STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) 2013

EDITORS: M. STACHOWITSCH[*], E.C.M. PARSONS[+] AND N.A. ROSE[¥]

INTRODUCTION

Several resolutions of the International Whaling Commission, including Resolutions 1997-7 and 1998-5, directed the Scientific Committee (SC) to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 welcomed the concept of the State of the Cetacean Environment Report (SOCER) and requested the annual submission of this report to the Commission. The first full SOCER (SC/55/E7) was submitted in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Mediterranean and Black Seas, Atlantic Ocean, Pacific Ocean, Indian Ocean, Arctic and Antarctic Seas. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2013 SOCER focuses on the **Mediterranean and Black Seas**, summarising key papers and articles published from ca. 2011 through 2013 to date.

MEDITERRANEAN SEA

General

First major attempt to quantify the overall effects of various stressors on Mediterranean marine habitats

An examination of 366 scientific studies and a rigorous analysis of 158 of these showed that fisheries, species invasion, aquaculture, sedimentation increase, water degradation and urbanization are having negative impacts on Mediterranean habitats and their associated species assemblages. Some, but not all, of these stressors reflect the recognised greatest global threats to the marine environment. For example, although the Mediterranean Sea is known to be undergoing 'tropicalisation', the analysis was unable to identify climate change as a major threat, because too few studies have been conducted and the examined response variables were not uniform. This first major quantitative effort draws attention to a "*critical lack of empirical knowledge about marine systems in many areas of the Mediterranean*" and insufficient studies on the cumulative and synergistic effects of multiple stressors. The authors draw attention to the shortcomings of the many efforts to develop ecological indices in the Mediterranean.

(SOURCE: Claudet, J. and Fraschetti, S. 2010. Human-driven impacts on marine habitats: A regional meta-analysis in the Mediterranean Sea. *Biol. Conserv.* 143: 2195-2206)

Marine protected area in the Adriatic downgraded

The Cres-Lošinj Special Marine Reserve has been downgraded from Special Reserve to Regional Park. This reserve, specifically designed to conserve a local bottlenose dolphin population, was the largest marine protected area in the Adriatic for three years (2006-2009). Lack of experience, governance and funding, coupled with strong opposition by the local tourism industry and economic/political paralysis in Croatia, created an imbalance between local development and international commitments. The downgrading, accompanied by movement of its boundaries to accommodate a marina, raises questions as to whether the area satisfies biological objectives. In particular, illegal and damaging fishing practices, along with aggressive dolphin watching tour boat behaviour, will continue to threaten the dolphin population.

(SOURCE: Mackelworth, P., Holver, D. and Fortuna, C.M. 2012. Unbalanced governance: The Cres-Lošinj special marine reserve, a missed conservation opportunity. *Mar. Pol.* 41: 126-133)

Call for a blue economy to protect the Mediterranean

A meeting between Mediterranean countries and the European Union in Paris (Paris Declaration) called for a 'blue' economy – a version of the Green Economy, applied to seas and oceans – to help fight the deterioration of the Mediterranean Sea. This effort seeks to continue the momentum provided by the entry into force of the Integrated Coastal Zone Management Protocol and the Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (the 'Offshore' Protocol). The Paris Declaration 1) reaffirms applying an ecosystem approach to the management of human activities; 2) agrees to develop a coherent, well-managed network of MPAs in the Mediterranean, the target being

[*] Department of Limnology and Oceanography, Faculty of Life Sciences, University of Vienna, Austria
[+]University Marine Biological Station Millport (University of London), Great Cumbrae, Scotland and Department of Environmental Science and Policy, George Mason University, Fairfax, Virginia, USA
[¥] Humane Society International, Washington, DC, USA

10% of the Mediterranean as MPAs by 2020; and 3) agrees to intensify efforts to curb marine pollution from land-based sources, including mercury, persistent organic pollutants and marine debris.

(SOURCE: 'News' section: Countries call for blue economy to protect the Mediterranean. 2012. *Mar. Pollut. Bull.* 64: 671)

Cetaceans can be used to help establish Marine Protected Areas in the Adriatic

Identifying Ecologically and Biologically Significant Areas (EBSAs) in the Adriatic Sea would pave "*the way for the further establishment of MPAs and, possibly, of Specially Protected Areas of Mediterranean Importance (SPAMIs) within the framework of the Barcelona Convention SPA/BD Protocol"*. The author points out that, among biogenic and physical features and various faunal elements, the presence of cetaceans can be used to refine the identification of EBSAs. Marine mammals in the Adriatic are represented by several odontocetes, although only the bottlenose dolphin is now regularly found in the northern part.

(SOURCE: Notabartolo di Sciara, G. 2010. Methods for the identification of EBSAs in the Adriatic Sea. 3rd International Workshop on Biodiversity in the Adriatic: towards a representative network of MPAs in the Adriatic. Piran, Slovenia. 16 pp.)

ACCOBAMS at the forefront of cetacean conservation in the Mediterranean and Black Seas

This comprehensive report provides an overview of cetacean species and their status in the region and then outlines the many threats currently facing these cetaceans. These threats – among them fisheries interactions, shipping interactions, habitat loss and pollution, noise, direct killing, and climate change – are compared to the situation eight years earlier and the changes highlighted. The legal framework is presented and the many deficits listed, including knowledge gaps and management shortcomings. Although the authors raise the possibility of drawing up a new strategy, they also conclude that many of the problems preventing cetaceans from reaching a favourable conservation status would be adequately addressed if the range states simply fully implemented and enforced the multiple obligations they have already committed to and that are already in force.

(SOURCE: Notarbartolo di Sciara, G. and Birkun, A. 2010. Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: An ACCOBAMS status report. ACCOBAMS, Monaco. 212 pp)

Habitat degradation

Fisheries interactions

Dolphins have minimal impact on fisheries in the western Mediterranean, but not vice-versa

In a study conducted in the Ionian Sea, Greece, the local populations of short-beaked common dolphins and bottlenose dolphins consumed 105 tons of biomass, whereas the local fishing fleet removed 3470 tons (3% vs 97% of total biomass removed). Trophic overlap between dolphins and fisheries depended strongly on the fishing gear used, and there was only minimal overlap between the two dolphin species. Nine purse seiners (only 3% of the active fleet) removed 32% of this biomass. The authors conclude that the ecological interactions between dolphins and fisheries in the western Mediterranean have minor effects on fisheries but that, conversely, "*prey depletion resulting from overfishing can negatively impact dolphins*".

(SOURCE: Bearzi, G., Agazzi, S., Gonzalvo, J. Bonizzoni, S., Costa, M. and Petroselli, A. 2010. Biomass removal by dolphins and fisheries in a Mediterranean Sea coastal area: Do dolphins have an ecological impact on fisheries? *Aquat. Conserv: Mar. Freshw. Ecosyst.* 20: 549-559)

Bycatch of endangered Mediterranean common dolphins could be reduced

The common dolphin population has experienced a severe decline in the Mediterranean. In addition to reduction in prey due to overfishing, bycatch is also a threat. Annual bycatch by pair trawlers off Spain in 2001 and 2003 was estimated at 394 dolphins, with most mortalities from May to September in the vicinity of the continental shelf break. This level exceeds 2% of the population and is therefore likely unsustainable. Hauling time, fishing depth and season were the key factors influencing bycatch. The levels of bycatch may rise further as pair trawlers are increasingly used to replace the drift nets banned by the European Union (to reduce bycatch of small cetaceans). These takes could be significantly reduced by restricting trawlers to operating in water deeper than 250m and probably avoided entirely by restriction to water deeper than 300m.

(SOURCE: Fernandez-Contreras, M.M., Cardona, L., Lockyer, C.H. and Aguilar, A. 2010. Incidental bycatch of short-beaked common dolphins (*Delphinus delphis*) by pairtrawlers off northwestern Spain. *ICES J. Mar. Sci.* 67: 1732-1738)

Bycatch of bottlenose dolphins in the Adriatic Sea

In compliance with European Regulation 812/2004, researchers coordinated a monitoring program of cetacean bycatch by Italian trawlers. The results of monitoring over 3000 hauls by pair trawlers in the Adriatic revealed a bottlenose dolphin bycatch rate of 0.0006 individuals per haul. This low number of deaths did not enable a reliable estimate of total mortality. More reliable estimates could soon be possible with the introduction of real-time electronic submission of fishing effort data, but the costs are considered to be prohibitive. Large bycatch estimates were obtained for other species of conservation concern, in particular rays and sharks, pointing to potential ecosystem-level effects from this fishery. The authors call for investing funds in testing and implementing mitigation measures rather than in the increased observer coverage necessary to arrive at better bycatch estimates.

