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.

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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.

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).

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.

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).

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).

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.*

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.

Chapter 5

Recommended Research and Education Initiatives

The main focus of the Cetacean Specialist Group (CSG), to date, has been on freshwater and coastal marine cetaceans, which we consider to be at particular risk because of their proximity to human activities, narrow ecological requirements, and often fragmented population structure. Conserving populations of these and other cetacean species requires coordinated effort among agencies, organizations, and communities within the animals' ranges. Some cetacean conservation issues are best addressed at a global and species level, and several projects in this Action Plan embody that approach. In general, however, the CSG emphasizes regional or population-level approaches. The intention is to tailor conservation strategies to the specific character of the ecological and socio-political environment where cetacean survival is threatened. Ideally, these strategies should be implemented under the leadership of local scientists, resource managers, and community groups. Conservation efforts will ultimately succeed only if they are embraced by the people living in and near the animals' habitats.

This chapter consists of 57 project descriptions, organized geographically as well as topically. Although most of the projects emphasize research and education, conservation measures are implicitly, if not explicitly, encouraged to ensue from the recommended research and education activities. In many instances, basic information is needed about the species present in an area and their abundance, habitat use, and mortality factors before appropriate conservation measures can be proposed. In other instances, we need to improve the state of knowledge and develop means of conveying key information to decision-makers and the general public in order to gain support for conservation initiatives. A series of focused and more explicit recommendations for conservation action of those cetacean species most at risk of extinction appears in Chapter 6. Both chapters 5 and 6 fall far short of being comprehensive with respect to species, geography, and management needs. As always, the Cetacean Action Plan needs to be viewed as a work in progress rather than as a definitive blueprint.

The recommended projects and actions reflect the knowledge of individual CSG members and their judgment about priorities and potential for successful implementation. No attempt has been made, however, to rank items in order of urgency or importance. These will depend upon the perspectives of individual readers or users. The inclusion of any subject in the list of recommended projects and actions means that the CSG accords it a high priority. A glaring omission is that there are no projects from Oceania in this chapter. To some extent, the existing Action Plan for Australian Cetaceans (Bannister *et al.* 1996) fills the gap, but in the future, the conservation and management needs of cetaceans in Oceania, along with Africa, will be given special attention by the CSG.

Some of the projects included in the present chapter have already been partially implemented, some are in the early stages of development and implementation, and others have yet to begin. While individual CSG members, and occasionally the CSG as a group, can be directly involved in some Action Plan projects, our intention is not to limit the range of people and organizations who end up leading, supporting, or assisting the various initiatives. On the contrary, it is hoped that many individual scientists, government agencies, and non-governmental organizations will become involved and contribute in whatever way makes sense. It is also important to emphasize that few of the projects are likely to take the form of a single, one-time effort with a clear-cut beginning and end. Rather, they are just as likely to involve a suite of activities undertaken by more than one individual or group, with multiple, staged milestones and completion times. The intended role of the CSG is simply to identify and help define the needed work, then promote it and ensure that it is conducted in a responsible fashion. Potential investigators, as well as potential funding sources, are encouraged to contact the chairman (Randall Reeves), deputy chairman (Giuseppe Notarbartolo di Sciara), or relevant regional coordinator (Enrique Crespo for Latin America, Brian D. Smith for Asia, Vic Peddemors for Africa, or Nick Gales for Oceania) to arrange for assistance with methodology or other aspects of proposal development. Also, the CSG welcomes the submission of proposals for review and endorsement. It is important to emphasize, however, that the CSG is not itself a source of project funding.

5.1 Asia

Burgeoning human populations and rapid economic development threaten the survival of cetaceans in much of the world, but nowhere more so than in Asia. With its extensive coastlines and productive floodplain rivers, Asia provides habitat for perhaps the greatest number of cetacean species at risk. This is especially true of the freshwater cetaceans. In the Yangtze River, the baiji faces imminent extinction and the Yangtze River finless porpoise, a freshwater population (subspecies) of an otherwise marine species, may be close behind it. In the case of the baiji, further research is considered a low priority, and the immediate challenge is to eliminate known threats to the survival of the species in its natural habitat (Chapter 6). In the Indus, Ganges-

Brahmaputra-Megna, and Karnaphuli-Sangu river systems, the *Platanista* river dolphins have declined in abundance and in the extent of their range. These cetaceans must compete with humans for shrinking water resources. Large-scale engineering projects that give people hope for economic development and relief from flood and famine pose dire threats to river cetaceans and other aquatic wildlife. Freshwater populations of Irrawaddy dolphins are also threatened by development projects in the Mekong river system of Vietnam, Cambodia, and Laos, and probably also in the Ayeyarwady (formerly Irrawaddy) River of Myanmar and the Mahakam River of Indonesia. Freshwater cetaceans are also threatened by the enormous pollutant loads carried in Asian waterways (Dudgeon 1992), and by destructive fishing activities, which result in high mortality from bycatch and reduced availability of prey. These animals are perhaps more vulnerable to these threats, in comparison to marine cetaceans, because their habitat requirements often place them in areas where human activities are most intense (Smith and Smith 1998).

Little is known about the status of most coastal cetacean populations in Asia. In many areas, even the most basic information, such as what species are present, is lacking. Particular problems relate to distinct populations (e.g., dwarf spinner dolphins) and poorly documented species (e.g., pygmy Bryde's whale). Recent projects in Vietnam (Smith *et al.* 1997b; Andersen and Kinze 2000), Thailand (Andersen and Kinze 1999), Myanmar (Smith *et al.* 1997a), Indonesia (Rudolph *et al.* 1997), and the Philippines and Malaysia (Dolar *et al.* 1997) have revealed diverse inshore cetacean faunas, but also serious threats, including fishery bycatch, deliberate killing, and possibly reduced prey due to overfishing. Throughout the continent, there is an urgent need for better information on the status of species and populations, and for the development of local expertise to help devise, advocate, and implement conservation programs (Perrin *et al.* 1996). Information is particularly lacking for western Asia (e.g., Iran and the Arabian peninsula), and the absence of projects for this region represents a significant gap that should be filled in subsequent action plans.

Projects

1. Monitor and evaluate ongoing threats to the Irrawaddy dolphins in the Mahakam River of Indonesia

The Critically Endangered Irrawaddy dolphins in the Mahakam River of East Kalimantan range in the mainstem from about 180km to 600km upstream of the mouth, seasonally entering several tributary rivers and lakes (Kreb 2002). The total population was estimated to number fewer than 50 individuals based upon eight surveys of their entire range conducted in 1999 and 2000. The dolphins were found primarily in deep pools located near confluences and meanders, which are also primary fishing grounds and subject to intensive motorized vessel traffic. Between 1997 and 1999, 16 deaths were recorded (ten from gillnet entanglement, three probably from vessel strikes, and three deliberate)(D. Kreb, pers. comm.). From 1997 to 1998, at least seven dolphins were also illegally live-captured from the river and taken to oceanaria, and plans exist to capture more animals for a new oceanarium to be built in Tenggarong (D. Kreb, pers. comm.). Intensive fishing with gillnets, electricity, and poison, and the accidental introduction of an exotic piscivorous fish, locally known as *ikan toman*, may have depleted the dolphins' prey (D. Kreb, pers. comm.). The high density of gillnets used in Semayang and Melintang lakes causes physical obstruction to dolphin movements, thereby reducing available habitat. This problem, together with sedimentation caused by devegetation of the surrounding shorelines, has probably resulted in the elimination of these lakes as primary habitat as reported by Tas'an and Leatherwood (1984). Leaks from dams in the upper reaches that retain mining wastes, including mercury and cyanide, occurred in 1997 and resulted in a massive fish kill (D. Kreb, pers. comm.).

An ongoing program, started in 1997 and conducted jointly by the University of Amsterdam and the East Kalimantan Nature Conservation Authority (*Balai Konservasi Sumber Daya Alam Kal*), has involved extensive monitoring of the Mahakam dolphins. This program should be continued and expanded to include toxicological and genetic analyses of tissues obtained from stranded or incidentally killed dolphins, investigations of factors that continue to degrade dolphin habitat, and further efforts to monitor abundance. The involvement of local scientists is vital. Because of this population's Critically Endangered status, every effort should be made to prevent any further catches (including live-capture) and improve the quality of the riverine environment (Chapter 6).

2. Investigate the status of cetaceans in the Indonesian archipelago

Indonesia is a huge country, with tens of thousands of islands and extensive, varied marine habitats (Figure 25). Indonesia's marine waters harbor a greater variety of species than any area of comparable size in the world (Gray 1997). Species of particular conservation interest in Indonesian near-shore waters include the Irrawaddy dolphin, Indo-Pacific humpbacked dolphin, Indo-Pacific bottlenose dolphin, finless porpoise, and small-type (pygmy) Bryde's whale. Relatively little is known, however, about the abundance and distribution of cetaceans in the region (Rudolph *et al.* 1997). Research has been limited primarily to the two whaling villages of Lamalera and Lamakera on the islands of Lembata and Solor, respectively (Barnes 1991, 1996); the small freshwater population of Irrawaddy dolphins in the Mahakam River (Project 1, above); waters near Manado, at the northern tip of Sulawesi

Figure 25. A sperm whale lifts its flukes as it dives near Manado Tua, a volcanic island within Bunaken Marine Park, northern Sulawesi, Indonesia, April 1999. This observation of a deepwater animal so close to a shoreline illustrates the extreme habitat gradients that typify the eastern parts of Southeast Asia, New Guinea, and the Solomon Islands. *Photo: Benjamin Kahn.*

(P. Rudolph, pers. comm.); and Komodo National Park (Kahn 2000). Hunting is largely unregulated throughout most of Indonesia, and environmental degradation proceeds unchecked. Political instability exacerbates such problems.

This project is intended to provide better documentation of Indonesia's cetacean fauna and a better understanding of the conservation issues affecting these species (cf. Rudolph *et al.* 1997). Although the ultimate goal should be to contribute to the development of a national conservation plan, it will be necessary to begin with visits to sites suspected of supporting high cetacean diversity or abundance. Information should be obtained initially through interviews with local people, beach and fish-market surveys, and opportunistic vessel surveys (Aragones *et al.* 1997).

3. Assess the status of cetacean populations and levels of incidental mortality in the Philippines

There has been a tremendous increase in knowledge about cetaceans in Philippine waters in recent years (Figure 26). Much of the motivation for conducting research in this region came from concern about reported kills of small cetaceans in directed fisheries and as bycatch. At fish landing sites along the south-western end of Negros Island, Dolar (1994) examined the carcasses of 20 Fraser's, 18 spinner, and 12 Risso's dolphins caught by a fleet of around 15 drift gillnetters over a 16-day period. Based on information from fishermen, the same author estimated that about 2000 dolphins, primarily spinner, pantropical spotted, and Fraser's, were being killed each year by a fleet of five tuna purse seiners using fish-aggregating devices. Directed fisheries for small cetaceans were also reported, with as many as 200–300 dolphins taken annually in San Francisco (Perrin *et al.* 1996) and smaller numbers taken for bait in shark and chambered nautilus (*Nautilus pompilius*) fisheries in Palawan (Dolar *et al.* 1994). Although the hunting of small cetaceans is believed to have declined as a result of protective legislation, monitoring has become more difficult because fishermen are secretive in disposing of their catches (Dolar *et al.* 1994).

Following the recommendations of Perrin *et al.* (1996), cetacean surveys were conducted in the eastern (Dolar and Perrin 1996) and southern (Dolar *et al.* 1997) Sulu Sea, and in Malampaya Sound, Palawan (Dolar *et al.* 2002). This latter survey focused primarily on a small isolated population of Irrawaddy dolphins. A more intensive investigation of Malampaya Sound was conducted by WWF-Philippines in 2001.

The efforts of scientists and NGOs in the Philippines should be continued and strengthened, with the continuing emphasis on capacity-building. Assessment of illegal hunting and of incidental catches in tuna purse seine and drift gillnet fisheries remains a high priority. Intensive surveys should be conducted to assess cetacean abundance and threats in biodiversity hotspots that already receive conservation attention, such as the Tubbataha National Park and World Heritage Site and adjacent Cagayan Islands. Valuable cetacean research in these areas can often be incorporated with other conservation activities, at little extra cost. More extensive surveys should involve cooperation with neighboring countries, e.g., the joint Philippines/ Malaysia survey in the Sulu Sea (Dolar *et al.* 1997) and a planned Philippines/Indonesia survey in the Sulawesi Sea (W.F. Perrin, pers.comm.). Both were organized under the auspices of the Convention on Migratory Species. The Irrawaddy dolphin population in Malampaya Sound presents a particular conservation challenge due to its small size and apparent isolation (Chapter 6). Long-term

Figure 26. A melon-headed whale breaching in the Philippines, July 1995. This species has a circumtropical distribution and often occurs in schools of 100 or more individuals. Its biology and status are not well known. *Photo: Thomas A. Jefferson.*

monitoring will be essential for gauging the success of ecosystem/community-based conservation approaches currently being implemented by WWF-Philippines.

4. Evaluate the status and levels of mortality of small and medium-sized cetaceans in Taiwan

The Wildlife Conservation Law of Taiwan was amended in August 1990 to prohibit the killing or disturbance of cetaceans and the possession or sale of their body parts (Chou in IWC 1994a, p.110). This legislation, while laudable in theory, has driven exploitative activities underground and hampered research. Although no systematic monitoring has been conducted, direct observations and anecdotal information suggest that cetacean mortality from deliberate exploitation and entanglement in gillnets is high, probably on the order of several thousands of animals per year along the east coast alone (J.Y. Wang, pers. comm.). Although considerable progress has been made toward documenting the occurrence and distribution of cetaceans in the waters of eastern Taiwan (Yang *et al.* 1999), there is a need for better documentation in other coastal areas. This can be accomplished, in part, by strengthening the existing stranding network and conducting at-sea surveys.

Protective legislation in Taiwan should be reviewed and, if necessary, modified to ensure that there are no regulatory impediments to bonafide research. A rigorous monitoring effort is needed to assess the scale of deliberate exploitation of cetaceans and fishery bycatch. One approach might be to conduct frequent but unannounced visits to fish-landing sites and marketing centers. Another component should be the placement of observers on-board fishing vessels, especially gillnetters. Training courses for local scientists to carry out these activities must be an integral component of this project.

5. Investigate and monitor the status of finless porpoises in the Yangtze River

As summarized in Chapter 4, survey data and the qualitative observations of Chinese scientists strongly suggest that the finless porpoise population in the Yangtze River has been declining rapidly in recent decades. Nevertheless, data on trends are not definitive. Comparisons between surveys are confounded by uncertainties related to methodological differences or problems in design and analysis. Efforts to conserve Yangtze finless porpoises would benefit from statistically robust estimates of abundance and trends.

This project should establish a consistent and affordable survey protocol for use by Chinese researchers, followed by a series of surveys. Surveys need to be consistent not only in their methodology, but also in their coverage and sighting conditions (Smith and Reeves 2000c). Special attention should be paid to trends in porpoise distribution (seasonal and annual) and to habitat features, using quantitative criteria. Acoustic methods might prove useful for supplementing visual search effort and interpreting results (Akamatsu *et al.* 2001; Goold and Jefferson 2002). Researchers studying finless porpoises in Hong Kong waters have employed an inexpensive, easy-to-use, automatic porpoise detector to help correct for sighting biases (T.A. Jefferson, pers. comm.), and such a device might be adapted for use in surveys of the Yangtze as well.

6. Investigate the feasibility of establishing a natural reserve for finless porpoises in and near Dongting Lake or Poyang Lake, China

Yangtze finless porpoises are sympatric with the critically endangered baiji and face similar threats (Reeves *et al.* 2000a). Although recent studies suggest a dramatic decline in abundance of finless porpoises, densities are said to remain relatively high in the mouths of Poyang and Dongting lakes. The Xin Luo Natural Baiji Reserve is a 135km segment of the Yangtze, centered at Honghu City and stretching upriver to a point about 20km below the mouth of Dongting Lake. Chinese scientists have proposed that the reserve be expanded to include finless porpoises and that its border be extended upstream to encompass the mouth of Dongting Lake. Finless porpoises are also frequently sighted in Poyang Lake around the mouth of the Gan River, near a proposed Siberian crane sanctuary in Wucheng (J. Barzen, pers. comm.)

This project should investigate the feasibility of establishing a protected area for finless porpoises in Dongting Lake or Poyang Lake and adjacent waters. It should include surveys to assess porpoise density during different water stages, investigations of porpoise behavior and ecology to ensure that a reserve would contribute to their conservation, and an analysis of the potential for enforcing protective regulations if such a reserve were to be established. If establishing a natural reserve that provides meaningful protection for finless porpoises is found to be feasible, a consultation process will need to be undertaken and a management plan will have to be developed for it.

7. Establish a marine mammal stranding network in China

China has an extensive coastline and a range of climatic conditions, from tropical in the Gulf of Tonkin to cool temperate in the Yellow and Bohai seas. Although there has been a great deal of research on populations of dolphins and finless porpoises in the Yangtze River, little work has been conducted on marine cetaceans. Even questions as basic as which species occur along the Chinese coasts and in offshore waters remain largely unaddressed (Zhou *et al.* 1995). China's extensive fishing fleets use gear, such as gill and trawl nets, known to kill cetaceans. Preliminary research indicates that the incidental catch of some small cetaceans, especially finless porpoises, is high (Zhou and Wang 1994; Parsons and Wang 1998). However, with the exception of

Figure 27. A male finless porpoise that was found stranded at Sai Kung, in the eastern part of Hong Kong, February 2000. There were clear net marks around its flippers, flukes, and elsewhere on the body, indicating that the animal had died from entanglement. This species' nearshore habitat is rapidly becoming degraded, and incidental capture in fishing gear is a major threat throughout its range in southern and eastern Asia. *Photo: Samuel K. Hung.*

Hong Kong (Figure 27), no region of China has an active program to study the status of cetacean populations or the impact of fishery bycatch on them.

A marine mammal stranding network in China, broadly similar to that in the United States (Wilkinson and Worthy 1999), would contribute significantly to filling these important knowledge gaps. A central office should coordinate activities and ensure the standardization of methods and data and compile information supplied by regional coordinators for national-level analyses. An essential component of the project would be the training of local researchers from various regions in dissection techniques and methods for identifying species from carcasses and skeletal materials.

8. Determine the migration route(s) and breeding ground(s) of western Pacific gray whales as a basis for their protection

The strong recovery of the eastern Pacific population of gray whales (Buckland *et al.* 1993b; Buckland and Breiwick 2002) has diverted attention from the Critically Endangered western Pacific population. A recent review by an international panel of scientists concluded that fewer than 50 mature individuals may remain, and the population was therefore classified by IUCN as Critically Endangered. On their summer feeding grounds in the Sea of Okhotsk, gray whales are subject to disturbance by activities related to the development of offshore oil and gas fields (Weller *et al.* 2002). Western Pacific gray whales migrate along the coasts of Japan, Korea, and China as they move to and from their breeding and calving grounds, presumably somewhere in southern China (Omura 1988).

These whales' breeding and calving habitats need to be identified and protected if they are to have a chance of recovery and long-term survival. The rapid industrial development and massive fishing pressure along the coast of southern China, in combination with the low remaining numbers in the whale population, give a sense of urgency to any protective measures that might be implemented. This project should include a critical evaluation of stranding and sighting reports, interviews with fishermen, and vessel surveys of probable breeding and calving grounds. Satellite tracking would help ascertain the movements of animals as they leave the feeding ground near Sakhalin Island. Once breeding and calving habitats and the migratory routes have been located, it should be possible to evaluate threats and develop appropriate recommendations to government authorities and NGOs in China, Japan, North and South Korea, and possibly Taiwan.

9. Investigate the status of Irrawaddy dolphins in the Mekong River of Laos, Cambodia, and Vietnam

Anecdotal reports and surveys suggest a dramatic decline in the abundance of Irrawaddy dolphins in the Mekong River (Baird and Mounsouphom 1997; Smith *et al.* 1997a), and the Mekong population is a high priority for Red List assessment (Figure 28). The situation in Cambodia is particularly worrisome. Several relevant NGO or IGO initiatives are underway or planned, including: (a) a "sustainable development" project in the lower Mekong, sponsored by UNDP, IUCN, and the Mekong River Secretariat, which includes the conservation of freshwater dolphins as one of its priorities (H. Friedrich, IUCN Asia Program, pers. comm.); (b) WWF-International's Living Waters Campaign, which has designated the Mekong as one of its focal rivers (B. Gujja, WWF-International, pers. comm.); and (c) a project sponsored by the Wildlife Conservation Society to investigate the status of Irrawaddy dolphins in the Mekong of Cambodia.

Those efforts should be coordinated to ensure that they result in a comprehensive and credible range-wide assessment of the Mekong River dolphin population. Researchers in the various programs should use consistent methods. The involvement of local scientists and resource managers should be a high priority to ensure that subsequent monitoring is also conducted using consistent methodology. The assessment should include an abundance estimate, a determination of range limits during various water stages, and an evaluation of habitat quality. Based on the results, a conservation and management plan should be developed that emphasizes ecosystem perspectives and local community involvement.

Figure 28. An Irrawaddy dolphin near Hang Sadam, a small fishing village on an island in the Mekong River along the border between Lao P.D.R. and Cambodia, March or April 1994. Freshwater populations of this species are gravely threatened by incidental mortality in fishing gear and by dams and other forms of water development. *Photo: Pam Stacey.*

10. Investigate the status of coastal small cetaceans in Thailand

A diverse cetacean fauna has been recorded for Thailand (Chantrapornsyl *et al.* 1998; Andersen and Kinze 1999). However, accidental killing in gillnets, deliberate removals for dolphinaria, reduced prey abundance caused by overfishing, and the destruction of mangrove habitat vital for fish reproduction have drastically reduced cetacean numbers in some areas (IWC 1994a, p.110). The Irrawaddy dolphin, finless porpoise, and Indo-Pacific hump-backed dolphin are probably the most severely affected species because of their near-shore distribution and susceptibility to entanglement. Recent surveys revealed that Irrawaddy dolphins have almost entirely disappeared from Songkhla Lake, a large lagoon system connected to the Gulf of Thailand that may have harbored a substantial resident dolphin population in the past (Beasley *et al.* 2002b). A dwarf form of the spinner dolphin has been described from specimens caught by shrimp trawlers operating in the Gulf of Thailand. If these animals belong to a discrete breeding population, the impact of the shrimp fishery alone could put that population in jeopardy (Perrin *et al.* 1989).

Much information on cetaceans in Thailand has been obtained through a stranding network centered at the Phuket Marine Biological Center (Chantrapornsyl 1996; Chantrapornsyl *et al.* 1996, 1998). Interview surveys have also provided information on cetacean distribution (Andersen and Kinze 1999). There is a need for at-sea surveys to assess cetacean abundance and distribution in the Gulf of Thailand and Andaman Sea. Particular emphasis should be placed on identifying areas of cetacean abundance ("hotspots") for special conservation attention. It is also important to locate areas of intensive fishing during the surveys. Biopsies should be collected to investigate genetic population structure, particularly for spinner dolphins. Information from the surveys should facilitate development of a conservation plan to guide government policies and manage economic development activities.

