SPBCP
South Pacific Biodiversity
Conservation Programme

Marine Mammals in the Area Served by the South Pacific Regional Environment Programme (SPREP)

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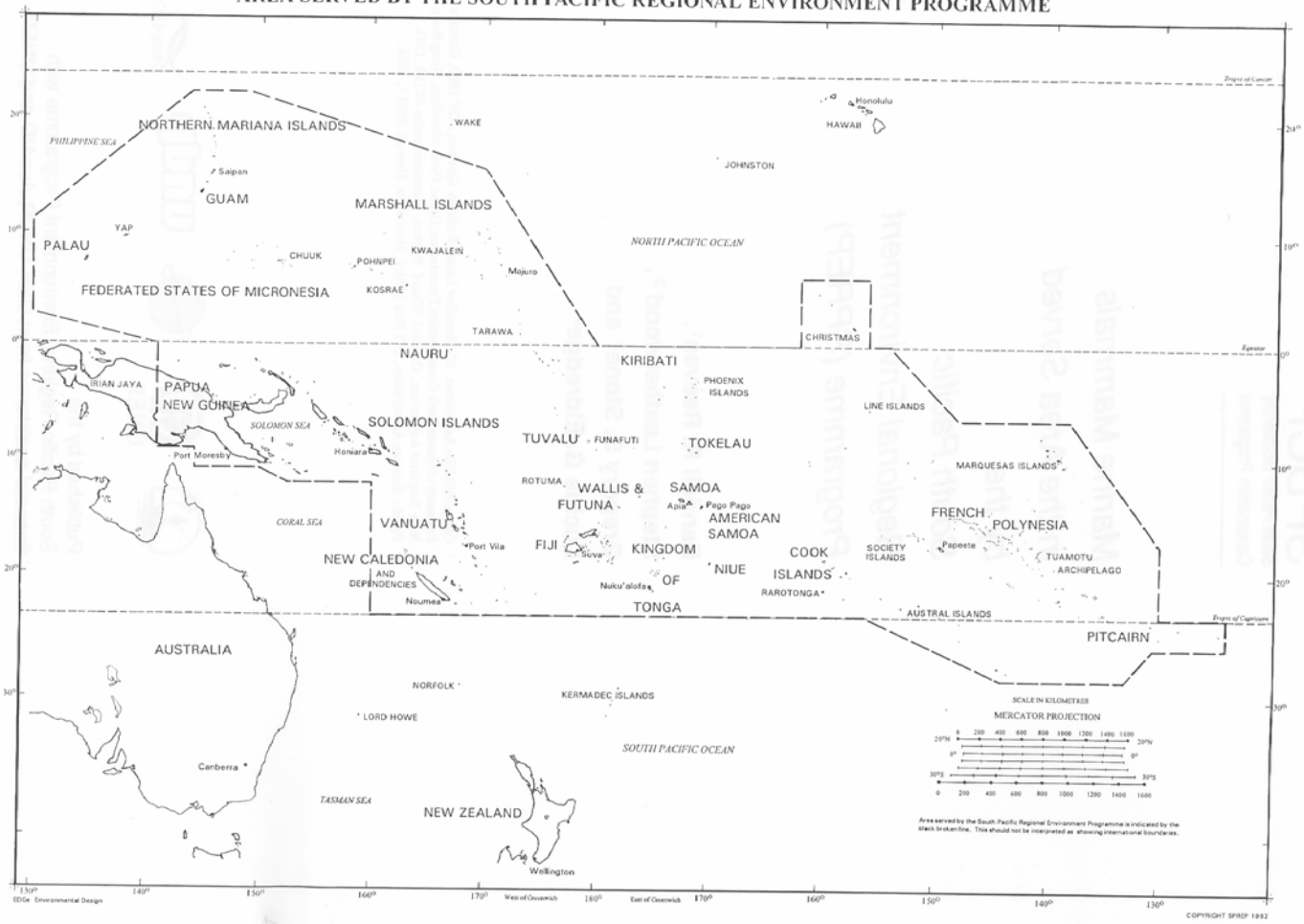
AREA SERVED BY THE SOUTH PACIFIC REGIONAL ENVIRONMENT PROGRAMME



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James Stephen (Steve) Leatherwood 1944–1997

At the time of his death in January 1997, Steve Leatherwood was known throughout the world for his work with whales and dolphins, which spanned almost 30 years and encompassed many species and areas. Much of his early work, first with the United States Navy and then with Hubbs Marine Research Center in San Diego, California, involved surveys and radio-tagging in the eastern Pacific. As the world became increasingly aware of marine mammals, and more concerned about their conservation, Steve helped lead the way to a better understanding of the animals, the threats they face and what can be done to reduce or eliminate conflicts with humans. In the Southern Hemisphere, he participated in research on minke and killer whales in the Antarctic and led several tours to the South Pacific islands. He was also active in the Indian Ocean, spending many months in Sri Lanka during the 1980s pursuing his own research on whales, dolphins and dugongs, and training local biologists to carry on with similar work after his departure. While serving with the United Nations Environment Programme in Nairobi, Kenya, as Secretary for the Marine Mammal Action Plan, Steve co-edited reports on the marine mammals of Sri Lanka and on the Indian Ocean Cetacean Sanctuary.

In 1991, Steve was appointed Chairman of the IUCN Species Survival Commission's Cetacean Specialist Group—a global volunteer network of experts on whales, dolphins and porpoises. In this role, he was able to initiate, coordinate and otherwise support conservation projects in many parts of the world, including Asia and the South Pacific. Having accepted a position as Director of the Veterinary and Education Department of Ocean Park in Hong Kong in 1994, he helped establish the Ocean Park Conservation Foundation. As well as managing a large staff at Ocean Park, Steve continued to be a productive scientist and a high-profile campaigner for marine conservation. Preparation of this overview of marine mammals in the SPREP region was one of the last projects that Steve undertook. Steve would be pleased to know that it has been completed.

Executive Summary

The SPREP region has a diverse marine mammal fauna, including representatives from the three major marine mammal groups: cetaceans, pinnipeds and sirenians. Populations of odontocete cetaceans are present in virtually all marine environments throughout the region. Species reported include: sperm whale *Physeter macrocephalus,* pygmy sperm whale *Kogia breviceps,* dwarf sperm whale *Kogia simus,* short-finned pilot whale *Globicephala macrorhynchus,* killer whale *Orcinus orca,* false killer whale *Pseudorca crassidens,* melon-headed whale *Peponocephala electra,* pygmy killer whale *Feresa attenuata,* Risso's dolphin *Grampus griseus,* bottlenose dolphin *Tursiops truncatus,* striped dolphin *Stenella coeruleoalba,* pantropical spotted dolphin *Stenella attenuata,* spinner dolphin *Stenella longirostris,* common dolphin *Delphinus spp.,* Cuvier's beaked whale *Ziphius cavirostris,* Fraser's dolphin *Lagenodelphis hosei,* Peale's dolphin *Lagenorhynchus australis,* Irrawaddy dolphin *Orcaella brevirostris,* rough-toothed dolphin *Steno bredanensis,* Indo-Pacific humpbacked dolphin *Sousa chinensis*, a species similar or identical to the southern bottlenose whale *Hyperoodon planifrons*, and at least four species of beaked whales of the genus *Mesoplodon*. Only one species of mysticete cetacean, the Bryde's whale *Balaenoptera edeni*, is a year-round inhabitant of the SPREP region. Minke whales *Balaenoptera bonaerensis* and *Balaenoptera acutorostrata* (dwarf form), humpback whales *Megaptera novaeangliae*, and blue whales *Balaenoptera musculus* are present, at least seasonally, in parts of the region.

Most stocks of the large, commercially important whales have been severely reduced by whaling. Continued protection is essential if these stocks are to recover to anything near their pre-exploitation levels. Direct hunting of small and medium-sized cetaceans may still occur at several islands in the western part of the SPREP region. These species are more generally vulnerable to by-catch in fishing gear. It is important that direct hunts be monitored and regulated and that by-catches be documented and minimised.

Only two types of pinniped regularly wander into the area, from principal habitats farther south: the leopard seal *Hydrurga leptonyx* and southern fur seals *Arctocephalus spp*. The SPREP region has little or no significance for pinniped conservation. One species of sirenian is found regularly in the region, the dugong *Dugong dugon*. The dugong is relatively safe only in Australia; elsewhere, including several parts of the SPREP region (Palau, Vanuatu, New Caledonia), small isolated populations are vulnerable to extinction. The study and protection of dugongs should be a high priority in the SPREP region.

Note

The authors of this book are fully aware that much information has become available since this review was first written in 1996. Unfortunately publication was delayed for various reasons beyond the authors' control and it has only gone to print in 1999. However, although somewhat outdated, there is still much useful information in the following pages that at the very least can be used as some sort of starting point onto which readers can base further findings.

Acknowledgements

This review is produced by SPREP's Regional Marine Mammal Conservation Programme. Funding assistance was provided by the Global Environment Facility/United Nations Development Programme/Australian Agency for International Development through the South Pacific Biodiversity Conservation Programme. Partial support was also provided by the United Nations Environment Programme through the "Global Plan of Action for Marine Mammals (Project FP/0402-94-44)".

1. Introduction

The region served by the South Pacific Regional Environment Programme (SPREP; fig. 1) is situated in the middle of the largest continuous marine habitat on the planet, the Pacific Ocean. Marine mammals (whales, dolphins, porpoises, dugongs and seals) range throughout much of this huge region. Of the world's approximately 120 living marine mammal species, three-quarters occur in the Pacific (cf. Rice, 1977a). Of the 90 or so Pacific species, perhaps a third are known to be resident in the SPREP region or at least to visit it seasonally or occasionally. However, due to the vastness of the region and the relative lack of research activity in it, very little is known about the marine mammals in the SPREP region. Much of what is known about the distribution and seasonal occurrence of large whales has come from 19th century American, French and British commercial whalers (cf. Townsend, 1935) and from researchers working in conjunction with modern Japanese whaling operations (cf. Miyashita et al., 1995a). Much of what is known about the smaller whales, dolphins and seals comes from the non-systematic, often opportunistic efforts of individual scientists. Dugongs have been studied relatively intensively in some areas because of international concern about their endangered status.

In 1991 the SPREP organised a workshop in Vanuatu on biodiversity of the South Pacific. A marine mammal conservation plan was developed and proposed at this workshop (Stone et al., 1992). The plan identified the following projects as priorities:

- preparation of a review document covering published and unpublished information on marine mammals of the region;
- compilation of information from knowledgeable sources in various countries of the region;
- throughout the region, the creation and distribution of education programmes, including an identification guide, poster and reporting form;
- establishment of a database at SPREP for collecting, storing and analysing marine mammal sighting and stranding data;
- identification of threats to marine mammals in the region including directed fisheries, by-catch in fisheries, habitat loss or degradation, environmental catastrophes (e.g. nuclear explosions, volcanic eruptions) and pollution; and
- despite the acknowledged lack of information on marine mammals in the SPREP region at the time of the meeting, several programmes were proposed for immediate action, including humpback whale surveys, further assessments of dugong populations and threats, and the development of a stranding response network.

Since the Vanuatu meeting, implementation of various elements in the plan has begun. The present report is intended as a response to the first item on the above list. It should be clear to any reader that the current state of knowledge about marine mammals in the SPREP region is far from adequate. Before a proper assessment can be made of the conservation status of the various species, more field work is needed to document distributions and movements, stock relationships and abundance. At the time of the Vanuatu workshop in 1991, it was acknowledged that one of the biggest obstacles for marine mammal conservation in the SPREP region was this shortage of basic information. It is hoped that the present report, essentially a review of the literature with some additional unpublished information, will serve as a useful starting point for further investigations.

Annex 1 provides a concise summary of the species found in the SPREP region.

2. Materials and methods

We made an extensive bibliographic search for literature related to the scope of this project. We also consulted with numerous colleagues, many of whom gave us unpublished data or provided us with citable documents containing relevant information. We wish to acknowledge, in particular, the contributions of Hal Whitehead, Jean-Pierre Sylvestre, M. Michael Poole, Fujio Kasamatsu and Porter V. Turnbull. Hal Whitehead, Pam Stacey, Toshio Kasuya, Michael Bryden, Richard Sears, John Calambokidis, Fujio Kasamatsu, Nobuyuki Miyazaki, Barbara Curry, Graham Ross, Peter Corkeron, Peter Arnold, John Bannister, Nick Gales, Scott Baker and Mike Donoghue reviewed portions of an earlier draft and provided useful input. We are also grateful to Randi Olsen for help with technical preparation of the manuscript.

Unpublished data from a cruise by Leatherwood, 14 March–10 April 1990, from Easter Island to Tahiti (and Moorea), Tuamotus and Marquesas then returning to Tuamotus and Tahiti, are included in this report.

The specimen inventory involved two primary consultations: one (by post and fax) with N. Miyazaki and T.K. Yamada at the National Science Museum (NSM) in Tokyo; the other (in person) with J.G. Mead at the United States National Museum (USNM), Smithsonian Institution, Washington, D.C. Miyazaki and Yamada provided us with their Catalogue of Marine Mammal Specimens in the NSM. Mead provided us with a printout of his own inventory of specimens in the USNM and other major collections in the world. We used Mead's list as a guide to the specimens as well as to the literature in which the relevant specimens are cited. For those instances in which no literature was available, we attributed the record to Mead as a personal communication, with his explicit permission (in litt., 10 February 1996).

No comprehensive attempt was made to use the vast amount of data from the SPREP region contained in commercial whaling logbooks and journals (cf. Du Pasquier, 1982; Langdon, 1984).

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3. Results and discussion

3.1 Annotated checklist of species

3.1.1 Mysticete cetaceans

Only one species of mysticete cetacean, the Bryde's whale (two forms or subspecies), is known to be a year-round inhabitant of the SPREP region. Three or four additional species—one or both of the southern hemisphere minke whales, the humpback whale and the blue whale—are regular seasonal migrants to at least certain portions of the region. The sei whale and fin whale have also been reported but apparently are not common (see Rice, 1979, 321; Balcomb, 1987, 6; Miyashita et al., 1995a). Historically, the southern right whale may have occasionally migrated into the southern fringes, and the northern right whale and possibly the gray whale into the northwestern fringes, of the region. The pygmy right whale is a possible rare visitor to the southern edges of the SPREP region.

Minke Whales, *Balaenoptera acutorostrata* Lacépède, 1804 and *Balaenoptera bonaerensis* (Burmeister, 1867)

Minke whales occur in marine waters worldwide, at virtually all latitudes (Stewart and Leatherwood, 1985; Horwood, 1990). For many years, cetacean systematists recognised only one species, *B. acutorostrata*, while acknowledging the existence of two or three morphologically distinct "forms" of minke whale. Minke whales in the northern hemisphere generally have white flipper bands while many of those in the southern hemisphere do not (Best, 1985). The latter are often referred to in the literature as the "dark-shouldered" or the "*bonaerensis*-type" of minke whale. The minke whales in the southern hemisphere that do have white flipper bands are consistently smaller than the other two forms (i.e. northern hemisphere animals with white flipper bands and southern hemisphere "dark-shouldered" animals) (Best, 1985; Arnold et al., 1987). Recent genetic studies support the hypothesis that northern hemisphere and southern hemisphere ("dark-shouldered") minke whales are separate species—*B. acutorostrata* and *B. bonaerensis*, respectively (Wada and Numachi, 1991; Árnason and Gullberg, 1994; van Pijlen et al., 1995; also see IWC, 1994a, 101).

Little is known about the winter distributions of the large populations of minke whales (apparently all, or at least primarily, *B. bonaerensis*) that move into Antarctic waters during the summer feeding season. Judging by population estimates from sighting and marking cruises, Areas V (130°E–170°W) and VI (170°W–120°W) may have the largest numbers of minke whales in the entire Antarctic (IWC, 1991, 117; 1993, 114). If, as is assumed, these whales move essentially north–south during their seasonal migrations, this would mean that relatively large numbers of minke whales use the SPREP region or waters immediately south of it for breeding, calving and calf rearing.

Recent observations by Japanese researchers were compiled to identify likely breeding grounds and routes of southbound migrations (Kasamatsu et al., 1995). The highest encounter rates in the SPREP region during October–December, ranging between 4 and 6 whales per 1000 nautical miles searched, were at the eastern end of the Tuamotu Archipelago (10–20°S, 130–140°W) and from American Samoa and Niue east to Tahiti (10–20°S, 150–170°W). These areas had some of the highest minke whale encounter rates found anywhere in the Southern Ocean during this period, the early part of which overlaps the estimated breeding season (August–October).

Kasamatsu et al. (1995) inferred from an apparent hiatus in distribution between 120°W and 130°W that the minke whale breeding area in the western South Pacific (centred at 150–170°W) is distinct from that in the eastern South Pacific. However these authors acknowledged that evidence from catch distributions, mark-recapture, morphological comparisons, isozyme analyses and DNA indicated substantial mixing of minke whales in the Antarctic feeding grounds. They also concluded that southern minke whales may not assemble in discrete breeding areas but rather are probably dispersed in open waters during the breeding season. This would distinguish these whales from right, humpback and gray whales, all of which migrate between nearshore breeding (or calf-rearing) concentration areas and more oceanic feeding areas. Mother–calf pairs of minke whales were observed in only two areas in or near the SPREP region: the northeastern Coral Sea and at *ca.* 19°S between Niue and the Cook Islands. It is important to emphasise that the search effort in the study by Kasamatsu et al. (1995) covered only the period of austral spring and summer (October to March).

Peter Arnold of the Museum of Tropical Queensland in Townsville, Australia (in litt., 28 July 1995) considers the dwarf minke whale to be an as-yet unnamed subspecies of *B. acutorostrata* (also see Pastene et al., 1994). He has been studying the dwarf minke whales that occur regularly in austral winter on the Ribbon Reefs (15–16°S) in the northern Great Barrier Reef. A dwarf minke whale was photographed by a diver in New Caledonia, and another minke whale was photographed at Marion Reef in the Coral Sea in August (Arnold et al., 1987). Arnold (in litt., 28 July 1995) has photographic documentation of a consistent colour pattern in dwarf minke whales from southern Africa, the east and west coasts of Australia, New Zealand, New Caledonia and Brazil.

