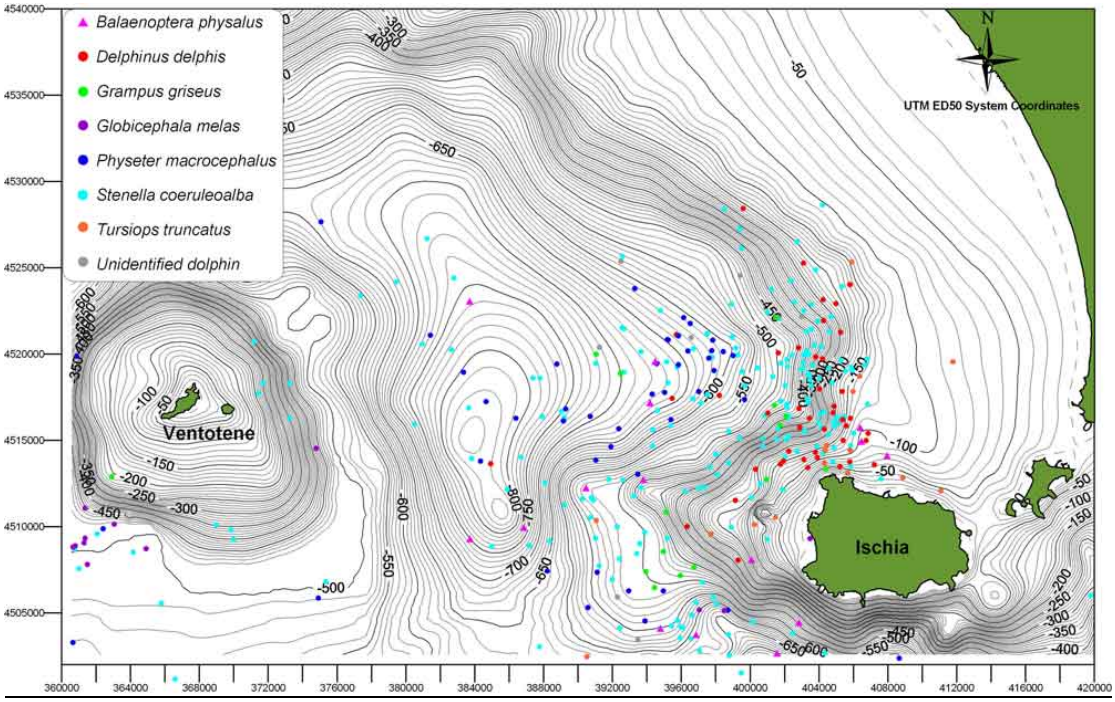
ISCHIA DOLPHIN PROJECT

(1991, in progress)



Encounters in the study area (2000-2008).

HISTORY AND BACKGROUND

The waters off the Islands of Ischia and Ventotene offer a unique opportunity for the study of cetaceans.

In 1991 the area was chosen because it was never been object of a systematic study on marine mammals. A long term study on cetacean was initiate to record the most common species, analyse seasonal variations in their presence, verify the existence of resident cetaceans (Mussi *et al*., 1998).