11. Assess populations and habitat of Ganges dolphins (susus) and Irrawaddy dolphins in the Sundarbans of India and Bangladesh

In recent years, much has been learned about the status of Ganges dolphins in India and Bangladesh (e.g., Mohan *et al.* 1997; Sinha 1997; Smith *et al.* 1998, 2001; Sinha *et al.* 2000) and freshwater populations of Irrawaddy dolphins in parts of Southeast Asia and Indonesia (e.g., Baird and Mounsouphom 1997; Smith *et al.* 1997a, 1997b; Smith and Hobbs 2002; Beasley *et al.* 2002b; Kreb 1999, 2002). However, little research has been conducted in the one area where the ranges of the two species are known to overlap extensively: the Sundarbans of India and Bangladesh. This is despite the fact that threats to cetaceans in the Sundarbans are increasing: accidental entanglement in gillnets, destruction of fish-spawning habitat through mangrove deforestation, toxic contamination from upstream "mega-cities" (Calcutta and Dhaka), non-selective catch of fish fingerlings and crustacean larvae in "mosquito nets" (Figure 29), and ship traffic. The situation is complicated by saline encroachment during the dry season, particularly on the Bangladesh

Figure 29. The ecological effects of intensive fishing can be truly devastating, not only to biodiversity but also to the long-term food security of people. In the Sundarbans Delta of Bangladesh, the widespread use of very fine-mesh nets (locally called *rocket jahl*) for catching shrimp fry to stock aquaculture ponds results in a massive bycatch of fish fingerlings. Although difficult to document and quantify, the implications for dolphin populations that inhabit such fresh- and brackish-water environments (e.g., Ganges dolphins, Irrawaddy dolphins, and Indo-Pacific hump-backed dolphins) are a serious concern. *Photo: Brian D. Smith.*

side of the Sundarbans, as a result of freshwater diversion and sub-surface extraction upstream in the Ganges Basin. Large portions of the delta are within UNESCO World Heritage sites.

This project should entail a training course for local researchers, followed by a field survey of waterways within the delta. The survey should include the collection of fishery data and the measurement of salinity and other physical parameters, as well as standard observations of dolphins and other fauna. One objective is to identify factors that limit the downstream range of the Ganges dolphin and the upstream range of the Irrawaddy dolphin in order to evaluate the effects on both species of further salinity flux in the Sundarbans (e.g., caused by upstream damming and diversion of fresh river waters). The feasibility of using nature tourism to assist in long-term monitoring of dolphin populations should be evaluated. As with several projects included in this Action Plan, collaboration should be sought with other biodiversity initiatives in the region, including the work of other SSC specialist groups (e.g., crocodilian, otter, freshwater turtle).

12. Investigate the use of dolphin oil as a fish attractant in the Brahmaputra River and conduct one or more experiments to test potential substitutes

Dolphin meat, intestines, and oil are used as fish attractant in the Ganges and Brahmaputra rivers of India and Bangladesh. In the Brahmaputra River, fishermen trail bound pieces of dolphin body parts alongside small boats while sprinkling the water with a mixture of oil and minced dolphin flesh. Small unbaited hooks are used to catch the fish as they come to the surface within the oil slick (Smith *et al.* 1998). Judging by the number of dolphin carcasses needed to supply fisheries that use dolphin oil, the number of animals killed is almost certainly unsustainable (Mohan *et al.* 1997; Bairagi 1999). Surveys of a 178km segment of the Brahmaputra River downstream of Guhuwati (Assam, India) in April 1999 found that dolphins had an extremely clumped distribution, with about three-quarters of the observed animals located in four counter-current areas (R.S.L. Mohan and B.D. Smith, unpublished data). Most of the fishing activity, especially with gillnets, was observed in these same areas. The overlap between prime fishing grounds and dolphin concentrations means that the dolphins are at risk of being taken accidentally, and perhaps deliberately. The market value of dolphin products creates an incentive for directed hunting and for fishermen to kill dolphins found alive in nets.

This project should document details of the dolphin oil fishery, including the number of people and boats involved, economic value of the fish, income levels of the fishermen, market value of dolphin carcasses, and how these are procured. A rigorous experiment (or field trial) should be conducted to test the effectiveness of alternative attractants such as sardines or scraps from locally caught fish. The results of trials in the Ganges have been encouraging (Sinha 2002). If other oils are found to be as effective as dolphin oil, a practical plan must be implemented to make these available to local fishermen.

13. Assess the distribution, abundance, and habitat of Ganges river dolphins and monitor ongoing threats – India and Bangladesh

Local and foreign scientists have conducted numerous surveys of dolphins in the Ganges-Brahmaputra-Megna and Karnaphuli-Sangu river systems since this project was initially proposed (Perrin 1988; Smith *et al.* 1994, 1998, 2001; Mohan *et al.* 1997, 1998; Sinha 1997, 2000; Ahmed 2000; Sinha *et al.* 2000)(Figure 30). Additional effort is nevertheless required to assess populations, habitat, and threats in rivers or portions of rivers that have not yet been surveyed. The status of river dolphins is unknown in the entire Sundarbans (Project 11, above) and in the Yamuna River between Delhi and the confluence of the Chambal River. Large-scale water abstraction for agricultural, industrial, and urban use has severely reduced dry-season flow in this latter segment. Information is also lacking on the status of dolphins in the entire Damodar river system, the Teesta tributary of the Brahmaputra, and the Burhi Gandak, Gomti, Mahananda and Ghaghara (downstream of the Girijapur Barrage) tributaries of the Ganges. It is also important to monitor the status of dolphins in areas that have been

Figure 30. A Ganges River dolphin, locally called shushuk in Bangladesh, surfaces in the Karnaphuli River. The small population inhabiting the Karnaphuli-Sangu river complex in southern Bangladesh (a count of 125 individuals in a 1999 survey provides a lower bound of population size) is relatively isolated from those in the much larger Ganges, Brahmaputra, and Meghna river systems.
Photo: Brian D. Smith.

surveyed and found to have high dolphin densities. These should include the Vikramshila Gangetic Dolphin Sanctuary in Bihar, India, and the Karnaphuli-Sangu and Kalni-Kushiyara river systems of Bangladesh.

This project should involve training courses for researchers from India and Bangladesh, followed by field surveys in nearby river segments. Special attention should be paid to documenting dolphin mortality, existing and planned water development projects, and sites where chemical pollutants are being released into the aquatic environment. Results from these investigations should be communicated to resource management agencies along with recommendations on measures to reduce or eliminate threats.

14. Investigate deliberate and accidental killing of coastal cetaceans in India

While national programs in India encourage expansion of marine fisheries to feed India's human population, large numbers of cetaceans die in gillnets (Mohan 1994). Recent newspaper articles indicate that bottlenose dolphins (probably *T. aduncus*), and possibly Indo-Pacific humpbacked dolphins, are also being deliberately killed along the coast of Andhra Pradesh because they are perceived as competitors for diminishing fish resources. Deliberate and incidental killing of cetaceans may be especially frequent along the east coast of India near major population centers (e.g., Calcutta and Madras), where the demand is high for fish and fishing employment. This eastern coastline, at least as far south as Vishakhapatnam, includes the westernmost range of the Irrawaddy dolphin (Stacey and Leatherwood 1997), a species that seems particularly vulnerable to gillnet entanglement because of its affinity for river mouths where fishing pressure is most intense. This project should entail a series of training courses and the establishment of a rigorous monitoring program to document cetacean mortality. Irrawaddy dolphins in Chilka Lake should be included.

15. Investigate and monitor the distribution, abundance, and habitat quality of Indus river dolphins (bhulans) and address ongoing threats in Pakistan

The provincial governments of Sind and Punjab have been conducting annual counts of dolphins in the Indus River since 1987 (Reeves and Chaudhry 1998). Nevertheless, there is a need for better coordination and cooperation between the wildlife departments in the two provinces so that conservation strategies can be pursued at the metapopulation level. It is still uncertain whether dolphins move through barrages when the gates are open. If they do, this would tend to augment downstream populations and deplete upstream ones. The claim by Khan and Niazi (1989) of a dramatic increase in the population between the Sukkur and Guddu barrages after the Sind Dolphin Reserve was established in 1974 might, therefore, be explained partly by attrition from upstream populations, rather than entirely by reproduction and improved survival as a result of protective measures within the Sukkur-Guddu segment. Recent reports of deaths from net entanglement and possibly illegal hunting, together with records that dolphins sometimes enter irrigation canals with no possibility of returning to the main river channel (Reeves and Chaudhry 1998; Braulik 2000), mean that there is a continuing need for stricter law enforcement, improved public awareness, and an organized rescue program to catch and return animals that have strayed from secure habitat. A major natural gas field has been developed along the left bank of the Indus River near the middle of the Sind Dolphin Reserve, and there are plans to expand this development on both sides of the main channel. Whether any of the activities associated with the gas development have affected, or will affect, river dolphins is difficult to determine. However, considering the site's proximity to one of the highest-density concentrations of dolphins in the entire Indus Basin, a rigorous assessment is needed of the potential impacts.

This project should include a training course for wildlife officials and researchers in Sindh and Punjab and additional range-wide surveys of the Indus dolphin. Concurrent with these efforts should be the further development and implementation of a dolphin rescue program. This program should include the translocation of animals trapped in irrigation canals back into the main channel of the Indus River (Figure 31), the collection of morphometric data and tissue samples for genetic and pollutant analyses, and efforts to tag and track the released dolphins with telemetry. Information on dolphin movements is essential for evaluating the barrier effects of barrages, survivorship of translocated animals, and fidelity to identified habitat. An additional component of this project should be an independent assessment of the current and potential impacts of gas-drilling operations.

Figure 31. An Indus dolphin is returned to the main channel of the Indus River near Sukkur in Sind Province, Pakistan, having been captured in an irrigation canal during January 2001. This animal was one of ten successfully rescued in 2001 by a team from WWF-Pakistan, with funding from the United Nations Development Programme and the Whale and Dolphin Conservation Society. *Photo: Gill Braulik.*

16. Assess the impacts of reduced water levels on river dolphins in the Ganges and Indus rivers – Pakistan, India, Bangladesh, and Nepal

River cetaceans face the same threats as marine cetaceans, with an important addition: they must compete with humans for fresh water, the very substance of their physical environment. Reeves *et al.* (1991) questioned whether diminishing water levels in Pakistan's Indus River would ultimately result in the extinction of the river's endemic dolphin population. This question applies equally to the Ganges (Padma) river system of India and Bangladesh. Year-round flows must be sufficient to allow dolphins to move freely between deep pools (Smith and Reeves 2000b). Abundant water is also required for maintaining suitable temperature regimes and for diluting the enormous volumes of pollutants discharged into these rivers. Water is abstracted from the Indus and Ganges basins by an extensive network of irrigation barrages (Smith *et al.* 2000). Much is also lost to evaporation from reservoirs. In downstream reaches, additional water is removed by tubewells and lost through seepage to recharge groundwater supplies. In the low-water season, the main channel of the Indus becomes virtually dry downstream of Sukkur Barrage, and completely dry downstream from Kotri Barrage to the delta, thereby eliminating dolphin habitat in the lower reaches (Mirza and Khurshid 1996; G. Braulik, pers. comm.). During the dry season in India, the Ganges becomes so shallow below the Gandak and Ghaghara confluences that people frequently walk across its main channel (R.K. Sinha, pers. comm.). The insufficiency of water released downstream of Farakka Barrage means that there is little or no dry-season habitat for dolphins between the barrage and the Ganges (Padma)-Brahmaputra confluence (Smith *et al.* 1998). It also means that salt water intrudes 160km farther inland from the Sundarbans Delta than it did before the barrage was constructed (Rahman 1986), which has probably reduced the amount of dolphin habitat. Dolphins are probably absent from about 400km of their previous upstream range in the Yamuna River and 100km of their previous range in the Son River below Indrapuri Barrage, in both instances because of insufficient water (Sinha *et al.* 2000).

The impacts of reduced supplies of fresh water are potentially catastrophic for river dolphins and humans. This project should involve a review of the hydrology, bathymetry, and temperature regimes of the Indus and Ganges-Padma river systems in relation to the environmental needs of river dolphins. The participation of a hydrologist familiar with the alluvial environment of the Indus and Ganges plains is essential. Results of the study should provide a baseline for long-term habitat monitoring, and an informed basis for promoting water use policies that consider the needs of dolphins and other freshwater organisms.

17. Investigate the status of small cetaceans in the Indus Delta, Pakistan

Little information is available on marine cetaceans in the Indus Delta, although Indo-Pacific hump-backed dolphins and finless porpoises were reported to be common there in the 1970s (Pilleri and Gihr 1972; Pilleri and Pilleri 1979). Recent reports indicate that the abundance of finless porpoises has declined dramatically, but that hump-backed dolphins are still seen occasionally. Bottlenose dolphins may also inhabit delta waters. Local declines in cetacean abundance are thought to have occurred as a result of increased ship traffic and intensive fishing (Ahmad 1994; Roberts 1997).

The Indus Delta comprises 600,000ha of mudflats, mangrove forests, and estuarine channels ("creeks"). It is located close to Karachi, Pakistan's largest port, and is heavily fished by shrimp trawlers and gillnetters (Majid 1988). The ecology of the delta is threatened by freshwater abstraction upstream in the Indus, which has reduced incoming flows by more than 90%. This has caused increased erosion, pollution, and saltwater intrusion in the delta, thereby threatening the viability of estuarine and mangrove habitat (Meynell 1991). There is a need to assess the status of small cetaceans in the Indus Delta and to evaluate the impacts of intensive fishing and reduced freshwater input on their populations. As with most projects in this Action Plan, the training and involvement of local scientists and use of standard methods are essential components.

18. Assess the status of cetaceans and threats from direct and indirect exploitation in Sri Lanka

Large numbers of cetaceans have been killed in directed hunts and by entanglement in fishing gear in Sri Lanka (Leatherwood and Reeves 1989; Leatherwood 1994). A recent survey of fish landing sites in south-eastern Sri Lanka recorded 14 cetacean species, dominated by spinner dolphins. A sizable proportion of the animals had been harpooned, and it appeared that deliberate hunting was increasing (Ilangakoon 1997). Although cetaceans were afforded legal protection at the national level in 1993, there is almost no enforcement (A. Ilangakoon, pers. comm.). The lack of reliable data on cetacean populations and mortality rates makes it impossible to assess the magnitude of the problem and to establish priorities for conservation.

IUCN's national office in Sri Lanka has proposed a comprehensive program to study cetacean populations and the impacts on them from hunting and fishing activities in south-eastern Sri Lanka, and to increase community awareness about the conservation of small cetaceans in two villages where large numbers of carcasses have been recorded at fish landing sites (Mirissa and Kirinda). The CSG has endorsed IUCN-Sri Lanka's proposal and urges that the proposed work be expanded to other areas of the country where similar problems occur. The public-awareness portion of the program is underway, but the research components still require development and funding (A. Ilangakoon, pers. comm.). Sri Lankan researchers need to be further trained and equipped to conduct at-sea surveys; collect biological samples; estimate the species, age, and sex composition of landed catches; and assess fishing effort by area and season. The potential for using nature tourism to support at-sea research and monitoring should be explored. To the extent possible, this project should incorporate dugongs, which were historically common in some areas of north-western Sri Lanka but are now seriously depleted there (Marsh *et al.* 2002).

19. Predict and investigate areas of high- density occurrence ("hotspots") for marine populations of Irrawaddy dolphins and identify focal areas for conservation effort

Irrawaddy dolphins are among the most vulnerable marine cetaceans because of their near-shore and estuarine distribution. Although there are few estimates of abundance, numbers are generally declining, and the species is thought to have been extirpated in some areas (Stacey and Leatherwood 1997). Identification of "hotspots," where the animals occur in relatively high density, is essential for conservation. Once these areas are identified, it may be possible to improve protection of both the animals and their habitat. In the foreseeable future, broad-scale surveys will be difficult to design, fund, and implement because so much of the species' range occurs along complex shorelines and in archipelagos.

This project should involve a review of the distribution and habitat preferences of Irrawaddy dolphins and the development of a scientifically tested habitat profile for the species. Data on dolphin occurrence, oceanography, bathymetry, river discharges, and biological features should be registered in a geographic information system (GIS) and analyzed to identify critical habitat components. This habitat index or profile would select, based on favorable habitat characteristics, unsurveyed areas that are likely to be hotspots. The model should be tested through field surveys and then refined. Negative survey results (i.e., few or no dolphins found in predicted hotspots) would be hard to interpret because they could mean that the predictive model was flawed, that the animals had already been depleted or extirpated by human activities, or that the survey was at fault, and dolphins that did in fact exist were not recorded. To the extent that the project is successful, however, it might be viewed as a prototype for application to other patchily distributed species of coastal or inshore cetaceans.

20. Convene a workshop to develop an action plan for conserving freshwater populations of Irrawaddy dolphins

Much progress has been made toward coordinating activities and developing conservation recommendations for the obligate river dolphins in Asia and the Yangtze finless porpoise. Although freshwater populations of Irrawaddy dolphins may be equally endangered, less attention has been devoted to their conservation needs (Projects 1 and 9). A workshop should be organized to evaluate information on abundance, habitat, threats, and discreteness of freshwater populations of Irrawaddy dolphins in the Mekong, Ayeyarwady, and Mahakam river systems. Recommendations also need to be developed for research and conservation. Isolated or partially isolated populations inhabiting Chilka Lake (India), Songkhla Lake (Thailand), and Malampaya Sound (Philippines) should also be considered. The workshop should attempt to standardize population and habitat assessment techniques so that results of research in different areas will be comparable.

21. Conduct intensive training courses on cetacean research techniques for scientists in South and Southeast Asia

One major reason that so little is known about the status of cetaceans in most developing countries is that too few scientists in those countries are trained, equipped, and funded to conduct rigorous population, habitat, and threat assessments. Several forums have called attention to the importance of this kind of training (Perrin *et al.* 1996, in press; Smith and Reeves 2000a). The courses proposed here would be designed to combine intensive classroom instruction on density sampling and other research approaches with actual field surveys. Participants would include scientists and conservationists who are already involved in cetacean work in Asia or who have demonstrated strong potential for contributing to research and conservation efforts. Lectures, discussions, and laboratory activities would be integrated with field observations, ideally followed by collaborative data analyses and report preparation, resulting in multi-authored publications. It is preferable that the training courses be implemented in areas of identified need, possibly in association with other projects (e.g., Projects 11 and 13, above).

5.2 Latin America (including Mexico, Central and South America, and the Caribbean)

Latin America, as defined in this chapter, is the region south of the Rio Bravo: that is, Mexico, Central America, the Caribbean islands, and South America. The problems faced by marine and freshwater cetaceans in Latin America are much like those elsewhere in the world, including: incidental mortality in fisheries, direct exploitation, habitat degradation and loss, and competition with humans for marine and freshwater resources. For most species and populations, there is little or no quantitative information on abundance and trends. Among the few exceptions are southern right whales off eastern South America and a few populations of small cetaceans, such as dusky and Commerson's dolphins in Patagonia (Argentina), franciscanas in southern Brazil, and river dolphins in parts of Amazonia. Although large whales are protected from whaling in most of the region (apart from some hunting of humpback and occasionally sperm and Bryde's whales in the eastern Caribbean), they are subject to mortality in fishing gear (e.g., sperm whales off Peru and Ecuador, humpback whales in Ecuador). Small and medium-sized cetaceans are taken incidentally in coastal and high-seas fisheries at all latitudes.

Figure 32. Fishing is a way of life for many residents of small coastal towns along the upper Gulf of California, Mexico. Unfortunately, the use of gillnets to capture large sciaenids and sharks (such as the mako shark shown here) results in the incidental catch of vaquitas (held here by the fisherman). The vaquita is, as a consequence, one of the world's most endangered marine mammal species. *Photo: C. Navarro/Proyecto Vaquita, courtesy of Lorenzo Rojas and Marine Mammal Images.*

The most critical situations in this regard are probably those of the vaquita and the franciscana (Chapter 6). Other species or local stocks that are known to be subjected to substantial, and possibly unsustainable, takes include tucuxis in parts of Brazil, dusky dolphins in Peru and Patagonia, long- and short-beaked common dolphins and Burmeister's porpoises in Peru, Commerson's dolphins in Patagonia, and Chilean dolphins in southern Chile (Reyes and Oporto 1994). In most instances, the problem of mammal bycatch has not been addressed by fishery management authorities. A complicating factor in Peru, Ecuador, and northern Chile is that cetaceans taken incidentally are frequently used for human food, oil, and bait, and in fact the distinction between incidental and direct catch has been increasingly blurred as fishermen set gillnets explicitly to catch dolphins as well as large bony fish and elasmobranchs.

Economic conditions (e.g., poverty and inflation) make attempts to assess and regulate such activities more difficult (Figure 32). In South America, cetaceans are generally not blamed for depleting target species of marine fisheries; pinnipeds are often accorded that role instead. The ecological impacts of fisheries, including their possible role in reducing the prey base for cetacean populations, are poorly understood and usually unacknowledged. These should be studied and addressed. Similarly, the effects of deforestation, pollution, water development, and tourism, however hard they may be to pinpoint, characterize, and quantify, are possibly influencing cetacean populations. Such effects need to be better understood and weighed against the claimed benefits of development and modernization. Vulnerability of the riverine and lacustrine habitat of botos and tucuxis to the effects of dam construction needs to be addressed on a basin-wide scale.

Projects

22. Investigate interactions between river dolphins and fisheries in Amazonia and Orinoquia

Fishermen and dolphins often interact, and in many different ways, throughout Amazonia and Orinoquia. In the central Amazon of Brazil, botos interact with several types of fisheries, such as those using set or floating gillnets and lampara seines (Best and da Silva 1989). Artisanal fishermen with traditional gear such as hooks, arrows, and atarrayas (throw-nets) use dolphins to detect concentrations of fish (Goulding 1989; Barthem and Goulding 1997). For the most part, they do not perceive dolphins as competitors or enemies. In contrast, fishermen who set driftnets in the main channels of the rivers to catch large silurids regard dolphins as pests. They sometimes shoot them with guns or throw them poisoned fish (Trujillo 1997; Reeves *et al.* 1999c). Even though the fishermen recognize that fish (e.g., family Cetopsidae) also steal or mutilate their catch and cause losses to the fisheries, they often use the dolphins as scapegoats.

This project is intended to provide updated and improved information about dolphins and fisheries. Individuals and teams of researchers working in different regions are encouraged to cooperate and share information. Because of the extremely heterogeneous nature of Amazonian fisheries, it is unlikely that conventional methods of assessing and monitoring dolphin bycatch will be effective. Therefore, novel approaches may be needed if there is to be any hope of gaining reliable insight about the nature and scale of human-caused mortality. Standard terminology and data collection protocols (e.g., in relation to types of fisheries, measures of fishing effort, and dolphin bycatch rates) will greatly facilitate aggregate and comparative analyses. Whenever possible, efforts should be integrated with government programs to facilitate the transition from short-term, NGO-sponsored programs to locally or nationally supported, long-term commitments. Also, cooperation with government agencies should ease the problem of obtaining permits for scientific specimen exchanges. Quantifying the effects of fisheries on cetacean populations, whether from operational interactions (e.g., bycatch, gear damage) or ecological interactions (e.g., competition for prey between dolphins and fisheries), is extremely difficult, and it is unrealistic to expect definitive results from any of the proposed studies. Even with reliable data on bycatch, for example, it is impossible to judge sustainability and significance without good data on population structure and abundance (Projects 33 and 39). It is nevertheless important to continue and expand efforts to document fishing effort, catches, and bycatches so that the vulnerability of dolphin populations can be assessed at least qualitatively.

