reference:
Panigada, V., Bodey, T. W., Friedlaender, A., Druon, J. N., Huckstädt, L. A., Pierantonio, N., ... & Panigada, S. (2024). Targeting fin whale conservation in the North-Western Mediterranean Sea: insights on movements and behaviour from biologging and habitat modelling. *Royal Society Open Science*, *11*(3), 231783. https://doi.org/10.1098/rsos.231783

- *Presenter: Eduardo Belda, Universitat Politècnica de Valencia, Spain*

Fin whale migration through the Ibiza channel and beyond

Fin whales were observed migrating along the western coast of the Ibiza Channel during the summer months (May-October). Passive acoustic monitoring revealed the presence of fin whales in the area almost all year round. Systematic observations were conducted in June-July 2021-2023, when the migration peaks. All whales observed (n=216) travelled southward. Satellite tracking (n=2) supports the idea that these whales migrate to the Atlantic looking for summer feeding grounds off the coast of Galicia and the Bay of Biscay. One tag transmitted data until the individual reached Lisbon and the second went all the way to the Bay of Biscay. Behavioural state-space models were used to identify feeding and transiting behaviours, revealing for the first time, feeding grounds for the fin whales that migrate from the

Mediterranean to the Atlantic. Area restricted searching behaviour, related to foraging, was only observed once the individual reached the Bay of Biscay, not on the way there.

- *Presenter: Renaud de Stephanis, CIRCE, Spain*

Insights from satellite tags in the Mediterranean, the Strait of Gibraltar, and Norway

Here, we heard about the results from 18 SPOT 5 satellite tags in strategic locations, the Mediterranean, the Strait of Gibraltar, and Norway, from various projects. The comparison of fin whale tracks highlights once again the link between Mediterranean Sea and Atlantic fin whales, with four animals that were tagged in the Ligurian Sea travelling to the Atlantic Ocean. The results from Lydersen et al. (2020) were also shown in this context. Future efforts will include a new tagging programme, including 14 tags in the Mediterranean Sea in the next six months, of which 6 will be deployed in Catalonia, 6 in Dénia, and 2 in the Strait of Gibraltar. These efforts are part of the INTEMARES program, which also encompasses a conservation plan for fin whales in the Iberian Peninsula. The findings from existing datasets illustrate that some whales travel from the northern Mediterranean waters to the Atlantic, reaching as far as the waters off Portugal, Galicia, the Gulf of Cadiz, and the Cantabrian Sea. A photo-identification catalogue with 68 individuals is freely available online and it was added that they have now also started a catalogue with drone photo-ID pictures.

Relevant reference:

Lydersen, C., Vacquié-Garcia, J., Heide-Jørgensen, M. P., Øien, N., Guinet, C., & Kovacs, K. M. (2020). Autumn movements of fin whales (*Balaenoptera physalus*) from Svalbard, Norway, revealed by satellite tracking. Scientific Reports, 10, 16966. https://doi.org/10.1038/s41598-020-73996-z

GENETIC ANALYSES

- *Presenter: Céline Tardy, MIRACETI/WWF France*

Relatedness of Mediterranean fin whales

The Mediterranean fin whale population, *Balaenoptera physalus*, is considered resident and is genetically distinct from the Atlantic population. In a recent study, a total of 508 fin whale samples from the Mediterranean Sea were analyzed using DNA microsatellite markers. The results showed that the population does not demonstrate a regional structure, but instead, is composed of numerous small families (e.g. 74.3% of families had only two individuals). We found three pairs of full-sibs, 77 half-sib relationships, and 25 parent-offspring relationships. Despite the small size of the Mediterranean population and its particular habitat, the population does not suffer from inbreeding depression.