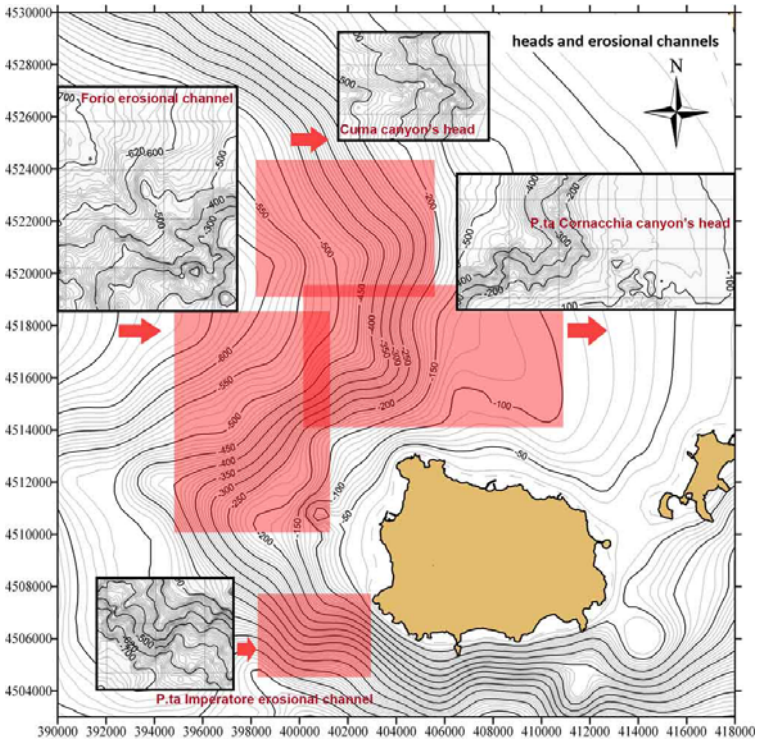
Research started with data collection by ferries, cargo and fishing boats, data were discontinuous but allow to find out the winter presence of cetaceans in the area.

In 1993, to get more information we started daily surveys from May to October using a 15m sailing boat, Barbarian, equipped with a GPS and (since 1995) an hydrophone system.

The first five years of observations allowed to establish the rich variety of cetaceans in the study area, seven different species were identified and the existence of resident bottlenose dolphins (*Tursiops truncatus*) and of five individuals of pilot whales (*Globicephala melas*) was verified (Mussi

et al., 1998, 2000). Fin whales (*Balaenoptera physalus*) and sperm whales (*Physeter macrocephalus*) presence was recorded all year round (Mussi *et al*., 1998).

In the following years, 1996-1998 the research effort was concentrated in the waters surrounding the Island of Ischia. This allowed to ascertain the concentration of fin whales in a small area (north west Ischia) corresponding to the submarine canyon of Cuma (Mussi *et al*., 1999). The fin whale feeding behaviour was repeatedly observed, the analysis of faecal material revealed the presence of euphasiaceans (*Meganyctiphaes norvegica*). Due to the high level of traffic in the study area, a study of fin whales' respiratory patterns was performed to investigate their reactions to the boats presence/absence (Diaz Lopez *et al*., 2000).



canyons and erosional channels in the study area

These observations allowed to focus the research on the submarine canyon of Cuma trying to define the role played in by submarine canyons in distribution and abundance of trophic resources of cetaceans (Mussi *et al*., 2004; Pace *et al*. 2012).

Since 1995, thanks to the common effort of Angelo Miragliuolo and Marco Battaglia, an acoustic system was developed to record cetaceans vocalisations. During years it was possible to modify and refine into a 100 m long towed stereo hydrophone array (100 Hz - 22kHz bandwidth) spaced 3 m apart. Time of arrival differences of cetaceans clicks and/or whistles on the two hydrophones are used to determinate bearings to animals. Several studies have been produced on acoustics,

analysing sperm whale clicks (Azzali *et al*., 2003, Mussi *et al*., 2005) and codas (Rendell *et al*., 2006), pilot whale vocalisations (Mussi *et al*., 2003), comparing acoustic signals between species (Impetuoso *et al*., 2004; Venier *et al*., 2009).

Through years also the presence of large groups of common, *Delphinus delphis* (Mussi *et al*., 2002; Bearzi *et al*., 2002, 2003), and striped (*Stenella coeruleoalba*) was related to the canyon bathymetries and the area was listed in the last IUCN Cetacean Action Plan – www.redlist.org - as critical habitat for the endangered short beaked common dolphins (Reeves *et al*., 2003).

Risso's dolphins (*Grampus griseus*) were observed too, alongside two preferential areas located north-west (corresponding to the canyons' head) and west Ischia Island (Mussi *et al*., 1998; Mussi and Miragliuolo, 2003; Pace *et al*., 2012).