23. Assess existing and planned water development projects and gold mining in the Amazon and Orinoco basins

Dams and other types of barriers have been constructed in many of the world's rivers for hydroelectric power generation, flood control, or irrigation. Such structures have various negative effects on river cetaceans and other wildlife, including population fragmentation and major changes in the physical and ecological attributes of their habitat (Smith and Reeves 2000b). In the Amazon and Orinoco basins of South America, several large dams have already been built, and numerous others are planned or being considered (Best and da Silva 1989). Portions of these river systems are also exposed to high inputs of mercury, a by-product of gold mining. Mercury is known to bio-accumulate in aquatic food webs. Even though mercury toxicity has not been linked directly to the health of any cetacean population, its potential effect on top predators is a matter of concern (e.g., Borrell and Aguilar 1999; O'Shea 1999).

The two endemic river dolphins of South America – boto and tucuxi – remain abundant and widespread, but their habitat is rapidly being altered by human activities (e.g., McGuire 2002). Therefore, it is important to establish a baseline of information on at least two potentially important types of threat: water development projects and gold mining operations. The goal of this project would be to produce a document similar to the Register of Water Development Projects Affecting River Cetaceans in Asia (Smith *et al.* 2000). It should list all dams and other artificial barriers as well as gold mining sites in the river systems inhabited by one or both South American river dolphin species. Technical and geographic details and accurate maps showing the locations of water development and gold mining projects should be included. This initiative is viewed as an important first step in evaluating the magnitude of these threats and recommending appropriate mitigation and management.

24. Develop a conservation strategy for South American river dolphins

Based on experience from the franciscana workshops in 1992, 1994, 1997, and 2000, and the first South American river dolphin workshop in Buenos Aires in 1992, this project aims to organize a second workshop to review existing knowledge about South American river dolphins and develop an agenda for ensuring their long-term conservation. Although the IWC Scientific Committee's Sub-committee on Small Cetaceans conducted a review of the boto and tucuxi in 2000 (IWC 2001a), only two of the range states (Brazil and Colombia) were represented and the discussions were relatively narrow and brief. It is generally agreed that both *Inia* and *Sotalia* are widely distributed and abundant, and therefore that most populations are secure for the moment. However, a great deal of research has been completed, or is ongoing, in various parts of the species' distributions, and the results are largely unpublished and dispersed among different researchers and institutions. Direct threats (mainly fishery bycatch) and indirect threats (e.g., habitat degradation, pollution, possible depletion of prey species) have been identified (IWC 2001a). Plans for widespread damming of Amazonian rivers loom as a potentially devastating threat, particularly in Brazil (Project 23).

The main goals of the workshop should be to: (a) identify conservation problems and research needs; (b) review the status of national and international legislation and of multilateral and bilateral agreements; (c) set priorities for conservation-related research and action; (d) compile information needed for the register described in Project 23; (e) where appropriate and feasible, establish networks for sharing data and specimens and for facilitating collaborative work; and (f) improve communications among the many researchers, conservation groups, and management authorities in areas where the species occur.

25. Assess fishery interactions with cetaceans in Brazil

Many species of small cetaceans are taken incidentally in coastal fisheries along the Brazilian coast (Pinedo 1994; Siciliano 1994). Although the franciscana is the species of greatest concern (Secchi *et al.* 1997; Di Beneditto *et al.* 1998; Kinas and Secchi 1998; Ott 1998; Secchi 1999), the tucuxi has also experienced relatively high levels of incidental mortality in some areas (Siciliano 1994; Zanelatto 1997; Alves-Júnior *et al.* 1996; Beltrán-Pedreros and da

Silva 1998; Di Beneditto *et al.* 1998; Santos 1999). Other species, including bottlenose, spinner, Risso's, rough-toothed, Atlantic spotted, and common dolphins and false killer, killer, pilot, minke, humpback, and southern right whales, have been taken in lower numbers (Simões-Lopes and Ximenez 1993; Pinedo 1994; Siciliano 1994; Bassoi *et al.* 1996; Lodi *et al.* 1996; Di Beneditto *et al.* 1998; Marques *et al.* 1998; Dalla Rosa 1998; Greig *et al.* 2001). Monitoring by on-board observers has been maintained on a regular basis in some regions (e.g., Rio Grande, Imbé/Tramandaí, and Torres in southern Brazil), but information is still almost entirely lacking on the scale and species composition of the bycatches, fishery characteristics, and fleet dynamics for most of the Brazilian coast. In northern Brazil (*c.*19ºS to *c.*29ºS), fishing villages are often small and separated by dozens of kilometers. The fisheries are essentially artisanal and fishing effort is restricted to areas close to the landing sites (Tiago *et al.* 1995; Bertozzi and Zerbini 2000). Thus, in northern Brazil, research effort should focus on documenting fishing villages, fishing grounds, and fleet characteristics, and on estimating franciscana mortality.

Driftnet fisheries in southern Brazil are also of concern because of their potential impacts on non-target species, including large marine vertebrates (Kotas *et al.* 1995). In a preliminary assessment of fleet and gear characteristics, landing ports, and cetacean bycatch off the south-eastern and southern Brazil coasts, Zerbini and Kotas (1998) determined that at least humpback, sperm, dwarf sperm, and pilot whales as well as spinner, Atlantic spotted, common, striped, clymene, and bottlenose dolphins were killed incidentally. Again, detailed information is needed on fleet characteristics and dynamics and on the numbers and species composition of the bycatch. For the latter, on-board observers are essential. Moreover, the impacts of driftnet mortality on cetacean populations can only be assessed if abundance estimates are available.

In all areas, the collection of biological samples from by-caught animals is necessary for investigations of stock identity and life history. This project should involve coordinated efforts of various individuals and groups working along different portions of the Brazilian coast, using standard methods.

26. Identify threats and evaluate the status of marine tucuxi populations in Brazil

The marine form of the tucuxi inhabits coastal marine and estuarine waters from southern Brazil to Central America (Borobia *et al.* 1991). The species faces various threats from human activities along its range, including incidental mortality in fisheries (Simões-Lopes and Ximenez 1993; Zanelatto 1997; Di Beneditto *et al.* 1998; Lailson-Brito *et al.* 1999; Monteiro-Neto *et al.* 2000; Edwards and Schnell 2001), habitat loss and disturbance (Flores 1995; Santos 1998), and chemical pollution (Brito *et al.* 1994). The species seems to occur as a series of small "resident" populations along the Brazilian coast (e.g., Flores 1999; Pizzorno 1999; Santos 1999), although further studies are needed to confirm it. The nature and degree of threats to these groups may differ, and therefore it is important to develop appropriate management strategies by area or stock. In addition to studies of population structure, information is needed on abundance, human-related mortality, pollutant loads, and life history. Long-term monitoring of relative abundance and bycatch rates can help identify emergent or acute conservation threats in particular areas.

Because of the great length of the Brazilian coast, and given the fact that the human population is growing rapidly and increasing its impact along many parts of it, this project should necessarily involve several local sub-projects. The scientists leading these sub-projects are strongly encouraged to exchange ideas and materials and to meet regularly to ensure that their efforts are well coordinated.

27. Conduct aerial surveys to estimate franciscana abundance

There is a continuing need for reliable information on abundance of franciscanas. In workshops and action plans, abundance estimation has long been identified as a research priority for the species (e.g., Perrin and Brownell 1989; Crespo 1992; Reeves and Leatherwood 1994a; Pinedo and Barreto 1997). With support from UNEP, a pilot study was carried out in southern Brazil in March 1996 (Secchi *et al.* 2001a). It consisted of a series of aerial surveys along the coast of Rio Grande do Sul State, where data on annual incidental mortality indicated a locally high density of franciscanas. This study demonstrated the feasibility of detecting franciscanas from the air and therefore provided justification for aerial surveys in additional areas. As the 1996 surveys took place in an area inhabited by the "southern" population or form of franciscana (cf. Pinedo 1991; Secchi *et al.* 1998), it is desirable that at least one of the next series of surveys be conducted within the range of the "northern" population or form. In addition, it is important that some effort be devoted to surveys of other types of habitat and different water mass conditions. For aerial surveys, a twin-engine, high-wing aircraft is essential. The feasibility of conducting line or strip transect surveys from vessels should also be explored. In all cases, through-water visibility and environmental variables (e.g., sea state) must be carefully considered in the design and planning of surveys.

28. Investigate stock identity of franciscanas

Since the threats to this western South Atlantic endemic vary in nature and degree along the species' 5000km range between south-eastern Brazil and central Argentina, it is important to know whether there are discrete populations. Such knowledge is essential for conservation and management efforts on a regional or local basis (Secchi *et al.* 1998).

Parasite loads have been used to discriminate "ecological stocks" in the southern portion of the franciscana's distribution (southern Brazil, Uruguay, and Argentina)(Aznar *et al.* 1995; Andrade *et al.* 1997). Variation in the D-loop region of the mtDNA between the two geographic forms (proposed by Pinedo 1991) suggests the existence of at least two genetically separate populations (Secchi *et al.* 1998). More genetic studies are ongoing and planned, with samples from many parts of the species' range. Secchi (1999) proposed using the phylogeographic concept of stock (Dizon *et al.* 1992) to define management units that can then be incorporated into site-specific fishery management policies to conserve franciscanas.

Considering the financial and ecological implications of most conservation measures involving threatened taxa, the identification of species, subspecies, populations, or other management units should be based on a range of research methods, including (but not limited to) the molecular genetic approach (Avise 1989). Ideally, investigators using a given approach should have access to pooled samples, with appropriate credit given to all contributors in any resultant report or publication. This project is essentially an endorsement of continued efforts to integrate knowledge of population structure and bycatch rates, with a view to developing appropriate advice for fishery management.

29. Develop a management strategy to conserve the franciscana

Researchers involved in studies of the franciscana met in 1992, 1994, 1997, and 2000 to discuss goals and priorities, identify knowledge gaps, and advise authorities on progress and needs (Crespo 1992, 1998; Pinedo 1994; Secchi *et al.* 2002). Progress has been made in many areas of franciscana research since 1992, especially in regard to obtaining reliable information on stock identity, abundance, and rates of incidental mortality. Improved knowledge of life history traits (e.g., age-specific survival and fecundity rates, life span, age at first reproduction) is still required for a proper assessment of the effects of incidental mortality and for determining alternative management strategies to address the bycatch problem. A better understanding is also required of fishing effort, fishery dynamics, and the social and economic dimensions of the coastal artisanal gillnet fisheries that are responsible for most franciscana mortality. Many studies of these subjects are ongoing throughout the franciscana's range (Crespo 1998; Pinedo and Barreto 1997), and it is therefore useful for specialists from the three range states to continue meeting every two or three years. The objectives of meetings should be to update and review: (a) the status of the species; (b) trends in incidental mortality; and (c) the state of knowledge about franciscana biology, behavior, and ecology. In addition, the meetings should be regarded as opportunities to develop specific, scientifically justified recommendations for management. Fishermen and their representatives, as well as decision-makers and representatives of management bodies, should be allowed and encouraged to participate in the meetings as much as possible.

30. Monitor cetacean interactions with Argentine fisheries

Argentina has an extensive coastal zone and a flat shelf, with several well-developed artisanal and high-seas industrial fisheries. Artisanal fisheries are concentrated in Buenos Aires, southern Santa Cruz, and Tierra del Fuego provinces. Most of the Patagonian shelf is exploited by industrial trawling and jigging fisheries. The artisanal fisheries for sharks and croakers (family Sciaenidae) in Buenos Aires Province have continued to take large numbers of franciscanas, with estimated total catches of around 500 per year during the mid-1980s (Pérez Macri and Crespo 1989) and at least 400 per year in the 1990s (Corcuera 1998; Cappozzo *et al.* 2000). Franciscana bycatch levels appear to have remained roughly constant in spite of the fact that some of the target populations in these fisheries have been declining. No abundance estimate is available for franciscanas in this region. The artisanal gillnet fisheries for robalo (*Eleginops maclovinus*) and silversides (*Austroatherina* sp.) off Tierra del Fuego and Santa Cruz provinces operate with the tide, and Commerson's dolphins and other species become entangled at least occasionally (Crespo *et al.* 1994; Goodall *et al.* 1994). Since total fish landings, bycatch levels, and even seasonal trends in effort are not well known for these southern fisheries, there is a need for rigorous evaluation.

Industrial fisheries have been increasing off Patagonia for the last 20 years, and they are presently very important to the regional and national economies. The main target species include hake (*Merluccius hubbsi*), shrimp (*Pleoticus muelleri*), and squid (*Illex argentinus*). Hake landings consistently exceeded quotas during the 1990s (Bezzi and Dato 1995; Crespo *et al.* 2000), and large quantities of undersized hake were discarded at sea, both in the hake fishery itself and in other fisheries where hake were part of the bycatch. The consequent recent collapse of the hake fishery has led to calls for reform of economic, social, and management policies in the fishing sector. During the 1990s, mortality rates and abundance levels were estimated for several marine mammal populations (Crespo *et al.* 1997). Although mid-water trawls, which appear to have the highest dolphin bycatch rates, are no longer allowed to be used for shrimp fishing, several experimental and commercial hauls carried out for anchovy *(Engraulis anchoita)* resulted in high incidental mortality rates for dusky and common dolphins (Crespo *et al.* 2000). It is therefore feared that as mid-water trawling effort is redirected away from hake and shrimp and toward anchovies or other species, continued or even increased cetacean mortality could result.

The purpose of this project is to investigate the ecological and operational interactions between fisheries and marine mammals in Argentine waters. On-board observer programs, stock assessment surveys, and trophic studies are among the elements needed to achieve this. Also, managers and decision-makers should be encouraged to incorporate marine mammal bycatch monitoring and bycatch reduction into fishery management.

31. Monitor interactions between fisheries and cetaceans in Chile

In Chile, takes of small cetaceans have periodically been documented in the past, most notably the hunting of Peale's, Chilean, and Commerson's dolphins for crab bait in southern Chile and the harpooning and net entanglement of various species off central and northern Chile (e.g., Sielfeld 1983; Guerra *et al.* 1987; Reyes and Oporto 1994). The prevailing perception is that cetacean exploitation in Chile is an exceptional occurrence and involves negligible mortality. However, point-sampling in 1998 indicated fishery-related killing, including illegal directed takes, of at least five small cetacean species (Burmeister's porpoise, pygmy sperm whale, long-beaked common dolphin, pygmy beaked whale, and long-finned pilot whale), and the systematic concealment of evidence was found to be a major obstacle to monitoring (Van Waerebeek *et al.* 1999b). Of specimens found in or near fishing ports in central and northern Chile, 80% showed physical signs of capture or utilization by humans. There is a clear need for better information on the nature, species composition, and levels of take in order to evaluate the likely implications for cetacean conservation. In addition, Van Waerebeek *et al.* (1999b) documented the existence of a small resident population of coastal bottlenose dolphins near Punta de Choros, characterized by an unusually low level of genetic polymorphism, suggesting endemism. This population may be threatened by unregulated tourism and live-capture operations (G.P. Sanino and K. Van Waerebeek, pers. comm.). Off north- central Chile, sperm whales are known to be attracted to longliners, reportedly to scavenge the targeted Patagonian toothfish (*Dissostichus eleginoides*), and fishermen shoot at them and use other means of deterrence (G.P. Sanino and K. Van Waerebeek, pers. comm.)(Project 57).

This project is intended to encourage researchers in Chile to initiate or continue studies of fishery-related mortality of cetaceans, perhaps following procedures similar to those used in Peru (Project 34). At a minimum, it is important to improve information on the scale and composition of bycatches and to determine the extent to which directed hunting occurs. Basic documentation is needed in relation to cetacean-oriented tourism and live-capture. Although the problem of sperm whale interactions with longlines will be addressed in a theoretical sense by the workshop proposed under Project 57, it is important to obtain better information on the nature and scale of the problem in Chile.

32. Assess illegal use of small cetaceans for crab bait in southern South America

Nearly 20 years have passed since it became widely known that marine mammals and seabirds were being used as crab bait in southern Chile and Argentina (Lescrauwaet and Gibbons 1994). The deliberate killing for this purpose, which was in addition to bycatch mortality, is believed to have contributed to reductions in abundance of Commerson's dolphins, Peale's dolphins, and other wildlife species. Under an agreement between the U.S. National Marine Fisheries Service and the Fishery Subsecretary of Chile, the Chilean government agreed to take certain measures to decrease the impacts of crab fisheries on marine mammals. This was to include programs to evaluate the scale of the problem, educate the fishing community concerning the ecological effects of the crab fisheries, and provide alternative sources of bait. Some action has been taken on all of these aspects. A proportion of the bait is now known to consist of fish or fishery by-products, either obtained by the fishermen themselves or provided through government agencies within a legal framework (A.-C. Lescrauwaet and J. Gibbons, pers. comm.). The practice of using dolphins and other marine mammals as bait is reported to have declined in recent years, due in part to the fact that legal bait has been more readily available and in part to measures taken by government agencies (Lescrauwaet and Gibbons 1994; Mansur and Canto 1997). However, a certain amount of illegal fishing and baiting is believed to continue, and recent surveys by local researchers suggest that the density of cetaceans in the region remains lower than in earlier times (A.-C. Lescrauwaet, J. Gibbons, J.C. Cárdenas, and A.C.M. Schiavini, pers. comm.).

This project involves updating information on the geographical distribution, scale, economics, and dynamics of the crab fisheries in southern South America and re- evaluating the extent to which cetaceans are still taken for bait. Field surveys to assess the status of dolphin populations in the crab fishing areas should be continued and expanded.

33. Investigate stock identity of endemic species in South America

Several species of small cetaceans are endemic to South America. Two of them, Peale's dolphin and Burmeister's porpoise, are found in cool temperate waters of both the south-western Atlantic and south-eastern Pacific, i.e., on both sides of the continent. The Chilean dolphin occurs along the Pacific coast, the franciscana along the Atlantic coast. Three additional species that are Southern Hemisphere endemics, the dusky and Commerson's dolphins and the spectacled porpoise, have what may be isolated populations in South American waters. The river dolphin *Inia geoffrensis* and the freshwater form of the tucuxi are endemic to the Amazon and Orinoco basins. Most of these species are widely distributed, but their distributions are generally thought to be discontinuous, which would mean that populations are demographically isolated. The populations are subject to various types of threat, which can differ by species and by region. For example, dusky dolphins and Burmeister's porpoises are taken incidentally or directly for human consumption in Peru (and possibly Chile) (Van Waerebeek *et al.* 1999b), and dusky dolphins, in particular, are also taken as a bycatch in trawl, purse seine, and gillnet fisheries along certain parts of the Atlantic coast (Crespo *et al.* 1994, 1997; Corcuera *et al.* 1994). The marine and fluvial, or river, forms of the tucuxi are threatened to a variable extent in different parts of their range, depending on local and seasonal fishing effort and other human activities. It is therefore important to define management units and to determine whether they straddle national borders. The results could have important management implications.

Among the more immediate and important examples, from a conservation perspective, are Burmeister's porpoise throughout its range, the dusky dolphin between Peru and Patagonia, and Peale's dolphin along the southern coasts of Chile and Argentina. Clarification of the differences between the fluvial and marine forms of *Sotalia* is a long-standing need, and a more recently recognized issue is whether one or both species of common dolphins (*Delphinus delphis* and *D. capensis*) are present in different parts of South America. Amazon dolphins in the genus *Inia* exist as three geographically isolated, morphologically distinguishable subspecies (Rice 1998). There is a need to improve understanding of the degrees of differentiation among these subspecies, define the limits of their respective distributions, and examine genetic and morphological variability within the subspecies. Individual researchers and teams throughout the region are encouraged to work collaboratively and share or split samples. The approach being taken by researchers in Brazil, Uruguay, and Argentina to study population structure of the franciscana provides a good model for application to the other species. Considering the strong influence of taxonomy on priorities for conservation of vulnerable or endangered species, it is important that taxonomic decisions be based on multiple sources of evidence, such as morphology, genetics, parasites, life history, distribution, and habitat.

34. Monitor incidental and direct catches of small cetaceans in Peru

A large variety of small and medium-sized cetaceans are still being taken incidentally in gillnets, in purse seines, and with harpoons in Peru (Van Waerebeek *et al.* 1999b). Bycatches remain high, presumably unchanged from earlier levels as no bycatch reduction measures have been implemented. Directed catches were believed to be increasing from a low immediately after 1990, when a dolphin conservation law was implemented and the markets for dolphin meat were officially closed by the Peruvian government (Van Waerebeek and Reyes 1994). In 1994 a second, more stringent small cetacean conservation law was enacted, which assigned joint responsibility for enforcement to district and provincial authorities. The species of most concern continue to be the dusky dolphin, which is taken in the greatest numbers, and Burmeister's porpoise, a species endemic to coastal southern South America. There is increasing use of cetacean meat as bait in the shark fishery. Dolphins are rarely landed openly on shore; instead, they are usually hidden and sold clandestinely or transferred to shark-fishing boats at sea (Van Waerebeek *et al.* 1999b, 2002). The continuous decline of dusky dolphins as a proportion of the overall cetacean catch since 1985 (when recording began), with roughly constant fishing effort, is consistent with the hypothesis that abundance of this species has been decreasing off central Peru (Van Waerebeek 1994; Van Waerebeek *et al.* 1999b, 2002).

There is still no national commitment in Peru to support stock assessment research, and it appears that the need for international funding and pressure will remain indefinitely. Thus, some of the actions indicated in the previous versions of the Action Plan are still recommended. Reliable estimates of total fishing mortality are needed for each species in Peruvian waters. Better information on stock structure is also needed, as are reliable estimates of abundance for the affected stocks. Total mortality caused by fisheries should be estimated using an on-board observer sampling scheme of some kind, in combination with information about total fishing effort.

35. Assess the impacts of artisanal gillnet fisheries on small cetaceans in the eastern tropical Pacific

Although much attention has been given to the bycatch problem associated with the international high-seas drift gillnet fishery (now banned under a global moratorium – United Nations General Assembly Resolution 46/215), comparatively little notice has been given to incidental catches of cetaceans in artisanal gillnet fisheries. In Latin America, exceptions to this inattention are the bycatch of vaquitas in the northern Gulf of California (Vidal *et al.* 1994; Rojas-Bracho and Taylor 1999; D'Agrosa *et al.* 2000) and the bycatch of franciscanas off southern Brazil, Uruguay, and northern Argentina (Projects 27, 28, and 29). Although few quantitative data are available, the magnitude of the cetacean bycatch in artisanal gillnet fisheries of the eastern tropical Pacific is suspected to be high (Vidal *et al.* 1994; Zavala-González *et al.* 1994; Mora-Pinto *et al.* 1995; Félix and Samaniego 1994; Reyes and Oporto 1994). Due to the inshore nature of these fisheries, they tend to affect cetaceans that are already subject to other forms of exploitation (e.g., bycatch in other fishing gear and, in some cases, directed hunting), and the overall degradation of coastal habitat from human activities (e.g., pollution inputs and destruction of fish spawning areas in estuaries and mangroves). An exploratory study of artisanal gillnet fishery bycatch levels in relation to estimates of small cetacean abundance in the eastern tropical Pacific estimated overall annual mortality rates of 4.4–9.5% (Palacios and Gerrodette

1996). Even at the bottom end of this range, the mortality would probably be unsustainable. It is generally recommended that removals should not exceed 1–2% of the population abundance (Wade 1998). Mortality rates may be even higher for coastal subspecies (e.g., coastal spotted and Central American spinner dolphins, *S. a. graffmani* and *S. l. centroamericana*, respectively) because animals from these populations are likely over-represented, relative to their abundance, in the bycatch (Palacios and Gerrodette 1996).