Although we do not have sufficient information to describe seasonal and spatial differences between the two types of southern hemisphere minke whale in the SPREP region, we can at least be certain that both forms occur there. Also, the northern hemisphere form of *B. acutorostrata* might occur in the northwestern sector of the SPREP region, but we have no firm evidence of its presence there.

Bryde's Whale, *Balaenoptera edeni* (Anderson, 1878)

Bryde's whales have a pantropical distribution and are common in much of the tropical Pacific (Masaki, 1972; Wada, 1975; Miyazaki and Wada, 1978a; Rice, 1979). The range map published by Cummings (1985, 146) which indicates a hiatus in the distribution of Bryde's whales across the Pacific between approximately 20°N and 20°S is badly outdated and misleading. The monthly indices provided by Miyashita (1995a), as individuals sighted per 10 000 nautical miles of search effort, give a much more reliable impression of Bryde's whale distribution.

The Bryde's whale apparently is the most abundant mysticete in the SPREP region. Rice (1979) encountered Bryde's whales more frequently than any other species of cetacean during a research cruise in the equatorial Pacific between Central America and Clipperton Island (*ca.* 110°W), and he noted that they were widely distributed in the open ocean as well as in coastal areas (also see Wade and Gerrodette, 1993, their fig. 18). At least some populations of Bryde's whales are migratory, with movement into higher latitudes in summer and into lower latitudes in winter. Several individuals marked with Discovery tags north of New Guinea and in the general vicinity of Nauru, for example, were later killed on the pelagic whaling grounds east of southern Japan at 25–30°N (Ohsumi, 1978a, 279; 1979a; 1980a, fig. 1). Generally, Bryde's whales are not found in areas where the surface water temperature is less than 15°C (Nemoto, 1959, 247; Ohsumi, 1977). Sightings in the western North Pacific in 1993–95 were interpreted as suggesting that the 20°C isotherm defined the northern limit of Bryde's whales in winter (Miyashita et al., 1995b).

The question of Bryde's whale stock boundaries in the southern hemisphere was tentatively resolved, for management purposes, by designating the whales south of the equator between 130°E and 150°W as a western South Pacific stock and those east of 150°W as an eastern South Pacific stock (IWC, 1982, 95). In addition, a Solomon Islands stock was recognised on the basis of the small size distribution of the animals (all < 12.2 metres total length) taken in the Japanese scientific permit catch (Donovan, 1991, 43–44). This stock is now called the Solomon Islands/Southeast Asia dwarf-form stock (IWC, 1996). A separate Peruvian stock was also recognised in the far eastern South Pacific around the equator (Donovan, 1991). The whales killed near the Solomon Islands during the Japanese "experimental" catches in the 1970s were all sexually mature at a smaller body size than "normal" Bryde's whales and had other distinctive features. Genetic analyses indicate that they should probably be assigned to a separate, but as yet undescribed, species (Wada and Numachi, 1991).

In spite of the evidence that Bryde's whales occur in equatorial waters and cross the equator, the tendency has been to treat North Pacific and southern hemisphere Bryde's whales separately, at least for management purposes within the IWC context. The boundary between the IWC's eastern and western North Pacific stocks of Bryde's whales at 160°W was, as Donovan (1991, 48) put it, "somewhat cryptically agreed" at the 1978 annual meeting of the Scientific Committee (IWC, 1979). The Bryde's whales in the East China Sea are considered to be a separate stock (Donovan, 1991, fig. 5; IWC, 1996). Due to the stock boundaries assigned by the IWC, which are not necessarily consistent with all of the biological evidence (see IWC, 1982, 95; IWC, 1996), most reports on distribution, stock identity, population size and exploitation of Bryde's whales in the Pacific fall into two arbitrary categories—North Pacific and southern hemisphere (often encompassing data from both the South Pacific and Indian oceans). We adopt the IWC's terminology here, in the hope that our doing so will minimise the confusion for readers. Stock definition and systematics of Bryde's whales in the Indo-Pacific are obviously in need of further refinement.

Bryde's Whales in the North Pacific

The western North Pacific stock has been interpreted to include the whales hunted by Japan, Taiwan, the Philippines and the Soviet Union in waters west of 160°W. At least some of the whales in this stock move seasonally into the western parts of the SPREP region (cf. Ohsumi, 1978a, 1979a; 1980a, fig. 1). Coastal whaling for Bryde's whales off Japan increased after the Second World War, and pelagic whaling for this species began in the western North Pacific in 1970 (Ohsumi, 1977; Tillman, 1977, 1978; Tillman and Grenfell, 1980). Bryde's whales in the North Pacific have been legally protected since 1986. The main pre-1986 whaling areas are shown by Ohsumi (1980a, fig. 1). The IWC Scientific Committee invested considerable time in assessing the status of this stock from the late 1970s to mid-1980s (e.g. IWC, 1977, 1979, 1980, 1982, 1983, 1985, 1986, 1988); a critical analysis of the assessments through 1984/85 was provided by Holt (1986). Many estimates of stock size have been made, using different approaches and assumptions (e.g. Tillman, 1977, 1978, 1981; Tillman and Grenfell, 1980; Miyashita and Kasamatsu, 1985; Miyashita, 1986). References to the "recruited" or "exploitable" population presumably mean the component of the total stock consisting of animals at least 35 feet (10.7 metres; shore-based whaling) or 40 feet (12.2 metres; pelagic whaling) long, as these are the minimum length limits established for Bryde's whales in the IWC Schedule of Whaling Regulations. Estimates of the exploitable component of this stock have ranged from as low as about 13 000 to as high as a few tens of thousands. Virtually all assessments have indicated a decline in the stock size since 1946, although the severity of the decline has been a matter of controversy.

The most recent estimate, based on Japanese sightings data, is 23 751 (CV = 0.20) for the western North Pacific stock, which includes much of the northwestern corner of the SPREP region (IWC, 1996; also see Miyashita, 1986).

"Sei" whales observed from a tuna vessel in the Micronesia/Marshall Islands area during June 1982 (at 8°39'N, 151°32'E, 27 June, 5°01'N, 162°13'E, 6 July, and 6°56'N, 172°02'E, 23 July; Patterson and Alverson, 1986) were probably Bryde's whales.

Bryde's Whales in the Southern Hemisphere

The exploitation of Bryde's whales within the parts of the SPREP region south of the equator has been very limited, consisting primarily of catches by Japanese whalers under special scientific permits during the late 1970s. Most of the information on distribution and relative abundance comes from Japanese catch, tagging and sighting data obtained during the late 1970s and early 1980s. In January–March 1975–1977 relatively high densities of Bryde's whales were observed in equatorial waters between 130°E and 180° (Ohsumi, 1978a). During 20 January–19 March 1976 they were seen mainly in the areas of the Manus and Solomon islands and Nauru (Miyazaki and Wada, 1978a). In October–November 1976 a Japanese whaling expedition took Bryde's whales in the Solomon Sea and in an area just south of the SPREP region between New Zealand and Fiji (Ohsumi, 1978b). Scouting boats associated with the expedition also sighted Bryde's whales in the area between New Caledonia and Fiji (Ohsumi, 1978b). The Bryde's whale stomachs that were sampled contained euphausiids exclusively (Kawamura, 1977). These whales were found to have an appreciably smaller filtering area on their baleen than do Bryde's whales in the North Pacific (Kawamura, 1978). In late October and early November 1977 Japanese whalers observed, marked and killed Bryde's whales in a large area between the Tuamotu Archipelago and Fiji, in waters between the southern border of the SPREP region and northwards to 10°S (one observation was made as far north as about 6°S) (Ohsumi, 1979b, 269, fig. 1). After additional sightings and catches in 1978–1979, Ohsumi (1980b) concluded that the stock of Bryde's whales in the South Pacific west of 120°W ("western South Pacific stock") totalled close to 60 000, and that a diminutive morph centred in the Solomon Sea ("Solomon stock") consisted of about 1800 whales. These estimates generated considerable debate in the IWC Scientific Committee (IWC, 1980). Although Ohsumi (1981) estimated total populations of more than 80 000 for the southern hemisphere stock between 20°E and 120°W (excluding the Solomons area) and 2800 for the Solomon stock (also see Shimada and Pastene, 1995), the Scientific Committee subjected the same data to a different analytical method giving an estimate of about 16 500 (exploitable component: 11 000) for the western South Pacific stock (IWC, 1981, 125, table 3).

Ivashin (1980) referred to "noticeable concentrations" of Bryde's whales in the areas 10–28°S, 157–177°E and 21–30°S, 179°E–170°W, citing Ohsumi (1978a or 1978b, 1979) as the authority.

Humpback Whale, *Megaptera novaeangliae* (Lesson, 1828)

Humpback whales move seasonally between high latitude feeding areas and low latitude breeding and calving areas (Dawbin, 1966b). At least six well-defined breeding stocks of humpbacks in the southern hemisphere were classically described by Mackintosh (1942, 1965). Some modifications to Mackintosh's model were made by Dawbin (1959, 1964, 1966b), based mainly on a large-scale mark and recovery programme in which thousands of whales were tagged in the Antarctic and along the coasts of Australia, New Zealand, Tonga, Fiji,

Norfolk Island, New Caledonia and Vanuatu (New Hebrides). This marking programme failed to link many of the proposed migratory destinations, however, and much refinement remains desirable (see IWC, 1994a, 105–106). The principal wintering grounds of southern hemisphere humpbacks are along continental coastlines and near island groups in tropical and subtropical latitudes. A rough estimate of the current total number of humpback whales summering south of 30°S is 15 000 (CV = 0.4) (Borchers, 1994).

Nineteenth-century whalers hunted humpbacks mainly around Tonga and the Northern Mariana Islands and in an area of the eastern Coral Sea to the west of the northwest corner of New Caledonia (Townsend, 1935). Importantly, it needs to be understood that the positions shown on Townsend's maps reflect the mapmaker's avoidance of overlaying dots signifying catches made in the same area. Thus, for example, the impression of a whaling ground around Tonga some 400 nautical miles in diameter is misleading. Most catches there were made within 30 nautical miles of the island groups (IWC, 1996). Scammon (1874) reported that the season for humpback whaling in Tonga (21°S, 174°W) was August–September and that the large females taken there produced an average of 40 barrels of oil, with yields ranging as high as 73 barrels. He also noted that most of the whales in Tonga were white on the undersides of the body and flippers.

A recent review of records from eastern Australia and the southwestern Pacific indicates that humpbacks may be present, at least in small numbers, in Torres Strait year-round and from New Caledonia east to the Society Islands seasonally (non-summer months) (P. Corkeron, pers. comm.; also see Australian National Parks and Wildlife Service, 1985). Dawbin (1972) stated that before they were severely depleted, humpbacks occasionally visited the Gulf of Papua and reached the vicinity of New Britain; however, he had no evidence of their presence along the north coast of New Guinea.

Several sites within the SPREP region have been identified as present-day wintering grounds for humpbacks presumed to belong to southern hemisphere stocks. The Area V Antarctic stock of humpbacks has two migratory "streams", one passing the east coast of Australia (the "east Australia group") and the other passing New Zealand and Norfolk Island, the latter thought to winter near Tonga and Fiji (the "New Zealand group") (Dawbin, 1966b; Bryden et al., 1990). Sightings of humpbacks have been reported throughout the islands of Polynesia, north of Tonga in Fiji, Samoa, Niue and the Cook Islands from January to October. The apparently considerable east–west movement by humpbacks in this region has been said to "confuse the overall picture" of stock identity (Anonymous, 1981, 204). Dawbin (1966b, 154) in fact concluded, based on tag returns, that there was "enough interbreeding among stocks that pass New Zealand, Fiji, Norfolk Island, eastern Australia and western Australia to preserve the racial homogeneity of the stocks as a whole throughout this sector". He went on to suggest that such homogeneity might exist throughout the southern hemisphere due to "progressive exchanges between adjacent groups". In a worldwide study of mitochondrial DNA variation and population structure, Baker et al. (1993, 1994) found significant genetic differences between populations from the west coast of Australia and those from the east coast of Australia and Tonga, combined. No significant differences were found between eastern Australia and Tonga, although sample sizes were small. One humpback tagged in Tonga was later killed in the Bellingshausen Sea, directly south of Cape Horn in Antarctic Area I (0°–120°W) (Dawbin, 1966b). Also, a photo identification match has been made of a whale observed in Tonga and Queensland (NE Australia) (P. Corkeron, pers. comm., 1995).

Paterson (1991) pointed out that there was still some uncertainty about the destination(s) of humpbacks that migrated northward along the east coast of Australia during the autumn. Simmons and Marsh (1986) concluded that most of them wintered in the Great Barrier Reef lagoon, where some calving occurred. However a connection between eastern Australia and New Caledonia was documented through photo identification in the early 1990s (Garrigue and Gill, 1994). Observations at New Caledonia and the Loyalty Islands, spanning the period from late June to early December (peak August–September), indicate that these areas are probably calving and breeding grounds for the Area V stock (Garrigue and Gill, 1994; Gill et al., 1995). Humpbacks seen in recent years in Vanuatu may be a part of this stock as well (Garrigue and Gill, 1994). A dead 7.3-metre humpback was found floating in a canal near Nouméa, New Caledonia, in early June 1989 (observed by B. Richer de Forges and N. Baillon, *fide* J.-P. Sylvestre, in litt.).

Females with small calves, and consorting adults, have been observed off Savu Savu, Fiji, in recent years (J. Moody, pers. comm., October 1991). A photograph of a breaching humpback whale off Kandavu Island, Fiji, was published by Lever (1964), and a lone humpback was observed and photographed as it swam southwestward through the Koro Sea, Fiji, in 1984 (C.R. Knowles, in litt., August 1987). The whales in Fiji are presumably Area V humpbacks (Dawbin, 1964).

The nearshore waters around Tonga are used for mating and calving by the New Zealand group of the Area V stock (Dawbin, 1964; Keller, 1982;

Abernethy et al., 1993). Sightings in Tongan waters span the months June–November, with a clear peak in August–September (Anonymous, 1981). In 1979 and 1980 approximately 200–400 humpbacks were estimated to visit Tongan waters during the winter (Anonymous, 1981; Keller, 1982). Reports of recent non-systematic surveys indicate that numbers remain low (C.S. Baker and M. Donoghue, pers. comm., May 1995).

Humpbacks arrive in American Samoa from the south between June and December, with peak numbers present during September–October (Craig, 1995). This area is probably another calving and mating ground for the New Zealand group of Antarctic Area V humpbacks.

Although it was seriously depleted by whaling up until 1962, the east Australian portion of the Area V humpback stock has made a strong recovery since it was given protection in 1962 (Paterson and Paterson, 1989; Bryden et al., 1990; Paterson, 1991). The annual rate of increase has been estimated at about 11 percent, with size of the Australian portion of the population in 1992 being about 1900 whales (Paterson et al., 1994). Recent evidence suggests that these figures need revision because of an imbalance between the numbers of males and females in the migrating population (Brown et al., 1995). By contrast with the situation for the east Australia group, there is no evidence of a substantial recovery of the New Zealand group (Abernethy et al., 1993), which continued to be exploited through 1963 (Paterson et al., 1994).

Poole (1993) documented the occurrence of humpbacks at 18 islands in French Polynesia during July–October. Their behavior, featuring "surface-active groups" and singing, and the presence of recently born calves indicate that this is a mating and calving ground, presumably for whales of the Area VI Antarctic stock.

Large whales, thought to be humpbacks, are observed close to shore (inside the lagoon) at Mangareva, Gambier Islands, during August–September (Tihoni Reasin, Rikitea, Mangareva, in litt., 10 January 1992). Local people at Tubuai, Austral Islands, told Leatherwood (unpub. data, 1990) that they see humpbacks regularly in July–October; one is said to have stranded there in July 1986. People at Kauehi, Tuamotus, told Leatherwood (unpub. data, 1990) that they see two kinds of whale: one grey with "knobs" on its head (presumably humpback) and one large with wrinkled black skin and teeth (presumably sperm). The humpbacks visiting the Gambier and Austral islands and the Tuamotu Archipelago would likely be part of the Area VI stock.

Leatherwood (unpub. data, 1990) was told by the local people at Hakahetau, Ua Pou, Marquesas Islands, that they see approximately one humpback each year near the island. This may represent the northern extreme of the winter distribution of the Area VI stock.

One northern hemisphere stock of humpbacks uses the northwestern part of the SPREP region in winter. The normal winter range of whales from the Ryukyuan stock (Nishiwaki, 1959) includes the Bonin (Ogasawara) Islands (Miyashita et al., 1996). At least one whale, thought to be an adult male, has been documented to switch wintering grounds, using the Ogasawara area in one year and Hawaii the next (Darling and Cerchio, 1993). Although results of a cruise in February 1993 led Ohizumi et al. (1993) to conclude that the Ryukyuan (or Asian) stock of humpbacks normally goes only as far south as Iwoto Island (24°45'N, 141°40'E) in winter, some animals move south to the Northern Mariana Islands, including Saipan and Guam. A group of three was photographed off Saipan in February 1991 (Darling and Mori, 1993), and sightings have also been reported in Guam in January and February (Eads, 1991; Anonymous, 1996; David Aldan, pers. comm.), including a mother and calf off the east coast of Rota in late February 1991 (Derek Stinson, CNHI Div. Fish & Wildlife, pers. comm.).

The Asian stock of humpback whales (wintering in the Ryukyu and Ogasawara islands) was estimated in the early 1990s to be at least in the high hundreds (Darling and Mori, 1993). More than 400 individual humpbacks were photo identified at the Ogasawara Islands during 1987–93 (Sato et al., 1995). Although it may be recovering, this stock is probably still well below its pre-exploitation level.

Sei Whale, *Balaenoptera borealis* (Lesson, 1828)

Sei whales have a worldwide distribution but are found mainly in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood, 1987). Reports in the literature from any time before the mid-1970s are suspect because of the frequent failure to distinguish sei from Bryde's whales (cf. Mead 1977, Rice, 1979, Horwood, 1987, 15, 21; Shimada and Pastene, 1995), particularly in tropical to warm temperate waters where Bryde's whales are generally more common than sei whales.

