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FOREWORD

Integrating science and management for marine mammal conservation

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For several centuries, marine mammals were viewed primarily as targets for human exploitation, for their meat and a wide variety of other products. During the first half of the twentieth century, various technological developments resulted in a marked increase in pressures upon marine mammal populations—not just through direct hunting but also from commercial fisheries, pollution, habitat degradation and disturbance. This drew public attention to their plight, and scientific endeavour that had largely been directed towards academic issues started to include studies that could be applied to conservation and management. Two relatively new threats face some marine mammals: collisions between ships and whales, both odontocetes and mysticetes, are nowadays regularly reported from all the world's oceans, representing, in some cases, one of the major causes of human induced mortality, and posing serious threats to the survival of particular species such as the northern right whale (Kraus *et al.*, 2005; Panigada *et al.*, 2006; Knowlton & Brown, 2007); and mid-frequency active sonar used by the military to detect submarines has been strongly implicated in recent mass-strandings of beaked whales such as the Cuvier's beaked whale (Evans & Miller, 2004; Cox *et al.*, 2006). Nowadays, science and management are regularly conducted alongside one another although too often insufficient attention is paid to ensuring their full integration. A notable example of the lack of integration between science and management is the political decisions reached at annual meetings of the International Whaling Commission where national interests often take precedence at the expense of the Scientific Committee's advice.

Scientific research may be directed at aspects of the biology of one or more marine mammal species—behaviour, ecology, physiology, genetics and population biology to name just some. Aggregation behaviour for feeding, mating or giving birth may make groups of animals vulnerable to a particular anthropogenic activity. Species that favour particular habitats such as the slopes of deep canyons can be exposed to loud sounds; and physiological adaptations to deep diving may impose further constraints. Mating systems showing strong polygyny may result in small effective population sizes with potential consequences such as inbreeding depression. Making the connection between biological attributes of a local marine mammal population and the impact of a human activity is often difficult. Implementing an appropriate management or mitigation action is even harder, not least because ultimately it is the human activities which must be managed. The chronic failure of fisheries management over several generations well illustrates that we often lack a good understanding of the social and economic drivers underlying human impacts, or of the relationships between regulations, enforcement, and human activity. Yet this is the challenge that confronts us and which we need to address urgently, in order to allow marine mammal species and humans to coexist.

The theme of the European Cetacean Society's 21st Annual Conference, held in San Sebastián (Basque Country, Spain) in April 2007, was 'Integrating Science and Management for Marine Mammal Conservation'. Many of the contributions to the *Journal of the Marine Biological Association of the United Kingdom*'s second special issue on marine mammals (2008) provide new information that can inform conservation management. Some relate to developing technologies, such as Kyhn *et al.* (2008) who show how laboratory measurements on acoustic click detectors called T-PODs can be used to calibrate individual units with different sensitivities for use in the field, thus enhancing the utility of this new technique for long-term surveillance of the presence of echolocating odontocetes, such as the harbour porpoise. Another example is given by Sholl *et al.* (2008), who used cytochrome b DNA analysis to identify to species the love charms that appear in markets in the Amazonian region of Brazil. They found that the estuarine boto-cinza (*Sotalia guianensis*) was probably more under threat than the Amazonian river dolphin or boto and the tucuxi.

A number of papers in the present volume investigated the effects upon marine mammals of particular human activities, including ship strikes on large whales (particularly fin whale and grey whale) in the Pacific north-west of the United States (Douglas *et al.*, 2008); disturbance from high-speed pleasure craft on bottlenose dolphins in the Mississippi Sound (USA) (Miller *et al.*, 2008); incidental capture of Amazonian manatee calves in shrimp trawls and gillnets in NE Brazil (De Meirelles, 2008) and the levels of heavy metals (mercury, cadmium and zinc) in boto-cinza and franciscana in south-eastern Brazil (de Carvalho *et al.*, 2008).

Several other papers identify habitat needs of small cetaceans in different regions of the world, relating these to various environmental factors including the distribution of potential food sources. These include striped, bottlenose and Risso's dolphins in Spanish Mediterranean waters (Gómez de Segura *et al.*, 2008); Cuvier's beaked whale distribution in the north-west Mediterranean (Gannier & Epinat, 2008); fin whales in the central Mediterranean (Aïssi *et al.*, 2008); in north-east Scotland, white-beaked dolphins (Canning *et al.*, 2008), and bottlenose dolphins (Culloch & Robinson, 2008); and harbour porpoises in an area of tidal streams in south-west Wales (Pierpoint, 2008). Information on cetacean habitat requirements can help us to understand niche partitioning between species, as well as shifts in distribution related to climate variation and change. MacLeod *et al.* (2008) compare habitat use by white-beaked and common dolphins and suggest that habitat use in summer is partitioned in relation to water temperature. Santos *et al.* (2008) analyse strandings and diet of the striped dolphin, a species which has recently extended its range northwards and now occurs fairly regularly in Scottish waters.

One important challenge for the future is to integrate habitat modelling with the management of human impacts. The former field needs to move beyond descriptive statistical modelling to provide predictive models based on a good understanding of the mechanisms linking environmental characteristics and cetacean presence—see Redfern *et al.* (2006) for a review of techniques and MacLeod *et al.* (in press) for a comparison of the efficacy of several specific approaches. It is often said that habitat use by cetaceans relates to the habitat requirements of their prey. However, as shown recently by Torres *et al.* (in press), use of physical environmental features as proxies for prey distribution is ultimately likely to be more successful than using data on the prey, reflecting the ready (and often free) availability of accurate satellite-derived data on sea surface conditions, as compared to the practical difficulties and expense associated with adequately sampling the distribution of fish, cephalopods and crustaceans. The ability to predict where and when cetaceans occur (and an understanding of the uncertainty involved) can then be integrated into mitigation strategies to manage human impact on cetacean populations. The challenge will be to identify the most appropriate environmental parameters for predictive modelling of habitat use.

Marine Protected Areas or networks of MPAs represent an important tool to integrate science and management (Evans, 2008). One European example comes from the Pelagos Sanctuary for the Conservation of Mediterranean Marine Mammals, a large MPA established in 2002 by a joint declaration between the Governments of France, Italy and Monaco, and located in the western Mediterranean Sea (Notarbartolo di Sciara *et al.*, 2007). One of the needs of the Pelagos Sanctuary is information on critical habitats for cetaceans, to provide information for conservation and management in the area, which is characterized by high levels of anthropogenic pressure. Studies include spatial modelling to describe habitat use and preference of cetaceans, using physiographic (depth, slope and distance from the coast) and remotely sensed variables (sea surface temperature and chlorophyll-*a* concentration), to assess areas of particular importance for the species present in the area (Panigada *et al.*, 2008). Moulins *et al.* (2008) identify 'hotspots' and 'coldspots' for cetaceans within the Sanctuary. Anthropogenic impacts, such as maritime and leisure traffic, should also be considered when analysing critical habitats or areas of particular importance for cetaceans. Heavy traffic levels may displace animals from preferred habitats to less favourable areas (Fortuna, 2006). Increasingly, governments are coming to recognize the need for management to be more ecosystem-based, with protected areas only one of a number of necessary actions. If humans are to live in harmony with other marine life, then conservation interests on a broader scale will need to be considered, and as a basis for that, scientific study is a prerequisite.

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