2002–2010 Conservation Action Plan for the World's Cetaceans

Dolphins, Whales and Porpoises

Compiled by Randall R. Reeves, Brian D. Smith
Enrique A. Crespo and Giuseppe Notarbartolo di Sciara

IUCN/SSC Cetacean Specialist Group

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Dedication

Steve Leatherwood served as chairman of the IUCN/SSC Cetacean Specialist Group (CSG) from 1991 to 1997. He became ill in April 1996 and spent the next nine months battling cancer. Steve is remembered as a dedicated, hard-working, and effective leader of the CSG. During his tenure as chairman, he used his position as Director of Ocean Park Conservation Foundation to develop and maintain an impressive network of initiatives in eastern and southern Asia, focusing on river dolphins and coastal small cetaceans (Jefferson and Smith 1997). He was instrumental in establishing collaborations among cetacean researchers worldwide, and his influence on cetacean conservation and science continues to be felt.

Cetacean researchers **Emily Argo, Jackie Ciano**, and **Michael Newcomer**, and their pilot **Tom Hinds**, died in a plane crash off the northern coast of Florida, USA, on 26 January 2003, just as this Action Plan was being printed. The plane was flying routine surveys of a North Atlantic right whale calving ground to monitor migratory habits and calving rates for this highly endangered species, and to provide information on whale locations as part of a ship-traffic advisory program. The researchers and pilot are remembered fondly for their dedication to the conservation of cetaceans and other marine wildlife.

Foreword

Since the 1960s, the global volunteer network called the Cetacean Specialist Group (CSG) has played a major role in identifying problems of cetacean conservation and brokering approaches to their solution. The first CSG action plan appeared in 1988 and consisted mainly of a list of recommended research projects related to assessment and conservation. The next plan, published in 1994, updated and supplemented the list of research needs. At least partly through the efforts of the CSG, most of the recommended projects have been initiated, if not fully implemented and completed. Many of them probably would never have gotten off the ground without the CSG's endorsement and, often, assistance in obtaining financial support. This is especially true for the projects carried out in the developing countries of Latin America, West Africa, East Asia, South Asia, and Southeast Asia.

Some progress has been made, but as the present plan testifies, grave threats to the continued existence of many cetaceans still exist, and some threats are worsening. The baiji, vaquita, and North Atlantic right whale are near extinction. It seems unlikely that the baiji will still be around when the next new action plan is formulated eight or ten years from now. Local populations of other species have disappeared or are seriously threatened. Cetacean diversity, like all biodiversity worldwide, is crumbling; we are losing it at a rapid and increasing rate. So we must redouble our efforts.

This new plan departs from its predecessors in recommending a number of specific conservation actions, including some related directly to management. This reflects the increasing role that conservation biologists must take in the real world of interactions between society and wildlife. Social, economic, and political factors will determine what we have left in a few years, and we need to understand and address those factors. If we don't speak up, if we don't go out of our way to prod and assist the managers, there will be no hope for continued abundance and diversity of whales, dolphins, and porpoises.

The CSG has done a lot. The challenge now is to do much more, and this new plan provides the needed guidance.

William F. Perrin
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Acknowledgments

We are indebted to Bill Perrin (NOAA/NMFS, Southwest Fisheries Science Center, La Jolla, California) for his central role in shaping the Cetacean Specialist Group during the 1980s, compiling the group's first Cetacean Action Plan in 1988, and continuing to play a constructive role in many aspects of the group's activities. Bob Brownell (NOAA/NMFS), Peter Best (Mammal Research Unit, University of Pretoria, South Africa), and Koen Van Waerebeek (Peruvian Centre for Cetacaen Research, Lima, Peru) have taken a special interest in CSG activities for many years, and they made important contributions to this Cetacean Action Plan. Justin Cooke (CEMS, Winden, Germany) has represented IUCN for many years in the Scientific Committee of the International Whaling Commission and has been instrumental in helping to develop and apply quantitative criteria for decisions about listing species and populations in the IUCN Red List of Threatened Animals. Barbara Taylor (NOAA/NMFS), as chair of the CSG's CITES/Red List subgroup, has made a crucial difference in our ability to handle the expanding responsibilities delegated to us by IUCN.

Major financial contributions from the Ocean Park Conservation Foundation (OPCF), the International Fund for Animal Welfare (IFAW) (special thanks to Vassili Papastavrou), World Wildlife Fund (WWF-US) (special thanks to Karen Baragona), and the IUCN/SSC Peter Scott Action Plan Fund have kept the CSG going in recent years and made it possible for us to complete this Action Plan. Much of Notarbartolo di Sciara's time has been covered by the Istituto Centrale per la Ricerca Applicata al Mare (ICRAM), Crespo's by the Laboratorio de Mamíferos Marinos (CENPAT-CONICET), and Smith's by the Whale and Dolphin Conservation Society (WDCS) and the Wildlife Conservation Society (WCS). WDCS, OPCF, WCS, WWF-US, the Convention on Migratory Species (CMS), and the Chicago Zoological Society (CZS) have contributed in recent years to projects identified as CSG priorities. From mid-February 1994 until mid-April 1996, substantial in-kind support was given to the CSG by Ocean Park and OPCF. Also during that time and through June 1997, OPCF provided direct funding to cover Reeves' office and administrative expenses related to CSG work. Similar support since 1997 has come from IFAW and, recently, WWF (US). Since 1990, a discretionary account has been administered on the CSG's behalf, without cost, by The Ocean Conservancy (TOC, formerly the Center for Marine Conservation) in Washington, D.C. This service has been crucial to the group's functioning and is greatly appreciated, as is a grant from TOC that supported some of the group's Red List work in 2001.

We are grateful for the many contributions made by other CSG members to the routine business of the CSG and to this Action Plan. Their willingness to devote time and thought to our requests for advice and assistance testifies to their individual commitments to cetacean conservation. Simon Stuart, as Head of the Species Programme at IUCN Headquarters in Gland, was for many years instrumental in helping the CSG deal with international issues, and his successor in that role, Sue Mainka, has carried on the cooperative tradition with efficiency and aplomb. Sue read an earlier draft of this Action Plan and provided useful suggestions, as did Luke Watson and Polly Phillpot while interns in Gland. A special note of thanks is due Amie Bräutigam. For many years she worked tirelessly and competently as the SSC Program Officer responsible for our group and the other marine-related specialist groups. She spent many strenuous hours reviewing this manuscript and sharing her thoughts on how it could be improved. Financial support from the World Wide Fund for Nature and from the US State Department (Voluntary Contribution to IUCN) helped make publication of this Action Plan possible.

Executive Summary

This Action Plan represents a consensus of the IUCN/SSC Cetacean Specialist Group concerning the status of the world's 86 currently recognized species of cetaceans (porpoises, dolphins, and whales), threats to their survival, and measures needed to better understand and address those threats. Two species – the baiji (*Lipotes vexillifer*) and the vaquita (*Phocoena sinus*) – and several geographical populations of whales and dolphins are classified in the Red List as Critically Endangered (Table 1). Other species, notably the Northern Hemisphere right whales (*Eubalaena glacialis* and *E. japonica*), blue whale (*Balaenoptera musculus*), Hector's dolphin (*Cephalorhynchus hectori*), and Ganges/Indus river dolphins (*Platanista gangetica*), are classified as Endangered. Numerous additional populations are known to be in serious danger of extirpation but have yet to be formally assessed for the Red List.

Known or suspected threats include: continued deliberate killing of some species for food and predator control; incidental killing as a result of entanglement in fishing gear, collisions with powered vessels, and entrapment in water-regulation devices; removal of live animals from small coastal populations to supply oceanaria and "research/rescue/captive breeding" facilities; and the disruption of foodwebs and depletion of prey resources as a result of industrial or intensive artisanal fishing. Cetaceans, especially freshwater and coastal species, are suffering from degradation of their habitat caused by dam construction, removal of water for irrigation, land "reclamation," and appropriation of bays for aquaculture operations. Longstanding concerns about the disturbance caused by ship noise, seismic operations, drilling, and other acoustic inputs to the marine environment have expanded to encompass the likelihood that new types of military sonar can cause lethal trauma to deep-diving cetaceans. Exceptionally high levels of chemical contaminants in the tissues of cetaceans may be affecting the animals' immune and reproductive systems.

Any removals from wild populations, whether by hunting, bycatch, or live-capture, need to be within sustainable limits, which means that sufficient data must be available and a regime for enforcement and monitoring in place. Because fishery bycatch is such a serious and widespread threat to cetacean populations, there is an urgent need to develop alternative fishing gear and practices, and at the same time to implement immediate mitigation measures, ranging from fishery closures to the mandatory use of acoustic deterrents to keep animals away from nets. While research is underway to better define the threats of chemical and noise pollution, acoustic trauma, and climate change, precautionary measures should be taken to moderate (and preferably eliminate) the relevant anthropogenic input factors.

Fifty-seven specific initiatives are identified and described for conservation-related research and education: 21 in Asia, 18 in Latin America, six in Africa, seven in Europe, two in North America, and three that are non-regional. The Cetacean Specialist Group has traditionally focused on problems in developing countries, presuming that the needs for support and expertise are greater there than in Europe, North America, and Oceania. Also, most of the group's attention has been devoted to the small and medium-sized cetaceans, as they are not officially recognized as falling within the aegis of the International Whaling Commission.

For the first time, this Action Plan identifies specific management actions needed to prevent the extinction of several of the most seriously threatened species and populations. The baiji and vaquita can be saved only by immediate efforts to drastically reduce fishery bycatch. Tighter fishery management is also needed urgently for at least some populations of franciscanas (*Pontoporia blainvillei*), Hector's dolphins, Irrawaddy dolphins (*Orcaella brevirostris*), and short-beaked common dolphins (*Delphinus delphis*). It is important to emphasize that these recommended actions are a mere beginning. To achieve our goal of conserving the planet's diverse and abundant cetacean fauna will require not only rapid progress on the work laid out in this Action Plan, but also a much wider and deeper vision of what needs doing, and the will to pursue that vision without delay.

Table 1. Species and populations classified on the Red List as Critically Endangered.

Species/population	Distribution	Main threats	Conservation efforts
Baiji	China	Fishery bycatch; habitat degradation	Some study but inadequate protection
Vaquita	Mexico	Fishery bycatch	Intensive study and some initial protective measures
Svalbard population of bowhead whales	Norway, Greenland, Russia	Very low numbers due to past hunting	Adequate protection but more monitoring needed
Mahakam River population of Irrawaddy dolphins	Indonesia	Fishery bycatch; habitat degradation	Some study but inadequate protection
North Island population of Hector's dolphins	New Zealand	Fishery bycatch	Intensive study and management

Introduction

Conserving cetaceans (and other wildlife) is an ongoing process that can never be considered complete. Conservation measures that are already in force need to be evaluated and re-evaluated, and new approaches need to be developed to address threats that were unrecognized or non-existent until recently. For example, global warming, noise pollution from low-frequency, high-amplitude sound sources, and reduced availability of prey are factors that were hardly considered as threats to cetaceans in the past but are now of great concern. At the same time, the all too familiar threats of accidental killing in fishing gear and exposure to toxic chemicals appear to be intensifying and remain almost intractable. It is likely that cetaceans have already been eradicated in some areas where fishing has been intensive, and the insidious effects of toxic contaminants may have taken a toll that will never be well understood and fully documented.

The claim that humans have not yet caused the extinction of any cetacean species is becoming increasingly tenuous. Surviving total populations of two species, the baiji (Yangtze River dolphin, *Lipotes vexillifer*) and the vaquita (Gulf of California porpoise, *Phocoena sinus*), are thought to be in the tens and mid-hundreds, respectively, and are probably still declining (Zhou *et al.* 1998; Jaramillo-Legorreta *et al.* 1999). Only about 300–350 North Atlantic right whales (*Eubalaena glacialis*) remain, almost all of them concentrated along the heavily industrialized east coast of North America (Katona and Kraus 1999; IWC 2001b). Although there may still be several hundred North Pacific right whales (*E. japonica*) in the Sea of Okhotsk, this species, too, has essentially disappeared from most of its range elsewhere in the North Pacific and is in grave danger of extinction (IWC 2001b).

Some populations of other species, such as the gray whales (*Eschrichtius robustus*) in the North Atlantic (Mead and Mitchell 1984) and possibly the blue whales (*Balaenoptera musculus*) in the western North Pacific (Reeves *et al.* 1998), have been exterminated. Many local and regional populations are seriously depleted. Among these are the belugas (white whales, *Delphinapterus leucas*) in Ungava Bay (Canada), in Cook Inlet (Alaska), and off West Greenland (IWC 2000a); the Irrawaddy dolphins (*Orcaella brevirostris*) in the Mahakam River of Borneo (Kreb 2002) and the Mekong River of Vietnam, Cambodia, and Laos (Smith *et al.* 1997a; Baird and Mounsouphom 1997); the finless porpoises (*Neophocaena phocaenoides*) in portions of the Inland Sea of Japan (reduced by more than 95% since the 1970s; Kasuya *et al.* 2002) and the Yangtze River (Wang *et al.* 2000; Zhou *et al.* 2000; Reeves *et al.* 2000a); and the harbor porpoises (*Phocoena phocoena*) in the Baltic and Black Seas (Buckland *et al.* 1992; Donovan and Bjørge 1995; IWC 1996). One population of spinner dolphins (*Stenella longirostris*) in the eastern tropical Pacific was reduced by at least half since the 1950s (Wade 1993). Other populations remain at extremely low levels after having been reduced by intensive commercial whaling in earlier times. For example, the gray whale population in the western North Pacific (Brownell *et al.* 1997; Weller *et al.* 2002) and bowhead whale (*Balaena mysticetus*) populations in the Sea of Okhotsk and in Arctic waters adjacent to the North Atlantic Ocean (IWC 1992; Zeh *et al.* 1993; Clapham *et al.* 1999) are severely depleted, and their prospects for recovery are uncertain.

Conservationists and scientists campaigned for many years to bring the direct exploitation of large cetaceans under effective control, largely by changing the policies of the International Whaling Commission (IWC), a body established under the 1946 International Convention for the Regulation of Whaling (Gambell 1999). Right and bowhead whales have been protected from commercial whaling under international law since 1935, gray whales since 1946, and humpback whales (*Megaptera novaeangliae*) and blue whales since the mid-1960s (Best 1993). The worldwide moratorium on commercial whaling, which took effect beginning in 1986 and continues at the time of this writing, was the most recent in a long line of protective measures implemented by the IWC. However, there was rampant non-compliance and falsification of documents by the Soviet whaling fleet (Yablokov 1994). Many thousands of right whales, blue whales, and humpback whales in the Southern Ocean and North Pacific were taken illegally during the 1950s and 1960s (Best 1988; Zemsky *et al.* 1995a, 1995b; Mikhalev 1997; Tormosov *et al.* 1998). These actions jeopardized population survival in some instances, and they have set back recovery for many decades. Japanese post-war records of sperm whale (*Physeter macrocephalus*) catches have also been shown to be unreliable (Kasuya 1999a), as have some of the whaling records from a shore station in South Africa (Best 1989). This evidence has reinforced skepticism about the effectiveness of international whaling management.

There is reason for cautious optimism about the status and future of some populations of great whales (i.e., the 14 recognized baleen whale species and the sperm whale). For example, some populations of southern right whales (*Eubalaena australis*) (IWC 2001b), humpback whales in many areas (e.g., Bannister 1994, Smith *et al.* 1999), gray whales in the eastern North Pacific (Jones and Swartz 2002), and blue whale populations in the eastern North Pacific (Carretta *et al*. 2001) and central North Atlantic (Sigurjónsson and Gunnlaugsson 1990) have shown signs of recovery under protection. In contrast, the continued small numbers of North Atlantic and North Pacific right whales, southern right whales in some areas of former abundance (e.g., around New Zealand, off Peru and Chile) (IWC 2001b), bowhead whales in some areas (see above), and blue whales and fin whales (*Balaenoptera physalus*) in the Southern Hemisphere, mean that there is no reason to be complacent about their futures (Clapham *et al.* 1999).

In the 1980s and 1990s, direct exploitation was less of an immediate threat to most endangered whale populations than was accidental mortality from ship-strikes and entanglement in fishing gear. Reduced abundance of prey as a result of overfishing (Bearzi *et al.* 1999) and possibly climate change (Würsig *et al.* 2001), the direct effects of pollution on health and reproduction (O'Shea *et al.* 1999; Reijnders *et al.* 1999), and the disturbance caused by noise from ship traffic and industrial activity (Gordon and Moscrop 1996; Würsig and Richardson 2002) have become additional major concerns in recent decades.

There is still much interest in the conservation of the great whales. The high public profile of commercial whaling ensures that governments, non-governmental organizations (NGOs), and inter-governmental organizations (IGOs) will continue to apply pressure on whaling nations to eliminate whaling altogether, or at least to keep harvests within sustainable limits. The Cetacean Specialist Group (CSG) membership has always been well represented in the IWC's Scientific Committee as well as in many of the relevant national government agencies, NGOs, and other IGOs. Members therefore have been involved directly in the work of developing an effective regime for whaling management and large whale conservation.

The first IUCN Cetacean Action Plan (Perrin 1988, 1989) attempted to expand the attentions and energies of conservationists to encompass the approximately 70 species of smaller and medium-sized cetaceans as well as the great whales (Brownell *et al.* 1989), while the second Cetacean Action Plan (Reeves and Leatherwood 1994a) further emphasized freshwater cetaceans and coastal populations of marine cetaceans as particularly at risk and, thus, needing concerted conservation efforts. These animals' exceptional vulnerability is often tied to their geographically restricted range, relatively narrow ecological niche, and dependence on resources that are also used intensively by humans.

The survival of freshwater cetaceans depends on the environmental quality of rivers, lakes, and estuaries in southern Asia and South America. These animals are in direct competition with humans for the necessities of life: food and fresh water. Whether to control flooding, produce electricity, or provide water for agricultural, domestic, or industrial uses, the impetus for constructing dams, barrages, embankments, and other river modifications grows relentlessly. These structures interrupt the movements of cetaceans and their prey and reduce the availability of suitable habitat (Reeves and Leatherwood 1994b; Reeves and Smith 1999; Smith and Reeves 2000b). Moreover, economic growth through industrialization and agricultural modernization, coupled with burgeoning human populations, means that rivers, lakes, and estuaries must absorb ever-increasing amounts of waste, while at the same time they are expected to provide increased quantities of fish, crustaceans, and molluscs for human consumption. Although freshwater cetaceans enjoy religious or customary protection from hunting in some areas (e.g., Baird and Mounsouphom 1997; Smith *et al.* 1997a, 1997b), they face many indirect threats, (e.g., accidental entanglement in fishing gear, electrocution from electric fishing, collisions with powered vessels, underwater detonations, and polluted or diminished food supplies). In some areas, deliberate killing continues, and there is a demand for river dolphin products such as meat and oil (Reeves *et al.* 1993; Mohan *et al.* 1997; Sinha 1997; Smith *et al.* 1998).

Coastal marine cetaceans are also perceived as competing with humans for certain resources, often with no direct evidence to support such perceptions. Some populations have experienced high mortality due to accidental entanglement in fishing gear, and in areas such as Peru (Read *et al.* 1988; Van Waerebeek *et al.* 1997), Sri Lanka (Leatherwood and Reeves 1989), the Philippines (Leatherwood *et al.* 1992; Dolar *et al.* 1994), and West Africa (Van Waerebeek and Ofori-Danson 1999), incidental catches have given rise to directed ones as fishermen have become more aware of markets for cetacean products. Culling, inspired by the perception that cetacean depredations on fish stocks were responsible for local declines in fish harvests, continued at least until the early 1990s in Japan (Kasuya 1985; Anon. 1992; Kishiro and Kasuya 1993) and possibly other areas such as the Philippines and Turkey (Earle 1996; Northridge and Hofman 1999). Although the officially sanctioned culling of cetaceans no longer occurs on a large scale, fishermen sometimes retaliate in their own ways (e.g., Matkin and Saulitis 1994; Reeves *et al.* 1999c).

The IUCN Red Data Book on cetaceans (Klinowska 1991) provided a comprehensive review of information on each species, and the 1994 IUCN Cetacean Action Plan included an abbreviated update (Reeves and Leatherwood 1994a). In the present version of the Cetacean Action Plan, we have again included brief summaries of the conservation status of each species of cetacean (Chapter 4). Current, authoritative information on the status of many populations is provided in the IWC's report series, which has continued since 1999 as the *Journal of Cetacean Research and Management*. Concurrent with its decision in 1982 to implement a global moratorium on commercial whaling (IWC 1983), the IWC called for "comprehensive assessments" of the commercially important whale stocks. By the middle of 2002, major reviews, and in some cases one or more intensive reassessments, had been completed for minke whales (*Balaenoptera bonaerensis* and *B. acutorostrata*) in the Southern Hemisphere, North Atlantic, and western North Pacific; fin whales and humpback whales in the North

Atlantic; bowhead whales in the Bering, Chukchi, and Beaufort seas; gray whales; and right whales.

The IWC's Standing Sub-committee on Small Cetaceans, established in 1974 (Mitchell 1975), has continued its annual reviews of priority stocks and conservation problems. The Commission encourages the Scientific Committee to address scientific issues regarding small cetaceans even though there is no agreement among member nations concerning the IWC's legal competence in this area. Annual meetings of the Sub-committee focus on particular species, stocks, or technical problems (e.g., methods of bycatch reduction), and an effort is made in each case to summarize the state of knowledge and identify ongoing research and conservation needs. At its meeting in 2000, for example, the Sub-committee discussed the status of freshwater cetaceans (IWC 2001a) and completed its deliberations concerning acoustic deterrents (IWC 2000a) and other approaches to bycatch reduction (IWC 2001c). Special IWC volumes have been published on the genus *Cephalorhynchus* (Brownell and Donovan 1988), the Northern Hemisphere pilot whales (genus *Globicephala*) (Donovan *et al.* 1993), the problem of incidental mortality in passive nets and traps (Perrin *et al.* 1994), the porpoises (family Phocoenidae) (Bjørge and Donovan 1995), and issues related to chemical pollutants (Reijnders *et al.* 1999).

The most important parts of this Cetacean Action Plan, in a practical sense, are the sections that describe research and education projects considered high priorities for conservation (Chapter 5) and offer recommendations for management actions to benefit some of the most threatened species and populations (Chapter 6). It is hoped that, as in the past, government agencies, IGOs, and NGOs will find the projects outlined in Chapter 5 useful in planning conservation efforts and making decisions on how to allocate funds. Numerous national governments and NGOs, and some IGOs, have produced their own plans of action for cetacean conservation (or in many instances, marine mammal conservation) (e.g., Bannister *et al.* 1996; Anon. 1997; Jefferson and Reeves 1999; Smith and Smith 2000; Notarbartolo di Sciara *et al.* 2001). For the most part, these different initiatives are complementary to, and convergent with, this IUCN Action Plan. The dynamic, ever-evolving threats to cetaceans demand that multiple approaches be pursued and that participation in addressing the threats be broad and inclusive.

Previous IUCN Cetacean Action Plans focused on conservation-oriented research and generally refrained from making explicit recommendations for conservation action. The inclusion of Chapter 6 in the present plan reflects a growing sense of frustration and impatience among CSG members. Most of the projects proposed in the 1988 and 1994 Action Plans have been either fully or partially implemented. Completed studies have helped elucidate known problems, improved the basis for assessing vulnerable populations, and identified and characterized emergent threats. What they have not done, and indeed research alone can never do, is bring about positive change. All too often, the residue of uncertainty that surrounds any scientific effort provides an excuse for inaction. Officials call for more research rather than making difficult choices about limits to human activity, or investing in mitigation. Thus, although the CSG's greatest strength continues to reside in its scientific expertise and independence from political constraints, we have chosen in this Action Plan to set forth a series of recommendations for action that are well-justified scientifically and that are urgently needed to improve the survival prospects of threatened species and populations. As explained in Chapter 6, these recommendations address only a sample of the vast array of problems that are pending in the field of cetacean conservation. In that sense, they are a mere beginning.

Chapter 1

Status of the World's Cetaceans

1.1 Systematics and taxonomy

The emergence and refinement of molecular genetic techniques have necessitated significant changes in the systematics of cetaceans. New tools and approaches have been vigorously applied to some cetacean groups and resulted in a stimulating, if somewhat unnerving, overhaul of traditional cetacean taxonomy. The limited sampling and "generally cautious attitude of some cetacean systematists" to which we previously referred (Reeves and Leatherwood 1994b) are giving way to a sense of greater confidence in splitting species and recognizing subspecies within the order Cetacea. Rice (1998) recognized 83 species of cetaceans, and 16 of these included from two to four subspecies (total: 42 subspecies). With the recent consensus that recognizes three rather than one species of right whale, the total number of species comes to 85 (Perrin *et al.* 2002), and the number of subspecies is reduced to 41.

Descriptions of new cetacean species, and revisions of old ones, were in preparation or about to be published as this Action Plan was going to press. Dalebout *et al*. (2002b) introduced Perrin's beaked whale (*Mesoplodon perrini*) (making the total 86 rather than 85), and van Helden *et al.* (2002) resurrected the name *Mesoplodon traversii* to replace *M. bahamondi*, suggesting the common name of spade-toothed whale in place of Bahamonde's beaked whale. Readers are cautioned against dogmatic adherence to precise numbers of species or subspecies. Higher-order cetacean systematics is also undergoing intensive re-evaluation and revision (e.g., Leduc *et al.* 1999). In preparing this Action Plan, we have avoided becoming bogged down in disputes about which species to recognize and what to call them. The sorting of subspecies, species, and higher- level relationships is an endless process. As it proceeds, we need to agree on a reasonable systematics and nomenclature, then proceed to articulate and address conservation issues within that framework. Rice's (1998) formulation, as amended by the IWC's Scientific Committee (IWC 2001g) and Perrin *et al.* (2002), is comprehensive, reasonably current, and sufficiently authoritative to serve as a basis for updating the list of species (and subspecies) in this Action Plan. Table 1.1 summarizes the current consensus and notes areas of disagreement.

An essential element of cetacean conservation, and indeed of marine conservation more generally, is recognition of intraspecific population structure. In other words, conservation efforts need to be directed not only at maintaining the viability of species, but also at maintaining the full range of behavioral, ecological, and genetic diversity within species (Dizon and Perrin 1997). Many, in fact probably most, cetacean species exist as series of populations that are largely isolated units with little or no genetic exchange. The concept of "stocks" has long been recognized and used in management by the IWC, even in the absence of a strict, biologically coherent definition of the term (Donovan 1991). The IWC's Scientific Committee established a Working Group on Stock Definition in 1998, and this group has met annually since then with the goal of developing operational definitions for use in the management of whaling and in whale conservation more broadly (e.g. IWC 2002a). It has been forcefully argued that management units should not be defined solely on the basis of genetic data and standard scientific analyses, but should also take account of specific management objectives and any anthropogenic risks facing a given wildlife population (Taylor and Dizon 1999). A major ongoing challenge for the Cetacean Specialist Group is to identify populations in an appropriate manner, assess their conservation status, and develop strategies for conserving them. At present, we have made only a modest start at this task.