Numerous difficulties arise in attempting to assess bycatches in artisanal gillnet fisheries. These fisheries tend to be widely dispersed, involve many relatively small vessels (ranging from rafts and dugout canoes to open motorized boats up to 10m long), and operate at subsistence or small-scale commercial levels. Thus, any meaningful assessment requires the cooperation of local fishermen, as well as coordination among scientists, government officials, and non-governmental groups. This project aims to create a network of scientists who work with local fishing communities to obtain quantitative data on fishing effort and gillnet-caused mortality of cetaceans. Ideally, these efforts should be accompanied by abundance surveys and investigations of population structure (stock identity). One or more workshops may be required to standardize methods among researchers and coordinate efforts to address the problem from a multinational perspective.

36. Develop a conservation plan for cetaceans in the Gulf of California (Sea of Cortés)

The Gulf of California, on the west coast of Mexico, has a high diversity of cetaceans, including large whales such as fin, gray, blue, Bryde's, humpback, and sperm whales, and at least 14 species of small cetaceans (Vidal *et al.* 1993). The Critically Endangered vaquita is endemic to the upper gulf. Fishing and whale-watching are among the valuable economic activities that take place within the gulf. Local commercial fisheries target anchovies, sardines, shrimp, squid, tuna, and sharks. Sport fishing is an important element of the tourism industry. Tens of national and foreign cruise ships bring tourists each year to watch whales along the west coast of the gulf between Loreto and Los Cabos. Human population centers in the bays of Guaymas, Topolobampo, La Paz, Cabo San Lucas and Banderas are sources of pollution that may degrade the environment and affect the gulf's high marine diversity and productivity.

Because human use of the gulf and its resources is constantly increasing and diversifying, there is clearly potential for serious impacts on cetacean populations (e.g., Findley and Vidal 2002). Some human activities may conflict with one another. For example, fishery- or pollution-caused reductions in local marine mammal populations would reduce the area's appeal for some tourists, leading to problems in the tourism industry. A comprehensive, integrated management plan for the gulf is needed to ensure that economic development is compatible with the needs of cetaceans and other wildlife. In support of such a plan, this project should include: (a) compilation and review of information on distribution, abundance, and seasonal movements of cetaceans at different scales of time and space; (b) efforts to describe and quantify interactions with human activities (e.g., fisheries, tourism, polluting industries, harbor development); (c) recommendations for cetacean conservation related, for example, to whale-watching, fishery bycatch, underwater noise; and (d) development of environmental education programs for people living along the shores of the gulf and for seasonal visitors.

37. Assess potential impacts on cetaceans of Mexico's planned "Nautical Stairway" along the coasts of Baja California and the mainland

The Mexican government has announced plans to build a network of 22 marinas and ports, spaced at intervals of approximately 120 nautical miles along the shores of the Baja California peninsula and the mainland states of Sonora, Sinaloa, Nayarit, and Jalisco. Although FONATUR (Mexico's national fund for the promotion of tourism) has not yet precisely defined the project, it includes the improvement of existing coastal cities, ports, and marinas, as well as the construction of new ones. This development, known as the Nautical Stairway or Steps (Escalera Naútica), is viewed as key to the economic future of the region. A wide variety of infrastructure projects are envisioned, including new and improved roads, airports, airstrips, golf courses, hotels, wharves, and restaurants. The construction of an 84-mile land bridge to facilitate the towing of yachts across the Baja California peninsula is a priority, as is improvement of the road between Mexicali and San Felipe to allow cross-border access to the Upper Gulf of California for large boat-towing rigs, facilities to supply mariners with fuel and other provisions, hotels, golf courses, etc. It is anticipated that by 2014, more than 60,000 vessels will be cruising in these waters each year, in contrast to only a few thousand at present. The region's large and diverse cetacean fauna is bound to be affected by this proliferation of coastal development, but little effort has been made to evaluate the implications for cetaceans and other marine life (Rojas-Bracho *et al.* in press).

This project involves a comprehensive assessment of the potential impacts on cetaceans. Among other things, it requires an inventory of the region's cetaceans (species and populations) and an evaluation of the present condition of their habitat. These elements then need to be evaluated in light of the various components of the Nautical Stairway so that areas of potential conflict can be identified and assessed. It is essential not only that the discrete impacts of individual development projects be considered, but also that the cumulative impacts of the entire development package, as a whole, be carefully assessed well in advance of decisions about whether and how to proceed (Moore and Clarke 2002). Governments in the region were expected to begin designing regulations regarding marinas, ports, and tourism infrastructure in 2002, and input by cetacean experts is desirable.

38. Investigate live-capture fisheries for bottlenose dolphins in Mexico and Cuba

Live-capture fisheries for bottlenose dolphins in Mexican waters of the Gulf of Mexico and around Cuba are known to be supplying animals for numerous display facilities in Latin America and possibly elsewhere. Local dolphin populations may become depleted if the captures are localized and the numbers being taken are high, if young females are selected for, and/or if the documentation and regulation of these fisheries are inadequate. The genus *Tursiops* is highly polymorphic, at both large and small geographic scales, and the existence of distinctive geographic races, based on morphology, is well known. Genetic studies have confirmed differences between offshore and coastal populations, particularly in US waters of the western North Atlantic and Gulf of Mexico where they are treated as separate stocks (Waring *et al.* 2001). Population studies in other regions also indicate the existence of at least these two forms (Wells and Scott 1999). In many inshore habitats, bottlenose dolphins exist in long-term resident communities that are functionally discrete. This may be true of the groups being exploited along the Mexican coast of the Gulf of Mexico and in Cuban waters. It has proven extremely difficult to document, much less regulate, the extensive international trade in live bottlenose dolphins. If there is to be any hope of verifying origins of individual captive animals, and therefore of achieving conservation goals through the monitoring and regulation of trade, it will be necessary to have certified reference samples that provide a basis for verifying origins of individual captive dolphins.

Scant information is available on the levels of past or current captures from these regions, and essentially nothing is known about abundance or stock structure. As a basis for assessing the effects of the live-capture fisheries, at least two kinds of research are needed, as follows: (a) compilation of data on past, ongoing, and planned live-capture operations to identify localities of concern and determine how many animals have been removed and how many have been caught and released; and (b) photo-identification and biopsy darting surveys to estimate abundance and vital rates, determine stock structure, and provide reference samples for trade monitoring. For (a), it will be necessary to encourage Cuban and Mexican authorities to monitor the live-capture fisheries more intensively. The proposed surveys (b) could involve small vessels with three- or four-person teams operating in coastal and inshore waters where removals have occurred. A minimum of three complete surveys of each region should be conducted for mark-recapture analyses, and a minimum of about 50 genetic samples should be collected from each region (Wells *et al.* 1997 for survey details). For stocks that have experienced large-scale exploitation, capture/release efforts would be useful to evaluate dolphin health and identify anthropogenic threats that might influence recovery, to obtain additional genetic material and morphological data for stock definition, and possibly to provide opportunities for tagging and various life history studies. In assessing the impacts of live-captures, it is important that other sources of stress and mortality specific to the affected population be taken into account.

39. Conduct cetacean abundance estimation workshops in Latin America

Reliable abundance estimates are needed if there is to be any hope of assessing the true nature, scale, and impact of cetacean interactions with fisheries. Series of abundance estimates also offer the possibility of detecting and measuring trends in populations caused by other factors such as chemical or noise pollution, boat disturbance, habitat degradation, etc. Although the situation is improving, there are still many areas of Latin America where local expertise in survey design, field observation procedures, and analytical techniques is either inadequate or altogether lacking. The great variety of species and habitats (e.g., river dolphins in the Amazon and Orinoco basins; whales, dolphins and porpoises in coastal and offshore marine ecosystems; Peale's, Chilean and Commerson's dolphins in the Fuegian Channels) dictates a need for multiple approaches, or at least some adaptations of traditional distance sampling methodology.

One or more workshops should be held with the objective of training Latin American scientists to conduct abundance surveys. It is important for workshop agendas to address explicit problems and needs of active researchers in a given region. The formats should be interactive so that local researchers have the opportunity to explain and discuss their study areas and study animals with experts, as well as any limitations that they anticipate in trying to apply rigorous survey methods in their specific circumstances. The experts should be expected to review current methodological principles and offer insights about analytical procedures and possibilities. The goal is to develop optimal designs and approaches tailored to particular problem areas.

5.3 Africa

The CSG has been far less active in Africa than in Asia and Latin America – a situation that needs to change in coming years. Although only a few projects are included in this Action Plan, this should not be interpreted to mean that there are few cetacean conservation problems in Africa. In fact, there are many (Jefferson *et al.* 1997; Notarbartolo di Sciara *et al.* 1998; Van Waerebeek *et al.* 2000). In 1997 the IWC Scientific Committee concluded that information on small cetaceans in Africa was very sparse outside southern Africa, and that issues of fishery bycatch in many areas and hunting in some areas urgently needed to be addressed (IWC 1998). Specifically, the committee's report noted the "extremely high intensity of fishing effort along the West African coast and the likelihood that substantial cetacean bycatch occurs but is not recorded." It also noted that "human-induced mortality of small cetaceans off the islands in the western Indian Ocean could be high, ... as a result of bycatch and directed takes." There is particular concern about coastal species with small, local populations, e.g., hump-backed, bottlenose, and Heaviside's dolphins (Peddemors 1999). In addition, a population of North Atlantic right whales that formerly used Cintra Bay on the coast of Western Sahara as a winter nursery may be extirpated (Notarbartolo di Sciara *et al.* 1998). Some other populations of large whales that were exploited commercially are still extant (Findlay *et al.* 1994; Rosenbaum *et al.* 1997; Walsh *et al.* 2000; Razafindrakoto *et al.* 2001; Van Waerebeek *et al.* 2001b), and some are (IWC 2001b) or may be (Best *et al.* 1996) recovering. The situation of cetaceans in East Africa is almost completely unknown. The absence of projects and recommendations for this area, with the exception of Madagascar, reflects the need to expand CSG membership so that meaningful projects can be formulated and promoted for the region in the future.

Projects

40. Investigate cetacean mortality in western Madagascar

Madagascar's coastal waters are inhabited by a diverse array of cetacean species. Preliminary surveys along the west coast indicate that several species are taken, both intentionally and accidentally, and that the meat is sold in local markets and restaurants (Cockcroft and Young 1998; Razafindrakoto and Rosenbaum 1998). A recent investigation in southern Madagascar revealed that hundreds of dolphins, mainly from three species (spinner, bottlenose, and Indo-Pacific hump-backed dolphins), had been killed during the previous five years in a single village (H. Rosenbaum, pers. comm.). The Indo-Pacific hump-backed dolphin is of particular concern as the animals in Madagascar's waters may be geographically isolated, and their near-shore distribution and generally low-density occurrence make them exceptionally vulnerable. Although initial investigations have identified some areas where hunting and bycatch occur (Andrianarivelo 2001), a more wide-ranging assessment is needed. This should be accomplished with training programs and the involvement of Malagasy scientists and conservation authorities. Further investigation is needed on cetacean distribution and abundance along the west coast. Documentation is also needed on the species and numbers of cetaceans taken deliberately and accidentally, with information on the types of gear used and the locations where the takes are occurring. The project should lead to recommendations for reducing cetacean kills and establishing long-term monitoring programs in areas judged to be of particular conservation importance.

41. Investigate bycatches and directed takes of small cetaceans in Ghana, West Africa

Exploratory sampling of landing sites of small-scale coastal fisheries in Ghana since 1998 have revealed that bycatches and directed takes of small cetaceans are commonplace, and possibly increasing. The largest catches, by far, are the result of deployment of large-meshed drift gillnets targeting tuna, sharks, billfish, manta rays, and dolphins. Fishermen and other people throughout the region appear to be familiar with handling and butchering dolphin carcasses, and this can be interpreted to suggest that the consumption of these animals has been occurring for some time, even though interviews reveal that it is a recent development (K. Van Waerebeek, pers. comm.). The species most frequently delivered to the landing sites include: the clymene dolphin (Ghanaians call it the "common dolphin"), bottlenose, pantropical spotted, Risso's, long-beaked common, and rough-toothed dolphins, together with short-finned pilot and melon-headed whales (Van Waerebeek and Ofori-Danson 1999; K. Van Waerebeek, pers. comm.). Dwarf sperm and Cuvier's beaked whales may also be caught with some regularity. Interestingly, stranded whales are worshiped by coastal communities and given burials. Notably absent from observed catches to date have been Atlantic hump-backed dolphins. If this pattern of absence continues to be observed, it could signify that either: (a) the species usually does not occur along major portions of Ghana's coastline due to a lack of preferred prey or habitat; or (b) numbers have been drastically reduced by bycatch and hunting. Either way, it raises further questions concerning the overall status of the species (cf. Van Waerebeek and Ofori-Danson 1999).

Port and fishery monitoring programs should be established to elucidate the apparently strong seasonality of takes, catch composition (species, sex, and age), and take levels. Further collection of biological specimens should be encouraged, with the objective of obtaining statistically representative samples. Senior officers in Ghanaian fishery and wildlife departments have shown an encouraging interest in, and awareness of, the potential for over-exploitation (K. Van Waerebeek, pers. comm.). With sufficient funding and appropriate training, it should be possible to achieve systematic data collection at the national level, and in turn make progress toward assessing trends and implementing sound conservation measures. Abundance estimation surveys should be conducted at sub-regional, rather than national, scales, but these will require intensive planning and international support.

42. Investigate bycatches and directed takes of small cetaceans in Senegal and The Gambia, north-western Africa

Recent surveys sponsored by CMS/UNEP in Senegal and The Gambia indicate continuing bycatches and deliberate takes of small cetaceans in artisanal and semi-industrial fisheries. Most of the animals taken are bottlenose, Atlantic hump-backed, and long- and short-beaked common dolphins and, on Senegal's Petite Côte, harbor porpoises (Van Waerebeek *et al.* 2000, 2001a). The consumption of small cetacean meat, traditionally limited to Christian coastal communities, is spreading among the dominant Muslim fishing societies. While presently there is no evidence of large-scale takes or wider commerce of cetacean products in rural areas/large city markets, the low mortality levels of Atlantic hump-backed dolphins are still problematic for a small population in Senegambian waters (possibly no more than a few hundred individuals), and a North-west African (Morocco to Guinea-Bissau) aggregate of perhaps less than 1000 (Van Waerebeek *et al.* 2001a)(Project 43). Attempts to obtain information on fishery interactions from the Senegal national fisheries observer scheme have been largely ineffective thus far. In contrast, personnel at Saloum Delta National Park have made good progress in locating dolphin carcasses. In The Gambia, cooperation from wildlife and fishery departments produced encouraging results, with increasing interest and ample reports on dolphin sightings but little information on bycatches. Supervised monitoring pointedly demonstrated that the illegality of cetacean captures and wide-ranging solidarity within fishing communities are responsible for most non-reporting (K. Van Waerebeek, pers. comm.).

Initial research and conservation activities have paved the way for much-needed local public awareness efforts in both countries. A new Dakar-based non-governmental organization, Conservation and Research of West African Aquatic Mammals, or COREWAM, and an inter-departmental Gambian Aquatic Mammal Working Group are now in place. These novel developments will require sustained encouragement and external financial support for several years before the costs, expertise, and logistics can be met by national resources.

43. Investigate the status of Atlantic hump-backed dolphins in north-western Africa

Field work in Senegal and The Gambia since 1995 suggests that local communities of Atlantic hump-backed dolphins are under threat (Van Waerebeek *et al.* 2000). The only firm evidence that *Sousa teuszii* still inhabits Senegal's Saloum Delta consists of three carcasses with rope tied around their tail stocks, found together in 1996 on a remote island. While the Saloum Delta (partly protected by National Park status) and the Gambia River still harbor relatively pristine environments, with little pollution and ship traffic, pressures from local fisheries are high. Bycatches, as well as limited direct takes, may occur (Project 42). Practical measures for the reduction of net entanglements may indeed be crucial to the survival of the dolphin communities. Hump-backed dolphins are still reported with reasonable frequency in the estuaries and coastal archipelago of less densely populated Guinea-Bissau (Van Waerebeek *et al.* 2000). However, artisanal fisheries there are also diversifying and expanding rapidly. Other small but possibly viable *S. teuszii* communities occupy coastal waters of the Parc National du Banc d'Arguin in Mauritania (Robineau and Vély 1998).

In Dakhla Bay, southern Morocco/Western Sahara, Notarbartolo di Sciara *et al.* (1998) reported a few sightings of small groups of hump-backed dolphins. The animals were shy and exceedingly difficult to approach. One juvenile was found dead entangled in an octopus line. Interactions with fisheries, possible depletion of food resources (through fisheries), competitive interactions with bottlenose dolphins, and population fragmentation may all be acting to wipe out *S. teuszii* from Dakhla Bay and perhaps throughout southern Morocco (Notarbartolo di Sciara, unpublished data).

There is a need to obtain baseline abundance data and establish seasonal patterns of distribution for *S. teuszii* in north-western Africa, as well as investigate the level of genetic interchange among different dolphin communities. At least two boat surveys, one each in the rainy and dry season, would need to be conducted in the estuarine and larger creek systems, and the coastal shelf waters of southern Senegal and The Gambia. Similar surveys of inshore and coastal waters are needed in Dakhla Bay and other parts of the Western Saharan and Moroccan coasts known or suspected to have hump-backed dolphins. Due to their rare availability, the collection of any carcasses for biological samples should be a high priority, although great care should be taken that the interest of researchers does not lead to directed killing by local fishermen in expectation of a reward. Exploratory work in Ghana and Togo has yet to yield a single record of *S. teuszii*. In fact, no recent records have been reported for the entire Gulf of Guinea (Van Waerebeek and Ofori-Danson 1999). This can be interpreted as suggesting that the aggregate West African hump-backed dolphin population is already fragmented to some extent. Finally, the long-standing question of whether *S. teuszii* is a species distinct from the Indo-Pacific hump-backed dolphin (cf. *Sousa chinensis*) should be addressed through analyses of cranial and genetic variation (IWC in press).

44. Investigate cetacean mortality in the eastern tropical Atlantic tuna purse seine fishery

Since at least the late 1960s, when Simmons (1968) observed nets being set around what he called common dolphins (*Delphinus delphis*) off West Africa, it has been known that dolphins are involved in the tuna purse seine fishery in the eastern tropical Atlantic Ocean. The tuna vessels are registered in several countries, including France, Spain, and the United States, as well as several West African countries. In 1971, P.J.H. van Bree indicated his suspicions of a potentially serious problem with dolphin mortality in this fishery. However, to this day, the levels of mortality, stock sizes, and even exact species involved are not known with certainty, and there is conflicting information on the extent of the problem. Statements have been made that dolphin kills are only occasional and that the mortality is not serious (e.g., Maigret 1981; Ariz *et al.* 1992), but the arguments supporting these statements are not convincing, and little evidence has been provided apart from data in captains' logbooks, which could be biased.

There is strong reason for concern about the cetacean kill in this fishery, based on the following facts: (a) the same dolphin species involved in the eastern tropical Pacific tuna fishery are present in the eastern tropical Atlantic; (b) the oceanic conditions that have been associated with the strong tuna/dolphin bond in the Pacific are also present in the Atlantic (Alverson 1991); (c) at least some vessels have helicopters and speedboats that can be used to herd dolphin schools (Simmons 1968); and (d) most vessels in the fleet do not have dolphin-saving gear or techniques available (Alverson 1991).

It has been suggested that dolphin mortality in this fishery could be very high, up to 30,000 or more animals per year (Alverson 1991). The species involved likely include several species of the genus *Stenella*, as well as common dolphins (*Delphinus* spp.) (Maigret 1981). Tuna/whale interactions are also known to occur (Alverson 1991), and baleen whales are considered to be good indicators of tuna schools (Levenez *et al.* 1980). Despite claims to the contrary, there is reason to suspect a serious problem that has been neglected for more than 30 years. Independent observer data on the composition and extent of the bycatch need to be obtained and published. Although observer programs may already exist in this fishery, adequate information to assess the cetacean bycatch is currently lacking.

45. Investigate the potential effects of oil and gas development on humpback whales and other cetaceans in coastal waters of West Africa

Humpback whales and other cetaceans that use shallow coastal waters off West Africa, whether as wintering areas, migratory corridors, or year-round home ranges, could be affected by activities related to hydrocarbon development, especially disturbance from seismic exploration and shipping activities associated with production, as well as possible pollution effects from oil spills. While conflicts between mineral extraction activities in marine waters and the status of cetacean populations are certainly not unique to West Africa, the situation there is particularly complicated, in part because so many countries are involved, some of which face major socio-economic and political upheaval or uncertainty. Intensive exploration, production, and transport of oil and gas already occurs off South Africa, Angola, Congo, Gabon, Equatorial Guinea, and throughout the Gulf of Guinea (New York Times, 7 March 1998). There has been virtually no monitoring to evaluate the effects of this activity on cetacean populations. On at least one occasion, active rigs were seen to be pumping oil directly into the water as a group of humpback whales swam through the surface slicks (H. Rosenbaum, pers. comm.).

Major international conglomerates are preparing for the next phase of development and are rapidly expanding their exploration of marine hydrocarbon deposits. As production rates decline, international companies may sell their oil and gas concessions to smaller local companies. While the operations of international firms may be influenced to some extent by environmental regulations and public opinion, smaller operators could more easily avoid close scrutiny and tight regulation. A regional, multi-national approach to evaluation of the effects of the oil and gas industry on cetacean populations would be timely, and the humpback whale is an appropriate focal species, as a large part of its putative breeding and migratory range off West Africa is believed to coincide with oil and gas development activities. A possible first step would be to use satellite telemetry to document the migration routes of humpback whales in relation to the distribution of oil and gas activity. The recently formed Indo-South Atlantic Humpback Whale Network has identified investigations along these lines as a high priority (Rosenbaum *et al.* 2001b).

5.4 Europe

In recent years, European scientists and conservationists have made considerable progress in documenting Europe's cetacean fauna, which remains surprisingly diverse and abundant considering the long and dismal history of whaling, dolphin and porpoise hunting, and habitat modification and degradation. Four geographic regions are of most concern. Two are covered by agreements concluded under the Convention on Migratory Species. ASCOBANS, the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, is principally intended to address the problems of fishery bycatch and habitat degradation (including chemical and noise pollution) in the Baltic and North Seas. The focal species of ASCOBANS is the harbor porpoise although a variety of other odontocetes (particularly the white-beaked dolphin) are regular inhabitants of the region (e.g., Kinze 1995; Kinze *et al.* 1997; Hammond *et al.* 2002). ACCOBAMS, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, will also need to address fishery bycatch and habitat degradation, but with a different combination of focal species. The problems of severe ecological stress due to pollution, overfishing, military operations, and high-speed vessel traffic are at least as severe in the Mediterranean and Black Seas as they are in the Baltic and North Seas. While ASCOBANS has been in force since 1994 and is well-established, ACCOBAMS came into force only in 2001 and therefore is still in its early stages of development.

The other two regions are: (a) Atlantic waters of western Europe and (b) the north-east Atlantic Arctic, specifically the Greenland and Barents seas. Bycatch in fishing gear, notably gillnets and trawls, is the most readily identifiable threat to cetaceans in coastal Atlantic waters (e.g., Couperus 1997; Tregenza *et al.* 1997; Tregenza and Collet 1998). In the Atlantic Arctic, the bowhead whale, white whale (beluga), and narwhal are essentially unexploited apart from narwhal hunting in East Greenland (Dietz *et al.* 1994). Bowheads, however, remain extremely scarce despite almost 75 years without being hunted in this region. The status of the Svalbard/Barents Sea stock of bowheads is, therefore, a major conservation concern that needs to be addressed through focused research.