(SOURCE: Fortuna, C.M., Vallini, C., Filidei, E. Jr., Ruffino, M., Consalvo, I., Di Muccio, S., Gion, C., Scacco, U., Tarulli, E., Giovanardi, O. and Mazzola, A. 2010. By-catch of cetaceans and other species of conservation concern during pair trawl fishing in the Adriatic Sea (Italy). *Chem. Ecol.* 26 (suppl.): 65-76)

Overfishing of sardines may have caused a dietary shift in Mediterranean striped dolphins

The progressive decline in sardine abundance due to overfishing in the western Mediterranean has apparently led to a dietary shift in striped dolphins from sardines to juvenile hake, cephalopods, anchovies and lanternfish. The reduction of fat-rich sardines in the diet could have numerous impacts, including physiological disorders, inadequate energy budgets, lower growth rates and changes in reproductive cycles. The authors conclude that overfishing has replaced pollutants as the main threat for this species, noting further that the population has probably not recovered well from the epizootic that decimated it in 1990.

(SOURCE: Gómez-Campos, E., Borrell, A., Cardona, L., Forcada, J. and Aguilar, A. 2011. Overfishing of small pelagic fishes increases trophic overlap between immature and mature striped dolphins in the Mediterranean Sea. *PLoS ONE* 6 (9): e24554, doi:10.1371/journal.pone.0024554)

Stranded Mediterranean cetaceans in Tunisia

A survey noted 132 cetacean strandings were reported along the Tunisian coastline between 1937 and 2009. More than 70% of these were reported during the period 2004-2009, after a stranding network was established. The common bottlenose dolphin and the fin whale were the main stranded species, with 83 and 21 cases respectively. Fishery interactions have the greatest impact on bottlenose dolphins. Due to a collapse in fish stocks in Tunisian waters, fishermen consider bottlenose dolphins to be direct competitors. They generally cut off the tail fluke of entangled animals to avoid greater damage to their gear, more recently resorting to intentional killings, largely of juveniles. Accidental captures of large cetaceans include two minke whales in a purse seine and drift net respectively, as well as two humpback whales in a driftnet and a gillnet respectively.

(SOURCE: Karaa, S., Bradai, M.N., Jribi, I., El Hili, H.A. and Bouain, A. 2012. Status of cetaceans in Tunisia through analysis of stranding data from 1937 to 2009. *Mammalia* 76: 21-29)

Longline bycatch of cetaceans in the Mediterranean

An observer program on longline fishing boats investigated bycatch rates by Spanish longliners in the western Mediterranean between 2000 and 2009. Fifty-six marine mammals were reported as bycatch; 59% were Risso's dolphins (striped dolphins, short-beaked common dolphins and long-finned pilot whales were also caught). Risso's dolphins were predominantly caught by 'Japanese longlines' or an infrequently used, experimental 'home-based longline' over the continental shelf. The authors conclude that "*controlling the use of* [Japanese longline gear] *over the continental shelf could strongly reduce the impact of these fisheries on populations of Risso's dolphin in the western Mediterranean*".

(SOURCE; Macías López, D.M., García Barcelona, S. Báez, J.C., de la Serna, J.M. and Ortiz de Urbina, J.M. 2012. Marine mammal bycatch in Spanish Mediterranean large pelagic longline fisheries, with a focus on Risso's dolphin (*Grampus griseus*). *Aquat. Liv. Res.* 25: 321-331)

Food patches created by human activity alter dolphin behaviour and distribution

Anthropogenic food patches – represented by aquaculture farms and fishing trawlers – affected the behaviour of bottlenose dolphins off Lampedusa Island, Italy. The distributions of some dolphin groups were associated with such food sources. Thus, these feeding opportunities directly affected these top predators and indirectly produced complex social responses based on the cohesion of such groups. Such altered social structure "*could have considerable impact on their long-term survival*".

(SOURCE: Pace, D.S., Pulcini, M. and Triossi, F. 2011. Anthropogenic food patches and association patterns of *Tursiops truncatus* at Lampedusa Island, Italy. *Behav. Ecol.* 23: 254-264)

Increasing aquaculture operations in the Mediterranean affect bottlenose dolphin populations

Marine aquaculture has increased considerably in the Mediterranean Sea in recent years. One study in western Greece showed that an increase in the number of aquaculture cages was responsible for an increase in dolphin presence near fish farms. Such open cage aquaculture benefits the dolphins by simplifying prey capture. These results were supported by a second study involving floating cages in Sardinia, Italy, where the predominant activity of bottlenose dolphins at the studied fish farm was foraging (predation and depredation). The occurrence of the dolphins was related to season and to the fish farming harvesting operations. A small part of the population interacted with the fish farm over a longer period of time. Moreover, the mean annual mortality rate related to the fish farm was 1.5% for the dolphin community: five dolphins were found entangled in predator nets around the fish farm cages between 2005 and 2008. The authors call for considering such site fidelity and residence patterns in developing coastal management initiatives. A third paper – the first on acoustic harassment devices in relation to bottlenose dolphins and a marine finfish farm – reported that these devices had no significant and immediate effect on the dolphins' presence, distance from the AHD, group size or time spent in the fish farm area.

(SOURCES: Piroddi, C., Bearzi, G. and Christensen, V. 2011. Marine open cage aquaculture in the eastern Mediterranean Sea: A new trophic resource for bottlenose dolphins. *Mar. Ecol. Prog. Ser.* 440: 255-266; Lopez, B.D. Bottlenose dolphins and aquaculture: Interaction and site fidelity on the north-eastern coast of Sardinia (Italy). 2012. *Mar. Biol.* 159: 2161-2172; Lopez, B.D. and Marino, F. 2011. A trial of acoustic harassment device efficiency on free-ranging bottlenose dolphins in Sardinia, Italy. *Mar. Freshw. Behav. Phy.* 44: 197-208)

Status of Mediterranean common dolphin

The common dolphin was formerly the most abundant cetacean in the Mediterranean, but has declined drastically since the 1960s and now inhabits only a few delimited areas. It has been classified as 'Endangered' by the IUCN. This decline has been attributed to overexploitation of their main prey (sardines, anchovies). This study shows that, as opposed to merely closing certain fisheries, only a total closure of all fisheries would allow the common dolphin population to increase markedly. The status of the common dolphin in the Mediterranean closely reflects that of overall ecosystem change and degradation, pointing to its importance as an indicator species.

(SOURCE: Piroddi, C., Bearzi, G., Gonzalvo, J. and Christensen, V. 2011. From common to rare: The case of the Mediterranean common dolphin. *Biol. Conserv.* 144: 2490-2498)

Marine Debris

High densities of microplastics in western Mediterranean

Almost all of the 40 stations sampled in one study of the western Mediterranean in 2010 contained microplastics (0.3-5mm). The abundances were significantly higher than in the Caribbean or North Atlantic, with peak values being within the same order of magnitude as in the North Pacific Gyre, a known area of heavy marine debris accumulation. The average ratio between microplastics and zooplankton was high enough to be a cause for concern regarding zooplankton feeders. Evidence for the consumption and metabolism of this material by cetaceans has recently been reported (toxic residues [phthalates] of microplastics identified in the blubber of stranded fin whales in the Mediterranean [Fossi *et al*. 2012]).

(SOURCE: Collignon, A., Hecq, J.-H-, Glagani, F., Voisin, P. and Collard, F. 2012. Neustonic microplastic and zooplankton in the North Western Mediterranean Sea. *Mar. Pollut. Bull.* 64: 861-864)

Ingested marine debris kills a sperm whale in the Mediterranean

A 10m-long male sperm whale was found stranded in southeast Spain, its stomach containing 20kg of plastic material. The cause of death was rupture of the stomach due to plastic, coupled with starvation (intestinal blockage). Most of the material was identified as stemming from the greenhouse agriculture industry (including 30m² of greenhouse cover material), pointing to a previously unrecognized source of marine debris and insufficient waste disposal by this industry in the Mediterranean. This is the second report of sperm whale death due to debris ingestion in this area and the fourth case worldwide. Marine debris (mostly plastics) is currently one focus of the IWC's standing working group on environmental concerns.