All species seems to use the zone as feeding ground and the presence of calves was noted both for whales and dolphins (Mussi *et al*., 2004; Pace *et al*., 2012).

In December 1999, the sinking of Barbarian, the research vessel, due to a violent storm which destroyed the entire port, caused a sharp stop to the project, which also suffered the loss of data and instrumentation stored on board.

In March 2000, Angelo Miragliuolo and Barbara Mussi, with the financial support of Karin Theimann, managed to buy a new sailing boat, Jean Gab, to renovate and equip it for research.

The following year, thanks to the strong motivation of Katia Massaro, who embraced the cause of the project, Delphis Mediterranean Dolphin Conservation, a non-profit organization dedicated to the conservation of cetaceans through research, dissemination and education, was founded.

DELPHIS, MEDITERRANEAN DOLPHIN CONSERVATION

Since 2002, thanks to the scientific collaboration with Daniela Silvia Pace, President of the non-profit organization Oceanomare, the collection of data was more structured and the database was enriched with data on the behavioral ecology of these animals, information about their movements in the environment, the size and composition of groups, behavior and acoustics.

In the same period with the scientific supervision of Cesare Furlanello and his research unit, Machine Learning, Bioinformatic and Geospatial Technologies, Fondazione Bruno Kessler, and the dedicated effort of Antonio Zucchini started the "GIS" experience.

Data collected in the field have been integrated into a normalized relational database Postgresql 9.1 with Postgis 2.0.0. Geographical and bathymetric maps of the study area were acquired at 50 m resolution bathymetry DTM format and 250 m resolution map UTM WGS 84. Then, the study area has been divided into a total of 8800 cells of 1000x1000 m and fixed covariates were calculated inside the cells of the resultant grid. Dynamic indices were computed overall and by species, within each cell and in relation to the different covariates, together with relevant descriptive statistics. Statistics were calculated with R 2.14 software. Dynamic queries space-time have been created into the database in parametric mode and a "dashboard parameters" developed for the

analysis of the sightings in relation to the different covariates; to improve the performance of the queries, static vector Shapes were generated to represent and publish geospatial analysis using Q-GIS 1.7.1, Quantum GIS "Enceladus" (Pace *et al*., 2010).

Delphis published annually the results of analyzes of data through conference proceedings, journals, national and international, and reports commissioned by international organizations such as Whale and Dolphin Conservation Society, Ocean Care, Humane Society International and Royal Society for the Prevention of Cruelty to Animals.

In collaboration with these organizations, a long term study on cetacean interactions with fisheries was performed. The research focalized on the driftnetting fleet and data were collected in the harbors and at sea from 2000 to 2006. Results confirmed the high impact of this fishing techniques on cetacean populations and that these kind of interactions are still a problem in the study area (Mussi *et al*., 2004, 2005, 2006). Within this study it was possible to extensively document a rescue of an entangled sperm whale pod composed by five individuals (Pace *et al*., 2008).

Delphis, in collaboration with the Tethys Research Institute, organized and supported Ischia Dolphin Project, the fields of naturalistic research on cetaceans. Hundreds of volunteers and students participated in the campaigns to collect data at sea on board the research vessel, contributing to current knowledge on the distribution and ecology of these animals.

Since 2002, every May, Delphis organized the Dolphin Day, a day dedicated to cetaceans and to environmental awareness. Through videos, lectures and presentations by experts, the participants met the world of dolphins and research at sea.

In 2003, thanks to an extended review (Bearzi *et al*., 2003) leaded by Giovanni Bearzi and involving Delphis Mediterranean Dolphin Conservation (Italy), Tethys Research Institute (Italy), Alnitak Marine Environment Research (Spain) and Pelagos Cetacean Research Institute (Greece), the short beaked common dolphin Mediterranean population was listed as endangered in the IUCN Red List.

