"Spatio-temporal distribution of resident bottlenose dolphins (*Tursiops truncatus*) in the north-east of Sardinia in relation to anthropogenic activities"

Catalina Angel Yunda (830611-015-130)

Niki Karagkouni (860806-422-060)

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Students: Catalina Angel Yunda (830611-015-130)

                           Niki Karagkouni (860806-422-060)

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                           Wageningen University and Research Center

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Supervisors: Rudi Roijackers (Wageningen University and Research Center - AEW)

                           Bruno Díaz López (Bottlenose Dolphin Research Institute – BDRI)

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Abstract

The resident population in the north-east coast of Sardinia has been studied for almost one decade by the Bottlenose Dolphin Research Institute (BDRI). The present study is part of major project carried out by the BDRI called "*Wild dolphins' communication and social lives in Sardinia Island, Italy*" in 2011. This project follows the aim of identifying the relations between the common bottlenose dolphins (*Tursiops truncatus*) and the anthropogenic activities in the area, with an additional description and comparison of two seasons, through the use of GIS. A total of 879 vessel surveys were carried out from February to August 2011, covering a total area of 670.672 Km². In order to find the density of bottlenose dolphins and the density of boat traffic, the area monitored was divided in grid-squares of 25 km^2 and represented by GIS interpolation. The dolphins were present during the whole study period, and exhibited an exclusively distribution in shallow waters (<100m). Due to their opportunistic behavior and their ability to capitalize human activities, dolphins showed high densities at the fish farm area and close to the trawlers. The degree of occurrence was affected by the presence of marine traffic (especially recreational boats in the high season), bringing along a concern of potential threats that this resident population could be facing. Especially in the high season, which concurs with the calving time of the year, the behaviour of the dolphins can be affected by the noise pollution and the increased risk of collisions. *Tursiops truncatus* is classified a "vulnerable" species in the Mediterranean Sea according to the IUCN Red List. Therefore, some conservation insights are presented in order to protect them from this kind of disturbance, or at least mitigate the impacts from anthropogenic activities over the population.

Acknowledgements

This thesis project was, in many ways, a dream come true. We have always imagined the possibility of studying whales and dolphins.

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1   Introduction

This research was part of a long term study "*Wild dolphins' communication and social lives in Sardinia Island, Italy*" to understand the ecology and the social system of Mediterranean common bottlenose dolphins (*Tursiops truncatus*). Distribution patterns of coastal resident dolphins are occurring in north Sardinia carried out by the BDRI (Bottlenose Dolphin Research Institute). The Mediterranean common bottlenose dolphins´ population that is currently at the area of north-eastern Sardinia is been disturbed by anthropogenic activities (fishing, tourism and aquaculture); this affects various aspects of the population such as their behavior and distribution. Knowing and understanding well enough the possible relationships and interactions between dolphin's behaviour along with the disturbing conditions generated by human activity, that enables us to enlighten further our data and make accurate decisions about the conservation and management of bottlenose dolphin populations, particularly regarding the resident community of dolphins present in the area.

This research has been done in sequence to analyze, whether anthropogenic activities might influence the resident community of dolphins (presence and degree of occurrence), taking into consideration the marine traffic. In spite of the wide range of distribution of common bottlenose dolphins, they are usually found on the continental shelf-remains. For this reason it is one of the most involved cetacean species in relations with coastal human activity (Bearzi, 2002). Moreover, dolphins that live in close proximity to man, expose themselves to anthropogenic disturbance and a potential degradation of their habitat (Moscrop, 1993 IN: Ingram & Rogan, 2002). Appropriate data on species distributions of bottlenose dolphins have already been demonstrated to provide useful information in support of a potential discussion for conservation planning (Wilson et al., 1999; Weir et al., 2008). Therefore, if and answer is to be found to the problem and effects of dolphins and anthropogenic interactions, would be a result of understanding general population dynamics and the ecosystem they inhabit. The combination and development of complete studies can offer significant insights on the state of the populations, bringing along possible new management approaches for the conservation of the species.

Finally, GIS (Geographical Information System) is considered as a potential tool to visualize the areas where the resident community of *Tursiops truncatus* and the human activity is present and whether interactions between them are spatially possible.

1.1 General description of the common bottlenose dolphin

Belonging to the family Delphinidae (Table 1), the common bottlenose dolphin (*Tursiops truncatus* Montagu, 1821) is characterized by its robust shape (head and body), relatively short and stubby beak, and a moderately tall and falcate dorsal fin. They present a varying coloration of different scales of gray, with a noticeable lighter ventral pigmentation (Figure 1) (Leatherwood & Reeves, 1983; Read et al., 1993).

Table 1. Taxonomic classification of the common bottlenose dolphin (*Tursiops truncatus*).

Phylum	Chordata
Subphylum	Vertebrata
Class	Mammalia
Order	Cetacea (Brisson, 1762)
Suborder	Odontoceti (Flower, 1867)
Family	Delphinidae (Gray, 1821)
Genus	*Tursiops* (Gervais, 1855)
Specie	*Tursiops truncatus* (Montagu, 1821)

2m
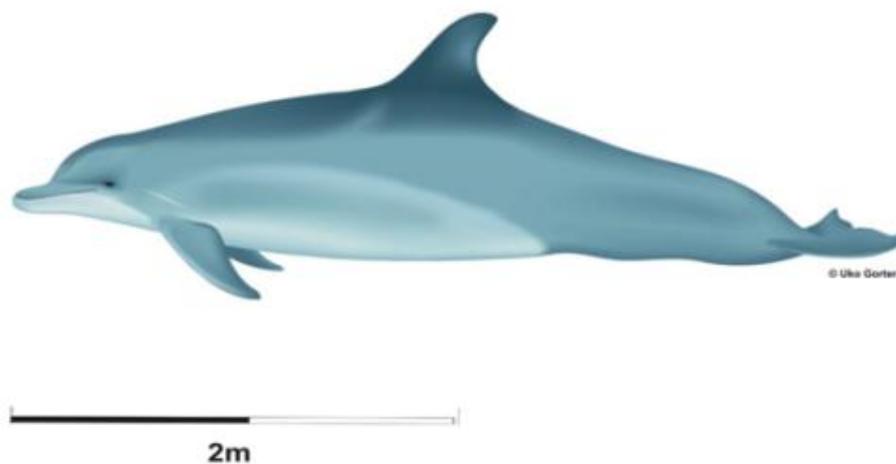
Figure 1. General scheme of common bottlenose dolphin (*Tursiops truncatus*). (Source: Gärtner et al., 2009).

1.2 Distribution, home range and habitat use of the common bottlenose dolphin

Distribution and home-range can be described as the spatial area of an animal´s movement during its everyday activities (Burt, 1943 IN: Ingram & Rogan, 2002). On the other hand, habitat use is the quantification of an animal's use of a habitat type in a specific period of time (Alle at al., 2001). Therefore the distribution, habitat use patterns and home range size, are directly related to features of the animal´s habitat (Balance, 1992).

The common bottlenose dolphin presents an extensive global range of distribution (Figure 2). Characterized also by a powerful ecological flexibility, they are commonly found in coastal waters (< 100 m depth), but also inhabiting cool-temperate environment (> 200 m depth). They are found world-wide in a wide range, inhabiting tropical and temperate coastal waters and seas. Often found in shallow coastal habitats and also showing a clear distribution throughout both the continental shelf and shelf edge (Leatherwood et al., 1983; Williams et al., 1993; Cañadas et al., 2002).
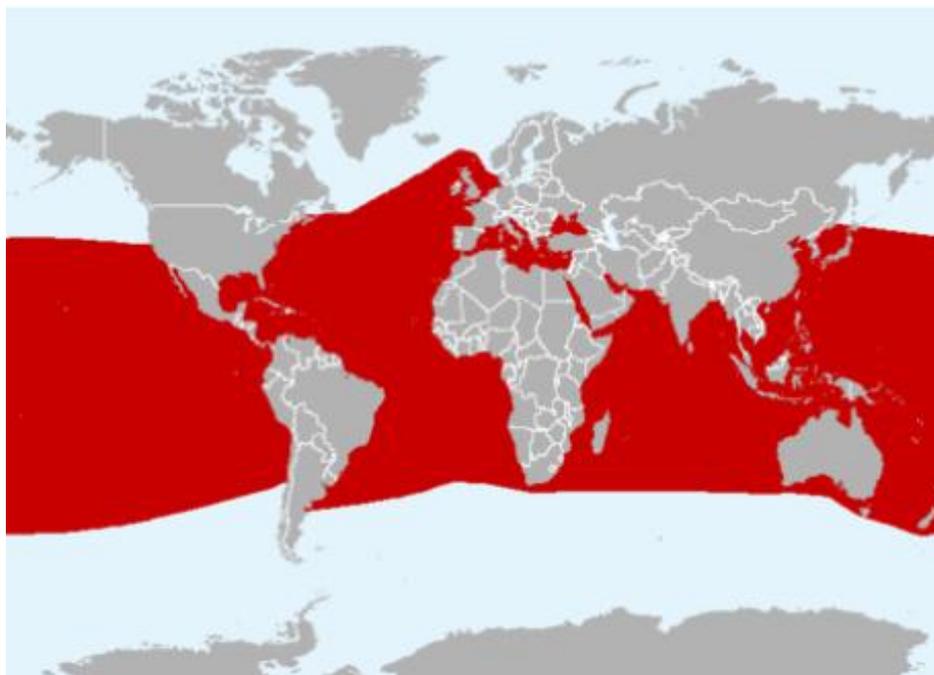
Figure 2. Global distribution of the common bottlenose dolphin (*Tursiops truncatus*), (Source: The IUCN Red List of Threatened Species, 2011 [1]).

In general, bottlenose dolphin populations exhibit extremely variable distribution patterns. The fact that they are top marine predators and they are characterized by their efficient movement, giving them the opportunity to have large home ranges. Moreover they are found in a wide variety of habitats, and therefore the habitat use by resident populations differs between locations (Ingram & Rogan, 2002). Some populations are entirely resident within confined areas, some have shown migratory patterns and others appear to be nomadic and showing seasonal preferences (Reviewed IN: Wilson et al., 1997; Ingram et al., 1999).

Bottlenose dolphins´ large home-ranges of distribution bring along a high diversity of habitats inhabited by populations around the world. These habitats are generally composed of a mosaic of patches which differ from each other physically and biologically. Some patches offer further protection from the elements or from predation; others offer less. Some patches support large concentrations of food and others are barren (Balance, 1992).

Dolphins may prefer habitats for reasons not only associated with foraging (*location and pursuit of prey*) and feeding (*capture and handling of prey*). Habitat use and habitat selection (*whereby selection is proven through the consideration of habitat availabilities in relation to their use*) can be also attributed to reasons associated with social behaviour or predator avoidance (Alle et al., 2001). For these reasons, the habitats and the habitat use of common bottlenose populations around the world vary. For example, in the west coast of Ireland a population has exhibited a preferential use of areas of the estuary with greatest benthic slope and depth (Ingram & Rogan, 2002). In a seasonal way for foraging, a population of dolphins in Florida preferred dredge channels and spoil-islands instead of sea grass habitats, also showing sometimes preference for natural channels (Alle et al., 2001). In the Gulf of California, common bottlenose dolphins have been seen to specialize on estuarine prey, or they may feed in the estuarine areas simply because of the abundance of potential prey that those systems support (Balance, 1992).

Resident communities of several species of whales and dolphins are found in Mediterranean Sea, despite the busy boat traffic, the pollution problems and marine invaders (Hoyt, 2011). Bottlenose dolphins are one of the most frequently observed cetaceans in the Mediterranean.

They have been reported in the waters of Albania, Algeria, Croatia, Cyprus, France, Gibraltar, Greece, Israel, Italy, Montenegro, Slovenia, Spain, Tunisia and Turkey (Figure 3). Many of these Mediterranean areas are subject of intensive human use where gaps of low densities of animals have been reported, for example in the north-western Ligurian Sea (France-Italy) and in the north-western Gulf of Vera (Spain). Variations in density might be related to the habitat characteristics, the local availability of prey and the generally sociable nature of the bottlenose dolphin communities. Furthermore, the distribution of common bottlenose dolphins in Mediterranean Sea is characterized by the ocean floor topography and features as surface salinity (Bearzi et al., 2008).
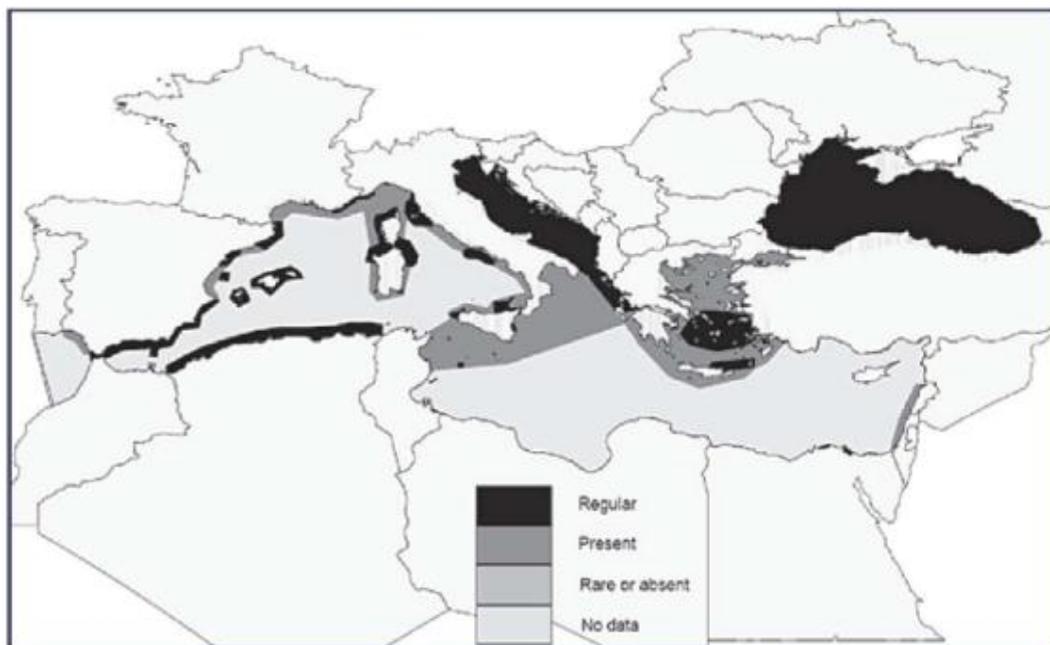
Figure 3. Common bottlenose dolphins' distribution in the Mediterranean Sea. (Adopted from Reeves & Nortarbartolo di Sciara, 2006).

Bottlenose dolphins are present in the north-east coast of Sardinia, Italy all year round. It is a social community of resident individuals which is commonly sighted in the area of the Gulf of Olbia. On the boundaries of this resident community of dolphins, individuals of other communities have been sighted as well. The resident community of dolphins presents a marked composition of groups with not so much of interchange of individuals. This distribution seems to be affected by the amount of food present in the area, enough to sustain

not very big groups, the reason for that is the obvious competition for recourses in the community (Díaz-López, personal communication, 2011).

Additionally, in the area, bottlenose dolphins seem to be attracted by the fish farm area. The reason might be that dolphins adapt unique feeding strategies catching the prey from the fish farm cages, as well as the wild prey around the fish farm area which is present due to the high amount of organic matter. Trawlers and gillnets also attract wild fish, bringing along the opportunity for the dolphins to develop other alternative feeding strategies, which might affect the distribution and enlarge the home range, while increasing the rate of feeding and saving energy from searching for food (Díaz López, 2006a). Opportunistic feeding activities like these reduce the association level among the dolphins, thus the benefit of cooperation decreases (Díaz López & Shirai, 2007).

1.3 Social structure and behaviour of the common bottlenose dolphin

The study of social structures defines an important class of ecological relationships between animals and their nearby co specifics (Whitehead, 1997 IN: Díaz López & Shirai, 2008). Bottlenose dolphins present some specific patterns of association, and are characterized for been animals that live in fission-fusion (FF) societies (Reviewed IN: Connor et al., 2000). FF societies can be described as stable social units in which individual group members are often found alone or in small subgroups and in which subgroup size and composition change frequently over time. Some group members often change subgroups, and should modify grouping patterns in response to varying social and environmental conditions (Díaz López & Shirai, 2008; Smith et al., 2008; Díaz López, 2011). In FF societies, acoustic communication provides a guide for members of a group to gain information about each other in order to interact more effectively (Connor et al., 2000). Hearing is the primary sense of cetaceans, vocal communication plays a very important role in the social structure, especially the one presented by dolphins, which are extremely vocal mammals (Herzing, 2000; Janik, 2009 ALL IN: Díaz López, 2011). They use vocalizations not only to communicate and maintain group cohesion, but also to locate prey and navigate themselves using echolocation (Lusseau &

Higham, 2004). Therefore communication plays an important role in mediating social interactions (Díaz López & Shirai, 2009).

The common presence of *Tursiops truncatus* in coastal areas leads the populations more likely to be in interaction with human activity (Wilson et al., 1997). Along with other threats, anthropogenic factors have been considered as the main causes of the changes in the distribution of bottlenose dolphins in Europe (Sini et al., 2005). Regarding the different types of fisheries, it is important to take into account that bottlenose dolphins can learn to get the fish from trawl nets, gillnets and aquaculture fish cages (Fertl & Leatherwood, 1997). This opportunistic predation behaviour can eventually generate a partial dependence on human activity, triggering conflicts in which both fishermen and dolphins target the same prey in the same area.