Table 1.1 Classification of the living cetaceans, order Cetacea, to the level of subspecies (following Rice 1998, except as noted). See text for identification and discussion of geographical populations.

Taxon	Vernacular Name	Red List Designation[1]
Suborder Mysticeti	**Baleen Whales**	
Family Balaenidae	**Right Whales**	
Balaena mysticetus [2]	Bowhead whale	LR(cd)
Eubalaena glacialis [3]	North Atlantic right whale	EN
Eubalaena japonica [3]	North Pacific right whale	EN
Eubalaena australis [3]	Southern right whale	LR(cd)
Family Balaenopteridae	**Rorquals**	
Balaenoptera acutorostrata	Common minke whale	NT
B. acutorostrata acutorostrata	North Atlantic minke whale	NE
B. acutorostrata scammoni	North Pacific minke whale	NE
B. acutorostrata subsp.	Dwarf-form minke whale	NE
Balaenoptera bonaerensis	Antarctic minke whale	LR(cd) (as "southern" minke whale)
Balaenoptera borealis	Sei whale	EN
B. borealis borealis	Northern Hemisphere sei whale	NE
B. borealis schlegellii	Southern Hemisphere sei whale	NE
Balaenoptera brydei [4]	Common Bryde's whale	DD
Balaenoptera edeni [4]	Pygmy Bryde's whale	DD
Balaenoptera musculus	Blue whale	EN
B. musculus musculus	North Atlantic/North Pacific blue whale	VU (North Atlantic Stock), LR(cd) (North Pacific Stock)
B. musculus indica	Indian Ocean blue whale	NE
B. musculus brevicauda	Pygmy blue whale	DD
B. musculus intermedia	Antarctic blue whale	EN
Balaenoptera physalus	Fin whale	EN
B. physalus physalus	Northern Hemisphere fin whale	NE
B. physalus quoyi	Southern Hemisphere fin whale	NE
Megaptera novaeangliae	Humpback whale	VU
Family Eschrichtiidae	**Gray whale**	
Eschrichtius robustus [5]	Gray whale	LR(cd)
Family Neobalaenidae	**Pygmy Right Whale**	
Caperea marginata	Pygmy right whale	LC
Suborder Odontoceti	**Toothed Cetaceans**	
Family Delphinidae	**Marine (Oceanic) Dolphins**	
Cephalorhynchus commersonii	Commerson's dolphin	DD
C. commersonii commersonii	Falklands and South American subspecies	NE
C. commersonii subsp.	Kerguelen subspecies	NE
Cephalorhynchus eutropia	Chilean dolphin	DD
Cephalorhynchus heavisidii	Heaviside's dolphin	DD
Cephalorhynchus hectori [6]	Hector's dolphin	EN
Delphinus delphis	Short-beaked common dolphin	LC
Delphinus capensis [7]	Long-beaked common dolphin	LC
Feresa attenuata	Pygmy killer whale	DD
Globicephala macrorhynchus	Short-finned pilot whale	LR(cd)
Globicephala melas	Long-finned pilot whale	LC
G. melas melas	North Atlantic long-finned pilot whale	NE
G. melas subsp.	North Pacific long-finned pilot whale	NE (probably extinct)
G. melas edwardii	Southern Hemisphere long-finned pilot whale	NE
Grampus griseus	Risso's dolphin or Grampus	DD
Lagenodelphis hosei	Fraser's dolphin	DD
Lagenorhynchus acutus	Atlantic white-sided dolphin	LC
Lagenorhynchus albirostris	White-beaked dolphin	LC
Lagenorhynchus australis	Peale's dolphin	DD
Lagenorhynchus cruciger	Hourglass dolphin	LC

Table 1.1 ... continued. Classification of the living cetaceans, order Cetacea.

Taxon	Vernacular Name	Red List Designation[1]
Lagenorhynchus obliquidens	Pacific white-sided dolphin	LC
Lagenorhynchus obscurus	Dusky dolphin	DD
L. obscurus fitzroyi	Falklands and South American dusky dolphin	NE
L. obscurus obscurus	South African and Indian Ocean dusky dolphin	NE
L. obscurus subsp.	New Zealand dusky dolphin	NE
Lissodelphis borealis	Northern right whale dolphin	LC
Lissodelphis peronii	Southern right whale dolphin	DD
Orcaella brevirostris [8]	Irrawaddy dolphin	DD
Orcinus orca	Killer whale or Orca	LR(cd)
Peponocephala electra	Melon-headed whale	LC
Pseudorca crassidens	False killer whale	LC
Sotalia fluviatilis [9]	Tucuxi	DD
S. fluviatilis guianensis	Marine tucuxi	NE
S. fluviatilis fluviatilis	Freshwater tucuxi	NE
Sousa chinensis [10]	Indo-Pacific hump-backed dolphin	DD
Sousa teuszi [10]	Atlantic hump-backed dolphin	DD
Stenella attenuata	Pantropical spotted dolphin	LR(cd)
S. attenuata subspecies A of Perrin (1975)	Eastern Pacific offshore spotted dolphin	NE
S. attenuata subspecies B of Perrin (1975)	Hawaiian spotted dolphin	NE
S. attenuata graffmani	Eastern Pacific coastal spotted dolphin	NE
Stenella clymene	Clymene dolphin	DD
Stenella coeruleoalba	Striped dolphin	LR(cd)
Stenella frontalis	Atlantic spotted dolphin	DD
Stenella longirostris	Spinner dolphin	LR(cd)
S. longirostris longirostris	Gray's spinner dolphin	NE
S. longirostris orientalis	Eastern spinner dolphin	NE
S. longirostris centroamericana	Costa Rican or Central American spinner dolphin	NE
Steno bredanensis	Rough-toothed dolphin	DD
Tursiops truncatus [11]	Common bottlenose dolphin	DD
Tursiops aduncus [11]	Indo-Pacific bottlenose dolphin	DD (within *T. truncatus*)
Family Monodontidae	**Monodontids**	
Delphinapterus leucas	Beluga or white whale	VU
Monodon monoceros	Narwhal	DD
Family Phocoenidae	**Porpoises**	
Neophocaena phocaenoides	Finless porpoise	DD
N. phocaenoides phocaenoides	Indian Ocean finless porpoise	NE
N. phocaenoides sunameri	Western Pacific finless porpoise	NE
N. phocaenoides asiaeorientalis	Yangtze River finless porpoise	EN
Phocoena phocoena	Harbor porpoise	VU
P. phocoena phocoena [12]	North Atlantic harbor porpoise	NE
P. phocoena subsp.	Western North Pacific harbor porpoise	NE
P. phocoena vomerina	Eastern North Pacific harbor porpoise	NE
Phocoena dioptrica	Spectacled porpoise	DD
Phocoena sinus	Vaquita or Gulf of California porpoise	CR
Phocoena spinipinnis	Burmeister's porpoise	DD
Phocoenoides dalli	Dall's Porpoise	LR(cd)
P. dalli dalli	*Dalli*-phase dall's porpoise	NE
P. dalli truei	*Truei*-phase dall's porpoise	NE

Table 1.1 ... continued. Classification of the living cetaceans, order Cetacea.

Taxon	Vernacular Name	Red List Designation[1]
Family Kogiidae	**Diminutive Sperm Whales**	
Kogia breviceps	Pygmy sperm whale	LC
Kogia sima	Dwarf sperm whale	LC
Family Physeteridae	**Sperm Whale**	
Physeter macrocephalus	Sperm whale	VU
Family Iniidae	**South American River Dolphins**	
Inia geoffrensis	Amazon dolphin or Boto	VU
I. geoffrensis humboldtiana	Orinoco dolphin	NE
I. geoffrensis geoffrensis	Amazon dolphin	NE
I. geoffrensis boliviensis	Bolivian dolphin	NE
Family Lipotidae	**Chinese River Dolphin**	
Lipotes vexillifer	Baiji or Yangtze dolphin	CR
Family Platanistidae	**South Asian River Dolphins**	
Platanista gangetica[13]	'Blind' river dolphin	(EN)
P. gangetica gangetica	Ganges dolphin	EN
P. gangetica minor	Indus dolphin	EN
Family Pontoporiidae	**Marine River Dolphin**	
Pontoporia blainvillei	Franciscana or La Plata dolphin	DD
Family Ziphiidae	**Beaked Whales**	
Berardius arnuxii	Arnoux's beaked whale	LR(cd)
Berardius bairdii	Baird's beaked whale	LR(cd)
Hyperoodon ampullatus	Northern bottlenose whale	LR(cd)
Hyperoodon planifrons	Southern bottlenose whale	LR(cd)
Indopacetus pacificus	Indo-Pacific beaked whale	DD (as *Mesoplodon pacificus*)
Mesoplodon hectori	Hector's beaked whale	DD
Mesoplodon mirus	True's beaked whale	DD
Mesoplodon europaeus	Gervais' beaked whale	DD
Mesoplodon bidens	Sowerby's beaked whale	DD
Mesoplodon grayi	Gray's beaked whale	DD
Mesoplodon peruvianus	Pygmy beaked whale	DD
Mesoplodon bowdoini	Andrews' beaked whale	DD
Mesoplodon traversii (= bahamondi)	Spade-toothed whale	NE
Mesoplodon carlhubbsi	Hubbs' beaked whale	DD
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale	DD
Mesoplodon stejnegeri	Stejneger's beaked whale	DD
Mesoplodon layardii	Layard's beaked (or Strap-toothed) whale	DD
Mesoplodon perrini	Perrin's beaked whale	NE
Mesoplodon densirostris	Blainville's beaked whale	DD
Tasmacetus shepherdi	Tasman or Shepherd's beaked whale	DD
Ziphius cavirostris	Cuvier's beaked (or Goosebeak) whale	DD

Notes:

[1]From Baillie and Groombridge (1996) or Hilton-Taylor (2000). Note that the designation Lower Risk (conservation dependent) or LR(cd) has been eliminated under the 2000 Categories and Criteria (IUCN 2001; see Appendix 2) but is retained here pending reassessments of the relevant taxa. Taxa previously listed as Lower Risk (least concern) under the 1996 Categories and Criteria are here listed as LC, or Least Concern, to conform to the 2000 Categories and Criteria. Similarly, the previous listing as Lower Risk (near threatened) has been changed to NT, or Near Threatened, in accordance with the 2000 Categories and Criteria. The other categories are: NE, Not Evaluated; DD, Data Deficient; VU, Vulnerable; EN, Endangered; CR, Critically Endangered.

[2]Rice (1998) recognized four or five "disjunct populations" of bowhead whales. The current Red List designations are as follows: Bering-Chukchi-Beaufort Sea stock, LR(cd); Hudson Bay-Foxe Basin stock, VU; Okhotsk Sea stock, EN; Baffin Bay-Davis Strait stock, EN; and Spitsbergen (Svalbard-Barents Sea) stock, CR.

Table 1.1 ... continued. Classification of the living cetaceans, order Cetacea.

Taxon	Vernacular Name	Red List Designation[1]

[3]Rice (1998) used the genus name *Balaena* for the right whales and recognized only one species, *B. glacialis*, with two subspecies, *B. g. glacialis*, the Northern Hemisphere right whales, and *B. g. australis*, the Southern Hemisphere right whale. He also noted that populations on the east and west sides of both the North Atlantic and North Pacific were "probably at least partially discrete." Recent genetic analyses support the concept of three separate species, one in the North Atlantic, one in the North Pacific, and one in the Southern Hemisphere (Rosenbaum *et al*. 2000; IWC 2001b). Also, the IWC Scientific Committee has decided to retain the genus name *Eubalaena*. North Atlantic and North Pacific stocks of right whales were designated EN in the 1996 Red List, and therefore this status can sensibly be "transferred" to the two species, *E. glacialis* and *E. japonica*, respectively.

[4]There are at least two morphologically distinct forms, very likely different species. The nomenclature of the two forms is unresolved (Kato 2002).

[5]Rice (1998) noted that the North Atlantic population had been extinct since early historical times and that there were two "geographically separated populations" in the North Pacific. These two living populations are listed as follows: Northeast Pacific (American) stock, LR(cd); Northwest Pacific (Asian) stock, CR.

[6]In 2000, the North Island (New Zealand) population was listed as CR.

[7]Although Rice (1998) recognized a third, very long-beaked species of *Delphinus* as the Arabian common dolphin, *D. tropicalis*, a recent examination of skull morphometrics suggests that differences are clinal and that *D. tropicalis* is probably not a valid species (Jefferson and Van Waerebeek 2002).

[8]In 2000, the Mahakam River (Indonesia) population was listed as CR.

[9]According to Monteiro-Filho *et al*. (2002), the two subspecies are valid species and should be designated as the estuarine dolphin (*Sotalia guianensis*) and the freshwater tucuxi (*Sotalia fluviatilis*).

[10]Although Rice (1998) recognized a third species as the Indian hump-backed dolphin, *S. plumbea*, the IWC Scientific Committee decided to maintain a conservative position and to recognize only two species, pending further genetic, morphological, and other analyses (IWC, in press).

[11]See Leduc *et al*. (1999) for systematic differentiation and problems of classification and nomenclature for this group.

[12]The 1996 Red List designated the Black Sea and Baltic Sea populations as VU. Although apparently not accepted by Rice (1998), a genetic analysis by Rosel *et al.* (1995) supported the earlier array of subspecies, based on morphological comparisons – *P. phocoena phocoena, P. phocoena vomerina*, and *P. phocoena relicta* for the Atlantic, Pacific, and Black Sea populations, respectively.

[13]The 1996 Red List recognized two species: *P. gangetica*, the Ganges river dolphin, and *P. minor*, the Indus river dolphin; both were listed as EN.

1.2 Red List or threatened status

The IUCN system for classifying species into various categories of threat, e.g., Endangered or Vulnerable, dates back for almost 40 years. Red Lists and Red Data Books have become widely understood as attempts to catalogue, and place into some kind of order, the state of biodiversity at any point in time. In other words, they are meant to apprise us of how well, or how poorly, we are faring in the battle to prevent extinctions. As mentioned in the Introduction, the IUCN Red Data Book for cetaceans, published in 1991, provided an excellent benchmark. In it, Justin Cooke provided a list of the 79 species recognized at the time (including two that were still unidentified and unnamed), with their Red List classifications and a concise summary of threats (Cooke 1991a). He also provided an explanation of the IUCN categories and criteria used at the time to classify species (Cooke 1991b). The decisions on classification were then, as now, made through a consultation process within the Cetacean Specialist Group. The 1991 Red List classified five species as Endangered (blue whale, northern right whale, vaquita, baiji, and Indus River dolphin) and seven as Vulnerable (Ganges River dolphin, boto, bowhead whale, southern right whale, sei whale, fin whale, and humpback whale). Of the rest, one was listed as Indeterminate (Hector's dolphin), one as Unlisted (gray whale), and 65 as Insufficiently Known.

Since 1991, IUCN has developed an entirely new set of Red List categories and criteria (Mace and Lande 1991; IUCN 1994, 2001; Baillie and Groombridge 1996; Hilton-Taylor 2000). All cetacean species were reassessed by the Cetacean Specialist Group in the mid-1990s using the 1994 categories and criteria (IUCN 1994), and the new listings were published in 1996 (Baillie and Groombridge 1996). Two species were classified as Critically Endangered (baiji and vaquita), six as Endangered (northern right whale, blue whale, fin whale, sei whale, Indus River dolphin, and Ganges River dolphin), and six as Vulnerable (humpback whale, sperm whale, beluga, boto, Hector's dolphin, and harbor porpoise). One species was placed in the Lower Risk/Near Threatened category (common minke whale), while 14 species were assigned to the Lower Risk/Conservation Dependent category. A large number of species (38) were still considered to belong in the Data Deficient category (equivalent to Insufficiently Known in the previous classification scheme). Thirteen species were regarded as Lower Risk/Least Concern, and therefore were not included in the 1996 Red List. In addition to species, 16 cetacean subspecies or geographical populations were included in the 1996 Red List. Of these, seven were classified as Endangered, five as Vulnerable, three as Lower Risk/Conservation Dependent, and one as Data Deficient (Table 1.1).

Since 1996, the Cetacean Specialist Group has continued to assess, reassess, and identify additional populations in need of assessment. As a result, several changes were made in the 2000 Red List, all based on the 1996 criteria. These included reclassification of the western Pacific population of gray whales and the Svalbard population of bowhead whales from Endangered to Critically Endangered, and

Figure 1. The hump-backed dolphins are distributed in shallow marine waters, mainly near shore and in estuaries. They occur on both the west and east coasts of Africa, along the rim of the Indian Ocean, and along portions of the Pacific coasts of China and Australia (the individual shown here is from Hong Kong waters). Their habitat preferences ensure extensive overlap with human activities in the coastal zone. Improved understanding of this genus's zoogeography and systematics, as well as the abundance and life history characteristics of local or regional populations, is badly needed. *Photo: Thomas A. Jefferson.*

Hector's dolphin and the Davis Strait/Baffin Bay population of bowhead whales from Vulnerable to Endangered (Hilton-Taylor 2000). Two new geographical populations were identified and classified as Critically Endangered: the North Island (New Zealand) population of Hector's dolphin and the Mahakam River (Borneo, Indonesia) population of Irrawaddy dolphins. A number of additional changes were pending at the time of writing, and many species and populations were being reassessed under the new (IUCN 2001) categories and criteria.

Most of the species listed as Data Deficient are small cetaceans that are poorly known, particularly on a global basis. One difficulty in making assessments has been that although one or more populations of a species may be known to be in serious trouble, other populations of that same species appear to be much less so. A good example is the Irrawaddy dolphin, currently listed as Data Deficient because there are no abundance estimates for most of its extensive range in southern Asia and northern Oceania (Chapter 4). Thus far, one of three known riverine populations is listed separately (Mahakam River), while the other two are prime candidates for assessment and listing (Ayeyarwady and Mekong Rivers). At least one marine population (Malampaya Sound, Philippines) is likely to qualify for Critically Endangered status, while numerous others have yet to be sufficiently well studied. Other examples of Data Deficient species that include populations known or thought to be in serious trouble are the franciscana, the finless porpoise, and both the Atlantic and Indo-Pacific hump-backed dolphins (*Sousa* spp.) (Figure1).

1.3 CITES

We mention the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) here even though they are quite different from Red List classifications. Species or populations are listed by CITES on the basis of a combination of biological and trade criteria. The biological criteria for inclusion in CITES Appendix I (no commercial trade allowed) are similar to the Red List criteria for one of the threatened categories, although the CITES criteria are less quantitatively precise (Wijnstekers 2001).

Under CITES, all cetaceans not listed in Appendix I are automatically listed in Appendix II (trade allowed, but regulated through export licensing). Since 1986, when the IWC moratorium on commercial whaling came into effect, CITES has included in Appendix I all species of whales protected under the moratorium. In other words, all of the commercially important whales were placed in Appendix I regardless of whether they met the biological criteria under CITES. This decision was to ensure consistency between the two conventions, as required in CITES Resolution Conf. 2.9, which recommends unequivocally that CITES parties should not allow commercial trade in any whale species or stock protected from commercial whaling by the IWC (Table 1.2).

Table 1.2 Proposals to amend the listings of cetacean populations in the Appendices to the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The proposals were considered in Harare, Zimbabwe: 10th Conference of the Parties (COP), June 1997; Nairobi, Kenya: 11th COP, April 2000; and Santiago, Chile: 12th COP, November 2002. In 2002 the Black Sea population of the common bottlenose dolphin was retained in Appendix II but with a zero annual export quota for live specimens removed from the wild. All other proposals shown below were either rejected or withdrawn. Note that the Latin names are those used by CITES.

Taxon/population	Nature of proposal	Proposing country
Harare (1997)		
Eastern Pacific stock of gray whale, *Eschrichtius robustus*	Transfer from Appendix I to Appendix II	Japan
Okhotsk Sea/West Pacific stock(s) of minke whale, *Balaenoptera acutorostrata*	Transfer from Appendix I to Appendix II	Japan
Southern Hemisphere stocks of minke whale, *Balaenoptera acutorostrata*	Transfer from Appendix I to Appendix II	Japan
Western North Pacific stock of Bryde's whale, *Balaenoptera edeni*	Transfer from Appendix I to Appendix II	Japan
North-east Atlantic and Central North Atlantic stocks of minke whale, *Balaenoptera acutorostrata*	Transfer from Appendix I to Appendix II	Norway
Nairobi (2000)	Transfer from Appendix I to Appendix II	Japan
Eastern North Pacific stock of gray whale, *Eschrichtius robustus*	Transfer from Appendix I to Appendix II	Japan
Okhotsk Sea/West Pacific stock(s) of minke whale, *Balaenoptera acutorostrata*	Transfer from Appendix I to Appendix II	Japan
Southern Hemisphere stock of minke whale, *Balaenoptera acutorostrata*	Transfer from Appendix I to Appendix II	Norway
North-east Atlantic and Central North Atlantic stocks of minke whale, *Balaenoptera acutorostrata*	Transfer from Appendix II to Appendix I	Republic of Georgia and USA
Black Sea population of bottlenose dolphin, *Tursiops truncatus ponticus*	Transfer from Appendix II to Appendix I	Republic of Georgia and USA
Santiago (2002) Northern Hemisphere stocks of minke whale (except Yellow Sea, East China Sea and Sea of Japan stock), *Balaenoptera acutorostrata*	Transfer from Appendix I to Appendix II	Japan
Western North Pacific stock of Bryde's whale, *Balaenoptera edeni*	Transfer from Appendix I to Appendix II	Japan
Black Sea population of bottlenose dolphin, *Tursiops truncatus ponticus*	Transfer from Appendix II to Appendix I	Republic of Georgia

Chapter 2

Threats Faced by Cetaceans

As pointed out in the Introduction, the threats facing cetaceans have changed through time. While overkill from hunting was the most obvious and immediate threat to some species and populations during much of the twentieth century, the relative importance of other threats, particularly bycatch in fisheries, has increased dramatically during the last few decades. It is often impossible to distinguish between perception and reality, particularly where pernicious threats such as pollution and climate change are concerned. In addition, it can be all but impossible to distinguish the effects of one threat from those of another when, as is usually true, multiple threats are acting simultaneously.

In this section, we identify and discuss some of the threats facing cetacean populations (Simmonds and Hutchinson 1996; Twiss and Reeves 1999; Whitehead *et al.* 2000; Evans and Raga 2001; Perrin *et al.* 2002; Reeves and Reijnders 2002). There are undoubtedly more threats than we know about today, and even the most basic information on cetacean mortality caused by human actions is lacking for many regions. Moreover, the total impact of the various threats cannot be predicted by simply summing their effects as though they were independent. It may be difficult to describe and quantify the role of synergy among threats in causing population declines, but it cannot be neglected. For example, the immunosuppressive effects of environmental contaminants (Lahvis *et al.* 1995), in combination with range shifts of pathogens caused by global warming and ship ballast transport (Harvell *et al.* 1999), could increase the susceptibility of cetaceans to emergent diseases. Wild populations are subject to pressures from both human activities and ecological variability, and there is nothing static about the task of trying to identify, track, and address the threats to a group of organisms as diverse and widespread as the cetaceans.

2.1 Unsustainable use (including incidental mortality)

Direct exploitation

Direct exploitation is usually driven by the demand for products, whether this means food to be consumed or exchanged at the local, household level ("subsistence"), or meat, blubber, oil, and other commodities to be sold in national and international markets ("commercial"). Without controls of some sort, the growing demand for products can lead to overexploitation. In the history of commercial whaling, there are many examples in which direct exploitation caused cetacean populations to decline. The great whales were sequentially over-exploited, beginning with the easiest to catch and most profitable species (right, bowhead, sperm, humpback, and gray whales), followed by the elusive but valuable blue, fin, and sei whales that could only be taken regularly once steam-powered vessels and harpoon cannons had become widely available. In some instances, populations were reduced to such an extent that their recovery may now be hindered by demographic and genetic factors (e.g., Northern Hemisphere right whales, western Pacific gray whales, and Antarctic blue whales). Moreover, there are signs that the massive reduction in populations of baleen whales has resulted in changes at the community or ecosystem level, shifting the equilibrium conditions and making full "recovery" of some populations unlikely if not impossible (e.g., Kawamura 1994; Clapham and Brownell 1996).

The small and medium-sized cetaceans have been taken for hundreds of years (Figure 2), and they continue to be taken in many areas for food, oil, leather, bait, and other uses. In Japan, for example, the drive fishery for small cetaceans led to a dramatic decline in the abundance of striped dolphins (*Stenella coeruleoalba*) by the early 1980s (Kasuya 1999c). This decline prompted fishermen to change their target species to killer whales (*Orcinus orca*) and bottlenose, pantropical spotted, and Risso's dolphins (*Tursiops* spp., *Stenella attenuata*, and *Grampus griseus*, respectively) to supply the profitable Japanese market for small cetacean meat (Kishiro and Kasuya 1993). In the Arctic, monodontids were over-exploited historically by

Figure 2. Harbor porpoises were killed in large numbers (up to 3000 in a single year) in a Danish drive and net fishery from the sixteenth century until the mid-twentieth century. This photograph was taken near Middelfart, inner Danish waters between the Baltic and North seas.
Photo: Middelfart Museum courtesy of Carl C. Kinze.

commercial hunters in many areas, either to obtain oil and leather for export or to provide food for sled dogs. Ongoing "subsistence" hunting (i.e., hunting for local consumption) has also caused the severe depletion of some populations of belugas (IWC 2000a).

While the threat of deliberate overkill seems to have been reduced on a global basis, serious problems remain. One of these is the absence of an international regulatory regime for the exploitation of small and medium-sized cetaceans, many of which inhabit the high seas beyond any coastal state's jurisdiction, or alternatively exist as "transboundary" stocks that require coordinated conservation by more than one nation. Another is that some populations with a limited coastal, inshore, or freshwater distribution are subject to unmanaged, poorly documented hunting. The low rates of natural increase and difficulties of monitoring population trends at scales useful for management make small cetaceans poor candidates for sustainable hunting (Perrin 1999).

Incidental mortality in fisheries (bycatch)

The role of incidental mortality, or bycatch, in fisheries as a cause of the depletion of cetacean populations has only been recognized during the past 30–40 years. We are not aware of any instance before the mid to late 1960s in which the magnitude of bycatch was considered great enough to threaten a population of cetaceans. Alarm over the killing of dolphins in the eastern tropical Pacific tuna fishery (perhaps as many as seven million in total since the late 1950s) stirred interest in other forms of "incidental" mortality. The tuna-dolphin problem is in fact best viewed as a special case of deliberate capture, since the dolphin schools are chased and encircled in the purse seines in order to capture the yellowfin tuna (*Thunnus albacares*) associated with them. Dolphin mortality occurs only when efforts to release them fail, whether due to unpredictable dolphin behavior, human error, or unfavorable conditions of weather, ocean currents, or lighting (National Research Council 1992; Gosliner 1999). During the past decade, rates of dolphin mortality in tuna nets in the eastern tropical Pacific have decreased dramatically, such that the tuna-dolphin problem is no longer viewed as an acute conservation concern.