In 2006 Delphis founded the "Cetacean Section" of the Museum of Villa Arbusto, Lacco Ameno, Ischia. The Cetacean Section shows a permanent exhibition dedicated to the cetaceans that frequent the waters of Ischia. The exhibits complete skeleton of a young common dolphin stranded in Ischia in November 2003 and recovered by volunteers.

In 2008 Delphis joined Cetacean Alliance, a not-for-profit network of non-governmental organisations committed to preserving marine biodiversity and reducing human impact on cetacean populations.

Delphis participated to the realization process of the MPA ‘Regno di Nettuno’, providing decision makers with reliable data on cetacean presence and distribution in the area. This leaded to the enlargement of the boundaries of the MPA, with the addition of a more pelagic zone dedicated to cetaceans (corresponding to the coastal heads of the Cuma’s canyon and to the critical habitat of common dolphin).

OCEANOMARE DELPHIS ONLUS

Oceanomare Delphis Onlus is a non-profit organization established to study and preserve cetaceans, and the ecosystems they inhabit, through knowledge, conservation and awareness actions.
Oceanomare Delphis Onlus is the outcome of the fusion of two different Italian associations – Oceanomare and Delphis MDC – that had both successfully led research projects and conservation activities on cetaceans in the Mediterranean Sea.
Sharing common views, actions and people, in 2010 Oceanomare and Delphis MDC decided to blend their effort, establishing a new, larger organization.

"We believe that a fusion of expertise and ideas towards a common goal is needed to meet challenges facing cetacean knowledge/conservation and beyond"
(Daniela Silvia Pace, Oceanomare President - Katia Massaro, Delphis MDC President)

Oceanomare Delphis Onlus advances the science and practice of conserving cetaceans and marine biodiversity, implementing non-invasive studies, promoting education and conservation programmes and enhancing public awareness of, and concern for, cetaceans and the marine environment.

Oceanomare Delphis Onlus advocates for financial support of scientific and conservation programmes and facilitates dissemination of results through professional networking, capacity building, public outreach and scientific publications.

Oceanomare Delphis Onlus believes the application of scientific knowledge to management and policy is essential for effective cetacean conservation.

THE PROJECT

Main goal of the project is the conservation of the cetacean species ad their environment through knowledge and management.

Ischia Dolphin Project is focused on the communities of cetaceans that can be encountered in a coastal area that covers about 8800 Km^2 between the islands of Ischia, Ventotene, Ponza and the Italian mainland.

Target species of the study are:

short beaked common dolphin (*Delphinus delphis*)

Once one of the most abundant cetacean species in the Mediterranean, common dolphins have declined throughout the region since the 1960s. This population has been classified as **Endangered** in the IUCN Red List. The causes of their decline include prey depletion by overfishing and incidental mortality in fishing gear.

sperm whale (*Physeter macrocephalus*)

No estimate of population size exists for the region, but the total number of sperm whales in the Mediterranean is more likely in the hundreds than the thousands. Experts participating in a regional Red List workshop organized in 2006 agreed that Mediterranean sperm whales qualify as **Endangered** according to the IUCN Red List criteria. The most likely cause of recent decline of sperm whales in the Mediterranean is entanglement in high-seas swordfish driftnets, which has caused considerable mortality since the mid-1980s. Such mortality is ongoing. The disturbance from intense marine traffic and collisions with vessels may be serious as well. Underwater noise from mineral prospecting (seismic airguns), military operations, and illegal dynamite fishing are other sources of concern.

bottlenose dolphin (*Tursiops truncatus*)

The most coastal cetaceans in the Mediterranean, bottlenose dolphins are particularly exposed to human activities. Until the 1960s they were one of the main targets of culling campaigns, with thousands of animals killed. In recent times, prey depletion caused by overfishing , incidental mortality in fishing gear and health effects caused by pollution are significant threats. Mediterranean bottlenose dolphins have been proposed for classification as **Vulnerable** in a Red List assessment by IUCN.

striped dolphin (*Stenella coeruleoalba*)

Striped dolphins are the most abundant cetacean species in the Mediterranean, and yet they have been proposed for classification as **Vulnerable**. Mortality events caused by viral infections have been related to contamination by xenobiotics as well as prey scarcity. Striped dolphins are also exposed to mortality in fishing gear, particularly drift gillnets.