In the Mediterranean Sea, the availability for the majority of the fish species takes place in shallow waters near the coast line. Consequently, the fish populations decline from fall to spring because of natural and fishing mortality. As a result the bottlenose dolphin population increases the time they spent in opportunistic feeding activities. In Sardinia, opportunistic feeding in the fish farm area and in gillnets indicates the behavioural flexibility of these animals to capitalize on human activity. Additionally, the seasonal behavioural fluctuations in the fish farm area, mainly in opportunistic feeding, show evidence of a high plasticity in their behaviour as a response to environmental changes and prey availability (Díaz López & Shirai, 2006).

Exploring furrther, behaviour refers to the actions of an organism related to the environment. In the study of dolphins some forms of behaviour have been distinguished to analyze the population´s response according to different inputs created by the environment surrounding (Díaz López & Shirai, 2009). The categories of behaviour change depending on the study (Table 2). Nevertheless, some of the most common forms of behaviour used in the study of bottlenose dolphins are: feeding, traveling and socializing (Shane, 1990; Balance, 1992; Díaz López, 2006a).

Table 2. Different categories of behaviour used in different studies of bottlenose dolphins.

Studies	Shane (1990); Balance (1992); Díaz-López (2006a)	Díaz López & Shirai (2009)	Lusseau & Higham (2004)	Sini et al., (2005)
Behaviour	- Feeding - Resting - Traveling - Socializing	- Predation - Depredation - Traveling - Socializing	- Diving - Resting - Traveling - Socializing - Milling	- Forage - Aerial - Displays - Normal swimming - Milling - Other: socializing, traveling or individual behaviour

Researchers of the BDRI (Bottlenose Dolphin Research Institute) study dolphins' feeding behaviour and how these animals modify their behaviour in order to capitalize on human activity (fisheries and aquaculture). Year-round, on a daily basis, groups of dolphins tend to follow predictable spatial patterns, foraging and socializing onshore. Additionally the influence of the human activity carried in the coast over the population has been observed (Díaz López, 2006a,b; Díaz López et al., 2008a; Díaz López, 2011).

1.4 Threats as a result of the interactions with human activity

All the activities mentioned before involve the presence of different boats and vessels working in the areas where dolphins are present, generating noise disturbance. Together with the threats mentioned before, pollution has an effect on the health and the reproductive capacity of cetaceans. It is very complicated to distinguish the effects when multiple threats can act simultaneously (Reeves et al., 2003; Bearzi et al., 2008).

The degradation of coastal habitats due to the explosion of human development is known to have important effect on cetacean populations (Ferlt & Leatherwood, 1997). Following the

preference for shallow waters, in the Mediterranean basin, bottlenose dolphins tend to be more abundant in habitats within the 100 m isobaths in coastal areas where human activity is concentrated (Sini et al., 2005). These preferences could be related to the feeding habits of the species, preying mostly on benthic and demersal fishes, exposing the species to experience a direct interaction with human activity in these areas.

An example of those coastal activities is the development of the aquaculture industry that has been accompanied by an increase in environmental impacts. Recreational activities in coastal waters, like tourism (including ecotourism), are activities that can also bring pressures over dolphin's populations (Lusseau & Higham, 2004). Some others are related with habitat modification, eutrophication, sedimentation and effects on the food web (Ferlt & Leatherwood, 1997; Díaz López, 2010). On the other hand, chemical pollution is a growing concern since there is the perception that the exposure to contaminants can decrease in a very dramatic way the reproductive performance of cetaceans (Reeves et al., 2003). The presence of large populations and different industries in the coast of the Mediterranean Sea bring along a great amount of pollution from agricultural runoff and seawage, and vessels carrying oil and other risky cargo (Hoyt, 2011).

1.4.1 Fisheries

Incidental catches (by-catch) made by fisheries along history has contributed largely to the decline of marine mammals populations worldwide, and nowadays it is considered one of the most dangerous threats towards cetacean populations (Smith, 1995; Bearzi, 2002; Reeves et al., 2003). With the expansion and growth of the industry, by-catch has become one of the major threats for many species of cetaceans, in such a high degree that in some areas it brought cetacean close to extinction. In addition, some other negative impacts present are injury or mortality from fishermen that see them as competitors, reduction of food prey, habitat loss and/or degradation, and short long term modifications due to the disturbance in their behaviour leading to emigration, dispersion or reduced reproductive rates (Bearzi, 2002). Conflicts between dolphins and fisheries have been identified in many countries around the world. However, these kinds of conflicts are more common in the Mediterranean, especially

in Italy, Spain, Greece, and Tunisia and in coastal areas in the Tyrrhenian Sea and the Gibraltar Strait (Bearzi, 2002; Bearzi et al., 2008). Most interactions are due to the different type of fisheries techniques and nets involved (Table 3).

Table 3. Types of fishing techniques and nets that creates conflicts between the fishery industry and cetaceans in the Mediterranean Sea.

Fisheries techniques and nets	Description	Impacts and threats
Pelagic driftnets	Long-non-selective nets with a strong, loose nylon mesh that can trap almost any kind of marine organism. In the Mediterranean these nets are used by the drift gillnet fishery to capture small pelagic fish, swordfish and albacore.	This fishery has impacted in a very severe way several cetacean populations, especially because of by-catch. Since 2002 in the EU the driftnets have been banned (Bearzi, 2002).
Gillnets / Trammel nets	In the coast of Golfo Aranci (Sardinia, Italy), these nets consist of single or triple nets mounted together on the same frame of ropes.	Entrapment of common bottlenose dolphins has been presented on this kind of nets (Díaz López 2006a).
Bottom gillnets	This fishing gear is used in waters up to 200 m deep, and usually targets demersal and bentho-pelagic organisms.	Some of the cetaceans affected by this gear are usually the harbor porpoises, bottlenose dolphins, humpbacked dolphins and common dolphins, among other species that might get entangled (Bearzi, 2002).
Trawl nets	Towed horizontal or obliquely shaped nets, consist of a cone-shaped net with a cod-end or bag for collecting fish or other target species of demersal and bentho-pelagic organisms.	Affecting a large number of cetaceans, not only with the incidental capture, but also, cetaceans have learned to follow bottom trawlers to take advantage of the fish caught, stirred up or attached by the net, or discarded from the net after trawling, adapting to their presence (Fertl & Leatherwood 1997; Cavaco, 1999; Bearzi, 2002).
Purse seines	This type of net is used in industrialized fisheries to capture different kind of pelagic species (especially tuna -e.g. yellowfin tuna (*Thunus albacores*) in the tropical Pacific-).	In this industry, the association between tuna and dolphins is used to assist in the location and capture of tuna schools. At the moment or trapping the tuna, dolphins may die if they become entangled or trapped in the billows of the net (Bearzi, 2002).
Longlines	Consisting of a series of baited hooks attached to a long, horizontal line by short connecting lines, this net is use to catch a wide variety of fish. In the	Mediterranean reports of cetaceans have been presented, where they get entangled in the line filaments or in other parts of the gear, or get hooked (Bearzi, 2002).

1.4.2 Aquaculture

Increase in marine aquaculture has brought different kind of impacts in cetaceans and generated many type of interactions. Factors like the increase of nutrient levels, complex substrate and provision of food bait in the proximity of the cages may create a favorable environment to attract potential bottlenose dolphin food prey generating opportunistic behaviour in the dolphins, affecting their distribution (Bearzi, 2002; Díaz López & Shirai, 2008). In Golfo Aranci, for example, bottlenose dolphins benefit from feeding around fish farm cages; this relationship seems to be harmful due to the antipredator control method employed (underwater nets) mitigating attacks of bottlenose that can generate incidental captures. Therefore, a "potential impact on top predators as a result of aquaculture interaction is death or injury through entanglement in gear" (Díaz López & Shirai, 2007).

Also, Bottlenose dolphins are known for their behavioural flexibility and their capacity to learn new feeding strategies (Shane et al., 1986). When the dolphins will discover the technique to gain access to the farmed fish, hostility will be expected by fishermen (Bearzi, 2002). Finally it could also indirectly affect their social structure and behaviour (Díaz López & Shirai, 2008). Therefore, the increasing aquaculture in coastal waters calls for a better understanding of its environmental effects (Díaz López et al., 2005;).

1.4.3 Tourism

Proliferation of tourism (including ecotourism) has shown in many studies that the activity brings pressures over dolphin populations in coastal areas, showing also a variety of responses to interactions with this activity. For example, land areas in the coasts of the Mediterranean are visited by 150 million tourists per year (Hoyt, 2011).

One of the effects that have been analyzed is the one generated by the interactions between the dolphins (e.g. *Tursiops* sp.) and the boats use for tourism activity, i.e. some species of marine mammals have shown signs of active avoidance in their behaviour, also presenting changes in group activities and occurrences of stress related behaviours. These can be the

result not only because of the presence of boats, but also boat manoeuvering patterns, such as sudden changes in boat speed or rapid approaches towards the animals (Englund, 2001; Lusseau & Higham, 2004).

1.4.4 Marine traffic

In most of the coastal activities carried by humans, the presence of boats is involved. Therefore, the risk of collision between cetaceans and ships is present. Some of the factors that contribute to this threat are the size of the vessels, their speed, the time of the year, the high marine traffic areas and the behaviour of the marine mammals immediately before the hit. In the Mediterranean the most affected cetaceans reported to be injured or dead by collisions are the fin whales (*Balaenoptera physalus*) and sperm whales (*Physeter macrocephalus*), but also bottlenose dolphins have been reported in accidents. The presence of injuries and scars together with possible internal injuries and deaths are some of the consequences that marine mammals have to face regarding marine traffic (Laist et al., 2001; [2]).

High boat traffic, like the one present in coastal areas, may also lead to the disturbance in bottlenose dolphins. Several populations of dolphins have been observed avoiding boats by increasing the amount of time spent underwater and other responses to these interactions have been studied (Lusseau & Higham, 2004; Sini et al., 2005; Díaz López et al., 2008b).

The Mediterranean represents one percent of the surface waters of the world, yet it has presented a 30% of the worlds ship traffic (Hoyt, 2011). For example, for fishery activities the boats vary (fishing boats and trawlers); in aquaculture there are boats used for feeding and monitoring the cages on fish farms, and for recreational activities inboards, outboards, sailing boats and ferries take part of boat traffic (especially during recreational seasons). All together (Table 4) these boats take an important place in the daily traffic in coastal areas like the north-eastern coast of Sardinia (Underhill, 2006; Underhill et al., 2007; Grassie, 2008).

Table 4. Categorical description of types of boats/vessels based on their use in human activity.

Activity	Type of boat/vessel	Description
Fisheries	Fishing boat	Wooden vessel (7 - 9 m) specializing on gillnet and cephalod line fisheries.
	Trawler	Wooden vessel (14 - 18 m) for offshore fisheries.
Aquaculture	Fish farm boat	Iron or aluminum vessels (12 - 14 m).
Tourism	Inboard	Motor vessel with an external engine.
	Outboard	Motor vessel with an internal engine.
	Sail boat	Vessel of any size with a sail.
	Ferry	Large commercial vessels (approximately 100 m) usually travelling at a cruising speed of 37 kts.

1.5 Conservation of marine mammals

Nowadays cetacean researchers are focusing more on habitat research, realizing that in order to design complete and effective Marine Protected Areas (MPAs) for cetaceans it is important to apply a *precautionary* approach. Furthermore, that the creation of these MPAs has a large impact in conservation issues around the world. Overall, Ecosystem Based Management (EBM) is essential since it includes the uses and the values of ecosystems with the point of view that "it is the escalating human interactions with the ecosystems and the species that need to be managed" (Hoyt, 2011). Regarding dolphins, studies in the United Kingdom (Aberdeen) on Special Areas of Conservation (SACs) have concluded that appropriate conservation measures require monitoring the populations of dolphins throughout their known home-range (Weir et al., 2008). Furthermore, the development of effective population conservation/management plans and the mitigation of potential anthropogenic impacts upon a population depend on knowledge of several factors: 1) the size of the population, 2) population status, and 3) the spatio-temporal distribution of the population (Evans & Hammond, 2004 IN: Weir et al., 2008).

The presence of resident cetacean populations in the Mediterranean waters is surprising despite the intense boat traffic, pollution problems and exotic marine invaders present on the area. Currently, there are several cetacean species in the Mediterranean Sea (Table 5); two

reported as vulnerable, two endangered and one critical endangered according to the UICN (Reeves et al., 2003; Hoyt, 2011).

Table 5. Mediterranean cetaceans belonging to the appendix of Red List UICN. Abbreviations: DD; data deficient, EN; endangered, VU; vulnerable and CR; critically endangered.

Specie	Scientific name	Status
Fin whale	*Balaenoptera physalus*	DD
Short-beaked common dolphin	*Delphinus delphis*	EN
Striped dolphin	*Stenella coeruleoalba*	VU
Common bottlenose dolphin	*Tursiops truncatus*	VU
Risso's dolphin	*Grampus griseus*	DD
Long-finned pilot whale	*Globicephala melas*	DD
Sperm whale	*Physeter macrocephalus*	ED
Cuvier's beaked whale	*Ziphius cavirostris*	DD
*Killer whale	*Orcinus orca*	CR

*Strait of Gibraltar; the specie has not been evaluated yet in terms of Mediterranean Sea.

Bottlenose dolphins in the Mediterranean Sea have been classified as DD (Data Deficient) IUCN category since 2006; in the last IUCN report on the Status of Cetaceans in the Mediterranean and Black Sea the species was classified as Vulnerable. Also listed in the Annex II of the Habitats and Species Directive (Council Directive 92/43/EEC), as a Species of Community Interest "species of community interest whose conservation requires the designation of Special Areas of Conservation (SAC)" (Wilson et al., 1999).

Their proximity to human activity expose common bottlenose dolphins to numerous of threats finding themselves vulnerable to habitat alteration. Therefore, the understanding of the many aspects that characterize these dolphins can form the basis for management that will lead to their conservation. The definition of management units makes it possible to relate specific threats to particular population units, allowing evaluation of potential impacts and provide a focus to mitigation efforts (Connor et al., 2000). Therefore, since it is considered a vulnerable species, this means that it is an endangered species in the area; thus conservation measurements must be taking into consideration and must be based in scientific and long-term research.

2   Objective

The main aim of the thesis project is to analyze any relation, interaction and/or change in bottlenose dolphin distribution and movements in the study area which may be related to the anthropogenic pressures present in that area. Based on a GIS representation of spatio-temporal distribution, the marine traffic will be analyzed, in order to observe how the presence of the different types of boats have a possible influence on the occurrence degree of the coastal resident community in north-east Sardinia (Italy). At the same time, other environmental variables will be analyzed, in order to observe and understand the influences of those variables on the presence of the dolphins in the area.

This information can be used for future reference on species status and will have wider implications for conservation issues regarding human activity and resident populations. An effective conservation program should take into account these findings: the favorable areas for the bottlenose dolphin should be identified and specific protection actions should be taken to conserve the habitat. Specific measures will be recommended to mitigate the possible disturbances regarding boat traffic (presence and density of boats activity).

3   Research questions

This paper will answer the following main question:

- What are the characteristics of the distribution and habitat use of the common bottlenose dolphin population in the study area?
- Are the spatiotemporal distribution and the degree of occurrence of the common bottlenose dolphin population influenced by anthropogenic activities?
- Are there variations in the anthropogenic activities, the presence and the degree of occurrence of the dolphins between seasons?

To answer the main questions, the following sub questions are formulated:

- What is the habitat use of the dolphins in the area?
- Which are the possible interactions between human activity and dolphins?
- What is the presence of boats in the study area (types of vessels and density)?
- Is the presence of boats (representing the human activity) affecting the distribution of the dolphins in the study area?
- Are there seasonal changes in the distribution of the dolphins?
- If there are seasonal changes in the distribution, are they related to boat traffic?
- In each season, which categories of boats are more related to the presence of dolphins?

4   Materials and Methods

4.1   Study area

The Mediterranean Sea (Figure 4) is a mid-latitude semi-enclosed sea, located between southwest of Europe and North of Africa. In the western portion the narrow Strait of Gibraltar limits the inflow of surface waters from the North Atlantic and the outflow of the salty Mediterranean waters. The Mediterranean Sea is covering a surface area of about 2.5 million km² is and mainly characterized by a narrow continental shelf (Robinson et al., 2001; Sherman et al., 2009; Hoyt, 2011).
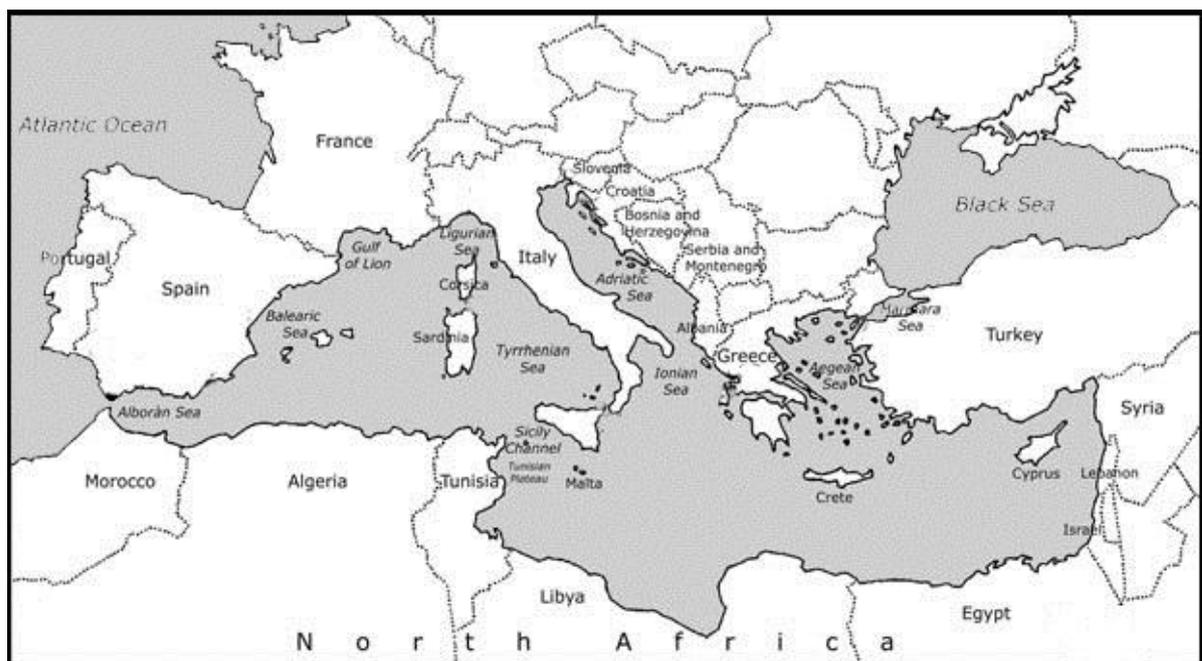

Figure 4. Mediterranean Sea (Modified from Robinson et al., 2001).