In contrast, with the continued proliferation of synthetic gillnets throughout the world, true bycatch has emerged as an extremely serious threat to cetaceans, as well as to seabirds, turtles, fishes, and other non-target organisms (Northridge 1991). It is in many respects a less tractable and more insidious problem than direct exploitation. Useful estimates of total kill and kill-rate have proven difficult to obtain, especially in developing countries where extensive artisanal fisheries account for a high proportion of the bycatch (e.g., Félix and Samaniego 1994; Palacios and Gerrodette 1996, for possible approaches to assessment in such situations).

The first large-scale cetacean bycatch to have become well known, other than the kill of oceanic dolphins in the Pacific tuna fishery, was that of Dall's porpoises (*Phocoenoides dalli*) in the Japanese North Pacific driftnet fishery for salmon (Ohsumi 1975). Many additional cases have been identified since then (Perrin *et al.* 1994; Jefferson and Curry 1994; Northridge and Hofman 1999), including: the Taiwanese driftnet fishery for sharks, tunas, and mackerel (family Scombridae) off northern Australia (Harwood and Hembree 1987); the Italian and Spanish driftnet fisheries for swordfish in the Mediterranean Sea (Notarbartolo di Sciara 1990; Silvani *et al.* 1999); the French tuna driftnet fishery in the north-eastern Atlantic (Goujon *et al.* 1993); and coastal gillnet fisheries in the United States (Bisack 1997), Canada (Trippel *et al.* 1996), western Europe (Tregenza *et al.* 1997; Vinther 1999), the Black Sea (Pavlov *et al.* 1996), and Brazil (Secchi *et al.* 1997; Pinedo and Polacheck 1999). Gillnet mortality is viewed as the chief threat to the survival of the Critically Endangered vaquita (D'Agrosa *et al.* 1995; Rojas-Bracho and Taylor 1999)(Figure 3) and the Endangered Hector's dolphin (Martien *et al.* 1999; Dawson *et al.* 2001).

The significance of cetacean mortality in trawl nets (e.g., Couperus 1997; Fertl and Leatherwood 1997; Dans *et al.* 1997; Crespo *et al.* 1994, 1997, 2000) and longlines (Crespo *et al.* 1997) has only recently begun to be recognized. As an example, recent pulses in strandings of dolphins (particularly short-beaked common and Atlantic white-sided dolphins; *Delphinus delphis* and *Lagenorhynchus acutus*, respectively) on the western and northern coasts of Europe have coincided

Figure 3. Large-mesh gillnets are deadly enemies of small cetaceans. Even when there is no reliable and consistent monitoring of the cetacean bycatch, merely knowing that these kinds of nets are used in an area inhabited by cetaceans almost guarantees that there is a problem with incidental catch. The vaquita (as shown here) is listed as Critically Endangered primarily because of mortality in such nets. *Photo: C. Faesi/Proyecto Vaquita, courtesy of Lorenzo Rojas and Marine Mammal Images*.

Figure 4. Risso's dolphin is one of many species of cetaceans taken in Sri Lankan waters, where a directed fishery for dolphins and whales emerged as markets developed for cetacean meat obtained as fishery bycatch, 1985. *Photo*: *Steve Leatherwood.*

in space and time with pelagic trawl fishing. It is clear that mortality of small delphinids in pelagic trawl fisheries has not been sufficiently recognized or studied in European waters, even though it could be having population-level effects (Tregenza and Collet 1998).

In most cases, fishermen regard the cetaceans that die incidentally in fishing gear as nuisances. Time and effort are required to extricate the carcasses, and the gear and catch are sometimes damaged. Since incidentally caught animals are usually discarded at sea, they provide no economic return and are essentially "wasted." In some areas such as Peru, Sri Lanka, and the Philippines, where artisanal gillnetting has caused the deaths of large numbers of small cetaceans, markets have emerged for cetacean meat, leading to directed hunts (Figure 4).

Incidental mortality of cetaceans also results from entanglement in derelict fishing gear ("ghost nets") and ingestion of plastic bags (Cagnolaro and Notarbartolo di Sciara 1992). Marine debris pollution is a global problem, and its impact on marine animal populations is extremely difficult to evaluate (Laist *et al.* 1999).

There is a clear and longstanding need for fishery agencies and managers at all levels to incorporate bycatch monitoring and bycatch reduction measures into management regimes. It is a major challenge for fishery managers to convince fishermen that bycatch is a problem. This may pertain especially to cetacean bycatch where the cetacean population has already been reduced to low densities and therefore a bycatch is a rare event (e.g., harbor porpoises in the Baltic Sea). Very low bycatch rates are difficult and costly to measure, and it is similarly difficult and costly to obtain precise abundance estimates in areas where cetaceans occur in low densities. Therefore, without bycatch mitigation, cetaceans remain scarce (making it difficult to obtain good abundance estimates), the bycatch remains small (making it difficult to quantify removals), and fishermen remain incredulous of the idea that bycatch is a serious problem.

Indirect effects of industrial fisheries

Large-scale industrial fisheries may have serious long-term consequences for cetacean populations quite apart from the deaths caused by entanglement in fishing gear. Unfortunately, the indirect effects are extremely hard to document and have rarely been evaluated. Of greatest concern are high-seas fisheries that extract vast amounts of fish and squid biomass from the world's oceans, and transform biological communities in the process (e.g., Jakobsson 1985). Fleets of large bottom and mid-water trawlers and jigging vessels, especially those with factories on board, possess fishing capacities that allow them to exploit biological systems at unprecedented levels and rates. Trawlers target particular species but are indiscriminate in what they take. Large bycatches of non-target species are always associated with trawl fisheries. Squid-jigging vessels are highly selective and have little or no bycatch, but they can account for large biomass extraction. In some instances, small-scale coastal and freshwater fisheries have been shown to have similarly devastating system-level effects (e.g., Alcala and Vusse 1993). In the Mediterranean Sea, the combination of some 50,000–100,000 small gillnet fishing boats, plus large bottom trawlers, has depleted numerous fish, crustacean, and mollusk populations, and much the same can be said of the North Sea.

Market policies and foreign investment in most Latin American and Caribbean countries have created incentives for fisheries to expand into little-exploited or nearly pristine areas. These regions presently provide more than 20% of total world fishery landings. From the late 1980s to late 1990s, the fleet of large trawlers targeting common hake (*Merluccius hubbsi*) and shrimp in the south-western Atlantic Ocean grew to about 200 vessels, and biomass extraction increased from about 0.3–1.2 million tons per year (Crespo, unpublished data). During the mid-1990s, some seven tons of bycatch were discarded (dumped back into the sea) per day per vessel, with each vessel fishing for an average of 300 days per year. The hake fishery involves the capture of more than 40 non-target species in coastal waters and at least 20 in offshore shelf waters. Therefore, even if the hake and shrimp stocks targeted by trawlers were themselves unimportant as prey for cetaceans (in fact they are important, Koen Alonso *et al.* 1998, 2000), some of the by-caught species certainly would be. This situation is only one example of what is undoubtedly a more widespread phenomenon.

Trawl fisheries in the Bering Sea have reduced fish stocks and changed the species composition of the region's fauna (National Research Council 1996). This has been implicated in the rapid decline in northern sea lion (*Eumetopias jubatus*) abundance, which in turn may have forced killer whales to switch from preying on them to preying increasingly on sea otters (*Enhydra lutris*). Now the population of sea otters along the Aleutian Islands has collapsed (Estes *et al.* 1998), and it is hard to foresee the next development in this "ecological cascade," probably driven at least to some extent by the world's largest trawl-fishing fleet.

Competition and culls

The belief that cetaceans compete with humans for harvestable resources has prompted culling operations in the past (e.g., belugas in Canada's St. Lawrence River, killer whales in Iceland and Greenland, and various odontocetes (toothed cetaceans) in Japan (Earle 1996)). In some areas, fishermen kill cetaceans in retaliation not only for competition over resources (whether real or only perceived), but also for causing damage to fishing gear. A particular problem has arisen in recent years in the Mediterranean Sea, where very loud acoustic harassment devices are used on an ever-expanding scale to keep dolphins away from fishing gear in coastal artisanal fisheries (Reeves *et al.* 2001a). At a minimum, these devices exclude the cetaceans from potential foraging areas. They may also damage the animals' hearing.

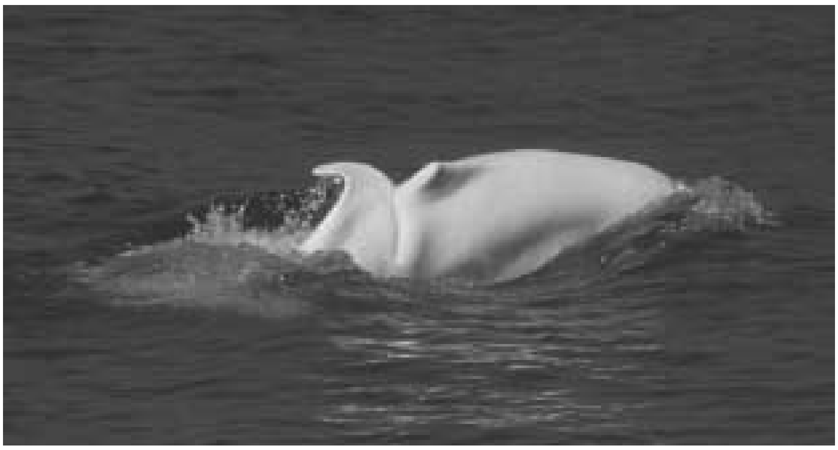
The belief that cetaceans are in competition with fisheries has been used to buttress economic incentives for commercial hunting. For example, Norway states that its ongoing commercial hunts for minke whales and harp and hooded seals (*Pagophilus groenlandica* and *Cystophora cristata*, respectively) in the North Atlantic are necessary components of "ecosystem management" (Hoel 1990), citing multi-species models (e.g., Víkingsson and Kapel 2000). Moreover, within the IWC Scientific Committee's Standing Working Group on Environmental Concerns, Japan has taken the lead in urging that the impacts of cetaceans on world fisheries be quantified (Tamura and Ohsumi 2000; IWC 2000b, 2001d). Although not explicitly stated in the published IWC reports, Japanese whaling interests are promoting the idea that recovering or expanding whale populations represent a threat to human food security. For example, the Government of Japan (2001) states that the subject of cetacean/fisheries interactions should be addressed without delay, "given the impending imbalance of world food supply and demand." From a different perspective that places cetacean conservation at the forefront, it is important that fishing policies take into account the ecological links between cetaceans and their food supplies ("Indirect Effects," above), as well as the operational links (e.g., bycatch) between cetaceans and fishing operations (Northridge and Hofman 1999; Crespo *et al.* 2000; DeMaster *et al.* 2001).

The concept of multi-species or ecosystem management is intuitively appealing. However, the onerous data requirements, the inherent complexity and dynamism of natural marine ecosystems, and the inadequacy of knowledge about functional relationships among organisms, make such management extremely difficult to achieve in practice (Mangel and Hofman 1999). Among key uncertainties is the extent to which cetaceans switch to alternative prey species as the availability of preferred prey declines. Also, it has been pointed out that "although marine mammals are the most obvious scapegoat of fishers because of their visibility, there is typically greater competitive overlap of the feeding 'niches' of fish predators [i.e., fishes that prey upon fish] with those of fishermen" (Plagányi and Butterworth 2002).

Ship-strikes

It has long been known that collisions with vessels, even sail-powered ships, occasionally kill or injure cetaceans (Laist *et al.* 2001). However, the significance of these events has become much greater in recent years as marine traffic has come to involve larger, faster vessels infesting waters inhabited by remnant or dwindling cetacean populations. Kraus's landmark study of mortality and injury in North Atlantic right whales (1990) established the importance of ship-strikes as a factor endangering that small population. Ship-strikes also kill fin and sperm whales in the Mediterranean Sea (Cagnolaro and Notarbartolo di Sciara 1992), southern right whales in Argentina (Rowntree *et al.* 2001), and sperm whales around the Canary Islands (André *et al.* 1994). Vessel collisions are also a factor in the mortality of the endangered Hector's dolphins in New Zealand (Stone and Yoshinaga 2000), Indo-Pacific hump-backed

Figure 5. An Indo-Pacific hump-backed dolphin in Hong Kong waters, with a mutilated back presumably as a result of being struck by a propeller, or perhaps from an encounter with fishing gear. *Photo: Thomas A. Jefferson.*



dolphins and finless porpoises in Hong Kong (Parsons and Jefferson 2000) (Figure 5), and probably many other species of small cetaceans around the world. A general problem in determining the causes of death is that floating carcasses or moribund animals can be struck by vessels, thus confounding interpretations of signs of trauma during necropsies.

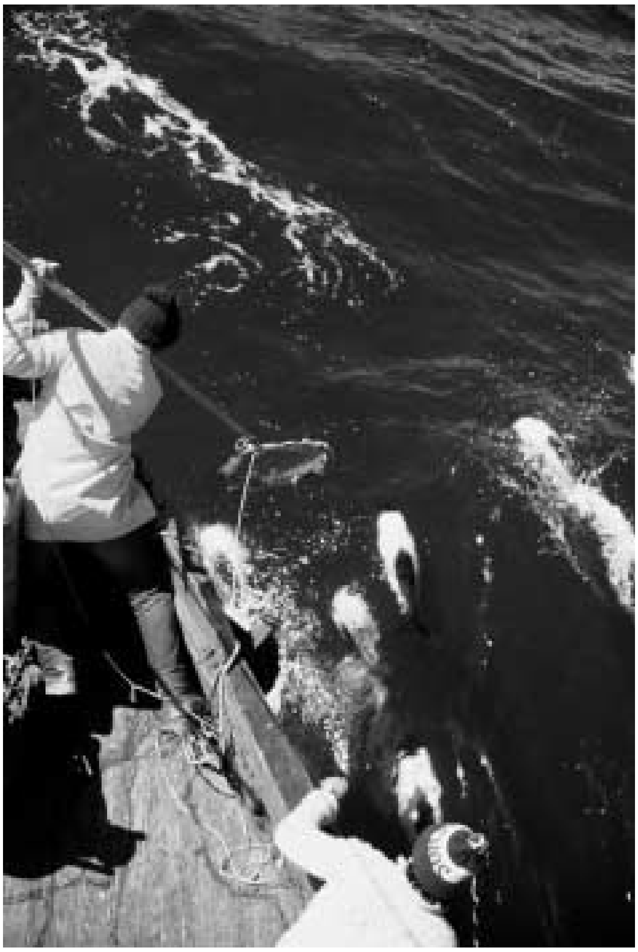
Wounds and scars on the bodies of living animals attest to the fact that some animals survive the injuries caused by collisions.

Live-captures for captive display and/or research

Removal of live cetaceans from the wild, for captive display and/or research, is equivalent to incidental or deliberate killing, as the animals brought into captivity (or killed during capture operations) are no longer available to help maintain their natural populations. When unmanaged and undertaken without a rigorous program of research and monitoring, live-capture can become a serious threat to local cetacean populations (Figure 6). All too often, entrepreneurs take advantage of lax (or non-existent) regulations in small island states or less-developed countries, catching animals from populations that are already under pressure from by-catch, habitat degradation, and other factors. For example, at least 22 Irrawaddy dolphins were taken from the Mahakam River system in Indonesia between 1974 and 1984 to supply the aquarium trade (Tas'an and Leatherwood 1984; Wirawan 1989). The Mahakam population is known to be very small (probably less than 50 individuals) and subject to a variety of ongoing threats, including the possibility of more live-captures (Chapters 4, 5, and 6). This population was classified as Critically Endangered by IUCN in 2000. Live-capture activities involving bottlenose dolphins (both *Tursiops truncatus* and *T. aduncus*), Irrawaddy dolphins, and Indo-Pacific hump-backed dolphins have taken place in various countries during recent years (e.g., Cuba, Bahamas, Mexico, Guinea-Bissau, Cambodia, and Myanmar), without adequate assessment of the wild populations and with little or no public disclosure of the numbers taken.

As a general principle, dolphins should not be captured or removed from a wild population unless that specific population has been assessed and it has been determined that a certain amount of culling can be allowed without reducing the population's long-term viability or compromising its role in the ecosystem. Such an assessment, including delineation of stock boundaries, abundance, reproductive potential, mortality, and status (trend) cannot be achieved quickly or inexpensively, and the results should be reviewed by an independent group of scientists before any captures are made. Responsible operators (at both the capturing end and the receiving end) must show a willingness to invest substantial resources in assuring that proposed removals are ecologically sustainable.

Figure 6. Live-capture of cetaceans for display in oceanaria is a controversial issue. One aspect on which most conservation biologists agree, however, is that any removals from the wild should be within the replacement yield of the wild population, i.e., "sustainable." Commerson's dolphins being netted for oceanaria off the coast of Chile, February 1984. *Photo: Steve Leatherwood.*



Whale- and dolphin-watching

Whale- and dolphin-watching has been promoted as an economic alternative to whaling and therefore as a conservation tool. Indeed, the global value of cetacean-centered tourism has been estimated as more than US$1 billion per year, and numerous business enterprises in dozens of countries depend on the ready availability of live, free-ranging cetaceans to attract customers (Hoyt 2000). There has been a growing awareness, however, that cetacean tourism, like tourism of all kinds, can have a downside. Intensive, persistent, and unregulated vessel traffic that focuses on animals while they are resting, feeding, nursing their young, or socializing can disrupt those activities, and possibly cause long-term problems for populations. Often, as entrepreneurs rush to take advantage of newly discovered whale- or dolphin-watching opportunities, there is little or no monitoring of the effects of these activities. For example, tour operators recently began offering

Figure 7. Commerson's dolphins on the bow of an inflatable boat during studies of the effects of such interactions on the animals. Bahia Engaño, Patagonia, Argentina, near the northern limit of the species' range, 1999. *Photo: Mariano Coscarella.*

trips to see dusky and Commerson's dolphins (*Lagenorhynchus obscurus* and *Cephalorhynchus commersonii*, respectively) off northern Patagonia (Argentina) (Figure 7) and Peale's dolphins (*Lagenorhynchus australis*) near Punta Arenas (Chile), but neither country has any laws to regulate this activity and limit its impact on the animals (Crespo, unpublished data). Whale-watching centered on southern right whales has flourished for the last 30 years in coastal Patagonia, where it has become the most important local tourist attraction (Rivarola *et al.* 2001). Incipient whale-watching industries along the Spanish Mediterranean coast and near the large tourism centers in south-eastern and north-eastern Brazil are expected to develop rapidly in coming years. Although there is little evidence to indicate that whale-watching has had negative effects on cetacean populations (IFAW, Tethys Research Institute and Europe Conservation 1995), one of the priorities of the IWC Scientific Committee's Sub-committee on Whale-watching is to examine the short- and long-term effects of tourism on cetacean populations and to develop general principles for minimizing these (IWC 1999a *et seq.*).

2.2 Habitat loss and degradation

Historically, the problem of habitat loss and degradation has probably been less severe or acute for cetaceans than for many terrestrial taxa. Nevertheless, it has become a serious issue for marine mammals in recent decades, especially for freshwater and coastal species (Harwood 2001). Water development projects in Asia, and to a lesser degree South America, have fragmented cetacean populations and, in some areas, eliminated their habitat (Reeves and Smith 1999; papers in Reeves *et al.* 2000b). Little is known about what characteristics make a particular river reach suitable for cetaceans, or about the specific ways in which vessel traffic, riverbank development, dams, and entrainment structures (e.g., groynes and embankments) affect these animals (Smith *et al.* 1998)(Figure 8). From what is known about the habitat requirements of cetaceans in running waters, they benefit from the refuge provided by complex physical features that interrupt strong current flows (e.g., bends and confluences). These features are often severely degraded by dams and embankments, with the waterways being transformed into biologically impoverished, canal-like systems (Smith and Reeves 2000b). Another potentially catastrophic problem is the upstream abstraction of water from river systems inhabited by cetaceans. Reduced water supplies have already caused range declines in Endangered South Asian river dolphin populations, and this trend is bound to continue as human populations expand and increase their consumption of water.

Appropriation of space by harbor construction, land "reclamation," and mariculture has similarly reduced the available habitat of coastal marine cetaceans. Even though cetaceans may occur in heavily used harbors and be seen regularly in the vicinity of "fish farms" (Figure 9), their health may be at risk. For example, in British Columbia

Figure 8. Embankments constructed for questionable flood-control benefits degrade the features that make Asian rivers suitable for supporting freshwater cetaceans and eliminate access to essential habitat for floodplain-dependent fishes and crustaceans. *Photo: Brian D. Smith.*

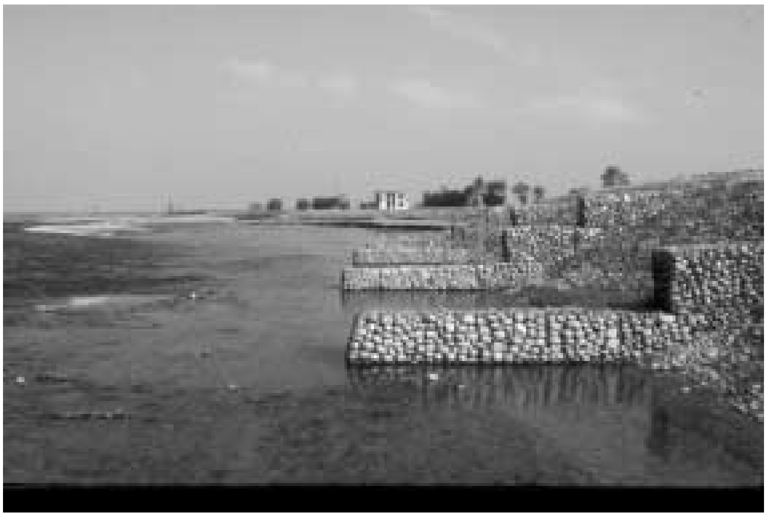


Figure 9. Dolphins are attracted to aquaculture facilities in some areas, and this can lead to conflicts, including occasional entanglement by the dolphins in the barrier nets. Common bottlenose dolphins are sometimes observed, as shown here, foraging near fish farms in the eastern Ionian Sea.
Photo: Tethys Research Institute/Giovanni Bearzi.

(western Canada), where salmon culturing is intensive and widespread, there is evidence that cetaceans are excluded from the inner reaches of bays where loud "seal scarers" are used to discourage pinnipeds from approaching salmon pens (Morton 2000; Morton and Symonds 2002; Olesiuk *et al.* 2002). In Australia, dolphins, attracted by the concentrations of scavenging fish in the vicinity of "tuna feedlots," sometimes become entangled and die in predator-exclusion nets (Kemper and Gibbs 2001). The anti-shark nets that protect prime bathing areas along the coasts of South Africa and Australia kill cetaceans, dugongs (*Dugong dugon*), and other non-target species as well as the large sharks that they are meant to deter (Cockcroft 1990, 1992; Cockcroft and Ross 1991; Paterson 1990; Parra *et al.* 2002).

An array of other threats falls under the broad heading of "habitat degradation," and some of these are treated separately below. For additional information, the reader is referred to the reports of the IWC's Working Group on Environmental Concerns, which has met annually since 1997 (IWC 1998, p.59–62 *et seq.*, now published in the annual supplement of the *Journal of Cetacean Research and Management*).

Disturbance from industrial and military operations

Cetaceans are acoustic animals. They use sound to navigate, find and capture prey, and locate mates, social partners, and predators (Tyack 1999, 2000). Man-made noise can mask signals that are essential for the animals' reproduction and survival. Underwater noise has also been shown to elicit disturbance responses at distances of hundreds of kilometers (Bowles *et al.* 1994), cause temporary or permanent hearing loss (Richardson *et al.* 1995), and probably cause physical injury (Balcomb and Claridge 2001). Noise levels in the world's oceans, seas, rivers, and lakes increased dramatically during the twentieth century (e.g., Gisiner *et al.* 1999; Jasny 1999) and are likely to continue rising in the twenty-first century unless drastic steps are taken to reduce anthropogenic inputs.

Of greatest concern are situations in which heavy vessel traffic, seismic testing, dredging, and drilling occur in or near areas where cetacean populations engage in vital activities such as calving, calf-rearing, resting, and feeding. There is no doubt that cetaceans react to noise, but it has proven extremely difficult to quantify the effects and establish thresholds of disturbance at which the animals will begin to abandon preferred areas or experience impaired health, reproduction, or longevity. Offshore oil and gas development in high-latitude areas of the Northern Hemisphere has generated numerous studies on the effects of noise and other sources of disturbance, prompted by concern about bowhead and gray whale populations (Richardson and Malme 1993; Brownell *et al.* 1997, respectively). Several humpback whales in Newfoundland died after being exposed to powerful underwater blasts associated with construction of an oil industry support facility (Ketten *et al.* 1993; Todd *et al.* 1996). Controversy surrounds the development of oil and gas deposits in many areas, including the Scotian Shelf off eastern Canada (Hooker *et al.* 1999) and the Atlantic Frontier off Ireland and the UK (Harwood and Wilson 2001).

Military operations involving the use of high-intensity sonar, explosive devices, and other intense noise sources pose both lethal and sub-lethal threats to cetaceans (Whitehead and Weilgart 1995; Katona and Kraus 1999). Unfortunately, the secretive nature of many such operations makes it difficult to document (or disprove) their effects. Recent mass strandings of beaked whales with auditory damage yet no sign of disease, blunt trauma, or fishing gear entanglement, have shown a strong correlation with naval military activities (Frantzis 1998; Rowles *et al.* 2000; Balcomb and Claridge 2001; IWC 2001d; Anon. 2001). A particular concern is the development by several navies of very loud low-frequency sonars, known as "LFA" sonar in the United States, with detection ranges, and thus potential effect ranges, of several hundred kilometers.

Military exercises that involve large numbers of vessels gathered in semi-enclosed gulfs or bays, ship-to-shore gunnery practice, and beach landings can cause danger and disturbance to cetaceans that either live year-round in such areas or enter them seasonally for calving and nursing. For example, Argentine naval forces formerly used the calm waters of the gulfs bordering Peninsula Valdés, a major right whale nursery area, for a variety of exercises. Such activities continued until as recently as 1983/1984, from which time they were officially prohibited (Crespo, unpublished data).

Along with humans and wildlife of many kinds, cetaceans suffer when war, or smaller-scale armed conflict, occurs in or near their habitat. The massive oil spill in the Persian Gulf at the end of the 1991 Gulf War was an ecological catastrophe, although local cetacean populations seem to have survived it (Robineau and Fiquet 1994a, 1994b). In South America's "war" against coca cultivation, centered in southern Colombia and now spreading to border areas in Ecuador, Peru, and Brazil, the United States military is facilitating the application of defoliants on a large scale. The disruptive effects of noise, chemical contamination, outright destruction of natural landscape features, and impoverishment of local people may be difficult to pinpoint in relation to cetacean populations, but there is no doubt that this activity contributes to the deterioration of aquatic habitat in Amazonia.