(SOURCE: de Stephanis, R., Gimenez, J., Caropinelli, E., Gutierrez-Exposito, C. and Canadas, A. 2013. A main meal for sperm whales: Plastic debris. *Mar. Pollut. Bull.* 69: 206-214)

Microplastics identified for the first time as a potential threat to large cetaceans in the Mediterranean

The threat of marine debris (mostly plastics) to cetaceans has been thought to involve larger items for the most part, leading to entanglement or blockage of the digestive tract after ingestion. Results from examinations of the Mediterranean fin whale suggest the emergence of a new plastics-related threat to baleen whales. The authors collected microplastics in the Pelagos Sanctuary, identified high amounts of toxic residues (phthalates) of microplastics in plankton samples, and identified these substances in the blubber of stranded fin whales. The authors conclude that phthalates could serve as a tracer for the ingestion of plastic by whales.

(SOURCE: Fossi, M.C., Panto, C., Guerranti, C., Coppola, D., Gianetti, M, Marsili, L. and Minutoli, R. 2012. Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale (*Balaenoptera physalus*). *Mar. Pollut. Bull.* 64: 2374-2379)

Chemical pollution

Mercury concentrations in Mediterranean dolphins

Mercury is a strong bioaccumulator and species such as dolphins, at the top of the food chain, have the highest concentrations in their tissues. An investigation of bottlenose and striped dolphins stranded along Italian coasts during the period 2000-2009 revealed highest concentrations in the liver. Different geographic areas in the Mediterranean are characterized by different values. The levels in these Italian specimens were exceeded only by those reported in an earlier study from French coasts. The values in the Mediterranean are generally higher than those from the same species in the Atlantic. This is partly because the Mediterranean is characterized by high natural sources of mercury (so-called mercuriferous belts), making any additional anthropogenic inputs a matter of concern.

(SOURCE: Bellante, A., Sprovieri, M, Buscaino, G., Buffa, G., di Stefano, V., Salvagio Manta, D., Barra, M, Filiciotto, F., Bonanno, A., Giacoma, V. and Mazzola, S. 2012. Stranded cetaceans as indicators of mercury pollution in the Mediterranean Sea. *Italian J. Zoo.* 79: 151-160)

Toxicological stress of cetaceans in the Mediterranean's largest marine sanctuary

The Pelagos Sanctuary is the only pelagic MPA in the Mediterranean and measures 90,000km². The levels of PCBs, DDTs and OCs in skin biopsies of striped dolphins within the sanctuary were1.7- and 1.5-fold higher than in two other tested areas (Ionian Sea, Italy; Strait of Gibraltar, Spain). The general toxicological stress level of the animals in the sanctuary was 1.4 times higher than at the other two sites, and this was correlated with lower genetic diversity in the sanctuary (*i.e.*, supporting an association between genetic diversity and an ability to manage toxicological stress). The authors conclude that the sanctuary has "*partially failed to fulfill its goal of significantly improving the conservation status of the area's cetacean populations*".

(SOURCE: Fossi, M.C., Pani, C., Marsili, L., Maltese, S., Spinsanti, G., Casini, S., Caliani, I., Gaspari, S., Munoz-Arnanz, J., Jimenez, B. and Finoia, M.G. 2013. The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin (*Stenella coeruleoalba*). *Mar. Pollut. Bull.* in press)

The herbicide atrazine still present in high concentrations in the Mediterranean 20 years after ban

The herbicide atrazine, a lipophilic persistent organochlorine, lost its approval in most northern European countries in the 1990s and was banned by the European Union in 2004. Its widespread occurrence in aquatic environments and its properties (including toxicity) make it a priority pollutant in the European Water Framework Directive. Maximum concentrations (31-41 ng/l) were found in Istanbul and the Dardanelles (indicating on-going contamination). A transformation product of atrazine, TERB, was recorded in the northern Adriatic Sea. Organochlorines have been associated with infertility, birth defects, tumours and other symptoms in cetaceans.

(SOURCE: Nödler, K., Licha, T. and Voutsa, D. 2013: Twenty years later – Atrazine concentrations in selected coastal waters of the Mediterranean and Baltic Sea. *Mar. Pollut. Bull.* in press)

DDTs, PCBs and heavy metals in eastern Mediterranean bottlenose dolphins

Mercury and other heavy metal concentrations in seven dolphins examined in 2006 from the eastern Mediterranean were similar to those in an earlier study conducted from 1994-2001, indicating stability over time. The total DDT and PCB concentrations were highest in the blubber. The blubber PCB values were an order of magnitude lower than those found in this and other delphinid species in the western Mediterranean, probably reflecting a lower rate of industrial waste input. Nonetheless, 15 different pesticides other than DDTs were detected in the various tissues. The high percentage of DDE in the total DDT concentration in these dolphins along the Israeli coast supports the

conclusion drawn elsewhere for the Mediterranean (Wafo *et al.* 2012) that the DDT is gradually degrading (into DDE) and that no significant new DDT is reaching the Mediterranean.

(SOURCE: Shoham-Frider, E., Kress, N., Wynne, D., Scheinin, A., Roditi-Elsar, M. and Kertem, D. 2009. Persistent organochlorine pollutants and heavy metals in tissues of common bottlenose dolphin (*Tursiops truncatus*) from the Levantine basin of the Eastern Mediterranean. *Chemosphere* 77: 621-627)

Organochlorine concentrations in Mediterranean dolphins may be declining

A comparison of the PCB and DDT concentrations in stranded striped dolphins in the Mediterranean between 2007 and 2009 revealed that the values of these organochlorines tended to decrease compared to studies conducted in the 1990s. Nonetheless, variable levels were detected in every tissue and organ examined (lung, muscle, liver, kidney, and blubber). Total PCBs were most abundant, followed by total DDT. DDE, as a breakdown product of DDT, made up 80% of the total DDTs, pointing to the on-going aging of DDT since the ban of its use in the Mediterranean basin in the late 1970s.

(SOURCE: Wafo, E., Risoul, V., Schembri, T., Lagadec, V., Dhermain, F., Mama, C. and Portugal, H. 2012: PCBs and DDTs in *Stenella coeruleoalba* dolphins from the French Mediterranean coastal environment (2007-2009): Current state of contamination. *Mar. Pollut. Bull.* 64: 2374-2379)

Disease and mortality events

General

Unusually high rate of cetaceans stranding along Turkish Black Sea coast in 2009

In a three week period, at least 114 cetaceans belonging to all three species known to inhabit the Black Sea (53 harbour porpoises, 9 common dolphins, 7 bottlenose dolphins, 45 unidentified) were reported dead along a 200km-long stretch of the western coast of the Turkish Black Sea. This represents 2.7 individuals per km. An additional nine common dolphins stranded alive. The authors conclude that most of the harbour porpoises found dead were related to bycatch. Two freshly stranded common dolphins were necropsied. They had empty stomachs as well as enlarged livers and spleens. The cause of this unusual mortality could not be determined, but no evidence for a dolphin morbillivirus (DMV) infection was found. An additional 23 cetaceans (mainly common dolphins) stranded alive in Ukraine (13), Georgia (5) and Bulgaria (5).

(SOURCE: Tonay, A.M., Dede, A., Öztürk, A.A., Ercan, D. and Fernández A. 2012. Unusual mass mortality of cetaceans on the coast of the Turkish Western Black Sea in summer 2009. *J. Black Sea/Med. Environ.* 18: 67-75. Birkun, A. Jr. 2009. The progress report on the implementation of the conservation plan for Black Sea Cetaceans November 2009 [October 2007-October 2009] Draft Doc. 12.6. BSC AG FOMLR Meeting Istanbul)

Harmful Algal Blooms (HABs)

Harmful algal blooms an issue in the Mediterranean

HABs are increasing in marine waters worldwide, including the Mediterranean. Two toxic benthic flagellates belonging to the family Ostreopsidaceae have been found with increasing frequency in several Mediterranean coastal areas. They produce palytoxin, one of the most potent non-protein marine toxins known. Palytoxin can cause mortality of benthic organisms, has noxious effects on humans, and shows high toxicity in mammals (LD50: 25-450 ng kg^{-1}). The Adriatic blooms appear to be more toxic than those occurring in other Italian areas. The authors point to the need for further studies to optimize the management of coastal monitoring.