Together with the Black Sea, the Mediterranean Sea form one of the eight marine regions of the World. This marine region has two Large Marine Ecosystems (LMEs); one of them is the Mediterranean Sea LME (Hoyt, 2011). It is recognized for its high productivity and number of species that are present in its habitats. Some of the anthropogenic pressures in the marine environment of the Mediterranean Sea include agricultural wastes that pollute the water discharged in the sea, physical changes on the coastline generated by human activity like

tourism, fisheries and aquaculture industries and the increase of the populations in the coastal cities (Sherman et al., 2009).

Spalding et al., (2007) recommended eight eco-regions for the Mediterranean Sea; Adriatic Sea, Aegean Sea, Levantine Sea, Tunisian Plateau/Gulf of Sidra, Ionian Sea, Western Mediterranean, Alboran Sea and the Black Sea. In the Western Mediterranean eco-region, the Island of Sardinia is located in Italian waters. Our study took place along the northeast coast of Sardinia, Italy. This island is characterized for having coasts that are generally high and rocky, stretching for miles with headlands and deep inlets fringed by islands and islets, long beaches with powdery sand. Sardinia's beaches are not just for jet setters and their yachts. Wild, untamed and stretching for miles the beaches of Sardinia are vast and varied, from high craggy cliffs to gentle sweeping dunes and juniper-sheltered coves. In addition to its pristine coastline and due to the varied topography and the warm waters, north-eastern Sardinian waters are a very productive coastal area and contain a rich diversity of marine life (Figure 5) (Díaz López, 2006a).
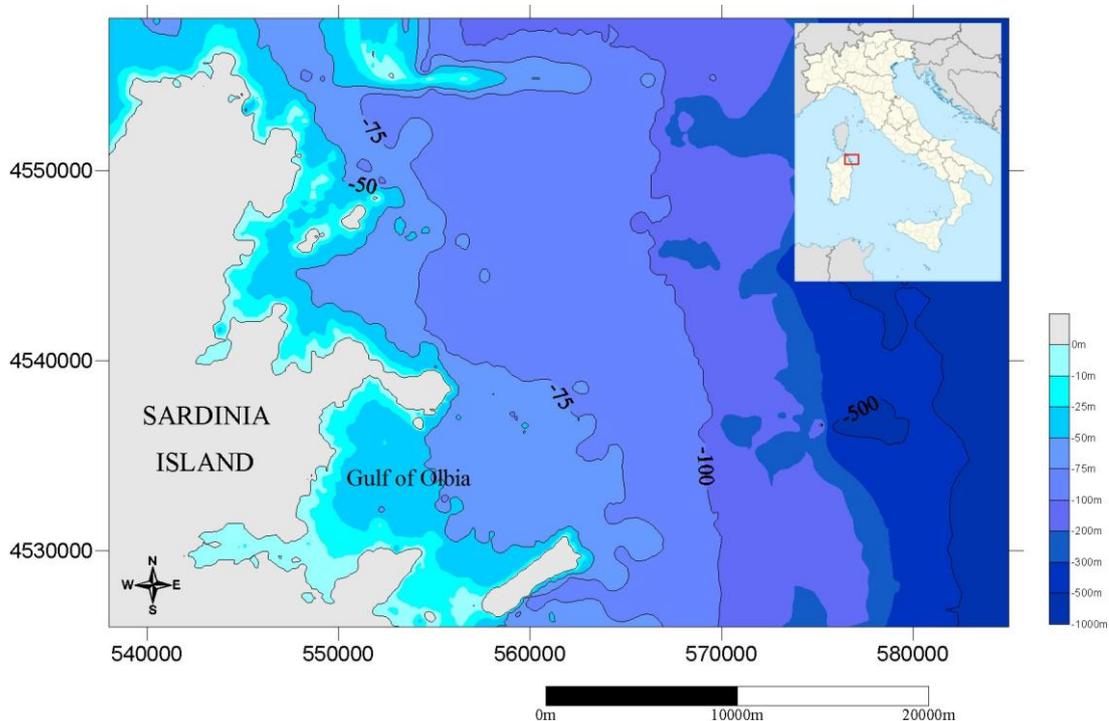
Figure 5. Map of the study area along the north-eastern coast of Sardinia (Italy), showing the bathymetric scale of the area.

4.2 Literature review

The literature review and data collection made part of the ongoing long term study "*Wild dolphins´ communication and social lives in Sardinia Island, Italy*" carried out by the BDRI (Bottlenose Dolphin Research Institute) in the north-eastern coast of Sardinia.

4.3 Field work

During the whole year (2011) an intense fieldwork was carried out in order to gather the data necessary for the project study. From the overall project, specific information was selected from the data collected between February and August 2011 to be analyzed in this research in order to answer the research questions established. The criteria to use this data is basically based on the fact that the data takes at least three months to be stored in the data base, and the data was started to be used by us since August, so it was not possible to include the data collected on September, October and December. Our direct participation in the field work in the study area took place in the BDRI from August until, and including, December 2011; taking part of the onboard surveys, observations, data collection, and laboratory work in the facilities among other activities carried out by the Institute in Sardinia.

4.3.1 Data collection

Boat based surveys (Appendix I) were conducted on board the BDRI vessel (a small 5.5 m motor craft powered by an outboard engine) or the SPARTANA (a large 10 m vessel powered by two inboard engines) on a regular daily basis with direct observations in order to collect information, following the Guidelines for Cetacean-Watching Activities in the Mediterranean Sea (Appendix II). During the surveys, instantaneous sampling of Environmental and Anthropogenic data were recorded every 20 minutes in each survey in order to obtain a general overview of the conditions during the study period. Sampling was conducted in different moments during the daylight hours from 06.00 to 19.00 h. When dolphins where present, sighting data was collected; some of these data was collected in a more frequently (e.g. geopositional data).

Data collected during the surveys:

- General survey information: Date, start/finish time and moment were recorded as solar time, the location (Latitude/Longitude (°) and UTM (m)) was marked every five minutes using a Geographical Position System (GPS; GARMIN e Trex camo), the depth (m) using a fish finder (GARMIN 120), the speed (kts) measured by the GPS and only when the boat was moving.

- Environmental data: The sea conditions were measured by using the Douglas scale (scale which measures the height of the waves) from 1-9, the swell (the direction of the waves) and wind direction measured by using the compass. Wind speed (m/s) was measured by using an anemometer. Visibility was measured on a scale of 1-4 (1 = poor and 4 = excellent). An approximate percentage was used for the cloud covering in the sky. The turbidity of the water was measured by a Secchi Disc (30 cm diameter and 50 m length of rope).

- Anthropogenic data: Information about human activity was collected simultaneously. Different types of boats were counted to describe the marine traffic in the area; fishing boats, fish farm boats, outboards, inboards, sailboats, ferries and trawlers. Also, the fishing nets present in the water were counted and further on deal with as a separate type of boat, for the analysis.

Data collected on sightings:

- General and anthropogenic information was collected with the same methods as in the surveys. Location (Latitude/Longitude (°) and UTM (m)) was marked every three minutes.

- Presence of dolphins: Group size was estimated based on the count of the individuals observed on the surface by counting the minimum number of adults, immature and newborns. Photo-identification data of the dorsal fins of the individuals and videos were used in every sighting.

- Behaviour: Continuous sampling, focal group of individuals and direct observations in the surface during the boat surveys. The duration of each behavioural category/activity performed by a dolphin group during a sighting (focal group sampling) was recorded in notes describing categories of behaviour determinated by the BDRI for the overall project.

4.4 Lab work

All the field observations and data collection were later copied in notebooks and then introduced into the BDRI database (Microsoft Access) for further analysis (Figure 6 and Appendix III).
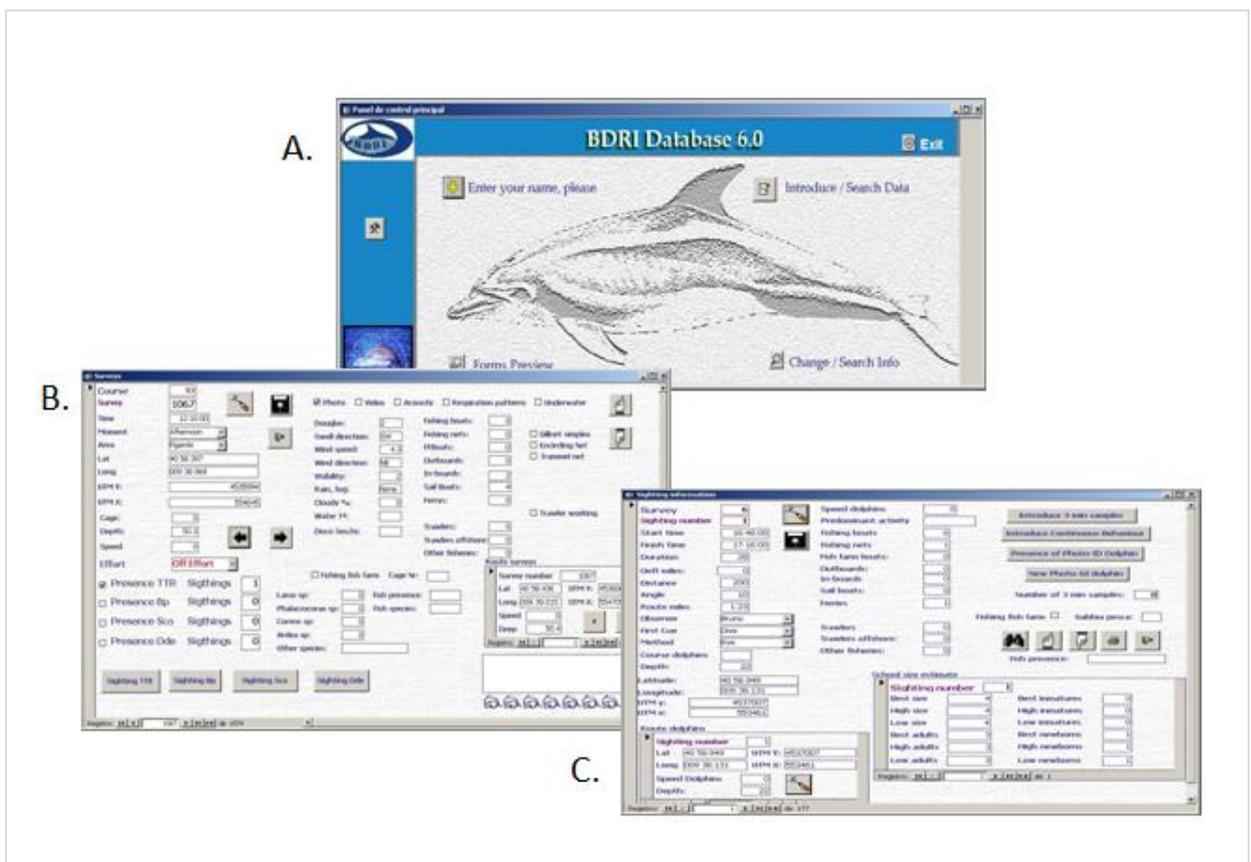
Figure 6. Data copied in BDRI data base; A) general menu view of the database, B) survey entry information and C) sighting entry information.

Photo-identification of individuals: Photo-identification data was used to avoid re-count of individuals, and, sometimes, to increase the minimum number of the individuals that were present to obtain an approximate description of the group size. It is important to take into consideration that immatures and newborns are considered together as calves for the description of the group sizes in this and other studies.

4.5 Data analysis

4.5.1 Surveys and sightings data

After the data had been collected, copied and organized in order to have valid and complete results in the further analysis, a series of tables was created with the data from the surveys and the sightings information in order to proceed with the different analysis in this research. Basically, the data selected was; the general information (GIS position, date and season), the boat information (number of each type of boats) and the information regarding dolphins (total number of dolphins, adults, immatures and newborns).

Sighting data base tables were created in order to show the number of the dolphins that were sighted; the number of the adults and calves (immatures and newborns) were also estimated in order to analyze the presence of dolphins in the area. Regarding the survey tables, the presence and absence of dolphin's information was included in order to analyze the degree of occurrence of dolphins in the area (time spent in the area).

The data was organized i.e. date, moment, area and UTM coordination (X and Y) and the consecutive numbers of the surveys. Environmental data; depth, Douglas scale, wind speed, water temperature and turbidity of the water. Anthropogenic data; the different types of boats where categorized in order to represent different activities and to describe the marine traffic (Table 6).

Table 6. Type of boats and fishing nets selected for the study.

Categorization	Fishing Boat	Recreational Boats	Ferries	Trawlers	Fishing nets
Abbreviation	FB	IB	F	TR	FN
Description	Wooden or fiberglass boat (7 - 9 m) specializing on gillnet and cephalod line fisheries.	Outboards (vessel with external engine), inboards (vessels with internal engine) and sailing boats (Vessel of any size with a sail)	Large commercial vessels (approximately 100 m) usually travelling at a cruising speed of 37 kts.	Wooden vessel (14 - 18 m) for offshore fisheries.	Different types of gillnets

4.5.2   Seasonal data

During the year, anthropogenic activities took place along the coast due to the economic importance of the area (e.g. the presence of the harbor in the Gulf of Olbia). Fisheries, marine aquaculture and tourism were present in the waters of the coastal area. Two periods can be described based on the anthropogenic activities; the low season, considered to be from the end of February until the end of April, characterized by a low presence of human activity (specially low presence of marine traffic) and the high season, considered from the beginning of May until the end of August, where the occurrence of human activity is higher due to summer season (e.g. high presence of recreational boats). It is important to take into account that the presence of these activities involves the constant presence of different types of boats regarding the marine traffic in the area, which will be a crucial point for the analysis of this research.

A temporal analysis was developed in order to observe if there was any difference in distribution, presence and degree of occurrence of the dolphins, between seasons and their relation with the marine traffic in each season.

4.5.3 Descriptive Analysis

For the description of the observation effort, the number of surveys and sightings were counted for the whole study period, also for each of the seasons. Furthermore, the information for the estimation and description of the group sizes, the marine traffic, the sightings and the surveys was organized and represented in tables, graphs and maps for a better representation of the results.

4.5.4 Statistical Analysis

With the statistic program PAST - PAlaeontological STatistics (version 1.34), a descriptive statistical test and Kruskal-Wallis test were used in the general descriptions of group size and marine traffic for the whole period and the description of each season. Also, they were used for the comparison of those aspects between the seasons.

The basic descriptive statistic gave a quick statistical description of the samples, calculating the following statistic parameters: Number of entries of samples (N), lowest value (Min), largest value (Max), mean value (Mean), standard error of the estimate of the mean (Std. error) and the population variance (which is, the variance of the population estimated from the sample) (Hammer et al., 2005).

The non-parametric ANOVA Kruskal-Wallis test was used to compare the medians of the samples. The p value for equality was given to observe if the populations have the same median. This test does not assume normal distribution, but assumes equal-shaped distribution for all the groups of samples (Zar, 1996).

Moreover, with the statistical program PAST, contingency tables were created to measure and give a probability if there is any association of two categorical variables (based on Chi-square). The contingency tables were also used to analyze the possible relations between seasons and the presence of dolphins (defined by the sightings) of dolphins in the study area.

For this analysis, the data of the surveys and sightings were separated in two seasons, in order to obtain and compare two categorical variables (Figure 7).
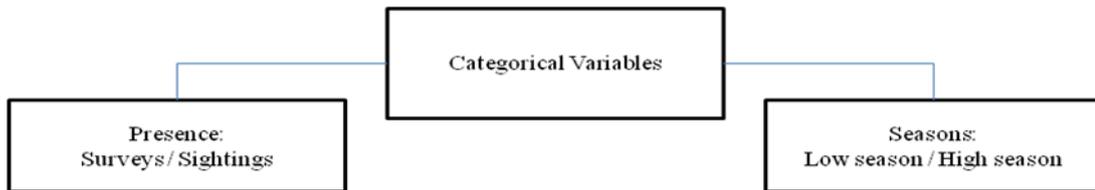

Figure 7. Categorical variables to observe the degree of association between seasons and the presence of dolphins.