Chemical pollution

Although the evidence for links between chemical pollutants and the health of cetaceans remains largely circumstantial and inferential, there is growing concern that exposure to contaminants can increase susceptibility to disease and affect reproductive performance. Odontocetes (toothed cetaceans) from many areas, particularly in the Northern Hemisphere, have large concentrations of organochlorines, organotins, and heavy metals in their tissues (O'Shea 1999; O'Shea *et al.* 1999; Reijnders *et al.* 1999; Ross *et al.* 2000). Polychlorinated biphenyls (PCBs) are of particular concern. These and some other organochlorines are known to interfere with both the hormone and immune systems of other mammals, and high levels (in excess of 100mg/kg) of these compounds have been associated with reproductive abnormalities and complex disease syndromes in some marine mammals (reviews listed above). Besides the possible indirect effects on populations resulting from reproductive impairment or reduced resistance to disease, some pollutants (or their breakdown and combustion products) are toxic, and high levels can be lethal. Reported levels of the conventional bio-accumulative pollutants in mysticetes (baleen whales) indicate that these animals are generally less contaminated than odontocetes, often by at least an order of magnitude (O'Shea and Brownell 1994; Weisbrod *et al.* 2000). However, enzyme markers in tissues of endangered North Atlantic right whales, for example, indicate significant exposure to a nonbioaccumulative, but potentially toxic, dioxin-like compound, such as one of the polycyclic aromatic hydrocarbons (PAHs) (M. Moore, cited in Reeves *et al.* 2001b). Freshwater cetaceans may be at greater risk from pollutants than marine cetaceans because they frequent counter-current areas that often coincide with discharge sites and probably inhibit the dispersal of pollutants (Smith *et al.* 2001; Smith and Hobbs 2002). The diminished flow in South Asian rivers due to extensive damming and abstraction reduces their ability to dilute the enormous quantities of pollutants that are discharged into them (Dudgeon 1992).

Oil pollution is in a special class. It can have toxic effects when cetaceans ingest contaminated prey or breathe contaminated air, but it also has the potential of causing mechanical damage through the fouling of baleen, which would impair a baleen whale's ability to feed (Geraci and St. Aubin 1990; Mayo *et al.* 2001). The effects of prolonged contact of hydrocarbon products with the skin are another concern.

A recently recognized potential threat is the dumping of mine tailings into submarine canyons, e.g., near certain Southeast Asian islands. The rationale behind such dumping is that the low oxygen content of deep ocean waters slows the rate of oxidation, and that the tailings eventually become "sealed" beneath a layer of ocean debris. There is concern, however, that an acidic, metal-enriched plume will develop around the tailing discharge point (Pierce 2000). Highly mobile cephalopods and other organisms of the meso- and bathypelagic food webs may serve as vectors for the vertical transport of trace metal contaminants. Several large mines in Sulawesi, Indonesia, dispose of their tailings in deep ocean canyons whose waters are known to support populations of sperm whales and various beaked whales (Kahn 2000) (Figure 10).

In addition to point-source pollution, the atmospheric transport of contaminants represents a global danger. It is a particular problem for arctic species because of their proximity to the industrially overdeveloped northern countries and the nature of polar wind patterns (Bard 1999).

Figure 10. Beaked whales (Ziphiidae) are inhabitants of deep marine waters. They tend to be difficult to observe and identify, living as they do in small groups, spending much of their lives diving far below the surface, and sometimes appearing shy of boats. This animal, identified by the photographer as a Cuvier's beaked whale, approached a stationary vessel in the Flores Sea, north of Komodo National Park, Indonesia, October 2001.
Photo: Benjamin Kahn.

Disease and exposure to biotoxins

Recently documented mass die-offs have involved bottlenose dolphins in the North Atlantic and Gulf of Mexico (Duignan *et al.* 1996), striped dolphins in the Mediterranean Sea (Aguilar 2000)(Figure 11), various cetacean species in the Gulf of California (Vidal and Gallo-Reynoso 1996), harbor porpoises in the Black Sea (Birkun *et al.* 1992), Indo-Pacific hump-backed dolphins in the Arabian (Persian) Gulf (Ross *et al.* 1994), and humpback whales in a small area of the western North Atlantic (Geraci *et al.* 1989). These events have fueled concern about the susceptibility of cetaceans to epizootic diseases (e.g., morbilliviruses) and biotoxins (e.g., dinoflagellates popularly known as "red tide" organisms), as well as discharges of highly toxic substances (e.g., cyanide) into the marine environment. Although the immediate, or primary, cause of a die-off may be evident, it often proves more difficult to establish the full etiology, including evaluation of the possible role of immunosuppression or loss of vigor caused, for example, by contaminant exposure or inadequate nutrition (Geraci *et al.* 1999). A die-off can be catastrophic for a species with a limited range or low abundance. Since it is inevitable that more die-offs will occur, it is important to ensure that cetacean populations are sufficiently robust to withstand the losses (Würsig *et al.* 2001).

Climate change and ozone depletion

A workshop sponsored by the International Whaling Commission (IWC) in 1996 placed the issue of climate change, including ozone depletion, firmly on the cetacean conservation agenda (IWC 1997b). Effects of climate change are complex and interactive, making them analytically almost intractable. The workshop report acknowledges the difficulties of establishing direct links between climate change and the health of individual cetaceans, or indirect links between climate change and the availability of cetacean prey resources. It emphasizes the precautionary principle and urges action to reduce emissions of ozone-depleting chemicals and greenhouse gases. Physical changes in sea ice and freshwater discharge are well advanced and ongoing in polar regions, and these changes are probably already influencing ocean productivity, human activities, and contaminant flux, all of which have implications for cetacean populations (e.g., Tynan and DeMaster 1997). Many of the most threatened cetacean populations are in temperate and tropical areas where the manifestations of climate change, such as greater frequency and severity of storms, flooding, and drought, will exacerbate resource-use conflicts between people and wildlife. A particular problem relates to the effects of altered discharge regimes in the Asian and South American rivers inhabited by cetaceans (Würsig *et al.* 2001).

Figure 11. Striped dolphins are the most abundant cetaceans in the Mediterranean Sea, including the Ligurian Sea Cetacean Sanctuary. Their bold markings make these animals relatively easy to identify. *Photo: Tethys Research Institute/Simone Panigada.*

Chapter 3

Possible Solutions to Cetacean Conservation Problems

No single strategy will facilitate recovery of depleted populations, reverse trends of population decline and habitat deterioration, and ensure that robust populations with high-quality habitat are secure. Approaches to conservation need to be multifaceted, adaptable, and often tailored to particular local or regional conditions. These and other central tenets of wildlife conservation have been exhaustively considered and articulated by numerous authors, notably Mangel *et al.* (1996) and Meffe *et al.* (1999). In the following brief overview, we focus on several elements that are integral to a comprehensive conservation strategy for cetaceans. The solutions must address the problems of unsustainable use and habitat loss/degradation. In addition, some cross-cutting initiatives related to capacity-building and governance are vital to achieve effective conservation.

3.1 Ensuring that any catches or other uses of cetaceans are sustainable

Although there is widespread resistance, particularly in parts of the industrialized western world and in certain regions of Asia where cetaceans enjoy traditional veneration, to the idea that cetaceans should be subjected to "consumptive use" (i.e., deliberate killing), such use continues on a substantial scale in the Arctic (e.g., Caulfield 1997; Freeman *et al.* 1998), in Japan and Norway (IWC reports in *Journal of Cetacean Research and Management*), in the Faroe Islands (Zachariassen 1993; NAMMCO annual reports for ongoing statistics), and in areas such as Peru (Van Waerebeek *et al.* 1997, 1999b, 2002) and the West Indies (Adams 1994). The following factors make the deliberate exploitation of cetaceans a high-risk endeavor from a conservation viewpoint: (a) intrinsically low rates of population increase are exhibited by most cetacean species; (b) most populations are also subject to bycatch in fisheries and other forms of incidental mortality; (c) much uncertainty is usually associated with estimates of life history parameters, absolute abundance, trends in abundance, and total mortality; (d) the effects of chemical and noise pollution, reduced prey abundance, and habitat degradation are potentially serious but difficult to quantify and account for; and (e) environmental stochasticity and catastrophic events are unavoidable. Recent disclosures of gross misreporting or under-reporting of commercial whaling data (see Introduction) have reinforced the belief that a profit-driven whaling industry cannot be adequately managed to prevent stock depletion.

Concern about unsustainable exploitation applies particularly to small cetaceans (Perrin 1999). In comparison to whaling, the hunting of dolphins, porpoises, and small whales has received relatively little attention and is often not managed or monitored in any way. Some species of small cetaceans are especially vulnerable because of their inland freshwater or coastal marine distribution. A complicating factor is that their size makes the carcasses of small cetaceans both easy to handle, transport, and process, and easy to conceal from management authorities (e.g., Romero *et al.* 1997; Van Waerebeek *et al.* 1997, 1999b, 2002). Measures to regulate directed takes of small cetaceans are not easy to devise and implement, but without them, species and populations are at serious risk. Among the elements that should be incorporated into such measures are: (a) a strong emphasis on stock discrimination, abundance estimation, and assessment of factors other than hunting that are likely to affect the hunted population(s); (b) a reliable means of measuring the offtake, that is, knowing how many animals are being taken (preferably by sex and at least relative age, or life-stage); (c) a risk-averse method for setting catch limits (quotas); (d) a national governmental agency with clear responsibility to manage hunting in territorial waters, based on a transparent, science-based decision-making process, and with appropriate links to corresponding agencies in other countries in cases of transboundary stocks; and (e) an international body (such as the IWC) with responsibility to manage hunting in international waters.

Any scheme for managed exploitation of large whales also needs to be risk-averse, with clear objectives and adequate enforcement. The IWC's Revised Management Procedure (RMP) provides a precautionary means of setting catch limits for baleen whales. Stocks that fall below 54% of their pre-exploitation abundance must be fully protected, and exploited stocks are to be maintained at equilibrium levels of approximately 72% of their initial size. The procedure specifically incorporates uncertainty in abundance estimates and vital rates. Moreover, the RMP has been shown through modeling to be robust to changes in carrying capacity during exploitation (e.g., habitat degradation, climate change, and unforeseen catastrophic events). At the time of writing, the IWC had not yet completed development of a Revised Management Scheme (RMS) under which the RMP would be implemented. Nor had the IWC's Scientific Committee finished its work on a management procedure for aboriginal subsistence whaling that would cover, for example, the whaling for bowhead whales in Alaska, bowhead and gray whales in eastern Russia, fin and minke whales in Greenland, and humpback whales on the island of Bequia, St. Vincent and the Grenadines. Moreover, there was no similar procedure that could be used to manage the exploitation of toothed cetaceans, such as the sperm whale.

Developing and encouraging alternative fishing techniques

There are few more urgent examples of the need for alternative fishing techniques than the fisheries for large "catfish" (*Eutropiichthys vacha* and *Clupisoma garua*) in the Ganges and Brahmaputra river systems of India and Bangladesh (Motwani and Srivastava 1961; Mohan and Kunhi 1996; Smith *et al.* 1998; Bairagi 1999)(Figure 12). In these fisheries, the fishermen use dolphin oil and body parts to attract the target fish near enough to be netted or hooked. Many Ganges river dolphins are used each year to supply the attractant. Although some proportion of the dolphins are killed incidentally in gillnets, others apparently are killed deliberately. Scientists in India have tested shark liver and sardine oil (Mohan and Kunhi 1996) and the fish offal available locally at outdoor markets (Sinha 2002) in the hope of finding an effective substitute for dolphin products. The latter, in particular, appears promising.

Another example of a problematic fishing method is in the cold waters off southern South America, where a major fishery for crabs has resulted in the deliberate killing of dolphins to supply bait for traps. The conservation implications for populations of Commerson's, Peale's, and Chilean dolphins (*Cephalorhynchus eutropia*) were highlighted in previous Cetacean Action Plans. Taking advantage of the availability of other sources of bait, preferably waste from slaughterhouses and fish plants, has been suggested as one option to reduce the numbers of dolphins killed (Lescrauwaet and Gibbons 1994).

Figure 12. In parts of India and Bangladesh, the flesh and oil of Ganges River dolphins are used to attract schilbeid "catfish" (*Clupisoma garua*). Bound portions of meat, blubber, or entrails are trailed alongside the boat while a mixture of oil and minced dolphin flesh are sprinkled onto the water. When the fish rise to the surface within the oil slick, they are caught on small, unbaited hooks. This use of dolphin products creates an incentive for hunting dolphins and a disincentive for gillnet fishermen to release any that become entangled in their nets. *Photo: Brian D. Smith.*

Reducing incidental mortality in fisheries through gear modification and the use of deterrent devices

There has been great progress in the task of documenting cetacean bycatch during the last few decades (Perrin *et al.* 1994), but more of this work is always needed. Until decision-makers and the general public are made aware that there is a problem, little support for mitigation measures can be expected. The eastern tropical Pacific tuna fishery provides a classic example of how irrefutable scientific evidence, conveyed to the public through a massive awareness campaign, led to changes in fishing gear and fishing practices, which in turn resulted in a dramatic reduction in cetacean bycatch rates. Introduction of the "backdown" procedure and the "Medina panel" in the 1970s made it possible for the tuna industry to accommodate conservation concerns while continuing to fish (Gosliner 1999).

More recently, the deployment of acoustic deterrents ("pingers") in gillnets has been effective in reducing cetacean bycatch rates for at least a few consecutive seasons in certain fisheries (Kraus *et al.* 1997; Barlow and Cameron 1999; Gearin *et al.* 2000; Bordino *et al.* 2002). There is uncertainty, however, about the long-term efficacy of pingers and their unintended side-effects on marine organisms, possibly including displacement of cetaceans away from key feeding habitat (IWC 2000a; Cox *et al.* 2001). Acoustic alarms may have an important role to play in conservation, but their use in a particular area and fishery should be conditional upon: (a) demonstration of effectiveness through controlled scientific experiments; (b) completion of field trials to address practical issues related to implementation; and (c) establishment of long-term scientific monitoring programs, preferably involving independent on-board observers. Moreover, acoustic deterrent devices should not be regarded as a panacea for solving all bycatch problems. Their *ad hoc* use by fishermen can create new problems or exacerbate old ones. Perhaps most importantly, it can lead people to believe that continued fishing is "safe" in an area where an endangered cetacean population is at risk. For example, pinger use is not considered advisable in the upper Gulf of California where gillnet fisheries threaten the Critically Endangered Vaquita (IWC 2000a). In New

Zealand, there is ongoing controversy among scientists and conservationists as to whether pingers can be effective in reducing the mortality of Hector's dolphins in gillnets (Dawson *et al.* 1998; Stone *et al.* 2000). Efforts to reduce dolphin mortality in anti-shark nets through the use of pingers have given disappointing results (Peddemors *et al.* 1991).

It is important to emphasize that approaches to bycatch reduction used in well-regulated commercial fisheries may not be appropriate or practical in the more diffuse, economically marginal artisanal fisheries of Latin America, Africa, and Asia. Unless the technique or device provides fishermen with a compelling economic advantage of some sort, there is little hope that they will incorporate it into their standard fishing practices. Other strategies, such as restrictions on the types of gear that can be used, or time/area closures (see below), may be the only ways to address the bycatch issue in those circumstances. Of course, in areas such as Peru, Sri Lanka, the Philippines, and parts of West Africa where there is a market for cetacean products, the first step must be to establish an incentive for reducing the bycatch. Technical fixes only work if people can afford them, know how to use them, and are willing to operate within a regulatory framework of some kind.

Reducing incidental mortality through rescue and release efforts

In the previous Cetacean Action Plan, it was noted that efforts were being made to rescue and release large whales entangled in fishing gear along the east coast of North America and in the Mediterranean Sea. Entanglements in the Mediterranean have become very rare, probably because of the declining abundance of sperm whales there. Programs to detect and disentangle right whales in the United States and Canada have been expanded, with government support and funding (Silber and Payne 1998; Right Whale Recovery Team 2000). It is important to acknowledge efforts outside North America and Europe, of which few are more impressive than the freeing of a humpback whale from a gillnet in Oman, as described by Baldwin (1995). In Pakistan, a program began in 2000 to rescue Indus dolphins that enter irrigation canals and are unable to return to the main river channel, or that become trapped in shallow pools downstream of barrages where they are unlikely to survive until the next flood season (Braulik 2000). In the first year, five of ten dolphins (known to have become marooned in canals) were rescued and in 2001 these numbers increased to ten of 15 (G. Braulik, pers. comm.). Rescuing animals that belong to endangered populations, especially when the risk to their lives is a direct result of human encroachment into their habitat, has clear conservation value. However, rescue efforts of all kinds are not equally justified. The often heroic attempts to return stranded whales and dolphins to the sea certainly reflect popular interest in the animals, and rehabilitation-and-release programs can contribute to scientific knowledge and heighten public awareness (Wells *et al.* 1999; Wilkinson and Worthy 1999). However, there are also risks associated with returning to the wild gene pool individuals that have been naturally "culled" and that may be carrying new pathogens after spending extended periods in captivity (St. Aubin *et al.* 1996). When decisions are made to return cetaceans to the wild, it is important to weigh the potential conservation, animal welfare, and scientific benefits against possibly negative outcomes. In any event, releasing cetaceans that have had prolonged exposure to humans (or other species non-native to their environment) should only be done after a thorough examination by a field veterinarian. Inadvertent disease transmission could have catastrophic effects on immunologically naive populations, especially when their fitness may have already been compromised by exposure to pollutants or by depleted prey resources.

Managing cetacean-oriented tourism to minimize biological impacts

Cetacean-oriented tourism has been promoted as a "non-consumptive" or "low-consumptive" use of cetaceans that promises monetary rewards to people without requiring that the animals be killed or removed from their natural environment. Although the effects of tourism are probably of minor relevance within the overall context of human-caused threats to cetaceans, it is important to make sure that whale- and dolphin-watching is conducted in a manner that is respectful of the animals, local human communities, and fellow tourists. Guidelines and codes of conduct are increasingly available, and should be adopted and promoted by the tourism industry and by government agencies (e.g., IWC 2002b). In general, long-established cetacean-watching enterprises are closely monitored and conducted responsibly. However, instances still occur in which numerous boats surround a single whale or pod of whales, disturbing the animals and at the same time detracting from the quality of the experience for the tourists.

Greatest concern applies to start-up activities in new areas or involving cetacean populations that have not been exposed previously to this kind of boat traffic. In such cases, a series of steps should be followed in advance of major capital investments and commercial-scale promotions. These might include: (a) obtaining a basic knowledge of the biology and ecology of the species (e.g., behavior, seasonal changes, and frequency of occurrence) and local ecological conditions (e.g., local currents, weather, and distance from shore); (b) completion of an impact study by an independent assessor; and (c) establishment of an interim framework for regulation and monitoring. One way of compensating for disturbance is to use the cetacean-watching programs to help accomplish research and monitoring objectives, especially in developing countries where alternative funding for dedicated surveys is unavailable (Leaper *et al.* 1997; Smith *et al.* 1997b; Leatherwood *et al.* 2000; Smith and Hobbs 2002).

3.2 Habitat protection and restoration

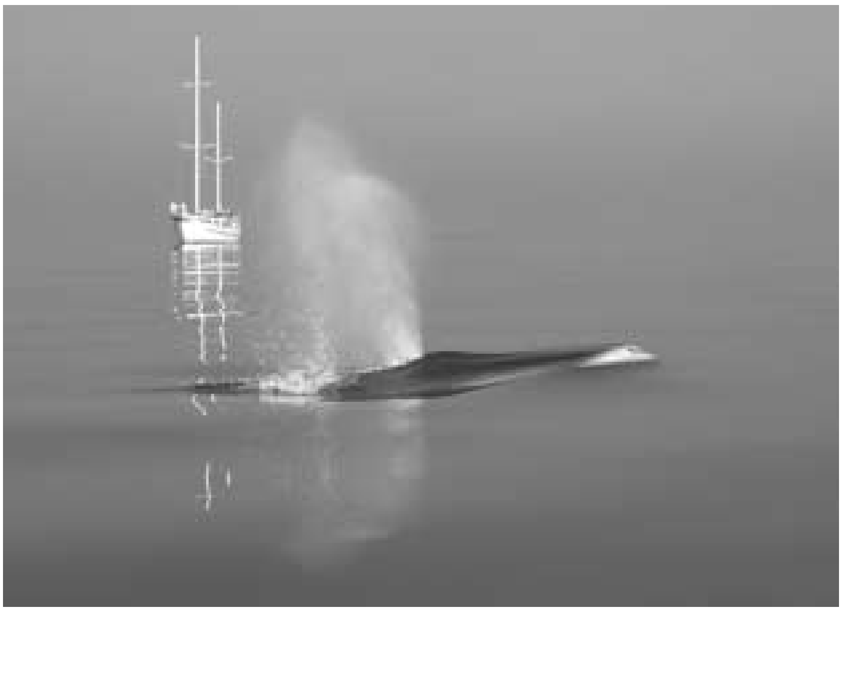
Protected areas and time/area fishing closures

The rapid proliferation of marine protected areas (MPAs) in recent decades has raised expectations and inspired confidence that populations of marine organisms, including cetaceans and their habitat, are gaining needed protection (Figure 13). For many reasons, however, the existing global network of marine and freshwater protected areas falls far short of what is needed. Few protected areas are appropriately designed or large enough to provide comprehensive protection to a cetacean population. In many cases, activities harmful to cetaceans are permitted inside a protected area (most notably, unselective or otherwise destructive fishing, but also intrusions such as large or high-speed vessel traffic). Too many designated protected areas are little more than "paper parks," so that even with a well-conceived management plan, the animals remain at risk in the absence of vigorous education, monitoring, and enforcement (Preen 1998). At the same time, "paper parks" can serve as catalysts for conducting the research necessary for guiding expansion or reconfiguration of protected areas, eventually allowing them to provide the intended conservation benefits. NGOs are often more likely to support site-based research and conservation programs when an area has been recognized by national or provincial governments as deserving protected staus. Regardless of how the conservation utility of protected areas is viewed, it is important to recognize that they are only a single component of a suite of measures necessary to protect threatened species and populations.

A major challenge in extending the coverage and level of protection conferred through protected areas is to convince "stakeholders," including local people, that conservation measures offer benefits to them and thus deserve their support. Such benefits might include: increased revenues from nature tourism, permission to use non-destructive fishing techniques inside the protected area, and the fact that protection of a breeding or nursery area for resource species can enhance fisheries outside the reserve. This last point, however, can be looked at another way. Inevitably, the protection afforded by a sanctuary, park, or reserve stops at its borders. A buffer zone can help, but even then, there is often an unfortunate "edge effect" (i.e., animals that are relatively safe from entanglement in fishing gear while inside a reserve may meet a gauntlet of nets as they move seasonally beyond its borders). New thinking about protected areas may lead to creative solutions to some of these long-standing problems. For example, it has been pointed out that an integrated approach to marine resource conservation would include a network of protected areas linked by "corridors" where effective management measures are in place to reduce the impacts of the "edge effect" mentioned above (T. Agardy, pers. comm.). Biologists and oceanographers are also seeking to address the problem of how to design protected areas offshore, where concentrations of key prey resources for cetaceans shift in space and time (Hyrenbach *et al.* 2000).

Time/area fishing closures have been used to reduce the bycatch of cetaceans in a few areas, most notably off the east coast of the United States. Some reserves and sanctuaries are, in effect, time/area closures because the main element of their management is prohibiting certain types of fishing in particular areas and at particular times in order to prevent bycatch (e.g., New Zealand's Banks Peninsula Marine Mammal Sanctuary and Mexico's Upper Gulf of California Biosphere Reserve) (IWC 2001c). Experience to date has shown that the success of a time/area closure strategy heavily depends on knowing a great deal about the dynamics of the fishery and about the biology and behavior of the species of concern. As time/area closures generally seek to balance the desire to maintain a viable fishery with the goal of conserving a vulnerable species (e.g., harbor porpoise, Hector's dolphin, or vaquita), they require intensive monitoring, education, and enforcement. Only when the bycatch problem is highly localized and predictable in time and space are time/area closures likely to be successful (Murray *et al.* 2000).

Figure 13. A fin whale surfacing in the Ligurian Sea Cetacean Sanctuary, Mediterranean Sea, with the research vessel "Gemini Lab" drifting in the background. *Photo: Tethys Research Institute/Simone Panigada.*



Reducing environmental pollution

Since publication of the previous Cetacean Action Plan in 1994, considerable progress has been made toward characterizing the nature, composition, and scale of marine and aquatic pollution. It remains true, however, that knowledge about the long-term effects of pollutants on cetaceans, in terms of animal health, survival, and reproductive success, lags far behind what is known about exposure, in terms of tissue contaminant levels and the presence of toxic chemicals in food webs. Much more research is needed to elucidate the relationships between cetacean health and contaminant exposure. Thus far, in nearly every case where pollution has been suspected of being implicated in a cetacean die-off or population decline, confounding factors have made it impossible to establish a definite cause-and-effect link. The ongoing work of the IWC Scientific Committee under its Pollution 2000+ program (IWC 1999b and subsequent reports of the Committee's Standing Working Group on Environmental Concerns) needs full support from member governments. In addition, a wide range of studies by national governments and academic institutions are needed, involving epidemiology, biomarkers, non-invasive sampling of free-ranging animals, and experiments with model and surrogate species (O'Shea *et al.* 1999). Most importantly, the research emphasis should be expanded to incorporate mechanistic and dose-response studies.

The ever-mounting body of evidence of pollutant effects on other organisms gives sufficient cause for precautionary action to reduce, or preferably stop, the production and dispersal of dangerous chemicals. Such measures are justified not only by concerns about the survival of wildlife populations, but also by human self-interest.

Minimizing human-induced underwater noise

Unlike chemical pollution, human-induced underwater noise is something that can be stopped instantaneously by simply shutting down an engine, hauling seismic gear out of the water, or switching off a sonar device. While it may be unrealistic to expect humans to allow the world's oceans, rivers, and lakes to return to anything approaching their natural sound conditions, it is nevertheless important to remember – and keep reminding decision-makers in government, industry, and the military – that cetaceans (and many other aquatic animals) depend for their survival on the ability to sense their environment acoustically. Getting people to understand and acknowledge the seriousness of the threat of underwater noise is an essential first step toward mitigation. At a minimum, activities that introduce significant amounts of high-energy sound to waters inhabited by cetaceans should require an environmental impact assessment and be monitored closely. A precautionary guiding principle is this: the less noise, the better. In some situations, it should be easy to reduce noise pollution. For instance, poorly maintained engines can produce much higher noise levels than are normal for a particular class of vessel. Proper maintenance is a benefit to all. However, other major sources of noise, such as seismic "shots" or "pings" and military sonar, are purposefully very loud to fulfill their functions. These noise sources generally have strong economic and political support, making it difficult to influence the scale of their deployment.

Legislation intended to protect cetaceans and their habitat should refer explicitly to sound energy and the need to manage it appropriately. The 1976 Convention for the Protection of the Mediterranean Sea against Pollution, for example, defines "pollution" as including both substances and energy introduced by humans into the marine environment (Whitehead *et al.* 2000). This definition makes it possible to use the treaty as a basis for regulating underwater noise as well as chemical pollution.