(SOURCE: Accoroni, S. *et al*. (+14 authors). 2011. *Ostreopsis* cf. *ovata* bloom in the northern Adriatic Sea during summer 2009: Ecology, molecular characterization and toxin profile. *Mar. Pollut. Bull.* 62: 2512-2519)

Disease

First report of herpesvirus in Mediterranean cetaceans

The tissues of 5 of 8 striped dolphins from the cetacean morbillivirus mortality episode in 2007 contained 8 novel herpesvirus (HV) genetic sequences. The lack of HV lesions in these morbillivirus-infected individuals indicates that HV may not have contributed to mortality. Nonetheless, this is the first report of this disease agent in any cetacean in the Mediterranean and the first report of such a co-infection. The results suggest that HV may be common among Mediterranean striped dolphins, indicating further study on such co-infection and the potential pathogenicity of HV is needed.

(SOURCE: Belliére, E.N., Esperón, F., Arbelo, M., Munoz. M.J., Fernández, A. and Sánchez-Vizcaíno, J.M. 2010. Presence of herpesvirus in striped dolphins stranded during the cetacean morbillivirus epizootic along the Spanish coast in 2007. *Arch. Virol.* 155: 1307-1311)

Stranded dolphins affected by toxoplasmosis along two coasts of Italy

A total of 22 dolphins stranded in Italy were necropsied – 6 striped and 8 bottlenose dolphins along the Tuscan coast and 8 striped dolphins along the coast of the Ligurian Sea. Thirteen of the animals from Tuscany (93%) and 4 from the Ligurian Sea (50%) were infected by toxoplasmosis. Di Guardo *et al.* concluded that *Toxoplasma gondii* was the likely agent of the lethal brain lesions in the Ligurian animals. Pretti *et al.* concluded that the level of *T. gondii* infection along dolphins in the marine area of Tuscany was high. This protozoan probably causes abortion and death in several marine mammal species and is "*of potential concern to cetacean health and conservation*". The transmission pathway by which dolphins become infected remains unknown. Moreover, the fact that this part of the Ligurian Sea includes the Tuscan Archipelago National Park and is part of a cetacean sanctuary MPA underlines that protected areas afford little to no barrier to disease.

(SOURCES: Di Guardo, G, Proietto, U., Di Francesco, C.E., Marsilio, F., Zaccaroni, A., Scaravelli, D., Mignone, W., Garibaldi, F., Kennedy, S., Forster, F., Iulini, B. Bozzetta, E. and Casalone, C. 2013. Cerebral toxoplasmosis in striped dolphins (*Stenella coeruleoalba*) stranded along the Ligurian Sea coast of Italy. *Vet. Pathol.* 27: 245-253; Pretti, C., Mancianti, F., Nardoni, S., Ariti, G., Monni, G., Di Bello, D., Marsili, S. and Papini, R. 2010. *Rev. Méd. Vét-Toulouse* 161: 428-431)

First reports of brucellosis and of combined infections in Mediterranean cetaceans

An adult male fin whale found stranded on the Tyrrhenian coast of Italy had high organochlorine concentrations (DDT). The pathogens *Morbillivirus* and *Toxoplasma gondii* were also found in the animal. These pathogens have been found in several cetacean species, but these are the first reports of both occurring simultaneously in a mysticete and of DMV in the Mediterranean fin whale population. These results highlight the risk toxoplasmosis poses to cetaceans already immunosuppressed by concurrent factors such as infections and contaminants. In another report, *Brucella ceti* (dolphin type) was isolated from the brain, lung and intestinal lymph nodes of a stranded striped dolphin found in Tuscany, Italy in February 2012, on the Tyrrhenian coast of the Mediterranean Sea. The animal had severe meningoencephalitis lesions associated with the *Brucella*. *Toxoplasma gondii* was also detected in brain tissue. The authors note that "*While the occurrence of brucellosis has been reported frequently in striped dolphins from the Atlantic Ocean since 1996… no previous information on* Brucellae *colonizing marine mammals or cetaceans had been available from the Mediterranean Sea until now*".

(SOURCES: Mazaroli, S., Marcer, F., Mignone, W., Serracca, L., Goria, M., Marsili, L., di Guardo, G. and Casalone, C. 2012. Dolphin *Morbillivirus* and *Toxoplasma gondii* coinfection in a Mediterranean fin whale. *BMC Vet. Res.* 8: 20; Alba P., Terracciano , G., Franco, A., Lorenzetti, S., Cocumelli, C., Fichi, G., Eleni, C., Zygmunt, M.S., Cloeckaert, A., and Battisti, A. 2013. The presence of *Brucella ceti* ST26 in a striped dolphin (*Stenella coeruleoalba*) with meningoencephalitis from the Mediterranean Sea. *Vet. Microbio.* 164: 158-163)

Chronic dolphin morbillivirus infection in Mediterranean striped dolphins

In 1990 and 2006-07, epizootics caused by DMV struck striped dolphins along the Spanish Mediterranean coast, with high mortality rates. This study examined 118 dolphins stranded in three regions of Spain, with 25-29% showing unusual DMV infections localized in the central nervous system (brain). Larger animals were more susceptible than smaller ones. The authors believe that the infection occurs in two different forms: acute events with massive die-offs, and sub-acute or chronic cases localized in the brain. This latter infection is thought to be a widespread phenomenon in the western Mediterranean. It constitutes the most relevant single cause of stranding following a DMV epizootic and might even have a greater effect than the epizootic itself.

(SOURCE: Soto, S., Alba, A., Ganges, L., Vidal, E., Raga, J.A., Alegre, F., Gonzalez, B., Medina, P., Zorrilla, I., Martinez, J., Marco, A., Perez, M., Perez, B., Perez de Vargas, A., Valverde, R.M. and Domingo, M. 2011. Post-epizootic chronic dolphin morbillivirus infection in Mediterranean striped dolphins *Stenella coeruleoalba*. *Dis. Aquat. Org.* 96: 187-194)

Direct exploitation

Four to five million cetaceans hunted in 20th century – a history of Black Sea hunts

A recent review on the history of cetacean fisheries in the Turkish waters of the Black Sea gives an idea of the scale of depletion of these populations. Harbour porpoises, short-beaked common dolphins and common bottlenose dolphins were the main species caught in these fisheries. The first reported large-scale hunting of cetaceans in the area dates to 400 BC; hunting was outlawed in 1983. Initially dolphins were the main species targeted but by the late 1970s, 80% of the catch was harbour porpoises. An estimated 4-5 million dolphins and porpoises were hunted in the 20th century alone, but poor to no records were kept on catch composition, so extrapolating historical population data is difficult. Such large-scale hunting undoubtedly had a major impact on the ecosystem of the Black Sea.

(SOURCE: Tonay, A.M. and Öztürk, A.A.2012. Historical records of cetacean fishery in the Turkish seas. *J. Black Sea/Med Environ.* 18: 388-399)

Climate change

On-going and predicted effects of climate change in the Mediterranean

Using a representative area of the western Mediterranean as a case study for climate change effects on Mediterranean ecosystems, the authors report an increase in surface temperature of about 1.1°C in the last 35 years, a progressive salinization of intermediate and deep waters, and a strengthening of stratification. They predict a considerable decrease in rainfall and wind, warmer surface waters and a prolonged stratification period. The projected repercussions include mass mortalities of sessile invertebrates, increases in the smallest phytoplankton, proliferation of gelatinous carnivores, including jellyfish, and a faster acidification of seawater compared with the global oceans. These processes, along with their synergies, will affect all levels of the ecosystem and ecosystem function. These results support an earlier study (Gambaini *et al*.) predicting altered marine biodiversity and productivity, trophic web mismatches, higher incidences of diseases and toxic algal blooms. Gambaini *et al*. draw a link between climate change and cetaceans in the Mediterranean, specifically in potential changes to euphausiid shrimp species that form the main diet of Mediterranean fin whales.

(SOURCES: Calvo, E., Simó, R., Coma, R., Ribes, M, Pascual, J., Sabatés, A., Gili, J.M. and Pelejero, C. 2011. Effects of climate change on Mediterranean marine ecosystems: The case of the Catalan Sea. *Clim. Res.* 50: 1-29; Gambaini, D.D., Mayol, P., Isaac, S.J. and Simmonds, M.P. 2009. Potential impacts of climate change and greenhouse gas emissions on Mediterranean marine ecosystems and cetaceans. *J. Mar. Biol. Assoc.* 89: 179-201)

Climate shifts in the North Atlantic unlikely to change back

Long-term records of air temperature, rainfall and air pressure at sea level were analysed for two periods of warm water in the Atlantic. Since 1996 there has been an increase in temperature in the Atlantic, and the last time temperatures were at this level, it took 30 years before they cooled. Therefore, species shifts due to warming temperatures in the Atlantic are unlikely to change back in the near future. In addition, this ocean temperature will mean higher summer rainfall in northern Europe and the United Kingdom (which reported its wettest summer in 100 years in 2012), and drier, hotter summers in the Mediterranean, which will have ramifications for coastal ecosystems (*e.g*., more fresh water runoff in Northern Europe).