Contingency tables were also used to analyze the possible relations between seasons and the degree of occurrence of the dolphins (defined by the surveys with presence). For this analysis, the data of surveys with presence and the surveys with absence of dolphins were separated in seasons, in order to compare two categorical variables (Figure 8).
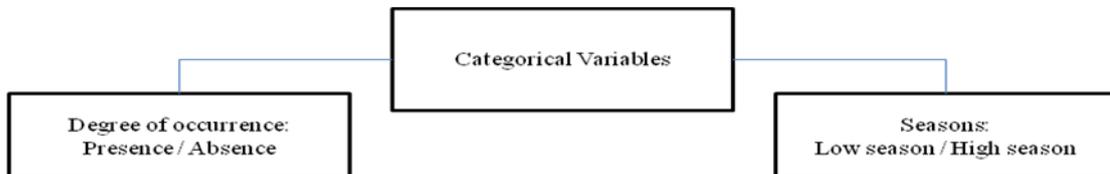
Figure 8. Categorical variables to observe the degree of association between seasons and the degree of occurrence of dolphins.

Finally, in order to analyze the relation between the boat traffic and the degree of occurrence of the dolphins (indicative of the time that the dolphins spend in the monitored area) in the two seasons, four dataset-tables were created with the information on absence and presence of dolphins in the two seasons (Figure 9). The tables were created with a random selection of 100 samples (surveys) to reduce possible bias affecting the analysis, in order to compare the abundance and presence of boats regarding the presence and absence of dolphins in each season. The tables were named after the season/presence or absence of dolphin's organization as follows: Low-Presence (L_PR), Low-Absence (L_AB), High-Presence (H_PR) and High-Absence (H_AB) (Table 7).
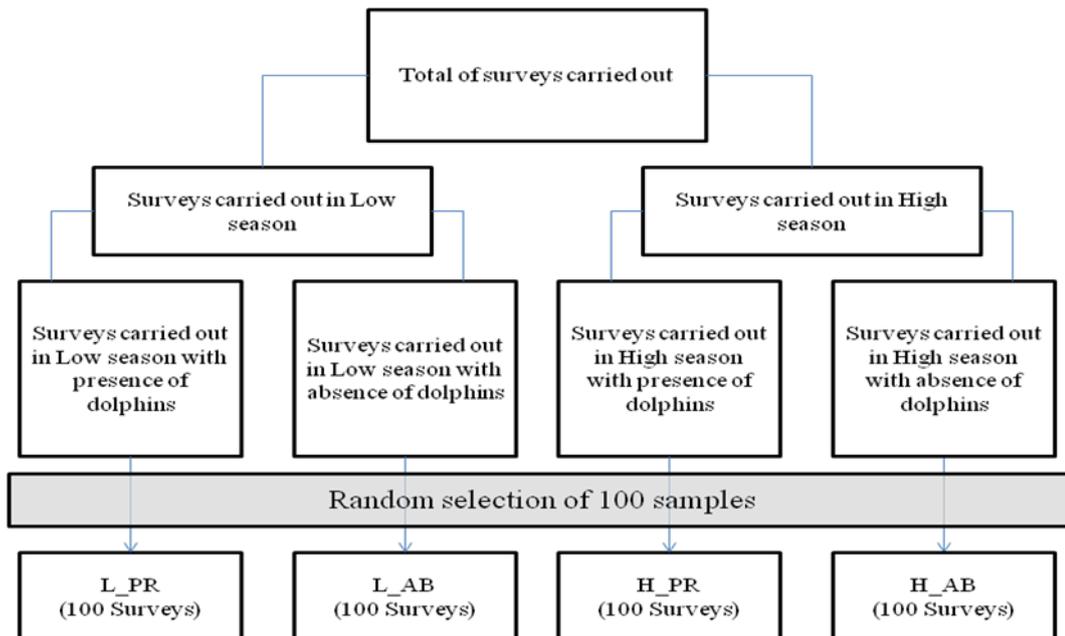
Figure 9. Organization and categorization of data obtained in the surveys to analyze the probability and degree of a relation between the degree of occurrence and each type of vessel in each of the seasons.

Table 7. Datasets based on a random selection for statistical analysis to describe the relation between boats and degree of occurrence of dolphins in each season.

Data sets	Description
Low season and Preset (L_PR)	100 surveys carried out in low season with presence of dolphins, plus boat information.
Low season and Absent (L_AB)	100 surveys carried out in low season with absence of dolphins, plus boat information.
High season and Present (H_PR)	100 surveys carried out in high season with presence of dolphins, plus boat information.
High season and Absent (H_AB)	100 surveys carried out in high season with absence of dolphins, plus boat information.

From each of the four tables of the random selected samples, the boat information was statistically analyzed; comparing each category of boats with a univariate test and Kruskal-Wallis test in order to see the probability and degree of a relation between the degree of occurrence of the dolphins and each type of vessel in each of the seasons.

4.6   GIS

Geographic information systems (GIS) have been used in the past few years as a tool for understanding the distribution of marine mammals. The use of GIS presents an enormous spatiotemporal complexity since it is almost guaranteed that the results of cetacean sighting surveys conducted at discrete locations and times are been influenced by external factors (environmental, biotic, and/or anthropogenic) (Davis et al., 1998 IN: Vigness-Raposa, 2003). Various studies have used GIS to explore the relationship between cetacean distribution and the previous mentioned external factors, in an attempt to characterize and predict habitat use and to analyze possible relations. In this research most of the information collected, was organized and used through GIS programs, in order to have a clear visual presentation of the results.

A representation in GIS was done in order to describe the results of the relations between anthropogenic activities (represented by the different categories of boats and fishing nets) and the presence and distribution of dolphins during the whole year, also to represent the differences between the two periods in different parts of the area.

4.6.1   Representative maps

For the background map of the study area, including the surface level and different levels of isobaths, apart from the data of the year 2011, were used older data and positions elaborated by the BDRI, in order to create a more accurate map. For the creation of the MAP with GIS, the positional data were included in UTM coordination (X, Y and Z). To create this background map and the different shape files (type of files for further use in the GIS programs) of the isobaths we used the program SURFER 8®. This program is a Powerful Contouring, Gridding, and Surface Mapping Package for Scientists and Engineers.

With help of the Quantum GIS (Free and Open Source Software GIS Application), a representation of the number or surveys and sightings was made in order to visualize the observation effort made during the whole study period. In the same way, maps were created to

show the distribution of the sightings as a function of the group size, i.e. for the total groups sighted, the adults and calves. Furthermore, maps were created to show the groups conformed only by adults and the groups with at least one calf present.

4.6.2 Distribution maps

For the distribution maps, the program Quantum GIS was used to create a grid of 5000 m (area of 25 Km² per square). The criterion for this grid was basically to avoid the bias that could influence the representation of the surveys, since the surveys where carried out every 20 minutes with a speed of about 4 kts/h, and therefore the approximated distance covered within this time was 2500 m.

Data collection is usually conducted only in a limited number of selected point locations in the research areas. In GIS, spatial interpolation of these points can be applied to create a raster surface with estimates made for all raster cells (Sutton et al., 2009). In this research, for the representation of the dolphin's distribution and the distribution of the different categories of boats in the area, the data were prepared for a spatial interpolation.

For the representation of the dolphin's distribution, in each square of the grid, a density was estimated based on the total surveys with presence of dolphins over the total surveys carried out in each square, locating this value in the middle position (X and Y) of the square (Figure 10). In this way, the grid was prepared for an interpolation to represent the data in a map.
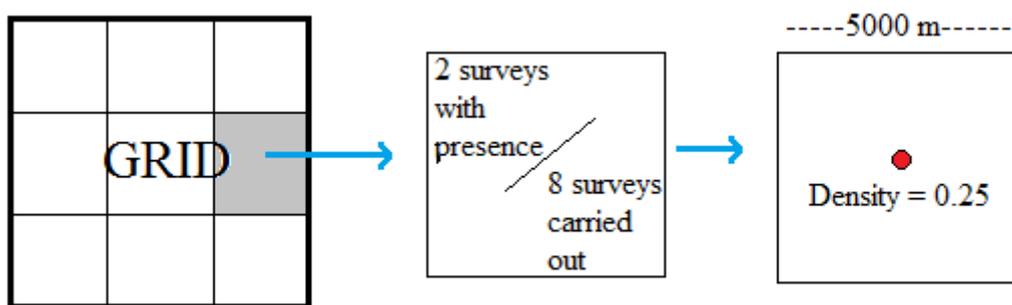
Figure 10. Preparation of the grid for the representation of dolphins' distribution in the area.

For the representation of the marine traffic distribution, for each category of boat in each square of the grid, the average was calculated based on the total of surveys carried out in each square, locating this value in the middle position (X and Y) of the square (Figure 11). In this way the grid was prepared for an interpolation to represent the data in a map for each type of boat category.
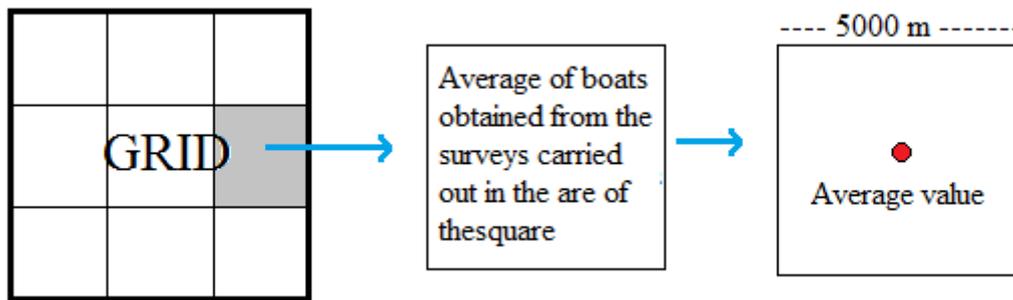
Figure 11. Preparation of the grid for the representation of the boat distribution.

After the data preparation, an interpolation was made as part of spatial analysis to represent the distribution of dolphins and marine traffic in the area. This spatial interpolation is the process of using points with known values to estimate values at other unknown points (Sutton et al., 2009). Therefore, the interpolations were created to represent the distributions of the points, which prepared previously, in each square of the grid, estimating the values of the rest of the points in the area.

For the interpolation process (Figure 12; example of interpolation for dolphins presence based on a calculated density) we created A) a base of the study area including the bathymetric scale, B) we located the total number of surveys and the surveys with presence based on the GIS information obtained on the field, C) a grid counting of total of surveys and surveys with presence per grid-square, D) calculated density value per grid-square and E) interpolation (from red: high to blue: low).
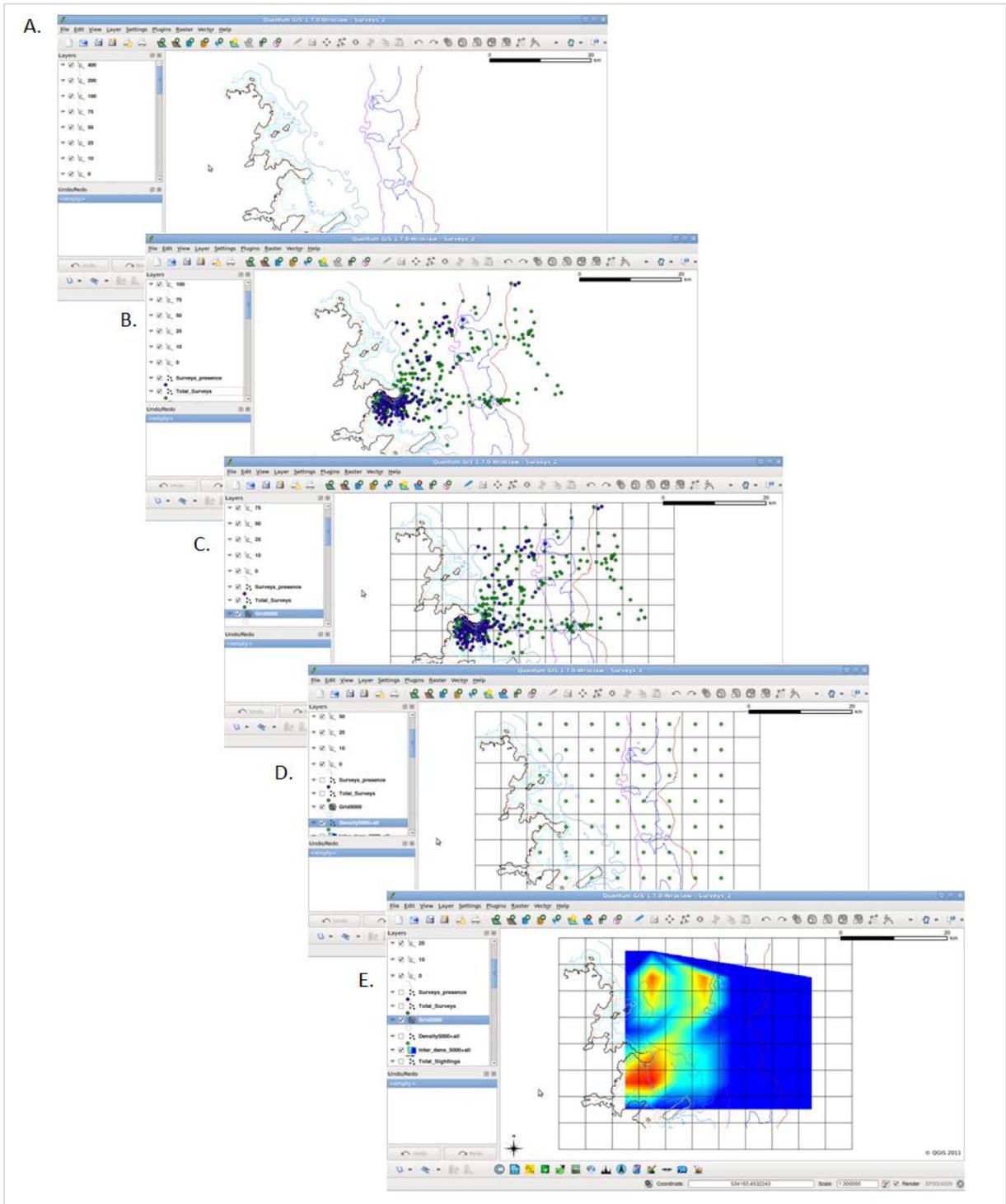
Figure 12. Example of the interpolation process; creation of interpolation maps to show the distribution of dolphins and boats in the area with spatial interpolation in GIS.

5 Results

5.1 General description

The observation effort for the whole study period consisted of 879 surveys that were carried out between February and August 2011 in the study area; covering a total of 670.672 Km² monitored. A total of 143 sightings of common bottlenose dolphins (*Tursiops truncatus*) were registered for the whole period of the study (Figure 13).

A.

B.
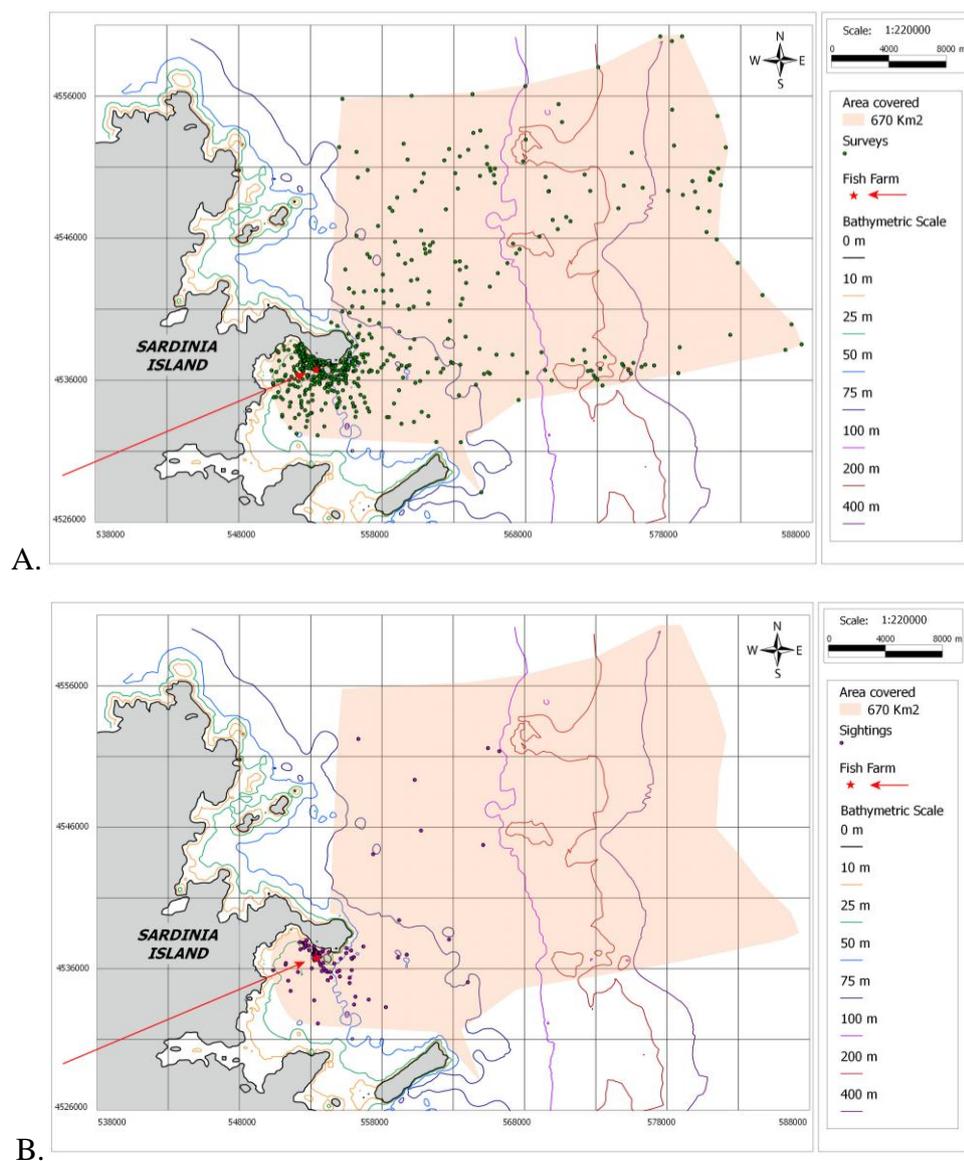
Figure 13. Observation effort: Showing the total area covered in the study. A) total surveys of carried out in the study area B) total sightings of bottlenose dolphins.