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Risso's dolphin (*Grampus griseus*)

The ecology and status of Risso's dolphins are poorly known. While no estimate of abundance is available for the Mediterranean, numbers are low in comparison to other small odontocetes. The main known threat is entanglement in drift gillnets. Other problems include noise disturbance and ingestion of plastic debris. Risso's dolphins are considered **Data deficient**.

pilot whale (*Globicephala melas*)

Estimates of abundance for the Mediterranean population are unavailable. Threats are poorly known, but likely include by-catch in pelagic fishing gear, collisions with vessels, man-made noise and the effects of accumulation of organochlorine and other contaminants. Pilot whales are considered as **Data deficient**.

fin whale (*Balaenoptera physalus*)

The fin whale is the commonest large whale species in the Mediterranean Sea. No population estimates exist for the entire region. Mediterranean fin whales face a number of actual and potential anthropogenic threats, including collisions with vessels, chemical and acoustic pollution, entanglement in fishing gear and disturbance by boats. Fin whales are considered as **Data deficient**.

Ischia Dolphin Project is supported by Ocean Care, Associazione Amici di Riccardo Domenici.

Research Activities

The aims of the research can be summarised as follows:

- estimate the degree of residency of cetaceans;
- estimate population sizes;
- examine the social structure of the different populations;
- examine habitat use and distribution;
- estimate the impact of both fishery operations and vessel traffic;
- describe the acoustic repertoire of the different species.

Data is collected following an interdisciplinary approach and applying different methods in order to describe the different aspects of cetaceans' life.

Techniques such as photo-identification, behavioural sampling, GIS and acoustical recording are used. In addiction, a detailed trip log of the route covered and GPS positions are automatically recorded every 3 minutes. Information on sea state, wind Beaufort and direction are also taken.

Photo-identification

It's a valuable and widely used technique in the research of cetaceans. By photographing cetaceans the different animals are identified on the base of natural and permanent markings present on their body. This method gives important information on population size, distribution and movements of cetaceans, social structure, reproductive rate and habitat use.

Behavioural sampling

Through the collection of behavioural data we obtain information that will lead to the understanding of cetacean's activities like feeding habits, social communication and interaction with human activities. We record different variables, e.g. group size and composition, aerial behaviours, social interactions and so on.

GIS

Geospatial analysis and GIS are common techniques used in ecological studies to design predictive models. We developed a specific model to the study of cetacean species applying various open source tools (Grass and Q-GIS, Geo Server, R, Postgresql with Postgis) to handle behavioural, acoustical, photo-identification, and survey data collected over a ten-years period.

Acoustic

During sightings, continuous recordings are taken to obtain a comprehensive acoustic data set based on local cetacean communities. Recordings of clicks, whistles and other vocalisations are collected in order to define the acoustic characteristics of the species in the area. Particular attention it is given to stereotyped vocalisations, in order to set up an acoustic 'signature' catalogue of individuals.
Correlations between habitat use patterns, biological noise, and cetacean vocalizations will be also examined; these factors could be particularly relevant in the acoustic behaviour of the animals. To assess the effects of underwater noise on the behaviour and the distribution of dolphins in the study area, the acoustic spectra of natural and anthropogenic sources recorded in the area will be compared with the echolocation and tonal frequencies used by cetaceans in the area.

Conservation

The conservation status of Mediterranean cetaceans has been a source of concern for many years. This was reflected in the 1991 Action Plan of the Barcelona Convention and in the global action plans for cetacean conservation published by the IUCN (World Conservation Union) in 1988, 1989, 1994 and 2003.