(SOURCE: Sutton, R.T. and Buwen Dong, B. 2012. Atlantic Ocean influence on a shift in European climate in the 1990s. *Nat. Geosci.* 5: 788–792)

Noise impacts

Noise and cetaceans in Mediterranean waters

In a special issue of *Marine Pollution Bulletin* devoted to cetaceans and military sonar, one paper outlined the progress made in recognising and tackling this issue in European waters, including the Mediterranean. Six species of beaked whales have been recorded in European waters. Regional conventions (ACCOBAMS and ASCOBANS), coupled with efforts in the European Union, such as the Marine Strategy Framework and the Habitats Directive (cetaceans provided 'strict protection'), have addressed the problem of anthropogenic sound, although other regional seas organisations (*e.g.*, OSPAR, Barcelona Convention) are still in early stages of engagement. The authors outline future proposals and recognise the difficulty in the transition from scientific research to policy implementation, underlining the urgency of this step in the case of naval sonar and associated beaked whale mortalities.

(SOURCE: Dolman, S.J., Evans, P.G.H., Notarbartolo di Sciara, G. and Frisch, H. 2011. Active sonar, beaked whales and European regional policy. *Mar. Pollut. Bull*. 63: 27-34)

Leisure boating displaces bottlenose dolphins

Intense leisure boating in the Cres-Lošinj archipelago in the northern Adriatic Sea caused significant seasonal displacement of bottlenose dolphins from noisy areas. In coastal areas, marine tourism contributes substantially to the overall sea ambient noise level. This noise may impair the dolphins' ability to use sound to communicate, navigate and forage. The resident bottlenose population has suffered a decline of about 40% between 1995 and 2006. Moreover, this area is an important nursing area, with frequent occurrence of mother/calf groups, and the authors interpret the absence of new-borns in the high impact area during the tourist season to indicate that more sensitive animals are being displaced. The authors call for development of appropriate conservation measures – speed limits, mandatory codes of conduct – to ensure that these important habitats are not abandoned in the future.

(SOURCES: Rako, N., Fortuna, C.M., Holcer, D., Mackelworth, P., Nimak-Wood, M., Pleslić, G., Sebastianutto, L., Vilibić, I., Wiemann, A. and Picciulin, M. 2013. Leisure boating noise as a trigger for the displacement of the bottlenose dolphins of the Cres-Lošinj archipelago (northern Adriatic Sea, Croatia). *Mar. Pollut. Bull.* 68 (1-2): 77-84; Rako, N., Picciulin, M., Mackelworth, P., Holcer, D., and Fortuna, C.M. 2012. Long-term monitoring of anthropogenic noise and its relationship to bottlenose dolphin (*Tursiops truncatus*) distribution in the Cres-Lošinj Archipelago, Northern Adriatic Sea. In: Popper, A.N and Hawkins, A. (eds), The Effects of Noise on Aquatic Life, *Adv. Exp. Med. Biol.* 730, DOI 10.1007/978-1-4419-7311-5_72)

GLOBAL

General

Odontocetes may recover less quickly than mysticetes after depletion

Odontocete populations do not appear to recover as quickly as mysticete populations after exploitation and depletion. This may be due to the life history, behavioural ecology and social behaviour of odontocetes. For example, reproductive success may rely on social cohesion and cooperation, through *e.g*., food sharing or defending against predators. Depleted populations may be less successful at these group behaviours. In addition, knowledge and cultural behaviours passed on to subsequent generations are important to survival. Social groups may have knowledgeable 'leaders', which if lost can result in a decline in the group's survivability and fitness. Because of low recovery potential, removal of only a few percent annually in odontocetes can lead to over-exploitation. The authors conclude "*the evidence for a lack of strong recovery in heavily exploited odontocete populations indicates that [their] management should be more precautionary*".

(SOURCE: Wade, P.R., Reeves, R.R. and Mesnick, S.L. 2013. Social and behavioural factors in cetacean responses to overexploitation: Are odontocetes less "resilient" than mysticetes? *J. Mar. Biol.* 2012: doi:10.1155/2012/567276)

Habitat degradation

Fisheries interactions

Major efforts being undertaken to detect derelict fishing gear at sea

Derelict fishing gear presents a threat of entanglement and ingestion to cetaceans and other marine animals. A special issue of *Marine Pollution Bulletin* has been devoted to outlining the increasing efforts to detect items such as (ghost) nets, line and buoys at sea, with a focus on the North Pacific. The efforts concentrate on understanding the characteristics of such gear, indirectly detecting them through (weather and ocean) modelling, and direct detection through remote sensing and aerial surveys. The ultimate goal of these multidisciplinary efforts, involving the so-called GhostNet Project, is to remove the items from the sea. A new project, WhaleWatch, uses satellite tracking to help reduce whale entanglement by determining areas whales are most likely to visit, thus identifying hotspots.

(SOURCE: *Mar. Pollut. Bull.* 2013. 65: 1-75; 'News' section: Satellite tracking to help reduce number of whales entangled in fishing gear. 2012. *Mar. Pollut. Bull.* 64: 1275)

Fishery interactions causing unsustainable mortalities in 86% of all toothed whale species worldwide

A report published by the Convention on the Conservation of Migratory Species of Wild Animals under the UN Environment Programme (UNEP/CMS) indicated that 86% of all toothed whales are suffering unsustainably high death tolls from entanglement in gillnets, traps, weirs, purse seines, longlines and trawls. Moreover, 50 species were affected by local hunting, deliberate killings or live-captures in 2011 (up from 47 in 2001). Finally, overfishing of predominant prey species threatened 13 species (up from 11 in 2001), which is associated with lack of food and forced dietary shifts. A Global Programme of Work for Cetaceans is being considered for adoption and would strengthen the role of UNEP/CMS.

(SOURCE: 'News' section. 2011. *Mar. Pollut. Bull.* 62: 2584)

Acidification

Dissolving shells observed in Southern Ocean invertebrates

Since the mid-1980s, the surface waters of the Southern Ocean have experienced a 30% increase in acidity due to increasing levels of dissolved carbon dioxide. Now, the shells of pteropod sea snails show evidence of dissolving. Because carbon dioxide dissolves more readily in cooler waters, the impacts of increasing ocean acidity are likely to be observed at the poles first. The impacts of increasing acidity on calcium carbonate-dependent krill, the foundation of most mysticete food webs, are unknown, but these results suggest negative impacts.

(SOURCE: Bednaršek, N., Tarling, G.A., Bakker, D.C.E., Fielding, S., Jones, E.M., Venable, H.J., Ward, P., Kuzirian, A., Lézé, B., Feely, R.A. and Murphy, E.J. 2012. Extensive dissolution of live pteropods in the Southern Ocean. *Nat. Geosci.* 5: 881-885)

Expert opinions on the impacts of ocean acidification

Fifty-three climate change experts were surveyed for their opinions on the potential impacts of ocean acidification. The experts agreed that non-anthropogenic ocean acidification occurred in the (geological) past; anthropogenic carbon dioxide emissions are the main reason behind current acidification; and anthropogenic ocean acidification will have impacts for centuries to come. They generally agreed that there will be impacts on biological and ecological processes and biogeochemical cycles. There was high agreement that there would be an impact on primary productivity in the oceans but less agreement as to the impact on oceanic trophic webs.