The southernmost confirmed sightings and catches of sei whales in the eastern North Pacific are from 18°30'N (Rice, 1977). In the western North Pacific sei whales have been taken during March and April as far south as the Bonin (Ogasawara) Islands (Horwood, 1987, 29) and sighted in the area 20–25°N, 165–170°E (data from various Japanese

sighting cruises summarised by Horwood, 1987, 32). Also, two sei whales that were tagged in the general vicinity of the Northern Mariana Islands in January were later killed a few hundred kilometres south of the western Aleutian Islands in summer (Horwood, 1987, 57-58). In the eastern South Pacific sei whales occur at least as far north as 5°S, where they were taken by whalers based at Paita, Peru.

In the southern South Pacific most observations have been south of 30°S, but sei whales apparently do occur at least occasionally in the SPREP region (Horwood, 1987, 39; cf. Kasuya and Wada, 1991). If the presumed winter distribution as shown by Horwood (1987, 45–46) is correct, then sei whales regularly migrate into at least the southern and northern fringes of the SPREP region.

Fin Whale, *Balaenoptera physalus* (Linnaeus, 1758)

Fin whales are more nearly cosmopolitan in their distribution and more predictable in their seasonal movements than sei whales. Although it is generally believed that fin whales make poleward feeding migrations in summer and move towards the equator in winter, few actual observations of fin whales in tropical and subtropical waters have been documented, particularly in the Pacific Ocean away from continental coasts (Mackintosh, 1942). In general, fin and blue whales were not found in large concentrations along continental coasts in the southern hemisphere in winter. Nor were they found anywhere else in large winter concentrations comparable to those observed in the Antarctic during summer. From this evidence, Mackintosh (1942, 250) inferred that these species became widely dispersed in winter, with some possibly migrating into tropical waters, many being scattered in the open ocean in subtropical and sub-Antarctic waters, and some remaining in the Antarctic. He was convinced that if major concentrations formed during winter, they would have been observed at least occasionally.

K.C. Balcomb (1987, 6) observed a group of 8–12 large fin whales some 460 kilometres south of Honolulu on 20 May 1966, in a feeding aggregation with many seabirds and small cetaceans. The lack of observations by Japanese whaling and scouting vessels during cruises for Bryde's and sperm whales in the western tropical Pacific (see references cited in Bryde's whale account, above) can be interpreted to indicate that fin whales are uncommon in the SPREP region. However it should also be kept in mind that relatively little of the search effort has been in low latitudes (between 20°N and 20°S) and that most of the effort has been limited to the austral spring and summer months of October–March (cf. Kasuya and Wada, 1991; Kasamatsu et al., 1995). A search of the scattered data and literature on catches, sightings and taggings, comparable to those done by Horwood (1987) for sei whales and by Kasamatsu et al. (1995) for minke whales, would be a useful start investigating the fin whale's status in the tropical and subtropical Pacific.

Blue Whale, *Balaenoptera musculus* (Linnaeus, 1758)

Various authors have suggested that blue whales which summer in high latitudes move into the subtropics and tropics in winter (Harmer, 1931; Mackintosh, 1942, 1966; Wheeler, 1946; Yochem and Leatherwood, 1985). Non-migratory populations may also be present in certain highly productive low-latitude areas (e.g., over the Costa Rican Dome west of Central America—Wade and Friedrichsen, 1979; Reilly and Thayer, 1990). Blue whales aggregate seasonally around Baja California (Rice, 1974; Reilly and Thayer, 1990), near the Galápagos (Reilly and Thayer, 1990), and near the coasts of Ecuador and northern Peru (Donovan, 1984; Reilly and Thayer, 1990). They have been recorded acoustically off Oahu and Midway, Hawaiian Islands (Northrop et al., 1971; Thompson and Friedl, 1982), but no direct observations of blue whales have been documented in Hawaiian waters. Elsewhere in the central and western tropical Pacific, evidence of blue whales is almost entirely lacking except near the Solomon Islands.

Twenty-one groups (41 individuals) of blue whales were observed in the vicinity of the Solomon Islands during a Japanese sighting survey in August 1957 (Ohsumi and Shigemune, 1993; Shimada and Pastene, 1995; IWC, 1996). This included one mother-calf pair in the western part of the Solomon Islands. None were seen during cruises to the same area in November–December 1993 and September–October 1994. It was suggested that this could reflect either the fact that the recent cruises were too late in the year or that blue whales have been further depleted since 1957 (IWC, 1996). As is now well known, the Soviet Antarctic whaling fleet continued to kill "protected" whales, including large (but previously unreported) numbers of blue whales, throughout the 1960s and until the International Observer Scheme was put in place in 1972 (Yablokov, 1994; Zemsky et al., 1995; IWC, 1996).

A single SPREP-region sighting was reported in the Japanese sightings programme between 1965 and 1993 (Kato et al., 1995). This was at the equator at about 170°E. We have been unable to locate any other definite evidence of the blue whale's occurrence within the SPREP region. The severe depletion of southern hemisphere stocks of blue whales due to commercial over-exploitation means that even in areas where they may have been common historically, these whales are unlikely to

occur in high densities at present (cf. Butterworth et al., 1995).

Zemsky and Sazhinov (1982) mapped the distribution of the pygmy blue whale (judged to be a subspecies, *Balaenoptera musculus brevicauda*, or, by some authors, a separate species, *Balaenoptera brevicaudis*) as encompassing not only much of the Indian Ocean but also extending into the Java, Banda and Tasman seas. These authors were informed primarily by data from Soviet whaling expeditions. Considering the known warm-water distribution of the pygmy blue whale, it is possible that this morph occurs more regularly in the SPREP region (e.g. the Solomon Islands area) than the "true" blue whale (see Shimada and Pastene, 1995; Kato et al., 1995).

Right Whales: Southern, *Eubalaena australis* (Desmoulins, 1822), and Northern, *Eubalaena glacialis* (Müller, 1776)

Cawthorn (1983b) reported sightings by weather station personnel at Raoul Island, Kermadec Group (*ca* 28°30'S, 177°30'W) of southern right whales "migrating past the island" (season not specified). Campbell Island and the Aucklands (both south of New Zealand) are areas of right whale concentration. Cawthorn (1983b) had no evidence confirming the area of dense October–November concentrations plotted by Townsend (1935) east of the Kermadec Islands, "even though shipping has passed regularly through that area en route to French Polynesia". If right whales do occur in the southern margins of the SPREP region, such occurrence is likely now rare.

Northern right whales are known to have occurred as far south as the East China Sea and Bonin (Ogasawara) Islands in the western Pacific, the Hawaiian Islands in the central Pacific and the coast of Baja California, Mexico, in the eastern Pacific (Scarff, 1991). It is therefore possible that an occasional vagrant would reach the northern edges of the SPREP region, but we have no evidence of this.

Gray Whale, *Eschrichtius robustus* (Lilljeborg, 1861)

Historically the western Pacific stock of gray whales migrated southward along the Asian coast to at least Formosa (Taiwan) Strait and the northern South China Sea (Wang, 1984; Omura, 1988; Henderson, 1990). Thus some occasional straying into the northwestern extremes of the SPREP region may have occurred at one time. The depleted status of this whale stock makes it very unlikely that a gray whale would wander into the SPREP region today.

Pygmy Right Whale, *Caperea marginata* (Gray, 1846)

The pygmy right whale is very poorly known but is thought to have a circumpolar distribution in the southern hemisphere, approximately between the 5°C and 20°C isotherms (Baker, 1985). Its range could at least occasionally extend into the southern parts of the SPREP region.

3.1.2 Odontocete cetaceans

At least 19 species of odontocete cetacean have been documented from the SPREP region, and several other species are likely to occur there at least occasionally.

Sperm Whale, *Physeter macrocephalus* (Linnaeus, 1758)

Sperm whales are cosmopolitan and occur throughout the SPREP region (see Rice, 1989, for a review of the species). They are the most abundant large cetaceans in the region, with the possible exception of Bryde's whales. Maps showing the 19th century whaling grounds demonstrate the far-flung, high-density occurrence of sperm whales (e.g. Townsend, 1935; Lever, 1964; Bannister and Mitchell, 1980). The most important whaling ground in the central Pacific was "on the line", i.e. along the equator. The Tuamotu archipelago was another well-recognised whaling ground for sperm whales. Some sperm whales were also taken in New Guinean waters, but this area was never a major sperm whaling ground (Dawbin, 1972). Sperm whales were frequently observed and hunted in Samoan waters during the late 1820s to late 1840s (Richards, 1992). Most of these were small animals encountered in small groups (Richards, 1992, 16).

Sperm whaling continued in parts of the SPREP region until well into the 20th century, and whaling in Australia and the Antarctic, on animals that may have belonged to the same stocks as those in the SPREP region, continued until 1980 when sperm whaling in most of the southern hemisphere was banned by the IWC. Berzin (1972, 164–165) speculated, apparently on the basis of a literature review, that "tropical waters promising for [modern sperm] whaling" would include: the New Guinea coast between 140°E and 146°E, New Ireland (from St. George Cape to St. Mary Cape), the east coast of New Britain, to the north of the Solomons, along the equator from 168°E to 175°E, the south side of the Ellice Islands, to the north of the Fiji Islands, and from Fanning Island (atoll) at 4°N, 159°W to the southeast as far as Christmas Island. Berzin (1972, 165) also summarised observations by Soviet "research whalers" in the 1960s during the northern hemisphere spring/summer period: groups of up to 200 sperm whales off Nauru and Malden islands;

groups of 100–200 off New Ireland, the Solomon Islands and Vanuatu (New Hebrides). Most of the whales in these exceptionally large aggregations were said to have been females with young, although "there were also many large males" among them. Sightings have been reported in Kimbe Bay (north coast of New Britain; Anonymous, 1995c) and the western Bismarck Sea (Bailey, 1991) and near the Solomons (Shimada and Pastene, 1995).

Japanese shore-based whalers took a few sperm whales in the vicinity of the Northern Mariana Islands during the early 1980s, although their main grounds, as well as those of 19th century American whalers (the Japan Ground), were generally north of the SPREP region's northwest border (Kasuya and Miyashita, 1988, see especially their figs. 4 and 5). Japanese whalers observed sperm whales in waters south of 21°S, from approximately Fiji in the west to the area between Niue and Rarotonga in the east, while hunting primarily Bryde's whales in late October to early November 1977 (Ohsumi, 1979b, their table 2). Sightings were made during May–July in the 1980s in the southern Philippine Sea (small animals) and around Guam (large animals) (Kasuya and Miyashita, 1988, fig. 6).

Rice (1977b) noted that the 19th century whalers had taken sperm whales near the equator all across the Pacific, year-round. He took this as suggesting "that they represent a stock separate from the breeding stocks at higher latitudes". An alternative hypothesis, not mutually exclusive with the first, would be that the equatorial populations consist of northern hemisphere animals during the boreal winter and of southern hemisphere animals during the austral winter (Rice, 1977b). Catches and observations of sperm whales around Samoa, as recorded in Richards (1992), occurred in all months except February and March (mid-December to late March is the hurricane season at Samoa).

The extensive stock assessment work of the IWC during the 1970s and 1980s centred primarily on sperm whales in the North Pacific and the Antarctic and along the coasts of southern Africa, Peru and Australia (e.g. Donovan, 1980). Relatively little direct attention was given to the SPREP region, *per se*, although it should be recognised that whales from these other stocks may well move seasonally into and out of the region. Three of the nine IWC stock divisions for sperm whales in the southern hemisphere overlap the SPREP region: Division 6, 130°E–160°E; 7, 160°E–170°W; and 8, 170°W–100°W (Donovan, 1991). Kasuya and Miyashita (1988) considered various hypotheses of stock relations in the North Pacific and concluded that stock boundaries in the west are latitudinal as well as longitudinal in orientation, defined at least partly by the movements of oceanic currents. Most of the catch, sighting and tagging data used in their analysis was from areas north of the SPREP region, and there is no basis, with the evidence currently available, for a comparably thorough investigation of stock relations in the tropical and South Pacific.

Hal Whitehead and his associates (in litt., 12 May 1995) have been examining the stock relations of sperm whales in the equatorial and temperate South Pacific, using photo identification, comparisons of acoustic characteristics (codas; the name for short, patterned series of clicks) and genetics. The lack of photographic matches between animals in the western Pacific (SPREP region) and eastern Pacific (e.g. Galápagos, northern Peru, Ecuador) was interpreted as suggesting that mixing, if it occurs, is infrequent (Dufault and Whitehead, 1995). The analyses of codas suggested distinct populations of sperm whales in different parts of the South Pacific, although the whales around Christmas Island and the Phoenix Islands (both areas encompassed by the "On the Line" whaling grounds) had similar coda repertoires (Weilgart et al., 1993). Studies of stock structure by reference to mtDNA were still in progress in mid-1995 (H. Whitehead, in litt., 12 May 1995).

Dawbin (1972) reported that individuals and small groups of sperm whales were "a not uncommon sight" in deep waters off New Guinea. Strandings have been reported in recent years in Guam (Kami and Lujan, 1976) and Ponape (Pohnpei; Ashby 1995), sightings and strandings at New Caledonia (Delauw, date unknown; Das, 1993) and American Samoa (R. Volk, in litt., 2 December 1991; Grant, 1995). Single sperm whales were sighted from a tuna purse seiner in Micronesia at 5°11'N, 150°38'E (28 June 1982) and 2°18'N, 168°42'E (4 August 1982); two were seen west of the northern Line Islands at 4°00'N, 163°11W, 24 October 1983 (Patterson and Alverson, 1986). A group of six sperm whales was photographed at Boro Island, near Bikini Atoll, Marshall Islands, in July 1947 (J.G. Mead, pers. comm.). Thirty sperm whales were seen near the Tongatapu Group, Tonga, during vessel surveys in 1979 (Anonymous, 1981, fig. 2). During an acoustic survey in 1992 sperm whales were recorded in the vicinity of the Tuamotus (11 August; male), the southern Line Islands (5 September; male), Tahiti (8 September), Christmas Island (11–13 September; females and males), Jarvis Island (25 September; male), the Phoenix Islands (1–4 October; females and males), Tokelau (8 October; male), Tonga islands (20 October–7 November; females and males) (H. Whitehead, in litt., 12 May 1995; also see Dufault and Whitehead, 1995).

Trade in sperm whale teeth, perhaps originally from strandings but later and on a larger scale from the whaling industry, has been a major feature in Fijian culture (see 3.3.1, below).

Pygmy Sperm Whale, *Kogia breviceps* (de Blainville, 1838)

A 2.9-metre specimen stranded at Guam in February 1989 (letter from T. Sherwood to G. Nitta, 29 December 1989). Two stranded specimens have been reported from southwestern New Caledonia, one in December 1974 (Robineau and Rancurel, 1981) and the other in September 1985 (identified from photographs by Sylvestre, 1988).

Dwarf Sperm Whale, *Kogia simus* (Owen, 1866)

This small whale is rarely observed at sea in most areas but is apparently abundant in some. Its distribution, as inferred mainly from strandings, is worldwide in tropical and temperate waters (Nagorsen, 1985). There are stranding records from at least Guam (Kami and Lujan, 1976) and New Caledonia (Robineau and Rancurel, 1981). Two specimens in the US National Museum were obtained from Guam (see 3.2.2, below).

Short-finned Pilot Whale, *Globicephala macrorhynchus* (Gray, 1846)

The short-finned pilot whale is another very widely distributed species. It ranges throughout tropical and warm temperate waters in all the oceans, often in sizeable herds. The species' distribution within the SPREP region is not known in any detail, but we assume that it is widespread and common in many areas.

Kami and Hosmer (1982) described this as the most frequently observed cetacean species around Guam, although this claim was questioned by Donaldson (1983). A group of more than 30 individuals was photographed in late April 1977 off the northwest coast of Guam (Birkeland, 1977). A small group was seen northwest of Truk, Micronesia, at 9°49'N, 149°22'E, on 26 June 1982 (Patterson and Alverson, 1986). About 18 pilot whales were reported to have stranded at Polowat Atoll, Truk, in March 1995 (M.S. Trianni, in litt., 17 May 1995, via S. Pultz, US Fish and Wildlife Service, Honolulu). Several sightings were made during Japanese whale sighting cruises in the area of 23–25°N, 142–144°E, i.e. to the north of the Northern Mariana Islands (Miyashita et al., 1995a). Sightings of groups of pilot whales were made from commercial tuna seiners in October and November near and to the west of the northern Line Islands (Patterson and Alverson, 1986).

Pilot whales are sighted "frequently" around Fiji and are present around the Solomon Islands and the north coast of New Guinea (Dawbin, 1974). Several schools were observed in the Solomon Sea during a whale sighting cruise in late November and early December 1993 (Shimada and Pastene, 1995). Dawbin (1972) noted that pilot whales were common in Astrolabe Bay, southern Bismarck Sea, an area from which some had been live-captured for Australian oceanaria, and they were described as common in Kimbe Bay on the north coast of New Britain during November–December 1994 (Anonymous, 1995c). Rancurel (1973a, 1973b) referred to single strandings of *Globicephala* at Vanuatu (Efate) and Tahiti (Mahina). A mass stranding of 52 animals occurred at Ouvéa Island, Loyalty Islands, on 22 May 1977 (J.G. Mead, pers. comm.; Das, 1993). A group of 20–30, including several calves, was photographed during the Fijian summer near the mouths of Savusavu and Wainunu bays (C.S. Knowles, in litt., August 1987).

Groups of 50–100 pilot whales were observed twice during surveys around Moorea, French Polynesia, January–February 1994 (J.C. Sweeney, in litt., 21 February 1995). Observations have also been reported from American Samoa (R. Volk, in litt., 2 December 1991), Palau (N. Idechong, pers. comm.) and the Austral, Gambier and Society islands and the Pitcairn group (Leatherwood, unpublished). Leatherwood (unpub. data) was told that pilot whales were seen occasionally near Ua Pou, Marquesas Islands, and he found a piece of pilot whale cranium on the beach at Raroia, Tuamotus.

Killer Whale or Orca, *Orcinus orca* (Linnaeus, 1758)

The killer whale has a cosmopolitan distribution and occurs, at least sporadically or seasonally, in many parts of the SPREP region. Observations reported during the 1950s to early 1960s by Japanese tuna longline fishermen suggested the widespread and year-round presence of killer whale pods in Pacific equatorial waters (Iwashita et al., 1963). These reports, however, are not sufficiently well documented to be taken at face value (see section 3.6, below). Observations from Japanese whaling or whale sighting vessels are more credible (Miyashita et al., 1995a). These indicate large concentrations of killer whales (>101 individuals per 10 000 nautical miles) east of the Phoenix Islands and north of the Northern Mariana Islands and smaller concentrations between the Phoenix and Tonga islands and in the vicinity of the Cook–Society–Austral islands triangle in November; a large concentration near Samoa in October; and another to the west of Samoa in March. The lack of search effort in most months means that any conclusions about seasonal movements by the whales, or about their absence in many parts of the SPREP region, should not be made solely on the basis of the Japanese data.

A 5.7-metre, badly decomposed specimen came ashore in Guam in August 1981 (Kami and Hosmer, 1982). A pod of four killer whales was photographed in Palau in early April 1993 (Rock, 1993). In the

newspaper article reporting that incident, reference is also made to unconfirmed reports of killer whales near Guam, Yap and Palau "for years" (Rock, 1993). R. Volk (in litt., 2 December 1991) reported that killer whales are seen "on occasion" near American Samoa. Dawbin (1972) stated: "In Papua New Guinea waters the most frequent sightings reported (of killer whales) are those from off the coast of northwest New Guinea". Small groups of killer whales, including mother–calf pairs and an adult male, were sighted in May, July and August 1994 in Kimbe Bay, PNG (approx. the centre of the north shore of New Britain) (Anonymous, 1995c). The whales were observed feeding on hammerhead sharks (probably *Shyrna lewini*) and tuna. A pod of five was seen off the southeastern end of the Solomon archipelago in late November or early December 1993 (Shimada and Pastene, 1995). Das (1993) reported that a pair of killer whales accompanied by a calf had been observed regularly outside the lagoon at La Foa, New Caledonia, apparently during the early 1990s.

A single adult male was sighted off Baker Island in March 1995 (Stephen Bailey, pers. comm.), and a small pod (5–8 individuals) was reportedly seen during the Fiji International Billfish Tournament in 1994 (Anonymous, 1995a).

False Killer Whale, *Pseudorca crassidens* (Owen, 1846)

False killer whales occur in tropical, subtropical and warm temperate seas worldwide (Stacey et al., 1994). They mass strand relatively often, and it is not unusual for several hundred animals to be involved in such events.

Dawbin (1972) mentioned that false killer whales had been taken between Papua New Guinea and Australia and that they had been sighted north of the island of New Guinea. Miyazaki and Wada (1978a) reported two small groups of false killer whales in the SPREP region: 10–20 animals southeast of Palau at 4°52'N, 138°35'E, on 27 January; 20–30 animals near New Ireland at 2°37'S, 153°01'E, on 6 March. Dawbin (1974) included the false killer whale among the species taken in the drive hunt at Malaita, Solomon Islands, and we have confirmed records of sightings from Budi-Budi, Laughlin Islands (extreme southeastern PNG), and Rabaul, New Britain, in 1986. Two groups totalling 17 individuals were observed off the Pacific side of the Solomons in early December 1993 (Shimada and Pastene, 1995). Leatherwood (unpub. data) saw a group of 8 near Rangiroa Island, Tuamotus, on 1 April 1990. A group of 15 was seen in the northern part of the Tonga archipelago, on 12 October 1992 (H. Whitehead, in litt., 12 May 1995). Judging from their documented distribution and relative abundance in well-studied tropical areas, false killer whales can be expected to occur throughout much of the SPREP region, year-round.

Melon-headed Whale, *Peponocephala electra* (Gray, 1846)

The circumglobal, tropical to subtropical distribution of this species is clearly evident from the records plotted by Perryman et. al. (1994, figure 1). Melon-headed whales are at least locally abundant around certain oceanic islands. There are numerous records from the SPREP region.

Specimens from the Bismarck Archipelago, Papua New Guinea, were in the Zoological Museum, Hamburg, Germany, but were destroyed during the Second World War (J.G. Mead, pers. comm.). A small pod (identification not confirmed) spent several weeks during September–October 1994 near Restorf Island in Kimbe Bay, PNG (north coast of New Britain) (Anonymous, 1995c). Two sightings were made off the Pacific side of the Solomon Islands in early December 1993, totalling 105 individuals (Shimada and Pastene, 1995).

A group of four melon-headed whales washed onto the beach at Palmyra Atoll, Line Islands, in 1964, and one skull was later obtained for the US National Museum (J.G. Mead, pers. comm.). W.F.J. Mörzer Bruyns observed whales, "most probably" belonging to this species, between the Society and Marquesas Islands in January 1968 (15 animals) and in other years (months and numbers of animals not stated) (Van Bree and Cadenat, 1968, 195). A French cinematographer reported observing a large concentration of melon-headed whales below the cliffs at Nuku Hiva, Marquesas Islands, in December 1995–January 1996 (Bertrand Loyer, in litt., 29 January 1996). Roughly 1000 animals, in groups of 50–100, seemed to make daily inshore-offshore movements in this area. Large herds, numbering up to 200–300 animals, often associated with Fraser's dolphins, were seen near Moorea, French Polynesia, during surveys in January–February 1994 (J.C. Sweeney, in litt., 21 February 1995).

Rancurel (1973a, 1973b, 1974a) described and illustrated a mass stranding of at least 231 melon-headed whales at Malekula Island, Vanuatu (New Hebrides), in November 1972. Other strandings have been documented in Guam (Kami and Hosmer, 1982; Donaldson, 1983) and Palau (Donaldson, 1983). Five melon-headed whales swam into the lagoon at Kwajelein Atoll, Marshall Islands, in November 1993. After 1–2 weeks they began to strand. All were consumed by local people (J.G. Mead, pers. comm.).

One immature female from a herd of about 20 animals, including several calves, was collected north

of Nauru on 20 February 1976 (Miyazaki and Wada, 1978a). This group of melon-headed whales was swimming with a herd of 400–500 Fraser's dolphins.

The difficulty of distinguishing among whales of the genera *Peponocephala*, *Feresa* and *Pseudorca* (especially young individuals) is generally acknowledged (see Bryden et al., 1977; Perryman et al., 1994).

Pygmy Killer Whale, *Feresa attenuata* (Gray, 1874)

This small blackfish has a circumglobal distribution in tropical and subtropical waters (Ross and Leatherwood, 1994). The sighting near New Ireland of a herd of 150–200 pygmy killer whales on 6 March 1976 (Miyazaki and Wada, 1978a, 193) was overlooked by Ross and Leatherwood (1994) in their review of the species. Dawbin (1972) cited a stranding record from Bogia on the north coast of New Guinea. Although we have found no other confirmed records of pygmy killer whales in the SPREP region, there is every likelihood that they do occur in many areas.

Pygmy killer whales occur in relatively small herds, usually of 50 or fewer animals and only occasionally of a few hundred (Ross and Leatherwood, 1994). The difficulty of distinguishing the pygmy killer whale from the melon-headed whale, and even the false killer whale, means that reports of at-sea observations should be subjected to critical consideration before acceptance (see Bryden et al., 1977; Perryman et al., 1994, table 1).

Risso's Dolphin, *Grampus griseus* (G. Cuvier, 1812)

Risso's dolphins are cosmopolitan animals that prefer tropical to warm temperate waters. They can be expected virtually anywhere in the SPREP region. Miyazaki and Wada (1978a) reported six sightings of small groups (usually <10 individuals), mainly in equatorial waters north of New Guinea. One sighting was near Guam (14°04'N, 144°56'E; 13 March). A group of 30 Risso's dolphins were taken in the drive hunt at Malaita, Solomon Islands, in 1964 (Dawbin, 1966a), and nine were taken in a purse seine off Honiara (capital of the Solomons) in July 1990 (Akimichi, 1992). A group of three was seen in the Solomon Sea in early December 1993 (Shimada and Pastene, 1995). Leatherwood (unpub. data) was told that Risso's dolphins are seen regularly near Ua Pou, Marquesas Islands.

Small groups (10–20 individuals) were sighted off Moorea, French Polynesia, during January–February 1994 (J.C. Sweeney, in litt., 21 February 1995). In the western North Pacific, sightings were made in winter 1993–95 around the Northern Mariana Islands and Guam (Miyashita et al., 1996).

Bottlenose Dolphin, *Tursiops truncatus* (Montagu, 1821)

The bottlenose dolphin has a cosmopolitan distribution in tropical to warm temperate marine waters. Extensive geographical variation in the genus has led to taxonomic uncertainty (Curry and Smith, 1997). In most areas where it has been studied at least two allopatric, or in some cases parapatric, forms, designated as coastal and offshore, have been documented (e.g. eastern North Pacific—Walker, 1981; western South America—Van Waerebeek et al., 1990; southeastern United States—Hersh and Duffield, 1990; Mead and Potter, 1995). Morphological differences among geographically separate populations of *Tursiops* have yet to be investigated in the SPREP region.

Bottlenose dolphins are seen far offshore in the eastern tropical Pacific (Scott and Chivers, 1990), and this is likely the case in the SPREP region as well. Scott and Chivers (1990) documented sightings near Tuamotu and the Marquesas islands, and Patterson and Alverson (1986) reported sightings of groups of bottlenose dolphins near the northern Line Islands (Washington, Fannin and Jarvis) during October 1983. H. Whitehead (in litt., 12 May 1995) reported sighting 30 animals near Christmas Island in September 1992. Two bottlenose dolphins were found stranded at Canton Island, Phoenix Islands, in 1976, and another stranded (alive?) on the same island in early August 1978 (J.G. Mead, pers. comm.). At least two specimens in the US National Museum were collected near the Equator in the general vicinity of the Line and Phoenix Islands (J.G. Mead, pers. comm.).

Miyazaki and Wada (1978a) observed bottlenose dolphins around the Solomon Islands and New Ireland, and they collected a lactating female off the northwest corner of New Ireland. A group of about 500 bottlenose dolphins was seen from a tuna seiner north of New Ireland at 1°12'N, 155°18'E, and herds were seen "daily" during September–October 1983 in the area 3°N–3°S, 155–170°E (Patterson and Alverson, 1986).

Bottlenose dolphins are considered common in American Samoa (R. Volk, in litt., 2 December 1991). Leatherwood has observed them from Fiji to Papua New Guinea and near the Marquesas and Tuamotu islands, both near shores or reefs and in pelagic waters. This includes six animals observed just north of Rapa, Austral Islands, on 25 March 1990. In April 1986 off western Malaita the dolphins were associated with pilot whales (Leatherwood, unpublished), an association well known from other areas (e.g. the eastern tropical Pacific; Scott and

Chivers, 1990). Dawbin (1972) described bottlenose dolphins as "fairly common" along the north coast of New Guinea. They definitely occur along the south coast as well (G.J.B. Ross, in litt., 14 May 1995).

In New Caledonia, bottlenose dolphins are said to be present near La Foa (Ouano Island), and a neonate stranded on a beach near Noumea (Magenta) on 26 July 1993 (Das, 1993).

J.C. Sweeney (in litt., 21 February 1995) reported observing a "resident" group of bottlenose dolphins at Rangiroa atoll, Tuamotu archipelago. This group, numbering up to 30 individuals, was usually sighted within 500 metres of the barrier reef. Other small groups (up to 15 animals) were seen 1–15 or more kilometres offshore of the atoll. On three occasions Sweeney saw a group of about 15 bottlenose dolphins swimming with melon-headed whales.

Dolphins of the Genus *Lagenorhynchus* (Peale, 1848)

The only known record of dolphins of the genus *Lagenorhynchus* anywhere in the SPREP region involved a sighting of a small group off Palmerston Atoll, western Cook Islands (18°10'S, 163°20'W), on 25 March 1988 (Leatherwood et al., 1991a). Experts who examined the photographs tentatively identified the dolphins as Peale's dolphins, *Lagenorhynchus australis*. The question remains whether there is a hitherto unknown tropical species of this genus, or if this observation merely represents an anomalous occurrence of known species from South America (*Lagenorhynchus australis* or possibly *Lagenorhynchus obscurus*) or New Zealand (*Lagenorhynchus obscurus*).

Indo-Pacific Humpbacked Dolphin, *Sousa chinensis* (Osbeck, 1765)

The taxonomy of this genus is uncertain. In the most recent review, Ross et al. (1994) tentatively recognised the humpbacked dolphins in the western Pacific Ocean as a separate species from those in the Indian and southeastern Atlantic oceans. Humpbacked dolphins are coastal animals and are usually observed in waters less than 20 metres deep. They are present along the east coast of Australia and in the Arafura Sea close to the Australian coast (G.J.B. Ross, in litt., 14 May 1995) and in parts of Indonesia and China, but there are no published records from New Guinea. Dawbin (1972) considered it "likely" that humpbacked dolphins inhabited New Guinean waters, as does P. Corkeron (pers. comm., 1995) who reports that they have been seen in Torres Strait during recent aerial surveys of dugongs.

Finless Porpoise, *Neophocaena phocaenoides* (G. Cuvier, 1829)

This small porpoise has a mainly coastal, estuarine and riverine distribution in the Indo-Pacific region (Kasuya, in press). In Japan, where it has been most closely studied, it is seen mainly within two kilometres of shore and only occasionally as much as a few kilometres from shore. Kasuya (in press) concluded after reviewing all available evidence that the species is absent in Sulawesi, Halmahera, and Timor (Indonesia) and in northern Australia. Recent sightings of small groups off the north coast of Palawan Island, Philippines (Dolar and Perrin, 1996), and in shallow water (<55 metres) of the Yellow/East China Sea some 240 kilometres from the coast (Miyashita et al., 1995b) indicate that finless porpoises occur fairly close to the western margins of the SPREP region. Nevertheless, the finless porpoise has not been documented in the SPREP region and, considering its known distribution, it is probably somewhat less likely than the Indo-Pacific humpbacked dolphin to occur there.

Striped Dolphin, *Stenella coeruleoalba* (Meyen, 1833)

This dolphin occurs in tropical and warm temperate waters worldwide. In oceanographic terms, its range is more similar to the common dolphin's than to those of the spinner dolphin and pantropical spotted dolphin (the short-beaked form of common dolphin is presumably intended for this comparison; see *Common Dolphins* section, below). Striped dolphins and common dolphins prefer areas with large seasonal changes in surface temperature and thermocline depth as well as seasonal upwelling, while spinner and pantropical spotted dolphins are more tied to tropical surface water typified by extensive stable thermocline ridging and relatively little annual variation in surface temperature (Perrin et al., 1994a). The distribution mapped by Perrin et al. (1994a) suggests that striped dolphins are widely distributed in the SPREP region. Published sightings or collections are from 04°02'N, 155°41'E in March 1976 (Miyazaki and Wada, 1978a), 05°21'N, 136°37'E in November 1981 (Cawthorn, 1983), 02°N, 142°20'E (Alverson, 1981), and Enewetok Atoll, Marshall Islands (Reese, 1987). Unpublished records cited by Wilson et al. (1987) include one from Guam, one from the Marshall Islands, and one from near the Gilbert Islands. A recent sighting of a herd of about 150 dolphins was made near 18°13'N, 150°21E, on 26 February 1993 (Ohizumi et al., 1993). Several sightings were made in winter to the north and west of the Northern Mariana Islands, just outside the SPREP region (Miyashita et al., 1996).

Striped dolphins have been taken by the Solomon Islanders. They were said to catch groups of up to

30 animals approximately once every three years (Dawbin, 1974).

Pantropical Spotted Dolphin, *Stenella attenuata* (Gray, 1846)

As its name implies, this species has a pantropical distribution in both coastal and oceanic waters. The species was redescribed by Perrin et al. (1987) whose analysis included a small sample of specimens from the Solomon Islands. These were collected by W.H. Dawbin who found during a visit to Malaita in the mid-1960s that large numbers of spotted dolphins were taken in a drive hunt (Dawbin, 1966a). Dawbin (1974) stated that spotted dolphins occurred "in very large schools ranging from the southern portion of the Solomon group through to the northern coast of New Guinea" (also see Shimada and Pastene, 1995). Their documented range in the mid Pacific is from the Hawaiian Islands in the north to at least the Marquesas in the south (Perrin and Hohn, 1994). They are said to be seen regularly around Ua Pou, Marquesas (Leatherwood, unpub. data). The actual range in the SPREP region is undoubtedly much greater than indicated by the many specimen localities illustrated by Gilpatrick et al. (1987) and Perrin and Hohn (1994) and tabulated by Patterson and Alverson (1986).

As indicated above under the striped dolphin, pantropical spotted dolphins are largely sympatric with spinner dolphins. Referring to the eastern Pacific, Au and Perryman (1985) defined the spotted dolphin as an inhabitant of the tropical, equatorial and southern subtropical water masses, characterised by a sharp thermocline at less than 50 metres depth, surface temperatures greater than 25°C and salinities less than 34 parts per thousand. There it is often found in aggregations that include spinner dolphins, yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*) and various oceanic bird species.

Spotted dolphins are considered common in American Samoa (R. Volk, in litt., 2 December 1991). J.C. Sweeney (in litt., 21 February 1995) reported two sightings of 200–500 spotted dolphins near Moorea, French Polynesia, in January–February 1994. The animals showed a strong avoidance response to the survey vessel.

Leatherwood's (unpub. data) observations include:

- 2 April 1990—two large groups (225–275 in one, 100–125 in the other) between Rangiroa, Tuamotus and Ua Pou, Marquesas, approx. 11°26'S, 142°53'W;
- 3 April 1990—a group of 60–70 (with a large number of spinner dolphins) at 9°38'S, 140°33'W, near Ua Pou, Marquesas; and
- 10 April 1990—a large group (with spinner dolphins) about 25 kilometres NW of Papeete, Tahiti.

A dolphin specimen from the Phoenix Islands, described and illustrated by Peale (1848) and assigned to the nominal species *Delphinus albirostratus* Peale, 1848, was identified by Perrin (1975, 22) as a spotted dolphin. A group of about 20 spotted dolphins was seen at 01°20'S, 174°22'W, north of the western Phoenix Islands in early October 1992 (H. Whitehead, in litt., 12 May 1995). Additional sightings made in late September during the same cruise were just below the equator at about 161°W (ibid.).

Sightings in the Philippine Sea, just outside the northwestern border of the SPREP region, were reported by Miyashita et al. (1996).

Spinner Dolphin, *Stenella longirostris* (Schlegel, 1841)

In an initial review of the distribution and taxonomic history of spinner dolphins, Perrin (1975, 135–137) referred to populations, *inter alia*, in the eastern Pacific, Hawaii, and western Pacific. In a subsequent analysis Perrin et al. (1979) described a "southern" stock of spinner dolphins centred in the eastern Pacific south of the Galápagos. Southern spinner dolphins are modally different from "whitebelly" spinner dolphins to the north but similar to "Hawaiian" spinner dolphins. Perrin et al. (1979, 182) referred to several specimens collected in French Polynesia (Marquesas and Tuamotus) by R. Costello and J.D. Bryant in 1970. Based on photographs and sketches of these animals, Perrin et al. concluded that these animals were "in some characters intermediate between the typical whitebelly and Hawaiian states". Perrin (1990) later referred these and specimens from elsewhere in the SPREP region (including the Line and Marshall islands, southern Micronesia, and the New Guinea and Solomon archipelagoes; see 3.2.2, below) to the subspecies *Stenella longirostris longirostris* (Gray, 1828).

The spinner dolphin probably has a much wider distribution throughout the SPREP region than is indicated by the available specimen and sighting records (Patterson and Alverson, 1986; Gilpatrick et al., 1987; Perrin and Gilpatrick, 1994). The comments concerning the range and habitat preferences of the pantropical spotted dolphin (above) apply to the spinner dolphin as well. Spinner dolphins have been described as especially abundant, observed in herds of hundreds and sometimes thousands, along the north coast of New Guinea, including Manus and New Britain and the southern part of the Solomon Sea (Dawbin, 1972; also see Anonymous, 1995c). Four schools, totalling 665

individuals, were observed on both the Solomon Sea and Pacific sides of the Solomon Islands during a whale sighting cruise in late November to early December 1993 (Shimada and Pastene, 1995).

Poole (1993) reported that spinner dolphins were present year-round in French Polynesia, having been documented near 16 islands, in or near reef passes and in bays. At Moorea spinner dolphins enter nearshore waters to rest and socialise during the day, tending to remain seaward of the 10 metre contour but preferring passes through the barrier reef and the seaward portions of bays. They generally avoid the deep, dark blue waters of the open ocean until evening hours when they head out to sea, presumably to feed (Poole, 1991a). Some exchange occurs between the spinner dolphin community at Moorea and that around Tahiti (Poole, 1991b). A photograph at sea near Huahine, Society Islands was published by Sylvestre (1986). Spinner dolphins are common around American Samoa (R. Volk, in litt., 2 December 1991), and they at least occasionally enter the lagoon at Enewetak Atoll, Marshall Islands (Reese, 1987). A group of more than 30 spinner dolphins became trapped in Erakor Lagoon, Port Vila, Vanuatu, during December 1994–January 1995. Some individuals from this group, which included newborn calves, were "rescued" and returned to the open sea (Decloitre, 1995).

In our experience spinner dolphins are the cetaceans most likely to be seen around oceanic islands throughout the SPREP region. They are also seen in pelagic areas far from land.

Leatherwood's (unpub. data) observations include the following:

- 28 March 1990—a large group seen outside the reef west of Maeva Beach, Papeete, Tahiti;
- 1 April 1990—two groups seen while leaving Rangiroa Island, Tuamotus, in and just outside Tiputa Passage at 4°57'S, 147°34'W and 4°58'S, 147°33'W. (Tourists from the hotel at Rangiroa often swim with spinner dolphins in this area.);
- 3 April 1990—a large group (>1000 animals), associated with a smaller number of spotted dolphins, between Rangiroa, Tuamotus and Ua Pou, Marquesas, at 9°38'S, 140°33'W (no pink belly, classic Marquesan form);
- 3 April 1990—groups of 30–40 and 30 animals, respectively, at 12 and 2 kilometres off Hakahetau, Ua Pou, Marquesas. The people at Ua Pou reported seeing this species regularly; it was formerly killed in a drive fishery there;
- 4 April 1990—groups of 20, 45, 25 and 50–70, respectively, at Atikea Bay, Anaho Bay, Hatihau Bay and Hane Bay, all in the Marquesas;
- 5 April 1990—groups of 15 and 8–10, respectively, in Bordelais Channel and Autona Bay, Marquesas;
- 6 April 1990—a group of 65 at the entrance of Virgin Bay, Fatu Hiva, Marquesas; and
- 10 April 1990—a large group (with spotted dolphins) about 25 kilometres NW of Papeete, Tahiti.

H. Whitehead (in litt., 12 May 1995) reported sightings near Christmas Island and elsewhere in the Line Islands during mid-September and near the Phoenix Islands in early October 1992.

Winter (boreal) sightings of spinner dolphins just outside the SPREP region to the west, at about 3–4°N, 128–129°E, and north, at about 23°N, 141–142°E, were reported by Miyashita et al. (1996).

Common Dolphins: Short-beaked Form, *Delphinus delphis* Linnaeus, 1758, and Long-beaked Form, *Delphinus capensis* (Gray, 1828)

The cosmopolitan genus *Delphinus* was recently reviewed by Heyning and Perrin (1994), who recognised the two morphologically distinct forms in the eastern North Pacific as separate species. The approximate world distributions as mapped by these authors, based on specimen and sighting records, indicate that short-beaked common dolphins inhabit waters around New Caledonia while long-beaked common dolphins, which are generally more coastal, are not confirmed to be present anywhere in the SPREP region. Since long-beaked common dolphins do occur off southern Japan and around Taiwan, however, they may be present in some parts of the SPREP region. Moreover, the offshore occurrence of short-beaked common dolphins in the eastern tropical Pacific, in an area bounded by 20–40°N and 140–170°W, and from the central American coast seaward in equatorial waters to as far west as about 135°W, points to the possibility that they are distributed more widely in the SPREP region than only near New Caledonia. Miyashita et al. (1995b) reportedly identifed both short- and long-beaked common dolphins in the East China Sea. H. Whitehead (in litt., 12 May 1995) reported a sighting of about 40 common dolphins on 7 November 1992 at 25°27'S, 177°42'W, southwest of Tonga and just outside the southern boundary of the SPREP region.

Fraser's Dolphin, *Lagenodelphis hosei* (Fraser, 1956)

Perrin et al. (1994b) described Fraser's dolphin as a tropical species. Its documented distribution is skewed towards the eastern Pacific, which may reflect the intensity of research associated with the tuna fishery rather than an actually higher density of occurrence there than in other tropical regions. The first record in the central Pacific was a herd of about 400 animals observed and photographed on the equator at 165°W, northeast of the Phoenix Islands, 11 August 1966 (Perrin et al., 1973). Additional sightings (not mentioned by Perrin et al., 1994b) were reported by Miyazaki and Wada (1978b) at 01°33'–03°00'N, 141°55'–142°04'E (herds of 40–50 animals) and 01°43'N, 164°53'E (a herd of 400–500 animals, associated with melon-headed whales), between New Guinea and Micronesia in February 1976. A school of 30 animals was sighted in the Solomon Sea, off the southeastern end of the Solomon archipelago, in early December 1993 (Shimada and Pastene, 1995). Sightings near the western (approx. 08–09°N, 127–128°E) and northern (approx. 23°N, 143°E) borders of the SPREP region were reported by Miyashita et al. (1996).

A photograph from the 1930s documents the occurrence of this species in the Fiji Islands (Baker, 1983, 114). Specimens in the US National Museum are from the Marquesas and Line islands (see 3.2.2, below).

Groups of 50–100 Fraser's dolphins were sighted several times off Moorea, French Polynesia, in January–February 1994, always in association with melon-headed whales (J.C. Sweeney, in litt., 21 February 1995).

Irrawaddy Dolphin, *Orcaella brevirostris* (Gray, 1866)

Its common name refers to a large river in Southeast Asia, but this dolphin also occurs in other rivers, estuaries and coastal marine waters from approximately the Bay of Bengal in the west to the east coast of Australia in the east (Marsh et al., 1985). Within the SPREP region the Irrawaddy dolphin is known to occur only near the coasts of New Guinea, where it ascends rivers to distances of at least 16 kilometres from the sea (Mitchell, 1975b, fig. 12). Dawbin (1972) reported that it was taken accidentally in fishing nets in the Gulf of Papua, but he had no direct evidence of its occurrence on the north coast of New Guinea. Some utilisation of Irrawaddy dolphins in the Purari delta, Gulf of Papua, was suggested by Pernetta and Hill (1981), citing Liem (1983). No details are provided, however, in the latter paper which lists Irrawaddy dolphins among the species used for food, in the context of both the subsistence and cash economies of the delta region.

The only reasonably large population (perhaps 1000 individuals) of Irrawaddy dolphins that has been investigated inhabits the turbid, shallow (2.5–18 metres) waters of Blue Mud Bay in the western Gulf of Carpentaria, northern Australia (Freeland and Bayliss, 1989). The Irrawaddy dolphin may have a somewhat wider distribution in the SPREP region than can be documented at present. However it is not likely to occur regularly outside the coastal waters of Papua New Guinea and possibly parts of the Solomon Islands.

Rough-toothed Dolphin, *Steno bredanensis* (Lesson, 1828)

This dolphin's distribution is worldwide in oceanic tropical and warm temperate waters (Miyazaki and Perrin 1994). Dawbin (1974) described it as being encountered "intermittently" by the dolphin hunters at Malaita in the southern Solomon Islands. Rough-toothed dolphins occur year-round in French Polynesia, often associated with aggregations of birds and near-surface fish schools (Poole, 1993). J.C. Sweeney (in litt., 21 February 1995) reported numerous sightings near Moorea, in groups of up to 21–30 individuals. They were often feeding on flying fish (*Cypselurus simus*) and on at least two occasions were feeding on 5 kg barracudas (*Sphyraena barracuda*). A sighting northeast of the Northern Mariana Islands was reported by Miyashita et al. (1996) during the boreal winter.

The range map by Miyazaki and Perrin (1994) shows records at just north of the equator near 145°E, at about 10°N, 165°E, and at several sites near the Line Islands and Marquesas. As stated by these authors (p. 4), rough-toothed dolphins are "likely to occur in most, if not all, of the tropical and subtropical waters that have not yet been thoroughly investigated". This would include much of the SPREP region. A skull at the US National Museum was collected at Rongerik Atoll, Marshall Islands, in 1946. The animal was killed in the lagoon and eaten by local people (J.G. Mead, pers. comm.).

Southern Bottlenose Whale, *Hyperoodon planifrons* (Flower, 1882)

Although the distribution of this species has traditionally been considered to be circumpolar in the Southern Hemisphere between Antarctica and approximately 30°S, observations and photographs from the tropical and subtropical Pacific have now shown that the range of southern bottlenose whales may extend into the North Pacific (Leatherwood et al., 1982, 92–93; Balcomb, 1987, 96–97; Mead, 1989a; IWC, 1989; Urban, R. et al., 1994). K.C. Balcomb,

III, observed a group of about 25 of these whales, along with some 50 pilot whales, northeast of the Phoenix Islands at the equator, 164°W on 11 August 1966. Additional sightings have been made since then in the same general area, in the northern part of the Philippine Sea and in an area bounded by 80–170°W and 15°N–15°S (IWC, 1989, 120; Wade and Gerrodette, 1993). The SPREP region certainly comprises part of the range of this whale, which is probably *H. planifrons* but could possibly prove to be a species new to science.

Cuvier's Beaked Whale, *Ziphius cavirostris* (G. Cuvier, 1823)

This cosmopolitan beaked whale probably occurs in deep waters throughout much of the SPREP region. Heyning's (1989) map of distribution is largely blank for the SPREP region, but he notes that gaps, such as the one in the tropical central Pacific, "are probably artificial due to a lack of data" (map legend, p. 295). The skull of a male was obtained from New Ireland (Hale, 1931); another skull from Ponape, Micronesia; and another from Sydney Island, Phoenix Islands (J.G. Mead, pers. comm.). References to a stranded specimen from Lindenhafen, New Britain, said to be in a museum in Sydney, Australia, and to a skull found at Treasury Harbour, Solomon Islands, are on file at the US National Museum (J.G. Mead, pers. comm.).

Sightings have been reported near the Nauru and Manus islands by Miyazaki and Wada (1978a), who noted the difficulty of making positive identifications because of these whales' cryptic behavior. Observations near the Mariana and Bonin (Ogasawara) islands were reported by Masaki (1972). At least three strandings have been documented in French Polynesia (Poole, 1993). Sightings have been made in many areas of the tropical South Pacific (Miyashita, pers. comm., October 1991) and off the north coast of Irian Jaya (Leatherwood, unpublished).

Beaked Whales of the Genus *Mesoplodon*

The distribution and biology of this group of oceanic species were reviewed by Mead (1989b). At least four of the 13 presently-recognised species are likely to occur within the SPREP region based on the proximity of strandings, sightings and catches. These are: Blainville's beaked whale (*M. densirostris*), the ginkgo-toothed beaked whale (*M. ginkgodens*), Longman's beaked whale (*M. pacificus*, sometimes assigned to a separate genus *Indopacetus*) and True's beaked whale (*M. mirus*). An additional six species could occur, at least as stragglers. These include Gray's beaked whale (*M. grayi*), the strap-toothed whale (*M. layardii*), Hector's beaked whale (*M. hectori*), Andrews' beaked whale (*M. bowdoini*), Hubbs' beaked whale (*M. carlhubbsi*) and the pygmy beaked whale (*M. peruvianus*). The last-mentioned species was recently described on the basis of several stranded and caught specimens from Peru (Reyes et al., 1991). Urbán-Ramírez and Aurioles-Gamboa (1992) proposed that the pygmy beaked whale's distribution may be limited to the eastern tropical Pacific south of 25°N and north of 15°S.

Dawbin (1974) referred to a record of Blainville's beaked whale from the Solomon Islands but gave no details; this record was not cited by Mead (1989b). Poole (1993) reported seven observations of this species at Moorea, French Polynesia, during the months March–August. He has concluded that Blainville's beaked whales are relatively common in nearshore waters of Moorea (M.M. Poole, in litt., 23 February 1995). In his letter Poole refers to a sighting at Rurutu, French Polynesia, sometime before 1988, to a juvenile male that stranded at Moorea several years ago (Poole collected the skull), and to an adult male photographed while breaching between Tahiti and Moorea. J.C. Sweeney (in litt., 21 February 1995) reported three sightings of small groups of unidentified beaked whales (2–6 individuals) off Moorea in January–February 1994. He estimated their length as 5–6 metres and noted that they had "tusks"; thus they may have been Blainville's beaked whales.

J.G. Mead (pers. comm.) provided two additional unpublished records of Blainville's beaked whales in the SPREP region: a specimen stranded at New Britain on an unspecified date, the skull of which is located in the Museo di Storia Naturale di Genova, Italy; and a skeleton photographed at Rapa Iti, Tubuai Islands, French Polynesia, in 1984.

We found no other confirmed sighting or specimen records of *Mesoplodon spp.* from inside the SPREP boundaries, but this is most likely due to a paucity of reporting rather than to a scarcity of the animals in this region.

3.1.3 Pinnipeds

Pinnipeds are largely absent from the SPREP region. No species is known to be a regular inhabitant. Antarctic phocids, particularly leopard seals and certain of the subantarctic otariids (fur seals; *Arctocephalus spp.*) are perhaps the most likely pinnipeds to appear as "strays" in the southernmost island chains. Eldredge (1991) called attention to the possibility that Hawaiian monk seals (*Monachus schauinslandi*) and northern elephant seals (*Mirounga angustirostris*) could occasionally wander

far enough from their normal ranges to appear at the Marshall or Gilbert islands (cf. Bertram and Bertram, 1973, 310). However the few specimen records to which Eldredge referred were unidentified to species.

Leopard Seal, *Hydrurga leptonyx* (de Blainville, 1820)

Although the leopard seal is primarily distributed in antarctic and subantarctic waters, individuals wander widely and appear as "strays" on continental and island coasts in temperate, and occasionally subtropical, latitudes (Kooyman, 1981). The northernmost records of the species are of two occurrences at Rarotonga, Cook Islands (Berry, 1960 [1961]; King, 1983, 116). In addition, an emaciated leopard seal was photographed at Tubuai, Austral Islands, in October 1981 (Dan Travers, pers. comm., March 1990; see Reeves et al., 1992, 218).

Several other records can be reported here. A leopard seal was caught in a fisherman's net inside the lagoon on the west side of Mangareva Island (Kivimivo/Taku area), Gambier Islands, on 12 August 1983 (Tihoni Reasin, Rikitea, Mangareva, in litt., 10 January 1992). Its skin was shipped to Tahiti for sale. Local people reported that seals of this species had been caught in the area at least once previously (ibid.). Also in the early 1980s, a leopard seal repeatedly appeared near the coral pier adjacent to the village of Akurei on Rapa Island, Austral Islands. The animal behaved passively and eventually took food offered by hand and allowed itself to be touched. Its death was apparently caused by poisoning (Mayor and Councillors of Akurei, pers. comm., 24 March 1990).

All of these records are, not surprisingly, from the southern edge of the SPREP region. They are consistent with Kooyman's (1981, 265) characterisation of leopard seals as "the greatest wanderers of the Antarctic seals".

Southern Fur Seals, *Arctocephalus spp.*

Breeding populations of fur seals occur on the Galápagos Islands (*A. galapagoensis*), Juan Fernández Islands (*A. philippii*), southern Perú and Chile (*A. australis*), southeastern Australia (*A. pusillus* and *A. forsteri* in Tasmania), and both the South and North Island as well as many of the New Zealand subantarctic islands (*A. forsteri*) (Croxall & Gentry, 1987; Reijnders et al., 1993). Individuals from any of these populations could wander into the SPREP region. Several records have come to our attention.

Three young New Zealand fur seals (*A. forsteri*; see King, 1976) came ashore in southern New Caledonia, two in July or August 1972 and one in September 1973. One of them was kept alive for nine months at the Nouméa Aquarium, one was found dead, and the other was killed by a fisherman. Rancurel (1973a, 1973b, 1974, 1975) reasoned, judging from the prevailing currents and wind patterns, that the animals probably originated in southern Australia or New Zealand.

Subantarctic fur seals (*A. tropicalis*), probably from Amsterdam and St. Paul islands, have occurred in increasing numbers in Australia and New Zealand (Taylor, 1992; Gales et al., 1994). Thus some subantarctic fur seals probably wander into portions of the SPREP region as well (N. Gales, pers. comm., May 1995). Most such wanderers are juveniles, and they are difficult to distinguish from other fur seal species.

A fur seal came ashore on Tubuai, Austral Islands, in 1986 and was held briefly in a fenced enclosure and then released (Dan Travers, pers. comm., 27 March 1990). It is not possible to identify the species from the photographs (in Leatherwood's files).

3.1.4 Sirenians

The dugong is the only living sirenian that is indigenous to the South Pacific Ocean.

Dugong, *Dugong dugon* (Müller, 1776)

Dugongs were formerly widely distributed in the tropical and subtropical Indo-western Pacific, including much of Melanesia and western Micronesia (Caroline Islands) but apparently not most of central and eastern Micronesia or the Ellice and Fiji Islands (Bertram and Bertram, 1973; Nishiwaki and Marsh, 1985). Their current range is still extensive but they have been extirpated or severely depleted in many areas. A single dugong observed in Cocos Lagoon, Guam, in the mid-1970s was considered a stray from a distant population, as the species is generally absent from the Marianas (Randall et al., 1975).

Of the five world dugong populations tentatively identified by Nishiwaki et al. (1979), two occur partly in the SPREP region. The approximate boundaries of the range of Population 1 are Vanuatu on the east and 140°E on the west, and the range includes virtually all of Melanesia, Papua New Guinea, and the northeast and east coasts of Australia (south as far as New South Wales). Population 2 is centred along the northwest and west coasts of Australia, Irian Jaya, and northwards to the Philippines. There is no evidence for a hiatus in distribution along the north coast of Australia, so the two "populations" may in fact be one. The animals in Palauan waters have been described as "the most isolated dugong population in the world", with the nearest adjacent groups in Indonesia 800 kilometres to the south

and the Philippines 850 kilometres to the west (Marsh et al., 1995).

An aerial survey in Torres Strait in November 1987 revealed especially high densities of dugongs on the extensive seagrass beds around Badu and extending north across Orman Reef around Buru Island and east to Gabba Island (09°46'S, 142°37'E) (Marsh and Saalfeld, 1988, 1991). High densities were also found around the Warrior Reef complex.

A series of "postal surveys" and aerial surveys during the 1970s and early 1980s documented the wide distribution of dugongs throughout Papua New Guinea (Hudson, 1976, 1981; Ligon and Hudson, 1976). Hudson's (1976) informants reported that groups of 20–50 dugongs were present along the northwest coast of Bougainville Island, the northwest coast of New Britain, all round Manus Island, and along the coasts of West Sepik, East Sepik, and Madang provinces of eastern New Guinea. The occasional presence of dugongs in New Ireland was documented by Williams (1985). Although they are reported to be present in significant numbers in the Western Province of the Solomon Islands, only a few dugongs were seen during aerial surveys of the adjacent Bougainville Island area (B. Hudson in Nishiwaki and Marsh, 1985, 10).

Nishiwaki and Marsh (1985, 9) reported that only "small numbers" of dugongs occur off New Caledonia and Vanuatu. Dugongs were said by Sylvestre and Richer de Forges (1985) to be common in the New Caledonia lagoon. The population of dugongs in New Caledonian waters was estimated at 2000–3000 in the mid 1970s (R. Martini manuscript cited by Marsh and Lefebvre, 1994). A study during 1987–1988, involving aerial surveys and a postal questionnaire survey, found dugongs to be widely distributed throughout Vanuatu (Chambers et al., 1989; Chambers and Bani, 1991). Group sizes were small (mostly <10 individuals), and sightings were mainly close to shore in association with shallow bays and fringing or platform reefs (see also Nicholson, 1996).

The estimated maximal rate of increase for a dugong population is five percent per year, but the actual rate is probably dependent upon the condition of local seagrass beds at any given time (Marsh, 1986, 1988; Marsh and Saalfeld, 1991).

Their reliance on relatively shallow seagrass beds for food limits the ability of dugongs to travel between islands and continents that are separated by extensive areas of deep water. For this reason, many island populations, including those around Vanuatu and Palau, are probably essentially isolated. Such isolation makes these groups of dugongs especially vulnerable to extinction (see Brownell et al., 1981).

3.2 Specimen inventory

Museum abbreviations are as follows:

AMM: Australian Museum, Sydney;

ANSP: Academy of Natural Sciences, Philadelphia, Pennsylvania, USA;

BMNH: British Museum (Natural History), London;

BPBM: Bernice P. Bishop Museum, Honolulu, Hawaii, USA;

MCZ: Museum of Comparative Zoology, Cambridge, Massachusetts, USA;

MONZ: Museum of New Zealand, Wellington;

NSM: National Science Museum, Tokyo;

SAM: South Australian Museum, Adelaide;

SWFC: Southwest Fisheries Science Center, La Jolla, Calfifornia;

USNM: National Museum of Natural History, Washington, D.C.; and

WHD: refers to the William H. Dawbin collection at the Australian Museum (AMM).

3.2.1 Mysticete cetaceans

Balaenoptera edeni

NSM Catalogue: NSM 24569 (S of New Caledonia at 23°12'S, 168°53'E; pelvic bone). Note that numerous other pelvic (NSM 24566–24587) and nasal bone (NSM 24279–24283) specimens from this general area on the southern edge of the SPREP region are available.

***Balaenoptera physalus* (?)**

J.G. Mead (pers. comm.): MONZ 1605 (Port Moresby, Papua New Guinea; 2 baleen plates).

Balaenoptera acutorostrata

J.G. Mead (pers. comm.): USNM 282318 (Ariikan Island, Marshall Islands; vertebra found on beach).

Megaptera novaeangliae

Mead (pers. comm.): USNM 12310, MCZ 7918 (Tonga, baleen, obtained from Charles Scammon—see Scammon 1874)

3.2.2 Odontocete cetaceans

Physeter macrocephalus
J.G. Mead (pers. comm.): MONZ 29 (Fiji; "old carcass")

Kogia simus
J.G. Mead (pers. comm.): USNM 504324 (Guam; fetus preserved in fluid); USNM 504336 (Guam; skull).

Globicephala macrorhynchus
J.G. Mead (pers. comm.): USNM 396081 (Howland Island, near equator north of Phoenix Islands, so just outside SPREP region; skull).

***Globicephala* sp.**
BPBM 2023 (Tuamotu Archipelago; mandible)

Pseudorca crassidens
NSM Catalogue: NSM 24772 (off NW Line Islands at 05°45'N, 162°12'W; juvenile; skeleton).

Tursiops truncatus
Miyazaki and Wada (1978a): NSM 24923 (01°55'S, 148°53'E; skeleton).

NSM Catalogue: NSM 25372 (SW of Palau at 05°14'N, 131°03'E; skull); NSM 25372 (05°14'N, 131°03'E; resting; skull).

T.K. Yamada (in litt.): NSM 29670–29675 (Kukum, Honiara, Solomon Islands; skulls).

J.G. Mead (pers. comm.): USNM 269184 (Howland Island at 00°48'N, 176°38'W; skull and skeleton); USNM 395781 (Jarvis Island, Line Islands, at 00°23'N, 160°01'W; skull, ribs, vertebrae).

Steno bredanensis
J.G. Mead (pers. comm.): USNM 282317 (Rongerik Atoll, Marshall Islands; skull).

Stenella coeruleoalba
Wilson et al. (1987): USNM 395776 (east of Marshall Islands at 09°N, 178°W—just outside SPREP region; Hubbs et al., 1973); USNM 504914 (Marshall Islands); BMNH 71.474 (Malaita, Solomon Islands); USNM 395776 (Sydney Island, Phoenix Islands, 04°30'S, 171°30'W). [Author's note: USNM 395776 appears twice, referring to separate collection localities.]

Stenella attenuata
Perrin et al. (1987) and Gilpatrick et al. (1987): BMNH 1966.11.18.2, 3, 5, 8 (4 specimens, Solomon Islands); WHD 278, 289, 440, 444, 451, 452, 456, 459 (Solomon Islands); AMM 12360–12364, 12366–12382, 12386–12397, 12384 (Solomon Islands); NSM 24924–24927 (Solomon Islands region; skeletons; Miyazaki and Wada, 1978a); NSM 25374 (02°56'N, 149°24'E; skull); NSM 25375 (04°27'N, 149°54'E; resting; skull); NSM 25377 (04°48'N, 149°54'E; skull).

NSM Catalogue: NSM 25371 (05°14'N, 131°03'E; lactating; skull); NSM 23655 (Northern Mariana Islands at 20°39'N,, 149°37'E; immature; skeleton).

T.K. Yamada (in litt.): NSM 26627 (00°28'N, 141°56'E; 195 cm female; skeleton).

Stenella longirostris
Gilpatrick et al. (1987) and Perrin (1990): ANSP 19194, 19195 (Christmas Island, Line Islands); USNM 504251 (Washington Island, Line Islands); USNM 504252 (Rangiroa, Tuamotu Islands); USNM 504253 (Hiva Oa, Marquesas Islands); USNM 395404 (Enewetok Atoll, Marshall Islands); NSM 24928, 24929, 24930, 24931, 24933, 24934 (Solomon Islands region; skeletons; Miyazaki and Wada, 1978a); NSM 24932 (03°11'N, 142°07'E; Miyazaki and Wada, 1978a); NSM 25373 (01°24'S, 147°22'E; skull); NSM 25376 (04°48'N, 149°45'E; resting; skull).

J.G. Mead (pers. comm.): USNM 291958 (Arno Atoll, Marshall Islands; skull); USNM 297851 and 297852 (Ifaluk Atoll, Caroline Islands; skull and partial skeleton, respectively).

Lagenodelphis hosei
NSM Catalogue: NSM 24921 (01°,33'N, 142°,04'E; skeleton; Miyazaki and Wada, 1978a, 1978b).

Peponocephala electra
Perrin and Kashiwada (1989): SWFC WFP0584 (Palau).

NSM Catalogue: NSM 24922 (off Nauru at 01°45'N, 164°53'E; immature; skeleton; Miyazaki and Wada, 1978a).

J.G. Mead (pers. comm.): USNM 395785 (Palmyra Island, Line Islands; skull); USNM 504250 (Nuku Hiva, Marquesas; skull and skeleton).

Ziphius cavirostris
J.G. Mead (pers. comm.): SAM 848 (Kopo, New Ireland; incomplete skull; Hale, 1931); USNM 306284 (Ponape, Caroline Islands; skull); USNM 395775 (Sydney Island, Phoenix Islands; skull).

Mesoplodon densirostris
J.G. Mead (pers. comm.): MSNG 16 (New Britain; skull).

Unidentified cetacean
BPBM 2032 (small cetacean; Marshall Islands; partial skull and vertebrae); BPBM 2078 (odontocete whale; Teraina Island, Line Islands; partial

skeleton); BPBM 2079 (odontocete whale); Rarotonga Island, Cook Islands; tooth).

3.2.3 Pinnipeds

A specimen of *Arctocephalus* sp. that came ashore on the south side of New Caledonia in August 1972 was shipped, frozen, to the Amsterdam Museum after it died in April 1973 (Rancurel, 1975).

3.2.4 Sirenians

Dugong dugon

The skull and skeleton of a specimen caught at Palau in February 1937 was deposited in the university museum, Taihoku Imperial University, now Taiwan National University (Hirasaka, 1939).

NSM Catalogue: NSM 936 (Marukyoku, Palau; skeleton).

3.3 Traditional or local uses of marine mammals

3.3.1 Large cetaceans

The people of Tonga hunted humpback whales in nearshore waters as recently as the 1970s (Keller, 1982). Approximately 11 whaling operations were active in Tonga until a few years before 1979 (Anonymous, 1981). In the last six years of this hunt (1973–78) the total catch was 35 whales, mostly females and including 6 calves (IWC, 1980, 109). Calves were often harpooned first in order to make their mothers easier to approach and kill; it was estimated that at least three whales were struck for each one secured (Anonymous, 1981). Although the hunting of baleen whales had been illegal in Tonga for many years, it was not until 1979 that the killing of humpbacks actually stopped (Anonymous, 1981; Keller, 1982; IWC, 1989, 106). The royal ban on Tongan whaling has been in effect since 1980. A request by a Japan-based company to re-open whaling in Tongan waters was rejected in 1995 (Anonymous, 1995b).

The use of sperm whale teeth as ransom or "barter money" is said to have been introduced to Fiji, from Tonga, during the late 18th century (Derrick, 1950, 71). These teeth became so important in Fijian culture that they eventually came to define the essence of *tabua*, "the price of life and death, the indispensable adjunct to proposals (whether of marriage, alliance, or intrigue), requests and apologies, appeal to the gods, sympathy with the bereaved" (Derrick, 1950, 9). The high importance of polished sperm whale teeth in Fiji continued at least into the 1960s (Lever, 1964) and according to Akimichi (1992) whale-tooth money and ornamentation have maintained their cultural significance in this and some other parts of Oceania. According to IWC (1994b, 17), the Fijian trade in sperm whale teeth "did not relate to a local fishery".

A whalepot for boiling blubber was purchased from a homeward-bound whaler, apparently with the intention of setting up a shore-based whale fishery at Swain's Island, about midway between Samoa and Tokelau, during the mid 1800s. There is no evidence, however, that this initiative ever developed beyond the planning stage (Richards, 1992, 195–196).

3.3.2 Small cetaceans

Local residents of the Solomon Islands traditionally practiced a drive hunt for small cetaceans (hereafter called "porpoise hunting"), with the primary objective of obtaining "porpoise" teeth and meat (Ivens, 1902, 1972; Pepys-Cockerell, 1965, 1973; Dawbin, 1966a, 1972; Boyd, no date; Takekawa 1996a, 1996b). Porpoise teeth are called *nifoi'a* in the Kwaio language (Akin, 1981; Takekawa 1996b). These teeth are sometimes woven into collars or headbands (*biru*) used in blood bounties (Akin, 1993, 881). Necklaces of porpoise teeth remain "essential" to the payment of bride price amongst some Malaitans. Porpoise teeth "have long served as money throughout Malaita, particularly in and around the Lau Lagoon and other areas to the north, and in 'Are'are" (Akin, 1993, 881). In 1994 the hard-currency value of one tooth was set (at Fanalei) at Solomon $0.5, equivalent to about US$0.16 (Takekawa, 1996b). Akin (1981) described and illustrated several types of porpoise tooth ornaments worn on the ears, nose and neck.

Some time before World War II the Lau people stopped porpoise hunting (Boyd, no date). By the late 1950s the people of Malaita were said to have been importing porpoise teeth from Micronesia to fill the local demand. In 1959 the local hunting was "resurrected" (Boyd, no date). Takekawa (1996b) noted that porpoise hunting was "revived" at Fanalei in 1948 and was "introduced" at Walande in 1958 and at villages in northern Malaita thereafter (also see Akimichi, 1992). Porpoise hunting at Malaita underwent a further expansion beginning in 1964, apparently because the availability of Australian currency increased the market demand for the necklaces made with porpoise teeth (Pepys-Cockerell, 1965). Not only were 20 additional large canoes bought from Santa Ysabel for hunting in 1964, but the tradition of allowing an interval of several years to elapse between major hunting episodes where no porpoise hunting occurred was also forsaken beginning in 1964 (Pepys-Cockerell, 1965). As of the mid-1960s the people of Langa Langa sub-district, living on artificial islands behind reefs to the south of Auki on the west coast of

Malaita, no longer hunted cetaceans although they had done so formerly. Only the people of Lau subdistrict on the extreme north and northeast of Malaita, as well as the islanders of Walande and Kwai to the south of Malaita, still hunted cetaceans (Pepys-Cockerell, 1965). The Lau people suspended their hunting for some time during the late 1960s or early 1970s because of a dispute with the Bitaama landowners at Tombaita (Pepys-Cockerell, 1973). The drive hunt at Malaita was apparently not pursued in 1970 (Dawbin in Mitchell, 1975a, 25). An average of 840 small cetaceans were taken per year at Fanelei from 1976 to 1993 (maximum: close to 2000 in 1986; minimum: less than 50 in 1979) (Takekawa 1996b). Pantropical spotted dolphins and spinner dolphins comprise the bulk of the catch at Fanalei (Takekawa 1996b).

Although the species and numbers of cetaceans taken are poorly documented, Dawbin (1966a) confirmed that catches from single drives could be in the hundreds, and he was told that annual catches, apparently in 1964, 1965 and 1966, were several thousand. Pepys-Cockerell (1965) reported that 1392 animals were taken in a single harbour (Bita'ama) between 13 May and 27 June 1964, and that more than 2000 had been taken there by the end of August. As 327 and 365 had been taken earlier that year at Walande and Fanalei, respectively, he estimated a total catch of more than 3000 in 1964.

Most of the cetaceans taken in the Solomon drive fishery are apparently long-snouted oceanic forms, including spinner (*raa*), pantropical spotted (*unubulu*), striped (*robo tetefe*), common (*robo manole*) and rough-toothed dolphins (Dawbin, 1972, 1974; in Mitchell, 1975b, 949; Takekawa 1996a, 1996b). Risso's dolphins were taken occasionally, but their low number of teeth made them of relatively little value to the Malaitans (Dawbin, 1966a). Spotted dolphins were said to be twice as valuable as spinner dolphins because their teeth, though fewer, are considerably larger (Dawbin, 1972). The larger teeth from a small cetacean species known locally as *lobo* were formerly of special importance in blood bounties and in payments to burial parties (Akin, 1981). *Lobo* were still needed for many types of public presentations at "Oloburi and south into 'Are'are" as recently as the early 1990s (Akin 1993, 883). Akin's *lobo* is probably either the melon-headed whale (*robo au*) or, less likely, the bottlenose dolphin (*Tursiops* sp.). According to Takekawa (1996a), melon-headed whales have the most valuable teeth of all. They are rarely taken today, apparently because they are not often seen. Bottlenose dolphins are generally not hunted because they cannot be driven in the usual manner (by clapping stones together underwater) (Takekawa, 1996a).

Accounts of the drive fishery for small cetaceans in the Solomon Islands do not indicate that there was any deliberate management for conservation embedded in the local culture. Although Christianity, introduced in the early 20th century, transformed many of the cultural and "spiritual" aspects of the hunting, it did not discourage the people from continuing their traditional fishery. The conversion to a cash-based economy, with the need for currency being met primarily by coconut farming and cattle raising, apparently has had a much more profound effect on the porpoise hunt than has Christianity (Boyd, n.d.).

Reference is made in Mitchell (1975b, 949) to similar drive hunting in New Guinea, citing Dawbin (1966a) as the authority. However the only reference in Dawbin (1966a) is to the fact that the author "requested sample catches from other parts of the Solomon Islands and Papua-New Guinea". Akimichi (1992) claimed that harpoons were used to kill sea turtles, sharks, dugongs and small cetaceans ("porpoises") at Manus, Admiralty Islands. He speculated that the technique was introduced there by Germans in the 1930s. He reported having received three specimens from Rabaul, New Britain, PNG, but gave no indication as to how or by whom they were captured. We have found no definite evidence of a drive hunt for small cetaceans in Papua New Guinea. According to Dawbin (1972), spinner dolphins were formerly hunted for meat and teeth (currency) from the village of Nova, Buka Passage, far northwestern Solomons. The finding of Risso's dolphin remains in archaeological material at Motupore Island, Bootless Inlet, southeastern New Guinea, led Pernetta and Hill (1981) to consider the possibility that small cetaceans were once hunted there opportunistically.

Small cetaceans were said to be prized as food in the Gilbert Islands (Kiribati), and some drive hunting apparently occurred there until at least as recently as the early 1980s (Tenakanai and Uwate, 1984). "Porpoise" teeth have been used there as currency and ornaments (Akimichi, 1992). A drive hunt similar to that in the Solomons also occurred on Woleai Atoll in the western Caroline Islands. According to Alkire (1968), who visited Woleai in 1965, the most recent catch of "porpoises" in the western lagoon was in 1953.

Leatherwood (unpub. data, 1990) was told by villagers on Ua Pou, Marquesas Islands, that there had been a drive hunt for small cetaceans at several villages on the island (also see IWC, 1994b, 17). The technique apparently was similar to that used in the Solomons, with men in many boats clanging rocks together underwater to drive dolphins, mainly spinner dolphins, inshore or onshore. The meat was cooked with onions and coconut milk, and the teeth were used for money. The hunt had been banned

some time before Leatherwood's visit (April 1990), and the most recent catches had been made more than ten years previously (on the east side of the island). The village of Hakehetau was known as the place where dolphin-tooth necklaces were made.

An early observation of local people on Saipan, Mariana Islands, driving a herd of 80 "sperm whales" ashore and feasting on them (Costenoble, 1905) has been interpreted as likely evidence of "porpoise" (= dolphin) hunting (Kami and Lujan, 1976). We are unable to evaluate this report. It does, however, seem sufficient to indicate that a drive hunt for cetaceans occurred at Saipan during the late 19th and early 20th centuries.

People in the Marshall Islands and Kiribati have harpooned small cetaceans for food (Reese, 1987; also see IWC, 1994b, 18), particularly after the animals have become disoriented and trapped inside atoll lagoons (Nitta, 1994). The killing of small cetaceans by Fiji islanders can be inferred from the photograph published by Baker (1983, 114), showing a Fraser's dolphin near a man with a spear. Baker's caption indicates that the dolphin was speared in Fiji in the 1930s. Rancurel (1973b) noted that a pilot whale "was stranded on the reef and killed by native fishermen" at Efate, Vanuatu, in 1972. Whether any use was made of the animal before it was buried is uncertain from Rancurel's account.

Akimichi's review (1992) of cetacean hunting in Oceania includes references to the driving or harpooning of small cetaceans at Manus (see above), Malaita (see above), Tuamotu and Marquesas (in the past), Tonga, the Caroline Islands (including Woleai; see above) and Mokil in eastern Micronesia.

3.3.3 Dugongs

Dugongs have been hunted throughout their range and are endangered in most areas outside Australia as a result (Bertram and Bertram, 1973; Nishiwaki and Marsh, 1985).

Dugong hunting has long been central to the subsistence economy and culture of Torres Strait Islanders (Nietschmann and Nietschmann, 1981) and to people throughout much of Papua New Guinea (Hudson, 1976, 1977, 1982, 1986a, 1986b, 1986c; Pernetta and Hill, 1981). The Kiwai living around the Fly River delta traditionally hunted dugongs by harpooning them from temporary platforms built in reef areas (Olewale and Sedu, 1982). This hunting method was replaced in the early 20th century by the use of two-masted, double-hulled canoes, from which the dugongs are harpooned mainly at night. Pregnant females apparently have always been hunted selectively; they are preferred because of their fatness and because fetuses provide good food for older people who have difficulty chewing (Olewale and Sedu, 1982). Dugong meat and oil are valuable as food and medicine (oil only), and they have provided the hunting communities with something to trade for sago, tobacco and money (Olewale and Sedu, 1982).

Hudson (1982) and Olewale and Sedu (1982) sought examples of ways in which traditional hunting methods in Papua New Guinea might have conserved dugongs, but they found few. Hudson (1982) noted that in Manus Province (especially at Baluan Island) a "tambu" against the hunting and eating of dugongs by a particular clan may have reduced somewhat the traditional hunting pressure. Also, the ritual importance of dugongs in marriages and funerals on Baluan Island meant that they were hunted there only irregularly. The reef tenure system meant that even this occasional hunting was spatially constrained. In contrast to these examples, the strong traditional preference for fat, pregnant female dugongs (Olewale and Sedu, 1982) probably meant that hunters traditionally removed more of this critical segment of the population than they would have if the hunting had been unselective.

The introduction of motor transport and nets in Papua New Guinea and northern Australia has had devastating effects on dugong populations (Marsh et al., 1984; Hudson, 1986a, 1986b, 1986c; Marsh, 1986a, 1986b). Netting intensified with development of markets for barramundi (*Lates calcarifer*) and crayfish (*Panulirus ornatus*) in both countries. Trawlers and other commercial fishing boats have sometimes been used as "mother ships" for dugong hunting on offshore reefs.

The dugong was given legal protection in Papua New Guinea in 1976, which made sale of products illegal but allowed continued "traditional" hunting and use of dugong products (Hudson, 1977, 1986b). This protection proved unenforceable in the case of the Kiwai, and they were encouraged to develop the Maza Wildlife Management Area, where the exploitation of dugongs and the selling of their meat would be subject to community regulation and monitoring. The approach was unsuccessful. The legally protected status of 1976 was reinstituted, and the sale of dugong meat at markets in Daru was again prohibited (Hudson, 1986a, 1986b).

The people of the Arawe Islands, West New Britain, have long hunted dugongs with fibre nets (Hudson, 1980). The people living on the Trobriand and Manus islands used nets made of pandanus palm leaves, while the people from the Siassi Islands used tree bark for making their dugong nets (Pyne, 1972). Dugongs still play a large role in the cultural life of the people living on Pilopilo Island, where the bones are used to make spears and other weapons, the skin and teeth to make jewellery and ornaments (Hudson 1980). It was estimated in the late 1970s

that about 10–20 dugongs were killed annually in the Arawe Islands, on each occasion a cause for feasting and celebration (Hudson 1980).

There was said to be a tradition of not harming dugongs in Nokon, New Ireland. The meat of one that was killed in 1985, apparently by gunshot, was not eaten (Greenwell, 1985; Williams, 1985). This would seem exceptional for Papua New Guinea in general, as there is a widespread tradition of dugong hunting throughout much of the archipelago.

Dugongs are generally protected in New Caledonia although permits are issued occasionally to authorise hunting for festivals. The animals are taken with harpoons or nets. Sixteen individuals were reported to have been taken between 1978 and 1984 (Sylvestre and Richer de Forges, 1985).

Dugongs are hunted on a small scale in some parts of Vanuatu (Chambers and Bani, 1988, 1991; Chambers et al., 1989) even though marine mammals are explicitly protected from fishing under the Vanuatu Fisheries Act of 1982. Dugong hunting in Vanuatu is largely opportunistic and limited to only a few communities. The species apparently does not play a significant role in local cultures there (Chambers and Bani, 1988).

In Palau dugongs were traditionally hunted with heavy spears thrown from canoes (Johannes, 1981; cf. Harry, 1956). They were a staple food source as recently as the 1920s (Kramer, 1929); there was even some inter-village commerce in dugong meat (Kubary, 1895). Dugongs were legally protected in Palau beginning in the early 1930s (Hirasaka, 1934), and they were given further protection by a Palau District Order in the early 1950s (Brownell et al., 1981). Nevertheless, the introduction of outboard engines and firearms has increased the ability of Palauans to find, follow and kill these animals, and poaching has been widespread. Explosives, apparently introduced by Japanese prior to World War II and widely available to fishermen and hunters since the war, were also used, at least until recently, to kill dugongs (Brownell et al., 1981; Rathbun et al., 1988). This use may now have stopped (Marsh et al., 1995). The additional protection given dugongs in Palau under the U.S. Marine Mammal Protection Act of 1972, US Endangered Species Act of 1973, and Trust Territory Endangered Species Act of 1975 (Brownell et al., 1981) has failed to stop the poaching (Johannes, 1981; Brownell et al., 1981; Rathbun et al., 1988; Marsh et al., 1995). The use of dugong vertebrae as wristlets in Palau has been continuous since at least the 18th century (Keate, 1788; Kramer, 1929; Hirasaka, 1934; Brownell et al., 1981), but this use was deemed "of minor relevance" in a recent study (Marsh et al., 1995). Ribs are used to some extent for carving jewelry (Marsh et al., 1995).

3.4 Commercial whaling

Pelagic whaling from sailing ships probably began in the tropical Pacific Ocean in the early 1800s. The first whaleship on record as having visited Samoa, for example, was the Nantucket vessel *Maro* in 1824 (Richards, no date). British whalers visited these waters as early as 1827–28. According to Richards (n.d., 12) at least 528 visits were made by 328 whaleships to Samoan waters between 1824 and 1878. After the first decade or two, the main reason for such visitation was provisioning rather than whaling.

Most of the 19th century whaling effort at the offshore islands and island groups in the tropical Pacific was centred on the sperm whale (Searles, 1936; Derrick, 1950; Dodge, 1971; Langdon, 1978, 1984; Forster, 1985, 1991; Richards, n.d.) although the migratory populations of humpbacks were also hunted, particularly around Tonga, Fiji and New Caledonia (Townsend, 1935; Lever, 1964).

Mitchell (1983) documented in detail a multi-year whaling cruise by the *Mariner* to the Pacific Ocean in the 1830s to 1840s, which included four seasons of whaling for sperm whales "on the line", i.e. off the Marquesas, Line and Phoenix islands, or in the Tuamotu Archipelago. According to Mitchell (1983), the *Mariner*'s itinerary was representative of the American whaling fleet in the Pacific at the time (cf. Wilkes, 1845; Hohman, 1928; Townsend, 1935; Bennett, 1840).

Modern shore whaling was initiated at the Ryukyu Islands, between southern Japan and Taiwan, in 1954 (Nishiwaki, 1959). Although initially involving mainly humpback whales, this whaling came to include more sperm whales and Bryde's whales as the quotas on humpbacks were lowered. Modern whaling for Bryde's whales was conducted by the Japanese on an "experimental" basis in the Solomon Sea and south of Vanuatu and Fiji during the Antarctic seasons 1976/77 to 1978/79 (Ohsumi, 1980b).

It is important to recognise that much commercial whaling outside the SPREP region has involved stocks of whales that migrate into the region seasonally. Whaling in the Antarctic and North Pacific has thus seriously affected the numbers of whales using the SPREP region.

3.5 By-catch in fisheries

Large by-catches of cetaceans in fisheries have occurred in many parts of the world (Northridge, 1984, 1991a; Perrin et al., 1994). Information on

gillnet and trap fisheries throughout most of the SPREP region is inadequate to judge effects on marine mammals (see IWC, 1994b, 18). It is fair to assume, however, that by-catches have occurred whenever set or drifting gillnets have been deployed in areas inhabited by cetaceans. Modern gear (mostly made of synthetic materials) has replaced traditional gear (mostly made of natural materials), and it has become difficult to distinguish among recreational, commercial and subsistence fishing (e.g. Nitta, 1994).

In the southeastern part of the SPREP region (eastwards from Fiji), passive fishing gear consists mainly of drift gillnets, deep and shallow set nets, and reef-top and reef-passage set gillnets (IWC, 1994b, 17). No information is available on cetacean by-catches in this area.

Experimental and large-scale pelagic driftnets have been used in the South Pacific since the mid-1970s (Northridge, 1991b; IWC, 1994b). Large by-catches of small cetaceans are known to have been made in the Taiwanese driftnet fishery for sharks, Spanish mackerel (*Scomberomorus spp.*) and long-tail tuna (*Thunnus tonggol*) in the Arafura Sea, between northern Australia and Irian Jaya, from 1974 to at least 1986 (Harwood and Hembree, 1987; Northridge, 1991b). When Australia forced the closure of this fishery in the Australian Fishing Zone in 1986, largely because of the by-catch of small cetaceans, the fleet relocated its operations into the Indonesian sector of the Arafura Sea (Richards, 1994).

Other large-scale driftnet fisheries have operated in the South Pacific. A joint Taiwan–PNG shark fishery in the western Gulf of Papua operated between 1980 and 1992. Although the cetacean by-catch was not monitored systematically, reports from crew members suggest that cetaceans were taken "frequently" (Richards, 1994). Taiwanese and Japanese driftnet fishing in the Tasman Sea is known to have taken large numbers of cetaceans, especially common dolphins and striped dolphins (Wright and Doulman, 1991; Watanabe, 1994; Hayase and Watanabe, 1994; Hagler 1994). Driftnet fishing for tuna was done by Japanese and Taiwanese vessels from the mid-1980s to early 1990s in the subtropical convergence zone south of Tonga, French Polynesia and the Cook Islands, but little is known of their incidental catch of marine mammals (Sharples et al., 1991; Richards, 1994).

A worldwide moratorium on high-seas driftnet fishing was established by the United Nations in the early 1990s, and since then the scale of such activities in the South Pacific has been dramatically reduced.

It was noted in the New Zealand annual progress report to the IWC that the one tuna purse seiner under New Zealand registry operating outside the New Zealand Exclusive Economic Zone around the Solomon Islands and New Caledonia in 1980–81 set only on schoolfish and thus did not take small cetaceans as a by-catch (Anonymous, 1982).

Substantial numbers of dugongs have been killed in gillnets and shark-meshing nets in many areas (e.g. Heinsohn et al., 1976; Compost, 1978; Brownell et al., 1981; Marsh et al., 1984; Marsh, 1986b, 1988). These animals are clearly susceptible to entanglement, so we assume that by-catches occur whenever nets are set in areas used by dugongs. Occasional by-catches of dugongs are also made by trawlers (Hudson, 1986a).

Dugongs are killed, whether by accident or design, when explosives are used for fishing. The impact of dynamite fishing on dugongs, reefs and fish stocks led to a ban on this practice in Manus Province, Papua New Guinea (Hudson, 1982).

3.6 Other causes of mortality or removals from natural populations

Collisions with vessels kill and seriously injure marine mammals. This cause of mortality, however, is poorly documented except in those few instances when an endangered population is being closely monitored. For example, collisions with boats and barges are responsible for a large proportion of the deaths of West Indian manatees (*Trichechus manatus*) in Florida, USA (O'Shea et al., 1985). Dugongs in most areas do not appear to be as susceptible to such collisions as are manatees. In Palau, the lack of scars on dugongs observed during aerial surveys has been interpreted as suggesting that boat strikes are "uncommon" there (Brownell et al., 1981). A "diver-friendly" dugong in Lamenu Bay, Epi Island, Vanuatu, has a gouge in its back, thought to have been made by a boat propeller (Nicholson, 1996).

Large whales are struck and killed or injured by vessels with surprising frequency. An analysis of scarring and deaths in North Atlantic right whales (*Eubalaena glacialis*) showed ship collisions to be a serious problem for this endangered species (Kraus, 1990). Even after allowing for the fact that many collisions happen post-mortem, S.D. Kraus (pers. comm., April 1995) has estimated that some 1000 large whales die each year from ship strikes worldwide. One of us (Stone) has learned that each year at least one or two ships arrive in Auckland, New Zealand, with the carcass of a balaenopterid

(groove-throated) whale draped over the bow anchors. The vessel captain apparently does not realise that his vessel has struck a whale until he reaches port. Many ships are too large for the crew to feel the impact of hitting a whale; the only indication is a slight loss of speed and a change in the wake pattern off the bow (Patten et al., 1980).

Whales occasionally interact with fishermen in ways that are dangerous to both parties. For example, two fishermen in Samoa died when a whale that had become entangled with an anchor line overturned their boat (McCoy, 1987).

Samoan fishermen have reported that "porpoises" (i.e. small odontocetes) take fish off trolling lines near at least one fish-aggregating device. This problem is similar to that in Hawaii (Schlais, 1984; Nitta and Henderson, 1993; Kobayashi and Kawamoto, 1995) and could lead to calls for control measures against the cetaceans.

Substantial damage was said to have been done by killer whales to Japanese longline fisheries for tuna in the equatorial Pacific during the 1950s and early 1960s (Iwashita et al., 1963). Although killer whales do occur in Pacific equatorial waters (e.g. Dahlheim et al., 1982; Miyashita et al., 1995a; see also section 3.1.2), we regard the identities of the cetaceans involved in interactions with tuna longlines as uncertain. Other "blackfish", especially false killer whales, could have contributed to the damage and led to at least some of the complaints from fishermen recorded by Iwashita et al. (cf. Leatherwood et al., 1991b, 42)

Small cetaceans were reported to be having an adverse effect on subsistence fishing for flying fish (Exocoetidae) in Arorae and Tamana islands, the two most southern islands in the Gilbert group (Kiribati) (Tenakanai and Uwate, 1984). The fishermen fished at night, using leaf torches and long-poled scoop nets. Cetaceans would take advantage of the light attraction and prey on the fish before the fishermen were able to scoop them into their nets. It was suggested that the driving techniques used to capture small cetaceans in other parts of the western Pacific might be used to herd problem animals away from the fishing areas (Tenakanai and Uwate, 1984). Poole (1993) also reported that rough-toothed dolphins were implicated in interactions with fisheries in French Polynesia.

Marine mammals have been live-captured for display in many parts of the world, but relatively little of this activity has occurred in the SPREP region. An oceanarium in Tahiti had spinner dolphins on display at some time in the past (J.C. Sweeney, pers. comm., 8 September 1994), and a dugong that had been speared by a Palau islander was taken alive to Steinhart Aquarium, San Francisco, California, in 1955 (Harry, 1956). Another dugong was on display at a local aquarium in New Caledonia, apparently in the 1960s (Bertram and Bertram, 1973, 310). An oceanarium in Port Moresby, PNG, had at least one dolphin in residence, but this facility is now closed (Eldredge, unpub. data). In early 1994 a US-based business enterprise (Dolphin Quest) live-captured seven small cetaceans (3 rough-toothed dolphins and 4 melon-headed whales) in the vicinity of Moorea, Tahiti. The animals were held in a sea pen in the lagoon at Moorea. After failing to adapt to captivity, the melon-headed whales were released within a few weeks after capture. Two of the three rough-toothed dolphins died soon afterward (M.M. Poole, in litt., 26 March 1994; J.C. Sweeney, pers. comm.), but as of February 1996 two rough-toothed dolphins were in residence at Dolphin Quest (Renato Lenzi, in litt., 4 February 1996).

4. Conclusions and recommendations

4.1 Large cetaceans

Sperm, humpback, Bryde's, and minke whales are believed to use areas within the SPREP region for calving, calf rearing and mating. Other large whales, particularly fin, blue, and possibly sei whales, may also regularly migrate into the region. Knowledge of the distribution, movements, abundance, and stock affinities of SPREP region populations of all these species is, however, rudimentary. The need for international cooperation in safeguarding the stocks of such wide-ranging, economically valuable animals is obvious, yet so is the historic failure of the IWC to accomplish this difficult mission. Considerable illegal whaling was done on Bryde's whales and other species (sperm, humpback and gray) in the western Pacific during the 1970s (Frizell et al., 1980; Brownell, 1981; IWC, 1981). At least some of these whales were killed within the SPREP region (western Caroline Islands), and some of those killed outside the SPREP boundaries probably belonged to stocks that use the SPREP region seasonally. Additional illegal whaling was done during 1983–86, including 13 trips into the areas of Palau and the western Caroline Islands (Greenpeace Environmental Trust, 1987?).

In spite of the current worldwide moratorium on commercial whaling, meat from baleen whales has continued to be sold in Japan. Some of this meat has been from species or stocks other than those subject to exploitation under special scientific permits (Baker and Palumbi, 1994). Thus the danger still exists that small, resident stocks in remote areas (e.g. the "Solomon stock" of Bryde's whale) could be seriously affected by illegal whaling operations.

The Southern Ocean Sanctuary was adopted by the IWC at its 47th annual meeting in 1994. The sanctuary boundary in the Pacific is at 40°S between 130°E and 130°W, and at 60°S between 130°W and 50°W. Commercial whaling is prohibited within the sanctuary. In effect, the sanctuary provides full protection from whaling to all of the commercially important whales during that part of the year when they are south of the sanctuary boundary. Terms of the sanctuary are subject to review every 10 years, with the first review due in 2004.

Besides continuing to pursue conservation goals within the IWC framework, countries in the SPREP region should take the initiative in establishing coordinated programmes to investigate and monitor whale populations in the region. The humpback whale provides a useful model for building such a programme. Due to its tendency to use shallow, near-shore waters, and to behave conspicuously near the surface (breaching, lifting flukes and flippers into the air, blowing visibly), the humpback is comparatively well known. Collaborative, broad-scale investigations of humpback populations are underway in many parts of the world (e.g. see Katona, 1990; Hammond *et al.*, 1990), including the SPREP region (e.g. see Baker et al., 1993, 1994; IWC, 1994). We therefore recommend that SPREP use the humpback as a focal species for developing a research and conservation programme for large whales. Scientists in Australia and New Zealand (cf. Baker et al., 1993; Paterson and Paterson, 1994; Garrigue and Gill, 1994) should be encouraged and supported to work collaboratively with scientists in SPREP countries, using photodocumentation, genetic sampling, abundance surveys, and other appropriate research approaches (see 4.4 below).

The problem of vessel collisions may be particularly important for populations of large whales (see 3.6, above). In addition to a more general programme of documenting cetacean mortality through stranding and sighting networks (see 4.4, below), we recommend that SPREP initiate and coordinate a survey of port authorities in the region to explore the nature and magnitude of vessel collisions involving large whales.

4.2 Small cetaceans

4.2.1 Solomon Islands

Since Dawbin's (1966a) landmark study of the hunt for small cetaceans on Malaita, little has been learned about this hunt's implications for biological conservation. In Dawbin's words: "In 1964, for reasons that are still not completely clear, the scale of hunting increased enormously and became a regular occupation during a large part of the year, resulting in catches of several thousand animals per year since that time". Market changes that may have increased the incentive for large catches, together with the large reported catches for some years (Pepys-Cockerell, 1965), warrant concern. Although some recent information on historical, cultural and economic aspects of the hunting is

available (Boyd, n.d.; Akimichi, 1992; Takekawa, 1996a, 1996b), a biological assessment of the exploited cetacean stocks is needed. Of particular interest and concern is the possibility that melon-headed whales have been depleted, at least locally if not regionally, by the traditional hunting in the Solomons (cf. Takekawa, 1996a). Any investigation of the situation should be undertaken with sensitivity for the knowledge, values and interests of the local people. Unless some additional documentation and evaluation of the biological impacts of the Solomons hunt has been completed in recent years without our knowledge, we consider this subject a high priority.

4.2.2 Other directed and incidental fisheries

The sparse information concerning directed takes and by-catches of small and medium-sized cetaceans contained in this report is not likely to represent the full range and scale of these types of mortality. Drive hunts reported to occur (or to have occurred) in the Gilbert, Marquesas and western Caroline Islands and in other areas (see Akimichi, 1992) warrant further investigation. A systematic effort should be made to identify and evaluate cetacean-fishery interactions in the SPREP region. The particularly devastating effects of large-scale driftnet fisheries (Richards, 1994) make it necessary to maintain vigilance and prevent any resumption of such activities (see IWC, 1994b, 18). Large-scale driftnet fishing is incompatible with conservation, not only of marine mammals but of target and non-target fishes, birds and reptiles. Unmonitored and unregulated smaller-scale gillnet activities are similarly wasteful and imprudent. The reference by Akimichi (1992) to the capture of Risso's dolphins in a purse seine off the Solomons in 1990 raises the possibility that cetaceans are taken deliberately in active fishing gear. According to Akimichi (1992, p. 136) the meat of the Risso's dolphins was either consumed by the fishermen or sold at the town market, and the teeth were either kept or used as gifts. As he put it, "This new business reminded the people of their traditional culture of porpoise teeth money".

4.3 Dugong

4.3.1 Torres Strait and Papua New Guinea

Marsh et al. (1984), Marsh (1986a, 1986b) and Hudson (1986a, 1986b) expressed strong concern that the killing of dugongs in the Torres Strait area since the mid-1970s was unsustainable, causing serious depletion of the population. Based on available catch data, a population estimate from aerial surveys in 1987 and current understanding of dugong life history, Marsh and Saalfeld (1991) were unable to confirm whether or not the dugong catch in Torres Strait was sustainable. Their "minimum population estimate" in November 1987 was 12 522 ± SE 1487 dugongs within the Torres Strait region and adjacent waters of the Great Barrier Reef Marine Park. The annual catch of dugongs in the Torres Strait area was at least 500–1000 for at least part of the period 1975–1982 (Marsh, 1986a), but it apparently declined substantially thereafter (Hudson, 1986c; Marsh and Saalfeld, 1988, 1991; Johannes and MacFarlane, 1991).

Marsh and Saalfeld (1991, 193) stated their concern that the situation of the dugong population in Torres Strait "has the potential to deteriorate rapidly if catches increase". It follows that:

- effort should be made to prevent any increase in catches;
- legal catches in both northern Australia and Papua New Guinea should be carefully monitored; and
- aerial surveys should be repeated at 5-year intervals as recommended by Marsh and Saalfeld (1989).

In addition, more of the dugong's range in Australian and Papuan waters waters should be included within sanctuaries, either by increasing the extent of existing protected areas or by developing new sanctuaries in high-density areas (see Marsh and Saalfeld, 1988, 1991).

4.3.2 Isolated island populations

Although Chambers et al. (1989) and Chambers and Bani (1991) concluded that dugongs are not threatened by either exploitation or habitat degradation in Vanuatu, the total population of dugongs inhabiting this archipelago is apparently not large. Also, there is relatively little suitable dugong habitat in Vanuatu, and the prospect of immigration from other, larger dugong populations is remote. This small, presumably isolated Vanuatu population, along with that in New Caledonia, should be closely monitored. Conservation measures should be developed, or reinforced, in both areas.

The situation is particularly critical in Palau. There, further research to document the dugong's status is far less relevant than is the urgent need for effective conservation measures. The call by Marsh et al. (1995) for a comprehensive programme of marine resource conservation, encompassing the entire Palauan archipelago, should be pursued as a

top priority for SPREP. Specific recommendations offered by Marsh et al. (1992) include much stricter enforcement of the ban on dugong hunting, stopping the illegal sale of jewellery made from dugong bone, initiation of a culturally appropriate public education programme, and the development of marine reserves in areas where sub-aquatic vegetation is suitable for dugongs.

4.4 General

It is important that marine mammals be explicitly considered in regimes intended to manage the exploitation of living marine resources. This imperative applies at many levels, from local to global. From geographical and ecological perspectives, populations of marine mammals can exist at vastly different scales. Some whale (and dolphin) populations may range across an entire ocean basin, whereas some dolphin communities and dugong stocks, in particular, may be resident near isolated islands or archipelagoes. Given the high mobility and advanced technology available in the industrialised world, all marine resources are vulnerable to distant-water fishing operations (e.g. factory-ship whaling, pelagic driftnets). Coastal resources need some kind of protection from both invasive "foreign" (pelagic) exploitation as well as local "indigenous" (shore-based) exploitation. We therefore believe that SPREP should be actively pursuing local and global initiatives simultaneously.

Some of the foregoing suggestions depend on the development of a mechanism (or mechanisms) to ensure the regular exchange of information among SPREP countries. We therefore recommend that national and international regulatory agencies in the SPREP region establish bodies (committees, working groups, etc.) specifically charged with obtaining information on marine mammals. These bodies should meet annually and require participants to report on new findings, problems, and plans. The present report should be used as a basis for opening a critical dialogue: gaps in information should be filled, uncertainties removed, mistakes rectified, and obsolete conclusions updated. Fisheries that involve marine mammals in some way (by-catches, direct killing, resource competition, gear damage, etc.) need to be identified and scrutinised.

It is critical that expertise be developed within the SPREP region. To this end, we recommend that SPREP consider the possibility of supporting a course in marine mammal biology and conservation at the University of the South Pacific. The purpose would be to provide students with basic knowledge, stimulate local interest in marine mammal science and conservation and, in the process, advance SPREP's long-term conservation objectives.

We also wish to call attention to the potential value of cetacean "watching" in those areas where whales or dolphins are commonly present. An appropriately managed tourism enterprise can provide significant economic benefits while at the same time raising awareness, educating people, and in some cases contributing to scientific knowledge.

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Annex 1
Summary of marine mammals in the SPREP region

Species	Known or probable temporal & spatial species occurrence	Comments
Minke whales *Balaenoptera acutorostrata* and *B. bonaerensis*	*B. bonaerensis* migrates into region from S during austral winter and occurs widely, with largest known concentrations at E end of Tuamotu Archipelago and from A. Samoa and Niue east to Tahiti. Dwarf form of *B. acutorostrata* known from New Caledonia.	Region may be important breeding ground for *B. bonaerensis* that summer in Antarctic.
Bryde's whale Balaenoptera edeni	All year, throughout region; dwarf form in Solomon Sea.	Pantropical, probably most abundant mysticete in region; at least some groups migratory.
Sei whale *Balaenoptera borealis*	Some probably enter N and S margins of region in winter.	Mainly limited to temperate waters, often confused with Bryde's whale.
Fin whale *Balaenoptera physalus*	Not known from region.	Mainly distributed in higher latitudes but may migrate into region in winter; can be confused with Bryde's whale.
Blue whale *Balaenoptera musculus*	Definitely known only from Solomon Sea in August.	Pygmy blue whales (*B. musculus brevicauda*) likely to occur in region, possibly year-round. Normal (Antarctic) blue whales would be likely to migrate into region in winter.
Humpback whale *Megaptera novaeangliae*	Mainly June–September in S. hemisphere; many sites. Mainly Jan.–March in N. hemisphere, N. Marianas.	Numerous calving, nursing and mating areas for S. hemisphere (Antarctic) animals; also at least one N. hemisphere stock reaches N. Marianas.
Sperm whale Physeter macrocephalus	All year; throughout region.	May still be most abundant large cetacean in region despite reduction in numbers from whaling; large historical database.
Pygmy sperm whale Kogia breviceps	Uncertain; probably throughout much of region; strandings in Guam and New Caledonia.	Rarely observed at sea; known mainly from strandings.
Dwarf sperm whale *Kogia simus*	All year; probably found throughout region; strandings in Guam and New Caledonia.	Rarely observed at sea; known in most areas mainly from strandings.

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Short-finned pilot whale *Globicephala macrorhynchus*	All year; probably found throughout region.	Usually seen in groups of 10 or more individuals; prone to mass strand.
Killer whale *Orcinus orca*	Widespread, probably year-round; some groups may migrate, others not.	Probably not abundant, but small pods can appear anywhere in region.
False killer whale *Pseudorca crassidens*	All year; throughout region.	Target of drive hunt in Solomons.
Melon-headed whale *Peponocephala electra*	All year; throughout region. (Can be difficult to distinguish from *Pseudorca* and *Feresa.)*	Records (mostly strandings) from many parts of region.
Pygmy killer whale *Feresa attenuata*	Likely to occur all year in many parts of region; large group seen near New Ireland, PNG, in March.	Circumglobal in tropical and subtropical waters. Difficult to distinguish from *Peponocephala.*
Risso's dolphin *Grampus griseus*	Likely to occur all year in many parts of region.	Cosmopolitan.
Bottlenose dolphin *Tursiops truncatus*	All year in many parts of region.	Cosmopolitan, with populations often associated with island shelf areas.
Short-beaked common dolphin *Delphinus delphis*	Around New Caledonia and probably elsewhere in region, especially in more temperate latitudes, all year.	Genus recently split into two species: short-beaked and long-beaked. Region may also have some long-beaked in near-shore regions or in northwest area.
Striped dolphin *Stenella coeruleoalba*	Likely to occur all year in many parts of region.	Distributed worldwide in tropical and warm temperate waters.
Pantropical spotted dolphin *Stenella attenuata*	All year in many parts of region.	Pantropical distribution; abundant.
Spinner dolphin *Stenella longirostris*	All year in many parts of region.	Pantropical distribution; abundant.
Fraser's dolphin *Lagenodelphis hosei*	Likely to occur all year in many parts of region.	Tropical, many sightings in eastern Pacific on tuna fishing grounds.
Lagenorhynchus spp.	Not known.	Only one published record in region, near Cook Islands, probably Peale's dolphin, *L. australis.*
Irrawaddy dolphin *Orcaella brevirostris*	New Guinean rivers, estuaries and coastal marine waters, probably year-round.	Overall range: Bay of Bengal to SE Asia, Indonesia, N and E coasts of Australia. Possibly occurs in parts of Solomons.
Rough-toothed dolphin *Steno bredanensis*	Likely to occur all year in many parts of region.	Distributed worldwide in oceanic tropical and warm temperate waters.

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Indo-Pacific *humpbacked* dolphin *Sousa chinensis*	Definitely known only from S. coast of PNG.	Coastal and estuarine distribution along N. Australia, S. Asia and E. Africa; occasionally near large islands away from continental coasts.
Southern bottlenose whale *Hyperoodon planifrons*	Possibly at least a seasonal migrant into parts of region.	Regularly occurs from Antarctica north to 30°S. Identity of bottlenose whales in tropical Pacific uncertain.
Cuvier's beaked whale *Ziphius cavirostris*	May be fairly common in deep water year-round.	Cosmopolitan in tropical and temperate waters.
Other beaked whales *Mesoplodon spp.*	At least 4 of 13 recognised species in the genus likely to occur in region: Blainville's beaked whale (*M. densirostris*), ginkgo-toothed beaked whale (*M.ginkgodens*), Longman's beaked whale (*M. pacificus*) and True's beaked whale (*M. mirus*).	Few confirmed sightings or specimens from inside SPREP boundaries, probably due more to limited reporting than to a scarcity; six additional species could occur at least as stragglers.
Leopard seal *Hydrurga leptonyx*	Occasionally wander from the Antarctic into the southern edges of the SPREP region.	Reported from Cook Islands, at Tubuai, Mangareve and Rapa. Several of these were emaciated, possibly sick seals; apparently regularly "stray" into SPREP region, but the species' primary habitat is farther south.
Southern fur seals *Arctocephalus spp.*	Occasionally wander from breeding grounds elsewhere.	Fur seals breed in Galápagos, SE Australia and New Zealand; occasional sightings in New Caledonia and Tubuai; primary habitat mainly S and E of SPREP region.
Dugong *Dugong dugon*	All year in at least Vanuatu, New Caledonia, Melanesia, New Guinea and Palau.	Range been reduced by over-hunting; limited to shallow waters with access to seagrasses for foraging.