In 2006 the IUCN Red List Authority and ACCOBAMS co-organised a workshop to assess the status of all cetacean populations in the Mediterranean and Black Seas. Of the 12 'units' assessed, one was proposed to qualify for Critically Endangered, five for Endangered and two for Vulnerable. The other four were considered Data Deficient, meaning that there was inadequate information to assess their extinction risk.

Anthropogenic impacts that threaten cetacean populations are listed below (based on Bearzi *et al*. 2010, modified):

Prey depletion. Depletion of food resources caused directly or indirectly by fishing

Incidental mortality and injury in fisheries (bycatch). Mortality or injury from accidental entanglement in gear of various types including passive and active nets, longlines, traps and discarded or lost nets and lines and illegal fishing practices (e.g. use of dynamite)

Intentional and direct takes. Killing or capture to obtain products for human consumption, live capture for display facilities, acts of retaliation for actual or perceived damage to fish catches or gear, and shooting for 'sport'

Vessel strikes. Accidental mortality or injury from contact with a vessel, particularly the hull or propeller

Disturbance. Behavioral disruption through intentional or non-intentional approaches, likely or proven to induce long-term effects on dolphin populations

Acoustic pollution (noise). Mortality, injury or chronic disturbance from exposure to man-made sounds

Chemical contamination. Accumulation in the body tissues (mostly through the food web) of chemicals known to adversely affect mammalian functions and health

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Ingestion of solid debris. Mortality or injury from the ingestion of foreign objects and materials (such as plastic, wood, textiles etc.) obstructing part of the digestive tract

Oil pollution. Mortality or health problems deriving from contamination, contact or ingestion of hydrocarbons deriving from oil spills and oil derivates at sea

Ecosystem change. Reduced habitat quality due to effects of coastal development (e.g. eutrophication, harmful algal blooms, alien species invasions)

Climate change. Changes in prey availability (abundance or distribution), shifts in distribution of competitors, exposure to novel diseases etc.

In the study area the cetacean populations face several threats.

Traffic and collisions

Commercial and passenger traffic (ferries, fast ferries and hydrofoils) in the Gulf of Naples and in the nearby Phlegrean Islands (Ischia, Procida and Vivara) exceeds 200000 trips/year, and up to 2000 recreational boats may be moored during the summer in Ischia harbours (Strada, 2000). Ship collisions in the area have been documented for several cetacean species (Mussi and Miragliuolo, 2003). Despite the presence of the MPA, the waters around Ischia are commonly used for unofficial offshore races, and the implementation of coastal speed limits is virtually non-existent.

One of the most important factors contributing to collision risk seems to be the spatial overlapping of the areas of cetaceans' presence and the zones of intense sea traffic (Mayol *et al*., 2007). This risk is particularly heavy in the study area, considering its overlapping with the Naples harbor business, as the threat of boat based harassment like that occurred to Risso's dolphins (Miragliuolo *et al*., 2004), a kind of interaction involving surfacing cetaceans that is becoming a every day routine in the busy summer months.

Driftnetting:

A potentially major threat for cetaceans in the area is represented by the illegal driftnet fishery, sadly known for the heavy toll paid by Mediterranean cetaceans (Di Natale and Notarbartolo di Sciara, 1994; IWC, 1994; Silvani *et al*., 1999). This fishery threatens the local cetacean communities and bycatch events have been documented for striped dolphins, bottlenose dolphins, sperm whales and fin whales (Centro Studi Cetacei 1996, 1997, 2004; Miragliuolo *et al*., 2002).

Notwithstanding the EU ban on driftnets since January 1st, 2002, followed by the ICCAT recommendation for the total ban of driftnets from the Mediterranean Sea, illegal fishing with driftnets is still an issue around Ischia. Annually, since 1995, swordfish boats equipped with driftnets have been observed daily in the area from May to August (Mussi *et al*. 1998; Mussi and Miragliuolo, 2003; Miragliuolo *et al*., 2002).