(SOURCE: Gattuso, J.-P., Mach, K. and Morgan, G. 2013. Ocean acidification and its impacts: An expert survey. *Climat. Change* 117: 725-738)

Disease and mortality events

Oil spills

Unusually high cetacean mortality rate in the Gulf of Mexico

In April 2010, the US government declared an unusual mortality event (UME), due to an unusually high number of cetacean strandings in the Gulf of Mexico. The UME began in February 2010, with 114 cetaceans stranding before the Deepwater Horizon oil spill into the Gulf of Mexico (30 April). During and immediately after the spill, an additional 122 cetaceans stranded. From 3 November 2010 to 7 April 2013, 694 cetaceans stranded (although six were killed in a scientific research project and one during dredging activity). The majority of the stranded animals were common bottlenose dolphins but sperm whales were also reported. From 2002-2009 the average annual number of stranded cetaceans in the Gulf was 70. The actual mortality is likely to be at least an order of magnitude higher than the stranding rate (Williams *et al.*). In the heavily oiled Barataria Bay, dolphins were reported as underweight, with low hormone and blood sugar levels and liver lesions – signs that were not seen in unoiled areas and may constitute a link between the oil spill and delayed mortality.

(SOURCE: NOAA. 2011. http://www.nmfs.noaa.goc/pr/health/oilspill/mammals/htm; NOAA. 2013. http://www.nmfs.noaa.gov/pr/health/mmume/cetaceam_gulfofmexico_faq.htm; Williams, R., Gero, S., Bejder, L., Calambokidis, J., Kraus, S.D., Lusseau, D., Read, A.J. and Robbins, J. 2011. Underestimating the damage: Interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. *Conserv. Lett.* 4: 228-233)

Decrease in sperm whales near Deepwater Horizon oil spill site

Passive acoustic monitoring of sperm whales has been on-going in the Gulf of Mexico for several years. Researchers compared baseline data in 2007 to those from just after the Deepwater Horizon oil spill in 2010. They found that sperm whale abundance and acoustic activity nine miles from the spill site had decreased by a factor of 2, but there was increased acoustic activity 25 miles away. The animals may have shifted their distribution due to decreased food availability or noise disturbance from increased boat traffic in the spill area. The sperm whale population was estimated at 1,665 in 2004, with a potential biological removal level of 2.8 animals a year. This has likely been exceeded since the oil spill, as sperm whales have been reported in the Gulf of Mexico UME; therefore, determining impacts of this spill on the sperm whale population should be prioritized.

(SOURCE: Ackleh, A.S., Ioup, G.E., Ioup, J.W., Ma, B., Newcomb, J.J., Pal, N., Sidorovskaia, N.A. and Tiemann, C. 2012. Assessing the Deepwater Horizon oil spill impact on marine mammal population through acoustics:

Endangered sperm whales. *J. Acoust. Soc. Amer*. 131 2306-2314; Waring, G.T., Josephson, E., Maze-Foley, K., and Rosel, P.E. (eds). 2012. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2011. NOAA Tech Memo NMFS NE 221. National Marine Fisheries Service, Woods Hole, MA)

Climate change

Climate change is shifting the distribution of fishery species

Analysis of fisheries catch and survey data have found a link between climate change and shifting distributions and fishery catch levels. Warmer water species can be found at higher latitudes, whereas there has been a decrease in tropical and sub-tropical species. This is directly related to increasing sea temperatures. The authors warn that "*changes in catch composition have direct implications for coastal fishing communities, particularly those in tropical developing countries, which tend to be socioeconomically vulnerable to the effects of climate change*". This study may have implications for cetacean prey species and also research on ecosystem modelling, especially for tropical and polar ecosystems as the warmer water species move out and into these regions, respectively.

(SOURCE: Cheung, W.W.L., Watson, R. and Pauly, D. 2013. Signature of ocean warming in global fisheries catch. *Nature* 497: 365-368)

Greenland ice sheet may be more stable than Antarctic, but is vulnerable

Ice drilling data show that Greenland temperatures were on average 8°C higher 115,000-130,000 years ago, but 75% of the ice sheet remained intact. These data help allay concerns regarding present-day ice sheet melting; complete melt could increase sea levels by ~8m. However, during this prehistoric warm period there was in fact an 8.5m rise in sea level, and if this rise was not due to massive loss of Greenland ice, it is believed that it was due to loss of ice in Antarctica. The temperature threshold for completely melting the Greenland ice sheet was estimated to be approximately 0.8°C (which has already happened) to 3.2°C, with a best estimate of 1.6°C above pre-industrial temperatures. Complete melt of the >3km thick ice sheet in an 8^{o}C-increase scenario would potentially take 2000 years. A 2°C temperature increase (the current upper level limit for international policy makers) would lead to complete melt in 50,000 years.

(SOURCES: Dahl-Jensen, D. *et al*. 2013. Eemian interglacial reconstructed from a Greenland folded ice core. *Nature* 493: 489-494; Robinson, A., Calov, R. and Ganopolski, A. 2012. Multistability and critical thresholds of the Greenland ice sheet. *Nat. Clim. Change* 2: 429-432)

Ice sheet dynamics in Greenland and Antarctica and sea level rise

Analysis of satellite data and ice sheet loss estimates determined that ice sheets in Greenland and Antarctica are losing three times as much ice as 20 years ago. The rate of melting in Greenland is particularly fast – five times greater than in the mid-1990s. This ice loss is contributing 0.6mm to the current observed sea level rise of 3mm per year. Furthermore, data from the ICESat satellite indicate that the thickness of ice shelves surrounding Antarctica has decreased. This thinning is attributed to warming patterns in underlying Southern Ocean waters, rather than air temperatures. As ice sheets lose mass, they can no longer hold back land-based glaciers; glacier speed increases, which increases deposition of land-based ice into the ocean, which in turn contributes to sea level rise. Warm water currents are also likely to cause significant melting of the Filchner-Ronne ice shelf in the Weddell Sea by 2100. The shelf is currently lying on the rim of a basin in the underlying bedrock and an influx of warmer water could cause the shelf to detach into the ocean. Researchers warn that loss of the Filchner-Ronne ice sheet will lead to additional losses of the West Antarctic Ice Sheet, whose total loss could lead to a 6m or more increase in sea level.

(SOURCES: Humbert, A. 2012. Cryospheric science: Vulnerable ice in the Weddell Sea. *Nat. Geosci.* 5: 370-371; Pritchard, H.D., Lightenberg, S.R.M., Fricker, H.A., Vaughan, D.G., van den Broeke, M.R. and Padman, L. 2012. Antarctic ice-sheet loss driven by basal melting of ice shelves. *Nature* 484: 502-505; Ross, N., Bingham, R.G., Corr, H.F.G., Ferraccioli, F., Jordan, T.A., Le Brocq, A., Rippin, D.M., Young, D., Blankenship, D.D. and Siegert, M.J. 2012. Steep reverse bed slope at the grounding line of the Weddell Sea sector in West Antarctica. *Nat. Geosci.* 5: 393-396; Shepherd, A. *et al.* 2012. A reconciled estimate of ice-sheet mass balance. *Science* 338: 1183-1189)

Anthropogenic carbon dioxide emissions are still increasing

In 2011, anthropogenic greenhouse gas emissions rose by 3%, to a total of 38.2 billion tons of carbon dioxide. Most of this increase was the result of higher levels produced by China (whose emissions rose by 10%) and India (7%). Of the ten highest carbon dioxide emitting countries, only the USA and Germany decreased their emissions in 2011. The authors state that "*significant emission reductions are needed by 2020 to keep 2 °C as a feasible goal*" and "*A delay*

in starting mitigation activities will lead to higher emission rates, higher costs, and the target of [a global warming temperature rise] remaining below 2 °C may become unfeasible".

(SOURCE: Peters, G.P., Andrew, R.M., Boden, T., Canadell, J.G., Ciais, P., Le Quéré, C., Marland, G., Raupach, M.R. and Wilson, C. 2013. The challenge to keep global warming below 2 °C. *Nat. Clim. Change* 3: 4-6)

Sea level rise is higher than predicted and may be extreme in the future

While temperature rises appear to be consistent with the projections made in the Intergovernmental Panel on Climate Change's (IPCC) most recent report (*i.e*., 0.16°C per decade), sea levels are rising 60% faster than its central projections. Satellite data show sea levels rising at a rate of 3.2mm a year, as opposed to the IPCC's most recent best estimate of 2mm a year. Data collected on rates of sea level rise along the coast of the northeastern USA found levels increasing at rates 3-4 times the global average due to oceanographic effects. These areas include critical habitat for right whales, amongst other species. A modelling exercise showed that introducing emissions caps limiting global temperature rise to 1.5°-2° C will nonetheless result in a 75-80cm rise in sea level in the next 100 years. If emissions were left unchecked, sea level rise would be 1m or more. With emissions caps, sea level increase was projected to be 2.7 m – but potentially up to 4m – by 2300.