A project was launched under the US-Russia Environmental Agreement in 1995 to study gray whales summering near Sakhalin Island in the southern Sea of Okhotsk, and to assess the potential effects of oil and gas development in the area. This project has been effective in drawing attention to the Critically Endangered status of the western Pacific gray whale population, and to the possibility that noise from seismic testing, drilling, and vessel traffic could be harmful. However, there has been no mitigation effort comparable to that in northern Alaska where, at least for a number of years in succession, government authorities monitored the occurrence of bowhead whales and required seismic operations to be suspended whenever the animals moved into the vicinity (Reeves *et al.* 1984). The latter is one of the few examples in which large-scale industrial activities have been subject to measures intended to protect cetaceans from acoustic disturbance (Montague 1993; Richardson and Malme 1993). An underwater air bubble curtain, or screen, was used experimentally in Hong Kong to test its effectiveness at reducing the near-field noise level in an area inhabited by Indo-Pacific hump-backed dolphins. The researchers concluded that this type of mitigation held promise for wider application (Würsig *et al.* 2000).

Military officials have been reluctant to accept responsibility for threats to cetaceans, which encompass not only noise disturbance, but also pressure-induced trauma from explosions by artillery and other munitions. On a few occasions, the planning and conduct of ship-shock trials (tests of the ability of naval vessels to withstand the shock from explosives) have incorporated measures to reduce the risks to marine mammals (Parsons 1995; J. Barlow, pers. comm.), and inquiries following unusual mortality events (e.g., North Atlantic right whales) (Katona and Kraus 1999) have led to high-level consultations and increased the pressure for greater cooperation by military authorities. Publicity surrounding the hypothesis that military exercises and research conducted under the auspices of the North Atlantic

Treaty Organization (NATO) caused a 1996 mass stranding of Cuvier's beaked whales (*Ziphius cavirostris*) in the Kyparissiakos Gulf, western Greece (Frantzis 1998), led to a series of NATO-funded meetings, experiments, and dedicated research cruises, with assurances that mitigation procedures and policies would be developed and implemented. Similarly, the mass mortality of Cuvier's, Blainville's (*Mesoplodon densirostris*), and Gervais' beaked whales (*M. europaeus*), and two minke whales, in the Bahamas in March 2000 resulted in a flurry of efforts to investigate the link with military activities (Balcomb and Claridge 2001; Anon. 2001).

Reducing and mitigating the effects of coastal development

The degradation of coastal and estuarine environments continues at a staggering rate over much of the planet, and cetaceans are merely one group in a long list of organisms that are losing habitat as a result. This problem, like so many others, ultimately boils down to the fact that the human population is increasing in size, and hence, our capacity to consume the earth's resources is growing at an alarming rate. Land "reclamation," deforestation of mangroves, and harbor development represent a few of the ways in which we rush to exploit, or transform, fragile and undervalued biological systems in the coastal zone.

It is difficult to see a way forward, considering how powerful the economic and political forces behind unchecked development are. However, if there is to be any hope of slowing, and perhaps even reversing, current trends, it must reside in our ability to force governments to plan and regulate development in the coastal zone. The public must insist on a transparent and rigorous process of environmental impact review, assessment, and mitigation. For their part, cetacean biologists need to improve our understanding of coastal ecology and convey our findings to a wide audience.

Reducing the effects of water development on freshwater-dependent cetaceans

Freshwater cetaceans need to be considered in the assessment of impacts of water development projects. In virtually every case, the preferred option, from a conservation perspective, is to refrain from interfering with the natural flow regime and to avoid constructing barriers to animal (and sediment) movement. However, given that further construction of dams, barrages, embankments, and other obstructions to natural flow is inevitable, the immediate goal must be to manage, rather than completely stop, water development. Toward this end, the following principles and guidelines were adopted at a 1997 CSG-sponsored workshop on water development and freshwater cetaceans (Smith and Reeves 2000b):

- Freshwater cetaceans require sufficient year-round water flow to move freely between deep pools, to forage successfully, and to carry out activities that ensure reproductive success and recruitment into the breeding population.
- The siting and operation of dams, barrages, and other gated structures in waterways must take into account the risks associated with barrier effects.
- If built, dams should be located in upstream tributaries or, as a last resort, in the main river channel immediately upstream of confluences.
- Large daily fluctuations in flow should be avoided.
- Equilibrium between sediment erosion and deposition is necessary to maintain essential habitat features, and this can often be accomplished by managing flow releases according to environmental criteria.
- Access to floodplains should be preserved to ensure natural spawning and rearing habitat for cetacean prey.
- Fishways should be considered for mitigating the barrier effects of dams. However, they must accommodate the specific needs of species within the context of the post-development environment and be designed so that their operation can be modified in the light of experimentation and monitoring.
- Information on the pre-development ecological conditions of a river is essential for evaluating the success of mitigation efforts and for informing future development decisions.
- Post-development empirical studies are needed to monitor the operational aspects of projects as well as the effects on upstream and downstream populations of cetaceans and their habitat.
- Cumulative and synergistic impacts of multiple developments should be considered in assessments of environmental impact. In cases where the predicted impacts are judged to be severe and cannot be reduced to acceptable levels, the option of not constructing the project should be considered.

It is important to recognize that the habitat of some marine cetaceans is strongly influenced by freshwater inputs. The needs of these freshwater-dependent, estuarine species (e.g., Indo-Pacific hump-backed dolphin, Irrawaddy dolphin, franciscana) should be considered when assessing the downstream effects of diversion or impoundment schemes.

3.3 Enhancing the capacity and governance framework for cetacean conservation

Capacity-building

Capacity-building refers to the enhancement of human capabilities through a combination of education and infrastructure improvement (Figure 14). It is vital that local scientists be able to provide impetus and expertise for cetacean conservation efforts in their own regions. Although considerable progress has been made through programs such as the Conference on Biology and Conservation of Small Cetaceans and Dugongs in Southeast Asia in 1995 (Perrin *et al.* 1996), followed in 2002 by the CMS-sponsored (Convention on Migratory Species) Second International Conference on Marine Mammals of Southeast Asia (Perrin *et al.* in press), large gaps remain between the levels of training and facilities in developing countries and those in North America, Europe, Australia, and New Zealand. Existing programs of scholarships to study abroad, technology transfer, collaborative research, and professional development need to be expanded and strengthened. This is especially important in view of the proportion of endangered freshwater and coastal cetacean populations that are endemic to the territorial and economic zones of developing countries.

People learn best by engaging in a task rather than simply listening to lectures. Therefore, whenever possible, training efforts should incorporate the production of useful outputs, such as a formal population or habitat assessment, or a management plan for an area or population. A tangible product can provide a practical framework and help demonstrate the program's usefulness to both participants and sponsors. Training programs that involve practical field or laboratory exercises can have multiple benefits by building capacity while at the same time contributing to scientific knowledge. One example of a project that successfully combined training with important research outcomes was the cooperative study of marine mammals of the Sulu Sea, involving scientists from Malaysia and the Philippines (Dolar *et al.* 1997).

All too frequently, efforts at capacity-building run aground when the trainees discover that few opportunities exist for applying newly acquired knowledge and skills in their own region. People involved in the planning and implementation of training programs should seek to ensure that such opportunities exist. The content of a training program should always be tailored to the circumstances of those being trained, and training should be linked with opportunities for meaningful research and conservation at the local or regional level.

Capacity-building need not be limited to situations in which foreign experts confer their esoteric skills and insights. For example, a series of franciscana workshops, organized and conducted by scientists from Argentina, Brazil, and Uruguay, have reinforced and upgraded the regional capacity to study and conserve this endemic species (Crespo 1992, 1998; Pinedo 1994; Secchi *et al.* 2002). Part of the purpose of these workshops was to strengthen working relationships, identify and agree on priorities, coordinate research activities, standardize methodology, and enhance the analytical skills of participants. The participation of government representatives from the three countries helped to ensure that workshop results were conveyed to and understood by management authorities.

Figure 14. Capacity-building is crucial to the conservation of wild animals in developing countries. Here, Asian students and young researchers learn how to examine and conduct a necropsy on a dolphin carcass during an intensive training course in Thailand. *Photo: Petch Manopawitr.*

Cooperation and coordination among conservation bodies

Over the past several decades, there has been a global proliferation of bilateral and multilateral conventions, agreements, and advisory groups that seek to play a role in cetacean conservation. In addition to the 1946 International Convention for the Regulation of Whaling, which created the International Whaling Commission (IWC), these include: the Inter-American Tropical Tuna Commission (IATTC, the "La Jolla Agreement"); Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR); Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention); Barcelona Convention (which includes a protocol concerning Specially Protected Areas of Mediterranean Importance and Biological Diversity); Convention on Migratory Species (CMS or Bonn Convention); World Heritage Convention; Canada-Greenland Joint Commission on the Conservation of Narwhal and Beluga (JCCNB); and North Atlantic Marine Mammal Commission (NAMMCO). Two agreements explicitly aimed at cetacean conservation were recently concluded under the CMS: the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS).

The existing array of instruments has great potential for achieving conservation goals. Nevertheless, there is a constant need for evaluation to ensure that such instruments are performing their intended functions. The effectiveness of the IWC has diminished in recent years as both Norway and Japan have proceeded to expand their whaling operations, the former having filed a formal objection to the global moratorium and the latter under the rubric of scientific research. Both countries are pressing CITES to allow a resumption of international trade in whale meat and blubber. Canada, having withdrawn its membership in the IWC in 1982, has witnessed a resumption of whaling for bowheads by Inuit, yet there is no indication that it intends to rejoin the commission and subject this hunt to international oversight and management. The IWC's continuing inability to address management issues related to small and medium-sized cetaceans means that many species and populations are exploited with little or no monitoring and regulation. Regional agreements show promise for filling this gap, but more are needed. Also, existing agreements must not be allowed to drift away from the central task of facilitating the development and implementation of concrete conservation measures, aimed at protecting *both* the animals and their habitat.

Incorporating cetaceans into national conservation laws and international agreements

In many countries, either (a) cetaceans are not covered explicitly by national conservation legislation, or (b) the relevant laws are inadequately communicated and enforced. It is important not only that the management and conservation needs of cetaceans are recognized in legislation (and that such recognition be backed by the political will and funding needed to assure awareness and compliance) but also that laws are updated to reflect new knowledge and circumstances. Laws simply protecting cetaceans from deliberate killing are insufficient because in many instances non-deliberate killing (e.g., bycatch in fisheries) is a more serious threat. All too often, policies that criminalize fishermen for accidentally killing cetaceans in their gear result in the loss of vital information, with decomposing, net-marked carcasses found on shore providing the only evidence that a bycatch problem exists. At the national level, incidental mortality of cetaceans should be considered in fishery management models and decision-making.

Because the vast majority of cetacean populations and their ecosystems straddle national borders, there is a clear need for international agreements. Ideally, such agreements should apply to entire ecosystems, common problems, and shared species. In South America, for example, except for a few endemic species, most cetaceans have a wide distribution and occur in more than one political jurisdiction. The legal status, the degree of enforcement, and, indeed, the perceived value of cetaceans vary between countries. Dusky dolphins taken by fishermen in Peru and northern Chile are used as bait and food, yet dusky dolphins are objects of tourism in Patagonia. Commerson's and Peale's dolphins have been used as crab bait for many years along the southern tip of South America, but they are now also targeted by dolphin-watching tourism in Chile and Argentina. The franciscana's distribution extends across the borders of Brazil, Uruguay, and Argentina. Although it is protected by law in all three countries, incidental mortality in fisheries is high, and an international agreement would ensure consistency in addressing this serious, shared problem. On the Pacific coast of South America, the governments of five countries (Colombia, Chile, Ecuador, Panama, and Peru) approved an Action Plan for the Conservation of Marine Mammals in the Southeast Pacific in 1991, and a similar approach would be desirable on the Atlantic coast of South America, in the Caribbean region, and elsewhere. In the western Mediterranean Sea, there is now a considerable history of efforts to achieve multilateral cooperation in cetacean conservation, manifested by the CMS agreement mentioned above (ACCOBAMS) and the establishment in 1999 of the International Sanctuary for Mediterranean Cetaceans centered in the Ligurian Sea.

Role of the Cetacean Specialist Group in cetacean conservation

The overall aim of the CSG is to promote and facilitate the conservation of cetaceans worldwide. While the emphasis is on the recovery of endangered species and populations, we recognize the importance of maintaining the full diversity of the order Cetacea, which includes about 86 species and many populations. This means ensuring that species continue to occupy, and function ecologically, throughout their entire geographical range. The CSG's chosen role has been to function as a catalyst, clearinghouse, and facilitator for conservation-related research and conservation action. Our guiding premise is that conservation ultimately depends upon good science, and the group's credibility and value are based on maintaining high standards of scientific rigor. The advice we provide relates mainly to the status of populations, abundance, trends, the effects of current or potential threats, and the efficacy of mitigation. We recognize that these areas of knowledge are always marked by uncertainty, and that the usefulness of science in guiding conservation action depends upon open channels of communication with non-specialists and on the ability to create and maintain the political will to effect change.

Chapter 4

Status of Cetacean Species and Selected Populations

This section has been updated and revised to reflect new information that has become available since publication of the previous Cetacean Action Plan in 1994. Further details on some of the species and populations are available through the IUCN Red List (Hilton-Taylor 2000 or website at www.redlist.org). A note about referencing in this chapter: We have sought to achieve a balance between the extremes of (a) providing a thorough review of the relevant literature (which is beyond the scope of this publication) versus (b) providing no citations to justify statements and direct readers to sources. We have placed a premium on authoritative sources published since 1994 and on review documents that themselves cite the important primary literature on a species or topic. Readers with access to the 1994 Cetacean Action Plan (Reeves and Leatherwood 1994a) may find it useful to check it for pre-1995 references that have been left out here to save space.

4.1 Right whales

Bowhead whale, *Balaena mysticetus*

The IWC recognizes five stocks of this Arctic species. Range-wide abundance is thought to be in the order of 10,000 individuals, with 8200 (7200–9400) in the Bering-Chukchi-Beaufort Seas (IWC 1996, based on Zeh *et al.* 1995), at least 350 in Davis Strait-Baffin Bay (Zeh *et al.* 1993), 284 ± 49 in Hudson Bay-Foxe Basin (Cosens *et al.* 1997), 100 or less in Svalbard-Barents Sea (Zeh *et al.* 1993), and 150–200 in the Okhotsk Sea (Zeh *et al.* 1993). All bowhead populations were severely depleted by commercial whaling, which began in the north-eastern Atlantic in the 1600s. While the species is not listed as Endangered globally, the Svalbard-Barents Sea (Spitsbergen) stock is classified as Critically Endangered, and the Okhotsk Sea and Davis Strait-Baffin Bay stocks as Endangered. The Hudson Bay-Foxe Basin stock is listed as Vulnerable.

The Bering-Chukchi-Beaufort stock continues to be hunted by indigenous people in Alaska, western Canada, and the Russian Far East (Chukotka). The Davis Strait-Baffin Bay and Hudson Bay-Foxe Basin stocks are hunted by Inuit of eastern Canada. The hunting in Alaska and Russia is regulated by the IWC in close collaboration with national agencies and regional co-management bodies, while that in Canada is co-managed by the national government and regional bodies created under land-claim agreements (Canada withdrew from the IWC in 1982). The Bering-Chukchi-Beaufort population has been monitored intensively for more than 20 years and was increasing in the 1980s and early 1990s at a rate of about 2–3% per year in spite of the removals by hunting (Zeh *et al.* 1995). No data are available on trends in the other bowhead populations, but if they are growing, they are doing so only very slowly.

Right whales, *Eubalaena* spp.

Taxonomy and nomenclature of the right whales are in flux, but there is no doubt that the populations in the North Atlantic and North Pacific oceans are completely isolated from each other and from the population(s) in the Southern Ocean. Recent genetic evidence supports the recognition of three species (Rosenbaum *et al.* 2000).

The North Atlantic population (*Eubalaena glacialis*) consists of a remnant of about 300–350 individuals off the east coast of North America. Some members of this population migrate annually to a near-shore winter calving ground off northern Florida and Georgia and then back northward through New England waters and on to summer feeding areas off south-eastern Canada. Right whales are occasionally seen in European waters, but the species is close to extinction in the eastern North Atlantic (Notarbartolo di Sciara *et al.* 1998). An intensive long-term effort, based primarily at the New England Aquarium in Boston and the U.S. National Marine Fisheries Service laboratory in Woods Hole, is underway to monitor the North Atlantic right whale population, identify risk factors, and develop and implement measures to reduce human-induced mortality and injury (Katona and Kraus 1999; Right Whale Recovery Team 2000). Recent evidence of decreased survival and reproductive rates indicates that the population may be declining (Caswell *et al.* 1999).

The right whale population in the North Pacific (*E. japonica*) is also only a tiny fraction of what it was in the mid-19th century (Scarff 2001; Brownell *et al.* 2001). On the east side, the few animals observed are usually alone and in scattered locations. The only exception is an area of the south-eastern Bering Sea where small groups of right whales (but no calves) have been seen in several successive years. In the western Pacific, a few hundred right whales spend the summer in the Sea of Okhotsk between Sakhalin Island and Kamchatka (Miyashita and Kato 1998). Large unreported kills by Soviet whalers in the 1950s and 1960s may have destroyed any chance of the right whale's recovery in the eastern and central North Pacific (Brownell *et al.* 2001).

In the absence of direct hunts, the most serious continuing threats to right whales in the Northern Hemisphere are ship-strikes and entanglement in fishing gear. More than half of the living right whales in the western North Atlantic have experienced at least one ship-strike or net entanglement, and at least a third of the deaths in this population each year are thought to be directly linked to human activities (cf. Kraus 1990; Kenney and Kraus 1993; IWC 2001b). Deaths from entanglement in fishing gear have also been documented recently in the western North Pacific (Brownell *et al.* 2001).

Unlike their relatives in the Northern Hemisphere, several populations of southern right whales *(E. australis*) have shown evidence of strong recovery (Bannister 2001; Best *et al.* 2001; Cooke *et al.* 2001). Although numbers are still small in absolute terms, totaling only about 7000 animals (IWC 2001b), there is reason to expect that continued protection will allow substantial recovery of at least some of these populations (Best 1993). A major factor delaying recovery was the illegal and unreported killing of more than 3300 southern right whales by the Soviet Union between 1951/1952 and 1971/1972 (Tormosov *et al.* 1998).

4.2 Rorquals

Common minke whale, *Balaenoptera acutorostrata*

Only within the last decade has the species distinction between the common minke whale and the Antarctic minke whale (*Balaenoptera bonaerensis*) become widely understood and accepted. The present convention is to regard *B. acutorostrata* as consisting of two, and possibly three, subspecies: the North Atlantic population, *B. a. acutorostrata*; the North Pacific population, *B. a. scammoni* (= *davidsoni*); and the "dwarf" minke whale, *B. a.* subsp., which is found in parts of the Southern Ocean (Rice 1998). Both the North Atlantic and North Pacific populations are widely distributed and relatively abundant. The dwarf form is best known from wintering areas off eastern Australia, New Caledonia, southern Africa, and Brazil, but it apparently moves to high latitudes (at least 65°S) in summer.

There are thought to be approximately 120,000 minke whales in the north-eastern North Atlantic, but this stock has been reduced by whaling to an estimated 45–70% of its pre-exploitation level of abundance and it continues to be hunted commercially by Norway (*c.* > 600 per year). There are an estimated 60,000 minke whales in the central North Atlantic, with no evidence of a significant decline. The commercial hunt for minke whales in Icelandic waters ended in 1986 and has yet to resume, despite repeated press reports that resumption is imminent. Greenland hunters kill at least 150 minke whales each year under an IWC quota. There is no overall estimate of abundance in the western North Atlantic, but at least a few thousand minke whales are present along the east coast of North America.

In the western North Pacific, two minke whale stocks are recognized by the IWC. One of them, called J-stock, inhabits the Sea of Japan, Yellow Sea, and East China Sea (Goto and Pastene 1997). The other, called O-stock, inhabits the Sea of Okhotsk and Pacific waters. J-stock is thought to have declined by more than 50% because of intensive whaling in the past by China, Taiwan, the Republic of Korea, and Japan. O-stock is also well below its pre-exploitation abundance but is less depleted than J-stock. Japan continues to hunt North Pacific minke whales, taking at least 100 per year under a national permit for scientific research. At least a few tens of minke whales are also taken annually as a fishery bycatch in South Korean waters (Kim 1999) and in set nets in Japan (Tobayama *et al.* 1992). A substantial proportion of the minke whales sold in Japanese markets are from J-stock (Dalebout *et al.* 2002a). It is uncertain to what extent these come from the "scientific" hunt, fishery bycatch, or natural strandings, but the scale of removals from J-stock is sufficient to cause serious concern for this population's long-term survival (Baker *et al.* 2000).

The common minke whale's classification as Near Threatened (under the 1996 categories and criteria) was based on the major declines in some stocks (e.g., J-stock in the western North Pacific) which, when aggregated, could have meant that there was an overall decline of at least 20%, the threshold for listing species as Vulnerable under the 1996 criteria. Although the continuing threat of commercial and "scientific" whaling is generally well known, the incidental mortality of common minke whales in fish nets and traps, which occurs throughout their range (e.g., Tobayama *et al.* 1992; Van Waerebeek *et al.* 1999a), has been given little attention. Such mortality should be taken into account in assessments to ensure that whaling quotas are appropriately risk-averse (e.g., IWC 1998, p.133). Also, since the meat and blubber of "by-caught" whales has commercial value in Japan and the Republic of Korea, there is an incentive to set gear deliberately in places where it is likely to catch minke whales, or to"drive" whales toward the nets. This issue has been a major source of controversy within the IWC's Scientific Committee.

Relatively little is known about the conservation status of the dwarf form. Dwarf minke whales are the objects of attraction for a unique tour enterprise on the Northern Great Barrier Reef, Australia, in which people observe the whales underwater (Birtles and Arnold 2000).

Antarctic minke whale, *Balaenoptera bonaerensis*

The Antarctic minke whale may be the most abundant baleen whale species today, with a total population of several hundred thousand. It occurs in highest densities in the Antarctic during the summer feeding season. The winter breeding areas are thought to be relatively dispersed in open ocean areas in tropical and subtropical latitudes (Kasamatsu *et al.* 1995). Antarctic minke whales were hunted intensively on their breeding grounds off Brazil between 1965 and 1985, when the total catch was about 14,600 (Zerbini *et al.* 1997). Otherwise, most of the whaling on this species has taken place in Antarctic waters, where the total catch from 1957/1958 to 1986/1987 reported by Japan and the Soviet Union (and possibly including a few unspecified "dwarf" minke whales) was 98,202 (Horwood 1990). Japanese whaling for minke whales has continued in the Antarctic under national scientific research permits, and this has led to much controversy within and outside the IWC. The annual catch under these permits has been approximately 300.

Sei whale, *Balaenoptera borealis*

The sei whale is widely distributed in temperate oceanic waters worldwide. It was heavily exploited in all areas once the stocks of blue and fin whales had been reduced. There is good evidence that the stocks of sei whales were depleted before gaining full protection from commercial whaling in the 1970s and 1980s. The extent to which stocks have recovered since then is uncertain. Relatively little research on sei whales has been conducted during the past quarter-century. The species' classification by IUCN as Endangered in the mid-1990s (under the 1996 categories and criteria) was based on an estimated decline of around 50% in worldwide total abundance over the last three generations. This assumes a generation time of roughly 20–25 years. Most of this decline would have occurred in the Southern Hemisphere, which had a much larger original population than the North Atlantic or North Pacific. While a change in classification to Vulnerable may be appropriate, there is a distinct lack of reliable survey data that could serve as the basis for reassessment.

Bryde's whales, *Balaenoptera edeni/brydei*

Bryde's whales are regarded as having a pantropical distribution, and in some areas (e.g., the western Pacific) they move seasonally into warm temperate latitudes. The difficulty of distinguishing Bryde's whales from sei whales has confounded much of the historical literature, and even some modern survey data. Bryde's whales became major targets of the commercial whaling industry only after the stocks of larger balaenopterids had been reduced to uneconomic levels. Nevertheless, some Bryde's whale populations, particularly in the western North Pacific, were subjected to intensive whaling and therefore were substantially reduced before the international moratorium was implemented in the 1980s. There is continued controversy about whether catches by Soviet, Japanese, Chinese, Philippine, and Taiwanese whalers were fully and accurately reported (e.g., IWC 2000c, p.88). In 2000, Japan killed 43 Bryde's whales in the western North Pacific as part of its "scientific research whaling" program (IWC 2002d), and another 50 were taken in 2001.

A major area of uncertainty, and the principal reason that the Bryde's whale is listed as Data Deficient on the IUCN Red List, is the question of how many species and populations should be recognized. In general (as summarized by Rice 1998), the animals traditionally called Bryde's whales fall into two groups based on consistent size differences. The "small form" or "pygmy" Bryde's whale (*B. edeni*), can reach physical maturity at 9m and rarely grows longer than about 11.5m, whereas the "ordinary" Bryde's whale (*B. brydei*) does not even reach sexual maturity until 11.2m (males) or 11.7m (females) and can grow to 14.6m (males) or 15.6m (females). While ordinary Bryde's whales occur in tropical and warm temperate waters around the world, small-form Bryde's whales have been documented in only a few specific areas (e.g., Solomon Sea, South China Sea, south-eastern Indian Ocean and possibly southern Japan) (Kato *et al.* 1996; T. Kasuya, pers. comm.) and appear to be limited to coastal and shelf waters (Figure 15). Species-level differences have been found in the mitochondrial DNA and cytochrome *b* gene of the two groups (Dizon *et al.* 1996; Yoshida and Kato 1999), but unsettled nomenclature has prevented formal recognition of the pygmy form as a separate species (Kato 2002). The strong continuing interest in Japan to resume commercial whaling for Bryde's whales creates an urgent need for improved understanding of both their systematics and population status.

Blue whale, *Balaenoptera musculus*

Although some populations of blue whales in the Northern Hemisphere appear to have recovered at least partially from their massive over-exploitation in the early to mid-twentieth century, others have not (Clapham *et al.* 1999). More than 350,000 blue whales were taken by whaling fleets in the Southern Hemisphere from 1904 to 1967, when they were given legal protection. Thousands more were killed, but not reported, by Soviet whaling fleets in the 1960s and 1970s. Numbers of living blue whales in the Antarctic remain extremely low (estimates are only in the hundreds), and it is uncertain what proportion are "true" blue whales (*B. m. intermedia*) as opposed to "pygmy" blue whales (*B. m. brevicauda*). Trends of increase around Iceland and off California contrast with the complete absence of blue whales today off southern Japan, and their apparent rarity in the Gulf of Alaska and southern Bering Sea where they were once abundant.

The species' Red List classification as Endangered (under the 1996 categories and criteria) was based on an estimated decline of at least 50% in worldwide total abundance over the last three generations, assuming a generation time of roughly 20–25 years. Three geographical populations ("stocks") and one subspecies were also included in the

1996 Red List (again, using the 1996 categories and criteria). The Antarctic stock was listed as Endangered because its abundance in the early 1990s was estimated to be only in the mid-hundreds, with the reasonable possibility that less than 250 mature individuals were alive at the time. The North Pacific stock was classified as Lower Risk/Conservation Dependent, mainly because the population was estimated at about 2000 in the early 1990s and evidence suggested an increase off California. The North Atlantic stock was listed as Vulnerable because available survey and photo-identification data suggested a total population of no more than about 1500, of which less than 1000 would have been mature. Finally, the pygmy blue whale, centered in the Sub-Antarctic Zone of the Indian Ocean between 0º and 80ºE, was listed as Data Deficient because of uncertainty about its taxonomic status and abundance. Of particular concern in this assessment was that more than 8000 pygmy blue whales had been taken illegally by Soviet whalers in the 1960s and 1970s (Clapham *et al.* 1999).

Blue whales require continued protection and close monitoring into the foreseeable future. There does not appear to be any immediate intention to resume commercial whaling for them, nor is there any other well-defined threat from human activities. As noted by Clapham *et al.* (1999), however, their nearly exclusive dependence upon euphausiids, especially krill (*Euphausia superba*) in the Antarctic, could make blue whales vulnerable to large-scale changes in ocean productivity caused, for example, by climate change.

Figure 15. There are definitely two species of Bryde's whale, but their taxonomy and nomenclature remain unresolved. The smaller of the two species, generally called the pygmy Bryde's whale, occurs in near-shore waters of southern Asia. The individual shown here was photographed off Loh Dasami Rinca, Komodo National Park, Indonesia, April 2000. Genetic analysis of a biopsy from the animal confirmed its identity as a pygmy Bryde's whale.
Photo: Benjamin Kahn.

Fin whale, *Balaenoptera physalus*

Like the blue whale, the fin whale was severely reduced worldwide by modern commercial whaling. Nearly three-quarters of a million fin whales were reportedly taken in the Southern Hemisphere alone between 1904 and 1979 (IWC 1995, p.129–130). Their current status is poorly known in most areas outside the North Atlantic (including the Mediterranean Sea), where recent studies indicate that there is a series of geographical "stocks" with limited genetic exchange (Bérubé *et al.* 1998), totaling more than 40,000 animals. Fin whales are currently hunted only in Greenland, but they would likely also become a principal target in Iceland if whaling were to resume there. Fin whales are rarely encountered today in those areas of the Southern Hemisphere where they were taken in large numbers. The species was classified as Endangered (under the 1996 categories and criteria) on the basis of an estimated decline of at least 50% worldwide over the last three generations (assumed generation time was 20–25 years). As in the case of blue whales, the greatest decline was in the Southern Hemisphere, which had the largest original population. Ship-strikes are a major cause of fin whale mortality (Laist *et al.* 2001).

Humpback whale, *Megaptera novaeangliae*

Humpback whales have a cosmopolitan distribution that generally involves long migrations between high-latitude summer feeding grounds and tropical breeding grounds (Clapham 2000). Although commercial whaling seriously depleted all humpback stocks, the species has demonstrated remarkable resilience and many of those stocks are recovering (Clapham *et al.* 1999). As coastal and charismatic animals, humpbacks are major tourist attractions in some areas. They are also the subjects of numerous local population studies (e.g., Steiger and Calambokidis 2000; Razafindrakoto *et al.* 2001) as well as basin-scale research programs (Baker *et al.* 1998; Smith *et al.* 1999). Although they are certainly vulnerable to ship collisions, entanglement in fishing gear, and disturbance (even serious injury) from industrial noise, humpbacks seem able to adapt, or at least tolerate, living in close proximity to a considerable variety and amount of human activities. They are actively hunted today only at Bequia, St. Vincent and the Grenadines, in the eastern Caribbean Sea. With growing humpback populations, however, pressure to resume commercial whaling in at least a few areas is likely to mount. The species was listed as Vulnerable (under the 1996 categories and criteria) based on the fact that, although most monitored stocks had shown evidence of fast recovery and may have increased to more than 50% of their levels three generations ago (1930s, assuming a 20-year generation time), they had not yet attained 80% of those levels. Importantly, the large illegal kills by Soviet factory ships in the Southern Hemisphere from the 1950s to the early 1970s would have delayed recovery of southern stocks.

4.3 Gray whale

Gray whale, *Eschrichtius robustus*

The gray whale was extirpated from the North Atlantic within the last 300–400 years, so the only extant representatives of the family Eschrichtiidae are the gray whales in the North Pacific. The western Pacific stock, which may number no more than about 100 individuals, was reclassified in the 2000 IUCN Red List from Endangered to Critically Endangered (under the 1996 categories and criteria). Its principal summer feeding area is off Sakhalin Island in the Russian sector of the Okhotsk Sea, where a major oil and gas field is being developed by a multinational energy consortium (Weller *et al.* 2002). The annual migration takes these whales into coastal waters of Japan, Korea, and China, where they are vulnerable to ship collisions and entanglement in fishing gear. Moreover, a female from this population was found on a Japanese beach in 1996 bearing several harpoons of the kind used in the Dall's porpoise hunt off Japan (Brownell and Kasuya 1999; Baker *et al.* 2002). This incident demonstrates that the western Pacific population is at risk from illegal hunting.

The eastern stock of more than 21,000 has been growing steadily in spite of an annual hunt in Russia governed by an IWC quota (Buckland and Breiwick 2002). In recent years, however, this population has experienced an unprecedented amount of mortality on its migration route and in the winter breeding areas, and exhibited a decline in calf production (Le Boeuf *et al.* 2000). There is concern that these trends, should they persist, could lead to a significant decline in abundance of the eastern Pacific stock.

4.4 Pygmy right whale

Pygmy right whale, *Caperea marginata*

The pygmy right whale is thought to have a circumpolar distribution in temperate and subantarctic waters of the Southern Ocean. It is one of the least known cetacean species, although recently completed anatomical studies (Kemper and Leppard 1999) and observations at sea (e.g., Matsuoka *et al.* 1996) have begun to reveal basic information. There are no known conservation problems (Kemper 2002).

4.5 Marine dolphins

Commerson's dolphin, *Cephalorhynchus commersonii*

Commerson's dolphins occur as two disjunct populations. The larger is centered in coastal and inshore waters of the western South Atlantic, including Patagonia, the Strait of Magellan, Tierra del Fuego, and the Falkland Islands (Las Malvinas). Some individuals move south through Drake Passage as far as the South Shetland Islands. The other population inhabits coastal waters around the Kerguelen Islands in the southern Indian Ocean (Goodall 1994).

The species' near-shore distribution makes it vulnerable to incidental capture in gillnets and other fishing gear used in coastal waters. Commerson's dolphins are killed at least occasionally in mid-water trawl nets on the Argentine shelf (Crespo *et al.* 1997). The South American population has also been subjected to harpooning (mainly for crab bait) and some live-capture for oceanaria (Lescrauwaet and Gibbons 1994). No good estimates are available on the magnitude of the catches, but recent surveys indicate that the species is still relatively abundant on the Patagonian shelf and in the Strait of Magellan (Lescrauwaet *et al.* 2000; Crespo, unpublished data).

Chilean dolphin, *Cephalorhynchus eutropia*

The Chilean dolphin is endemic to coastal waters of Chile, from near Valparaíso (33°S) south to Navarino Island near Cape Horn (55°15'S). It is relatively common in the channels of Chile's convoluted coastline south from Chiloé Island. The crab bait fishery in southern Chile (cf. Lescrauwaet and Gibbons 1994) and a variety of other fisheries (particularly coastal gillnet fisheries) have been viewed as potentially serious threats. Some shooting and harpooning also occurs, with the dolphins used for bait or human consumption. Unfortunately, there is no systematic monitoring of either mortality or abundance, so the species' status is uncertain. In addition to the mortality caused by entanglement and hunting, Chilean dolphins may now be excluded by salmon aquaculture operations from some of the bays and fiords that they traditionally inhabited (Claude *et al.* 2000).

Heaviside's dolphin, *Cephalorhynchus heavisidii*

Heaviside's dolphins have an extremely limited range (Figure 16). They occur only in coastal waters off the west coast of southern Africa, from near the Angola-Namibia border (at about 17°S) south to Cape Point, South Africa (near Cape Town). They are said to be the most commonly sighted dolphins in Namibian waters. There is no clear

Figure 16. Heaviside's dolphins off the south-western coast of Africa, shown here, are among the more poorly assessed cetaceans. There is no abundance estimate for the species, nor is there reliable information on the magnitude of incidental or direct mortality. *Photo: Thomas A. Jefferson*.

evidence of a conservation problem for this species, but its restricted distribution alone makes it vulnerable (Peddemors 1999). At least a few animals are killed in gillnets, purse seines, beach seines, and trawls. Some are illegally shot or harpooned, apparently for their meat (Best and Abernethy 1994).

Hector's dolphin, *Cephalorhynchus hectori*

In the years since 1994, when the previous Cetacean Action Plan was published, much new information has become available concerning this species, which is endemic to coastal waters of New Zealand. The most recent abundance estimates total around 7400 animals, of which almost all occur along the coasts of the South Island (Slooten *et al.* 2002). The aggregate population is fragmented into at least three genetically isolated, regional groups, one of which (North Island population) numbers fewer than about 100 individuals, all with a single mitochondrial DNA lineage (Pichler *et al.* 1998; Russell 1999; Pichler and Baker 2000). Hector's dolphins throughout their range are subject to incidental mortality in fishing gear, although the Banks Peninsula Marine Mammal Sanctuary has been of some benefit in reducing mortality in an area off the east coast of the South Island. Based on a sensitivity analysis, Martien *et al.* (1999) predicted the extinction of the North Island population within the next few decades unless gillnet fishing effort is substantially reduced (Dawson *et al.* 2001). In addition to fishery-related mortality, young Hector's dolphins are sometimes struck and killed by boats (Stone and Yoshinaga 2000).

Hector's dolphin was reclassified in the 2000 IUCN Red List from Vulnerable to Endangered (under the 1996 categories and criteria), based on the recent and continuing population decline caused by incidental entanglement in gillnets and the fact that, at the time of the assessment, there were estimated to be fewer than 2500 mature individuals. The North Island population was listed separately as Critically Endangered.

Short-beaked common dolphin, *Delphinus delphis*

The short-beaked common dolphin is widely distributed in temperate marine waters of the Atlantic and Pacific Oceans. Although it remains abundant globally, several regional populations are thought to be in serious trouble. The population in the Black Sea was seriously depleted by overhunting and is probably affected now by the severe degradation of its habitat. Common dolphins were fairly abundant in the northern part of the western Mediterranean Sea as recently as the 1970s, but for unknown reasons they are now rarely seen there (Forcada and Hammond 1998). It is likely that illegal driftnetting operations by Spain, Italy, and Morocco have been responsible for at least some of the decline in that area (cf. Silvani *et al.* 1999) but additional factors are likely involved. In Atlantic waters off western Europe, large-scale and recurrent mortality in trawl nets (Tregenza and Collet 1998), tuna driftnets (Tregenza and Collet 1998), and sink gillnets (Tregenza *et al.* 1997) is a source of concern. There are an estimated 75,000 common dolphins on the Celtic Sea shelf (Hammond *et al.* 2002).

Short-beaked common dolphins are taken in considerable numbers in Sri Lanka, Peru, Ecuador, and probably India. Although much of the catch is incidental, there are markets in these countries for dolphin meat, and therefore an incentive to take the animals deliberately. In none of these areas is there even a single good abundance estimate for the species, much less a series of estimates that could be used to assess trends. Mid-water trawls on the Patagonian shelf pose a risk to common dolphins and other anchovy predators (Crespo *et al.* 2000). Short-beaked common dolphins were heavily exploited by the tuna purse seine fishery in the eastern tropical Pacific during the 1960s and 1970s. They experienced large-scale mortality in high-seas driftnets in many parts of the world until these were banned under the United Nations moratorium in 1993. Kill-rates in the California drift gillnet fishery dropped considerably after the use of pingers was required (Barlow and Cameron 1999). Abundance estimates suggest that there are more than 370,000 short-beaked common dolphins off the western United States (Carretta *et al.* 2001), more than 30,000 off the eastern United States (Waring *et al.* 2001), and perhaps close to three million in the eastern tropical Pacific.

Long-beaked common dolphin, *Delphinus capensis*

The long-beaked common dolphin occurs in continental near-shore tropical and warm temperate waters of at least the Pacific, Atlantic, and western Indian oceans (including Madagascar). In the northern Indian Ocean and south-eastern Asia, an even longer-beaked variety replaces *D. capensis*, and some authors consider it a valid species, *D. tropicalis* (van Bree and Gallagher 1978; Rice 1998). Recent morphological evidence indicates that differences between the two forms are probably clinal, and therefore not species-level (Jefferson and Van Waerebeek, 2002). Although its known distribution is more restricted than that of the short-beaked common dolphin, and its aggregate abundance probably much lower, the long-beaked species is not known to face any major immediate threats to its survival. In several areas, however, most notably West Africa and the east and west coasts of South America, the documentation of abundance and catches is insufficient for proper status evaluation. There is growing concern about the large numbers of long-beaked common dolphins killed off Peru and used for human food or shark bait (K. Van Waerebeek, pers. comm.).

Pygmy killer whale, *Feresa attenuata*

The pygmy killer whale is widely distributed in tropical and subtropical waters worldwide (Figure 17). It appears to be naturally uncommon, and group sizes are generally no larger than around 30 to 50 individuals. Wade and Gerrodette (1993) estimated that there were about 40,000 of these whales in the eastern tropical Pacific. Because of their relatively low abundance, even small takes in localized areas could be significant. However, there is no basis for serious concern about this species at present.

Short-finned pilot whale, *Globicephala macrorhynchus*

This species occurs in tropical and warm-temperate waters worldwide, and its distribution extends into cold-temperate waters in the North Pacific (Bernard and Reilly 1999). Stocks are ill-defined except off Japan, where two morphologically distinct, allopatric forms have been identified. The species is abundant globally, but at least one of the two forms hunted off Japan is depleted. The northern form, whose population is estimated at only 4000–5000, is subject to small-type whaling with an annual national quota of 50. The southern form, with an estimated population of about 14,000 in coastal waters (Miyashita 1993), is subject to small-type whaling, hand-harpoon whaling, and drive whaling, and there is an annual national quota of 450.

Short-finned pilot whales are hunted by artisanal fishermen in the Lesser Antilles, especially St. Vincent and St. Lucia, where the combined catch was in the hundreds annually until at least the mid-1970s. Reliable catch data are not available for the Caribbean hunts. The species is also hunted in Indonesia and Sri Lanka, but again with no regular reporting of catch levels. Many short-finned pilot whales are taken incidentally in fishing gear throughout their range. Population assessments are needed in areas where directed hunting takes place or where a large bycatch is known or suspected. A resident population of pilot whales in the Canary Islands is exposed to intensive, and thus potentially disruptive, whale-watching and fast-ferry traffic. There are about 150,000 short-finned pilot whales in the eastern tropical Pacific (Wade and Gerrodette 1993) and about a thousand in shelf waters off the North American west coast (Carretta *et al.* 2001).

Long-finned pilot whale, *Globicephala melas*

This species is abundant and widely distributed in temperate to subpolar marine waters. Two subspecies are recognized: one in the cold temperate and subarctic North Atlantic, the other in temperate to subantarctic waters of the Southern Hemisphere to as far south as about 68ºS (Bernard and Reilly 1999). In the North Atlantic, the species occurs in deep offshore waters, including those inside the western Mediterranean Sea, North Sea, and Gulf of St. Lawrence. Long-finned pilot whales tend to follow their prey (squid and mackerel) inshore and into continental shelf waters during the summer and autumn.

The southern subspecies has not been exploited on a significant scale; about 200,000 are estimated to occur in waters

Figure 17. Profile of a pair of pygmy killer whales swimming near Manado Tua, north-western Sulawesi, Indonesia, August 1998. These small whales are relatively common in south-eastern Indonesian waters and can sometimes be confused with juvenile Risso's dolphins. *Photo: Benjamin Kahn.*

south of the Antarctic Convergence in January (Kasamatsu and Joyce 1995). Long-finned pilot whales in the North Atlantic have long been exploited in drive fisheries as well as in shore-based and pelagic hunts. They are also commonly killed incidentally in gillnet, trawl, and longline fisheries. A drive fishery in Newfoundland considerably reduced the numbers of long-finned pilot whales in the western North Atlantic before it ceased in the early 1970s (Mercer 1975). The only area with a continuing large direct kill is the Faroe Islands, where the annual catch (by driving) increased from an average of about 1500 in the early 1970s to nearly 2500 in the 1980s, and declined to approximately 1000–1500 in the 1990s. Sighting surveys in 1987 and 1989 supported a population estimate of more than 750,000 pilot whales in the central and north-eastern North Atlantic (Buckland *et al.* 1993a). The removals by drive hunting at the Faroes have therefore been considered sustainable (NAMMCO 2000a).

Figure 18. Risso's dolphins exhibit their typically piebald, or heavily scarred, appearance. These animals are fairly common in the Mediterranean Sea, including the Ligurian Sea Cetacean Sanctuary. *Photo: Tethys Research Institute/Vittorio Fadda.*

Risso's dolphin, *Grampus griseus*

Risso's dolphins are abundant in tropical and temperate latitudes throughout the world's oceans (Kruse *et al.* 1999) (Figure 18). They prey almost exclusively on squid. A recent study of habitat preferences in the northern Gulf of Mexico indicated that Risso's dolphins occur mainly on steep sections of the upper continental slope (Baumgartner 1997). There are an estimated 29,000 off the eastern United States (Waring *et al.* 2001), 2700 in the northern Gulf of Mexico (Waring *et al.* 2001), 16,500 off the western United States (Carretta *et al.* 2001), 83,000 in three areas of concentrated occurrence off Japan (Miyashita 1993), and 175,000 in the eastern tropical Pacific (Wade and Gerrodette 1993).

Risso's dolphins are hunted regularly in Japan, with reported catches in recent years ranging from about 250–500 (see tables of catches of small cetaceans appended to annual reports of the Sub-committee on Small Cetaceans of the IWC's Scientific Committee, published in the annual supplement of the *Journal of Cetacean Research and Management*). They are also a major target of artisanal hunting, and taken often in gillnets and other fishing gear in Sri Lanka and the Philippines. Populations in these areas with large kills have not been properly assessed.

Fraser's dolphin, *Lagenodelphis hosei*

This tropical oceanic species is poorly known but reasonably abundant (Jefferson and Leatherwood 1994) (Figure 19). Schools of thousands are sometimes observed, and there are estimated to be more than 250,000 in the eastern tropical Pacific (Wade and Gerrodette 1993). Fraser's dolphins have been, and probably continue to be, hunted at least opportunistically in Japan, Sri Lanka, the Philippines, Lesser Antilles, and Indonesia. There is little information on population size or abundance (outside the eastern tropical Pacific).

Atlantic white-sided dolphin, *Lagenorhynchus acutus*

This species is widespread in temperate pelagic waters across the rim of the North Atlantic (IWC 1997a; Reeves *et al.* 1999b). Abundance estimates off eastern North America total close to 40,000 (Palka *et al.* 1997; Kingsley and Reeves 1998), and there are probably at least tens of thousands in the central and eastern North Atlantic. These dolphins are hunted regularly at the Faroe Islands, where a few hundred

Figure 19. Fraser's dolphins approaching a research vessel far off New Britain in the Bismarck Sea, Papua New Guinea, March 2001. These individuals lack the bold dark stripe along the side that is so distinctive for this species, particularly on adult males. *Photo: Benjamin Kahn.*

are taken by driving in some years. Reported catches in the years from 1995 to 1998 were 157, 152, 350, and 438, respectively (Bloch and Olsen 1998, 1999; Bloch *et al.* 1997, 2000). Smaller numbers are taken occasionally in southern Greenland. Relatively small numbers are also killed in fishing gear throughout much of the species' range (e.g., Palka *et al.* 1997; Couperus 1997). Mortality in mid-water trawls is a particular concern (Couperus 1997). No population assessment is associated with the Faroese hunting of white-sided dolphins, nor is there evidence that this aspect of the drive fishery has a long history, such as that of the pilot whale component. In the absence of any proper assessment of stock identity and abundance, it is impossible to judge whether this can be regarded as a sustainable hunt.

White-beaked dolphin, *Lagenorhynchus albirostris*

White-beaked dolphins are endemic to the northern North Atlantic, where they occur mainly on the continental shelf and in semi-enclosed waters, notably the Gulf of St. Lawrence and North Sea (Northridge *et al.* 1997; Kinze *et al.* 1997; Reeves *et al.* 1999a). Eastern and western populations are phenotypically distinct (Mikkelsen and Lund 1994). Estimates of abundance for a number of areas indicate that there are at least tens of thousands of these dolphins, with particularly large numbers in the Barents, Norwegian, and North seas (Øien 1996; Hammond *et al.* 2002). White-beaked dolphins are hunted for food in Newfoundland and Labrador, but no records are kept of numbers killed, and there has been little effort to assess stocks (but see Alling and Whitehead 1987).

Peale's dolphin, *Lagenorhynchus australis*

This dolphin is endemic to coastal and shelf waters of the southern cone of South America, from central Chile to northern Argentina (Goodall *et al.* 1997a, 1997b; Brownell *et al.* 1999b). It also occurs around the Falkland Islands and on Burdwood Bank. In some areas it is closely associated with kelp beds. Although common within its core distribution, Peale's dolphin is confined to near-shore waters and has a limited total range. There are no published estimates of abundance.

The dolphins in Beagle Channel, the Magallanes, and southern Tierra del Fuego have been harpooned for crab bait since the 1970s. The scale of this killing was great enough to cause reduced abundance by the late 1980s. Although recent evidence suggests that the scale of this exploitation has declined and that some recovery may be occurring (Lescrauwaet and Gibbons 1994; Goodall *et al.* 1997b), there is an ongoing need for better information on population structure and the extent to which these dolphins may still be used as crab bait. Peale's dolphins are subject to entanglement in gillnets set near shore, but the scale of incidental mortality is not considered large in any area of their range. There is also concern that the proliferation of salmon-culture facilities in southern Chile, especially along the indented coastline of Chiloé Island, is having a negative effect on Peale's dolphins – similar to that reported for Pacific white-sided dolphins and killer whales in British Columbia, Canada (Morton 2000; Morton and Symonds 2002).

Hourglass dolphin, *Lagenorhynchus cruciger*

The hourglass dolphin has an oceanic circumpolar distribution in the Southern Hemisphere (IWC 1997a; Goodall 1997; Goodall *et al.* 1997c; Brownell and Donahue 1999). There are an estimated 144,000 dolphins south of the Antarctic Convergence in summer (Kasamatsu and Joyce 1995). The species has never been subjected to significant exploitation. A few animals are known to have died in set nets off New Zealand and in driftnets elsewhere in the South Pacific (Goodall *et al.* 1997c). Almost nothing is known about the ecology and behavior of hourglass dolphins.

Pacific white-sided dolphin, *Lagenorhynchus obliquidens*

This species is abundant and widely distributed across the northern rim of the North Pacific, from Baja California in the east to Japan and Taiwan in the west (IWC 1997a; Brownell *et al.* 1999a). Phylogeographic partitioning has been documented through mtDNA and morphometric studies (Lux *et al.* 1997), and differences are exhibited as latitudinal as well as longitudinal strata. For example, animals off Baja California, Mexico, differ significantly from those farther north and offshore, and animals in British Columbia and Alaska are significantly different from those in all other areas sampled thus far.

Although there are probably at least hundreds of thousands of these dolphins in the offshore waters where the multinational squid driftnet fishery operated until 1992, incidental mortality in that fishery may have been high enough to cause depletion (Yatsu *et al.* 1994; IWC 1997a). Moderate numbers of white-sided dolphins are sometimes killed deliberately in the harpoon and drive fisheries in Japan and accidentally in gillnets and other fishing gear throughout the species' range. There are an estimated 26,000 Pacific white-sided dolphins off the coasts of California, Oregon, and Washington (Carretta *et al.* 2001). A long-term study at an inshore site in British Columbia suggests an association between the local occurrence of Pacific white-sided dolphins and large-scale oceanographic events (e.g., El Niño). The same study indicates a decline in abundance of this species and other cetaceans from 1994 to

1998, coincident with the introduction of loud underwater acoustic deterrent devices intended to keep pinnipeds away from salmon-culture pens (Morton 2000).

Dusky dolphin, *Lagenorhynchus obscurus*

Dusky dolphins have a disjunct distribution in the cold temperate Southern Hemisphere (IWC 1997a; Brownell and Cipriano 1999). Their presence near Tasmania and southern Australia, long supposed, was only recently confirmed (Gill *et al.* 2000). Populations centered in New Zealand, the west coast of South America, and south-western Africa are genetically distinct and may deserve at least subspecies status (Würsig *et al.* 1997). There is also a hiatus in their distribution spanning about 1000km along the Chilean coast, and the animals off Patagonia are smaller than those off northern Chile and Peru, suggesting that the populations in western and eastern South America are separate (Figure 20). It remains uncertain whether the groups around oceanic islands in the western South Pacific (Campbell, Auckland, and Chatham), South Atlantic (Gough and the Falklands), and Indian Ocean (Amsterdam, Prince Edward, and St. Paul) are discrete or regularly mix with animals in other areas.

Dusky dolphins are found in large schools and are generally considered abundant. However, recent catches off Peru, consisting mainly of gillnet entanglement but with the addition of illegal harpooning, have been large enough to cause serious concern (Van Waerebeek 1994; Van Waerebeek *et al.* 1997, 1999b, 2002). Changes in the catch composition suggest that the regional population of dusky dolphins is depleted. A growing concern in Peru is the demand for dolphin meat and blubber to be used as shark bait (Van Waerebeek *et al.* 1999b).

Figure 20. A dusky dolphin breaching high above the surface in Golfo Nuevo, Patagonia, Argentina, November 1999. *Photo: Mariano Coscarella.*

Incidental mortality in mid-water trawls off Patagonia in the mid-1980s was estimated at 400–600 dolphins per year, primarily females, declining to 70–215 in the mid-1990s (Dans *et al.* 1997). At least 7000 dusky dolphins were present along a portion of the Patagonian coast in the mid-1990s (Schiavini *et al.* 1999). Several hundred continue to die each year in various types of fishing gear off Argentina (Crespo *et al.* 2000). Some animals are also taken in beach seines and purse seines and by harpooning off South Africa, but the number is not thought to be large. The estimated annual incidental kill of dusky dolphins in fishing gear around New Zealand was within the range of 50–150 during the mid-1980s (Würsig *et al.* 1997).

Northern right whale dolphin, *Lissodelphis borealis*

The northern right whale dolphin is widely distributed across the cool temperate North Pacific. It was subject to very high incidental mortality in pelagic driftnet fisheries for squid from the late 1970s through the 1980s. Estimated annual kills in the low to mid tens of thousands were almost certainly large enough to cause at least local or regional stock depletion (Mangel 1993; Yatsu *et al.* 1994). The UN moratorium on large-scale high-seas driftnets that came into effect in 1993 relieved this pressure to a considerable extent, but the continued use of gillnets to catch billfish, sharks, squid, and tuna inside the exclusive economic zones (EEZ) of North Pacific countries results in the killing of hundreds of right whale dolphins each year. These dolphins have not been exploited directly on a significant scale anywhere in their range although they are sometimes taken in the harpoon fishery for Dall's porpoises in northern Japan (Miyazaki 1983). There are about 14,000 northern right whale dolphins off the west coast of the United States (Carretta *et al.* 2001).

Southern right whale dolphin, *Lissodelphis peronii*

This oceanic species has a circumpolar range in cool temperate waters of the Southern Ocean, mainly between the Subtropical and Antarctic convergences (Newcomer *et al.* 1996). No abundance estimates are available, but these dolphins occur in large schools and can be common in productive areas. Although they are killed occasionally in fishing gear, no large-scale incidental mortality has been documented. However, there is concern that large numbers are being killed in the driftnet fishery for swordfish (*Xiphias gladius*) that began in northern Chile in the early 1980s (Reyes and Oporto 1994). The lesson from the North Pacific (see above), where high-seas driftnet fishing caused massive mortality of northern right whale dolphins, is that southern right whale dolphins would be vulnerable to any large-scale deployment of gillnets within their offshore range (cf. Peddemors 1999).

Irrawaddy dolphin, *Orcaella brevirostris*

Irrawaddy dolphins are patchily distributed in shallow, near-shore tropical and subtropical marine waters of the Indo-Pacific, from northern Australia in the south, north to the Philippines (Dolar *et al.* 2002) and west to north-eastern India (Stacey and Leatherwood 1997; Stacey and Arnold 1999). Their distribution is centered in estuaries and mangrove areas. Freshwater populations occur in three river systems; the Mahakam of Indonesia, the Ayeyarwady (formerly Irrawaddy) of Myanmar (formerly Burma), and the Mekong of Laos, Cambodia, and Vietnam. Irrawaddy dolphins also occur in completely or partially isolated brackish water bodies, including Chilka Lake in India and Songkhla Lake in Thailand. The animals in northern Australian waters are morphologically distinct from those in Asia (Beasley *et al.* 2002a).

The distribution of Irrawaddy dolphins overlaps areas of intensive use by humans. For example, in the Mekong delta, rows of netting stretch across many channels, providing a likely explanation for the lack of recent dolphin sightings in the area even though several skulls are preserved in local "whale temples" (Smith *et al.* 1997a). The species apparently has been seriously depleted in parts of Thailand (Andersen and Kinze in IWC 1994a, p.110). Incidental mortality in fisheries (e.g., gillnets, explosives) is likely the principal cause of depletion, although the degradation of river and lake systems caused by damming, forestry practices, and mining could also play an important role (Baird and Mounsouphom 1997; Smith *et al.* 1997b; Kreb 1999; Smith and Hobbs 2002). Live-capture for captive display poses an additional pressure on small, localized populations such as those in the Mahakam River and possibly the Ayeyarwady River. In Australia, Irrawaddy dolphins are killed in anti-shark nets and gillnets (Parra *et al.* 2002).

Recent surveys indicate dramatic declines in range and abundance of the Mekong and Mahakam freshwater populations (IWC 2001a). The latter was classified as Critically Endangered in the Red List in 2000 after surveys found only a few tens of dolphins, confined to an approximately 300km segment of river (Kreb 1999, 2002). Another small group of animals living at the head of Malampaya Sound in Palawan, Philippines, appears to be geographically isolated (Dolar *et al.* 2002). If this proves to be the case, the Malampaya population should also be classified as Critically Endangered simply by virtue of its low numbers. Surveys in 2001 resulted in an estimate of 77 individuals (CV 27.4%) confined to a $133km^2$ area of the inner sound (B.D. Smith, unpublished data).

Killer whale or Orca, *Orcinus orca*

The killer whale has a cosmopolitan distribution, but there is much geographical variation in its morphology, behavior, and ecology (Dahlheim and Heyning 1999). Further research may justify recognition of more than one species (Rice 1998; Baird 2000). Although killer whales are fairly abundant and widespread on a global scale, regional populations can be small and highly specialized, and therefore vulnerable to over-exploitation and habitat deterioration. Killer whales are large enough to represent good value for effort in whaling operations; they are available in many coastal areas; and their predatory habits mean that "predator control" is an added incentive for killing them (even though there is no evidence that such culling actually enhances fish stocks). Hunting of killer whales is not conducted on a large scale at present, but considerable numbers were killed until the early 1980s in the North Atlantic by Norwegian whalers, in the western North Pacific by Japanese whalers, and in the Antarctic by the Soviet whaling fleet. Small numbers are still killed in coastal whaling operations in Japan, Indonesia, the Lesser Antilles, and Greenland. Their place at the top of marine food webs means that killer whales come into conflict with humans in unique ways. One recent example comes from the Aleutian Islands in the North Pacific, where killer whale predation has been proposed as a major factor in the rapid decline of sea otters. According to this hypothesis, human overfishing of forage fishes reduced the carrying capacity for seals and sea lions, the traditional prey of certain pods of killer whales, forcing the whales to increase their predation on otters. With declines in otter densities, sea urchin populations were released from predation, allowing them to increase and cause deforestation of near-shore kelp beds (Estes *et al.* 1998). Another well-established and growing concern is depredation by killer whales (and other species such as false killer whales and sperm whales) on commercial longlines. Such interactions result in direct retaliation by fishermen and calls for organized control measures.

Their popularity as display animals creates a strong demand for live killer whales to be brought into captivity. However, few have been removed from the wild in recent years. Anti-captivity campaigns, along with limited success at captive breeding, have reduced the pressure on wild populations to supply oceanaria. One inshore population of killer whales in British Columbia and Washington has declined in recent years (Ford *et al.* 2000), prompting concern about the exceptionally high levels of contaminants found in their tissues (Ross *et al.* 2000) and the possibility that they are suffering from the depletion of local salmon stocks (their preferred prey) or the disturbance caused by ship and boat traffic (Baird 2000).

Melon-headed whale, *Peponocephala electra*

This poorly known species is distributed in deep oceanic waters at tropical and subtropical latitudes worldwide (Jefferson and Barros 1997). Abundance estimates indicate that there are about 45,000 in the eastern tropical Pacific (Wade and Gerrodette 1993) and 4000 in the northern Gulf of Mexico (Waring *et al.* 2001). Small numbers of these pelagic animals are taken in nets and by harpooning throughout the tropics, but no particular conservation problem has been identified.

False killer whale, *Pseudorca crassidens*

False killer whales occur in deep tropical and temperate waters worldwide (Stacey *et al.* 1994; Odell and McClune 1999). Their interactions with fisheries, particularly their tendency to remove bait and catch from longlines and sport fishing gear, have made them the targets of culling efforts. More than 900 were killed in drive fisheries in Japan beween 1965 and 1980, and they continue to be taken opportunistically in Japanese harpoon and drive fisheries (Kishiro and Kasuya 1993). They are also hunted at least opportunistically in Indonesia and the West Indies, and they are killed incidentally in various fisheries. Some of the animals caught in the Japanese drive fisheries are kept alive and sold to oceanaria. Abundance estimates, even for large tracts of habitat such as the eastern tropical Pacific, are only in the low tens of thousands. This species, while not considered threatened on a global scale, could easily be over-exploited regionally because of its low potential for population increase (possibly less than 2%), relatively low abundance, and economic value (especially in combination with the antipathy of the fishing industry) (Kishiro and Kasuya 1993).

Tucuxi, *Sotalia fluviatilis*

This small dolphin inhabits river and lake systems of Amazonia, the lower Orinoco River, and coastal marine waters from the Florianópolis region of Brazil, north to at least Nicaragua (Carr and Bonde 2000; IWC 2001a). Freshwater and marine animals are morphologically separable, the latter being significantly larger-bodied (Monteiro-Filho *et al.* 2002). Both forms are at least locally abundant. Tucuxis are generally not hunted, but they are extremely vulnerable to capture in gillnets. A recent study of bycatch in the mouths of the Amazon indicated a kill of more than 1050 tucuxis in a single year (Beltrán 1998), and along with franciscanas, tucuxis are the most commonly caught cetaceans in Brazilian coastal gillnet fisheries (Siciliano 1994) (Figure 21). The tucuxi may also be the cetacean most commonly taken as bycatch in coastal fisheries of the southern Caribbean Sea (Vidal *et al.* 1994). The genital organs and eyes of tucuxis are sometimes sold as amulets, and their meat and blubber are eaten or used as shark bait. Although in the Amazon such products are assumed to come mostly from incidentally caught specimens (IWC 2001a), there is evidence of intentional capture in some coastal areas of Brazil (Siciliano 1994). The tucuxi's freshwater and near-shore marine distribution means that it is vulnerable to the effects of water development projects, chemical pollution, and noise, as well as bycatch. The IWC Scientific Committee urged in 1994 that steps be taken by member states to reduce incidental mortality while at the same time establishing better systems of recording and monitoring take levels (IWC 1995, p.89). A particular concern is the status of mangrove forests, which are threatened in many areas by pollution and coastal development. Tucuxis probably depend to a considerable extent on the productivity derived from mangrove ecosystems.

Figure 21. A tucuxi that died from entanglement in a fishing net in Paraná State, Brazil, September 1994. *Photo: Regina Zanelatto.*

Indo-Pacific hump-backed dolphin, *Sousa chinensis*

This neritic and estuarine dolphin is widely distributed along the rim of the Indian Ocean, near some island coasts (e.g., Madagascar, Borneo), and in Pacific near-shore waters from approximately as far north as the Yangtze River mouth in China, south to New South Wales, Australia (IWC in press). It seems to occur in pockets of high density separated by areas of low density along stretches of coast. In at least China and southern Asia, hump-backed dolphins are most common in estuaries and mangrove habitats, although this seems less true in the western Indian Ocean, where their preference seems to be defined as much by proximity to shore as by the pattern of continental runoff.

Living as they often do in close proximity to industrialized, polluted, and heavily populated regions, hump-backed dolphins are exceptionally vulnerable. A population of more than 1000 animals inhabits the Pearl River estuary (near Hong Kong), one of at least eight sites in China that may have concentrations of these dolphins (Jefferson 2000). A population of at least 450 dolphins inhabits Algoa Bay on the eastern cape of South Africa (Karczmarski *et al.* 1999).

Anti-shark nets off Kwazulu-Natal, South Africa, and Queensland, Australia, kill hump-backed dolphins (and other cetaceans) in numbers that are high relative to estimated abundance (Cockcroft 1990; Paterson 1990; Corkeron *et al.* 1997). Entanglements in gillnets have been recorded across the rim of the Indian Ocean (Ross *et al.* 1994; Jefferson and Karczmarski 2001). The greatest direct source of human-caused dolphin mortality in Hong Kong appears to be from incidental catches in fishing gear (most likely pair trawls) and vessel collisions (Jefferson 2000). Organochlorines, especially DDTs, may be compromising the health of populations in at least southern China and the Bay of Bengal (Tanabe *et al.* 1993; Parsons and Chan 1998). Mercury levels are exceptionally high in Hong Kong dolphins (Jefferson 2000).

Atlantic hump-backed dolphin, *Sousa teuszii*

The Atlantic hump-backed dolphin is endemic to the eastern tropical Atlantic, where it is limited to coastal and inshore waters. Highest densities are in brackish, mangrove-lined estuaries. The species appears to exist as a series of local communities with little interchange, although this hypothesis needs testing with genetic and other evidence. There is much concern about the species' conservation status. Although no abundance estimates are available, it has become rare in at least two areas where it used to be common. These are the coastal waters of Senegal and the Gambia (Van Waerebeek *et al.* 2000) and the shallow waters of upper Dakhla Bay, Morocco/ex-Western Sahara (Notarbartolo di Sciara *et al.* 1998). In both cases, the very high intensity of fishing is viewed as a threat to hump-backed dolphins because of both entanglement in fishing gear and reduced prey availability. These dolphins are a high priority for research and conservation because of their restricted range, narrow ecological niche, generally low abundance, and continuing threats (IWC in press).

Pantropical spotted dolphin, *Stenella attenuata*

This abundant and very widely distributed species is, as the name implies, pantropical. It inhabits both near-shore and oceanic habitats in tropical and warm temperate seas. Three subspecies are currently recognized in the Pacific Ocean, where large samples have been available for study as a result of mortality in the tuna purse seine fishery. These are an unnamed Hawaiian race, an unnamed eastern Pacific offshore race, and an eastern Pacific coastal race (*S. a. graffmani*) (Rice 1998). Offshore spotted dolphins bore the brunt of the massive dolphin kill by tuna seiners from the late 1950s to the 1980s. For example, in the period 1959 to 1972, nearly five million dolphins were killed, and of this number, about three million were from the north-eastern offshore stock of spotted dolphins (Wade 1995). Although mortality rates have been greatly reduced, a recent assessment of this population indicated that it was not recovering at the expected rate and that the stress of being chased and captured repeatedly in the tuna nets, separation of mothers from young, and under-reporting of fishery kills could account for the depressed growth rate (Southwest Fisheries Science Center 1999). Abundance estimates based on surveys in the late 1980s totaled about two million spotted dolphins in the eastern tropical Pacific (Wade and Gerrodette 1993). In 1998, the north-eastern offshore stock was estimated at about 600,000–1,000,000 and the coastal stock at about 70,000–100,000 (T. Gerrodette, pers. comm.).

Pantropical spotted dolphins are subject to high mortality in some other parts of the world, notably Japan, where they are killed by harpooning and driving. Catches in Japan have been in the thousands in some years (Kishiro and Kasuya 1993), although they have totaled less than 500 per year over the past decade (see summary tables in *Journal of Cetacean Research and Management* annual supplements). Estimated abundance in Japanese waters was about 440,000 in the early 1990s (Miyashita 1993). Other areas where large numbers of spotted dolphins have been killed for food or bait include the Solomon Islands, Sri Lanka, Lesser Antilles, Indonesia, and the Philippines. Although the species is not considered threatened, there is a need for improved understanding of regional stock differences, abundance, and take levels.

Clymene dolphin, *Stenella clymene*

This species occurs in deep tropical and subtropical Atlantic waters, including the Gulf of Mexico and the Caribbean Sea but not the Mediterranean. It is not considered abundant anywhere. There are an estimated 5000–6000 clymene dolphins in the northern Gulf of Mexico (Waring *et al.* 2001). Clymene dolphins are harpooned at least occasionally by fishermen in the Lesser Antilles, and they are sometimes caught in fishing gear elsewhere. The only area in which a significant bycatch is thought to occur is in the eastern tropical Atlantic, where, according to unconfirmed sources, significant numbers may be taken in tuna purse seines (T. Jefferson, pers. comm.). This situation merits closer investigation (Chapter 5, Project 44).

Striped dolphin, *Stenella coeruleoalba*

The striped dolphin is cosmopolitan in tropical and temperate waters. It is generally abundant, but some populations are in serious trouble. The most important of these are in the western North Pacific and the Mediterranean Sea. Catches of striped dolphins in Japan have declined dramatically since the 1950s, and there is clear evidence that this decline is the result of stock depletion by over-hunting (Kasuya 1999c). Although abundance estimates for striped dolphins in Japanese waters during the 1980s totaled more than half a million (in three areas of concentration) (Miyashita 1993), and catch limits are in force, major problems still remain. More than one population may be involved in the drive and harpoon fisheries, and striped dolphins have been completely or nearly eliminated from some areas of past occurrence (Kasuya 1999c). The strong demand for dolphin meat in Japan makes the imposition of effective conservation measures problematic.

A different array of threats faces striped dolphins in the Mediterranean (Aguilar 2000). A morbillivirus epizootic caused a die-off of more than 1000 animals between 1990 and 1992. Pollution and reduced prey availability were viewed as potential triggering factors for the die-off, and these problems, together with large kills in pelagic driftnets, persist. Surveys conducted one year after the main epizootic outbreak in the western Mediterranean produced an abundance estimate of around 120,000 dolphins (Forcada *et al.* 1994; Forcada and Hammond 1998).

Striped dolphins are taken directly and incidentally in many other parts of the world, but there is no evidence of major stock declines outside the western North Pacific and the Mediterranean (IWC 1998). Large incidental kills in pelagic trawl and driftnet fisheries off western Europe are a source of concern (IWC 1998; Tregenza and Collet 1998).

Atlantic spotted dolphin, *Stenella frontalis*

Atlantic spotted dolphins occur throughout much of the tropical and warm temperate Atlantic Ocean. They are generally abundant in shelf waters of the Gulf of Mexico and Caribbean Sea. Some animals are harpooned for food or bait in the Caribbean Sea and possibly elsewhere along the coasts of north-eastern South America, West Africa, and offshore islands. There are few abundance estimates, and mortality in gillnets and other fishing gear is poorly documented. No serious conservation problems are known, but it is important to emphasize that no proper assessment has been conducted.

Spinner dolphin, *Stenella longirostris*

Spinner dolphins occur in large schools throughout the tropics, with numerous locally resident populations centered around islands or archipelagos (Norris *et al.* 1994; Perrin 1998, 2002) (Figure 22). The species has pronounced geographical variation in body shape and color pattern. Three subspecies are recognized: *S. l. longirostris* in all tropical seas; *S. l. orientalis* in pelagic waters of the eastern tropical Pacific; and *S. l. centroamericana* in shelf waters off western Central America and southern Mexico. There is morphological evidence for a fourth subspecies, *S. l. roseiventris* (previously subsumed under *S. l. longirostris*), a dwarf form restricted to shallow, protected waters of Southeast Asia and northern Australia (Perrin *et al.* 1999).

The incidental kill of eastern spinner dolphins (*S. l. orientalis*) by the tuna fishery in the eastern tropical Pacific caused a major reduction in their abundance. As in the case of the north-eastern offshore stock of pantropical spotted dolphins (above), the observed recovery rate of eastern spinner dolphins has been slower than expected in view of their reproductive potential (Southwest Fisheries Science Center 1999). They continue to be killed, although in greatly reduced numbers, in the tuna purse seine fishery. Surveys in the late 1980s indicated about 580,000 eastern spinners and close to a million whitebelly spinners (*S. l. orientalis* × *S. l. longirostris* intergrades) in the eastern tropical Pacific (Wade and Gerrodette 1993). More recent surveys indicate that there could be less than 200,000, or possibly as many as 2,200,000, eastern spinners (T.Gerrodette, pers. comm.).

Large catches of spinner dolphins in gillnets and by harpooning in Sri Lanka and the Philippines have continued for the past 20 years, with no assessment of past or present abundance. Another area of concern is the Gulf of Thailand, where dwarf spinners are subject to bycatch in shrimp trawls. As in Sri Lanka and the Philippines, there is no catch monitoring or population assessment program in Thailand.

Rough-toothed dolphin, *Steno bredanensis*

This tropical to warm temperate species occurs offshore in deep water, usually in relatively small groups and often in association with other delphinid species. It is less abundant than some of the other warm-water, oceanic delphinids (e.g., *Stenella* spp., *Tursiops truncatus*, *Delphinus* spp.). Rough-toothed dolphins are taken in relatively small numbers, both directly and as a bycatch, in various fisheries

Figure 22. A group of spinner dolphins approaches a research vessel near Alor, south-eastern Indonesia, November 2001. The Alor region is considered one of the most important areas of cetacean abundance and diversity in Indonesia. It includes several narrow, deep inter-island passages that funnel migratory animals as they move through.
Photo: Benjamin Kahn.

around the world. There are estimated to be some 150,000 in the eastern tropical Pacific (Wade and Gerrodette 1993) and about 850 in the northern Gulf of Mexico (Waring *et al.* 2001). Rough-toothed dolphins are notorious for stealing bait and catch from fishing lines, making them unpopular with many recreational and commercial fishermen.

Common bottlenose dolphin, *Tursiops truncatus*

The common bottlenose dolphin occurs in all tropical and temperate waters, including the littoral zone, inshore lagoons, estuaries, and bays, and the offshore realm (Wells and Scott 1999; Reynolds *et al.* 2000). In some areas where the species has been studied closely, offshore animals are distinguishable from coastal animals on the basis of morphology and ecological markers (e.g., Mead and Potter 1995). Moreover, the two forms in the North Atlantic have fixed genetic differences and, therefore, eventually may be assigned to different species (Leduc and Curry 1997; Hoelzel *et al.* 1998). Coastal and island-centered populations are especially vulnerable to hunting, incidental catch, and habitat degradation (Curry and Smith 1997 for a review).

Acute conservation problems are known or suspected in at least: (a) the Mediterranean and Black seas, where past hunting, incidental catches, and environmental degradation have caused population declines (IWC 1992); (b) Sri Lanka, where this is one of the principal species taken by harpoon and gillnet for fishbait and human food (Leatherwood and Reeves 1989); (c) Peru (and possibly Chile), where both directed (mainly the inshore form) and incidental (mainly the offshore form) killing occurs (Read *et al.* 1988; Van Waerebeek *et al.* 1990; K. Van Waerebeek, pers. comm.); (d) Taiwan, where there was a recent drive and harpoon fishery on the Penghu Islands (Hammond and Leatherwood 1984; Perrin 1988) and where exploitation for meat on the east coast apparently continues (Wang *et al.* 1999); and (e) Japan, where large numbers (e.g., nearly 3400 in 1980) have been taken in some years in the drive and harpoon fisheries (Miyazaki 1983) and where more than 4000 were culled for fishery protection at Iki Island from 1977 to 1982 (Kasuya 1985). The culling off northern Kyushu has declined in recent years, but the take in drive and hand-harpoon fisheries along the Pacific coast has increased since the early 1980s (IWC 1992; Kishiro and Kasuya 1993). Tens of bottlenose dolphins are killed in some years in pilot whale drives in the Faroe Islands. On the east coast of the United States and in the northern Gulf of Mexico, large-scale die-offs of bottlenose dolphins have occurred, but the causes are not fully understood (Geraci *et al.* 1999).

The common bottlenose dolphin is the species most often held in captivity; hence, problems concerning the welfare of cetaceans in captivity often center on it. Unregulated live-capture fisheries can contribute to the depletion of wild populations. A regime is in place for managing live-capture operations in the south-eastern United States (Scott 1990), but captures in Cuba, mainland Latin America, and elsewhere are poorly documented and often unregulated (Chapter 5, Project 38).

Indo-Pacific bottlenose dolphin, *Tursiops aduncus*

This coastal, mainly tropical and subtropical species has only recently been accorded full species status. Much of the literature on bottlenose dolphins (including Reeves and Leatherwood 1994a) makes no distinction between the common and Indo-Pacific species. The Indo-Pacific bottlenose dolphin is known from southern Japan southward to Australia and along the entire rim of the Indian Ocean (including the Indo-Malay archipelago) to Cape Agulhas in south-eastern Africa, including the Red Sea. Although not considered to be endangered as a species, its very near-shore distribution makes this dolphin vulnerable to environmental degradation, direct exploitation, and fishery conflicts (Curry and Smith 1997; Wells and Scott 1999). In the recent past, large numbers were killed in a Taiwanese drive fishery. Although this deliberate killing is now prohibited in Taiwan, gillnet mortality continues to be a problem there and throughout most of the species' range. Large numbers of Indo-Pacific bottlenose dolphins died in a Taiwanese driftnet fishery in the Arafura Sea, off north-western Australia, during the early 1980s (Harwood and Hembree 1987). In South Africa and Australia, Indo-Pacific bottlenose dolphins also suffer considerable mortality in the large-mesh nets set to protect bathers from sharks (cf. Peddemors 1999). As a preferred species in captive displays, there is substantial, and growing, demand for this dolphin in the expanding oceanarium trade throughout southern Asia (Wang *et al.* 1999).

4.6 Monodontids

White whale or Beluga, *Delphinapterus leucas*

This circumpolar species was formerly abundant throughout the Arctic and Subarctic. There may still be in the order of 150,000 white whales in total (IWC 2000a; NAMMCO 2000b), but many of the 29 stocks provisionally recognized by the IWC Scientific Committee have been seriously reduced by hunting. Even these depleted populations continue to be hunted and are therefore at risk of being extirpated. They include the belugas in Cook Inlet, Alaska (*c.*350 individuals); Ungava Bay, Canada (<50); West Greenland (*c.*2000); and eastern Hudson Bay, Canada (*c.*1000) (Kingsley 2000). There is also concern about many other white whale populations. The St. Lawrence River population of perhaps 1200 animals may be increasing slowly but remains vulnerable owing to its low numbers, restricted range, and exposure to marine traffic and contaminants (Kingsley 1998, 2001; Lesage and Kingsley 1998; Michaud and Béland 2001). The Cumberland Sound population in the eastern Canadian Arctic numbers only several hundred whales but continues to be hunted.

In addition to the threat of over-hunting, the constant increase in vessel traffic is a concern, especially in some of the northern bays and estuaries where white whales congregate in the summer and autumn. Local and regional management bodies exist in Canada, Greenland, and Alaska, with the expectation that they will ensure the conservation of belugas for the sustainable benefit of maritime aboriginal hunting communities. Their record of accomplishing this mandate is variable, as indicated in the preceding paragraph. In the Russian Federation, however, where almost half of the 29 provisional stocks of belugas spend at least part of the year, there is less infrastructure for hunt management and population assessment. Studies of stock structure, abundance, and contaminants in Russian belugas should be a high priority. Another concern is that in 1999, 13 tons of beluga meat were exported to Japan for commercial use, and further shipments were planned. This initiative ended when export permits covering the additional shipments were abruptly withdrawn (Marine Mammal Commission 2000), but the event signals the potential for resumed commercial hunting of belugas in Russia, whether solely as a meat-for-export enterprise, or combined with live-capture operations to supply foreign oceanaria.

Narwhal, *Monodon monoceros*

The narwhal is endemic to Arctic waters, where three stocks have traditionally been recognized: one centered in Baffin Bay; one in northern Hudson Bay; and one in the Greenland Sea and eastward. Future research is expected to reveal further stock structure (IWC 2000a; NAMMCO 2000b). Abundance estimates include about 35,000 in the Baffin Bay-Davis Strait region, 1400 in northern Hudson Bay, and 300 in Scoresby Sund (east Greenland). In all instances, the numbers refer to animals at the surface and visible from a low-flying aircraft, with no adjustment for diving animals that would have been overlooked.

Narwhals are heavily exploited in the eastern Canadian Arctic and Greenland for their skin, meat, and tusks. The narwhals in Davis Strait and Baffin Bay, as a “shared” stock, are subject to monitoring by the Canada-Greenland Joint Commission on Conservation and Management of Narwhal and Beluga. The responsibility for conservation rests with national agencies. At present, there is no official limit on the number of narwhals that can be taken in either Canada or Greenland, nor are data on catch and hunting loss reported regularly to the IWC. Although the IWC Scientific Committee attempted to review the status of narwhal and beluga stocks in 1999, Canada and Greenland refrained from participating in the meeting. However, both countries participated fully in a review of these species by the Scientific Committee of the North Atlantic Marine Mammal Commission in the same year (NAMMCO 2000b).

4.7 Porpoises

Finless porpoise, *Neophocaena phocaenoides*

Finless porpoises inhabit shallow and often partially enclosed marine waters along the coasts of southern and eastern Asia, from the Persian Gulf east to Sendai Bay, Japan (approx. 38ºN), and south to Java. A freshwater population inhabits the Yangtze River and its adjacent lake systems (Reeves *et al.* 1997, 2000a; Parsons and Wang 1998; Kasuya 1999b). Three subspecies are recognized: *N. p. phocaenoides* in the Indian Ocean and South China Sea; *N. p. sunameri* in northern China, Korea, and along the coast of Japan; and *N. p. asiaeorientalis* in the Yangtze. In the eastern and central parts of the Inland Sea of Japan, the number of porpoises has declined by approximately 95% since the late 1970s (Kasuya *et al.* 2002). There were an estimated 2700 in Ariake Sound, western Kyushu, during the 1980s and early 1990s (Shirakihara *et al.* 1994), and there are at least 200 in Hong Kong waters (Jefferson *et al.* 2002a). Based on surveys from 1984 to 1991, Zhang *et al.* (1993) estimated that there were about 2700 porpoises in the Yangtze River, while Zhou *et al.* (2000) estimated that only 700 remained in the lower reaches between Nanjing and Hukou between 1989 and 1992. Wang *et al.* (2000) concluded that porpoise abundance had declined considerably and that there could be fewer than 2000 animals in the Yangtze. The Yangtze population is classified by IUCN as Endangered.