The total group size ranged from one single individual to groups of 18 dolphins showing a mean group size of 4.97 ± 0.25 individuals. Adults were present in a high percentage (71%) meanwhile calves (immatures and newborns) were present in lower numbers (Figure 14). The mean group size for adults was 3.46 ± 0.17, for immatures 1.21 ± 0.10 and for new born dolphins 0.15 ± 0.03. The three groups (adults, immatures and newborns), are independent from each other (Kruskal-Wallis $p < 0.05$).
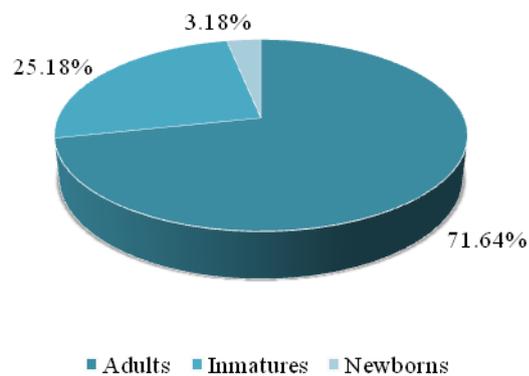
Figure 14. Percentages of the total group size (Adults, immatures and newborns).

During the whole period of the study the presence of adults was always high; groups of adults only (40 sightings, 27.97%) were also observed, the maximum number of members in these adult groups was 12 individuals. Nevertheless, it was more common to have sightings of groups with young individuals (103 sightings, 72.03%); the number of immatures and/or calves usually was two or three in the group.

Regarding anthropogenic activities, analyzing the marine traffic during the whole study period we could observe a high presence of recreational boats (67.53%) with a mean of 6.56 ± 0.28 in the area, followed by fishing boats (19.01%) and less ferries and trawlers (Figure 15 and Table 8). The different types of boats are independent from each other (Kruskal-Wallis $p < 0.05$). Furthermore, fishing nets were present (0.54 ± 0.03) during the whole period of study with a significant value.
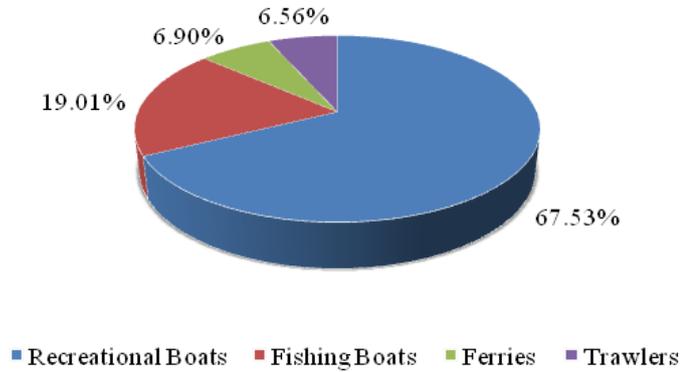
Figure 15. Percentages of presence of boats in the whole study.

Table 8. Univariate test for statistical description of the group sizes in the whole study period. Abbreviations; FB: Fishing boats, TR: Trawlers, RB: Recreational boats and F: Ferries.

|	FB	TR	RB	F
N (surveys)	879	879	879	879
Min/survey	0	0	0	0
Max/survey	18	6	61	5
Sum	1623	560	5766	589
Mean/survey	1.85±0.08	0.64±0.04	6.56±0.28	0.67±0.03

In general recreational boats and fishing boats appear to have a constant, predominant and significative presence in the area; ferries and trawlers both appear in low numbers, presenting more occasionally in the area throughout the year.

5.2   Description and comparison of the two seasons

Regarding the two seasons analyzed in this research, a total of 456 surveys (82 sightings) were carried out in the low season during the months from February to April, and a total of 423 surveys (61 sightings) for the high season during the months from May until August.

Regarding the seasonal group size, in the low and high season there was a high presence of adults (69.43% and 75.39%) in the sightings. The total mean group best size in low season is 5.49 ± 0.29, 3.68 ± 0.20 for adults, 1.51 ± 0.14 for immatures and 0.11 ± 0.04 for new born

dolphins. In the high season the total mean group best size is 4.28 ± 0.41, for adults is 3.16 ± 0.30, for immatures 0.82 ± 0.11 and for new born dolphins is 0.21 ± 0.06 (Figure 16 and Table 9). The Kruskal-Wallis test showed (p = 4.814 E -47 and p = 3.22 E-30 < 0.05 for low and high season respectively) that the population in general is not being affected by the seasons.

A.

B.
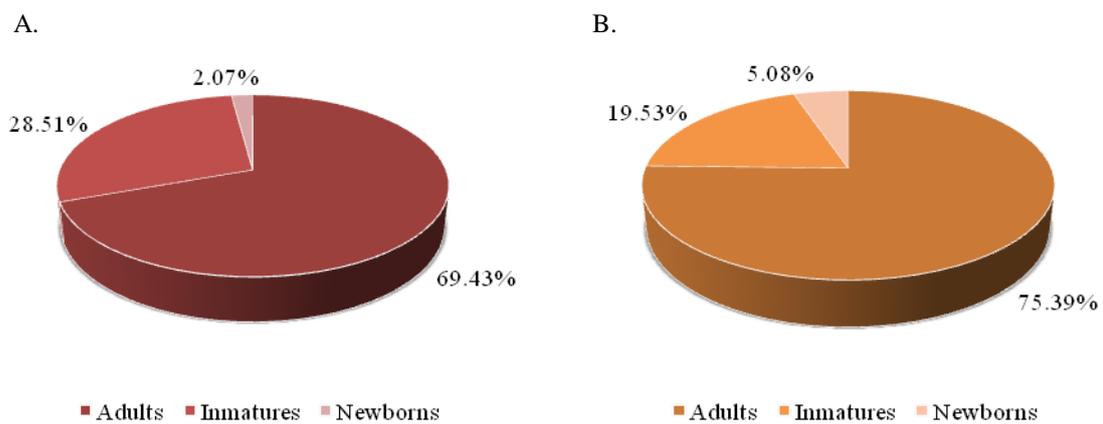
Figure 16. Percentages of the group sizes; A) low season and B) high season.

Table 8. Univariate test for statistical description of the group sizes in low and high season.

|	Total	Adults	Immatures	Newborns
Low season				
N (sightings)	82	82	82	82
Min / sightings	1	0	0	0
Max / sightings	13	8	5	2
Sum	450	302	124	9
Mean / sightings	5.49±0.29	3.68±0.20	1.51±0.14	0.11±0.04
High season				
N (sightings)	61	61	61	61
Min / sightings	1	0	0	0
Max / sightings	18	15	3	2
Sum	261	193	50	13
Mean / sightings	4.28±0.41	3.16±0.30	0.82±0.11	0.21±0.06

Nevertheless, newborns in the high seasons presented a higher mean, but this was not significant (Kruskal-Wallis test: p = 0.27 > 0.05), meaning that the newborns group size

between seasons differ, therefore there is a relation between high season and the high presence of newborns in this time of the year. No significative differences between seasons regarding the rest of the mean group sizes (adults and immatures) (Figure 17).
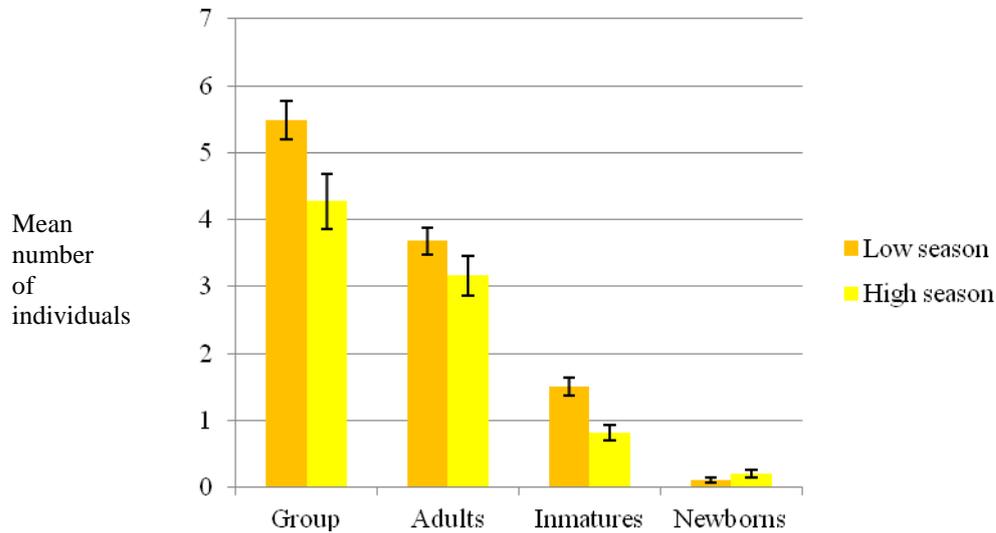
Figure 17. Comparison of means of group sizes between the two seasons. Error bars represent standard error.

Regarding marine traffic in the low season the presence of fishing boats and recreational boats was high (41% and 40% respectively), while trawlers and ferries were present in lower numbers. In high season the presence of recreational boats increased dramatically in number (79%), whereas the presence of the other three categories was lower in this season (Figure 18).
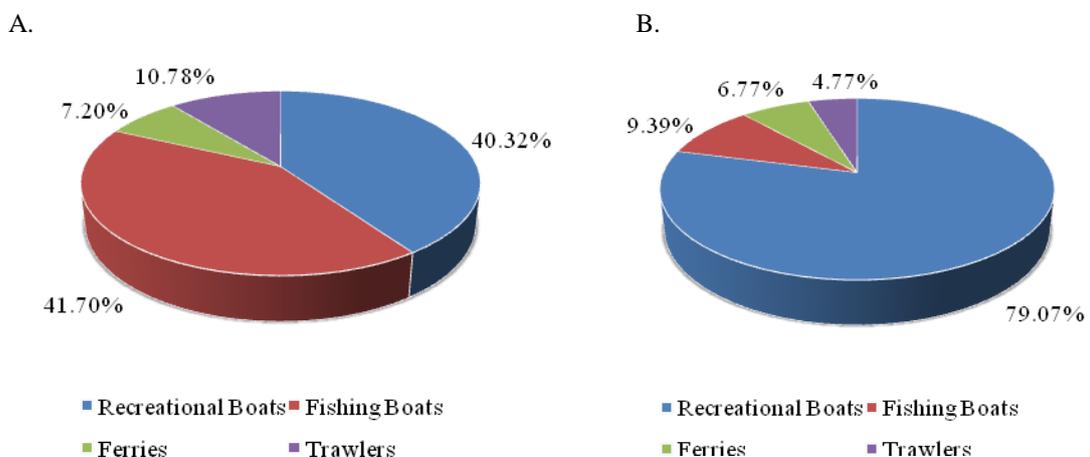
**Figure 18.** Percentages of boats; A) low season and B) high season.

In the low season the mean of fishing boats and recreational boats were high and very similar (2.31 ± 0.13 and 2.25 ± 0.08 respectively), followed by trawlers and ferries. In the high season the mean of recreational was very high (11.21 ± 0.48) and the other three categories present lower means (Table 10). The types of boats remained independent from each other in the two seasons (Kruskal-Wallis $p = 1.336 \, E \, -106$ and $p = 6.446 \, E \, -155 < 0.05$ for low and high season respectively). Moreover, there were more fishing nets in the low season and less in high season (mean of 0.66 ± 0.04 and 0.41 ± 0.03 respectively); nevertheless they were present in the area during the whole period of study, since this type of fishery is common in the region and it is an activity of economical importance for the people in the area.

Table 10. Univariate test for statistical description of the different categories of boats in low and high season. Abbreviations; FB: Fishing boats, TR: Trawlers, RC: Recreational boats and F: Ferries.

	Low season				High season			
	FB	**TR**	**RC**	**F**	**FB**	**TR**	**RC**	**F**
N (surveys)	456	456	456	456	423	423	423	423
Min / surveys	0	0	0	0	0	0	0	0
Max / surveys	18	6	11	5	17	5	61	4
Sum	1060	274	1025	183	563	286	4741	406
Mean / surveys	2.32±0.13	0.60±0.05	2.25±0.08	0.40±0.03	1.33±0.10	0.68±0.06	11.21±0.48	0.96±0.05

For marine traffic each category of boats was also compared between seasons. Recreational boats show a high and significative presence in both seasons (41% in the low season and 79% in the high season), the drastically high presence of recreational boats (11.21 ± 0.48) in high season is due to the increase of tourism in the area in summer time (Figure 19). For all the categories of boats during the whole period of the study Kruskal-Wallis test showed a high significance in the results, meaning that they remain independent from each other and from the seasons. Except for trawlers (Kruskal-Wallis $p = 0.88 > 0.05$); this boats were constantly present since in Golfo Aranci there are only eight trawlers working in the study area all year long (Table 11).
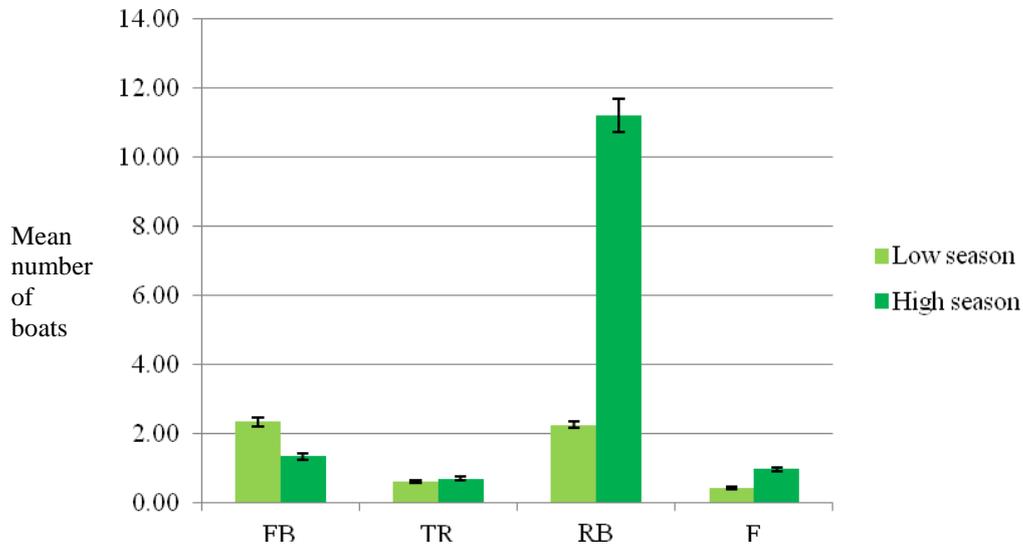
Figure19. Comparison of the means of each category of boats between seasons. Error bars represent standard error. Abbreviations; FB: Fishing boats, TR: Trawlers, RB: Recreational boats and F: Ferries.

Table 11. Comparison of each type of boats between seasons with the Kruskal-Wallis test.

Boats	Kruskal-Wallis (p)
Recreational boats	0.00
Fishing boats	0.00
Ferries	0.00
Trawlers	0.88

5.3 Relations between seasons, presence and degree of occurrence

In general dolphins were present during the whole period of study. Based on the total of surveys and the total of sightings in both seasons (Table 12) there is not a significant degree of association between the presence of dolphins (sightings) and either of the two seasons (contingency table: Chi square p = 0.225 > 0.05).

Table 12. Contingency table for association of categorical variables: presence of dolphins and seasons.

Presence/Season	Low Season	High Season
Surveys	456	423
Sightings	82	61

Since the presence of dolphins was included in the surveys (independently from the sightings) the degree of occurrence was analyzed. There is a significant degree of association and relation between the degree of occurrence of dolphins (time spent in the water; based on their presence/absence) and either of the seasons (contingency table: Chi square $p = 0.00134 < 0.05$) (Table 13). In the low season the degree of occurrence was higher than in the high season, even with fewer surveys carried out and a smaller area monitored.

Table 13. Contingency table for association of categorical variables: degree of occurrence of dolphins and seasons.

| Degree of occurrence/Season	Low Season	High Season
Surveys with presence	239	176
Surveys with absence	217	247

5.4 Relations of boat traffic and degree of occurrence of dolphins between and within the two seasons

The presence of common bottlenose dolphins was not to be affected by the marine traffic, but their degree of occurrence does. By comparing the presence of each type of boat in each of the seasons in presence and absence of dolphins the results show a clear relation of recreational boats p-value <0.05 with the presence and absence of dolphins in both seasons (Table 14).