(SOURCES: Rahmstorf, S., Foster, G. and Cazenave, A. 2012. Comparing climate projections to observations up to 2011 *Environ. Res. Lett.* 7:doi:10.1088/1748-9326/7/4/044035; Sallenger, A.H., Doran, K.S. and Howd, P.A. 2012. Hotspot of accelerated sea-level rise on the Atlantic coast of North America. *Nat. Clim. Change* 2: 884–888; Schaeffer, M., Hare, W., Rahmstorf, S and Vermeer, M. 2012. Long-term sea-level rise implied by 1.5 °C and 2 °C warming levels. *Nat. Clim. Change* 2: 867–870)

Current temperatures unprecedented

A recent Bayesian analysis of ice cores, tree rings and lake sediment samples going back 600 years found that current northern hemisphere temperature extremes have been unprecedented. The temperatures in the summers of 2005, 2007, 2010 and 2011 were significantly higher than the average summer temperatures going back to 1400. Going back 11,300 years (*i.e.,* the onset of the Holocene era), 73 temperature proxy studies found a ~0.7°C cooling beginning less than 5000 years ago (with a ~2°C cooling in the North Atlantic), with the coolest period during the 'little ice age' 200 years ago. Current temperatures are warmer than 75% of the Holocene era, and IPCC temperature predictions for 2100 are warmer than the temperatures for the entire Holocene.

(SOURCES: Tingley, M. and Huybers, P. 2013. Recent temperature extremes at high northern latitudes unprecedented in the past 600 years. *Nature* 496: 201-205; Marcott, S.A., Shakun, J.D., Clark, P.U. and Mix, A.C. 2013. A reconstruction of regional and global temperature for the past 11,300 years. *Science* 339: 1198-1201)

Noise impacts

Effects of sonar signals on bottlenose dolphins

Thirty common bottlenose dolphins in the US Navy program were exposed to mid-frequency sonar signals (1 second duration; 3.25–3.45 kHz) and their behaviours recorded, *e.g*., changes in breathing rate and fluke/flipper slapping. Dolphins were exposed to signals at 115, 130, 145, 160, 175 or 185 dB re 1 μPa (rms) sound pressure level (SPL). The study found the occurrences and 'severity' of behaviours increased with SPL. Although 'habituation' was reported at SPLs below 160dB, SPLs above 175 dB always caused responses and at 185 dB, all dolphins "*refused to participate*" in the study. The researchers noted that the responses of the dolphins "*are likely not directly transferrable to conspecifics in the wild. The dolphins have years of experience under stimulus control, which is a necessary condition for the performance of trained behaviors, and they live within an environment with significant boating activity. These factors likely impact the threshold of responsiveness to sound exposure, potentially in the direction of habituation or increased tolerance to noise"*.

(SOURCE: Houser, D.S., Martin, S.W. and Finneran, J.J. 2013. Exposure amplitude and repetition affect bottlenose dolphin behavioral responses to simulated mid-frequency sonar signals. *J. Exp. Mar. Biol. Ecol.* 443: 123-133)

Common dolphin stranding in UK linked to naval exercises

At least 26 dolphins died in a mass stranding event in Falmouth Bay, Cornwall on 9 June 2008. The animals had been feeding well and their auditory tissues appeared normal, although five animals had microscopic haemorrhages in the ear and one of these had inflammation of the inner ear. The animals did not test positive for algal toxins and contaminant levels were low. No signs of gas/fat embolism, disease, bycatch or ship strike were noted. Four days before the stranding event, military exercises (incorporating sonar use) were used in the area, with helicopter

exercises on the morning of the stranding event. The authors determined "*naval activity to be the most probable cause of the Falmouth Bay [mass stranding event]*". The authors suggest that the stranding event was a two-stage process; the exercises drove these pelagic dolphins into the inshore waters of Falmouth Bay and then helicopter exercises drove them to strand.

(SOURCE: Jepson, P.D., Deaville, R., Acevedo-Whitehouse, K., Barnett, J., Brownlow, A., Brownell, R.L., Clare, F.C., Davison, N., Law, R.J., Loveridge, J., Macgregor, S.K., Morris, S., Murphy, S., Penrose, R., Perkins, M.W., Pinn, E., Seibel, H., Siebert, U., Sierra, E., Simpson, V., Tasker, M.L.,Tregenza, N., Cunningham, A.A. and Fernández, A. 2013. What caused the UK's largest common dolphin (*Delphinus delphis*) mass stranding event? *PLoS ONE* 8: e60953)

Beluga heart rate significantly increases during sound exposure

A beluga whale was exposed to sound of differing durations and frequencies while monitoring its heart rate. Heart rate increased significantly, to over double the control heart rate, with the maximum heart rate occurring when the whale was exposed to sound frequencies of 19-27 kHz. The whale had a significantly higher heart rate at higher frequencies (54-78 kHz and 78-108 kHz). Not only did heart rate increase significantly when the noise was initiated, but when the noise stopped, heart rate decreased significantly, regardless of duration of exposure. The heart rate was also affected by sound intensity, with heart rate increase at 140dB exposure significantly less than at 150dB exposure, and significantly higher at 160dB exposure. Heart rate response showed no signs of habituation. The respiration rate of the animal also increased significantly during the first minute of exposure, but this was not correlated with heart rate. "*Tachycardia is considered a cardiovascular component of the stress reaction, indicator of animal defense reaction and level of 'social' stress*" and "*severe tachycardia*" developed in the beluga at even relatively low noise intensities (*i.e.*, 140dB). These results could be an indicator of a relatively severe physiological stress response to anthropogenic noise exposure in beluga whales at levels as low as 140dB.

(SOURCE: Lyamin, O.I., Korneva, S.M., Rozhnov, V.V. and Mukhametov, L.M. 2011. cardiorespiratory changes in beluga in response to acoustic noise. *Doklady Akademii Nauk* 440: 704-707 [In Russian])

Behavioural changes in beaked whales in response to shipping noise

The acoustic responses of Blainville's beaked whales to ship noise (206 dB re 1 µPa broadband) were recorded using hydrophones in a military range in the Bahamas. The authors report "*that broadband ship noise caused a significant change in beaked whale behavior up to at least 5.2 kilometers away from the vessel*". At this distance, the received level of sound was estimated at 135 dB re 1 µPa, using simple sound propagation models. Although the whales did not cease foraging, "*[t]he concern about such behavioral changes is thus likely to be chronic rather than acute, with a progressive reduction of condition associated with the cumulative behavioral disruption. Such energetic deficiencies have the potential to lead to impacts on individual survival and reproductive capability and, ultimately, could lead to population decline*". The authors warn that this adds to increasing evidence that broadband shipping noise can negatively affect odontocetes.

(SOURCE: Pirotta, E., Milor, R., Quick, N., Moretti, D., Di Marzio, N., Tyack, P., Boyd, I., and Hastie, G. 2012.Vessel noise affects beaked whale behavior: Results of a dedicated acoustic response study. *PLoS ONE* 7: e42535, pp 1-8)

Shipping noise causes chronic stress in whales

After 11 September 2001, there was a dramatic decrease in shipping traffic in the Bay of Fundy, Canada and a 6dB shift in associated low frequency (<150Hz) shipping noise. An analysis of stress-related hormone markers in faecal samples of North Atlantic right whales reported a decrease in stress hormones coincident with this decrease in ocean noise. The authors note that "*[t]his is the first evidence that exposure to low-frequency ship noise may be associated with chronic stress in whales*" and, as stress can affect reproduction and other life history and health parameters, this has implications for the recovery of depleted whale species.

(SOURCE; Rolland, R.M., Parks, S.E., Hunt, K.E.,Castellote, M., Corkeron, P.J., Nowacek, D.P., Wasser, S.K., and Kraus, S.D. 2012. Evidence that ship noise increases stress in right whales. *Proc. Royal Soc. B* 279: 2363-2368)

Minke whale hearing and anthropogenic noise

The hearing abilities of baleen whales are difficult to ascertain. An anatomically accurate computer model was developed of northern minke whale hearing structures to determine their hearing range. The model estimated that a minke whale's best hearing range was 30Hz-7.5 kHz or 100Hz-25 kHz. The exercise determined that "*many anthropogenic noise sources operate at similar frequencies to those heard by the minke whale*", including shipping

noise, seismic surveys and military sonar (*i.e.*, 1-10 kHz). The latter is of particular interest, as several minke whales have stranded during atypical mass strandings linked to military exercises (*e.g.*, in 2000 in the Bahamas).