Projects

46. Assess abundance and threats to survival of harbor porpoises in the Black Sea and surrounding waters

Harbor porpoises in the Black Sea are isolated from Atlantic populations by a range hiatus in the Mediterranean Sea (Read 1999). Harbor porpoises that occur in Greek waters of the Aegean Sea may belong to the Black Sea population or, alternatively, be a remnant of a separate Mediterranean population (Frantzis *et al.* 2001). Porpoises also occur in Kerch Strait between the Black and Azov Seas (Birkun and Krivokhizhin 1998) and in the Marmara Sea and Strait of Bosporus (Öztürk and Öztürk 1997). Reports that harbor porpoises have been extirpated from the Azov (Gaskin 1984; Klinowska 1991; IWC 1992) are erroneous; they are commonly seen in this water body from late March to late October (Birkun and Krivokhizhin 1998; Krivokhizhin and Birkun 1999). Although no reliable abundance estimates exist (Buckland *et al.* 1992), the Black Sea population is thought to have been reduced dramatically, as evidenced by the steep decline in catches prior to the suspension of dolphin and porpoise hunting in 1983. There is concern that disease, perhaps influenced by exposure to contaminants or poor nutritional status, has also affected the population. Morbillivirus antibodies were detected in 39 of 75 harbor porpoise specimens taken incidentally between 1997 and 1998 along the coasts of the Ukraine, Georgia, and Bulgaria (Müller *et al.* 2000). The Black Sea population of harbor porpoises is classified as Vulnerable in the Red List.

Cetacean fisheries ended in the Soviet Union, Bulgaria, and Romania in 1966 (Smith 1982) but continued until 1983 in Turkey, mainly in the south-eastern Black Sea (Klinowska 1991). From 1976 to 1981, harbor porpoises were believed to account for 80% of the total catch of cetaceans in Turkey, with 34,000–44,000 taken annually (IWC 1983). With an estimated loss rate (porpoises killed but not recovered) of 50% (Berkes 1977), total mortality could have been as much as double these numbers. Illegal catches of unknown magnitude were also reported in 1991 (Buckland *et al.* 1992; IWC 1992). A die-off of harbor porpoises, involving mainly young animals, was reported along the Crimean, Taman, and Bulgarian coasts in 1989–1990 (Birkun *et al.* 1992). Harbor porpoises in the Black Sea are also threatened by accidental killing in bottom-set gillnets, offshore gas and oil drilling, industrial pollution, and possibly declines in their prey (Birkun and Krivokhizhin 1996).

This project should involve a series of line-transect surveys in coastal areas of the Black, Marmara, Aegean, and Azov seas, and the Kerch, Bosporus and Dardanelle straits, to determine distribution patterns and estimate abundance of harbor porpoises. Standard methods for surveying harbor porpoises should be employed (e.g., Barlow and Hannan 1995; Palka 1995; Polacheck 1995; Laake *et al.* 1997; Hammond *et al.* 2002). Concurrent with these activities, a systematic study of the threats facing harbor porpoises in the Black Sea should be conducted. This study should include: (a) toxicological analyses of tissue samples from strandings and incidentally caught animals (with special emphasis on persistent contaminants, heavy metals, and hydrocarbons discharged from shoreline industries); (b) interview surveys, visits to fish markets and landing sites, and on-board observer programs to evaluate incidental catches and illegal hunting; and (c) review and analysis of existing fishery data to assess trends in porpoise prey. Results of the population and threat assessments should lead to the development of a basin-wide conservation plan. International cooperation for training and implementation of research goals is essential. The first International Symposium on the Marine Mammals of the Black Sea, June 1994, Istanbul, Turkey (Öztürk 1996) is a strong example of the type of coordination and information exchange that will continue to be needed, now under the purview of ACCOBAMS, for conducting basin-wide assessments.

47. Investigate the distribution, abundance, population structure, and factors threatening the conservation of short-beaked common dolphins in the Mediterranean and Black Seas

Short-beaked common dolphins in the Mediterranean and Black Seas have undergone a dramatic decline in abundance during the last few decades, and have almost completely disappeared from large portions of their former range (UNEP/IUCN 1994; Aguilar *et al.* 1994). Mediterranean regions where common dolphins no longer occur include the northern Adriatic Sea (Notarbartolo di Sciara and Bearzi 1992; Bearzi *et al.* 2001), Balearic Sea, Provençal basin, and Ligurian Sea (Notarbartolo di Sciara *et al.* 1993; Forcada 1995; Forcada and Hammond 1998). Genetic mixing between individuals in the Mediterranean and the Atlantic appears to be limited to dolphins in the Alboran Sea (Natoli in press). Some authors consider common dolphins in the Black Sea to be an endemic subspecies (Tomilin 1967; Heptner *et al.* 1996). Recent line-transect surveys resulted in an estimate of about 15,000 common dolphins in the south-western Alboran Sea, but abundance was not estimated for the rest of the western Mediterranean due to the low number of sightings (Forcada 1995; Forcada and Hammond 1998). No credible information exists on the abundance of common dolphins (and other cetaceans) in the Black Sea, but massive directed killing, which continued to the early 1980s, is believed to have considerably reduced the population size (Buckland *et al.* 1992). Currently, the main threats facing common dolphins in both regions include accidental killing in fishing gear, reduced availability of prey due to overfishing and habitat degradation, and the effects of toxic contaminants. This last threat may have increased the population's susceptibility to epizootic outbreaks that resulted in mass die-offs in the Black Sea (Birkun *et al.* 1999). In the Mediterranean, epizootics and reproductive disorders appear to have affected striped dolphins primarily (Van Bressem *et al.* 1993; Munson *et al.* 1998), but common dolphins may also be at risk because of their similarly high contaminant loads (Fossi *et al.* 2000).

This project should entail a series of surveys to determine the distribution and abundance of common dolphins in the Mediterranean and Black seas and their connecting waters. Standard methods should be used so that results can be compared over time and from one region to another. Biopsies should be collected for genetic and contaminant analyses, while recognizing that the darting to obtain biopsies is not without risk to free-ranging dolphins (Bearzi 2000). Samples should be archived in a central repository, and collaborative studies should be initiated to better understand population structure and identify regional differences in contaminant exposure. Sighting surveys, stranding networks, and related activities require collaboration among national scientists, government agencies, and NGOs in the various range states. ACCOBAMS provides an ideal basis for coordination and collaboration. This project should result in a comprehensive assessment of the status of Mediterranean and Black Sea common dolphins and lead to appropriate measures for their conservation.

48. Investigate the distribution and abundance of bottlenose dolphins in the Mediterranean and Black Seas, and evaluate threats to their survival

In the Mediterranean and Black seas, bottlenose dolphins occur in scattered inshore communities of perhaps 50–150 individuals, and the gaps between them appear to be getting larger (Bompar *et al.* 1994; Bearzi *et al.* 1997; Notarbartolo di Sciara and Gordon 1997; Birkun and Krivokhizhin 1998; Fortuna *et al.* 2000; Pulcini *et al.* in press). Genetic evidence suggests that there is gene flow between bottlenose dolphins in the Mediterranean and the North Atlantic (Natoli and Hoelzel 2000). Some authors regard the Black Sea population to be an endemic subspecies (e.g., Heptner *et al.* 1996), and although no firm morphological or genetic evidence has been presented to support this claim, available information suggests that the population is substantially isolated from that in the Mediterranean and therefore vulnerable to depletion and extirpation. Bottlenose dolphins are common in the Kerch Strait (Birkun and Krivokhizhin 1998) and probably occur at least occasionally in the Sea of Azov (Birkun *et al.* 1997). Conservation threats are roughly similar to those facing short-beaked common dolphins (see above) and other small cetaceans of the region, except that bottlenose dolphins in the Mediterranean and Black seas may be particularly vulnerable to human activities due to their near-shore occurrence and fragmented population structure. Recent dramatic changes to the ecosystem of the Black Sea have generally been attributed to extensive pollution, coastal development, disturbance from vessel traffic, overfishing, and the effects of introduced species (GESAMP 1997). Incidental kills of bottlenose dolphins in trammel and gillnets occur frequently in some areas (Silvani *et al.* 1992; UNEP/IUCN 1994). Overfishing of demersal fish may have affected the prey base for bottlenose dolphins in some areas. Sharp declines in the abundance and range of some fish species have been observed in the Black Sea, attributed to environmental pollution, blooms of an exotic ctenophore, and overfishing (Andrianov and Bulgakova 1996). The live-capture of bottlenose dolphins for Russian and Ukrainian oceanaria, and for export, is believed to be adding to the pressure on local dolphin communities in the Black Sea (A. Birkun, pers. comm.). Based on trade data submitted by member countries of CITES and managed by the UNEP-World Conservation Monitoring Centre, at least 92 bottlenose dolphins were exported from the Black Sea between 1990 and 1999. In addition, unknown numbers are removed from the wild each year by countries bordering the Black Sea for military purposes, to replace animals that die in display facilities, and to supply the captive dolphins used in human therapy programs.

This project consists of a series of intensive population assessments in areas of the Mediterranean and Black seas, and interconnecting waters, where bottlenose dolphins are known to occur, combined with larger-scale but less intensive surveys to identify previously unknown hotspots of occurrence (Figure 33). Efforts are also required to monitor incidental catches (best accomplished through on-board observer programs)(cf. Silvani *et al.* 1999) and to investigate the possible problem of nutritional stress from reduced availability of suitable prey (cf. Bearzi *et al.* 1999). A particular need is for genetic studies of bottlenose dolphins in the Black Sea to determine the extent to which they are distinct from other populations. Similar to the common dolphin project described above (Project 47), this project requires coordination among various national agencies and scientists, which may be accomplished under the auspices of ACCOBAMS.

Figure 33. Common bottlenose dolphins – mother and calf – race along the surface near the coast of the Greek island of Kalamos in the eastern Ionian Sea. *Photo: Tethys Research Institute/Sebastiano Bruno.*

49. Develop and test approaches to reducing conflicts between bottlenose dolphins and small-scale fisheries in the Mediterranean Sea

There is a long history of interactions between bottlenose dolphins and coastal, small-scale commercial fisheries in the Mediterranean Sea. In recent years, issues related to perceived competition and direct conflict between dolphins and fisheries have become major concerns. A workshop sponsored by Italy's Institute for Applied Marine Research was held in Rome in May 2001 to investigate and evaluate efforts by fishermen and others to deter dolphins from nets (Reeves *et al.* 2001a). It was concluded that although the problem of dolphin depredation has become a major issue in the eyes of Mediterranean fishermen (and therefore deserves to be addressed in a responsible manner by government agencies and conservation groups), there is a danger that the *ad hoc* and even experimental use of noise-making deterrence devices could have unintended adverse effects on other species (e.g., Critically Endangered Mediterranean monk seals, *Monachus monachus*). Such devices may also prove ineffective for reducing fishery-dolphin conflicts. The workshop produced a series of recommendations for research and development, and concluded that high-intensity acoustic devices that are typically used to keep pinnipeds away from aquaculture facilities are inappropriate for use in alleviating conflicts between dolphins and fisheries in the Mediterranean.

This project consists of implementing the recommendations made by the Rome workshop. As an initial step, it is necessary to obtain detailed quantitative information on the characteristics of bottlenose dolphin populations in the Mediterranean (Project 48) and on the spatial, seasonal, and operational features of small-scale coastal trammel and gillnet fisheries in the region. Identification of hotspots where overlap occurs (i.e., high dolphin densities matched with high levels of fishing activity) should be followed by rigorous site-specific studies to characterize and quantify the costs of dolphin depredation. Where serious problems are found to exist, rigorous tests of potential solutions should be conducted after extensive consultations with fishermen as well as technical experts. It is important that due consideration be given to the real or potential adverse side effects of any mitigation approach. The workshop concluded that non-acoustic means of reducing conflicts, such as changes in methods of gear deployment or the use of quieter engines, hold promise and deserve to be evaluated.

50. Conduct a basin-wide assessment of sperm whale abundance and distribution in the Mediterranean Sea

In the Mediterranean, sperm whales occur primarily in deep slope and offshore waters of the Alboran, Ligurian, Tyrrhenian, Ionian, and Aegean Seas, with only vagrants in the Adriatic (Affronte *et al.* 1999). Differences in vocal repertoire, year-round observations of all age-classes and both sexes in the eastern Mediterranean, and the scarcity of sightings in the Strait of Gibraltar provide circumstantial evidence of demographic isolation from sperm whales in the North Atlantic. Although no estimates of abundance are available, encounter rates for sperm whales have been unexpectedly low during recent surveys (Notarbartolo di Sciara *et al.* 1993; Marini *et al.* 1996). Large numbers of sperm whales are known to have been killed incidentally in the high-seas driftnet fishery for swordfish, possibly reducing their abundance in the Mediterranean (Notarbartolo di Sciara 1990; IWC 1994b, p.38). Noise from mineral prospecting, military operations, intensive hydrofoil traffic, and dynamite fishing may also be affecting sperm whales (Notarbartolo di Sciara and Gordon 1997). Sperm whales in the Mediterranean have not been the subject of explicit attention from the IWC and its Scientific Committee, perhaps because they have not been hunted there commercially in recent decades.

Surveys are needed to assess the abundance and distribution of sperm whales in the Mediterranean. This project can be implemented most effectively using a combination of visual and acoustic techniques. One potential approach would be to divide the Mediterranean into tracts that could each be covered with a towed array within a three-week period (about 10–15 tracts), and then to conduct simultaneous surveys of these tracts in July when the seas are calmest. Surveys should include efforts to identify critical habitat. Similar to other transnational projects, this one requires a high level of international cooperation among agencies and scientists, ideally under the auspices of ACCOBAMS .

51. Assess abundance, distribution, and population structure of harbor porpoises in the Baltic Sea and support efforts to promote their recovery

A major challenge facing ASCOBANS is addressing the need to improve the status of harbor porpoises in the Baltic Sea. It is widely acknowledged that this population is depleted, likely as a result of historical over-exploitation, ongoing bycatch in fisheries, and possibly other factors such as pollution and habitat degradation (Skóra *et al.* 1988; Donovan and Bjørge 1995; Berggren 1994; Berggren and Arrhenius 1995; Kinze 1995; Kock and Benke 1996; Berggren *et al.* 2002; MacKenzie *et al.* 2002; Huggenberger *et al.* 2002). The Baltic Sea population is classified as Vulnerable in the IUCN Red List. Although relatively precise abundance estimates are available for the North Sea and the channels connecting the North and Baltic seas (Hammond *et al.* 2002), survey coverage of the Baltic proper has been partial, and the low sighting rates in surveyed portions have resulted in very imprecise abundance estimates.

This project envisions a comprehensive investigation of the current status of harbor porpoises in the Baltic, coupled with efforts to improve the prospects for population recovery in the region. Novel, mainly acoustic, approaches to determining where and when porpoises are present, and obtaining indices of their relative abundance, are already being developed and tested (e.g., Chappell *et al.* 1996; Gordon *et al.* 1998), and these should continue. In addition, there is a need to obtain credible estimates of bycatch in fisheries, or at least to ascertain which fisheries within the Baltic are likely to represent the greatest risk to porpoises. Approaches to reducing bycatch, such as the use of acoustic deterrents, time/area closures, and changes in gear, need to be developed jointly by regulatory agencies, the fishing industry, and technical experts. Other potential threats must also be investigated, notably the possibility that toxic chemical contamination has contributed to the decline of porpoises in the Baltic, and factors such as diminished food supplies or changed ecological conditions in key areas of former distribution. A long-awaited recovery plan for Baltic Sea harbor porpoises has been developed under ASCOBANS and provides a blueprint for required research and management measures.

52. Assess the status of bowhead whales between East Greenland and Russia and identify threats to their survival and recovery

Bowhead whales in waters between eastern Greenland and the central Russian Arctic were the first of their species to be subjected to intensive commercial exploitation. Historical research suggests that this was the largest of the five "stocks" of bowheads prior to commercial exploitation, perhaps numbering at least 25,000 (Woodby and Botkin 1993) and possibly as many as 46,000 (Hacquebord 2001) in the early 1600s. A recent qualitative assessment of the status of the Spitsbergen (or Svalbard) stock, as this population is generally known (also known in the IUCN Red List as the Svalbard-Barents Sea stock, classified in 2000 as Critically Endangered, based on the 1996 categories and criteria), judged it to be a "severely depleted remnant" (Zeh *et al.* 1993). Although some authors have continued to claim that the Spitsbergen stock is biologically extinct (Hacquebord 2001), recent observations of small numbers of bowheads, including calves, near Franz Josef Land (Wiig 1991) and Svalbard (N. Øien in IWC 2000d) indicate that the species still occurs within the stock's area of distribution. The degree to which the whales in this region are genetically distinct from those to the west (Davis Strait and Baffin Bay) and east (Chukchi Sea) is uncertain.

This project could take one of two forms, depending on the availability of human and financial resources. One option would be to promote coordination among institutions and programs to optimize the possibilities of obtaining useful quantitative information on Spitsbergen bowheads during the course of biological and environmental research in the Eurasian Arctic. Most observations of Spitsbergen bowheads over the last half-century have been opportunistic rather than the result of dedicated searches (Moore and Reeves 1993). While this situation may need to continue in view of the costs of mounting dedicated surveys for bowheads, the establishment of a program of bowhead research centered in Russia or Norway (preferably with international support and participation) would represent progress. A second option would be to conduct a series of dedicated field surveys in areas of known or expected occurrence. Such surveys should be stratified, at least in part, on the basis of historical catch and sighting data, and they should include protocols for obtaining high-quality photographs and biopsies. Either of the options could be organized under the auspices of an existing international or regional body, e.g., the IWC, NAMMCO (North Atlantic Marine Mammal Commission) or ICES (International Council for the Exploration of the Sea). Important components of the program should be to evaluate stock discreteness, identify threats, and bring results to the attention of appropriate national and international agencies. Existing plans to analyze recently collected biopsy samples and archaeological remains (e.g., Rosenbaum *et al.* 2001a) should improve understanding of population identity and stock discreteness.

5.5 North America

The role of the Cetacean Specialist Group (CSG) in North America (here considered to include only the United States and Canada) has traditionally been extremely limited for a simple reason: cetacean conservation is a high priority in both countries (especially the United States), and there is a relatively strong institutional capacity to identify and address threats to cetaceans. The few Action Plan projects in North America should not be interpreted to mean that there are no serious problems there. Right whales in the North Atlantic and North Pacific are highly endangered. Fishery bycatch is a major problem for some populations of small cetaceans on both the east and west coasts. In the Arctic, ongoing hunts for belugas, narwhals, and bowheads are of great concern, having led to the near-extirpation of some local populations (e.g., belugas in Cook Inlet, Alaska, and in Ungava Bay, Canada).

The 1994 Cetacean Action Plan included a project to locate an additional "nursery" for right whales in the western North Atlantic. Although no such area has yet been identified, this problem is being addressed along with many others facing this whale population (e.g., Right Whale Recovery Team 2000; IWC 2001b). No North America-based right whale projects are included in the present Action Plan, but it is important to re-emphasize that the CSG considers Northern Hemisphere right whales to be among the highest priorities for conservation research and action.

Projects

53. Promote intensive field research on bowhead whales in the eastern Canadian Arctic

Canada does not belong to the IWC, and hunting of bowhead whales in the eastern Canadian Arctic was resumed in 1996 with the official sanction of the Canadian government. The two whale populations being hunted are classified in the IUCN Red List as Vulnerable (Hudson Bay/Foxe Basin stock) and Endangered (Davis Strait/Baffin Bay stock). There are clearly different views of the risks associated with exploitation of these populations (e.g., Department of Fisheries and Oceans 1999; Finley 2001), and the IWC has repeatedly expressed displeasure with the fact that the Canadian hunt is continuing without the benefit of international scientific assessments and advice (e.g., IWC 1999c, p.49; 2000e, p.55; 2001e, p.55). The reasoning used by Canada to set quotas on these stocks is based on the assumptions that: (a) the populations have increased since the 1920s; and (b) documented removals by hunting since the 1920s were sustainable and allowed for continued growth in the whale populations. Thus, allowable takes of one whale every three years in Hudson Bay/Foxe Basin and one every 13 years in Davis Strait/Baffin Bay are considered to represent annual removal rates of 0.2% for the current Hudson Bay/Foxe Basin stock and 0.02% for the current Davis Strait/Baffin Bay stock (IWC 2001f, p.171). These assumptions and numerical estimates have never been subjected to a rigorous review in an international scientific forum.

The purpose of this project is to encourage more intensive research on bowhead whales in eastern Canadian and western Greenland waters (the Davis Strait/Baffin Bay stock moves between the two countries). It is important that initial efforts to estimate abundance (Cosens *et al.*1997; Cosens and Innes 2000) and determine the genetic distinctiveness of whales in the two stock areas (Maiers *et al.* 2001; Rosenbaum *et al.* 2001a) be continued and expanded, and that factors potentially relevant to conservation, in addition to deliberate removals by whaling, be thoroughly examined. Moreover, it is important that results of the research that forms the basis for hunt management be subjected to peer scrutiny, and that Canada's management regime for these stocks be risk-averse.

54. Investigate the status of narwhal populations subject to hunting, and ensure that regulations are adequate for conservation

Narwhals have been hunted by northern residents of Canada and Greenland for hundreds of years, for both food and cash income. Over the last few decades, concern has been raised periodically about the possibility that this hunting has been too intense, influenced by the increasing demand for tusk ivory in world markets and for maktaq (whale skin) in native communities (Reeves 1993; Heide-Jørgensen 1994; Reeves and Heide-Jørgensen 1994). Two recent scientific assessments of the status of narwhal populations (NAMMCO 2000b; IWC 2000a) emphasized the uncertainty surrounding stock identity in particular, and expressed concern that annual takes from local stocks could exceed the replacement yield. They also pointed out the inadequacy of documentation of catch levels and hunting loss. The government of Canada recently abandoned a settlement quota scheme that had been in place for more than 20 years, so there is now no limit on the numbers of narwhals that can be killed in either Greenland or Canada.

This project calls for continued and expanded programs of monitoring and research in Canada and Greenland. It is necessary to improve documentation of catch and hunting loss, develop a better understanding of stock identity, and increase the accuracy and precision of abundance estimates for populations subject to intensive hunting. It is also important to investigate the factors that influence hunting, such as the cash value of products, demographic changes within hunting and consuming communities, market factors, hunt technology, and governmental regulations. Conservation policies in both Canada and Greenland need to be aligned with scientific knowledge about narwhals, and this must include recognition and incorporation of uncertainty into estimates of abundance, life history parameters, and removals by hunting (i.e., not only whales killed and secured, but also those that are wounded or killed and lost).

5.6 Topical projects

55. Promote increased consideration of freshwater cetaceans in water development projects

Much progress has been made since 1988, when an earlier version of this project was presented in the first IUCN Cetacean Action Plan. A workshop on the effects of water development on river cetaceans, organized by the CSG, took place in Bangladesh in 1997, and one of the outputs was a set of principles and guidelines (Smith and Reeves 2000b) for water development projects. These have been disseminated widely among water development agencies and the cetacean conservation community and are summarized in Chapter 3 ("Reducing the Effects of Water Development on Freshwater-Dependent Cetaceans"). Two related projects from the previous plan have also been implemented: "Assess the realized and potential effects of the Flood Action Plan on river dolphins in Bangladesh" (Smith *et al.* 1998) and "Investigate ways of restoring river dolphin habitat in the vicinity of Farakka Barrage, India" (Sinha 2000). In addition, Smith *et al.* (2000) compiled a register of water development projects affecting river cetaceans in Asia, and Liu *et al.* (2000) and Ahmed (2000) reviewed the effects of water development on river cetaceans in the Yangtze River of China and the southern rivers in Bangladesh, respectively.