In Italy, a Decree by the Fishery Ministry (27 March 2003) authorizes the use of a kind of fishing gear called "ferrettare da posta", i.e. a small driftnet anchored to the bottom. The term "da posta" (anchored) associated to a driftnet merely represents a means to bypass the existing regulations and allow the continued use of driftnets. The deliberate ambiguity of this decree allows fishermen (even those that benefit from the EU conversion plan and receive indemnity funds) to continue the use of driftnets.

The impact on the pelagic fauna of these "ferrettara" driftnets, is still unknown owing to a lack of studies and observations in the field. However, such impact is likely to be similar or equal to that of the normal driftnets.

Overfishing and prey depletion:

Fishermen claim that the fleet targeting the Atlantic saury (locally a key prey for common dolphins) has decreased by one order of magnitude due to the decline in fish stocks. Moreover, purse seiners and trawlers are not requested to comply with the regulations intended to prevent overfishing, (Mussi and Miragliuolo, 2003), therefore producing clear environmental damage.

A review by Buia *et al*. (2003) reported a remarkable alteration in the structure of Neptune grass (*Posidonia oceanica*) beds, related to the illegal and uncontrolled trawling. Neptune grass beds, distributed all around the island of Ischia up to about 30 m of depth, have been monitored since 1975 (Colantoni *et al*., 1982). Terlizzi (1991) analysed the fauna associated to the leaf stratum and found a notable diminution in biomass value in 1988-89, as compared to 1981-1982, as well as an important reduction of biodiversity. Finally, a general survey around the hard bottoms of Ischia conducted by Gambi *et al*. (2003) showed that fish stocks are generally scarce and dominated by non-commercial species.

Pollution:

Ischia is close to the Gulfs of Gaeta and Naples, which receive the continuous inflow of three polluted rivers: Volturno, Garigliano and Sarno. These rivers include waters classified as "very bad" in the second report on environmental quality by ARPA Campania (2003); pollutant levels brought by the Sarno river, in particular, are unlikely to be sustainable. Sewage plants on the islands of the archipelago are totally inadequate and lack any kind of systems of purification. Zucco (2003) localised in the island of Ischia six highly polluted discharges and 11 pipes releasing sewage into the sea. Moreover, about 90 un-authorised outlet pipes were counted. The evidence provided above suggests that water pollution may be an issue in the waters surrounding Ischia.

During the study period, only one common dolphin specimen was found stranded, in 2003 in

Ischia. The carcass has been analyzed by Letizia Marsili (University of Siena Eco-toxicology Department). Results showed high level of contamination by DDTs and PCBs beyond sustainability for the survival of the population (Marsili, pers. comm.).

Management

Sadly, after four years from MPA establishment, no real conservation measures have been implemented, and the cetaceans living in the protected area aren't getting benefits from the new designation. Thus, we are now promoting a new coordinated effort with both the Italian Ministry of Environment and the Marine Biology Society, in order to protect the whole canyon system within a SCI (Site of Community Importance) and to also cover the critical habitat of the sperm whale.

Management measures should include:

1. Stopping the industrial fishery (purse seiners, trawlers) in the area corresponding to the submarine canyon of Cuma and to the Bank of Forio;
2. Monitoring the uncontrolled and illegal fishery that continues undisturbed (including several methods of commercial fishing, also sporting and pleasure fishing, especially the use of explosives in the latter);
3. Reducing and controlling the speed limits around the islands, in particularly near Monte Vico, Punta Imperatore and Punta S. Pancrazio and creating dedicated routes for commercial and passenger traffic in the whole canyon area. This could be very useful in decreasing the speed of the tourist trips around the island, the fleet of which is composed of big and fast motorboats that normally drive at 25/30 knots;
4. Disseminating the ACCOBAMS code of conduct and rules on whale watching (today there are no commercial whale watching activities in Ischia, but this should be considered within the MPA to provide for any changes in the future);
5. Promoting a series of educational activities to spread information and raise awareness among the publics about the threats and problems of cetaceans and their environment;
6. Publishing/sharing the results of the research to/with the local and the international authorities, as well as to the scientific community and the environmentalist organizations.

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