Relevant references:

Tardy, C., Ody, D., Gimenez, O., & Planes, S. (2023). Abundance of fin whales (*Balaenoptera physalus*) in the north-western Mediterranean Sea, using photo-identification and microsatellite genotyping. *Marine Ecology*, *44*(1), e12737. https://doi.org/10.1111/maec.12737

Tardy, C., Planes, S., Jung, J. L., Ody, D., & Boissin, E. (2020). Characterization of 25 new microsatellite markers for the fin whale (*Balaenoptera physalus*) and cross-species amplification in other cetaceans. *Molecular Biology Reports*, *47*(9), 6983-6996. https://doi.org/10.1007/s11033-020-05757-0

These presentations were followed by a discussion on the topic of population structure. Pauline Gauffier and Anna Schleimer provided a brief update on the progress of North Atlantic and Mediterranean Sea fin whale population genetics paper that represents a large body of work with many collaborators. A manuscript was submitted, underwent a first round of peer review and has since been revised with additional microsatellite loci, samples, and updated analyses. However, publication has been delayed up until now but is an essential component of the fin whale CMP. How to achieve this as rapidly as possible in conjunction with the IWC and ACCOBAMS and to ensure future collaborative studies is discussed further in Section 3. There is also a question of who will take over the samples from WWF France/Céline Tardy.

Sandro Mazzariol shared his work at the Mediterranean Marine Mammals Tissue Bank (MMMTB) located at the Department of Comparative Biomedicine and Food Science of the University of Padova. They could receive/send/store fin whale samples, although most of their genetic work relates to gene expression rather than population genetics, as they have received funding for next generation sequencing. Analysis by alternative genetic laboratories in parallel was discussed to reduce the backlog in genetic studies. However, this would require reprocessing all available samples and/or to perform calibrations between labs.

Antonella Arcangeli points out that the FLTMED network has been collecting water samples from ferry lines for eDNA analysis of presence/absence of species in combination with stable isotope analysis to create an isoscape across the Mediterranean Sea.This dataset could be useful to address questions relating to the trophic ecology and distribution.

The workshop then discussed movement patterns and it was concluded that Mediterranean fin whale behaviour does not always comply with the traditional mysticete migration patterns and movements. It can be strongly influenced by environmental conditions without clear migratory corridors. Cow and calf pairs have been observed outside the main reproductive seasons in the Ligurian Sea for the past 30 years. We thus need to get a better understanding on the spatiotemporal movement patterns (and associated explanatory variables) to be able to assess the effects of climate change and mitigate marine threats posed by shipping and other anthropogenic activities. By understanding movement patterns, we can better interpret the population structure, assess exposure to threats, and define MPAs. It was agreed that no single technique can provide all answers. We thus need to combine different methodologies in a coordinated way. It was suggested to combine existing data relating to sightings, acoustics and telemetry to gain a better understanding on density patterns (e.g. as a PhD project).

2.2 Abundance and trends

This section provided updates on studies estimating fin whale abundance using photo-identification or distance sampling. Assessing population trends is only possible through dedicated monitoring efforts and constitute a crucial component for the assessment of the conservation status.

- *Presenter: Margherita Zanardelli, Tethys Research Institute, Italy*

Long-term photo-identification study of fin whales in the Pelagos Sanctuary (NW Mediterranean) as a baseline for targeted conservation and mitigation measures

Merging four existing photo-id catalogues yielded a Mediterranean fin whale catalogue with 507 individuals (1990-2007). The collaborating partners included Tethys (N=437), GREC

(N=37), EPHE (N=26), and CEBC (N=7). Findings suggest a persistent site fidelity to feeding grounds in the Pelagos Sanctuary, with 17% of individuals resighted across time-intervals of up to 17 years, but also a feeding habitat significantly extending westwards. The mark–recapture population estimates confirm past estimates obtained from line-transect surveys (1990s). The low number of sightings after 2010 supports the hypothesis of a more dispersed feeding area and whales' redistribution, within the Mediterranean or elsewhere. These results underline the strength of photo-id to provide robust estimates of abundance and survival rates and stress the need for a unified basin-wide catalogue.

Relevant reference:
Zanardelli, M., Airoldi, S., Bérubé, M., Borsani, J. F., Di-Meglio, N., Gannier, A., ... & Panigada, S. (2022). Long-term photo-identification study of fin whales in the Pelagos Sanctuary (NW Mediterranean) as a baseline for targeted conservation and mitigation measures. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *32*(9), 1457-1470. https://doi.org/10.1002/aqc.3865

- *Presenter: Natalia Amigo, Submon, Barcelona, Spain*

Fin whale abundance, density and collision high-risk areas in the northern section of the 'Mediterranean Cetacean Migration Corridor' Marine Protected Area