Although there is generally an increasing awareness and greater concern about environmental impacts on the part of international financial institutions (e.g., World Commission on Dams 2000), range states continue to pursue water "megaprojects"on their own (e.g., Three Gorges Dam in China) or with funding and technical assistance from private corporations (e.g., recently suspended plans by the US-based Enron Corporation to finance construction of a high dam in the Karnali River, Nepal). This trend toward privatization of infrastructure projects opens the possibility that development will proceed without the environmental scrutiny or mitigation measures required for projects funded by international financial institutions. Megaprojects are not the only problem. Habitat degradation and fragmentation from multiple small projects (e.g., approximately 1800 floodgates and culverts have been constructed since 1949 in the Yangtze River)(Liu *et al.* 2000) and interrupted migrations and dispersal of dolphins and their prey caused by multiple gated dams (Reeves and Smith 1999) pose serious problems for freshwater cetaceans in Asia. Thus, the following sub-projects are needed: (a) monitor plans for new water developments in Asia and South America; (b) prepare a register of water development projects affecting South American freshwater cetaceans (Project 23, above); (c) document the effects of projects that are already built or are currently being constructed; and (d) provide advice to governments, NGOs, and IGOs on the potential ecological effects of water development and on approaches to mitigation. The potential effects of water development on estuarine-dependent cetaceans (e.g., franciscana, humpbacked dolphins, Irrawaddy dolphin) also need to be evaluated. Collaboration with other SSC freshwater specialist groups should be promoted.

56. Investigate the feasibility of using a passive acoustic method to estimate abundance of freshwater cetaceans

Standard distance sampling methods used in surveys of marine cetaceans have rarely been used in surveys of freshwater cetaceans, at least partly because it is difficult or impossible to: (a) follow systematic or random transect lines given the complex morphology of floodplain rivers; (b) obtain unbiased samples from extremely clumped distributions (especially in view of the preceding problem); (c) define clusters (pods or groups) when animals exhibit no obvious social affiliations (at least for the "blind" river dolphins and perhaps the boto); and (d) detect animals that are often available to be sighted only for a split second as they surface (Smith and Reeves 2000c).

Freshwater cetaceans possess highly evolved echo-location abilities that allow them to inhabit turbid environments where vision is of little use. All three obligate river dolphin species produce ultrasonic (>20 kHz) echo-location clicks and burst pulses, and some produce lower-frequency whistles. Passive acoustic techniques take advantage of these vocalizations to detect and locate animals. Recently developed software algorithms have been used to determine bearings to dolphin clicks and whistles from a towed array (Thode *et al.* 2000; J. Barlow, pers. comm.). Detection ranges depend on both source (e.g., the power and frequency of vocalizations) and propagation characteristics (e.g., substrate type, water depth, and topography), which will be key considerations for evaluating the usefulness of acoustic survey techniques. Other important considerations are that surveys for freshwater cetaceans are generally conducted with extremely limited budgets, and local scientists are unlikely to have experience with acoustic equipment and techniques of analysis. An automated acoustic sampler has been used to detect finless porpoises in marine waters (Goold and Jefferson 2002). This system has the advantages of simplicity and economy. However, it does not give information on animal range, and other sounds in the environment that overlap in frequency could cause erroneous detections (false positives).

An acoustic approach should be considered as an alternative, or adjunct, to visual survey methods normally used for assessing freshwater cetacean abundance. A team of acoustics experts and cetacean biologists should collaborate to assess feasibility, and, if it appears promising, devise a low-cost, user-friendly system to integrate into visual surveys. This project is a methodological study that could be combined with one or more of the freshwater cetacean assessment projects described above (e.g., Projects 11, 13, 15).

57. Global review of interactions between cetaceans and longline fisheries

Most concern about interactions between cetaceans and fisheries has, appropriately, focused on passive net and trap fisheries, trawl fisheries, and large-scale purse-seining for tuna. Much less attention has been given to problems of interactions with longline fisheries. In fact, the use of longlines to replace gillnets has been considered as a way of reducing cetacean bycatch in Peru (Reyes and Oporto 1994). However, in recent years it has become increasingly evident that serious conflicts exist between longline fisheries and cetaceans, particularly sperm whales, killer whales, and false killer whales (Iwashita *et al.* 1963; Sivasubramanian 1964; Ohsumi 1972; Matkin and Saulitis 1994; Yano and Dahlheim 1995; Ashford *et al.* 1996; Secchi and Vaske 1998). Attempts at deterring whales from approaching and depredating longlines have been unsuccessful thus far (Reeves *et al.* 1996). Except in the case of "rolling-hooks" used in the Yangtze River (baiji and finless porpoise), there is no reason to believe that interactions with longline fisheries are causing sufficient incidental mortality to threaten the survival of any species or population of cetaceans. Nevertheless, such interactions appear to be increasing in both scope and scale. They clearly influence fishermen's attitudes toward cetaceans and lead to retaliatory measures. Some injury and incidental mortality of cetaceans occurs, but it is generally believed that these interactions cause greater harm to fisheries than to cetacean populations (references cited above). Chilean longline fishermen claim that sperm whales take or bite hooked Patagonian toothfish (*Dissostichus eleginoides*), a highly valuable commercial species, when the lines are hauled. Although fishery authorities have tended to treat this problem as insignificant, there are indications of retaliation by the fishermen against the sperm whales (G.P. Sanino and K. Van Waerebeek, pers. comm.).

The purpose of this project is to review the subject in a comprehensive manner, then rank specific fisheries and specific cetacean populations according to the seriousness or importance of the interactions from a conservation perspective. Potential means of resolving the conflicts need to be summarized and evaluated. The scope of the study should be broad enough to include the problem of ingestion of fish hooks, regardless of whether these hooks are from longlines or some other type of gear (e.g., cod "trawls")(Dong *et al.* 1996). In the case of the Chilean longline fishery, the dynamics of sperm whale interaction (e.g., frequency of occurrence, circumstances, and localities) and the correlated behavior of the whales need to be studied first-hand using sound and video recordings as supporting evidence. Some fishermen have expressed their willingness to collaborate with a research plan and would voluntarily accept observers on their boats in the hope for a solution.

Chapter 6

Recommended Conservation Action

The Cetacean Specialist Group has traditionally focused on developing and promoting research projects. Our chosen role has been to identify and characterize conservation problems, leaving advocacy groups, intergovernmental bodies, and government authorities with the tasks of developing, promoting, and implementing appropriate conservation measures. However, over the past 15 years it has become clear that, in certain cases, existing scientific evidence is sufficient to justify, or indeed require, immediate action. The CSG therefore decided to include here a number of recommendations that go beyond research. In these and other instances, we recognize that more and better data are desired, but in the meantime, there is a danger that the call for more science will allow authorities and decision-makers to postpone difficult choices that could be decisive in preventing extirpations or extinctions.

None of the recommendations included in this chapter are entirely new; most have been stated in other fora. Members of the CSG participate routinely in a wide variety of advisory bodies, research institutions, and, occasionally, management agencies. Therefore, the membership has often contributed, albeit in other contexts, to the formulation of management advice. The recommendations included here are far from exhaustive. It represents little more than a first step in calling attention to a sample of the most pressing actions needed to conserve cetacean species and populations (Figure 34).

Figure 34. The Northern Hemisphere right whales (*Eubalaena glacialis* in the North Atlantic, *E. japonica* in the North Pacific) were nearly exterminated by commercial whaling, and they are the most endangered species of large whales. Although fully protected from whaling, their existence is now threatened by ship strikes and entanglement in fishing gear. Also, the demographic and genetic effects of small population size may be inhibiting their recovery. This breaching right whale is one of about 300–350 that migrate along the east coast of North America, from wintering areas between Cape Cod and Florida to summer feeding grounds off south-eastern Canada and across the rim of the North Atlantic to Iceland and, at least occasionally, Norway. *Photo: Stephanie Martin, courtesy of New England Aquarium.*

Figure 35. Qi Qi, the only baiji in captivity and one of the few surviving representatives of this Critically Endangered species, died in his tank at the Wuhan Institute of Hydrobiology in 2002. Earlier hope that the species might be rescued by an *ex-situ* breeding program has waned, and much of the attention of Chinese scientists and conservationists has shifted to the sympatric freshwater population of finless porpoises. *Photo: Steve Leatherwood, 7 March 1995.*

6.1 Species

Baiji, or Yangtze river dolphin

History: The baiji, or Yangtze River dolphin, is the most endangered cetacean (Figure 35). It is likely to become extinct in the near future. Recommendations in the 1988–1992 Cetacean Action Plan were that anthropogenic mortality (by entanglement in fishing gear and collisions with vessels) be reduced, baseline studies for a "semi-natural reserve" at Shishou be carried out, the population be monitored, and movements and population structure be investigated through the use of tags and natural marks. The baseline studies for the reserve were initiated, and population surveys were carried out, although their reliability remains in question (Ellis *et al.* 1993; Zhou *et al.* 1994; Leatherwood and Reeves 1994). The studies of movements were marginally successful and not conclusive. Extensive surveys of the entire range between 1997 and 1999, using up to 53 vessels, sighted only 21–23 dolphins, including one calf (Zhang *et al.* 2001). Although some animals may have been missed by the survey teams, it is very likely that less than a hundred dolphins, and possibly only a few tens, survive in the Yangtze. It is also noteworthy that the sighting rate over the three years of surveys declined at an annual rate of about 10% (Zhang *et al.* 2001).

In 1994, the CSG and others urged that all surviving dolphins in the wild be brought into a "semi-natural reserve" to establish a captive breeding population, but only after removal of finless porpoises from the reserve (Zhou *et al.* 1994; Reeves and Leatherwood 1994a). The Chinese government began the capture and translocation program, but despite extensive efforts, only one dolphin was captured and placed in the reserve (together with finless porpoises). This animal died in 1996 of causes that remain unclear (Perrin 1999). Many recent deaths of dolphins in the wild (5 of 12 documented in the 1990s) have been attributed to electrofishing, and this fishing method is now viewed as the most important threat to the species' survival (Zhang *et al.* 2001). Previously, the main cause of mortality was considered the use of a snagline fishing gear called "rolling hooks." Although at least some types of "rolling hooks" are illegal, their use continues within the limited remaining range of the baiji. Efforts are underway to end electrofishing within the baiji's range (D. Wang, pers. comm.).

Remaining issues: The "semi-natural reserve" initiative has apparently failed, although the concept is still alive in conservation circles in China, and progress has been made in improving the reserve by replacement of net barriers with earthen dams and elimination of fishing (Zhang *et al.* 2001). Extinction seems inevitable in the absence of effective protection of the baiji in its wild habitat.

Conservation recommendations: Without a safe and efficient relocation program that would place the few remaining dolphins in a suitable "semi-natural reserve", no further research projects are recommended at the present time. The baiji's dire situation has been well documented from a scientific standpoint, and its fate now depends entirely upon management and conservation action that must be taken by the people and government of China. Due to the low density of dolphins in the river, large investments of time and money in additional surveys to estimate abundance are probably not warranted. Instead, the CSG **recommends** that available resources be devoted to eliminating the known threats to the survival of this species in its natural habitat. The CSG specifically **recommends** that immediate action be taken at the national, provincial, and local levels in China to fully enforce the ban on the use of "rolling hooks" and to end electrofishing. We recognize that, in parallel with these bans, programs may be needed to improve the economic outcomes of fishing (e.g., through support for alternative fishing gear that poses no risk to the baiji). Even if these efforts fail to prevent the baiji's extinction, they are warranted on behalf of the Yangtze population of finless porpoises, which is also affected by these types of fishing.

The CSG **strongly recommends** that *if the Chinese government elects to continue the effort to translocate remaining dolphins into the "semi-natural reserve,"* the following conditions be met (IWC 2001a):

- Capture operations be improved to prevent injury to the dolphins;
- Water quality in the reserve be rigorously monitored, with appropriate measures taken to ensure high standards; and
- The finless porpoises be removed from the reserve to prevent any possible disadvantageous ecological or behavioral interactions with the dolphins.

Vaquita, or Gulf of California porpoise

History: When the first Cetacean Action Plan was published in 1988, the vaquita's status was uncertain and it was classified in the IUCN Red List as Vulnerable (Figure 36). The only Action Plan recommendation at that time was to monitor the incidental catch of vaquitas in local fisheries (Perrin 1988). In 1991, on the recommendation of the IWC's Scientific Committee, the vaquita's Red List status was revised from Vulnerable to Endangered (Klinowska 1991). In 1992, President Carlos Salinas of Mexico created the "Comité Técnico para la Preservación de la Totoaba y la Vaquita" (Technical Committee for the Preservation of the Totoaba [an endangered sciaenid fish] and Vaquita). Prof. Bernardo Villa Ramírez, the leader of this group, developed a recovery plan for the vaquita that included broad-reaching recommendations to monitor fishery bycatch, stop illegal fishing for and export of totoabas, evaluate habitat issues, estimate population size and trends, and coordinate local, state, federal and international recovery efforts (Villa Ramírez 1993). On 10 June 1993, the Government of Mexico established the Biosphere Reserve of the Upper Gulf of California and Colorado River Delta, in large part to protect the habitat of vaquitas and totoabas. The management plan for this reserve called for a ban on commercial fishing in its "nuclear zone."

The 1994 Cetacean Action Plan described the vaquita as "the most critically endangered marine cetacean" but added no new vaquita projects, on the understanding that the Mexican navy was helping to enforce the ban on the use of large-mesh gillnets for totoabas in the northern Gulf of California and that fishing activities within the vaquita's range were being effectively monitored (Reeves and Leatherwood 1994a). The earlier Action Plan recommendation for monitoring gillnet fisheries in the northern Gulf of California was carried out from 1993 to 1995 and revealed that all gillnets used in the upper Gulf (mesh sizes of 7–20 cm) were catching vaquitas and that the bycatch in small-mesh gillnets (including those for shrimp and chano (*Micropogonias megalops*)) was sufficient, by itself, to threaten the survival of the species (previously, large-mesh gillnets had been believed to be the primary threat)

Figure 36. Vaquitas that were captured and killed accidentally during "experimental" gillnet fishing to assess the population status of totoabas (*Totoaba macdonaldi*) near El Golfo de Santa Clara, Sonora, Gulf of California, Mexico (Brownell *et al.* 1987). *Photo: Alejandro Robles.*

(D'Agrosa 1995; D'Agrosa *et al.* 2000). At its 1994 annual meeting, the IWC's Scientific Committee commended the Government of Mexico for its efforts and made three major recommendations: (a) to monitor fishing activities and bycatch throughout the vaquita's range; (b) to conduct a complete survey of vaquita abundance; and (c) to take immediate action to eliminate incidental catches of vaquitas (IWC 1995). In 1996, the vaquita was one of two cetacean species (along with the baiji) listed by IUCN as Critically Endangered (Baillie and Groombridge 1996).

Surveys between 1986 and 1993 indicated that there were only a few hundred vaquitas left (Barlow *et al.* 1997). Soon after these results became known, the Government of Mexico convened an international panel of experts to form a recovery team – El Comité Internacional para la Recuperación de la Vaquita (the International Committee for the Recovery of the Vaquita), generally known as CIRVA. This group met in January 1997 and February 1999 to develop recommendations to promote the recovery of the species. At its first meeting, CIRVA recommended that a new, more nearly complete abundance survey should be undertaken. As a direct result of this recommendation, a joint Mexico/US survey was carried out later in 1997, confirming that the entire population numbered in the hundreds of individuals (probably fewer than 600) (Jaramillo-Legorreta *et al.* 1999). Also at its first meeting, CIRVA reviewed risk factors affecting vaquitas and concluded that fishery bycatch represented the greatest and most immediate threat. Although loss of fresh water and associated nutrient input from the Colorado River was not viewed as an immediate threat to the species (Rojas-Bracho and Taylor 1999), long-term changes in vaquita habitat were identified as a concern that must be investigated. CIRVA's 1999 recommendations were that: (a) vaquita bycatch be reduced to zero as soon as possible; (b) the southern boundary of the

Biosphere Reserve be expanded to incorporate the known range of the vaquita; (c) gillnets and trawlers be phased out in the entire Biosphere Reserve; (d) effective enforcement of fishing regulations begin immediately; (e) acoustic surveys for vaquitas be initiated; (f) research on alternative gear types be started; (g) public outreach and education be developed; (h) consideration be given to the compensation of fishermen for lost income; (i) research be initiated on vaquita habitat; and (j) international and non-governmental cooperation be fostered (Rojas-Bracho and Jaramillo-Legorreta 2002). At its second meeting, CIRVA analyzed potential mitigation alternatives (e.g., pingers, season and area closures) and concluded that banning gillnets in the entire range of the species was the single measure most likely to prevent extinction. Much additional information on vaquitas and their risk factors has been published in recent years (Rojas-Bracho and Taylor 1999; Rosel and Rojas-Bracho 1999; Taylor and Rojas-Bracho 1999). In 2000, the Joint Initiative for the Gulf of California was developed by a coalition of World Wildlife Fund (WWF-Mexico), Conservation International (CI-Mexico), and other NGOs. Under this initiative, WWF organized and hosted a meeting of collaborators (working with CIRVA) to promote vaquita conservation. A working group was established to develop a strategy to promote vaquita recovery based on CIRVA's recommendations. This group is currently working to ensure that these recommendations are followed.

Remaining issues: Notwithstanding the progress outlined above, the vaquita remains Critically Endangered. It appears certain that unless anthropogenic sources of mortality are eliminated, the species will not survive much longer. Bycatch remains the single biggest issue, and fishing with gillnets (that are known to take vaquitas) has not been eliminated from the porpoise's distribution range. It is now widely recognized that the "nuclear zone" of the Biosphere Reserve has no overlap with the core area of vaquita abundance and that almost half of all vaquitas are entirely outside the reserve at any one time. A ban on gillnet fishing in the nuclear zone or even in the whole of the Biosphere Reserve is not likely to be sufficient to ensure the survival of the species. Furthermore, it is clear that fishing with gillnets is continuing even in the nuclear zone where it is prohibited, indicating that enforcement is a major problem that needs immediate attention.

Conservation recommendations: The CSG **recommends** that immediate actions be taken to prevent the extinction of the vaquita. Specific needed actions fall within the recommendations already developed by other groups (for summaries, IWC 2000a, 2001a). We emphasize three points, as follows:

- Fishing methods that result in bycatch of vaquitas should be eliminated throughout the range of the species.
- Fishery monitoring and enforcement should be initiated and maintained to ensure that the risks to vaquitas are reduced.
- Monitoring of the vaquita population should be initiated with the goal of detecting trends in abundance (recovery or further declines) over a long time period (decades). Another ship survey will not be sufficient because variances in abundance estimates are too great (Taylor and Gerrodette 1993). A new, more cost-effective method (such as acoustic surveys) is needed to detect trends in the abundance of this rare species.

To ensure the long-term success of conservation efforts, socio-economic alternatives will be needed for the people whose incomes are affected by restrictions on gillnet (and other) fisheries in the upper Gulf of California.

Franciscana

History: The franciscana has been subject to incidental mortality in gillnets along the coasts of Brazil, Uruguay, and Argentina for more than 50 years. Although no meaningful survey data on the abundance of franciscanas were available until recently (Secchi *et al.* 2001a), the scale of observed and estimated mortality has been sufficiently high to cause great concern about their conservation status (e.g., references cited in Chapter 4). South American experts who have met at regular intervals since 1986 to consider the species' research and conservation needs have concluded that catch rates in at least some areas are unsustainable. Recent modeling studies have indicated that the franciscana stock off southern Brazil and Uruguay (Secchi *et al.* in press a) is declining due to the unsustainable levels of bycatch (Secchi 1999; Secchi *et al.* 2001b, in press b; Kinas 2002). Studies of stranding rates provide additional evidence (Pinedo and Polacheck 1999). The franciscana may be at greater risk of extinction than any other cetacean species in the western South Atlantic.

Key issue: There is no doubt that the greatest immediate requirement for franciscana conservation is to reduce levels of incidental mortality in gillnets.

Conservation recommendations: Because of the difficulty and cost of conducting surveys of franciscanas, and of obtaining rigorous estimates of bycatch mortality in the small-scale, artisanal gillnet fisheries thought to be responsible for most of the mortality in some areas, it is unlikely that the scientific argument for precautionary management can be made much stronger in the near future than it is now. Due to the past efforts of scientists from Brazil, Uruguay, and Argentina, the existing evidence is sufficient to justify management action, with the proviso that efforts to delineate stock boundaries, assess abundance, and quantify bycatch mortality continue and, if possible, be expanded. The CSG **urges** management authorities to implement measures to reduce franciscana mortality. The following approaches are **recommended**:

- Modify fishing gear and practices, e.g., by forcing changes in fishing areas, reducing the total fishing effort, imposing spatial and/or temporal fishing closures, or introducing alternative fishing methods. Such modifications may be pursued not only to reduce franciscana mortality, but also to conserve economically valuable fish stocks that are depleted or rapidly declining. Government agencies, the fishing industry, fishery and marine mammal biologists, and representatives of local fishing communities will need to work together to design and promote appropriate conservation measures in particular areas.

- Existing fishery regulations should be enforced, and additional regulations considered. Some fish stocks have declined because of inadequate policing; for example, extensive trawling close to shore has had a large impact on benthic fauna and on juveniles of target fish species (some of which are important prey of franciscanas). One regulatory approach might be to impose limits on the allowable length of gillnets. For example, in Rio Grande do Sul, southern Brazil, the coastal gillnet fleet (about 175 boats) uses nets with an average length of 5–6km (some boats use nets more than 10km long). Lowering the allowable net size could bring benefits both to franciscanas and to fish stocks.
- While acoustic deterrents ("pingers") have the potential to contribute to bycatch mitigation, it is essential that their effectiveness be demonstrated through controlled scientific experimentation **before** their widespread use in fisheries is authorized (Bordino *et al.* 2002), and that such use is monitored to confirm continuing effectiveness and to detect unforeseen consequences. This applies equally to other gear changes and alternative fishing methods.
- The people of the region should be made aware of the risks that gillnet fishing poses to the franciscana, and of the ways in which the conservation of franciscanas might be related to that of more general marine resource conservation, including valued teleost and elasmobranch stocks. Education programs in schools are one obvious mechanism, but broader efforts to publicize the franciscana's existence, as well as its vulnerability to bycatch, may be appropriate.
- The three range States should engage in discussions aimed at an agreement for bilateral or trilateral management for conservation of franciscanas. The species is migratory, as defined by the Bonn Convention, and its ecosystem is influenced by factors within the jurisdictions of more than one state (e.g., river runoff). The concept of shared responsibility for franciscana conservation among the three range states is viewed by the CSG as a priority.

Hector's dolphin

History: Hector's dolphin is endemic to New Zealand, where there are at least four genetically distinct populations (Pichler *et al.* 1998; Pichler and Baker 2000) and evidence of additional local populations with very limited dispersal (Martien *et al.* 1999). The total size of all populations is estimated at around 7400, with 7270 (CV 16.2%) distributed around South Island (Slooten *et al.* 2002) and some 100 individuals off the west coast of North Island (Russell 1999). The species is listed as Endangered and the North Island population as Critically Endangered.