Table 14. Comparison of the different boat categories in presence and absence in low season. Highlighting the results of recreational boats in the Kruskal-Wallis test.

| Low season	Fishing boats		Recreational boats		Ferries		Trawlers	
	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence
N (surveys)	100	100	100	100	100	100	100	100
Min/surveys	0	0	0	0	0	0	0	0
Max/surveys	11	11	8	7	3	5	4	5
Sum	233	206	265	196	33	59	69	57
Mean/surveys	2.33±0.26	2.06±0.23	2.65±0.20	1.96±0.14	0.33±0.06	0.59±0.09	0.69±0.10	0.57±0.10
Kruskal-Wallis (p)	0.58		0.01		0.07		0.18	
High season	Fishing boats		Recreational boats		Ferries		Trawlers	
	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence
N (surveys)	100	100	100	100	100	100	100	100
Min/surveys	0	0	1	0	0	0	0	0
Max/surveys	11	8	42	47	4	4	5	5
Sum	147	112	1291	985	91	101	77	66
Mean/surveys	1.47±0.19	1.12±0.16	12.91±0.96	9.85±0.98	0.91±0.52	1.01±0.11	0.77±0.13	0.66±0.12
Kruskal-Wallis (p)	0.18		0		0.52		0.81	

Analyzing the different types of boats, based on the presence of the dolphins (Figure 20), we found an evident and significant presence of recreational boats (Kruskal-Wallis $p < 0.05$); nevertheless dolphins are still present when the number of boats is high in both seasons. Recreational boats seem to be attracted by the dolphins and affecting, in a very strong way, the time that the animals spend in the area.
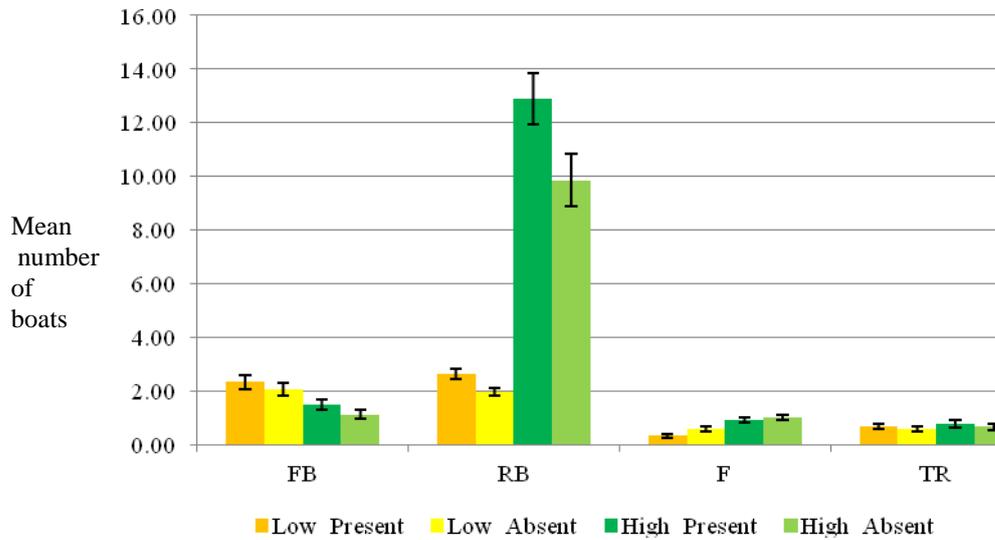
Figure 20. Comparison of the mean for each type of boat in presence of dolphins in low and high season. Error bars represent standard error. Abbreviations; FB: Fishing boats, TR: Trawlers, RC: Recreational boats and F: Ferries.

5.5   Distribution of common bottlenose dolphins

Common bottlenose dolphins were present in the area during the whole term of the study, which confirms that they are a resident population in the north-east of Sardinia. Based on the surveys with presence of dolphins, the interpolation showed the bottlenose dolphin preference for shallow waters (<100 m depth) in the study area, with a constant presence close to the fish farm and its surrounding area. There is also a clear absence of dolphins offshore (>100 m). Because of their opportunistic feeding behaviour, bottlenose dolphins are present in the area close to the fish farm where levels of nutrients and organic matter are high and therefore a presence of prey resources exist. Also a high density is seen in the north coastal area, where sometimes there was presence of dolphins from another "population"/social community (Figure 21).
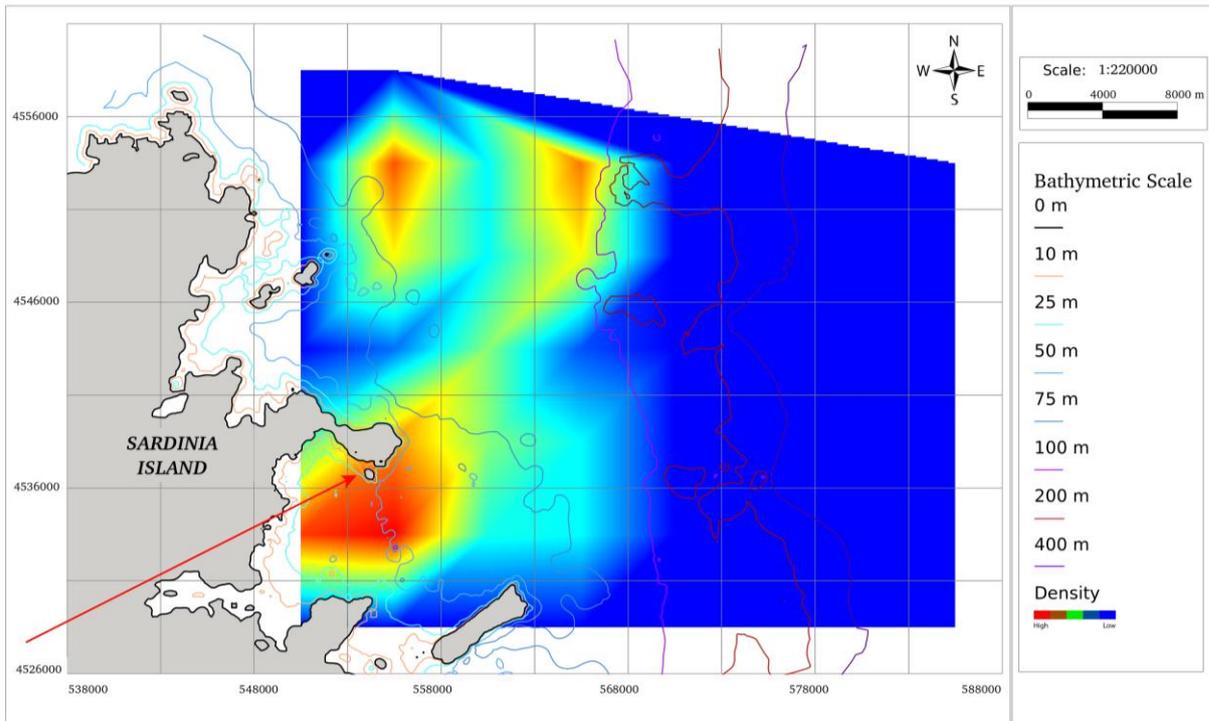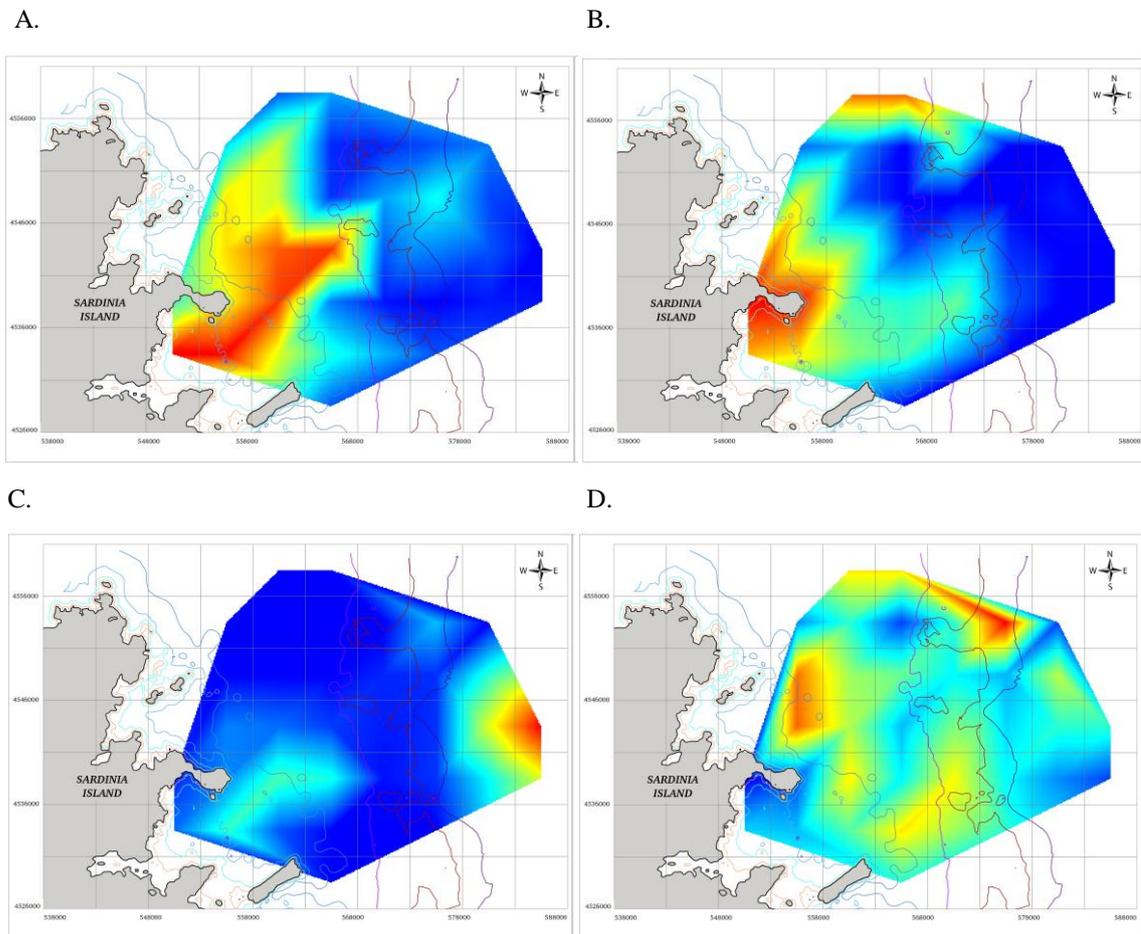
Figure 21. Map showing the distribution of the common bottlenose dolphins based on the density in the study area for the whole period of study. Fish Farm pointed by the red arrow.

5.6   Distribution of anthropogenic activities

A general visualization of the situation regarding boat traffic and anthropogenic activities: Fishing Boats, Recreational Boats (Outboards, Inboards and Sailing boats), Ferries and Trawlers are given by Figure 22.

According to the maps, it is evident that during the whole year there is a high density of Recreational boats in the same area as the dolphins are present; close to the coast and the fish farm area. Showing that the Recreational boats are attracted from the presence of the dolphins while stay at the same area. Moreover, the density of the Fishing boats is high in the same area, as well. It is clear that this sector has been affected by the aquaculture. Due to the high levels of nutrients and organic matter, has been created a favorable environment for the wild fish population. On the other hand, the highest density of presence of Trawlers is usually offshore (>100m depth) but the possibility of working close to the coast can affect the

distribution of the dolphins. Also, the presence of the Ferries and the route that follow is constant all over the year, having no relation with the distribution of the dolphins.

A.

B.

C.

D.

Figure 22. Maps showing the distribution of the different categories of boats to describe marine traffic in the area for the whole period of the study based on their average; A) Recreational boats, B) Fishing boats, C) Trawlers and D) Ferries (For legends refer to figure 21).

Finally, there is presence of fishing nets close to the coast during the whole year, which can affect the dolphins' distribution (Figure 23).
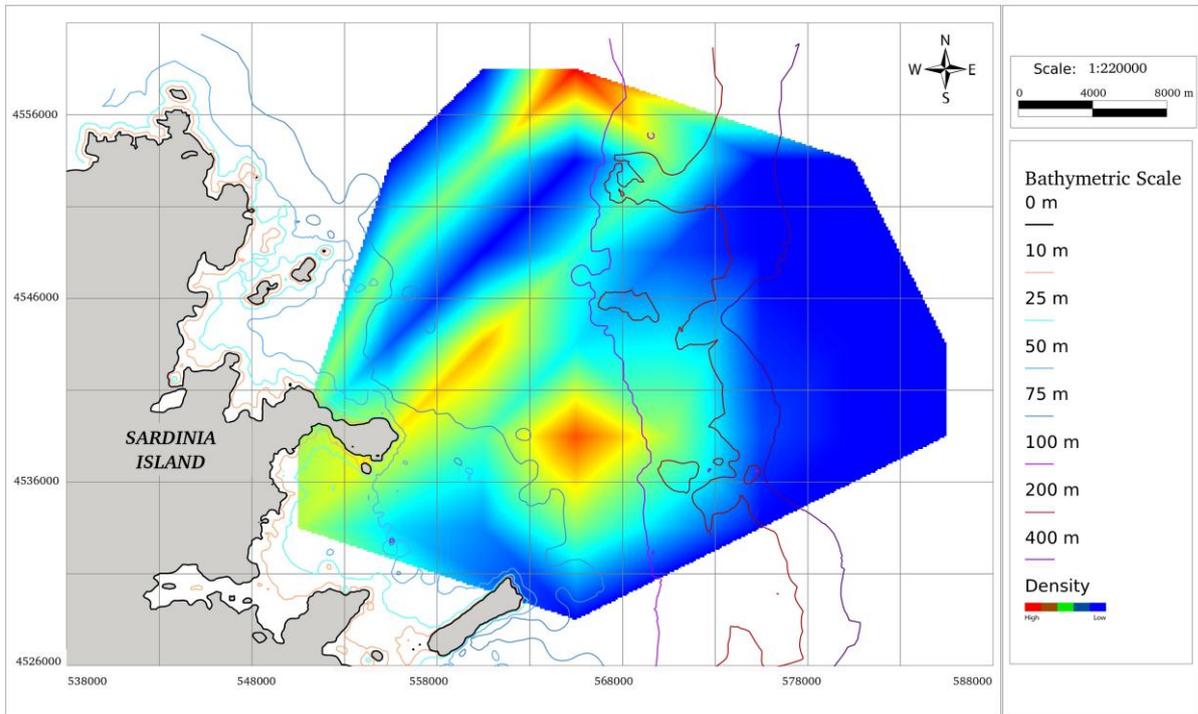
Figure 23. Map showing the distribution of the fishing nets in the area for the whole period of the study based on their average.

5.7 Seasonal distribution of common bottlenose dolphins

Due to bad weather conditions a small part of the study area (42.9% = 153.576 Km² of 670.672 Km²) was monitored during low season, with a total number of 456 surveys (30 days) and 82 sightings. Therefore the presence of dolphins was restricted to the monitored area. During high season bigger area was monitored (97.1% = 643.183 Km² of 670.672 Km²), with a total of 423 surveys (29 days) and 61 sightings. Furthermore in high season, the dolphins show a broader distribution, showing presence in the north part of the study area and one time present in offshore waters. During the low and the high season, there is not a remarkable change on the distribution of the density of the different type of boats. Nevertheless, there is a difference on the maps of the Trawlers and the Fishing nets, where the density in the low season seems to be higher closer to the coastal area. These results can be influenced evidently by the less monitored area during the low season (Appendix IV).

6 Discussion

6.1 Bottlenose dolphins in Sardinia

The study area is a broad area with an evident presence of common bottlenose dolphins reflected in the 143 of sightings during the study period and the fact that the sightings were similar between the two selected seasons. In this study, a resident population of *Tursiops truncatus* in the north-eastern Sardinia has been recognized, consisting of 20 individuals approximately. In previous studies (Díaz López, 2006a), these individuals have been identified with the help of the photo-identification methods. Nevertheless, in this research, it was not possible to confirm this number of individuals since we did not implement a complete photo-identification process.

The group size of the population ranged from one single individual to groups of 18 dolphins. The group size can vary according to the biogeographical region, prey available in the area, activity and other factors (Bearzi et al., 2008). This resident population present a mean group size of 4.97 ± 0.25, similar and consistent to those reported for the population in the study area or other populations in the Mediterranean Sea (4.95 ± 0.3) (Díaz López et al., 2005; Díaz López, 2006a). This indicates the constant presence of small groups of dolphins, probably because of the availability and the distribution of food resources in the area. There was not any significative difference between the two seasons regarding the mean sizes; thus, the group size remains almost the same in both seasons. However, it is remarkable that the newborns in high seasons presented a higher mean group size (0.21 ± 0.06) than in low season (0.11 ± 0.04). The high season, especially the months of April, May and June, concurs with the calving season as has also been mentioned in other studies in temperate waters (Fernandez & Hohn, 1998). Also, Grellier et al. (2003) has confirmed our observations, that calves up to seven years old were often found spending most of their time in a close proximity to their mother.

6.2 Distribution, home-range and habitat use

In general the dolphins were present in shallow waters and clearly absent offshore (>100 m depth), confirming that this resident community of bottlenose dolphins correspond to the neritic or coastal ecotype. Gnone et al., (2005) investigating the distribution of bottlenose dolphins (*Tursiops truncatus*) along the Italian peninsula for 18 years (1986-2002), found that there is a strong positive correlation with the extent of the continental shelf facing the coast line, suggesting that bottlenose dolphins tend to be more abundant in shallow waters areas (<100 m isobath). Moreover, because of their opportunistic behaviour for feeding, bottlenose dolphins were present in the area close to the fish farm in the Gulf of Olbia, where levels of nutrients and organic matter are high, as observed; therefore high prey resources surround the cages exist. It was also evident that the distribution was influenced by the presence of trawlers, confirming the interest and the opportunistic feeding behaviour of the animals by the human activity exploiting the dolphins' food availability (Shane, 1990; Fertl & Leatherwood, 1997; Merriman et al., 2009).

Therefore, it is important to highlight that the study area occurs as a feeding area which the dolphins keep on visiting all year long, offering fish like: flathead millet (*Mugil cephalus*), selema (*Salpa sarpa*), European pilchard and garpike (*Belone belone*), generating their preference to remain close to the shoreline (Díaz López et al., 2005; 2006b).