Finless porpoises, like other phocoenids (Jefferson and Curry 1994), are extremely susceptible to entanglement in gillnets, and large numbers have been, and continue to be, killed throughout their range (Jefferson *et al.* 2002b). Despite the fact that it is illegal, electric fishing has become widespread in the Yangtze system during the last decade, and it probably kills porpoises outright and contributes to the depletion of their prey (Reeves *et al.* 2000a). Vessel collisions, especially involving high-speed ferries, may be a particular problem for porpoises in Hong Kong (Parsons and Jefferson 2000). Finless porpoises in Japan have high concentrations of organochlorines, butyltins, and mercury in their tissues (Kannan *et al.* 1989; Iwata *et al.* 1994, 1995; Jefferson *et al.* 2002b), and DDT levels of porpoises in Hong Kong are among the highest recorded for cetaceans (Parsons and Chan 1998). Porpoise habitat in the Yangtze has been degraded by water development, including the Gezhouba and Three Gorges dams and about 1300 smaller dams in tributaries (Liu *et al.* 2000; Smith *et al.* 2000). The extensive modification of coastlines for shrimp farming and rampant harbor development throughout Asia means that there is less habitat for finless porpoises.

Harbor porpoise, *Phocoena phocoena*

The harbor porpoise is widely distributed in coastal waters of the temperate and subarctic Northern Hemisphere (Read 1999). Populations in the North Pacific, North Atlantic, and Black Sea/Sea of Azov are geographically isolated from one another. Numerous regional populations (stocks) are also recognized, particularly in the North Atlantic (Rosel 1997; Rosel *et al.* 1999). Abundance has declined in many areas as a result of excessive incidental mortality in fishing operations. Although large commercial catches were once made in the Baltic, North, and Black seas, the only area known to have a large direct hunt today is West Greenland, where a thousand or more porpoises are shot for food each year (Annual Reports of North Atlantic Marine Mammal Commission, NAMMCO). Depletion of prey populations, pollution, and other anthropogenic disturbances are believed to have contributed to population declines, but the evidence is less conclusive for these factors than it is for fishery bycatch.

The IWC Scientific Committee has reviewed the status of harbor porpoises in the North Atlantic, most recently in 1995. The aggregate abundance for surveyed areas in the North Atlantic totals well over half a million (Donovan and Bjørge 1995; Hammond *et al.* 2002), and there are probably close to 100,000 harbor porpoises in US waters of the eastern North Pacific (Angliss *et al.* 2001; Carretta *et al.* 2001). The immediate conservation concern, therefore, is not for the species but rather for those regional populations that have been severely depleted and remain threatened. Populations in the Baltic Sea and the Black Sea/Sea of Azov are classified as Vulnerable in the IUCN Red List but may in fact be Endangered. In the Baltic, survey data show that the species is now rare in areas where it was formerly common (IWC 1996); in the Black and Azov seas, there is a lack of information on porpoise abundance and mortality but also evidence of a generalized ecological collapse (Öztürk 1996).

Spectacled porpoise, *Phocoena dioptrica*

This small porpoise has a fairly broad distribution in subantarctic and cold temperate waters of the Southern Hemisphere (Goodall and Schiavini 1995; Brownell and Clapham 1999a). It is uncertain whether the animals near large islands and island groups (e.g., Falkland, South Georgia, Kerguelen, Heard, Tasmania, Macquarie, Auckland, and Antipodes) constitute separate populations, and similar uncertainty exists for the groups found along the South American mainland (e.g., Uruguay and Tierra del Fuego). Sightings made far offshore between 54ºS and 59ºS (IWC 1991) suggest that there may be some movement across expanses of open ocean. The spectacled porpoise remains a very poorly known species, and its conservation status is uncertain in all areas. Some mortality occurs in fishing gear, but the scale of this mortality relative to population abundance and rate of increase is completely unknown.

Vaquita (Gulf of California porpoise), *Phocoena sinus*

The vaquita is endemic to the upper Gulf of California, Mexico (Vidal *et al.* 1999). Its total abundance is estimated to be in the mid-hundreds (Jaramillo-Legorreta *et al.* 1999), and the population may be declining rapidly (Barlow *et al.* 1997). Commercial and artisanal fishing for a variety of species (e.g., sciaenids, scombrids, shrimp, and elasmobranchs) is intensive in the upper Gulf, and the incidental killing of vaquitas, particularly in gill and trawl nets, is the principal threat (Vidal 1995; D'Agrosa *et al.* 1995, 2000; Rojas-Bracho and Taylor 1999). In addition, this Critically Endangered porpoise's habitat has been drastically altered by damming of the Colorado River in the United States. Long-term changes due to the reduced freshwater input are matters of concern and should be investigated. However, the immediate priority is for decisive action to eliminate the bycatch of vaquitas in fishing gear.

Burmeister's porpoise, *Phocoena spinipinnis*

This porpoise is endemic to coastal waters of the South American mainland from northern Peru southward, round Cape Horn, and northward to southern Brazil (Goodall *et al.* 1995; Brownell and Clapham 1999b). Some evidence suggests that the Burmeister's porpoises in the Pacific and Atlantic belong to separate populations (Corcuera *et al.* 1995). They are frequently killed in set and drift gillnets throughout most of their range. Some are killed deliberately in the Peruvian multi-species fishery that employs both gillnets and harpoons to take cetaceans (Van Waerebeek and Reyes 1994), and additional animals may be taken at least occasionally for crab bait in southern Chile (cf. Lescrauwaet and Gibbons 1994). The presumably substantial but poorly documented take of this species in Peru is the greatest concern. Nothing is known about abundance or trends in any area.

Dall's porpoise, *Phocoenoides dalli*

This porpoise is endemic to the North Pacific and adjacent seas. It occurs as far south as Baja California, Mexico, in the east and northern Japan (including the Sea of Japan) in the west, northward to the southern Bering Sea (Houck and Jefferson 1999). Two subspecies are recognized based on geographical variation in color patterns. *Dalli*-type animals (*P. d. dalli*) predominate in most of the species' range, except in a limited area of the western Pacific (between approximately 35°N and 54°N) where *truei*-type animals (*P. d. truei*) are more common. As many as eleven stocks have been proposed, each centered on what are thought to be major calving grounds (IWC 2002c).

Large numbers of Dall's porpoises were killed incidentally in salmon (north-western North Pacific and Bering Sea) and squid (central North Pacific and adjacent seas) driftnet fisheries, starting as long ago as the 1950s. Bycatches were in the thousands if not tens of thousands in some years before the United Nations ban on high-seas driftnet fishing came into effect at the end of 1992 (IWC 1992, p.212–213). In addition, a large-scale hand-harpoon hunt for Dall's porpoises has existed in Japanese waters for many decades. This hunt intensified during the 1980s, reportedly to compensate for the shortage of whale meat (due to the IWC whaling moratorium) and the reduced catch of striped dolphins (due to depletion from over-exploitation; see above). Approximately 111,500 Dall's porpoises were removed by hunting between 1986 and 1989 from two stocks centered in the Okhotsk Sea (IWC 1991). The Japanese government began to regulate the hand-harpoon hunt in 1989, and reported catch levels decreased to fewer than 11,500 in 1992 (IWC 1994a). Thereafter, the quota was increased to 17,700 per year, and the reported catch reached above 18,000 in 1997 (IWC 1999d).

Even though the species remains abundant, numbering at least in the hundreds of thousands, there is concern about populations in the western Pacific and adjacent seas. In addition to the fact that there is always strong pressure to increase the directed catch for meat in Japan, large numbers of Dall's porpoises die in driftnets within national waters of Japan and Russia, where the UN ban on driftnets does not apply. The estimated bycatch in the Japanese salmon driftnet fishery operating in the Russian EEZ totaled close to 12,000 for the period 1993 to 1999, ranging from 643–3149 on an annual basis (IWC 2002c).

4.8 Sperm whales

Pygmy sperm whale, *Kogia breviceps*, and Dwarf sperm whale, *Kogia sima*

These species are both widely distributed in the world's oceans, particularly in warm temperate and tropical areas. They are difficult to observe and have not been studied directly in the wild. Much of what is known about them comes from strandings. A limited amount of hunting has taken place in at least Japan, the Lesser Antilles, Sri Lanka, and Indonesia, but these whales are not major targets of exploitation. Mortality in fishing gear, especially gillnets, is likely a more serious problem. However, the data on mortality levels and whale abundance are far from sufficient for a proper assessment. Ingestion of plastic debris may contribute to morbidity and mortality (J. Mead, cited in Laist *et al.* 1999).

Sperm whale, *Physeter macrocephalus*

Sperm whales are cosmopolitan, occurring primarily in deep waters where they prey on squid (Figure 23). Their long history of commercial exploitation and continuing economic value (mainly as meat in Japan) make them a high priority for management. The IWC's moratorium has protected sperm whales from deliberate hunting since the 1980s, except at Lamalera in Indonesia, where a few to a few tens are taken each year with hand harpoons (612 landed from 1959 to 1994) (Rudolph *et al.* 1997), and the Lesser Antilles, where the St. Vincent and St. Lucia whalers take them occasionally (Price 1985; Reeves 1988). In 2000, Japan initiated a "scientific research" hunt for sperm whales in the North Pacific. Sperm whales die fairly often from entanglement in fishing gear, especially pelagic driftnets, including "ghost nets" (Notarbartolo di Sciara 1990; Haase and Félix 1994; Barlow *et al.* 1994; Félix *et al.* 1997), and as a result of vessel collisions (Cagnolaro and Notarbartolo di Sciara 1992; André *et al.* 1994; Laist *et al.* 2001). There is also concern about the residual effects of whaling. The selective removal of large males may have reduced pregnancy rates, and the loss of adult females within matricentric pods may have made these groups less well equipped to survive (Whitehead and Weilgart 2000). As a species, the sperm whale is not immediately threatened, but some regional populations require close evaluation and monitoring.

Figure 23. A sperm whale viewed underwater, with its mouth wide open, revealing the narrow lower jaw lined with teeth, and the massive head. The eye is visible in the upper right corner of the photograph, and the blowhole in the upper left, positioned asymmetrically on the left side of the top of the head. Near the Sangihe-Talaud Islands, a volcanic chain between northern Sulawesi (Indonesia) and Mindanao (Philippines), May 2000.
Photo: Benjamin Kahn.

For example, in the Mediterranean Sea, deaths from ship strikes and entanglement occur relatively frequently, and in the eastern tropical Pacific the most recent phase of whaling was particularly intensive and current birth rates are low (Whitehead *et al.* 1997a).

4.9 River dolphins

Boto (Amazon dolphin), *Inia geoffrensis*

The boto is less threatened than the other two obligate freshwater cetacean species (*Lipotes vexillifer* and *Platanista gangetica*). It is distributed widely throughout much of the Amazon and Orinoco river basins. Three subspecies are recognized: *I. g. geoffrensis* in the Amazon basin (except for the Madeira drainage in Bolivia above the Teotonio rapids); *I. g. boliviensis* in the upper Madeira drainage; and *I. g. humboldtiana* in the Orinoco basin. There is no evidence of a major reduction in the species' historic range. Abundance estimates are available only for relatively small segments of the total range, but there are probably tens of thousands of botos in total.

Although there is no regular hunt for botos, they are sometimes killed and maimed deliberately by fishermen to protect their catch and gear, or in retaliation for perceived competition for fish resources. Most human-caused mortality is incidental. However, in the absence of any systematic effort to record the bycatch, and with so little information on the species' abundance and population biology, it is impossible to determine whether there are significant conservation problems. With growing human populations in Amazonia and Orinoquia, the conflicts between fisheries and dolphins are certain to intensify. Similarly, although water development has so far been much less extensive in the Amazon and Orinoco than in the large Asian rivers inhabited by river dolphins, several dams have already fragmented the Amazonian boto population, and many more have been proposed (Best and da Silva 1989; IWC 2001a). As mercury is often used to separate gold from soil and rock in mining operations along the Amazon (Pfeiffer *et al.* 1993), where mining for gold is pervasive if not rampant, contamination of the dolphins' food web is a further concern (Aula *et al.* 1995).

Baiji (Yangtze dolphin), *Lipotes vexillifer*

The baiji is considered the most endangered cetacean, and its prospects for survival are extremely doubtful (IWC 2001a). The species' recent distribution has been limited to the main channel of the Yangtze River, principally the middle reaches between the two large tributary lakes, Dongting and Poyang. In the past, it also occurred as far upstream as Tonglu in the Fuchun River (referred to as Quantangjiang in Chen 1989), a separate drainage situated just south of the lower Yangtze, and also in the two aforementioned lakes (Zhou *et al.* 1977). The upper range limit used to be 50km above Gezhouba Dam, near Yichang (Zhou *et al.* 1977), but it is now 150km downstream of the dam site, near Jingzhou or Shashi (Liu *et al.* 2000). The present downstream limit in the Yangtze is near Fuanzhou, 135km upstream of the river mouth (Chen and Hua 1987). On the basis of surveys conducted in 1985 and 1986, Chen and Hua (1989) estimated that the total population was around 300 individuals. Numbers are thought to be much lower today. An intensive survey in November 1997 produced a total count of only 13 dolphins (Wang 2000). There may be no more than a few tens of Yangtze dolphins in existence today.

Deaths from entanglement in fishing gear (especially bottom-set, snagging longlines called "rolling hooks"), electrocution from electric fishing, collisions with vessels, and underwater blasting for channel maintenance are at least partially responsible for the declines in baiji range and abundance. In addition, the damming of tributaries, drainage for land "reclamation," dredging, overfishing, and the noise and congestion caused by vessel traffic in the river have substantially degraded the Yangtze environment (Zhou *et al.* 1998). The species disappeared from the Qiantang (Liu *et al.* 2000) and Fuchun Rivers after construction of a high dam in the Xinan River (a tributary of the Fuchun upstream of Tonglu) in 1957. Construction of the controversial Three Gorges Dam began in 1994. Erosion from the clear water released below the dam (Kondolf 1997) is expected to eliminate counter-currents for approximately 200km downstream and to degrade them in another long stretch downstream to Chenglingji (Chen and Hua 1987). The increase in large ship traffic, resulting from improved navigation in the upper reaches after the Three Gorges Dam is completed, will likely increase the incidence of ship-strikes.

"Blind" river dolphins, genus *Platanista*

The taxonomy of the genus *Platanista* has not been adequately studied using genetic and morphometric techniques. Here, we follow Kasuya (1972) and Rice (1998) in recognizing a single species and two subspecies.

Ganges dolphin (susu or shushuk), *P. gangetica gangetica*

Although it still has a fairly extensive range, this animal's distribution has contracted, and its abundance has declined dramatically in some areas. It is found in the Ganges-Brahmaputra-Megna and Karnaphuli-Sangu river systems of India and Bangladesh (Mohan *et al.* 1997; Sinha *et al.* 2000; Smith *et al.* 2001). A few individuals survive in Nepal in the Karnali River and possibly the Sapta Kosi River.

There is no meaningful estimate of range-wide abundance, but at least hundreds and probably a few thousand Ganges dolphins are alive today.

Construction of 50 or more dams and barrages within the Ganges dolphin's historic range has drastically altered its habitat and fragmented the metapopulation (Smith *et al.* 2000) (Figure 24). More such structures are planned or under consideration. Approximately 3500km of embankments have been constructed along the main channel of the Ganges and its tributaries (Mishra 1999). Embankments interrupt access to spawning habitat for floodplain- dependent fishes and eliminate eddy-counter currents where the dolphins spend much of their time. Although plans for constructing an extensive network of embankments in the rivers of Bangladesh have been drastically scaled back, several projects are proceeding (Smith *et al.* 1998). Dredging and the removal of stones, sand, and woody debris also compromise the ecological integrity of the riverine environments, especially in small tributaries. Organochlorine and butyltin concentrations in the tissues of Ganges River dolphins are high enough to cause concern about effects (Kannan *et al.* 1993, 1994, 1997), and pollutant loads are expected to increase with industrialization and the spread of intensive (modern) agricultural practices (Smith and Reeves 2000a).

Figure 24. The relatively low, gated dams (barrages) built in South Asian rivers to divert water for irrigation and to control flooding have had major consequences for river dolphins. Not only do barrages interrupt the dolphins' movements and fragment their populations, but they also degrade the riverine environment in numerous ways. The barrage shown here, Girijipuri in India near the border with Nepal, has isolated a small, upstream group of Ganges dolphins. *Photo: Brian D. Smith.*

Deliberate killing of Ganges dolphins for meat and oil is believed to have declined in most areas but still occurs in the middle Ganges near Patna (Smith and Reeves 2000a), in the Kalni-Kushiyara River of Bangladesh (Smith *et al.* 1998), and in the upper reaches of the Brahmaputra (Mohan *et al.* 1997). The demand for these products means that there is little incentive for fishermen to reduce the bycatch or to release dolphins that are still alive when found in nets. A particular problem is the use of dolphin oil as an attractant for catfish (Motwani and Srivastava 1961). Oil rendered from fish scraps has shown promise as an affordable and effective alternative (Mohan and Kunhi 1996; Sinha 2002).

Indus dolphin (bhulan), *P. gangetica minor*

This dolphin is endemic to Pakistan. It ranged historically throughout much of the Indus basin, including the Sutlej, Ravi, Chenab, and Jhelum tributaries, but is now present in only about one fifth of its nineteenth-century range (Reeves *et al.* 1991). Dolphins no longer occur in the lower reaches of the Indus because upstream water extraction leaves downstream channels virtually dry for several months each year. A survey of the entire known range during March and April 2001 resulted in a total count of 965 dolphins, most of them (602) in the 180km segment in Sind province between Guddu and Sukkur barrages (G. Braulik, pers. comm.). The observed density in this latter segment is among the highest recorded for river dolphins anywhere.

As is true of the Ganges dolphin, dams and barrages, together with water abstraction, are responsible for much of the Indus dolphin's plight. Upstream segments of the Indus may have lost dolphins as the animals moved downstream through barrages during high-water periods. Strong currents likely prevent them from swimming upstream through barrages. Dolphins that move downstream of Sukkur Barrage or into irrigation canals are unable to return to suitable habitat and thus are lost to the population (Reeves and Chaudhry 1998; Reeves 1998). A program to rescue canal-entrapped dolphins and return them to the river was recently established and has had some success (Braulik 2000; G. Braulik, pers. comm.).

Deliberate killing of Indus dolphins for meat and oil took place until at least the early 1970s. Although hunting is now banned, poaching still occurs occasionally, and dolphins die from entanglement in fishing gear. Pollution may also be playing a role in inhibiting population increase, especially considering the decline in the flushing effect of abundant water and the clumped distribution of the dolphins below convergences and meanders, which are also areas of high human use. Massive fish kills have apparently been caused by industrial pollution in urban areas, and the use of pesticides on irrigated crops has increased along the riverbank (Reeves and Chaudhry 1998).

Franciscana (La Plata dolphin), *Pontoporia blainvillei*

This small cetacean occurs only along the east coast of South America, between Itaúnas (Espirito Santo, Brazil, 18°25'S) (Moreira and Siciliano 1991) and Golfo San Matías (northern Patagonia, Argentina, 41°10'S) (Crespo *et al.* 1998). Based on the distribution of sightings and catches, it seems to inhabit a narrow strip of coastal waters between the surf line and the 30m isobath. It is ecologically tied to areas that receive large volumes of nutrient-rich continental runoff and are influenced by subtropical shelf waters. Juvenile sciaenid fish are the franciscana's principal prey. Two franciscana populations are recognized based on differences in skull morphology and genetic and parasite markers: a smaller northern form between Rio de Janeiro and Santa Catarina; and a larger southern form in Rio Grande do Sul, Uruguay, and Argentina (Pinedo 1991; Secchi *et al.* 1998). Recent aerial surveys indicate that there may be about 42,000 franciscanas in the waters of Rio Grande do Sul and Uruguay (95% confidence interval: 33,047–53,542) between the shore and the 30m isobath – an area of about 64,000km^2 (Secchi *et al.* 2001a).

The franciscana is a particular conservation concern because of its restricted distribution and vulnerability to incidental capture in fishing gear. Large numbers are killed in gillnets. Although the largest documented catches in the 1970s were in Uruguay, catches in recent decades have also been high in southern Brazil and Argentina (Praderi *et al.* 1989; Pérez Macri and Crespo 1989; Monzón and Corcuera 1991; Secchi *et al.* 1997; Secchi 1999). Available evidence suggests that mortality rates are excessive and unsustainable (Crespo 1998; Secchi *et al.* 2002; Secchi and Wang 2002). Scientists in the three range countries are well aware of the need for more research and conservation action, but they need external support.

4.10 Beaked whales

Arnoux's beaked whale, *Berardius arnuxii*

This species is widely distributed in the Southern Ocean from the edge of the Antarctic pack ice north to approximately 34°S. In comparison with the generally sympatric southern bottlenose whale, Arnoux's beaked whale is considered uncommon. Arnoux's beaked whales have never been exploited on a significant scale, and no conservation problem is evident at present.

Baird's beaked whale, *Berardius bairdii*

This deep-water species is found only in the North Pacific, mainly north of 34°N in the west and 28°N in the east. It was hunted from shore stations in both North America and Asia and also taken occasionally by Soviet factory ships until the early 1970s. Baird's beaked whales are still subject to entanglement in pelagic driftnets and coastal gillnets (IWC 1989). The continuing commercial hunt for this species in Japan is regulated by a national quota, but review by the IWC Scientific Committee has become a contentious issue. At the 2000 annual meeting of the Scientific Committee, Japan explicitly expressed its unwillingness to subject its research and management program for this species to international scrutiny (IWC 2001h, p.53). Three putative western Pacific stocks are hunted, one off the east coast of Japan, one in the Sea of Japan, and the other in the Sea of Okhotsk (Kasuya and Miyashita 1997). The quota for the three stocks, combined, was set at 40 whales per year in 1983, increased to 60 in 1988, reduced to 54 in 1990, and increased to 62 in 1999. Surveys in the 1980s and early 1990s produced abundance estimates of 1260 (CV 45%) and 5029 (CV 56%) in the Sea of Japan and off the Pacific coast, respectively (IWC 2001a). A more frequent and rigorous assessment of stock status is needed to ensure that the hunt does not deplete any of the affected whale populations.

Northern bottlenose whale, *Hyperoodon ampullatus*

The northern bottlenose whale is endemic to the temperate and subarctic North Atlantic. It was hunted commercially for many decades, particularly by Norway (60,000 killed from 1882 to the late 1920s, 5800 from 1930 to 1973; NAMMCO 1997, p.90), but has been essentially unexploited for almost 30 years, with only a few animals taken in some years in the Faroe Islands. The aggregate population was certainly reduced by whaling, and the extent of recovery is uncertain. A crude estimate of about 40,000 bottlenose whales in north-eastern and north-central Atlantic waters in the late 1980s includes a sizeable adjustment to account for their deep diving (NAMMCO 1997). The species is not in immediate danger of extinction and is still at least locally abundant. A small (about 130 individuals) and largely isolated population, centered in an area called the Gully, off the coast of Nova Scotia, Canada, has been studied intensively for more than a decade (Whitehead *et al.* 1997b, 1997c; Gowans *et al.* 2000). Large-scale oil and gas development near the core distribution of this population is a major concern. The Gully has been designated a "Pilot Marine Protected Area" under Canada's Oceans Act, with the expectation that this will enhance precautionary measures as development of offshore hydrocarbon resources proceeds (Hooker *et al.* 1999; Gowans *et al.* 2000).

Southern bottlenose whale, *Hyperoodon planifrons*

Southern bottlenose whales have an extensive distribution throughout the Southern Ocean from Antarctica north to about 30°S. They have never been exploited on a significant scale (42 taken in the Antarctic from 1970 to 1982; Kasamatsu *et al.* 1988) and are considered abundant. There are estimated to be about half a million in the Antarctic during the summer (Kasamatsu *et al.* 1995).

Longman's beaked whale, *Indopacetus pacificus* (= *Mesoplodon pacificus*)

For many years, the existence of this whale was known only from two skulls found on beaches in the South Pacific (Queensland, Australia) and western Indian Ocean (Somalia). However, a type of "bottlenose whale" seen and photographed repeatedly in tropical waters of the Pacific and Indian oceans appears to be this species (Pitman *et al.* 1999; Pitman 2002a), suggesting that it is fairly widespread and more abundant than previously supposed. There is no evidence that the species is threatened by human activities.

Mesoplodonts – Beaked whales of the genus *Mesoplodon*

This diverse genus includes at least 13 species worldwide (Mead 1989; IWC 1989; Pitman 2002b). Mesoplodonts are generally deep-water animals; they occur from cold temperate and sub-polar latitudes to the tropics. New species were described in 1991 (pygmy beaked whale; Reyes *et al.* 1991), 1996 (Bahamonde's beaked whale – Reyes *et al.* 1996; renamed spade-toothed whale in 2002 – van Helden *et al.* 2002), and 2002 (Perrin's beaked whale; Dalebout *et al.* 2002b). Additional species may exist that have yet to be described (e.g., Pitman *et al.* 1987; Pitman 2002b). Mesoplodonts have been taken occasionally by whalers but are not presently the main targets of any hunt. Entanglement in fishing gear, especially gillnets in deep water (e.g., for billfish and tuna), is probably the most significant threat. In addition, there is evidence that mesoplodonts are susceptible to acoustic trauma caused, for example, by military activities (Rowles *et al.* 2000; Anon. 2001).

Shepherd's beaked whale, *Tasmacetus shepherdi*

This whale has been documented only from strandings in southern Africa, southern South America, New Zealand, South Australia, and offshore islands in the South Atlantic and South Pacific. These records, together with a few probable sightings, suggest a circumglobal distribution in cold temperate waters of the Southern Ocean. The species' conservation status is completely unknown.

Cuvier's beaked whale, *Ziphius cavirostris*

This cosmopolitan species is probably the most widely distributed beaked whale (Heyning 1989). It is the most frequently sighted medium-sized cetacean in the eastern tropical Pacific, and the number of strandings of this species in the Northern Hemisphere is approximately the same as that of all other ziphiid species combined (IWC 1989). Cuvier's beaked whales are occasionally killed by artisanal whalers in the tropics, but they are not the subjects of a regular hunt anywhere. They die accidentally in fishing gear in many areas (e.g., Sri Lanka, the Mediterranean Sea, Taiwan, and the west coast of North America), and the scale of bycatch is probably large enough to merit conservation concern in a number of these areas. Also of concern is the fact that there have been several mass strandings of Cuvier's beaked whales coincident with military exercises involving the use of very loud, low-frequency sonar (Frantzis 1998; Rowles *et al.* 2000). They appear to be exceptionally vulnerable to acoustic trauma.