In 2023, aerial and maritime line transect surveys were conducted within the northern section of the Marine Protected Area "Mediterranean Cetacean Migration Corridor", covering 70% of the MPA. The primary objective was to obtain the first spring local density and abundance estimates and assess the risk of collision for fin whales in the area. Using the aerial and maritime datasets the distribution of fin whales within the Marine Protected Area (MPA) was predicted using Generalised Additive Models (GAMs). The encounter rate was 0.0036 sightings/km for the aerial surveys and 0.018 sightings/km for the ship surveys. Overlaying these results with maritime traffic density revealed a higher collision risk in the western part of the research area. The results highlight the areas where conservation efforts should focus to mitigate the risk of collision for fin whales. Abundance estimates are currently being validated.

- *Presenter: Simone Panigada, Tethys Research Institute, Italy*

Updates on ACCOBAMS Survey Initiative results: aerial, vessel-based and acoustic surveys

Panigada presented a summary of the visual line-transect distance sampling aerial surveys, undertaken under the framework of the ACCOBAMS Survey Initiative (ASI). This effort covered 77% of the Mediterranean Sea to monitor all the relevant Mediterranean habitats and the species therein. The aerial component of the ASI was carried out between June and August 2018. Overall, eight planes monitored more than 55,000 km along predetermined transects, from the Gulf of Cadiz to the West to the Israeli coast to the far East, over a surface of almost 2 million km². A thorough description of cetaceans' summer distribution, densities and patterns, was also presented, underlining a strong longitudinal gradient, from low densities in the east to high densities in the west, shared by most cetacean species. Fin whales' abundance was estimated at 1,749 animals (CV=0.3), which, once corrected for both availability and perception biases, resulted in 3,282 (CV=0.31). The highest fin whale density was found in the Western Mediterranean area (2.3 10^{-3} ind/km^2, CV=0.29), notably in pelagic waters from the Ligurian Sea to north of the Balearic Islands. These results facilitated the recent re-assessment of the conservation status (sensu International Union for the

Conservation of Nature – IUCN) of the Mediterranean sub-population of fin whales, which was uplisted from VU to EN.

Relevant references:

Panigada, S., Pierantonio, N., Araújo, H., David, L., Di-Méglio, N., Dorémus, G., ... & Cañadas, A. (2024). The ACCOBAMS Survey Initiative: the first synoptic assessment of cetacean abundance in the Mediterranean Sea through aerial surveys. *Frontiers in Marine Science*, *10*, 1270513. https://doi.org/10.3389/fmars.2023.1270513

Cañadas, A., Pierantonio, N., Araujo, H., David, L., Di Meglio, N., Doremus, G., ... & Panigada, S. (2023). Distribution patterns of marine megafauna density in the Mediterranean Sea assessed through the ACCOBAMS Survey Initiative (ASI). *Frontiers in Marine Science*, *10*, 1270917. https://doi.org/10.3389/fmars.2023.1270917

2.3 Threats

This section reviewed recent results on fin whale health and the exposure to anthropogenic pressures, notably ship strikes.

- *Presenter: Anissa Belhadjer, Ecoocéan Institut, France*

Computing ship strikes and near miss events of fin whales along the main ferry routes in the Pelagos Sanctuary and adjacent western area, in summer

The Mediterranean Sea is a high-density marine traffic area, particularly inside the Pelagos Sanctuary. Ship strikes are one of the main human threats for the fin whale. The « Fixed Line Transect Mediterranean monitoring Network » carries out systematic surveys from ferries. From 2008 to 2019, 13 routes crossing the Pelagos Sanctuary and the adjacent western area were monitored, totalling 238,499 km in effort. The Near Miss Events (NMEs) were reported, as a proxy indicator of ship strikes, along these routes, during ‘summertime’. 2,775 fin whales were sighted and 43 individuals were involved in NMEs. The NMEs thus represent 1.55% of all sightings. 67% occurred within the Pelagos Sanctuary. High-risk areas were identified, for instance between Toulon and Ajaccio, and the behaviour of animals involved in NMEs was also analysed. It was commented that the distance used to define near miss events may have been too conservative given the size of some tankers, but the distance was chosen to be comparable to previous studies. No ship strike was observed, only NMEs.

The next steps will be to analyse data from the winter months and provide a summer update with data from 2023 during which 14 NME occurred. It would also be interesting to estimate exposure during night time when fin whale diving patterns might differ.

Relevant references:

David, L., Arcangeli, A., Tepsich, P., Di-Meglio, N., Roul, M., Campana, I., ... & Crosti, R. (2022). Computing ship strikes and near miss events of fin whales along the main ferry routes in the Pelagos Sanctuary and adjacent west area, in summer. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *32*(3), 442-456. https://doi.org/10.1002/aqc.3781

- *Presenter: Nino Pierantonio, Tethys Research Institute, Italy*

Do fin whales show avoidance responses to approaching vessels? Insights from satellite telemetry and AIS data

Between 2021 and 2023, eleven fin whales were satellite-tagged in the Balearic Sea and the Gulf of Lion in the late spring and early summer. AIS data combined with whale tracks indicate several instances of close approaches between whales and vessels. Although whales’ avoidance strategies in response to oncoming traffic could not be fully evaluated, data suggest little evidence for lateral avoidance – i.e., limited horizontal movements away from a ship and

shallow dives. This constrained response repertoire, also observed in other large whales, makes fin whales particularly susceptible to ship strikes and calls for strong preventative measures to reduce the risk of fatal collisions. In the context of this project, the deployment of FastLock GPS tags is planned for summer 2024. There is also a need to integrate tag and AIS data with other vessel related information. An animation of a single whale that interacted with three different tankers was shown.

Relevant references:
McKenna MF, Calambokidis J, Oleson EM, Laist DW, Goldbogen JA (2015) Simultaneous tracking of blue whales and large ships demonstrates limited behavioral responses for avoiding collision. Endang Species Res 27:219-232. https://doi.org/10.3354/esr00666

- *Presenter: Sandro Mazzariol, University of Padova, Italy*

Results of post-mortem investigations on fin whales carried out in the period 2006-2022 in the Italian waters

Between 1986 and 2022, 93 fin whales were reported stranded along the Italian coastlines. Before 2006, 15/62 animals were deemed a victim of ship strikes and 10/62 animals died from other anthropogenic causes but only 2 post-mortem investigations were carried out. After 2006, 15/31 animals were analysed and a lethal interaction of human activities was hypothesised in 20% of the examined whales. Three blunt traumas (1 after 2019) were reported, all inside the Pelagos Sanctuary. The majority of the investigated specimens died from natural diseases, accounting for 73.3% of the analysed animals. It should be stressed that infectious agent epidemiology could be affected by climate change and other anthropic impacts. Moreover, only an evidence-based approach with a complete post-mortem investigation can assess the impact of human activities on fin whale carcasses and support conservation policy on this matter. For the period 2019-2023, six fin whale strandings were reported in Italy.

- *Presenter: Cristina Panti, University of Siena, Italy*

New insights into Mediterranean fin whale ecotoxicology

Mediterranean fin whales simultaneously face concurrent exposure to multiple stressors, such as marine litter (including microplastics), climate change, bioaccumulation of chemical contaminants, as well as infectious diseases, resulting in effects on population stability. Recent advancement to understand the cumulative stress to this species have been made by applying a multi-diagnostic approach to demonstrate the use of exposomics combined with gene expression analysis for assessing the *Balaenoptera physalus* susceptibility sampled in the Pelagos Sanctuary SPAMI. The exposure to high/low levels of contaminants during their lifetime can exert variation on DNA methylation, which can be assessed using exposomics. The first application of wide-scope chemical exposomics with and gene expression molecular endpoint analysis fin whale blubber and skin provided insights on the toxicological effects related to accumulation of legacy and emerging contaminants never measured before (e.g. pharmaceuticals). This study transferred knowledge, tools and approaches from human exposome research to the environmental monitoring of endangered species.

Relevant reference:
Mancia, A., Abelli, L., Fossi, M. C., & Panti, C. (2021). Skin distress associated with xenobiotics exposure: An epigenetic study in the Mediterranean fin whale (*Balaenoptera physalus*). *Marine genomics*, *57*, 100822. https://doi.org/10.1016/j.margen.2020.100822

2.4 Novel technologies

The final set of presentations gave insight into novel technologies that may be useful to monitor fin whales.