Hector's dolphins have been by-caught in gillnets throughout most of their range since gillnetting became widespread in New Zealand waters in the early 1970s (Dawson 1991; Slooten and Lad 1991; Taylor 1992). Based on the best estimate of maximum population growth rate ($\lambda_{max} = 1.018$) (Slooten and Lad 1991), gillnet mortality is anticipated to cause continuing declines in all of the populations (Martien *et al.* 1999). The Banks Peninsula Marine Mammal Sanctuary was created in 1988 to reduce bycatch off the Canterbury coastline on the east side of the South Island. Independent observers were first placed on gillnet vessels fishing north and south of Banks Peninsula during the 1997–1998 season. The estimated bycatch by commercial gillnetting vessels during that season was 16 Hector's dolphins (CV 39%) (Baird and Bradford 2000). These were caught outside the sanctuary in an area with an estimated 300 Hector's dolphins (CV 36.5%)(Du Fresne *et al.* 2001). While there are no quantitative estimates, several dolphins are killed each year in recreational gillnets, and there are at least occasional catches in trawl nets (Baird and Bradford 2000). The commercial gillnet fishery, on its own, seriously threatens local populations (Martien *et al.* 1999; Slooten *et al.* 2000).

In view of continued recreational and commercial bycatch north and south of the sanctuary (Baird and Bradford 2000) and continued low survival rates (Slooten *et al.* 2000), regulations were recently introduced to prohibit recreational gillnetting along the Canterbury coastline from 1 October to 31 March. Commercial fishermen have developed a voluntary code of practice (COP) for reducing bycatch in the Canterbury area, as an interim measure while a management plan for the species is prepared. Acoustic deterrents ("pingers"), specially developed for Hector's dolphin based on field studies of this species (Stone *et al.* 2000), are being used by Canterbury gillnet fishermen as part of the COP. Although there have been no reports of catches of Hector's dolphins in any of these fishermen's nets (G. Stone, pers. comm.), the fishery is too small for a statistically robust study of effectiveness to be carried out (cf. Dawson *et al.* 1998). Therefore, uncertainty remains concerning the effectiveness of pingers and other components of the COP.

Even in the absence of human impacts, the North Island population of Hector's dolphins may be vulnerable to extinction for decades because it has been reduced to such a low level (Martien *et al.* 1999; Dawson *et al.* 2001). A meeting of fishermen, conservation groups, scientists, and government officials concluded in May 2000 that mortality due to human activities must be reduced to zero to allow the

North Island population to recover. In August 2001, the New Zealand Minister of Fisheries created a protected area that prohibits amateur and commercial gillnet fishing within four nautical miles of shore along a 400km segment of the west coast of the North Island. The boundaries of this protected area are very close to those recommended by Dawson *et al.* (2001). An observer program is also planned for trawlers and Danish seine vessels fishing in the area closed to gillnetting.

Remaining issues: Progress has been made in protecting Hector's dolphins in two areas – Banks Peninsula and the North Island west coast. However, bycatch continues throughout most of the species' range. The greatest immediate requirement for Hector's dolphin conservation is to reduce mortality in gillnets to sustainable levels. Additional threats unrelated to fishing include tourist interactions and ship-strikes in high density/sensitive habitat (e.g., Stone and Yoshinaga 2000; Nichols *et al.* 2001).

The management measures described above go a long way toward minimizing human impacts on the North Island Hector's dolphin population, but they will not eliminate mortality or necessarily reduce it to sustainable levels. There are two important gaps: (a) trawling and seining are still allowed inside the protected areas, and (b) gillnetting is allowed to continue inside the harbors and bays on the North Island west coast (e.g., Kaipara, Hokianga, Kawhia). Hector's dolphins have been sighted in most of these latter areas, and trawling is known to entangle Hector's dolphins occasionally.

Conservation recommendations: The CSG **urges** management authorities to implement the following, with the goals of reducing gillnet entanglement and other sources of human-caused mortality to sustainable levels throughout the species' range, and eliminating human-caused mortality for the North Island population so that it can recover rapidly to a viable level:

- In areas with seriously threatened populations (e.g., North Island west coast) allow fishing only with methods known not to catch Hector's dolphins (e.g., replace gillnetting or trawling with line fishing) and work toward reducing pollution, boat strikes, and other known and potential threats.
- Increase the size of existing protected areas. In particular, include the harbors and bays in the North Island sanctuary and extend the offshore boundaries of both sanctuaries.
- Implement a statistically robust observer program throughout the species' range, to verify whether and when bycatch has been reduced to sustainable levels.
- Continue to monitor abundance and distribution of Hector's dolphins and study their movements and population structure to assess exposure to threats and the effectiveness of management efforts.

6.2 Geographical populations

Irrawaddy dolphins in the Mahakam River, Indonesia

History: The population of Irrawaddy dolphins in the Mahakam River was recently listed as Critically Endangered, based on surveys in 1999 and 2000 that estimated the population of mature individuals to be fewer than 50 (Kreb 2002). Between 1995 and 2001, at least 37 dolphins died, primarily from entanglement in gillnets, but also from vessel collisions and illegal hunting (D. Kreb, pers. comm.; Kreb 2000). A proposal is being promoted to build an aquarium in the provincial capital, Tenggarong, and to stock it with dolphins from the Mahakam. This dolphin population is further threatened by a recent increase of large coal-carrying ships transiting through the core area of their distribution (D. Kreb, pers. comm.). Such boats occupy over three-quarters of the river's width and therefore force prey fish into shallow areas that are seasonally inaccessible to the dolphins. The vessels also affect dolphin movements and often collide with the tree-lined banks, causing extensive damage to root systems where fish lay eggs.

Management issues and conservation progress: Irrawaddy dolphins are protected from killing and live-capture according to Indonesian law, but monitoring and enforcement are minimal. There is also little enforcement of laws against destructive fishing methods (e.g., the use of electricity and poisons) and the logging of riparian forests, which causes sedimentation and destroys fish spawning sites. In early 2001, a local NGO, the Conservation Foundation for the Protection of Rare Aquatic Species of Indonesia (*Yayasan Konservasi RASI*), together with conservation authorities of the East Kalimantan government, initiated the Pesut Mahakam Conservation Program. The primary aims of this community-based program are to establish effective protection for dolphins in their core habitat and to create an informed and concerned constituency to support dolphin conservation.

Conservation recommendations: While stressing the importance of population monitoring and further evaluation of threats (Project 1, Chapter 5), the CSG **recommends** that:

- Immediate action be taken to eliminate or drastically reduce human-caused mortality. At a minimum, alternative employment options for gillnet fishermen should be promoted so that accidental killing is reduced (IWC 2001a). Regulations that prohibit the intentional killing of dolphins, destructive fishing methods, and the logging of riparian forests should also be enforced. This will require the development of a reporting network among local villagers so that authorities become aware of infractions in a timely manner and can take appropriate action.
- Permanent removals for captive display facilities have the same effect as hunting or bycatch on the dolphin

population. Therefore, no exceptions should be allowed to the national law that prohibits dolphin captures (IWC 2001a).

- Because of concern about the habitat degradation and physical displacement of dolphins and their prey caused by large coal-carrying ships, alternative means of coal transport, such as smaller, less destructive barges, should be employed.

Irrawaddy dolphins in Malampaya Sound, Philippines

History: A geographically isolated population of Irrawaddy dolphins was recently discovered at the head of Malampaya Sound, Palawan, Philippines (Dolar *et al.* 2002). Line-transect surveys conducted in 2001, as part of the WWF-Philippines Malampaya Sound Ecological Studies Project, estimated that the total population consists of 77 individuals (CV 27.4%) confined to a 133km^2 area in the inner sound (Smith, unpublished data). Between February and August 2001, researchers from the same project confirmed that two dolphins were accidentally killed in bottom-set nylon gillnets used to catch crabs (called *matang quatro* nets locally). They also received reports from local fishermen that as many as three additional dolphins were killed in these nets during the same period. These findings strongly suggest that the Irrawaddy dolphin population in Malampaya Sound is in immediate danger of extinction due to low numbers, limited range, and high mortality. This is the only known population of the species in the Philippines, and the nearest area where another population of this coastal and riverine species is known to occur is in northern Borneo, some 550km to the south.

Fishermen in Malampaya Sound are generally poor, and the crab fishery provides substantial employment and income in an economically depressed region. This fishery requires little monetary investment and is therefore an attractive local employment option. It would be inadvisable to prohibit this fishing technique without providing alternatives that ensure an equal or greater income to the fishermen.

Conservation recommendations: Immediate action is needed to prevent the extirpation of Irrawaddy dolphins from Malampaya Sound. The CSG therefore **recommends** that dolphin mortality in the crab fishery be eliminated or at least drastically reduced. Similar to the situation of the vaquita, this will require action on the socio-economic front as well as assistance from cetacean and fishery scientists. The CSG therefore strongly **urges** that socio-economic alternatives be developed to help promote the conservation goal of reducing entanglement in *matang quatro* gillnets. In addition, we **emphasize** the need for long-term monitoring of dolphin abundance and mortality in Malampaya Sound (IWC 2001a).

Short-beaked common dolphins in the Mediterranean Sea

History: Historical literature, photographic documentation, and osteological collections indicate that the short-beaked common dolphin was once abundant in much of the Mediterranean Sea (Figure 37). However, the species has experienced a dramatic decline in numbers during the last few decades, and has almost completely disappeared from large portions of its former range, particularly in the central Mediterranean Sea (UNEP/IUCN 1994; Forcada and Hammond 1998). There is no overall abundance estimate for short-beaked common dolphins in the Mediterranean Sea. Line-transect surveys in 1991 and 1992 in the western basin found them to be abundant only in the Alboran Sea between southern Spain and Morocco (approx. 15,000 individuals in the south-western stratum)(Forcada 1995), while sighting frequencies in other western Mediterranean areas were very low (Forcada 1995; Forcada and Hammond 1998). Genetic studies indicate significant divergence between Mediterranean and Atlantic populations; genetic exchange seems to be limited to the Alboran Sea, possibly due to local oceanographic features (Natoli in press). There is also no evidence of significant movement through the narrow Dardanelles Strait between the Aegean and Marmara Seas. Despite growing interest in cetacean conservation, and the recent implementation of regional treaties and agreements (i.e., the Barcelona Convention Protocol on Specially

Figure 37. Short-beaked common dolphins, mother and calf, in the eastern Ionian Sea. The marked decline in abundance of common dolphins in the Mediterranean Sea is a conservation challenge. Immediate measures are needed to allow the species to recover, yet the causes of its decline in this region are not well understood.
Photo: Tethys Research Institute/Elena Politi.

Protected Areas and Mediterranean Biodiversity, and the CMS agreement on conservation of Mediterranean and Black Sea cetaceans mentioned in earlier chapters), little progress has been made toward understanding the causes of the short-beaked common dolphin's regional decline; and no concrete measures have been taken to arrest and reverse this trend.

Contamination by xenobiotics, such as PCBs, and a decrease in prey quality or availability have been implicated in the common dolphin's regional decline (Bearzi 2001; Politi and Bearzi in press; Fossi *et al.* in press). Indeed, it is possible that these factors have been acting synergistically, with the poor nutritional status of individuals prompting the mobilization of lipophilic contaminants that would otherwise be "stored" in their blubber. However, the relative importance of these and other factors is not understood, and it is therefore difficult to design and implement mitigation measures. Bycatch and intentional killing may have had an impact in some areas (e.g., Silvani *et al.* 1999), but these factors do not seem to have played a significant role in some of the Mediterranean areas where common dolphins have declined (e.g., in the northern Adriatic Sea)(Bearzi and Notarbartolo di Sciara 1995; Bearzi *et al.* 2001). Although the Mediterranean Sea represents less than 1% of the planet's water surface area, it hosts 15% of all commercial traffic and 30% of all hydrocarbon ship commerce. The impacts of overfishing and chemical pollution in the Mediterranean are extensive and relatively well documented (e.g., Stanners and Bourdeau 1995; FAO 1997; EAA/UNEP 2000).

Remaining issues: No specific management measures have been taken to protect the few remaining groups of common dolphins in the central and eastern Mediterranean even though it is well known that they are exposed to direct disturbance by vessel traffic, bycatch in fishing gear, and habitat degradation (e.g., chemical pollution, possibly prey depletion). Although the lack of scientific information is a serious problem in attempting to pinpoint and address specific threats, it does not justify continued inaction.

Conservation recommendations: In addition to **stressing** the importance of more research (Project 47, Chapter 5), the CSG **recommends** that a small number of pilot conservation and management projects be implemented immediately in selected areas where relict groups of common dolphins are known to reside. Two such areas could be waters adjacent to the island of Kalamos in Greece, and near the island of Ischia in Italy. Both areas are known to provide critical habitat for small populations of common dolphins. The dolphins around Kalamos have declined dramatically within the past eight years (Politi and Bearzi in press). The immediate establishment of protected areas should be accompanied by experimental management plans that include intensive monitoring of the dolphins, restrictions on vessel traffic and fishing activity, education efforts directed at the local fishing communities and recreational users, and focused research.

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Appendix 1

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Appendix 2

IUCN Red List Categories and Criteria Version 3.1

Prepared by the IUCN Species Survival Commission
As approved by the 51st meeting of the IUCN Council, Gland, Switzerland – 9 February 2000

I. Introduction

1. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk. However, while the Red List may focus attention on those taxa at the highest risk, it is not the sole means of setting priorities for conservation measures for their protection.

   Extensive consultation and testing in the development of the system strongly suggest that it is robust across most organisms. However, it should be noted that although the system places species into the threatened categories with a high degree of consistency, the criteria do not take into account the life histories of every species. Hence, in certain individual cases, the risk of extinction may be under- or over-estimated.

2. Before 1994 the more subjective threatened species categories used in IUCN Red Data Books and Red Lists had been in place, with some modification, for almost 30 years. Although the need to revise the categories had long been recognized (Fitter and Fitter 1987), the current phase of development only began in 1989 following a request from the IUCN Species Survival Commission (SSC) Steering Committee to develop a more objective approach. The IUCN Council adopted the new Red List system in 1994.

The IUCN Red List Categories and Criteria have several specific aims:

- to provide a system that can be applied consistently by different people;
- to improve objectivity by providing users with clear guidance on how to evaluate different factors which affect the risk of extinction;
- to provide a system which will facilitate comparisons across widely different taxa;
- to give people using threatened species lists a better understanding of how individual species were classified.

3. Since their adoption by IUCN Council in 1994, the IUCN Red List Categories have become widely recognized internationally, and they are now used in a range of publications and listings produced by IUCN, as well as by numerous governmental and non- governmental organizations. Such broad and extensive use revealed the need for a number of improvements, and SSC was mandated by the 1996 World Conservation Congress (WCC Res. 1.4) to conduct a review of the system (IUCN 1996). This document presents the revisions accepted by the IUCN Council.

The proposals presented in this document result from a continuing process of drafting, consultation and validation. The production of a large number of draft proposals has led to some confusion, especially as each draft has been used for classifying some set of species for conservation purposes. To clarify matters, and to open the way for modifications as and when they become necessary, a system for version numbering has been adopted as follows:

Version 1.0: Mace and Lande (1991)
The first paper discussing a new basis for the categories, and presenting numerical criteria especially relevant for large vertebrates.

Version 2.0: Mace *et al. (1992)*
A major revision of Version 1.0, including numerical criteria appropriate to all organisms and introducing the non-threatened categories.

Version 2.1: IUCN (1993)
Following an extensive consultation process within SSC, a number of changes were made to the details of the criteria, and fuller explanation of basic principles was included. A more explicit structure clarified the significance of the non-threatened categories.

Version 2.2: Mace and Stuart (1994)
Following further comments received and additional validation exercises, some minor changes to the criteria were made. In addition, the Susceptible category present in Versions 2.0 and 2.1 was subsumed into the Vulnerable category. A precautionary application of the system was emphasised.

Version 2.3: IUCN (1994)
IUCN Council adopted this version, which incorporated changes as a result of comments from IUCN members, in December 1994. The initial version of this document was published without the necessary bibliographic details, such as date of publication and ISBN number, but these were included in the subsequent reprints in 1998 and 1999. This version was used for the *1996 IUCN Red*

List of Threatened Animals (Baillie and Groombridge 1996), *The World List of Threatened Trees* (Oldfield *et al.* 1998) and the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000).

Version 3.0: IUCN/SSC Criteria Review Working Group (1999)

Following comments received, a series of workshops were convened to look at the IUCN Red List Criteria following which, changes were proposed affecting the criteria, the definitions of some key terms and the handling of uncertainty.

Version 3.1: IUCN (2001)

The IUCN Council adopted this latest version, which incorporated changes as a result of comments from the IUCN and SSC memberships and from a final meeting of the Criteria Review Working Group, in February 2000.

All new assessments from January 2001 should use the latest adopted version and cite the year of publication and version number.

4. In the rest of this document, the proposed system is outlined in several sections. Section II, the Preamble, presents basic information about the context and structure of the system, and the procedures that are to be followed in applying the criteria to species. Section III provides definitions of key terms used. Section IV presents the categories, while Section V details the quantitative criteria used for classification within the threatened categories. Annex I provides guidance on how to deal with uncertainty when applying the criteria; Annex II suggests a standard format for citing the Red List Categories and Criteria; and Annex III outlines the documentation requirements for taxa to be included on IUCN's global Red Lists. It is important for the effective functioning of the system that all sections are read and understood to ensure that the definitions and rules are followed. (**Note:** Annexes I, II and III will be updated on a regular basis.)

II. Preamble

The information in this section is intended to direct and facilitate the use and interpretation of the categories (Critically Endangered, Endangered, etc.), criteria (A to E), and subcriteria (1, 2, etc.; a, b, etc.; i, ii, etc.).

1. Taxonomic level and scope of the categorization process

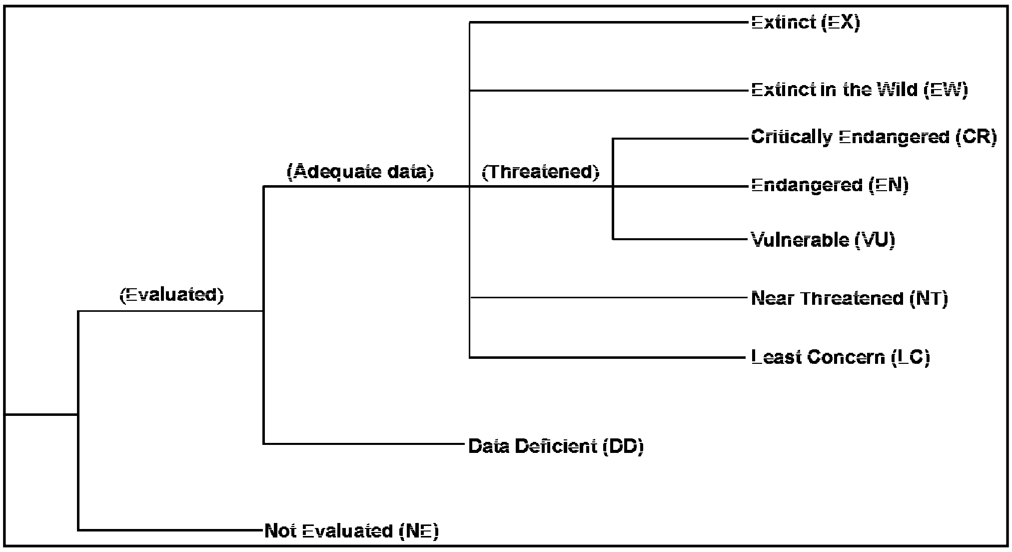
The criteria can be applied to any taxonomic unit at or below the species level. In the following information, definitions and criteria the term 'taxon' is used for convenience, and may represent species or lower taxonomic levels, including forms that are not yet formally described. There is sufficient range among the different criteria to enable the appropriate listing of taxa from the complete taxonomic spectrum, with the exception of micro-organisms. The criteria may also be applied within any specified geographical or political area, although in such cases special notice should be taken of point 14. In presenting the results of applying the criteria, the taxonomic unit and area under consideration should be specified in accordance with the documentation guidelines (see Annex 3). The categorization process should only be applied to wild populations inside their natural range, and to populations resulting from benign introductions. The latter are defined in the IUCN *Guidelines for Re-introductions* (IUCN 1998) as '...an attempt to establish a species, for the purpose of conservation, outside its recorded distribution, but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historic range'.

2. Nature of the categories

Extinction is a chance process. Thus, a listing in a higher extinction risk category implies a higher expectation of extinction, and over the time-frames specified more taxa listed in a higher category are expected to go extinct than those in a lower one (without effective conservation action). However, the persistence of some taxa in high-risk categories does not necessarily mean their initial assessment was inaccurate.

All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together these categories are described as 'threatened'. The threatened categories form a part of the overall scheme. It will be possible to place all taxa into one of the categories (see Figure 1).

Figure. 1 Structure of the Categories



3. Role of the different criteria

For listing as Critically Endangered, Endangered or Vulnerable there is a range of quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. Each taxon should be evaluated against all the criteria. Even though some criteria will be inappropriate for certain taxa (some taxa will never qualify under these however close to extinction they come), there should be criteria appropriate for assessing threat levels for any taxon. The relevant factor is whether *any one* criterion is met, not whether all are appropriate or all are met. Because it will never be clear in advance which criteria are appropriate for a particular taxon, each taxon should be evaluated against all the criteria, and *all* criteria met at the highest threat category must be listed.

4. Derivation of quantitative criteria

The different criteria (A-E) are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. The quantitative values presented in the various criteria associated with threatened categories were developed through wide consultation, and they are set at what are generally judged to be appropriate levels, even if no formal justification for these values exists. The levels for different criteria within categories were set independently but against a common standard. Broad consistency between them was sought.

5. Conservation actions in the listing process

The criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it. It is important to emphasise here that a taxon may require conservation action even if it is not listed as threatened. Conservation actions which may benefit the taxon are included as part of the documentation requirements (see Annex 3).

6. Data quality and the importance of inference and projection

The criteria are clearly quantitative in nature. However, the absence of high-quality data should not deter attempts at applying the criteria, as methods involving estimation, inference and projection are emphasised as being acceptable throughout. Inference and projection may be based on extrapolation of current or potential threats into the future (including their rate of change), or of factors related to population abundance or distribution (including dependence on other taxa), so long as these can reasonably be supported. Suspected or inferred patterns in the recent past, present or near future can be based on any of a series of related factors, and these factors should be specified as part of the documentation.

Taxa at risk from threats posed by future events of low probability but with severe consequences (catastrophes) should be identified by the criteria (e.g. small distributions, few locations). Some threats need to be identified particularly early, and appropriate actions taken, because their effects are irreversible or nearly so (e.g., pathogens, invasive organisms, hybridization).

7. Problems of scale

Classification based on the sizes of geographic ranges or the patterns of habitat occupancy is complicated by problems of spatial scale. The finer the scale at which the distributions or habitats of taxa are mapped, the smaller the area will be that they are found to occupy, and the less likely it will be that range estimates (at least for 'area of occupancy': see Definitions, point 10) exceed the thresholds specified in the criteria. Mapping at finer scales reveals more areas in which the taxon is unrecorded. Conversely, coarse-scale mapping reveals fewer unoccupied areas, resulting in range estimates that are more likely to exceed the thresholds for the threatened categories. The choice of scale at which range is estimated may thus, itself, influence the outcome of Red List assessments and could be a source of inconsistency and bias. It is impossible to provide any strict but general rules for mapping taxa or habitats; the most appropriate scale will depend on the taxon in question, and the origin and comprehensiveness of the distribution data.