(SOURCE: Tubelli, A.A., Zosuls, A., Ketten, D.R., Yamato, M. and Mountain, D.C. 2012. A prediction of the minke whale (*Balaenoptera acutorostrata*) middle-ear transfer function. *J. Acoust. Soc. Amer.* 132:3263-3272)

Table 1. PCB levels in striped dolphins from the Italian coast of the Adriatic Sea (n=17)

Maximum levels ($\mu g.g^{-1}$ wet weight)	Melon	Blubber	Liver	Kidney	Lung	Heart	Muscle
ΣPCB	61.869	69.822	17.270	1.191	2.277	2.011	2.104
ΣTEQ $ng.g^{-1}$ wet weight	56.813	120.205	16.908	1.874	1.673	1.413	0.391

(SOURCE: Storelli, M.M., Barone, G.,Giacominelli-Stuffler, R. and Marcotrigiano, G.O. 2012. Contamination by polychlorinated biphenyls (PCBs) in striped dolphins (*Stenella coeruleoalba*) from the Southeastern Mediterranean Sea. *Environ. Monit. Assess.* 184: 5797-5805)

Table 2. Toxic trace element levels in dolphins from the Croatian coast of the Adriatic Sea

Maximum levels ($\mu g.g^{-1}$ wet weight)	Common bottlenose dolphin (n= 14)	Striped dolphin (n=5)	Risso's dolphin (n=4)
As (liver)	8.95	5.06	4.69
Cd (kidney)	10.1	17.6	16.8
Hg (liver)	1790	295	1738
Pb (liver)	0.38	0.094	1.15

(SOURCE; Bilandžić, N., Sedak, M., Đokić, M,. Gomerčić, M.Đ., Gomerčić, T., Zadravec, M., Benić, M. & Crnić, A.P. 2012. Toxic element concentrations in the bottlenose (*Tursiops truncatus*), striped (*Stenella coeruleoalba*) and Risso's (*Grampus griseus*) dolphins stranded in Eastern Adriatic Sea. *Bull. Environ. Contam. Toxic.* 89: 467-473)

ACKNOWLEDGMENTS

The editors once again thank David Janiger for providing his database of recently published marine mammal papers and for supplying .pdf copies of difficult-to-obtain papers. Alexei Birkun, Antonella Arcangeli, Frederic Briand, Antonio Fernandez, Caterina Fortuna, Sylvia Frey, Dani Kerem, Giuseppe Notarbartolo di Sciara, Fabian Ritter, and Renaud de Stephanis sent us relevant literature or made connections to important sources. The editors are especially grateful to the Government of Austria and Humane Society International for continuing to provide support for SOCER preparation, as requested by Resolution 2000-7. We also thank the IWC Secretariat for allotting funds for preparing SOCER 2013.

Appendix 1

GLOSSARY

Species glossary

Beluga whale	*Delphinapterus leucas*
Blainville's beaked whale	*Mesoplodon densirostris*
Common bottlenose dolphin	*Tursiops truncatus*
Common dolphin (short-beaked)	*Delphinus delphis*
Fin whale	*Balaenoptera physalus*
Harbour porpoise	*Phocoena phocoena*
Humpback whale	*Megaptera novaeangliae*

Long-finned pilot whale	*Globicephala melas*
Minke whale (northern)	*Balaenoptera acutorostrata*
Risso's dolphin	*Grampus griseus*
Sperm whale	*Physeter macrocephalus*
Striped dolphin	*Stenella coeruleoalba*
Anchovy	*Engraulis encrasicolus*
Hake	*Merluccius merluccius*
Lanternfish	*Diaphus* spp
Sardine	*Sardina pilchardus*
Krill	*Euphausia* spp.

Glossary of terms

ACCOBAMS: Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area.

AHD: Acoustic harassment device – these devices are intended to produce high intensity sounds that will actively displace predators from an anthropogenic food source, such as a fish farm cage.

ASCOBANS: Agreement on Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas.

Atypical mass stranding: A stranding of two or more animals, not a mother-calf pair, that occurs over an extended geographical area (in a relatively short period of time) instead of in a single location.

Barcelona Convention and SPA/BD Protocol: The Barcelona Convention is the Convention for the Protection of the Mediterranean Sea against Pollution. The SPA/BD Protocol is the Mediterranean's main tool for implementing the 1992 Convention on Biological Diversity.

Benthic: Of or related to the bottom level of the ocean, including the sediment or ocean floor.

Bioaccumulator: A pollutant that increases in concentration from the environment to the first and subsequent organisms in a food chain.

Cephalopod: Marine molluscs, such as squid or octopus.

dB: Decibel – a logarithmic measure of sound pressure level.

DDE: The organochlorine dichlorodiphenyldichloroethylene, a breakdown product of the pesticide DDT.

DDT: The organochlorine pesticide dichlorodiphenyltrichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Depredation: In ecology, when animals feed on anthropogenically available resources, such as dolphins taking fish on lines or elephants eating crops.

DMV: Dolphin morbillivirus.

EBSA: Ecologically and Biologically Significant Area(s).

Epizootic: A rapid outbreak of disease in an animal population.

Euphausiid: Of the family Euphausiidae, to which krill belong (may also include the single species found in the family Bentheuphausiidae).

Flagellate: An organism with a whip-like organelle called a flagella – some zooplankton are flagellates.

HAB: Harmful algal bloom.

HV: Herpesvirus, a large family of viruses that cause disease in animals, such as chicken pox or mononucleosis.

Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz = 1000 Hertz).

Holocene era: Geological epoch that began about 12,000 to 11,500 years ago and continues to the present.

Indicator species: Species that can provide information on ecological changes and give early warning signals regarding ecosystem processes due to their sensitive reactions to them. They can also be called sentinel species.

IPCC: International Panel on Climate Change.

IUCN: International Union for Conservation of Nature.

Lipophilic: Capable of dissolving in lipids (fats); having an affinity for lipids.

Meningoencephalitis: A medical or veterinary condition that simultaneously resembles both meningitis, which is an infection or inflammation of the membranes that envelop the central nervous system, and encephalitis, which is an infection or inflammation of the brain.

MPA: Marine protected area.

Morbillivirus: A family of viruses that are typically highly infectious and pathogenic – the family includes measles, dog distemper and dolphin morbillivirus. A number of mass mortality events have been associated with viruses from this family.

ng: Nanogram.

OC: Organochlorine – organic compounds that contain chlorine. Many are toxic and used as pesticides. Most of these compounds persist in the environment (are not biodegradable) and also tend to accumulate in fatty tissue (*e.g.*, blubber) of cetaceans and other marine organisms.

OSPAR: Oslo/Paris Convention for the Protection of the Marine Environment of the North East Atlantic.

Pathogen: A disease-causing agent (*e.g.*, bacterium, virus).

PCB: Polychlorinated biphenyls (209 different forms that contain differing numbers of chlorine atoms arranged in various positions on the aromatic rings) are industrial organochlorines that were manufactured to be used in electrical transformers and other applications. These man-made chemicals do not occur naturally and all traces reflect pollution.

Phthalates: Esters of phthalic acid, used mainly as plasticizers (substances added to plastics to increase their flexibility, transparency, durability, and longevity). They are used primarily to soften polyvinyl chloride.

Pteropod: Specialised free-swimming pelagic sea snails and sea slugs.

Sessile: Fixed in one place or immobile – organisms such as sponges and barnacles are sessile.

SPL: Sound pressure level – a measure of the intensity of sound, in decibels.

Stratification: The formation of water layers based on salinity and temperature.

Tachycardia: Heart rate that exceeds the normal range for a species.

TEQ: Toxic equivalent; the overall toxicity or environmental threat posed by a set of closely related pollutants.

TERB: Terbuthylazine, a breakdown product of atrazine.

Toxoplasma gondii: A parasitic one-celled organism that causes the disease toxoplasmosis.

Toxoplasmosis: See *Toxoplasma gondii*.

Trophic web: Levels or connections of consumption (*e.g.*, plant-herbivore-carnivore) in an ecosystem.

UME: Unusual mortality event.

UNEP/CMS: The Convention on the Conservation of Migratory Species of Wild Animals under the United Nations Environment Programme.

μPa: Micropascal, a unit of pressure.

Wet weight: A basis of measurement whereby concentrations of a substance are compared with content of a material without water removed.