Furthermore, a high density of bottlenose dolphins in the north coastal area of Sardinia can be attributed to the occasional presence of different individuals of other populations in the north that in some occasions are in the same area with individuals from the resident population in the study area (personal communication, Díaz López, 2011).

6.3 Anthropogenic activities and dolphins

In general human activity was present all year long in the study area. The combination of the understanding of the presence of marine traffic and the fishing nets gave us an accurate representation of the different anthropogenic activities that are taking place in the area. The marine traffic is a solid way to reach some understanding of the possible interactions between humans and the dolphins in the area. At the same time, the constant presence of boat traffic can be attributed to the economical importance (fisheries and tourism) of the study area for Sardinia. Also, the marine traffic is representing various anthropogenic activities, bringing the opportunity to observe how human activity may lead to generate disturbance on dolphin's behavior, as it has being suggested in previous studies due to direct impacts from boating and shipping and acoustic disturbance (Laist et al., 2001; Lusseau & Higham, 2004; Underhill, 2006; Bearzi et al., 2008; Díaz López at al., 2008b).

It seems that the dolphins did not show any seasonal variation in their presence in the study area, we can think that the marine traffic did not have any influence. Therefore dolphins might be somehow habituated to the traffic (Díaz López at al., 2008b). Furthermore, the presence of dolphins in the area and their distribution might be affected by other factors such as physiological aspects, distribution of food sources, etc.

During summer, tourists are attracted by the bays and warm weather (aprox. 25°C). Also, by the festivities in the towns of the island, they celebrate their patron saint's day with festivals in the whole region combined with the landscapes, [3]. Due to this promotion that is given to the area, the increased number of tourists in summer is confirmed by an increased number of boats in the area.

Nevertheless, there was an evident seasonal variation in the degree of occurrence of the dolphins in the area; in the low season they stay longer periods of time in the area. This can be attributed to lower boat traffic in the low season, resulting in no disruption and less avoidance behavior. On the other hand, we have to consider the possibility that the distribution of the

dolphins could be almost the same in both seasons; but as a consequence of the bad weather and lack of monitoring area, this cannot be confirmed.

Regarding fisheries, the effort done by the fishermen in the area was confirmed by the constant presence of fishing boats and nets during the whole period. Because fishermen inhabit the coasts of the study area, fishing boats are present constantly (19.01%) the whole year long, confirming the economical importance of fisheries in the region.

Furthermore, all over the area the occasionally presence of trawlers was observed to be low but constant; some of them were found working offshore (shrimp) and others working close to the coastline (cephalopods and coastal fish species). The relation between the presence and distribution of the dolphins with the trawlers confirmed their opportunistic characteristic in their feeding behaviour, where they can be following the nets of the trawlers in order to take advantage of the fish caught, attracted or discarded from the nets after trawling (Fertl & Leatherwood, 1997; Bearzi, 2002).

Also, some ferries of the Corsica and Sardinia Ferries Co. were present in the area using a delineated route for their transit on their way from Livorno and Citavecchia (Italy) towards Sardinia. The interaction between this kind of vessels and the dolphins seems not to be so strong; nevertheless the noise pollution generated by big vessels in the natural environment must be taken into account (Donoghue & Wheeler, 1990).

The constant and high presence of recreational boats (67.53%) can be attributed to the large amount of sailing boats, outboards and inboards that frequently visit the area because of its touristic attractiveness. Recreational boats seem to be attracted by the dolphins in the area during the high season, which increases the risks of collisions. The high traffic of tourist boats and its relation with dolphins have being analyzed before, indicating that dolphins are more sensitive to interactions with recreational boats when they are resting and socializing; this was confirmed in Doubtful Sound, New Zeland (Lusseau & Higham, 2004). The possible disturbance from boats supports the results of other studies where noise generated by boat traffic is a major source of pollution (Lusseau & Higham, 2004; Underhill, 2006).

6.4 Conservation remarks

Most of the results showed that the bottlenose dolphin is a very complex species from the viewpoint of conservation, since it is a species strongly related to human activity. Therefore conservation is a challenge to be applied in areas where human activity is developing in the way that it does in the study area. For this reason more than MAPs (Marine Protected Areas), there must be special areas with more useful measures (for example; regarding marine traffic). Unfortunately the legislation in Italy is only a synergetic law, i.e. to not hunt the animals in the wild; nevertheless it does not refer to possible disturbances from the marine traffic or boat regulations (Bearzi, et al., 2008; Hoyt, 2011).

Nevertheless, Italy has the Legislation on MPAs and Cetaceans (Appendix V), and it is important to highlight that the common bottlenose dolphin is the only species found around Italy which isincluded on the Annex II of the directive (EU Habitats Directive, 1992) and that this directive stipulates that a network of Special Areas of Conservation (SACs) must be designated to conserve outstanding natural habitats and prime examples of habitat types, as well rare, vulnerable or endangered species (Hoyt, 2011).

In Sardinia (Italy), these dolphins have been the focus of a long term study. Previous BDRI research has focused on the interactions of bottlenose dolphins and human activity (fisheries, aquaculture and tourism), alterations in top predators food distribution (creation of food patches), and dolphin social structure (Díaz López et al., 2005; Díaz López 2006a,b; Díaz López & Shirai, 2007; 2008). BDRI's researchers have also studied the diving behaviour of bottlenose dolphins (Díaz López, 2009) in relation with these human activity, finding out that in this area anthropogenic activities influence the distribution of food resources and dolphins behaviour (Díaz López, 2006a,b; 2009), which promote the evolution of social organizations (Díaz López & Shirai, 2008a) and individual habitat preferences for the area (Díaz López & Shirai, 2008). All these studies in the area bring along a very good base for conservation issues.

Marine traffic brings along the addition of a constant ambient noise level in the marine environment. There are some international regulations and national instruments that can help protecting marine wild life from this kind of disturbance (Appendix V). For example, the Habitats and Species Directive (Council Directive 92/43/EEC of 21st May 1992) within the EU Directives provides two forms of protection for cetaceans: Article 2 which explains that "the aim of the Directive shall be to contribute towards ensuring biodiversity through the conservation of natural habitats of the wild fauna and flora in European territory of the member states, to which treaty applies" and Article 3 which requires that "a coherent European network of special areas of conservation shall be set up… hosting the natural habitat of species listed in Anex II" (Simmonds et al., 2003). This means that the second one can applied directly to the common bottlenose dolphins in Sardinia, Italy.

Also, ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area) recognizes "disturbance" in one preambular paragraph where parties are required to "take co-ordinate measures to achieve and maintain a favorable conservation status for cetaceans" and the Article II 4 requires that they must implement the prescribed conservation measures under the *precautionary principle*. In the same way, the Conservation Research and Management Measures for ACCOBAMS in Point 1C requires that parties shall "require impact assessments to be carried out in order to provide a basis for either allowing or prohibiting the continuation and future development of activities that may affect cetaceans or their habitat…including… offshore exploration and exploitation, nautical sports, tourism and cetacean watching, as well as establishing the conditions under which such activities may be conducted" (Simmonds et al., 2003).

Finally it is important to take into consideration all the conservation issues above, in order to mitigate the possible impacts of anthropogenic activities (especially marine traffic) over the common bottlenose dolphins in the area. "Mediterranean population has been reduced by at least 30% over the last 60 years" (Reeves & Notarbartolo di Sciara, 2006 IN: Bearzi et al., 2008). Especially in the high season, this resident population is exposed to many different risks, like collisions due to the high traffic of recreational boats, disturbance in different behaviours affecting the calving season in the population.

7   Conclusions and Recommendations

Being part of the coastal ecotype, the individuals of the resident population of common bottlenose dolphins in the north-east of Sardinia were usually present in shallow waters along the coast, close to the fish farm due to their opportunistic feeding behaviour. A relatively high density in the north coastal area since there is a presence of dolphins from other populations.

There is a very evident interaction between the aquaculture, the fisheries sectors and the dolphins in the area. Dolphins were observed on adjusting their distribution in the area around the fish farm and following the trawlers that work in coastal waters.

In the area, the presence of boats was evident representing many of the anthropogenic activities; recreational boats, for touristy activities, were present in high density during summer time; fisheries were represented by the trawlers, fishing boats and nets during the whole year, and ferries appeared in a constant way.

The presence and distribution of the dolphins is not affected by the marine traffic, the animals seem to be habituated to boats presence. Nevertheless, there are seasonal variations in the degree of occurrence of the dolphins. The time they spend in the waters in the area was confirmed to be disturbed by the high presence of recreational boats that might be generating disturbances in the animals. It is important to highlight, that summer is the calving season for this resident population, making them vulnerable to the high presence of boat traffic in this time of the year. Furthermore, recreational boats are attracted by the dolphins in the area during high season, increasing the risks for collisions, the noise pollution and increasing the risk of behavior disturbance over the population.

The understanding of marine traffic and dolphins' interactions bring along the opportunity to apply some international regulations and national instruments. These regulations can help protecting marine wild life from this kind of disturbance in the area, or at least mitigate the impacts from anthropogenic activities over the population.

This type of studies is very important to determine special areas for the conservation of this species, taking in consideration that most of these animals are highly mobile covering very large areas. Monitoring dolphin population and understanding the factors influencing their habitat selection is vital for developing management and conservation plans (Bearzi et al., 2008). It is also very important to protect feeding and nursing areas for the conservation of these species. However this type of studies shall be always complemented with an awareness process directed to the community and the stakeholders that take part in the coastal anthropogenic activities, along with the political will to take action (Gonzalvo & Bearzi, 2008).

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Appendixes

Appendix I: BDRI field survey layout for data collection.

Data Collection 2010 "Bottlenose Dolphin Research Institute - BDRI"

Course:	Date:	Start time:	Finish time:	Observers:

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Survey:	Time:	Moment:	Area:	Mark:
F.F.Cage:	Depth:	Speed:	Spartana/BDRI/F.F	ON / OFF / PASS
PRESENCE	Photo/Video/Acoustic/Underw/Resp.Patt		Douglas: Swell:	Wind:
Visibility: 1-2-3-4	Cloudy: Rain/Fog	Water Tª:	PH: mV:	D. Secchi:
F.Boats:	F.Nets:	F.F.Boats:	Outboard: In-:	Sail boats:
Ferries:	F.Ferries:	Trawlers:	Trawlers Off:	O.Fisheries:
F.F.Farm: Cage:	Fish presence:	Depth-fish:	Spp:	Nº Sightings:
Interm. Positions&Depth:				

Appendix II: Guidelines for Cetacean-Watching Activities in the Mediterranean Sea.

# Guidelines for Cetacean-Watching Activities in the Mediterranean Sea

1. Approach animals slowly and from the side if possible, allowing the dolphins to adjust to the presence of the boat. Manoeuvre the boat parallel to a dolphin group, boats should remain at least 50 meters (watching zone) away from the dolphins (unless the dolphins approach the boat).

2. Never cut off the route of travel of a dolphin group. Never split up a dolphin group.

3. Between the watching zone and a distance of 300m from the animals (approach zone), vessels should maintain a slow (no more than 6 knots) and constant no-wake speed this should allow them to close with the animals but not chase them.

4. Under no circumstances should cetaceans be driven or their movements blocked by vessels; only one vessel at any one time should be in the watch zone and no more than two in the approach zone;

5. If cetaceans approach the vessel or bow ride, maintain a slow, steady speed without changing course;

6. Vessels should be operated so as not to disrupt the normal behaviour of cetaceans; contact with cetaceans should be abandoned at any stage if they show signs of becoming disturbed or alarmed; particular care should be taken when calves are present;

7. No rubbish, sewage or other polluting substances or food should be disposed of in the proximity of the cetaceans.

9. Time in the watching zone should be limited; periods of twenty or thirty minutes may be appropriate;

10. No make excessive noises, any kind of percussion, or others beyond those generated by the normal operation of the vessel, when less than 300m from any cetacean;

11. It is forbidden to swim within a distance of 50m from any cetacean, for your safety because they are wild animals and can be dangerous.

Bottlenose Dolphins are protected by European law (Barcelona, Bonn, Berna, CITES, Habitats Euopean Council Directive 92/43/EEC – Infractions to these norms will be punished according to Italian Law 157/1992.

The implementation of these guidelines is in accord with Article 2 of ACCOBAMS.
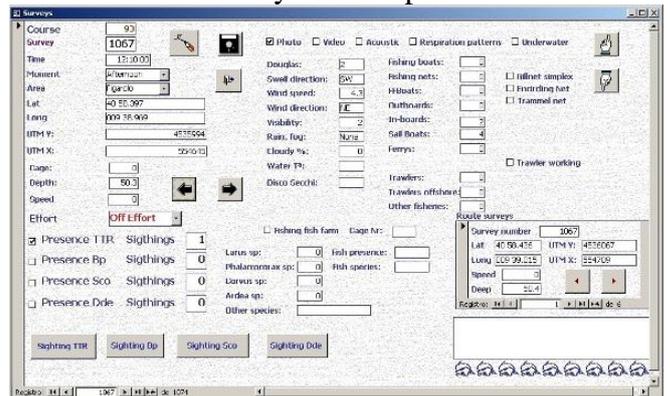
Appendix III: BDRI database.
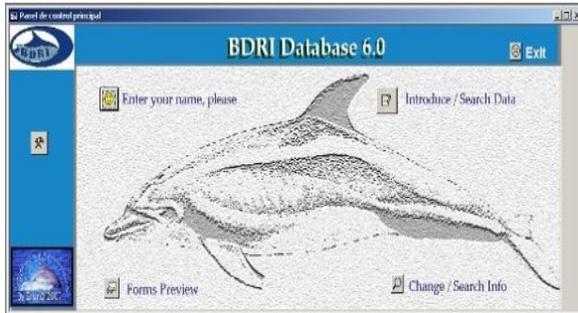
Microsoft Access Tables

BDRI Database 6.0
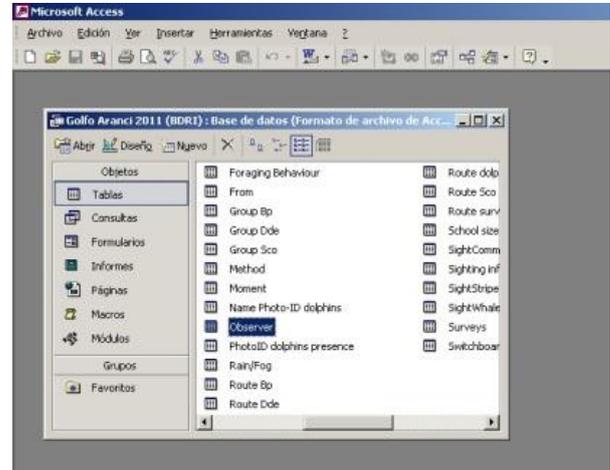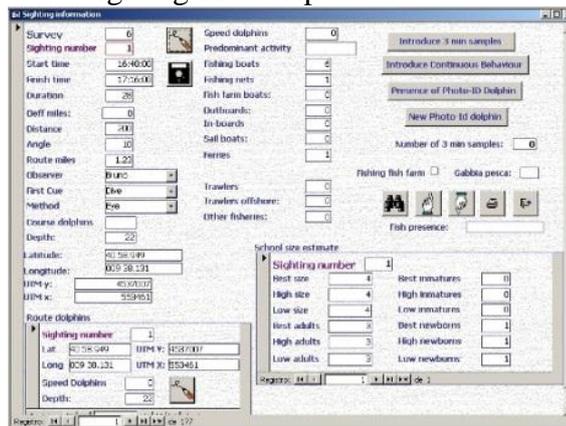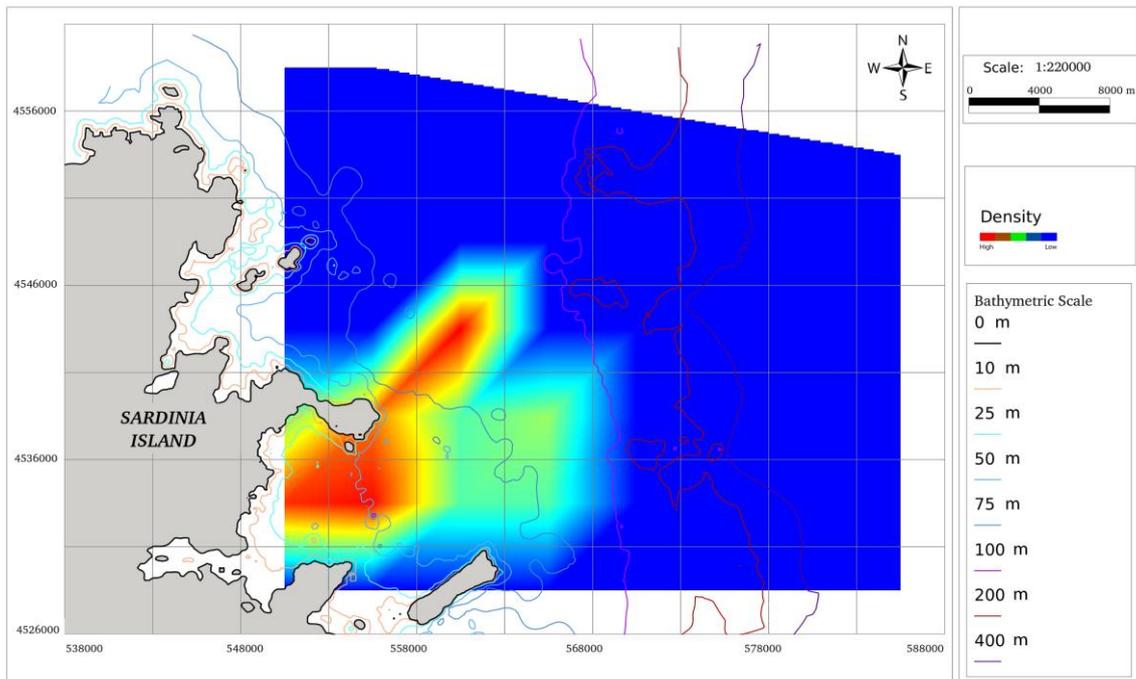

