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Cetaceans monitoring programme in the waters of Madeira archipelago

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ABSTRACT

The Madeira Whale Museum established in 2004 a monitoring programme directed to cetacean populations occurring in Madeira waters. This programme resulted from the ”Project for the Conservation of cetaceans in Madeira archipelago – Cetaceos Madeira” and involves nautical and aerial surveys, photo-id studies, a stranding network and monitoring of whale-watching and fisheries activities. Its scientific aims are: to update the knowledge on cetacean biology (e.g. population dynamics, distribution and occurrence); to monitor the identified threats, detect new ones and its impacts upon cetaceans and maintain a regular update on the conservation status of cetacean species in the archipelago. The overall goal of this programme is to provide scientific knowledge to managers and governmental conservation departments in order to promote measures towards conservation and sustainable management of Madeira’s Cetacean populations. The programme is being progressively implemented in its different components and it is expected to be fully implemented by 2012. To date, 28 cetacean species were reported to Madeira archipelago representing an important natural richness to preserve, due to its value to the marine ecosystem and biodiversity and for its economic value for the local whale-watching industry. Among them are large whales (e.g. sperm whale, fin whale, or Bryde’s whale), beaked whales and delphinids (e.g. Common Bottlenose dolphin, Atlantic spotted dolphin or common dolphin). Although all species are targeted by the monitoring programme, the most vulnerable to human activities and the most frequent will have special attention.

KEYWORDS: CONSERVATION, MANAGEMENT PROCEDURE, SUSTAINABILITY, CETACEANS

INTRODUCTION

Cetaceans are protected by regional, national and international legislation namely the Regional Law nº 6/86/M, the Bone, the Bern and Washington conventions, all of them applying particularly or in general to the cetacean species occurring in Madeira archipelago waters. Since 1986 cetaceans have been protected in Madeira archipelago, when capture (whaling) was forbidden by regional law. However, legislation was not followed neither by management neither by monitoring measures in order to identify and mitigate the possible threats to cetaceans. Monitoring biological parameters is crucial to evaluate the trends and natural changes on cetacean populations (biodiversity, distribution, abundance, etc.) and distinguishing it from changes in populations that can be induced by human activity. In that sense, the Madeira Whale Museum (MWM) and as result of the “Project for the Conservation of cetaceans in Madeira archipelago – Cetaceos Madeira” established a monitoring programme of cetaceans in the waters of Madeira archipelago which is based in several assumptions that are described further ahead. The monitoring programme has been implemented in several phases, and although some of the actions have been already implemented (e.g. nautical surveys, aerial surveys, photo-id, look out posts, necropsies) not all can be considered has fully implemented.

Assumptions

The plan must allow the qualitative and quantitative monitoring of changes in the biological parameters (e.g. population) that may suggest possible anthropogenic impacts on cetaceans.

The plan must allow the monitoring of threats and impacts that have been already identified.

The plan should be flexible in it’s methodologies in order to detect new threats and news impacts upon cetaceans that may arise and evaluate the positive or negative evolution of those new threats and impacts.

The plan should allow the monitoring of a wider range of species both in terms of population parameters and in terms of anthropogenic threats.

The methodologies have to produce data comparable to the data obtained in previous projects, namely "Projecto para a Conservação dos Cetáceos no Arquipélago da Madeira" (see brief description on methods section) and EMECETUS project (Study, monitoring, education for the conservation of the cetacean in the Macaronesia region) in order to detect possible trends of the monitored parameters. Therefore, it assumes that methodology will be used in long-term surveys on the same area of study according to the same sampling procedure.

The plan has to be logistically feasible and economically sustainable in a long-term basis in order to guarantee its application.

Goals

The general goal of the programme is to update the biological knowledge on the cetaceans (e.g. population dynamics, distribution, etc.);

Monitor the evolution of the identified threats and to detect new threats or impacts upon cetaceans;

Regularly update the conservation status of cetaceans species occurring in Madeira archipelago waters;

To provide scientific knowledge to managers and decision makers so that management and conservation measures aiming the sustainable conservation of the cetacean populations in Madeira archipelago may be taken.

Target species

Madeira archipelago acts as an "oasis" for cetaceans in the middle of the vast ocean, due to its environmental particularities. Up to now, 28 cetacean species were reported to Madeira archipelago. As top-predators, these species constitute an important element of the marine ecosystem, whose conservation is of paramount importance. Besides their biological importance, cetaceans also have both economical and cultural importance in Madeira Island, namely in the whalewatching activity. Therefore, the responsibility of proper and sustainable management and conservation of this natural marine heritage is highlighted.

From the total species identified three are the most commonly observed:(*Tursiops truncatus; Delphinus delphis; Stenella frontalis*), 4 are common (*Balaenoptera physalus*; *Physeter macrocephalus*; Globicephala macrorhynchus; *Stenella coeruleoalba)*, 8 species are considered occasional (*Balaenoptera borealis; Balaenoptera edeni; Kogia breviceps; Ziphius cavirostris; Mesoplodon densirostris; Orcinus orca; Pseudorca crassidens; Grampus griseus*) whilst the remaining are rare (e.g. *Balaenoptera musculus*; *Megaptera novaeangliae; Balaenoptera acutorostrata; Mesoplodon bidens; Steno bredanensis).* There has been a significant increase in the number of cetaceans found in Madeira archipelago as a result of the studies developed by the MWM in these last years.

The monitoring program was conceived to target all species. Nevertheless, some of them will be subject of particular attention due to its vulnerability to human activities, higher vulnerable conservation status and due to its regular presence on Madeira waters and the importance of Madeira waters to these populations.

METHODS

The sampling methods are the same applied in the Project "Projecto para a Conservação de Cetáceos no Arquipélago da Madeira" - Project Life99 NAT/P/006432" carried out between 2000 and 2004. That project made an inventory of cetacean species occurring in Madeira Archipelago, determined the relative abundance and established a general pattern of temporal and spatial distribution of cetaceans species in the Archipelago's coastal waters. Therefore, in the present program, the following methods will be used: nautical surveys (visual and acoustic), photo-id, aerial surveys, observations from look out posts, random surveys, opportunistic sightings, questionnaires and necropsies of stranded animals (See annex) .

Sampling Area

The monitoring plan predicts the assessment of cetacean populations in the inshore and offshore of Madeira. Due to logistic constraints and in order to be financially sustainable, the plan will focus on areas that are submitted to higher levels of human activities and where there is a higher potential of interaction between human activities and cetaceans. Thus, sampling concentrates on the coastal zones with higher anthropogenic pressure, but still monitoring open-oceanic waters using platforms of opportunity. This last action is one of the goals of the MWM new project CETACEOS MADEIRA II, co-financed by EU initiative LIFE +, which aims to perform surveillance of the conservation status of cetacean species in the off-shore waters of Madeira EEZ.

The coastal zones of Madeira, Desertas and Porto Santo Islands will be monitored until the 20 NM offshore whilst Selvagens Islands will be monitored up to 12 NM. The South coast of Madeira Island is the main target zone, i.e. the zone of bigger concern since it is the area targeted by the whalewatching and big-game fishing boats besides being the area with more ship traffic.

The marine reserves that belong to Marine Natura 2000 network do not include preferential habitats for cetaceans yet, and thus are not considered presently in the monitoring program. The oceanic zones to survey are limited by the 200NM EEZ limit, including Selvagens islands and the seamounts (Dragão, Seine, Leão e Unicórnio). On those areas the main goal is to assess interactions between fishing activities and cetaceans, as well as, to detect marine pollution (area comprised between 100 to 200 NM where fishing boats from European Union can operate).

Nautical surveys

Nautical surveys will be performed according to the protocol defined in the Project "Projecto para a conservação dos Cetáceos no Arquipélago da Madeira - Project Life99 NAT/P/006432". The surveyed area, comprising 10 sectors (see figure 1) that corresponds to the sea around the islands (mean distance of 7 NM, minimum distance of 3,5NM and maximum of 12NM) will be covered with zigzag line transects. The line transects will be carried out in 7 days periods sampling all sectors every 3 months. On the first year the sampling surveys will occur in January, April and October. On the second year in February, May, August and November and in the third year the remaining months would be sampled to accomplish a year-round cycle. Due to logistical constraints and distance from Madeira Island, Selvagens Islands have only one annual survey and thus need a four year sampling to cover all year.

PARAMETERS

***Biological parameters* -** will allow the assessment of populations on its main features, monitoring the population evolution and therefore understanding how anthropogenic activities can negatively impact these populations. The data obtained will be used in future processes of re-evaluation of the conservation status of cetacean species inhabiting Madeiran waters.

Diversity – assess the evolution of the number of cetacean species in the study area.

Relative abundance – monitor the evolution of cetacean species relative abundance in order to evaluate a possible decrease in the number of individuals in the study area, which may result from natural phenomena or human impact.

Seasonality – monitor possible changes of species frequency of occurrence along the year.

Distribution – monitor the changes on the distribution of the different cetacean species and understand how natural factors or anthropogenic impacts can affect its distribution.

Animal activities – study the different animal activities (feeding, reproduction, socialization, resting, etc.) and its areas of occurrence in order to assess the importance of the inshore waters of Madeira for these animals.

Breeding – monitor birth and growth of calves in the study area in order to assess the importance of Madeiran waters has a breeding ground for the several cetacean species and the effects of possible negative human impacts.

Animal behaviour – study and monitor the natural behaviour of cetaceans in opposition to behavioural reactions that cetaceans can show when submitted to human activities such as whale-watching.

Size, aggregation and groups – monitor the structure evolution (size, groups, constitution) of the different cetaceans groups.

Environmental parameters - monitor a set of environmental parameters that could affect the sampling effort at sea (e.g. visibility, sea conditions) and the data that will be collected.

Cetacean Acoustic activity- record of acoustic activity (echolocation and communication)

Anthropogenic parameters

Interaction between boats and cetaceans – the interactions between whale-watching boats and cetaceans will be recorded to evaluate the impact on the animals.

Fishing activity - in order to assess the intensity and distribution of fishing activity and possible interactions between fishing boats and cetaceans, the fishing boats occurrence during transect-lines surveys will be recorded, as well as information on type of gears used.

Nautical traffic - all boats observed in the pathway of the transect lines and the type of activity will be recorded in order to study the intensity and distribution of nautical traffic in Madeira archipelago waters.

Frequency and intensity of underwater noise – the natural and anthropogenic noises during transect lines will be recorded.

Measurement of persistent litter on the sea – concentrations of persistent litter on the sea will be recorded in order to monitor the evolution of the situation on Madeira and understand the real dimension of the problem.

Record of other pollutants – namely oil spills along the transect lines.

Number of land depositions in the sea – recorded every time that is detected.

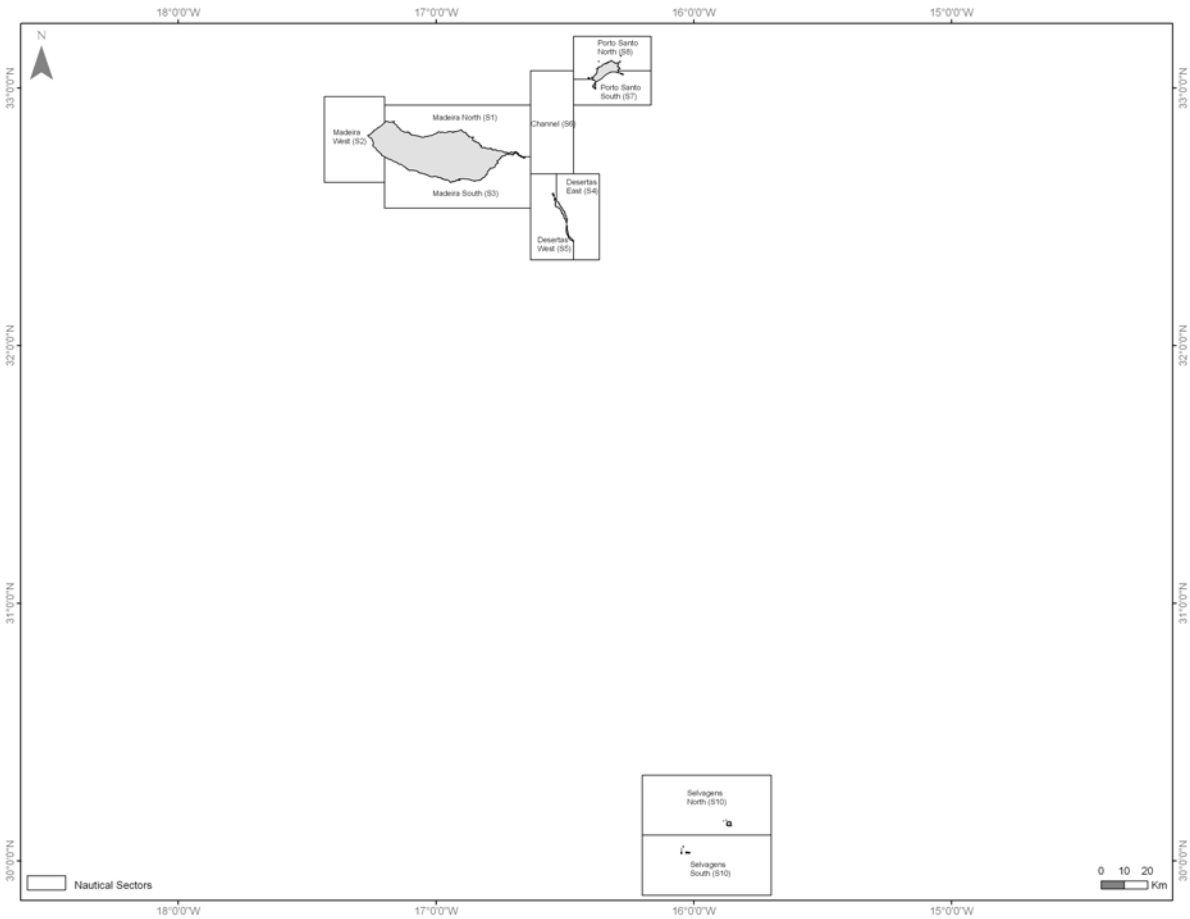

Figure 1 – Study area for nautical surveys, includes 10 sectors around Madeira island, Porto Santo Island, Desertas and Selvagens Islands

Aerial surveys

Aerial surveys will be performed according to the protocol defined in the Project "Projecto para a conservação dos Cetáceos no Arquipélago da Madeira - Project Life99 NAT/P/006432". 3 flights per month are scheduled in order to cover the 4 sectors. This sampling effort is dependent on helicopter hours allocated to the program, presently of 5 hours/ month.

Sampling Area

The area of study is divided in 4 sectors, namely North Madeira, South Madeira, Desertas and Porto Santo (see figure 2)

Figure 2 – Aerial surveys area divided in 4 sectors around Madeira Island, Desertas and Porto Santo Island

PARAMETERS

Biological parameters: diversity, relative abundance, seasonality and distribution.

Anthropogenic parameters: fishing activity, nautical traffic, measurement of persistent litter on the sea, number of land depositions in the sea

Photo-ID

Surveys for Photo-ID will be carried out according to resources availability, with at least 2 boat trips per month. Moreover, if a target species is sighted during nautical transect lines, photo-id will be carried out. Photo-ID techniques will be used based on photographic images or videos from dorsal and caudal fins (depending on the species in question).

Sampling area

The photo-ID work will be performed on the coastal sea around Madeira, Desertas and Porto Santo. The routes will be opportunistic and any useful information will be considered in order to increase detectability of the targeted species in the sea.

PARAMETERS

Biological parameters

Minimum abundance – whilst setting a data base of individual's identification we intend to estimate the minimum number of animals that use the sampling area in a specific period of time.

Movements- with identification and re-identification of individuals of a certain species in different places it is possible to start to understand its movements, residence or seasonal occurrence in Madeira waters.

Habitat use – studying the species and animals movements understand how they use the habitat around the island.

Look out post

Observations from land stations will be performed according to the protocol defined in the Project "Projecto para a conservação dos Cetáceos no Arquipélago da Madeira - Project Life99 NAT/P/006432". A total of 7 hours per day in a total of 5 days per month.

Sampling area

The whale-watching activity is based on the West coast of Funchal (<6 NM). The boats start's trips leaving from Funchal harbour going to SE untill Ponta do Garajau and then change direction to West. Thus, two look out post where defined in order to cover the area to east and west of Funchal (see figure 3).

PARAMETERS

Biological parameters: relative abundance, Seasonality, Animal activities, Animal behaviour – study and monitor the natural behaviour and reactions of the cetaceans to whalewatching activity and size and groups aggregation

Anthropogenic parameters: Boat type, activity and traffic intensity, compliance of the voluntary conduct code – record sightings events and evaluate if the rules are being followed by the whalewatching boats, Re-orientation rate and cetacean velocity changes – measure these parameters in order to detect possible pressures upon cetacean as result of the whalewatching activity, including the compliance of the code of conduct, behaviours indicating disturbance - record cetacean's behaviour on the presence of boats in order to compare them in the absence of boats.

Oportunistics Sightings

Using information of sightings from fishing boats/recreational boats, even though with no regular neither homogenous effort. It allows to record the presence of cetaceans in the areas more offshore, namely in the seamounts.

PARAMETERS

Biological parameters: environmental parameters, specific diversity, seasonality, animal behaviour, groups' size.

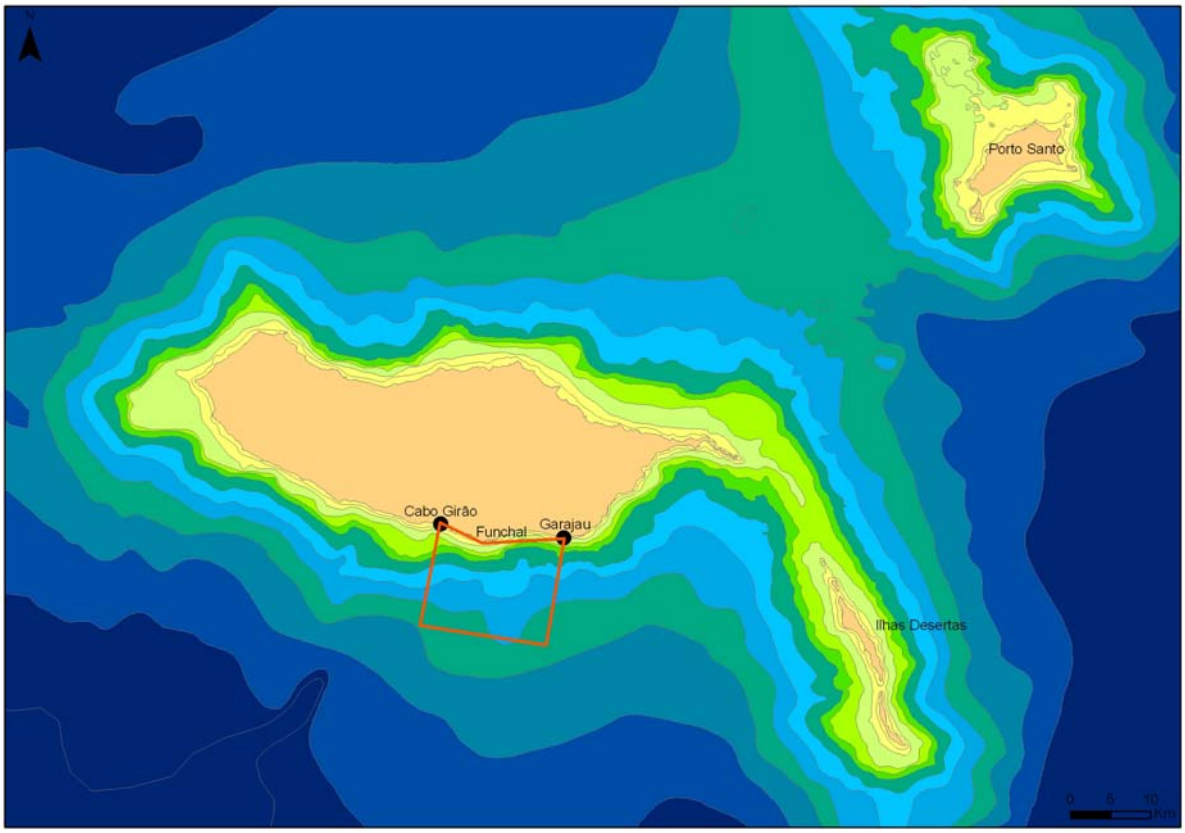

Figure 3 – Look out post located on the S- SW coast of Madeira where the whalewatching activity occurs. Red line limit the main area used by the whalewatching boats.

Questionnaires

Questionnaires will be done to whalewatching boat operators and to its customers, to fishing boats captains and fish farms operators in order to evaluate the degree of interactions with cetaceans. The questionnaires were considered with the aim of assessing compliance of the voluntary code of conduct by whalewatching boats (5 questionnaires/moth/boat), to characterize the fishing fleet operating in Madeira and to assess about possible interactions with cetaceans around the fish farms existing in the island.

Sampling Area

Madeira EEZ

PARAMETERS

Anthropogenic parameters:

Whale-watching - questionnaires directed to the whalewatching customers to assess the level of perception relative to the compliance of the voluntary code of conduct. Also to monitor the type and quantify the information about cetaceans that is transferred to the customers.

Fishing interactions – accidental captures – questionnaires will be carried out in order to obtain information about cetacean interaction with fisheries

Aquaculture – presence of cetacean on the boundaries of the fish farms.

Boardings

In order to monitor fishing activities there will be observers boarding the fishing boats. To maximize the resources, the observers will sight the cetacean species observed during each trip and record the interactions between cetaceans and the fishing boats. The boarding's are set by Direcção Regional de Pescas (DRP) and probably will be not occur on a regular basis. Moreover, included in the MWM new project CETACEOS MADEIRA II, boarding's on tuna fish boats are planned to do surveillance of the conservation status of cetacean species in the off-shore waters of Madeira EEZ. The data sheets for the fishing boats will record boats routes, observation effort, environmental conditions, sightings data and interactions between cetaceans and fishing gears. To the "whalewatching" boats the plan is a monthly trip per boat that signed the voluntary code of conduct. The data sheets will comprise issues/fields relating the compliance of the code of conduct and also clarification sessions directed to the whalewatching boats crew will be considered.

Sampling Area

The total area to monitor comprises the area of action of each activity: entire EEZ for fishing activity and area comprising the area west of Funchal for whale-watching activity (see figure 3).

PARAMETERS

Biological parameters: Diversity, seasonality, distribution, animal activities, breeding, animal behaviour, size, aggregation and group composition, environmental parameters

Anthropogenic parameters: accidental captures of cetaceans in the fishing gears, compliance of the code of conduct

Necropsies

The stranded animals will be submitted to a post-mortem exam, i.e. necropsy every time it's possible and there conditions to perform it.

Sampling area

Post-mortem examination will be done to all dead cetaceans found in Madeira archipelago.

PARAMETERS

Biological parameters: Feeding diet - collect the stomach contents and intestines, pathology, genetic – collection of genetic samples to help the study of population structure of the different species in the Atlantic; parasithology – parasites collected from the different organs for population description; morphometry, natural history.

Anthropogenic parameters: Directed and accidental captures, toxicity levels, ship strikes, mortality resulting from urban wastes.

CHANGES AND UPDATES

The present monitoring plan will maintain the same methodology during its application period in order to be comparable among years and therefore to be possible to assess the evolution of certain aspects. Though, upgrade and changes of methodology are considered but still guaranteeing that will produce data comparable to the data previously collected.

The goal is to have a wide coverage and a flexible plan in order to detect new threats to cetaceans. Specific studies to answer to specific questions have to be considered in order to consolidate the knowledge obtained and answer to specific questions in management and conservation of cetaceans in Madeira archipelago. In that sense, MWM has a new project LIFE + CETACEOS MADEIRA II – titled "Identifying critical marine areas for the bottlenose dolphin and surveillance of the cetacean's conservations status in Madeira archipelago". This a 4 years project to start on june 2009 and finish on june 2013. Cetaceos Madeira II will generate the data necessary for the identification of critical habitats for bottlenose dolphins, contribute to minimize the impact of the commercial whale-watching industry growth on cetaceans and to support and develop a surveillance of the conservation status of cetaceans in the off-shore waters of Madeira archipelago, in line with the aims of Habitats Directive and the nature conservation interest of Madeira Autonomous Region.

The Direcção Regional do Ambiente supports the project and will take in consideration the recommendations coming out of the project, namely the identification of critical areas for bottlenose dolphins in the archipelago, which will be considered as candidates for the Natura 2000 marine sites network. Any further recommendations resulting from project, namely the information regarding the carrying capacity for whalewatching boats in Madeira archipelago, will be considered to avoid the overgrowth of the industry that would have negative impacts on cetaceans, potentially on their conservation status and on the industry itself. The surveillance of conservation status of cetaceans in the off-shore area to be carried out in this project will be integrated in the Monitoring plan of cetaceans in Madeira archipelago waters

ANNEX

Table I – Resume of methods used in the monitoring plan, parameters and threats to be monitored.

Method	Monitored Parameters		Target species	Threats or monitored impacts	Sampling effort
	Biological	**Anthropogenic**			
Nautical surveys	▪ Diversity; ▪ Relative abundance; ▪ Seasonality; ▪ Distribution; ▪ Animal activities; ▪ Breeding; ▪ Animal behaviour; ▪ Size group; ▪ Groups aggregation; ▪ Groups constitution; ▪ Environmental parameters; ▪ Acoustic cetacean activity;	▪ Interaction between boats and cetaceans; ▪ Fishing activity; ▪ Nautical traffic; ▪ Frequency and intensity of underwater noise; ▪ Measurement of persistent litter on the sea; ▪ Record of other pollutants; ▪ Number of land depositions in the sea;	All species	▪ Whalewatching; activities; ▪ Interaction between cetaceans and fisheries (direct observation); ▪ Nautical traffic; ▪ Persistent litter on the sea and other visible pollutants; ▪ Underwater noises resulting from anthropogenic activities; ▪ Organic content; ▪ Land dumping;	▪ Sectores MadN, MadW, MadS, DesE, DesW, Trv, PSN, PSS 7days period each 3 month Year 1 – Jan/Apr/Jul/Oct Year 2 - Fe/May/Aug/Nov Year 3 - Mar/Jun/Sept/Dec ▪ SelvN, SelvS 1 survey/year Year 1 – spring Year 2 – summer Year 3 – autumn Year 4 – winter
Aerial surveys	▪ Diversity; ▪ Relative abundance; ▪ Seasonality; ▪ Distribution;	▪ Fishing activity; ▪ Persistent litter on the sea and other visible pollutants; ▪ Ship traffic; ▪ Number of land depositions in the sea;	All species	▪ Persistent litter on the sea and other visible pollutants; ▪ Nautical traffic; ▪ Land deposition;	▪ Sectors: South, North, Desertas and Porto Santo 3 flight/month
Photo-ID	▪ Minimum abundance; ▪ Movements; ▪ Habitat uset;		*Physeter macrocephalus* *Tursiops truncatus* *Globicephala macrorhynchus*	N/A	▪ regular opportunistic

Method	Monitored Parameters		Target species	Threats or monitored impavcts	Sampling effort
	Biological parameter	**Anthropogenic**			
Look out posts	▪ Relative abundance index; ▪ Seasonality; ▪ Animal activities; ▪ Animals behaviour; ▪ Groups size; ▪ Groups aggregation;	▪ Boat type, activity and traffic intensity; ▪ compliance of the voluntary conduct code ▪ Whalewatching rules, e.g., boats speed, minimal distance to boats, observation time, etc; ▪ Animal re-orientation rate; ▪ Changes of cetaceans speed; ▪ Disturbance behaviours	All	▪ Nautical traffic ; ▪ Whalewatching activity; ▪ Laisure boats; ▪ Whalewatching code of conduct application;	▪ 5 h/month ▪ 7 hours/day
Opportunistic Sightings	▪ Diversity; ▪ Seasonality ; ▪ Animals behaviour; ▪ Groups size; ▪ Environmental parameters ;		All	N/A	▪ opportunistic
QuestionnaireS	N/A	*Whale-watching* ▪ Level of customers perception relative to the compliance of the voluntary; *Fishing activity* ▪ Acidental capture in fishing gears; *Aquaculture* Presence of cetaceans around fish farms and interactions	N/A	▪ Whalewatching code of conduct application; ▪ Accidental captures in fishing gears; ▪ Aquaculture;	Whale-watching ▪ 5 questionnaires/boat/month; Fishing activity ▪ To establish; Fish farms ▪ To establish;

Method	Monitored Parameters		Target species	Threats or monitored impavcts	Sampling effort
	Biológicos	*Antropogénicos*			
Boardings	(Observadores da DRP) ▪ Diversity; ▪ Relative abundance; ▪ Seasonality; ▪ Distribution; ▪ Animal activities; ▪ Breeding; ▪ Animal behaviour; ▪ Size group; ▪ Groups aggregation; ▪ Groups constitution; ▪ Environmental parameters;	*Whale-watching* ▪ Whalewhatching rules, e.g.: boats speed, minimal distance to boats, observation time, etc; *Fishing interactions* (DRP observers) ▪ Cetaceans acidental capture in fishing gears;	All	▪ Cetaceans interactions with whalewatching boats; ▪ Accidental captures in fishing gears;	▪ 1 trip/month in each boat that signed the code of conduct; ▪ To set with Direcção Regional de Pescas (DRP);
Necropsies	▪ Feeding diet; ▪ Pathology; ▪ Genetic; ▪ Parasithology ▪ Morphometry; ▪ Natural history; ▪ Biology;	▪ Acidental capture; ▪ Toxicity levels (heavy metals, etc.) ▪ Ship strikes; ▪ Mortality caused by sewage;	All	▪ Acidental capture in fishing gears; ▪ Heavy metals; ▪ Nautical traffic (ship strikes); ▪ Urban sewage;	▪ Variable (according to the number of stranded animals)