- *Presenter: Viola Panigada on behalf of Peter Fretwell and Hannah Cubaynes, British Antarctic Survey*

Monitoring whales from space

Fin whales and other cetacean species have successfully been detected in very high-resolution satellite imagery (30-50cm resolution), presenting it as a potential complementary tool to aerial and boat-based surveys. The latest developments in using this technology to monitor whales include 1) standardised methods to manually review imagery and create datasets necessary for automated approaches; 2) automating the detection of various species; and 3) efforts within the community to share data, code and knowledge. There are efforts to make the field more equitable by building partnerships with satellite image providers to facilitate access to imagery, through the International Whaling Commission correspondence group "Satellite to Study Whales". The method requires the purchase of imagery from satellite providers which can incur high costs. The images provide a snapshot and it would be difficult to use them to detect high-risk ship collision areas. The algorithm can be trained with rough sea conditions and provide labels of identification certainty.

Relevant references:

Cubaynes, H. C., Fretwell, P. T., Bamford, C., Gerrish, L., & Jackson, J. A. (2019). Whales from space: four mysticete species described using new VHR satellite imagery. *Marine Mammal Science*, *35*(2), 466-491. https://doi.org/10.1111/mms.12544

Green, K. M., Virdee, M. K., Cubaynes, H. C., Aviles-Rivero, A. I., Fretwell, P. T., Gray, P. C., ... & Jackson, J. A. (2023). Gray whale detection in satellite imagery using deep learning. *Remote Sensing in Ecology and Conservation*, *9*(6), 829-840. https://doi.org/10.1002/rse2.352

- *Presenter: Eduard Degollada, Edmaktub*

The use of drones and thermal cameras in fin whale research

Drones can be used to assist in the study of fin whale behaviour, abundance, group structure, and health (e.g. morphometrics, blow sampling). As such, a top-down view can be useful to distinguish between cow and calf and male-female pairs. The unique chevron pattern of the fin whale can be used to create drone photo-identification catalogues. In the future, AI can help to identify individuals. Drones are also useful to assist in deploying tags or taking biopsies by coordinating approaches to animals.

Thermal cameras are being trialled as a tool to avoid vessel collisions by monitoring whales from ships. In that context, images were acquired to develop automatic detection software. Preliminary results suggest that detections are possible up to 1500m. Efficiency decreased with high water/air temperature and waves.

Relevant references:

Degollada E, Amigó N, O'Callaghan SA, Varola M, Ruggero K, Tort B. A Novel Technique for Photo-Identification of the Fin Whale, Balaenoptera physalus, as Determined by Drone Aerial Images. Drones. 2023; 7(3):220. https://doi.org/10.3390/drones7030220

3. Suggestions for future work within and outside the context of the ACCOBAMS/IWC CMP

GENETICS

- Follow ACCOBAMS Best practices on cetacean population genetics
- GAP: >2,000 samples have been collected and processed in the Mediterranean Sea and Atlantic Ocean but the population structure in the Mediterranean is still unclear.
- Analytical work for the Schleimer/Gauffier et al. manuscript should be completed and published as soon as possible.
- Need for more recent samples from Galicia and areas of interest, especially if in recent years movement is changing
- Make use of the existing tissue banks for additional samples
- Collect regular eDNA samples, creation of isoscape, to improve sample coverage

After a brief verbal summary of the workshop was presented at the IWC Scientific Committee meeting (22 April to 3 May 2024 in Bled, Slovenia), the SC welcomed the workshop and produced the following recommendations (IWC 2024):

"The draft work on the fin whale CMP has identified the need to clarify the relationships between fin whales in the Mediterranean and adjacent North Atlantic waters. Although other approaches also provide insights (e.g., telemetry, sightings and acoustics data), the need to complete genetic analyses on the many existing tissue samples from a variety of locations in the region has been highlighted.

*The Committee **recommended** that every effort be made to complete the laboratory and analytical work by the end of 2025. This will facilitate the work to finalise the joint ACCOBAMS/IWC CMP at the forthcoming stakeholder workshop."*

ACOUSTICS

- Create an international network of hydrophones/sensors to record fin whale calls, including existing ones (CNR-Italy, IEO-Spain, Univ. Poly. Valencia, Univ. Toulon, look for other sources) and identifying missing areas of interest
- To minimise bias due to mismatch in season/years:
    - Compare recordings from same time periods across the entire ACCOBAMS area
    - Coordinate future efforts to facilitate the collection simultaneous recordings across the entire ACCOBAMS and neighbouring areas
- Be careful of over interpretation of acoustic results, as vocal behaviour is still not fully understood and may be very flexible

ABUNDANCE AND TRENDS

- Support ACCOBAMS LTMP and associated guidelines

- Push for coordinated efforts to share and combine existing sighting data (e.g., through a PhD project) to gain insight across wider spatial/temporal scale and to have more power to detect/confirm trends
- Missing data from winter (acoustics, satellite telemetry), but also diurnal patterns (different dive patterns at night)
- Some gaps in data, less from southern and especially eastern area
- While new technologies (e.g., drones) can be useful for photo-ID, continue using photo-ID from boats not to lose data from long term catalogues and match drone/boat photo-ID catalogues

TELEMETRY

- Must follow the IWC best practice guidelines including risk/benefit analysis
- Valuable to collect e.g. continuous data on movements and diurnal behaviour
- Collect biopsy of tagged animals to try to link their movement patterns to their population identity

BIOLOGICAL PARAMETERS

- Lack of knowledge on breeding, e,g., using hormones (Eduard)
- Blow analysis (microbiomes, genetics e.g., using eDNA techniques to amplify DNA and UAV to collect the blow)
- Hormones for reproductive status, but more data for validation is needed à joining information

THREATS

- Consider effects of non-lethal collisions; monitor scarring, injuries, using drones and long term photo-ID catalogues
- Include info from diurnal patterns (different dive patterns at night, possibly more time spent at surface increases risk from ship strike)
- Promote post-mortem training for researchers and the adoption of common and harmonized protocols to assess evidence of human interaction and post-mortem investigation results
- Promote rescue training for response in case of fin whales in difficulties (entanglement, ship-strike, live stranding, etc.)

GENERAL

The Workshop identified the importance of regular contact amongst fin whale experts in the region in addition to more intensive workshops (say every 5 years). Suggested options include establishing a more formal fin whale community, use of an email list, use of NETCCOBAMS. It was suggested that the organisers of the present workshop investigate this and develop a proposal for consideration by the participants.

Given the workshop discussions regarding data sharing and prompt analyses and publication of results, the workshop participants were supported by the recent IWC recommendations (IWC 2024):

“CMPs form a valuable component of the conservation work of both the IWC and ACCOBAMS. The work in the Mediterranean Sea and elsewhere has shown that the science underlying conservation efforts is immeasurably enhanced by the collaboration (both with data and analyses) of all research groups operating within the region.

*The Subcommittee **recommended** that every effort is made by CMP coordinators to use the framework of CMPs to facilitate such collaboration; such efforts must recognise the need to develop data sharing agreements that build trust and improve cooperation.”*

Conclusion

The Workshop provided a valuable forum to discuss recent developments in fin whale research in the region. The report and especially Section 3 will be of great value in discussions within the IWC and ACCOBAMS on updating the draft CMP for Mediterranean fin whales that will be finalised at a forthcoming stakeholder workshop for final adoption by the two intergovernmental organisations. The organisers agreed to update the participants on progress with this (including asking for assistance in drafting where appropriate).

Appendix 1: Agenda

Held ahead of the European Cetacean Society conference - 9th April 2024

8h30 Start of the workshop	
Convenor's opening remarks	
Adoption of the Agenda	
Brief presentation of the draft CMP on the Mediterranean fin whales	Greg Donovan (online)
Update on current knowledge in the ACCOBAMS area (after 2019)	
Population structure, distribution and movement	
Acoustics	
Fin whale acoustic presence and song characteristics in seas to the southwest of Portugal	Andreia Pereira (online)
Acoustic Studies of Fin Whale Occurrence and Behavior in the Central Mediterranean Sea	Virginia Sciacca
Sightings	
Long term monitoring data by the FLTMEdNEtwork	Paola Tepsich (online)
Insights from the opportunistic data collection obtained from whale-watching off Genoa: changes of fin whale's encounter rate over the period 2019-23	Aurélie Moulins
Fin whales on the Catalan coast, northwestern Spanish Mediterranean. A spring feeding ground. Updating a ten-year project	Beatriu Tort
Insights on fin whales from Madeira	Pauline Gauffier
Satellite tagging	
Migration ecology of fin whales: a mid-Atlantic perspective	Mónica Silva
Targeting fin whale conservation in the North-Western Mediterranean Sea: insights on movements and behaviour from biologging and habitat modelling	Viola Panigada
Fin whale migration through the Ibiza channel and beyond	Eduardo Belda
Insights from satellite tags in the Mediterranean, the Strait of Gibraltar, and Norway	Renaud de Stephanis (online)
Genetic Analyses	
Relatedness of Mediterranean fin whales	Céline Tardy
COFFEE BREAK	
Implications for population structure hypotheses	
Knowledge gaps and future directions	

Abundance and trends	
Fin whale population estimates from mark-recapture	Margherita Zanardelli
Fin whale summer abundance estimates in the Mediterranean Cetacean Corridor	Natalia Amigo
Updates on ACCOBAMS Survey Initiative results	Simone Panigada
Knowledge gaps and future directions	
LUNCH BREAK	
Threats	
Ship strikes	
Computing ship strikes and near miss events of fin whales along the main ferry routes in the Pelagos Sanctuary and adjacent west area, in summer	Anissa Belhadjer
Do fin whales show avoidance responses to approaching vessels? Insights from satellite telemetry and AIS data	Nino Pierantonio
Strandings	
Results of post-mortem investigations on fin whales carried out in the period 2006-2022 in the Italian waters	Sandro Mazzariol
Contamination	
New insights into Mediterranean fin whale ecotoxicology	Cristina Panti (online)
Knowledge gaps and future directions	
Novel technologies	
Monitoring whales from space	Viola Panigada
The use of drones and thermal cameras in fin whale research	Eduard Degollada
Conclusions	
Proposed research priorities - recommendations	
Convenors' summary	

Appendix 2: List of participants

Name	Organisation	Type
Anna Schleimer	Odyssea Luxembourg	Organiser
Greg Donovan		Organiser
Pauline Gauffier	Madeira Whale Museum	Organiser
Simone Panigada	Tethys Research Institute	Organiser
Alexander Nicolas Rychwalski	University of Hamburg	Participant
Andreia Pereira	IDL, University of Lisbon	Online
Angela Maria Gonzalez	CIRCE	Participant
Anissa Belhadjer	Eco Ocean Institut	Participant
Antonella Arcangeli	FLTMED network	Participant
Aurélie Moulins	CIMA Foundation	Participant
Beatriu Tort	Edmaktub	Participant
Blanca Feliu	Spanish Institute of Oceanography	Participant
Céline Tardy	WWF France/MIRACETI	Participant
Cristina Fossi	University of Sienna	Online
Cristina Panti	University of Sienna	Online
David Silgado	CIRCE	Participant
Eduard Degollada	Edmaktub	Participant
Eduardo Belda	Universitat Politècnica de València	Participant
Elena Fontanesi	Delfini del Ponente	Participant
Flavia del Pizzo	WWF Italy	Participant
Guido Pietroluongo	Univ. Padova	Participant
Jazel Ouled-Cheikh Bonan	University of Barcelona	Participant
Jean Michel Cottalorda	Université Côte d'Azur	Participant
Marc Ruiz i Sagalés	University of Barcelona	Participant
Margherita Zanardelli	Tethys Research Institute	Participant
Maÿlis Salivas	ACCOBAMS Secretariat	Participant
Monica Silva	University of Azores	Participant
Natalia Amigo	Submon	Participant
Nathalie Di Meglio	Eco Océan Institut	Participant
Nino Pierantonio	Tethys Research Institute	Participant
Oriol Giralt Paradell	University College Cork	Participant
Pablo Pezzino	CEFE-CNRS	Participant
Paola Tepsich	CIMA Foundation	Participant
Renaud de Stephanis	CIRCE	Online
Sabrina Congiu	WWF Italy	Participant
Sandro Mazzariol	University of Padova	Participant
Viola Panigada	Tethys Research Institute / British Antarctic	Participant

Name	Organisation	Type
	Survey	
Virginia Sciacca	CNR-ISP	Participant