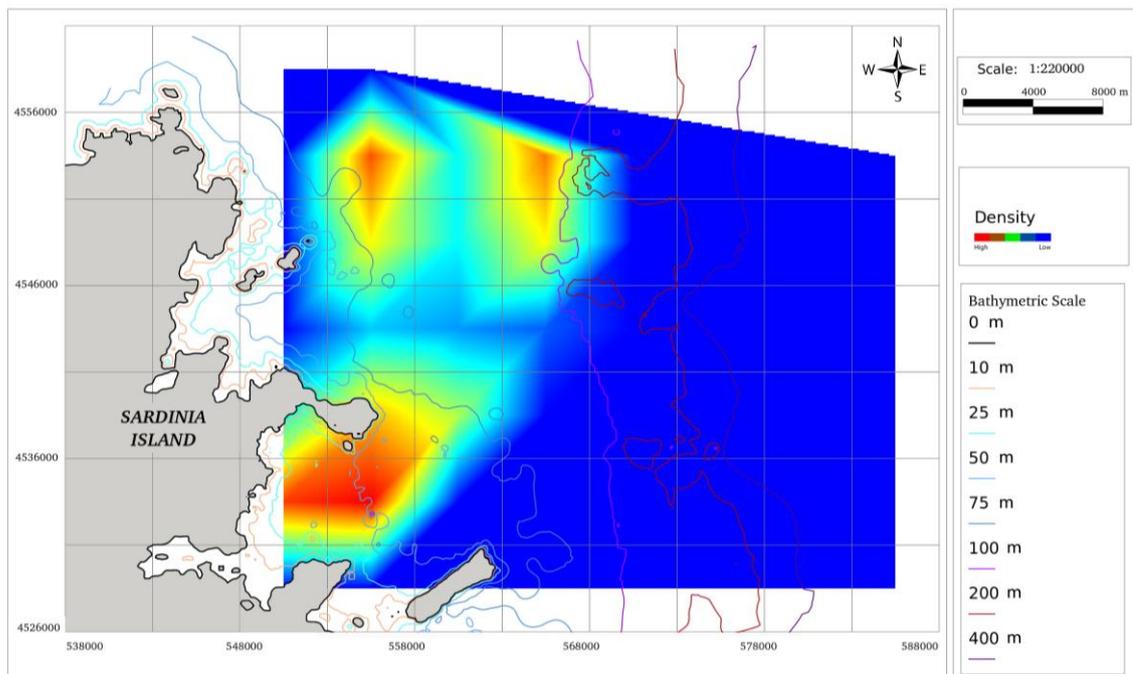Course Transcription
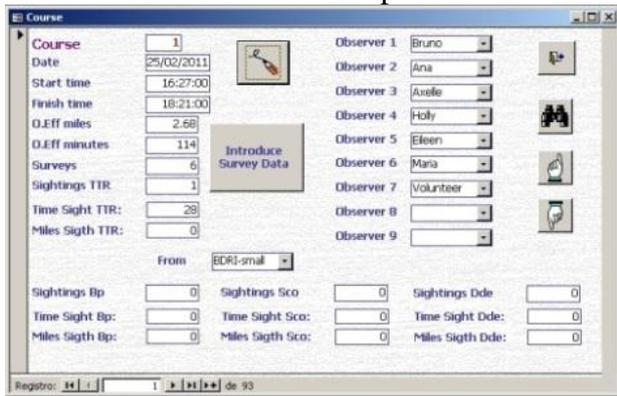
Survey Transcription

Sighting Transcription

Appendix IV: Distribution maps for bottlenose dolphins and anthropogenic activities in the two seasons.

A. Distribution of dolphins in the low season:
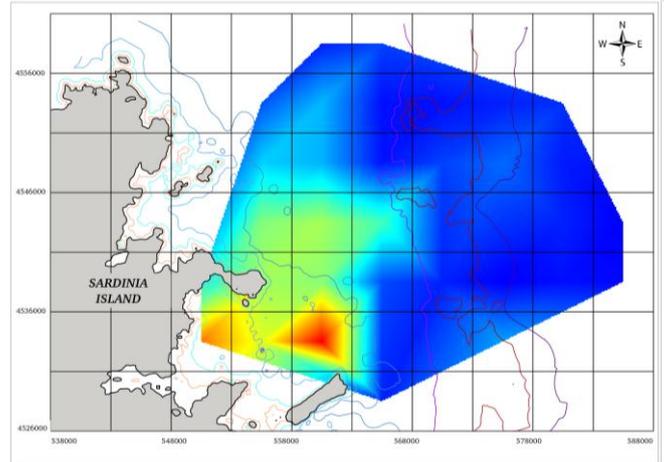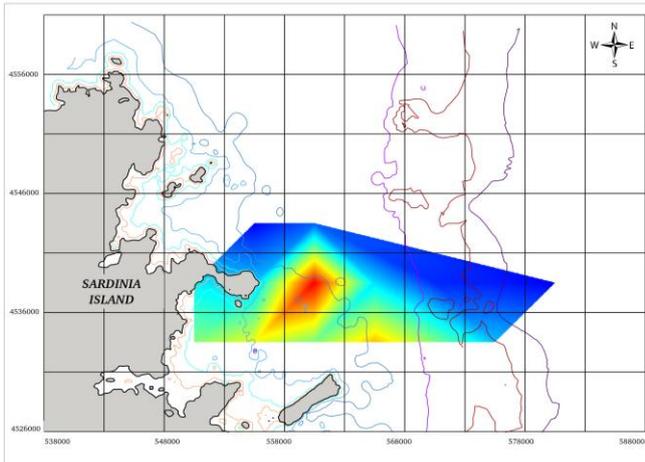

B. Distribution of dolphins in the high season:

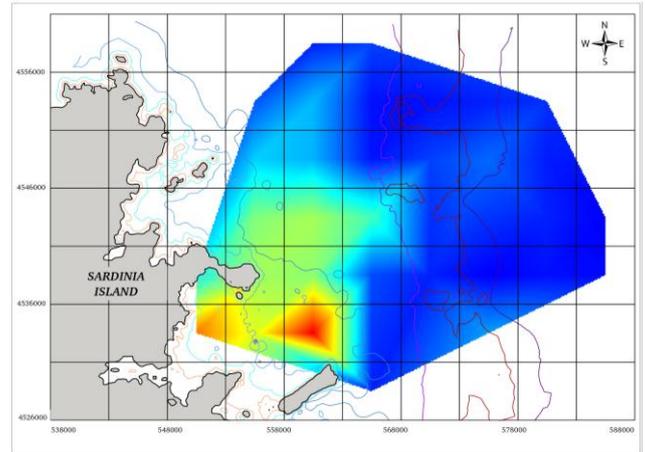Distribution maps for the type of boats and fishing nets in the two seasons:
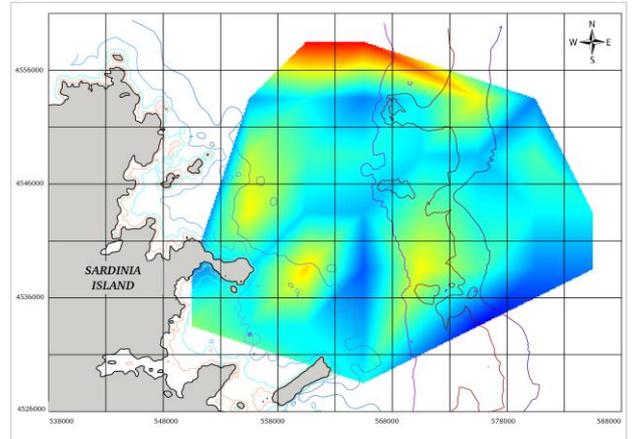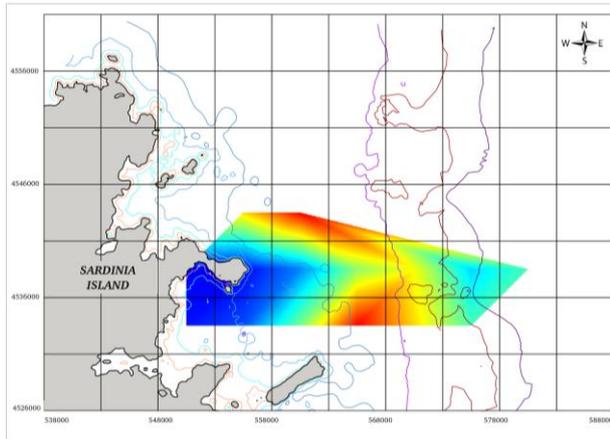
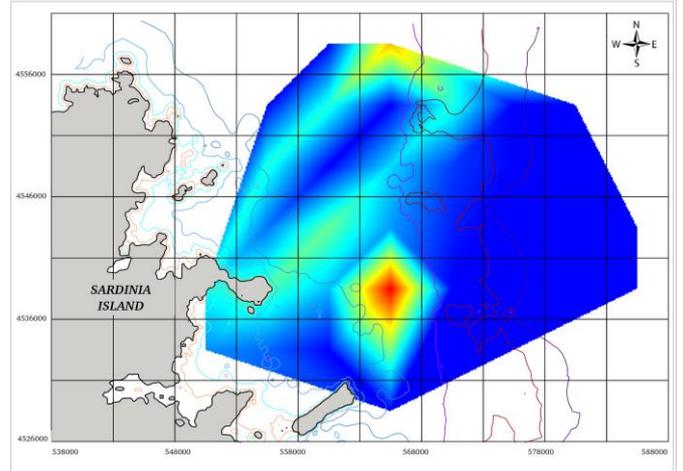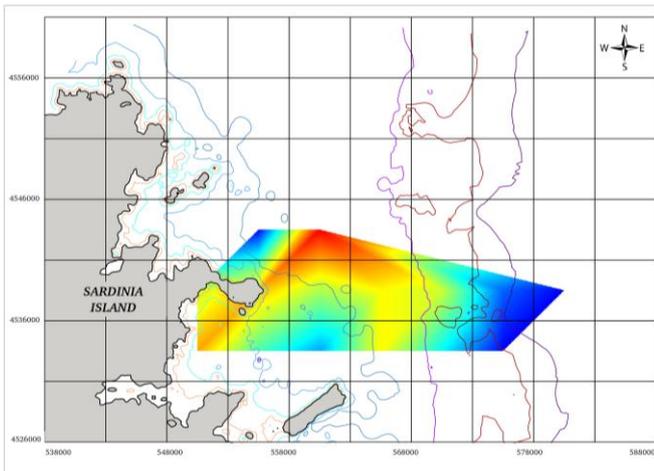Low season | High season

Recreational boats

Fishing boats
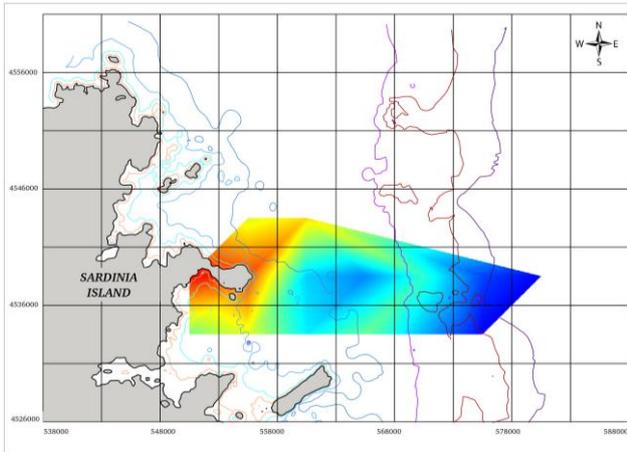
Trawlers
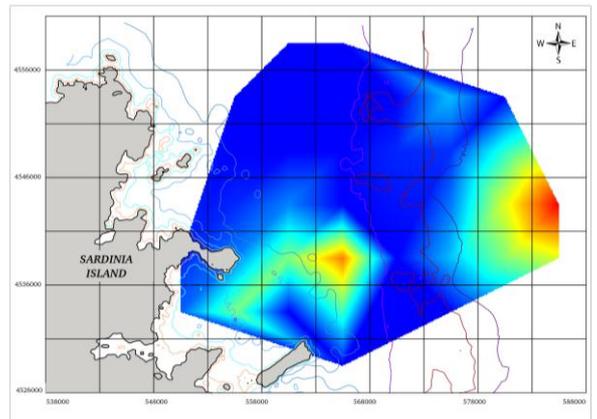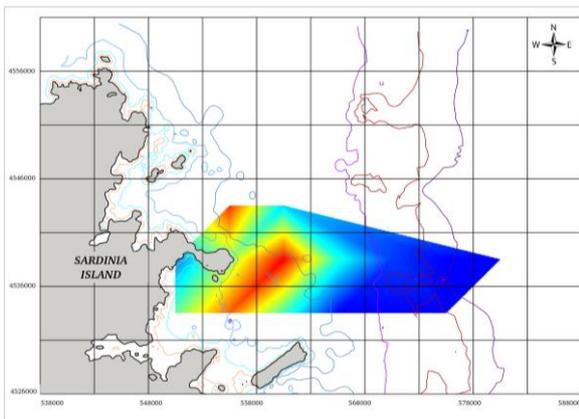
Ferries

Fishing nets

Appendix V: Legislations regarding conservation.
International Legislation and Conservation for Cetaceans:

ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area)

 The ACCOBAMS agreement was signed in 1996, under the Bonn Convention (Convention of Migratory Species of Wild Animals - CMS), and entered in force in 2001, applying to coastal Mediterranean and Black Seas countries. The aim is specifically to establish a Network of "Special Protected Areas to Conserve Cetaceans" in order to conserve habitats and species, including a wide range of protections for cetaceans, especially prohibiting the deliberate killing of species in national waters (Simmonds et al., 2003; Hoyt, 2011). The ACCOBAMS Scientific Committee working in MPAs developed some criteria and guidelines for the proposal and establishment of 17 new MPAs to work as a Mediterranean and Black Seas cetacean MPAs Network. The boundaries are open to change pending on furthers scientific research. Until now, only two of these MPAs have being declared; one in Croatia to protect common bottlenose dolphins (*Tursiops truncatus*) and one in Italy to protect manly short-beaked common dolphins (*Delphinus delphis*) and sperm whales (*Physeter macrocephalus*) (Hoyt, 2011).

IUCN (*International Union for Conservation of Nature*)

The Conservation Action Plan for the World´s Cetaceans 2002 - 2010 created by the IUCN recommended initiatives regarding research and education for the Mediterranean and Black Sea waters, some of them specific for the common bottlenose dolphins; "to investigate the distribution and abundance of *Tursiops truncatus* in the Mediterranean and Black Seas, and evaluate threats to their survival" and "develop and test approaches to reduce conflicts between *Tursiops truncatus* and small-scale fisheries in the Mediterranean Sea" (Reeves et al., 2003). Most of the work suggested in the Action Plan had been initiated by 2011, and some completed, still the governments have been slow in the action taking of the scientific recommendations (Hoyt, 2011).

CITES (The Convention of International Trade in Endangered Species)

Concern to prevent continuing depletions of wild animal populations to satisfy the requirements of commerce.

UNEP (United Nations Environment Programme)

The "Global Plan for the conservation of Marine Mammals" by US´s FAO, IUCN and IWC.

National Legislation and Cetaceans Italy (Hoyt, 2011: page 162):

Marine Protected Areas in Italy have been proposed on the basis of specific national legislation that identifies areas of Italian coast line where MPAs may be established. The relevant laws are as follows:

- L 979/82. "Disposizioni per la difesa del mare", identifies 21 areas which may be awarded protection measures.
- L 394/91. "Legge quadro sulle aree protette", identifies another 26 marine areas which require potential protection measures.
- L 344/97. "Disposizioni per lo sviluppo e la qualificazione degli interventi e dell´occupazione in campo ambientale", adds one more marine are ato the list – Parco Marino Torre del Cerrano.
- L 426/98. "Nuovi interventi in campo ambientale", puts the Pelagos Sanctuary for the Mediterranean Marine Mammals on the MPAs list.

As for 2002, 15 MPAs had been established according to the process identified by the Servizio Difesa Mare, Ministero dell´Ambiente (the Marine Protection Service of the Ministry of Environment), which is the national legal body in charge of the marine resource protection. Eight of these MPAs are managed by local management bodies; 2 are managed by National Parks, 1 is managed by WWF-Italy and the remaining 4, for which a management body has not being designated, are being managed temporarily by the Local Coast Guard offices (Capitanerie di Porto).

Cetaceans have been protected in Italy since the ratification of CITES (1975), the Bern (1981) and Bonn (1983) conventions, the regulation of the EU Habitat Directive (1997) and the ratification of the Barcelona Convention Protocol Concerning Specially Protected Areas and Biological Diversity (SPA) (1999). According to a 1992 national law, fines and sanctions have been established to prevent the harming or trading of cetaceans.

As of late 2010, according to data compiled by the Italian High Institute for Environmental Protection and Research (ISPRA) (formerly Central Institute for Applied Marine Research, or ICRAM); 26 MPAs had been established, 3 of them inside the Pelagos Sanctuary and 3 underwater MPAs. At least 5 of the have cetacean populations.

Code of conduct and guidelines for marine traffic: