

Cetacean diversity, common occurrence and community importance in Fijian waters

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Abstract. Fiji has demonstrated a strong commitment to cetacean conservation via national, regional and international plans and agreements. To provide baseline information in support of these efforts, this paper provides an updated listing of cetacean species found in Fijian waters and identifies locations where cetaceans have been noted on a consistent basis. Information for this review was sourced from peer-reviewed publications, field reports, historical whaling records, national consultations, anecdotal and opportunistic sources, as well as a national database held by the Fiji Government's Department of Fisheries. Reliable and recent records were confirmed for 10 cetacean species in Fijian waters. In addition, less reliable records and regional species' information provides support for the occurrence of at least 14 additional species or groups of similar-looking species that could not be identified more specifically. Thirteen hotspot areas within the Fiji Economic Exclusive Zone were preliminarily identified as being particularly important for cetaceans, including numerous sites within the Vatu-i-Ra and Lomaiviti passages and surrounding waters. Issues with the available data include uneven coverage, inherent biases within available sources, and difficulties with species identification and verification in some cases. Nevertheless, it is hoped that this review will provide a reference point from which to move forward with cetacean management and conservation efforts in Fiji.

Additional keywords: cetaceans, Fiji, Pacific Regional Whale and Dolphin Action Plan, SPREP, Convention of Migratory Species.

Received 20 November 2015, accepted 4 April 2016, published online 7 June 2016

Introduction

The Fiji Government has demonstrated a strong interest in protecting and conserving cetaceans in national waters. On 11 March 2003, the Fiji Government declared their Economic Exclusive Zone (EEZ) as a Whale Sanctuary (Fiji Government 2003). Fiji has also been an active participant in the Secretariat of the Pacific Regional Environment Program (SPREP) regional review workshops, precipitating the development and drafting of the 2003–07, 2008–12, and 2013–17 marine species action plans (SPREP 2003, 2007, 2012). In addition, as a SPREP member, Fiji has adopted important cetacean protection measures including the Pacific Islands regional guidelines for whale and dolphin watching (IFAW *et al.* 2009) and the Oceania humpback whale recovery plan (SPWRC and SPREP 2011).

In 2006, Fiji was one of the initial signatories to the Convention of Migratory Species Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Island Region (CMS 2006). Furthermore, in 2013 Fiji became the 119th member of the UN Convention on Migratory Species (CMS). Fiji has also been a member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1997. Engagement with CITES is particularly pertinent for Fiji given the cultural importance and associated trade of sperm whale teeth (known locally as tabua) (Ewins 2013). These national, regional and international pledges represent promising steps forward for cetacean conservation in Fiji. However, a significant obstacle to implementing tasks and priorities associated with these laudable commitments is an

incomplete assessment of cetacean diversity and distribution in Fiji's EEZ.

A pioneering regional review on marine mammals in the South Pacific established that more than 40 cetacean species could be confirmed (or were likely to occur) in the region (Reeves *et al.* 1999). Paton and Gibbs (2002) updated these sighting records for Fiji, as did Miller (2009), who also included a classification scale for relative confidence in present-day occurrence of each species listing. Data for these three reviews stemmed from a variety of information sources including whaling expeditions, associated sighting surveys, and historical summaries (Townsend 1935; Dawbin 1959; Ohsumi 1978, 1979, 1980; Kawamura 1980; Kasamatsu *et al.* 1995; Kanda *et al.* 2007), anecdotal and opportunistic reports (Reeves *et al.* 1999), as well as some field observations and surveys (Paton and Gibbs 2002), scientific meeting documents (Gibbs *et al.* 2006), and a peer-reviewed documentation of a stranding event (Leslie *et al.* 2005). Such records contained a range of detail, accuracy, and specificity. Correspondingly, the number of sightings contained within such records, as well as the time frame during which they were collected, was variable. General locations in which cetaceans are found within Fijian waters have not been summarised previously.

This paper investigates records of cetacean diversity, presence, and community importance within Fijian waters. Simple criteria were developed in order to provide a systematic approach to data inclusion, given high variability in data quality. In addition, we discuss the caveats and characteristics of information used to ensure that the biases and necessary qualifications of the collated data are understood. The application of compiled records to established objectives for cetacean management and conservation in Fijian waters is noted.

Methods

Site description

Fiji's EEZ occupies a total area of 1.26 million km², including ~844 islands, cays and islets dispersed between 177–178°W and 15–23°S. The Fiji EEZ lies at the midpoint of two convergent subduction zones (Tonga Kermadec and New Hebrides) and is separated by the Fiji Basin to the west and the Lau Basin to the east. Sea surface temperature ranges between 24 and 31°C and south-easterly swells predominate throughout the year (Vuki *et al.* 2000).

Cetacean species occurrence in Fijian waters

We compiled information on the presence of cetacean species within the Fijian EEZ from a variety of information sources. In addition to the references used in previous review documents, reference materials were updated with several technical reports (Smith *et al.* 2011; Fox *et al.* 2012), student theses (Hunt 2009), unpublished field trip reports (Paton *et al.* 2009; Batibasaga and Sharma-Gounder 2011), and a peer-reviewed publication (Cribb *et al.* 2012). Well documented, opportunistic visual records were also included (J. Smith, pers. comm.; C. Miller, pers. obs.). In addition, records from the Fiji cetacean database (Fiji Fisheries Department 2014) were also examined. The Fiji cetacean database was initiated in 2007 and contains more than 100 records of cetacean sightings. Reports to the database have primarily been

submitted by dive operators, Department of Fisheries' extension officers, as well as members of the public. Reports are provided on a voluntary basis; however, the Fiji Fisheries Department also actively solicits information when made aware of a stranding or sighting. All reports request the following information (if available): description of the animal(s) seen, group size, location, behaviour, sighting platform (and distance from animals), as well as any images. All information submitted to this database was verified and assessed for accuracy by Fisheries officers and colleagues with expertise in cetacean biology.

Sightings records from all data sources were individually evaluated as either confirmed or probable. Species listed as confirmed were those records in which: (1) the sighting had occurred within the past 10 years; and (2) a well documented and verifiable record or source was available to definitively confirm the species. Species were listed as probable if the record was: (1) more than 10 years old; and/or (2) the associated documentation was less detailed in terms of specificity and documentation. For some probable records it was not possible to identify a single species due to difficulties distinguishing among similar-looking species, the historical nature of some reports especially given relatively recent taxonomical changes, or a lack of specificity in the record (e.g. when a given record was listed only as 'minke whales'). To address this uncertainty, the following species were grouped together within the listing of probable species: (1) 'Bryde's-like' whales – Bryde's whale (*Balaenoptera edeni*), including any subspecies, Omura's whale (*B. omurai*), and Sei whale (*B. borealis*); (2) minke whales – Antarctic minke whale (*B. bonaerensis*) and common minke whale (*B. acutorostrata* including any subspecies); (3) blue whales – blue whale (*Balaenoptera musculus*), including any subspecies; (4) bottlenose dolphins – common bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific bottlenose dolphin (*T. aduncus*); (5) common dolphin – short-beaked common dolphin (*Delphinus delphis*) and long-beaked common dolphin (*D. capensis*); and (6) diminutive sperm whales – pygmy sperm whale (*Kogia breviceps*) and dwarf sperm whale (*Kogia sima*). In addition, regional reviews of cetacean species records were used to expand the list of probable cetacean species likely to occur in Fijian waters (Reeves *et al.* 1999).

Reported locations of common occurrence and community importance of cetaceans within Fijian waters

Collation of areas where cetacean species have been reported on a regular basis was undertaken as a first step in gaining a more detailed understanding of cetacean distribution within Fijian waters. Key sources of information for gathering locational data was taken from the following: (1) peer-reviewed publications and relevant technical reports; (2) two national consultations related to identifying areas of important biodiversity within Fijian waters; and (3) the national cetacean sightings database managed by the Fiji Fisheries Department. The different information sources considered in regard to cetacean occurrence varied in the way that cetacean habitat or presence was considered and geographically defined. Furthermore, a variety of expertise and coverage (of Fijian waters) was associated with the contributing stakeholders. These differences are outlined (see Table 1) and compared in more detail within the Discussion section.

Table 1. Overview of sources of information used to develop the preliminary list of areas of common occurrence and community importance for cetaceans in Fijian waters
 Key sources of information for this list included two national consultations (i.e. the Fiji Islands Marine Eco-regions Workshop ('Eco-regions') (WWF 2004) and the National Protected Areas Committee Workshop ('Protected Areas') (Jupiter *et al.* 2011)), peer-reviewed articles and technical reports, as well as data contained within the Fiji Government's national cetacean sightings and strandings database (Fiji Fisheries Department 2014)

Key sources of information for distribution data	How information was collated	Further criteria used (as relevant to cetaceans)	Participants, consultants, authors	How boundaries of location or sighting were defined	Potential biases
Eco-regions workshop	Important locations for cetaceans across Fiji were identified and described within biodiversity sessions on 'Open ocean areas', 'Species of special concern areas' and 'Community priority areas'.	Important feeding, breeding, calving or migration sites, sites important for ecological processes, and sites of outstanding or unique species richness.	Key stakeholders – scientists, government and non-governmental organisation representatives, community members, interested user groups, and workshop participants.	Species-specific as decided by the workshop participants and consultants.	Geographic representation and background of participants. Taxonomic expertise of participants.
Protected areas workshop	Within each province, candidate sites for protection and management were nominated that could simultaneously satisfy national and provincial biodiversity conservation and resource management objectives.	Habitat/species management areas, conservation areas, conservation corridors, locally managed marine areas, and managed marine areas.	Provincial administrators, with the assistance of government, non-government participants, scientists and researchers.	Species' presence and diversity reports were given at the scale of the qoliqoli (customary fishing grounds) or district.	Qoliqoli and district waters are primarily coastal in nature and therefore reflect the information gathered. Taxonomic expertise of participants.
Publications and reports	Review of relevant scientific publications and reports.	Species reported at given locations on more than 20 occasions within a 10-year period.	Research scientists, fisheries records, government reports.	Study location and/or specific area within surveys.	Uneven effort, coverage and relatively small area of relevant research studies have been conducted within the Fiji EEZ. Taxonomic focus (and associated research methodology) on key species only in some cases.
National cetacean sightings database	Review of the national cetaceans sightings database.	Species reported at given locations on more than 20 occasions within a 10-year period.	Fiji Fisheries Department	Point location and/or general area description as given by the sightings report.	Sightings network reports are voluntary yet also reliant on the observer being aware of the network and information required. Members primarily consist of dive operators, Fisheries extension officers, and national researchers who primarily work within coastal waters.

Table 2. Listing of ‘confirmed’ cetacean species within Fijian waters

The criteria for confirmation were the following: (1) the sighting had occurred within the past 10 years; and (2) a well documented and verifiable record or source was available to definitively describe the species. IUCN red-list status (IUCN 2016) for each record is listed using the following acronyms: EN (Endangered); VU (Vulnerable); LC (Least concern); and DD (Data deficient). In addition, the listing of species on the Convention of Migratory Species (CMS) and the Convention of International Trade in Endangered Species (CITES) appendices is reported

Common name	Scientific name	References	IUCN	CMS	CITES
Common minke whale ^A	<i>Balaenoptera acutorostrata</i>	C. Miller 2012 (pers. obs.)	LC		I
Humpback whale ^A	<i>Megaptera novaeangliae</i>	Townsend 1935; Dawbin 1964; Paton and Gibbs 2002; SPWRC 2009; Batibasaga and Sharma-Gounder 2011; Smith <i>et al.</i> 2011; Fox <i>et al.</i> 2012	EN ^B	I	I
Short-finned pilot whale ^A	<i>Globicephala macrorhynchus</i>	Gibbs and Paton 2003; SPWRC 2009; Batibasaga and Sharma-Gounder 2011	DD		
Killer whale	<i>Orcinus orca</i>	J. Smith 2010 (pers. comm.)	DD		
False killer whale ^A	<i>Pseudorca crassidens</i>	Gibbs and Paton 2003; SPWRC 2009	DD		
Pantropical spotted dolphin	<i>Stenella attenuata</i>	Gibbs and Paton 2003; UNEP-WCMC 2003; C. Miller 2014 (pers. obs.)	LC		
Spinner dolphin ^A	<i>Stenella longirostris</i>	Gibbs and Paton 2003; SPWRC 2009; Hunt 2009; Cribb <i>et al.</i> 2012	DD		
Common bottlenose dolphin	<i>Tursiops truncatus</i>	Smith <i>et al.</i> 2011	LC		
Sperm whale ^A	<i>Physeter macrocephalus</i>	Townsend 1935; Lever 1964; Ohsumi 1978, 1979, 1980; Paton and Gibbs 2002; Batibasaga and Sharma-Gounder 2011	VU	I/II	I
Blainville’s beaked whale	<i>Mesoplodon densirostris</i>	Leslie <i>et al.</i> 2005	DD		

^AReliably recorded within the Fiji cetaceans national database also.

^BStatus refers to that of the Oceania subpopulation for this species.

Peer-reviewed publications and technical reports

All of the sources used to support confirmed cetacean diversity records were also investigated for detail on distribution. A species was considered to commonly occur in a given location if there were records of more than 20 sightings within the past 10 years. Locations and/or boundaries of given sightings were taken from survey sighting information (either GPS or geographic description) or associated maps.

National consultations

We reviewed outputs from two national consultations: the Fiji Islands Marine Eco-regions Workshop (‘Eco-regions’) (WWF 2004) and the National Protected Areas Committee Workshop (‘Protected Areas’) (Jupiter *et al.* 2011). The overarching objective of the Eco-regions workshop was to gather information on the biodiversity and associated threats to Fiji’s marine environment (WWF 2004). The first steps of this process included collecting scientific and anecdotal biodiversity knowledge from participating scientists, government and non-government organisations, community members, and marine tourism representatives. Participants with expertise in large marine species’ were directed to identify areas of cetacean feeding, breeding, seasonal migration, and relatively high biodiversity within the Fiji EEZ.

The Protected Areas workshop was convened to advance Fiji’s commitments under the Convention of Biological Diversity Program of Work on Protected Areas (Jupiter *et al.* 2011). Specific objectives for the workshop were to identify candidate sites within each province that might warrant protection of some form based on applicability to a typology of protected area types, historically in use in Fiji. Definitions of each category were

given to assist participants in making decisions and delineating boundaries. The Protected Areas consultation included a broad group of stakeholders, including administrators from Fiji’s 14 provinces as well as several national technical experts on key species and habitats.

During discussions that occurred during the national consultations, participants physically drew boundaries of specific areas related to cetacean species’ habitat. All locations identified during the national workshops were further reviewed for also having adequate information available to verify cetacean species’ presence in the given location.

Results

Cetacean diversity

Ten cetacean species were confirmed to be found within Fijian waters (Table 2). The two species with most numerous records were spinner dolphins (*Stenella longirostris*) and humpback whales (*Megaptera novaeangliae*). Detailed records of spinner dolphin occurrence are most readily available from a known daytime resting location for this species that has been the focus of numerous research studies (Hunt 2009; Cribb *et al.* 2012) and that also supports a local community-run ecotourism operation. However, reliable records have also been recorded in numerous other parts of Fiji for this species (Gibbs and Paton 2003; SPWRC 2009; Smith *et al.* 2011; Fiji Fisheries Department 2014). Patterns in humpback whale migration have been investigated in several different studies in recent years (Gibbs and Paton 2003; Gibbs *et al.* 2006; Paton *et al.* 2009; Batibasaga and Sharma-Gounder 2011; Smith *et al.* 2011; Miller *et al.* 2015). Unpublished surveys conducted by the late Dr W. Dawbin in the late 1950s provided critical insights into historical densities of

Table 3. Listing of ‘probable’ cetacean species within Fijian waters

The criteria for ‘probable’ were the following: (1) the sighting was more than 10 years old; and/or (2) the associated documentation was less robust in terms of level and detail available. For some records it was not possible to list a single species due to such issues as difficulties with identification at sea (with species of similar appearance), record specificity, and changes to taxonomic classification. The species constituting the following groups are listed in the table below: (a) ‘Bryde’s-like’ whales; (b) minke whales; (c) blue whales; (d) bottlenose dolphins; (e) common dolphin; and (f) diminutive sperm whales

Common name / group	Scientific names	Clarification and notes on species identification	References
Minke whales	<i>Balaenoptera acutorostrata</i> <i>Balaenoptera bonaerensis</i>	Record may refer to <i>Balaenoptera acutorostrata</i> (confirmed – see Table 2) or <i>Balaenoptera bonaerensis</i> (Antarctic common whale)	Ohsumi 1979; Kasamatsu <i>et al.</i> 1995; Paton and Gibbs 2002
‘Bryde’s-like’ whales	<i>Balaenoptera edeni</i> <i>Balaenoptera omurai</i> <i>Balaenoptera borealis</i>	Different records likely refer to different species: Kanda <i>et al.</i> (2007) lists Bryde’s whales (<i>Balaenoptera brydei</i>), Paton and Gibbs (2002) list Bryde’s whale (<i>Balaenoptera edeni</i>), and Dawbin (1959) lists Sei whales (<i>Balaenoptera borealis</i>)	Dawbin 1959; Ohsumi 1978, 1979; Paton and Gibbs 2002; Kanda <i>et al.</i> 2007
Blue whales	<i>Balaenoptera musculus</i> (and additional subspecies)	Two animals were seen just south of the Fiji EEZ (Ohsumi 1979)	Ohsumi 1979
Fin whale	<i>Balaenoptera physalus</i>	Two individuals were seen within (and one just outside of) the Fiji EEZ (Ohsumi 1979)	Ohsumi 1979
Common dolphins	<i>Delphinus capensis</i> <i>Delphinus delphis</i>	Based on probable distribution information for this species, the record most likely refers to short-beaked common dolphin (<i>Delphinus delphis</i>)	Reeves <i>et al.</i> 1999
Bottlenose dolphins	<i>Tursiops truncatus</i> <i>Tursiops aduncus</i>	Record may refer to <i>Tursiops truncatus</i> (confirmed – see Table 2) or <i>Tursiops aduncus</i> (Indo-Pacific bottlenose dolphin)	Reeves <i>et al.</i> 1999
Fraser’s dolphin	<i>Lagenodelphis hosei</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999
Rough-toothed dolphin	<i>Steno bredanensis</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999
Risso’s dolphin	<i>Grampus griseus</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999
Pygmy killer whale	<i>Feresa attenuata</i>	Recent anecdotal report as well as probable distribution based on regional review	M. Oremus 2014 (pers. comm.); Reeves <i>et al.</i> 1999
Melon-headed whale	<i>Peponocephala electra</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999
Striped dolphin	<i>Stenella coeruleoalba</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999
Diminutive sperm whales	<i>Kogia breviceps</i> <i>Kogia sima</i>	Pygmy sperm whale (<i>Kogia breviceps</i>) is listed in UNEP-WCMC 2003. Dwarf sperm whale (<i>Kogia sima</i>) was listed in Batibasaga and Sharma-Gounder 2011.	UNEP-WCMC 2003; Batibasaga and Sharma-Gounder 2011
Ginkgo-toothed beaked whale	<i>Mesoplodon ginkgodens</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999
Cuvier’s beaked whale	<i>Ziphius cavirostris</i>	Probable distribution based on regional review	Reeves <i>et al.</i> 1999

humpback whales during their migration (see Gibbs *et al.* 2006). In addition, many records for this species are present within the national cetacean database (Fiji Fisheries Department 2014). A stranded Blainville’s beaked whale (*Mesoplodon densirostris*) is the only record of this species in Fijian waters (Leslie *et al.* 2005). Records from various recent cetacean surveys and interviews as well as the national database have been found for short-finned pilot whales (*Globicephala macrorhynchus*), false killer whales (*Pseudorca crassidens*), and sperm whales (*Physeter macrocephalus*) (Paton and Gibbs 2002; Paton *et al.* 2009; SPWRC 2009; Batibasaga and Sharma-Gounder 2011; Smith *et al.* 2011; Fiji Fisheries Department 2014). The latter species also has a significant number of historical records due to whaling activity (Townsend 1935; Lever 1964) and cultural importance in Fijian society (Derrick 1957). A definitive observation of common bottlenose dolphins (*T. truncatus*) in Fijian waters was made within the past five years (Smith *et al.* 2011); however, additional records for *Tursiops* sp. are available (see probable species below). Opportunistic yet well documented visual records were available

for two additional species: killer whale (*Orcinus orca*) (J. Smith, pers. comm., 2010) and common minke whale (*B. acutorostrata*) (C. Miller, pers. obs., 2012–14). A previous record cited the presence of killer whales in Fijian waters; however, details and corroborating evidence were limited (Reeves *et al.* 1999). Numerous minke whale records are also available; however, none distinguished between *B. bonaerensis* and *B. acutorostrata* (see probable species below).

Less reliable but probable records were found for nine species and six species groups (see Methods for more details) (Table 3). Published reports from whaling expeditions and associated sighting surveys and summaries are the source for records of several whale species including minke, Bryde’s, blue, fin (*Balaenoptera physalus*), humpback, and sperm whales (Townsend 1935; Lever 1964; Ohsumi 1978, 1979, 1980; Kasamatsu *et al.* 1995; Kanda *et al.* 2007). Townsend (1935) summarises humpback whale and sperm whale records extracted from American whaling ship logbooks. Records for humpback whales did occur primarily in Tongan waters

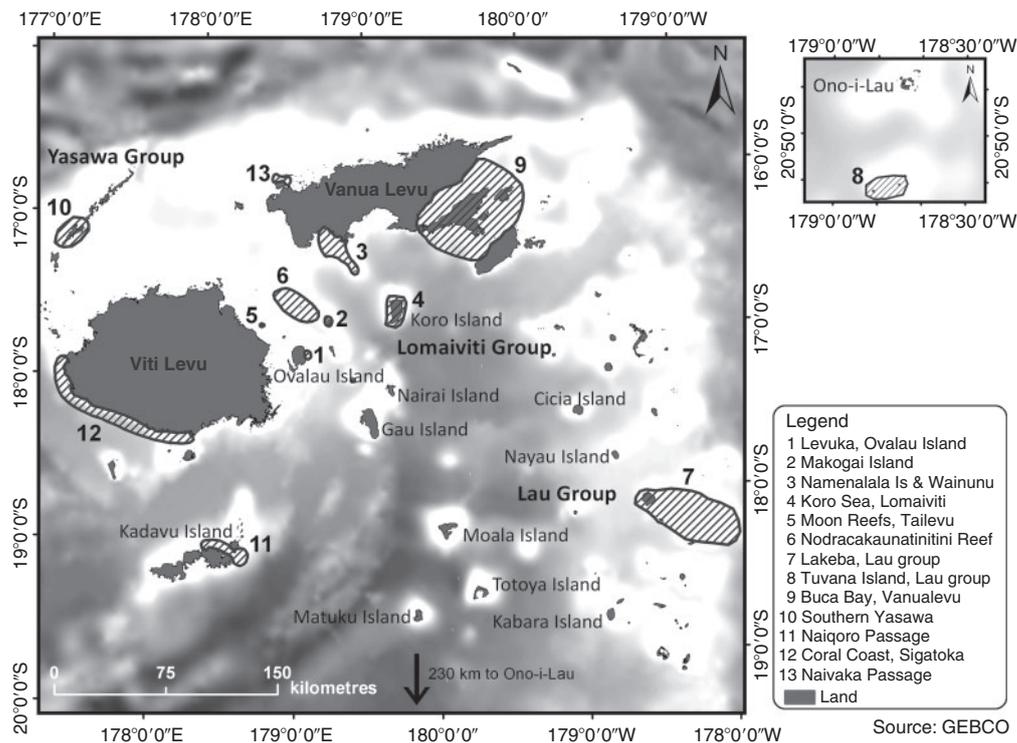


Fig. 1. Thirteen locations within the Economic Exclusive Zone of Fiji were identified as being areas in which cetaceans commonly occurred and/or were of community importance. Data sources and noted cetacean species* for each of these locations is listed in Table 4.

although catches appear to have also occurred along the eastern side of the Fiji EEZ (Smith et al. 2012). Density of sperm whales was notably high at times (Ohsumi 1979) and whaling was apparently conducted 'year-round' during the 19th century (Lever 1964). Special research permit whaling took place between 1976 and 1979 in waters within (and close to) the Fijian EEZ (Ohsumi 1978, 1979, 1980). Ohsumi (1979) indicates Bryde's, minke and sperm whales being both seen and caught within Fijian waters. Genus and species were not listed in the original reports although more recent analyses using these data report Bryde's whale species as *B. brydei* (Kanda et al. 2007). In addition, a few individual fin whales and two blue whales were reported to be caught close to the Fiji EEZ boundary. Summary information from 'Pacific' trips also indicated sightings of Cuvier's beaked whales (*Ziphius cavirostris*), killer whale, pilot whale, and 'other cetaceans'; however, the exact location within the region was not attributed. Low densities of Antarctic minke whales ('southern minke whales' listed as *B. acutorostrata*) were also noted to occur in Fijian waters from data collated by Japan during sighting and marking surveys conducted in the Southern Hemisphere during 1976–87 (Kasamatsu et al. 1995). Paton and Gibbs (2002) provided anecdotal reports from dive operator logs for minke whales (in this case listed as *B. bonaerensis*) and Bryde's whales. Relatively recent video footage from an underwater diver in waters close to Levuka, Ovalau, also supports the presence of 'Bryde's-like' whales (Fiji Fisheries Department 2014).

For the smaller cetacean species, all of the probable records are from anecdotal reports (Table 3). The common dolphin

sighting (listed as *Delphinus* sp.) occurred in 1992 within the most southern portions of the Fijian EEZ (Reeves et al. 1999). Two visual records of a diminutive sperm whale (*Kogia* sp.) have been made (C. Miller pers. obs., 2010 and 2012). A record for this species group is also found on the World Conservation Monitoring Centre database; however, no specific reference is cited for this inclusion (UNEP-WCMC 2003). Another recent anecdotal report is a likely sighting of a pygmy killer whale (*Feresa attenuata*) (M. Oremus, pers. comm., 2014). An image from the 1930s indicated the presence of Fraser's dolphin (*Lagenodelphis hosei*) within the Fiji EEZ at that time (Reeves et al. 1999). Additional cetacean species commonly found in the region (Reeves et al. 1999) include: Risso's dolphin (*Grampus griseus*), melon-headed whale (*Peponocephala electra*), striped dolphin (*Stenella coeruleoalba*), ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*), and Cuvier's beaked whale.

Reported locations of common occurrence and community importance for cetaceans within Fijian waters

Support for the presence of cetaceans at 13 different areas within the Fijian EEZ was found (Fig. 1, Table 4). Locations coming from published accounts and technical reports include: Moon Reef (Makalati); Lomaiviti passage waters (including Levuka, Wakaya, Gau, and Makogai); and Vatu-i-Ra Island, Vatu-i-Ra passage, and Monkey-face passage (Gibbs et al. 2006; Paton et al. 2009; Batibasaga and Sharma-Gounder 2011; Smith et al. 2011; Cribb et al. 2012; Fox et al. 2012). Participants at the Eco-regions workshop identified the following sites as being important for cetacean feeding, breeding, seasonal migration, or

Table 4. A preliminary listing of areas of common occurrence and community importance for cetaceans in Fijian waters

Cetacean species noted to occur at given locations, as well as information sources available, are listed. Y, Yes, N, No. Both the 'Confirmed' and 'National database' columns refer to a location that has at least one species that: (1) has been seen more than 20 times in the past 10 years; and (2) has a well documented and verifiable record or source to definitively describe the given species. In the case of confirmed species the source was typically a peer-reviewed publication or technical report, whereas for the national database it was the Fiji Government cetacean sightings and strandings database. Locations identified in national consultations ('Eco-Regions' and 'Protected Areas') were identified through these two workshops and then independently checked for adequate information being available to corroborate the presence of cetaceans in the given location. Locations on the list that were not specifically identified by participants yet do occur within the Vatu-i-Ra and Lomaiviti passages and surrounding waters are marked as VRLP if that location was documented during the given workshop

Location	Cetacean species present	Sources of support			
		Confirmed	Eco-regions	Protected Areas	National database
Waters close to Levuka, Ovalau Island, Lomaiviti group	Humpback whale, sperm whale, short-finned pilot whale, spinner dolphin, minke whale, pygmy sperm whale, false killer whale, bottlenose dolphins, pantropical spotted dolphin	Y	VRLP	VRLP	Y
Waters surrounding Makogai Island, Lomaiviti group	Humpback whale, short-finned pilot whale, minke whale, spinner dolphins, bottlenose dolphins, sperm whale	Y	VRLP	VRLP	Y
Waters surrounding Namenalala Island (including Namena Marine Reserve and Wainunu Bay), Vanua Levu group	Minke whale, short-finned pilot whale, sperm whale, humpback whale, bottlenose dolphin, spinner dolphin, false killer whale	N	Y	VRLP	Y
Waters surrounding Koro Island (including Bligh waters), Lomaiviti group	Spinner dolphin, pantropical spotted dolphin, humpback whale, bottlenose dolphin, minke whale	N	Y	VRLP	Y
Moon Reef / Makalati and waters directly surrounding, Dawasamu district, Viti Levu group	Spinner dolphin, minke whale, sperm whale, short-finned pilot whale, humpback whale	Y	VRLP	VRLP	Y
Waters surrounding Nodracakaunatinitini Reef, Vanua Levu group	Humpback whale, bottlenose dolphin, short-finned pilot whale, spinner dolphin, minke whale	Y	VRLP	VRLP	Y
Waters inside and near Monkey Passage located between Yaqaga Island and Vanua Levu, Vanua Levu group	Spinner dolphin, humpback whale, short-finned pilot whale, bottlenose dolphin	N	VRLP	VRLP	N
Waters surrounding Lakeba Island (including those outside of Napotu Reef), Lau group	Spinner dolphin	N	Y	N	Y
Waters surrounding Tuvana Island, Lau group	Killer whale, spinner dolphin	N	N	Y	Y
Waters surrounding Rabi Island, northern Taveuni and south-eastern Vanua Levu (including Buca Bay, Natewa Bay, and Somosomo Strait), Vanua Levu group	Spinner dolphin, minke whale	N	N	Y	Y
Waters surrounding Naviti Island, Yasawa group	Bottlenose dolphin	N	Y	N	N
Waters along the eastern side of Kadavu Island (including Naiqoro Passage), Kadavu group	Humpback whale, spinner dolphin	N	N	N	Y
Waters along the Coral Coast of Viti Levu, Viti Levu group	Spinner dolphin	N	N	N	Y

general cetacean biodiversity value: Lomaiviti Triangle; waters surrounding Namenalala Island; east side of Buca Bay and surrounding waters; waters surrounding Cikobia Island; pelagic waters of the Koro Sea; waters surrounding Lakeba; and waters surrounding the southern Yasawa Islands. Consultations during the Protected Areas workshop resulted in several additional areas highlighted as being important for cetaceans, including: (1) Natewa Bay, Cakaudrove Province (proposed habitat/species management area for spinner dolphins); (2) waters surrounding Tuvana, Lau group (proposed offshore marine

protected area for cetaceans, including humpback whales); and (3) Vatu-i-Ra passage and Lomaiviti group (presence of humpback whales, spinner dolphins, bottlenose dolphins and short-finned pilot whales). Review of the national cetacean database by the Fiji Fisheries Department staff revealed two further locations of cetacean occurrence in the Naiqoro passage in Kadavu Province (due to the presence of humpback whales and spinner dolphins), as well as various locations along the southern coast of Viti Levu (known locally as the 'Coral Coast') for frequent sightings of spinner dolphins. Although not

specifically meeting the criteria for common occurrence, numerous records are available in the national database for spinner dolphins, humpback whales, minke whales, short-finned pilot whales, and sperm whales.

Discussion

This is the first published record of areas of common occurrence of cetaceans within Fijian waters. Such a summary is important in establishing baseline information for management and conservation of cetaceans in Fiji. The 10 confirmed cetacean species for Fiji demonstrate a variety of life-history patterns, including species that are known to migrate on an annual basis to Antarctic waters, potentially range across national boundaries, as well as species likely to be resident in Fijian waters year-round. Several species are considered threatened on the IUCN red-list and two species appear on appendices of both CMS and CITES.

Given the necessity of collating relatively disparate data sources for this review, it is important that methods of assessing information are well outlined. Data used for common occurrence and community importance differed in several ways, including: criteria for identifying an area as part of a given cetacean species' distribution; delineation of the boundary of a given area; and nature of stakeholders involved (see Table 1). Biases of the different data sources are also acknowledged. One such bias is the spatial coverage of collated records. For example, stakeholders present at the Protected Area workshop had much stronger knowledge and familiarity with inshore areas than with offshore areas. Recognition and documentation of given cetacean species' was likely also dependent on the distinctiveness, size and behaviours of the animal itself. Furthermore, voluntary contributions made to the national cetacean database were more likely to include species that could be viewed in relative proximity to boats. The definition of location (and associated spatial coverage) for each sighting was also inconsistent between data sources. Such biases are inevitable given the limited resources available and restricted focus on understanding cetaceans in Fiji. These issues provide an obstacle in being able to systematically identify 'hotspots' or be able to discuss the importance of waters where surveys have not been undertaken. Hence, caution should be taken in use of this listing as an assessment of relative density or importance of habitat for cetaceans on a national scale. Rather, it is simply a collation of locations where there is information available indicating that cetaceans are present on a regular basis for at least part of the year. Such a qualified list provides at least a preliminary first step in better understanding cetacean distribution in Fijian waters.

During the course of the review it was apparent that the information from the two national workshops' and the national cetacean database represented very useful sources of data. Recognition of these data sources is particularly important as they represent two of the potentially repeatable (in some form) and relatively cost-effective avenues of collecting cetacean data in Fiji in the future. However, a more comprehensive and specific consultation process, along with provision of resource materials (such as cetacean identification guides) and education programs to relevant stakeholders, would likely improve the

quality of data gained from these sources. Solicitation and investigation of additional data records from fisheries' observers, ferries, dive operators, marine researchers and non-government organisations would be of benefit as would a more thorough examination of historical whaling records. In the longer term, however, it is robust, multiyear survey data on key species that is required to enhance our understanding of Fijian cetaceans. Given the limited data collected to date, a focus on hotspots identified in this review would serve as a logical selection of sites. Subsequent effort in areas known to have limited coverage or consultation is also a necessary avenue for exploring relative density and importance of a wider array of habitats.

Establishing a baseline of information on cetacean diversity for Fiji has several important policy uses. Some immediate areas of application of our work include: (1) a useful data source within the next iteration of Fiji's National Biodiversity Strategic Action Plan (and associated implementation schedule) as well as Fiji's sixth national report to the Convention of Biological Diversity, (2) as a resource for ongoing discussions by the Fiji government regarding prioritisation and management of 30% of marine areas, (3) within environmental impact assessments for activities being conducted in marine areas, and (4) an indicator of progress against the Pacific regional whale and dolphin action plan 2013–17 (SPREP 2012). The latter plan is presently being used as a framework for development of the national cetacean management plan so this current review is timely.

Conclusion

The review and classification of available cetacean records and identification of important localities for cetaceans provides a useful stepping stone to progress management and conservation planning for cetaceans in Fijian waters. Some of the issues with the available data include uneven coverage, sparse datasets, and difficulties with species identification and verification in some cases. Nonetheless, despite these caveats, a baseline of key information for cetacean diversity and common occurrence in Fiji has now been established.

Acknowledgements

WCS acknowledges funding support from the Marisla Foundation. The authors thank Ingrid Qauqau for her production of the cetacean occurrence map. Furthermore, the authors express their appreciation to the reviewers for provision of useful and constructive comments.

References

- Batibasaga, A., and Sharma-Gounder, S. (2011). Research progress report: Establishing a long term data set for monitoring trends in humpback whale migration through Fijian waters. Australian Marine Mammal Centre, Australian Government.
- CMS (2006). Convention of Migratory Species Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Island Region. 17th Secretariat of the Pacific Regional Environment Programme annual meeting, Noumea, New Caledonia.
- Cribb, N., Miller, C., and Seuront, L. (2012). Site fidelity and behaviour of spinner dolphins (*Stenella longirostris*) in Moon Reef, Fiji Islands: implications for conservation. *Journal of the Marine Biological Association of the United Kingdom*. doi:10.1017/S0025315412000033

- Dawbin, W. H. (1959). New Zealand and South Pacific whale marking and recoveries to the end of 1958. *Norsk Hvalfangst-tidende* **48**, 213–238.
- Dawbin, W. H. (1964). Movements of humpback whales marked in the southwest Pacific Ocean 1952–1962. *Norsk Hvalfangst-tidende* **53**, 68–78.
- Derrick, R. A. (1957). 'A History of Fiji.' 3rd edn. (Government Press: Suva, Fiji.)
- Ewins, R. (2013). Two important whale-tooth ivory objects from Fiji, hidden under the sobriquet of "scrimshaw" in the W.L. Crowther Library Collection, Hobart. *Kanunnah* **6**, 94–107.
- Fiji Fisheries Department (2014). National cetacean sightings and strandings database. Fiji Fisheries Department, Ministry of Primary Industries, Fiji Government.
- Fiji Government (2003). Declaration of Fiji's Exclusive Economic Zone as a Whale Sanctuary (1160/29-2). Fiji Government Cabinet Decision CP (03)99.
- Fox, M., Miller, C., Nand, Y., and Naisilisili, W. (2012). Cetaceans of the Vatu-i-Ra Seascape: outcomes of the 2012 Vatu-i-Ra survey. Wildlife Conservation Society, Fiji.
- Gibbs, N. and Paton, D. (2003). Preliminary report on the survey of whales and dolphins in the Lomaiviti Island group of Fiji, August–September 2003. Report to the Australian Department of Environment and Heritage and the Fijian Department of Environment.
- Gibbs, N., Paton, D. A., Childerhouse, S., and Clapham, P. J. (2006). Assessment of the current abundance of humpback whales in the Lomaiviti Island Group of Fiji and a comparison with historical data. Paper SC/A06/HW34. International Whaling Commission, Cambridge.
- Hunt, T. (2009). A preliminary examination of spinner dolphin (*Stenella longirostris*) diurnal behaviour and site fidelity at a reef complex in Fijian waters. B.Sc.(Honours) thesis, Flinders University, Adelaide.
- IUCN (2016). The IUCN Red List of Threatened Species. Version 2015-4. Available at: <http://www.iucnredlist.org> [Verified 24 May 2016]
- IFAW, SPREP and Operation Cetaceans (2009). Pacific Islands regional guidelines for whale and dolphin watching. IFAW, Surrey Hills, Victoria.
- Jupiter, S., Tora, K., Mills, M., Weeks, R., Adams, V., Qauqau, I., Nakeke, A., Tui, T., Nand, Y., and Yakub, N. (2011). Filling the gaps: identifying candidate sites to expand Fiji's national protected area network. Outcomes report from provincial planning meeting, 20–21 September 2010. Wildlife Conservation Society, Fiji.
- Kanda, N., Goto, M., Kato, H., McPhee, M. V., and Pastene, L. A. (2007). Population genetic structure of Bryde's whales (*Balaenoptera brydei*) at the inter-oceanic and trans-equatorial levels. *Conservation Genetics* **8**, 853–864. doi:10.1007/S10592-006-9232-8
- Kasamatsu, F., Nishiwaki, S., and Ishikawa, H. (1995). Breeding areas and southbound migrations of southern minke whales *Balaenoptera acutorostrata*. *Marine Ecology Progress Series* **119**, 1–10. doi:10.3354/MEPS119001
- Kawamura, A. (1980). Food habits of the Bryde's whales taken in the South Pacific and Indian Oceans. *Scientific Reports of the Whales Research Institute* **32**, 1–23.
- Leslie, M. S., Batibasaga, A., Weber, D. S., Olson, D., and Rosenbaum, H. C. (2005). First record of Blainville's beaked whale, *Mesoplodon densirostris*, in Fiji. *Pacific Conservation Biology* **11**, 302–304.
- Lever, R. J. A. W. (1964). Whales and whaling in the western Pacific. *South Pacific Bulletin* **14**, 33–36.
- Miller, C. (2009). Current state of knowledge of cetacean threats, diversity and habitat in the Pacific Islands Region. Meeting document UNEP/CMS/PIC2/Inf.6-01 submitted to 2nd Meeting of the Parties for the Convention of Migratory Species Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region, Auckland, New Zealand.
- Miller, C., Batibasaga, A., Sharma-Gounder, S., and Solomona, P. (2015). Very low numbers of endangered Oceania humpback whales seen in Fijian waters. *The South Pacific Journal of Natural and Applied Sciences* **33**, 39–45. doi:10.1071/SP15006
- Ohsumi, S. (1978). Provisional report on the Brydes whales caught under special permit in the Southern Hemisphere. *Report of the International Whaling Commission* **28**, 281–287.
- Ohsumi, S. (1979). Provisional report of the Bryde's whales caught under special permit in the Southern Hemisphere in 1977/78 and a research programme for 1978/79. *Report of the International Whaling Commission* **29**, 267–273.
- Ohsumi, S. (1980). Population study of the Bryde's whale in the Southern Hemisphere under scientific permit in the three seasons, 1976/77–1978/79. *Report of the International Whaling Commission* **30**, 319–331.
- Paton, D. A., Batibasaga, A., Shama, S., O'Connor, W., and Nand, N. (2009). Report of the Whale and Dolphin Survey undertaken in the Lomaiviti Island group, Fiji 2008. Blue Planet Marine, Australia. 31pp.
- Paton, D., and Gibbs, N. J. (2002). Documented and anecdotal cetacean sightings, 1761–2001, in the Samoa, Fiji, Vanuatu and Solomon Island regions. Report to Environment Australia (Australian Commonwealth Department of Environment and Heritage).
- Reeves, R. R., Leatherwood, S., Stone, G. S., and Eldredge, L. G. (1999). Marine Mammals in the Area served by the South Pacific Regional Environment Programme (SPREP). South Pacific Regional Environment Programme, Apia, Samoa.
- Smith, B., Fox, M., Naisilisili, W., Dulunaqio, S., and Jupiter, S. (2011). Status of cetaceans in the Vatu-i-Ra Seascape and the development of local capacity for their research and conservation. Wildlife Conservation Society, Fiji. Available at: www.wcsfiji.org
- Smith, T. D., Reeves, R. R., Josephson, E. A., and Lund, J. N. (2012). Spatial and seasonal distribution of American whaling and whales in the Age of Sail. *PLoS One* **7**(4), e34905. doi:10.1371/JOURNAL.PONE.0034905
- SPREP (2003). Pacific Islands Regional Marine Species Programme 2003–2007. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa.
- SPREP (2007). Pacific Islands Regional Marine Species Programme 2008–2012. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa.
- SPREP (2012). Pacific Islands Regional Marine Species Programme 2013–2017. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa.
- SPWRC (2009). Report of the annual meeting of the South Pacific Whale Research Consortium (SPWRC), Auckland, New Zealand: 9–12 February 2009. Document SC/61/SH15 submitted to the 61st International Whaling Commission scientific meeting, Madeira, Portugal.
- SPWRC and SPREP (2011). The Oceania humpback whale recovery plan. Meeting document (22SM/WP.8.1.2/Att.1) at the 22nd Secretariat of the Pacific Regional Environment Programme (SPREP) annual meeting, Apia, Samoa. Available at: www.sprep.org.
- Townsend, C. H. (1935). The distribution of certain whales as shown by logbook records of American whalerships. *Zoologica* **19**, 1–50.
- UNEP-WCMC (2003). Checklist of mammals listed in the CITES appendices and in EC regulation 338/97. 6th edn. JNCC Report No. 342. UNEP-WCMC, United Nations Environment Programme – World Conservation Monitoring Centre, Cambridge, UK.
- Vuki, V. C., Zann, L. P., Naqasima, M., and Vuki, M. (2000). The Fiji islands. In 'Seas at the Millennium: an Environmental Evaluation'. (Ed. C. R. C. Sheppard.) pp. 751–764. (Pergamon: Amsterdam.)
- WWF (2004). Setting priorities for marine conservation in the Fiji Islands Marine Ecoregion. WWF, Suva, Fiji.