8. Uncertainty

The data used to evaluate taxa against the criteria are often estimated with considerable uncertainty. Such uncertainty can arise from any one or all of the following three factors: natural variation, vagueness in the terms and definitions used, and measurement error. The way in which this uncertainty is handled can have a strong influence on the results of an evaluation. Details of methods recommended for handling uncertainty are included in Annex 1, and assessors are encouraged to read and follow these principles.

In general, when uncertainty leads to wide variation in the results of assessments, the range of possible outcomes should be specified. A single category must be chosen and the basis for the decision should be documented; it should be both precautionary and credible.

When data are very uncertain, the category of 'Data Deficient' may be assigned. However, in this case the assessor must provide documentation showing that this category has been assigned because data are inadequate to determine a threat category. It is important to recognize that taxa that are poorly known can often be assigned a threat category on the basis of background information concerning the deterioration of their habitat and/or other causal factors; therefore the liberal use of 'Data Deficient' is discouraged.

9. Implications of listing

Listing in the categories of Not Evaluated and Data Deficient indicates that no assessment of extinction risk has been made, though for different reasons. Until such time as an assessment is made, taxa listed in these categories should not be treated as if they were non-threatened. It may be appropriate (especially for Data Deficient forms) to give them the same degree of attention as threatened taxa, at least until their status can be assessed.

10. Documentation

All assessments should be documented. Threatened classifications should state the criteria and subcriteria that were met. No assessment can be accepted for the IUCN Red List as valid unless at least one criterion is given. If more than one criterion or subcriterion is met, then each should be listed. If a re-evaluation indicates that the documented criterion is no longer met, this should not result in automatic reassignment to a lower category of threat (downlisting). Instead, the taxon should be re-evaluated against all the criteria to clarify its status. The factors responsible for qualifying the taxon against the criteria, especially where inference and projection are used, should be documented (see Annexes 2 and 3). The documentation requirements for other categories are also specified in Annex 3.

11. Threats and priorities

The category of threat is not necessarily sufficient to determine priorities for conservation action. The category of threat simply provides an assessment of the extinction risk under current circumstances, whereas a system for assessing priorities for action will include numerous other factors concerning conservation action such as costs, logistics, chances of success, and other biological characteristics of the subject.

12. Re-evaluation

Re-evaluation of taxa against the criteria should be carried out at appropriate intervals. This is especially important for taxa listed under Near Threatened, Data Deficient and for threatened taxa whose status is known or suspected to be deteriorating.

13. Transfer between categories

The following rules govern the movement of taxa between categories:

A. A taxon may be moved from a category of higher threat to a category of lower threat if none of the criteria of the higher category has been met for five years or more.

B. If the original classification is found to have been erroneous, the taxon may be transferred to the appropriate category or removed from the threatened categories altogether, without delay (but see Point 10 above).

C. Transfer from categories of lower to higher risk should be made without delay.

14. Use at regional level

The IUCN Red List Categories and Criteria were designed for global taxon assessments. However, many people are interested in applying them to subsets of global data, especially at regional, national or local levels. To do this it is important to refer to guidelines prepared by the IUCN/SSC Regional Applications Working Group (e.g., Gärdenfors *et al.* 1999). When applied at national or regional levels it must be recognized that a global category may not be the same as a national or regional category for a particular taxon. For example, taxa classified as Least Concern globally might be Critically Endangered within a particular region where numbers are very small or declining, perhaps only because they are at the margins of their global range. Conversely, taxa classified as Vulnerable on the basis of their global declines in numbers or range might be Least Concern within a particular region where their populations are stable. It is also important to note that taxa endemic to regions or nations will be assessed globally in any regional or national applications of the criteria, and in these cases great care must be taken to check that an assessment has not already been undertaken by a Red List Authority (RLA), and that the categorization is agreed with the relevant RLA (e.g., an SSC Specialist Group known to cover the taxon).

III. Definitions

1. Population and Population Size (Criteria A, C and D)

The term 'population' is used in a specific sense in the Red List Criteria that is different to its common biological usage. Population is here defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life forms, population size is measured as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

2. Subpopulations (Criteria B and C)

Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less).

3. Mature individuals (Criteria A, B, C and D)

The number of mature individuals is the number of individuals known, estimated or inferred to be capable of reproduction. When estimating this quantity, the following points should be borne in mind:

- Mature individuals that will never produce new recruits should not be counted (e.g. densities are too low for fertilization).
- In the case of populations with biased adult or breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals, which take this into account.
- Where the population size fluctuates, use a lower estimate. In most cases this will be much less than the mean.
- Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g. corals).
- In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.
- Re-introduced individuals must have produced viable offspring before they are counted as mature individuals.

4. Generation (Criteria A, C and E)

Generation length is the average age of parents of the current cohort (i.e. newborn individuals in the population). Generation length therefore reflects the turnover rate of breeding individuals in a population. Generation length is greater than the age at first breeding and less than the age of the oldest breeding individual, except in taxa that breed only once. Where generation length varies under threat, the more natural, i.e. pre-disturbance, generation length should be used.

5. Reduction (Criterion A)

A reduction is a decline in the number of mature individuals of at least the amount (%) stated under the criterion over the time period (years) specified, although the decline need not be continuing. A reduction should not be interpreted as part of a fluctuation unless there is good evidence for this. The downward phase of a fluctuation will not normally count as a reduction.

6. Continuing decline (Criteria B and C)

A continuing decline is a recent, current or projected future decline (which may be smooth, irregular or sporadic) which is liable to continue unless remedial measures are taken. Fluctuations will not normally count as continuing declines, but an observed decline should not be considered as a fluctuation unless there is evidence for this.

7. Extreme fluctuations (Criteria B and C)

Extreme fluctuations can be said to occur in a number of taxa when population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e. a tenfold increase or decrease).

8. Severely fragmented (Criterion B)

The phrase 'severely fragmented' refers to the situation in which increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, with a reduced probability of recolonization.

9. Extent of occurrence (Criteria A and B)

Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy (see Figure 2). This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat) (but see 'area of occupancy', point 10 below). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

10. Area of occupancy (Criteria A, B and D)

Area of occupancy is defined as the area within its 'extent of occurrence' (see point 9 above) which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases (e.g. irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data (see point 7 in the Preamble). To avoid inconsistencies and bias in assessments caused by estimating area of occupancy at different scales, it may be necessary to standardize estimates by applying a scale-correction factor. It is difficult to give strict guidance on how standardization should be done because different types of taxa have different scale-area relationships.

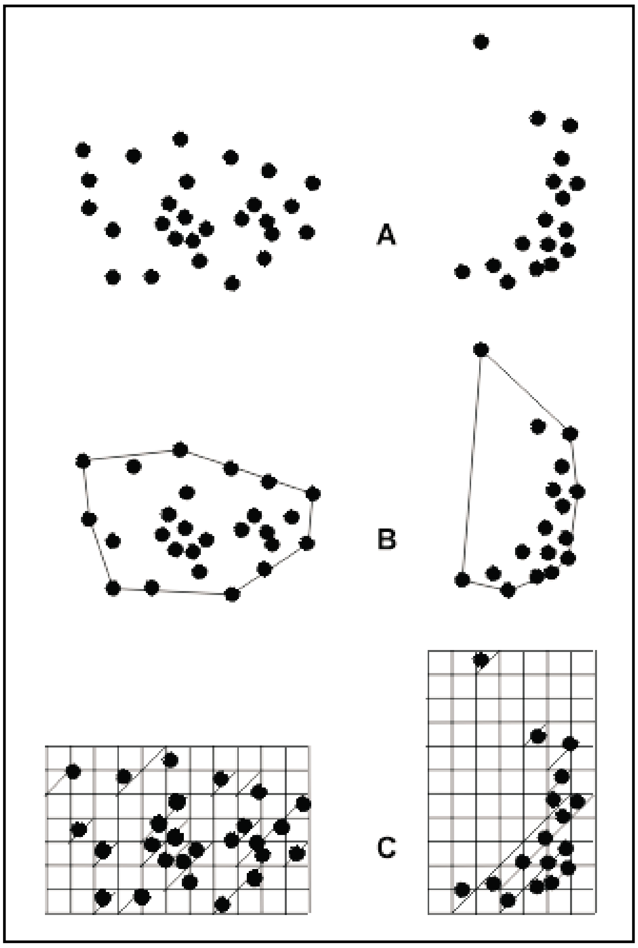


Figure 2. Two examples of the distinction between extent of occurrence and area of occupancy. (A) is the spatial distribution of known, inferred or projected sites of present occurrence. (B) shows one possible boundary to the extent of occurrence, which is the measured area within this boundary. (C) shows one measure of area of occupancy which can be achieved by the sum of the occupied grid squares.

11. Location (Criteria B and D)

The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.

12. Quantitative analysis (Criterion E)

A quantitative analysis is defined here as any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options. Population viability analysis (PVA) is one such technique. Quantitative analyses should make full use of all relevant available data. In a situation in which there is limited information, such data as are available can be used to provide an estimate of extinction risk (for instance, estimating the impact of stochastic events on habitat). In presenting the results of quantitative analyses, the assumptions (which must be appropriate and defensible), the data used and the uncertainty in the data or quantitative model must be documented.

IV. The Categories [1]

A representation of the relationships between the categories is shown in Figure 1.

EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive

[1] **Note**: As in previous IUCN categories, the abbreviation of each category (in parenthesis) follows the English denominations when translated into other languages (see Annex 2).

surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

V. The Criteria for Critically Endangered, Endangered and Vulnerable

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
   1. An observed, estimated, inferred or suspected population size reduction of 90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
      a. direct observation
      b. an index of abundance appropriate to the taxon
      c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
      d. actual or potential levels of exploitation
      e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
   2. An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
   3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.
   4. An observed, estimated, inferred, projected or suspected population size reduction of 80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
   1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a-c:
      a. Severely fragmented or known to exist at only a single location.

- b. Continuing decline, observed, inferred or projected, in any of the following:
  - (i) extent of occurrence
  - (ii) area of occupancy
  - (iii) area, extent and/or quality of habitat
  - (iv) number of locations or subpopulations
  - (v) number of mature individuals.
- c. Extreme fluctuations in any of the following:
  - (i) extent of occurrence
  - (ii) area of occupancy
  - (iii) number of locations or subpopulations
  - (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a-c:
   - a. Severely fragmented or known to exist at only a single location.
   - b. Continuing decline, observed, inferred or projected, in any of the following:
     - (i) extent of occurrence
     - (ii) area of occupancy
     - (iii) area, extent and/or quality of habitat
     - (iv) number of locations or subpopulations
     - (v) number of mature individuals.
   - c. Extreme fluctuations in any of the following:
     - (i) extent of occurrence
     - (ii) area of occupancy
     - (iii) number of locations or subpopulations
     - (iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   - a. Population structure in the form of one of the following:
     - (i) no subpopulation estimated to contain more than 50 mature individuals, OR
     - (ii) at least 90% of mature individuals in one subpopulation.
   - b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of 70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   - a. direct observation
   - b. an index of abundance appropriate to the taxon
   - c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
   - d. actual or potential levels of exploitation
   - e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
2. An observed, estimated, inferred or suspected population size reduction of 50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.
4. An observed, estimated, inferred, projected or suspected population size reduction of 50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a-c:
   - a. Severely fragmented or known to exist at no more than five locations.
   - b. Continuing decline, observed, inferred or projected, in any of the following:
     - (i) extent of occurrence
     - (ii) area of occupancy
     - (iii) area, extent and/or quality of habitat
     - (iv) number of locations or subpopulations
     - (v) number of mature individuals.
   - c. Extreme fluctuations in any of the following:
     - (i) extent of occurrence
     - (ii) area of occupancy
     - (iii) number of locations or subpopulations

(iv) number of mature individuals.
2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than five locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:
   1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR
   2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
      a. Population structure in the form of one of the following:
         (i) no subpopulation estimated to contain more than 250 mature individuals, OR
         (ii) at least 95% of mature individuals in one subpopulation.
      b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
   1. An observed, estimated, inferred or suspected population size reduction of 50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
      a. direct observation
      b. an index of abundance appropriate to the taxon
      c. a decline in area of occupancy, extent of occurrence and/or quality of habitat
      d. actual or potential levels of exploitation
      e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
   2. An observed, estimated, inferred or suspected population size reduction of 30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
   3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.
   4. An observed, estimated, inferred, projected or suspected population size reduction of 30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
   1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a–c:
      a. Severely fragmented or known to exist at no more than 10 locations.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.
   2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a–c:
      a. Severely fragmented or known to exist at no more than 10 locations.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations

(v) number of mature individuals.
c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:
1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
a. Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 1000 mature individuals, OR
(ii) all mature individuals are in one subpopulation.
b. Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:
1. Population size estimated to number fewer than 1000 mature individuals.
2. Population with a very restricted area of occupancy (typically less than $20km^2$) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Annex 1: Uncertainty

The Red List Criteria should be applied to a taxon based on the available evidence concerning its numbers, trend and distribution. In cases where there are evident threats to a taxon through, for example, deterioration of its only known habitat, a threatened listing may be justified, even though there may be little direct information on the biological status of the taxon itself. In all these instances there are uncertainties associated with the available information and how it was obtained. These uncertainties may be categorized as natural variability, semantic uncertainty and measurement error (Akçakaya *et al.* 2000). This section provides guidance on how to recognize and deal with these uncertainties when using the criteria.

Natural variability results from the fact that species' life histories and the environments in which they live change over time and space. The effect of this variation on the criteria is limited, because each parameter refers to a specific time or spatial scale. Semantic uncertainty arises from vagueness in the definition of terms or lack of consistency in different assessors' usage of them. Despite attempts to make the definitions of the terms used in the criteria exact, in some cases this is not possible without the loss of generality. Measurement error is often the largest source of uncertainty; it arises from the lack of precise information about the parameters used in the criteria. This may be due to inaccuracies in estimating the values or a lack of knowledge. Measurement error may be reduced or eliminated by acquiring additional data. For further details, see Akçakaya *et al.* (2000) and Burgman *et al.* (1999).

One of the simplest ways to represent uncertainty is to specify a best estimate and a range of plausible values. The best estimate itself might be a range, but in any case the best estimate should always be included in the range of plausible values. When data are very uncertain, the range for the best estimate might be the range of plausible values. There are various methods that can be used to establish the plausible range. It may be based on confidence intervals, the opinion of a single expert, or the consensus opinion of a group of experts. Whichever method is used should be stated and justified in the documentation.

When interpreting and using uncertain data, attitudes toward risk and uncertainty may play an important role. Attitudes have two components. First, assessors need to consider whether they will include the full range of plausible values in assessments, or whether they will exclude extreme values from consideration (known as dispute tolerance). An assessor with a low dispute tolerance would include all values, thereby increasing the uncertainty, whereas an assessor with a high dispute tolerance would exclude extremes, reducing the uncertainty. Second, assessors need to consider whether they have a precautionary or evidentiary attitude to risk (known as risk tolerance). A precautionary attitude will classify a taxon as threatened unless it is certain that it is not threatened, whereas an evidentiary attitude will classify a taxon as threatened only when there is strong evidence to support a threatened classification. Assessors should resist an evidentiary attitude and adopt a precautionary but realistic attitude to uncertainty when applying the criteria, for example, by using plausible lower bounds, rather than best estimates, in determining population size, especially if it is fluctuating. All attitudes should be explicitly documented.

An assessment using a point estimate (i.e. single numerical value) will lead to a single Red List Category. However, when a plausible range for each parameter is used to evaluate the criteria, a range of categories may be obtained, reflecting the uncertainties in the data. A single category, based on a specific attitude to uncertainty, should always be listed along with the criteria met, while the range of plausible categories should be indicated in the documentation (see Annex 3).

Where data are so uncertain that any category is plausible, the category of 'Data Deficient' should be assigned. However, it is important to recognize that this category indicates that the data are inadequate to determine the degree of threat faced by a taxon, not necessarily that the taxon is poorly known or indeed not threatened. Although Data Deficient is not a threatened category, it indicates a need to obtain more information on a taxon to determine the appropriate listing; moreover, it requires documentation with whatever available information there is.

Annex 2: Citation of the IUCN Red List Categories and Criteria

In order to promote the use of a standard format for citing the Red List Categories and Criteria the following forms of citation are recommended:

1. The Red List Category may be written out in full or abbreviated as follows (when translated into other languages, the abbreviations should follow the English denominations):

   Extinct, EX
   Extinct in the Wild, EW
   Critically Endangered, CR
   Endangered, EN
   Vulnerable, VU
   Near Threatened, NT
   Least Concern, LC
   Data Deficient, DD
   Not Evaluated, NE

2. Under Section V (the criteria for Critically Endangered, Endangered and Vulnerable) there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the Category. Under the criteria A to C and D under Vulnerable, the first level of the hierarchy is indicated by the use of numbers (1-4) and if more than one is met, they are separated by means of the '+' symbol. The second level is indicated by the use of the lower-case alphabet characters (a-e). These are listed without any punctuation. A third level of the hierarchy under Criteria B and C involves the use of lower case roman numerals (i-v). These are placed in parentheses (with no space between the preceding alphabet character and start of the parenthesis) and separated by the use of commas if more than one is listed. Where more than one criterion is met, they should be separated by semicolons. The following are examples of such usage:

   EX
   CR A1cd
   VU A2c+3c
   EN B1ac(i,ii,iii)
   EN A2c; D
   VU D1+2
   CR A2c+3c; B1ab(iii)
   CR D
   VU D2
   EN B2ab(i,ii,iii)
   VU C2a(ii)
   EN A1c; B1ab(iii); C2a(i)
   EN B2b(iii)c(ii)
   EN B1ab(i,ii,v)c(iii,iv)+2b(i)c(ii,v)
   VU B1ab(iii)+2ab(iii)
   EN A2abc+3bc+4abc; B1b(iii,iv,v)c(ii,iii,iv)+
   2b(iii,iv,v)c(ii,iii,iv)

Annex 3: Documentation Requirements for Taxa Included on the IUCN Red List

The following is the **minimum** set of information, which should accompany every assessment submitted for incorporation into the *IUCN Red List of Threatened Species*™:

- Scientific name including authority details
- English common name/s and any other widely used common names (specify the language of each name supplied)
- Red List Category and Criteria
- Countries of occurrence (including country subdivisions for large nations, e.g. states within the USA, and overseas territories, e.g. islands far from the mainland country)
- For marine species, the Fisheries Areas in which they occur should be recorded (see www.iucn.org/themes/ssc/sis/faomap.htm for the Fisheries Areas as delimited by FAO, the Food and Agriculture Organization of the United Nations)
- For inland water species, the names of the river systems, lakes, etc. to which they are confined
- A map showing the geographic distribution (extent of occurrence)
- A rationale for the listing (including any numerical data, inferences or uncertainty that relate to the criteria and their thresholds)
- Current population trends (increasing, decreasing, stable or unknown)
- Habitat preferences (using a modified version of the Global Land Cover Characterization (GLCC) classification which is available electronically from www.iucn.org/themes/ssc/sis/authority.htm or on request from redlist@ssc-uk.org)
- Major threats (indicating past, current and future threats using a standard classification which is available from the SSC web site or e-mail address as shown above)
- Conservation measures, (indicating both current and proposed measures using a standard classification which is available from the SSC web site or e-mail address as shown above)
- Information on any changes in the Red List status of the taxon, and why the status has changed
- Data sources (cited in full; including unpublished sources and personal communications)
- Name/s and contact details of the assessor/s
- Before inclusion on the IUCN Red List, all assessments will be evaluated by at least two members of a Red List Authority. The Red List Authority is appointed by the Chair of the IUCN Species Survival Commission and is usually a sub-group of a Specialist Group. The names of the evaluators will appear with each assessment.

In addition to the minimum documentation, the following information should also be supplied where appropriate:

- If a quantitative analysis is used for the assessment (i.e. Criterion E), the data, assumptions and structural equations (e.g., in the case of a Population Viability Analysis) should be included as part of the documentation.
- For Extinct or Extinct in the Wild taxa, extra documentation is required indicating the effective date of extinction, possible causes of the extinction and the details of surveys which have been conducted to search for the taxon.
- For taxa listed as Near Threatened, the rationale for listing should include a discussion of the criteria that are nearly met or the reasons for highlighting the taxon (e.g., they are dependent on ongoing conservation measures).
- For taxa listed as Data Deficient, the documentation should include what little information is available.

Assessments may be made using version 2.0 of the software package RAMAS Red List (Akçakaya and Ferson 2001). This program assigns taxa to Red List Categories according to the rules of the IUCN Red List Criteria and has the advantage of being able to explicitly handle uncertainty in the data. The software captures most of the information required for the documentation above, but in some cases the information will be reported differently. The following points should be noted:

- If RAMAS Red List is used to obtain a listing, this should be stated.
- Uncertain values should be entered into the program as a best estimate and a plausible range, or as an interval (see the RAMAS Red List manual or help files for further details).
- The settings for attitude towards risk and uncertainty (i.e. dispute tolerance, risk tolerance and burden of proof) are all pre-set at a mid-point. If any of these settings are changed this should be documented and fully justified, especially if a less precautionary position is adopted.
- Depending on the uncertainties, the resulting classification can be a single category and/or a range of plausible categories. In such instances, the following approach should be adopted (the program will usually indicate this automatically in the Results window):
    - If the range of plausible categories extends across two or more of the threatened categories (e.g. Critically Endangered to Vulnerable) and no preferred category is indicated, the precautionary approach is to take the highest category shown, i.e. CR in the above example. In such cases, the range of plausible categories should be documented under the rationale including a note that a precautionary approach was followed in order to distinguish it from the situation in the next point. The following notation has been suggested e.g. CR* (CR-VU).

- If a range of plausible categories is given and a preferred category is indicated, the rationale should indicate the range of plausible categories met e.g. EN (CR-VU).

- The program specifies the criteria that contributed to the listing (see Status window). However, when data are uncertain, the listing criteria are approximate, and in some cases may not be determined at all. In such cases, the assessors should use the Text results to determine or verify the criteria and sub-criteria met. Listing criteria derived in this way must be clearly indicated in the rationale (refer to the RAMAS Red List Help menu for further guidance on this issue).
- If the preferred category is indicated as Least Concern, but the plausible range extends into the threatened categories, a listing of 'Near Threatened' (NT) should be used. The criteria, which triggered the extension into the threatened range, should be recorded under the rationale.
- Any assessments made using this software must be submitted with the RAMAS Red List input files (i.e. the *.RED files).

New global assessments or reassessments of taxa currently on the IUCN Red List, may be submitted to the IUCN/SSC Red List Programme Officer for incorporation (subject to peer review) in a future edition of the *IUCN Red List of Threatened Species*™. Submissions from within the SSC network should preferably be made using the Species Information Service (SIS) database. Other submissions may be submitted electronically; these should preferably be as files produced using RAMAS Red List or any of the programs in Microsoft Office 97 (or earlier versions) e.g. Word, Excel or Access. Submissions should be sent to:

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Cambridge, CB3 0DL, United Kingdom.
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Email: redlist@ssc-uk.org

For further clarification or information about the IUCN Red List Criteria, documentation requirements (including the standards used) or submission of assessments, please contact the IUCN/SSC Red List Programme Officer at the address shown above.

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Appendix 3

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The Kouprey. An Action Plan for its Conservation. Edited by J.R. MacKinnon and S.N. Stuart. IUCN/SSC Asian Wild Cattle Specialist Group, 1988, 19pp. (out of print)

Weasels, Civets, Mongooses and their Relatives. An Action Plan for the Conservation of Mustelids and Viverrids. Compiled by A. Schreiber, R. Wirth, M. Riffel and H. van Rompaey. IUCN/SSC Mustelid and Viverrid Specialist Group, 1989, 99pp. (out of print.)

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