

Humpback whales in the Southern Cook Islands, South Pacific

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ABSTRACT

The presence of humpback whales in the Southern Cook Islands (South Pacific) was investigated during a three-week exploratory survey conducted at Palmerston Atoll in September and October of 1998 and during a three-month survey conducted at Rarotonga, Aitutaki and Palmerston Atoll from July to October in 1999. During a total of 48 survey days in both years and all areas, 50 sightings of 83 humpback whales were made. All classes except mother/calf/escort trios were observed, including singers, mothers and calves, and one competitive group. To date, 31 humpbacks have been individually identified from natural markings, 29 sloughed skin samples were collected for genetic analysis and 15.6 hours of song recordings were made. Reports of whales in other areas of the Cook Islands were also noted, and included records of mother/calf pairs. The Cook Islands region appears to represent a breeding ground for humpback whales, presumably from the little-studied Area VI population. The relationship of humpbacks in this region to those in adjacent tropical areas remains largely unknown, although recent matches between the Cook Islands and both Tonga and French Polynesia indicate some movement through Oceania.

KEYWORDS: HUMPBACK WHALE; SOUTH PACIFIC; COOK ISLANDS; STOCK IDENTITY; SURVEY-VESSEL; PHOTO-IDENTIFICATION; BREEDING GROUNDS

INTRODUCTION

Humpback whales (*Megaptera novaeangliae*) are widely distributed throughout the oceans of the Southern Hemisphere. Traditionally, populations of baleen whale species have been divided into six management units, termed Areas I to VI¹, although knowledge of actual stock boundaries is in most cases inconclusive (Donovan, 1991). Humpback whales from all six Areas feed in the circumpolar waters of the Antarctic, and migrate to a variety of distinct breeding grounds in tropical waters to the north (Kellogg, 1929; Mackintosh, 1942; Chittleborough, 1965). The most recent view of the IWC (International Whaling Commission) Scientific Committee on the feeding and breeding grounds of humpback whales in the Southern Hemisphere is given in IWC (2001).

Most of the information concerning the biology of humpbacks from these areas has come from 20th century commercial whaling catches, which were extensive throughout the Southern Hemisphere. However, current knowledge concerning the occurrence, distribution and population identity of humpbacks varies considerably by Area. Areas IV and V, which include (respectively) the western and eastern coasts of Australia, are relatively well studied as a result of thoroughly documented coastal whaling, as well as more recent investigations of living whales (Chittleborough, 1965; Dawbin, 1966; Abernethy *et al.*, 1992; Bannister, 1994; Paterson *et al.*, 1994; Brown *et al.*, 1995). In contrast, very little is known about the humpbacks that inhabit Area VI, the boundaries of which extend from the equator to the margins of the Antarctic continent from 120° to 180°W.

Within Area VI lie the Cook Islands, a group of islands and atolls scattered over approximately 800,000 square miles of the southwestern South Pacific (Figs 1 and 2). Little

or no whaling has taken place in this region during the 20th century and records of earlier (historical) catches there are sparse. Except for occasional opportunistic observations (e.g. Leatherwood *et al.*, 1991), there have been no field studies of cetaceans in the area. Consequently, nothing is known about the biology or behaviour of humpback whales in the Cook Islands group. This paper reports survey results from the waters off Palmerston Atoll, Aitutaki and Rarotonga in the Cook Islands and suggests that this region represents a mating and calving area for humpbacks from the Area VI population.

MATERIALS AND METHODS

Study area

The Southern Cook Islands (Fig. 2) include nine islands or atolls between latitudes 18°S and 22°S. To date, this survey has been focused on three: Palmerston Atoll, a 30 mile² atoll lying at 18°04'S, 163°10'W on the northwestern margin of the Southern Cook group; Aitutaki, roughly 200 n.miles east of Palmerston; and Rarotonga, roughly 270 n.miles ESE of Palmerston. Since all three islands are the surface peaks of large seamounts, the seabed around the islands rapidly drops to abyssal depths exceeding 4,000m. Palmerston consists of small areas of land on the margin of a cratered lagoon that is protected by a barrier reef system. Surface water temperatures around Palmerston and Aitutaki average approximately 26°C with little seasonal variation. Surface water temperatures around Rarotonga are slightly cooler, averaging 25°C. Local weather is dominated by often strong easterly trade winds; thus, rough seas and large swells are common.

Study period and survey methods

Surveys of the Palmerston area were conducted from 19 September to 3 October 1998 and 4 October to 17 October 1999. Surveys off Aitutaki were conducted from 26 July to 11 August 1999. Surveys off Rarotonga were conducted from 17 August - 7 September 1999. Surveys took place on

¹ Some early workers, notably Mackintosh (Mackintosh, 1965) applied the word 'Group' to humpback whales, whereas 'Areas' has been used to represent common geographical boundaries for all Southern Hemisphere baleen whales, apart from Bryde's whales (see discussion in Donovan, 1991). We use 'Area' here.

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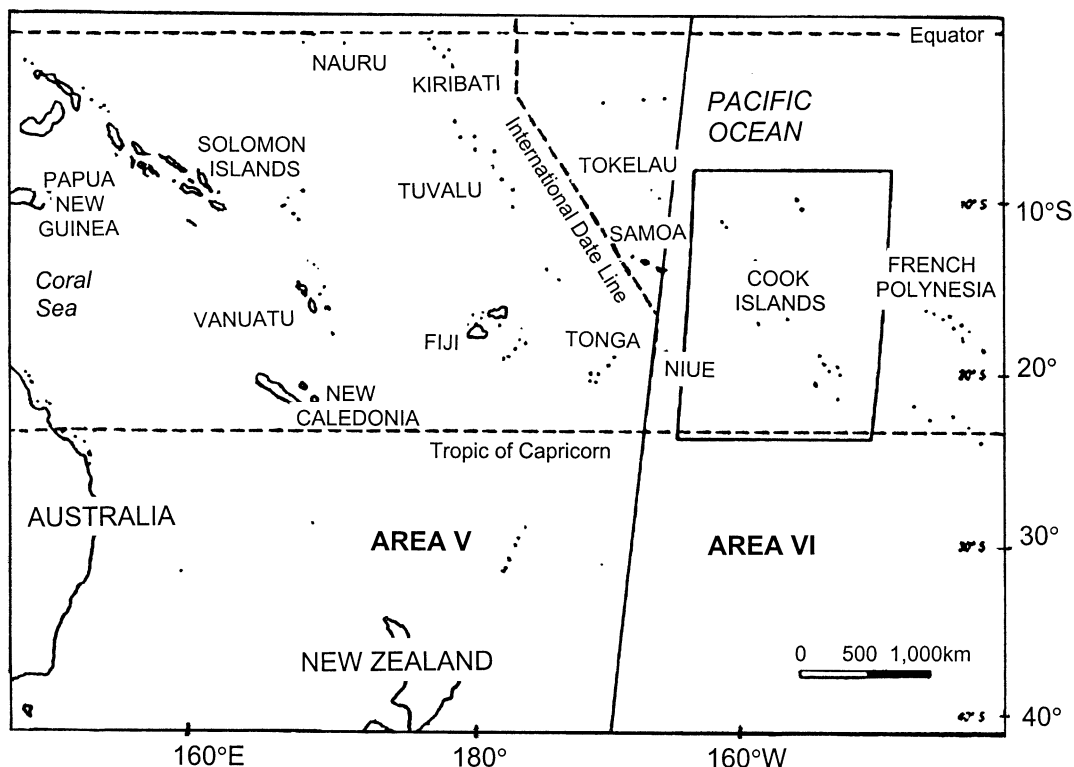


Fig. 1. The Pacific Ocean.

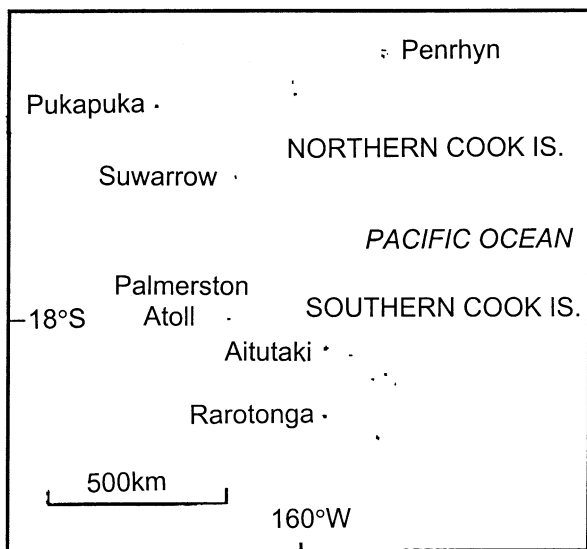


Fig. 2. The Cook Islands.

all days in which wind conditions (<30 knots) permitted the operation of small (4-5.5m) aluminium or fibreglass boats powered by outboard engines ranging from 15hp to 50hp. Although attempts were made to cover all areas around the islands, weather conditions and the nature of the platform precluded the use of a systematic survey protocol. Most observations were made on the western side of the islands, where there was sometimes a small lee from the trade winds. There was no *a priori* selection of whale groups of a particular size or type to approach; generally, the vessel proceeded to the nearest sighting.

When humpback whales were sighted, the following data were recorded: time, location (relative to the islands), group size, group class and behaviour. Group class categories

included non-singing singletons, singers, pairs, non-competitive trios, mother/calf pairs, mother/calf/escort trios and competitive groups. The latter were defined as involving three or more whales, with clearly recognisable group structure and occasional agonistic behaviour (Tyack and Whitehead, 1983; Baker and Herman, 1984; Clapham *et al.*, 1992). All single whales were approached and a hydrophone was used to determine if they were singing. All data were recorded using *Sony* micro cassette recorders and later transcribed to data forms.

Whenever possible, humpback whales were individually identified using photographs or videotape recordings of natural markings. In particular, the pattern on the ventral surface of the flukes was used (Katona and Whitehead, 1981), as well as other variable features visible either underwater or from surface observations. Photographs were taken with a 35mm camera equipped with a telephoto lens, recording data back, power winder and 400 ISO colour slide or black and white print film. Video observations were recorded using 3-chip mini-DV camcorders equipped with marine housings. Still video frames were captured with an *Apple G3/300* computer using a Radius Moto-DV digital capture board.

Sloughed skin samples were collected from the water column in close proximity to the whales (Clapham *et al.*, 1993; Valsecchi *et al.*, 1998). Samples collected in 1998 were stored in a saturated salt solution for subsequent genetic analysis.

Samples collected in 1999 were stored in a solution of saturated sodium chloride and 20% DMSO. Humpback whale songs (Payne and McVay, 1971) were recorded using an HTI hydrophone and either a DAT recorder or a mini-DV camcorder.

In addition to the work at Palmerston in 1998, a one-day survey was conducted on 6 October at the island of Aitutaki. Observations were made from a 10m aluminium fishing vessel equipped with an inboard diesel engine. Opportunistic

Table 1

Survey hours and humpback whale sightings, by day and group class, off Palmerston, Aitutaki, and Rarotonga in 1998 and 1999. Group class abbreviations: SN singleton, SI singer, PR pair, TR non-competitive trio, MC mother/calf, MCE mother/calf and escort, CG competitive group. Singers heard but not seen are not included in Sightings or Group Class columns.

Location	Dates (No. of survey days)	Survey hours	Sightings			Group class						Mean group size	Song heard
			Groups	Whales	SN	SI	PR	TR	MC	MCE	CG		
Palmerston	18 Sep. - 6 Oct. 1998 (13 days)	41.3	19	36	2	4	7	3	2	0	1	1.77 SD=0.77, n=19	8 of 13 days
Aitutaki	26 Jul. - 11 Aug. 1999 (11 days)	52.9	4	7	0	1	2	0	1	0	0	1.75 SD=0.50, n=4	4 of 11 days
Rarotonga	17 Aug. - 7 Sep. 1999 (12 days)	56.5	19	28	5	5	9	0	0	0	0	1.5 SD=0.51, n=19	9 of 12 days
Palmerston	4 Oct. - 17 Oct. 1999 (12 days)	61.4	8	12	4	0	3	0	1	0	0	1.5 SD=0.53, n=8	11 of 12 days
Totals	48 days	212.1	50	83	10	11	21	3	4	0	1	1.66 SD=0.62, n=50	n/a

sightings were also made *en route* from Rarotonga to Palmerston and back, aboard the 86m cruise ship *World Discoverer*.

While in the Cook Islands, local fishermen, naturalists and other individuals were interviewed regarding sightings of humpback whales in the region. The sighting records of the Cook Islands Natural Heritage Trust, which began a whale-sighting network in the Cook Islands in 1991, were also examined. Sighting forms originally developed by the Trust were distributed to field workers of the Cook Islands Fisheries Ministry to document whale sightings throughout the region.

RESULTS

Humpback whale occurrence

An overall summary of effort, sightings and group characteristics is given in Table 1. In total, 83 humpback whales were observed in 50 groups. Summary details are provided below for each area.

1998 Palmerston and Aitutaki

Thirty-six humpback whales (in 19 groups, mean group size 1.77, SD=0.77) were recorded over 13 days (41.3 hours) from 19 September to 3 October 1998. These included six humpbacks observed during the one-day survey at Aitutaki, and three *en route* to or from Rarotonga.

1999 Aitutaki

Seven humpback whales (in 4 groups, mean group size 1.75, SD=0.5) were recorded over 11 days (52.9 hours) from 26 July to 11 August 1999.

1999 Rarotonga

Twenty-eight humpback whales (in 19 groups, mean group size 1.5, SD=0.51) were recorded over 12 days (56.5 hours) from 17 August to 7 September 1999.

1999 Palmerston

Twelve humpback whales (in 8 groups, mean group size 1.5, SD=0.53) were recorded over 12 days (61.4 hours) from 4 to 17 October 1999.

At all three islands in 1999, humpback whales were found in a wide range of depths, including close to the reef, along the 'wall' and in abyssal depths away from the island. Because of rough weather, surveys could not be conducted more than about three miles from any of the islands, but at

this distance the water depth exceeded 1,000m. Singers were observed in both shallow and deep areas. Distinct classes of whales were sighted, including non-singing singletons, singers, pairs, and mother/calf pairs; however, no non-competitive trios, mother/calf/escort trios or competitive groups were observed in 1999. Although the surveys were not designed to quantitatively estimate whale density, no trend in local abundance was evident over the study period.

Sample and data collection

Individual identification

Although analysis is ongoing, 31 humpbacks have been individually identified from photographs or frames captured from digital videotape to date (20 November 1999). Ventral fluke photographs were obtained for 20 of the 31 identified whales.

Of the 31 whales identified so far, all but five were sighted once. The exceptions were: (1) a whale photo-identified on 21 September 1998 off Palmerston and resighted ten days later on 1 October; (2) a whale photo-identified on 19 August, 1999 off Rarotonga and resighted four days later on 23 August; (3) a whale photo-identified on 26 August, 1999 off Rarotonga and resighted four days later on 30 August; and (4) a pair of whales each photo-identified on 27 August, 1999 off Rarotonga and resighted the next day, 28 August. To date no whales photo-identified in 1998 have been re-identified in 1999 photographs.

Skin samples

Seven sloughed skin samples were collected in 1998, and 22 were collected in 1999. These have been sent for analysis to the Ecology and Evolution Group at the University of Auckland (New Zealand), where DNA will be extracted and shared with other institutions for regional comparison purposes.

Song recordings

In 1998, approximately 4.1 hours of song recordings, covering a minimum of 11 full song cycles, were collected on six different days. Recordings ranged in length from 7 to 43min. During the one-day survey at Aitutaki, 1998, 28 minutes of song were recorded. In 1999, approximately 11.5

hours of song recordings were collected on 12 different days at Aitutaki, Rarotonga and Palmerston. No analysis has been conducted on any of these recordings to date.

Reports from elsewhere in the Cook Islands

Since 1991, the Cook Islands Natural Heritage Trust has distributed whale posters and sighting forms in various places throughout the region. Humpbacks are regularly reported to the Trust (primarily off Rarotonga) from July through November, and a pair of humpbacks was reported off Rarotonga in February 1991. Sighting reports and interviews with local individuals during the present study indicated that humpback abundance peaks between August and October. Cow-calf pairs and larger groups were also reported. Although species identifications are not easy to confirm, it is probable that most large whales seen in the coastal waters of the Cook Islands during the austral winter are humpbacks. However, it is possible that some sightings represent sperm whales (*Physeter macrocephalus*) or Bryde's whales (*Balaenoptera edeni*).

DISCUSSION

The results of this survey indicate that the Southern Cook Islands represent a calving ground for humpback whales during the austral winter. This is strongly suggested by the presence of mothers with calves in the area (both in our observations and in local sighting reports); some of our observations have involved very small calves with the grey, wrinkled skin typical of newborns. The sightings and acoustic detection of many singers, as well as the observation of a competitive group, further indicate that the area serves as a mating ground, since both singing and competitive behaviour have been strongly linked to courtship (Tyack, 1981; Tyack and Whitehead, 1983; Baker and Herman, 1984; Clapham *et al.*, 1992). It is likely that humpbacks at present use much or even the entire Cook Island region for calving and mating, although more work is required to confirm this belief.

The Cook Islands do not appear to have ever been a major site for humpback whaling. Maps compiled by Townsend (1935) from American whaling logbook data show only three records of humpbacks in the vicinity and it seems likely that these whales were encountered opportunistically by vessels *en route* to more established grounds at Tonga or elsewhere in the southwestern Pacific region. Documentation of local shore-based whaling in the Cook Islands is sparse, although there are reports of whales taken by natives at Rarotonga. That the focus of these local catches was probably the humpback whale is suggested by a local tradition that the flowering of the Ngatae (Indian Coral) tree during July represented a cue for local whalers to prepare boats and equipment for the arrival of the first whales (McCormack, 1990); this coincides with the timing of the humpbacks' migration into Cook Island waters. The other plausible target species, the sperm whale is much less seasonal in its occurrence.

Future work in this area should involve more intensive photographic and genetic sampling of humpback whales over a longer time period. The choice of the September/October period for this exploratory study was dictated solely by the availability of transportation to Palmerston. Elsewhere in the Southern Hemisphere (including Tonga), humpback whale abundance in breeding areas peaks in late August or early September (Dawbin, 1966; Abernethy *et al.*, 1992), and there is no reason to

believe that Area VI whales follow a different trend. However, Chittleborough (1965) found peak abundance on the southward migration at 28°S off eastern Australia in late August, which would imply an earlier peak on the breeding grounds.

The population identity of the humpbacks in the region remains to be established. It is likely that they are a component of the Area VI stock, which is believed to feed on summering grounds in Antarctic waters to the south. The suggestion that humpbacks range through much of Oceania during winter is indicated by preliminary comparisons among photo-identification catalogues from several study sites in this region; these comparisons have revealed a match between the Cook Islands and Tonga, as well as between the Cook Islands and French Polynesia (Garrigue *et al.*, 2000). Further resolution of the extent of this movement will be resolved only through collection and comparison of additional photographic or genotypic individual identification data. As Cawthorn (1995) has noted, although Townsend's (1935) plotting of humpback catches in the Tongan Islands region suggests a widely dispersed breeding ground, re-examination of a subset of logbooks indicates that the great majority of catches were made in a narrowly defined area within 30 miles of specific islands.

Of the various island groups in the southwestern South Pacific, Tonga has been the focus of most recent work; Tonga lies in the eastern portion of Area V, some 600 miles west of Palmerston. The reported lack of recovery of humpbacks at Tonga (Abernethy *et al.*, 1992) contrasts with high estimated rates of increase of humpbacks off eastern and western Australia (e.g. Bannister, 1994; Paterson *et al.*, 1994). This suggests that either these two regions host separate populations or that much of the maternally transmitted fidelity (which led whales to return to the Tongan breeding area) has been lost through whaling. Additional support for the existence of separate stocks in the eastern and western portions of Area V comes from analysis of humpback songs, which have often been used as indicators of population mixing (see Payne and Guinee, 1983). Helweg *et al.* (1998) found distinct differences in songs recorded at Tonga compared to those from eastern Australia, Kaikoura (New Zealand) and New Caledonia.

To date, genetic results have been inconclusive with regard to population identity. Using mitochondrial DNA, Baker *et al.* (1994; 1998) confirmed the division between humpback populations in Areas IV and V, but the number of samples from Tonga was too small to test for significant division between this area and the western portion of Area V. However, the authors noted that the occurrence of non-shared haplotypes between Tonga and eastern Australia might indicate some division; resolution of this issue awaits analysis of additional samples from Tonga.

The abundance and population status of the whales from the Cook Islands are also unknown. Although no major whaling on humpbacks has ever occurred in the tropical portions of Area VI, large catches were made in the high-latitude feeding grounds of this management area (and that of eastern Area V); among these were substantial illegal takes by the USSR (Zemsky *et al.*, 1997; Yablokov *et al.*, 1998), including almost 13,000 animals taken in a single season (1959/60). As such, it is likely that the Area VI population was heavily depleted by commercial whaling; however, whether the number of whales observed in the Cook Islands reflects this depletion, or whether the major breeding concentration of this stock lies elsewhere, is unclear. Investigations of the current status of this population are clearly needed; however, obtaining reliable

estimates of abundance from this region will not be easy, since working conditions are likely to be difficult in both high- and low-latitude portions of the whales' range. In the Cook Islands, the persistent strong trade winds and lack of substantial landmasses (to provide a lee) complicate the gathering of samples, photographs and data, and this problem is likely to be encountered in other island groups at similar latitudes. Assessment of this population's status and structure will require a coordinated effort by researchers in several locations.

In many locations where humpback whales have been studied using photo-identification, ventral fluke and other pigmentation patterns vary considerably from all white to all black (e.g. Katona and Whitehead, 1981; Baker *et al.*, 1986; Allen *et al.*, 1994). However, as is the case for whales in Areas IV and V (Kaufman *et al.*, 1987; Rosenbaum *et al.*, 1995), the ventral colouration of the humpbacks off Palmerston appears heavily biased towards white. In our study, 17 (85%) of the 20 identified individuals had all-white flukes; the remaining three flukes were one Category 2 and two Category 3, as defined by Rosenbaum *et al.* (1995).

The resulting reduction in variability relative to that of humpbacks in many other areas complicates recognition of individuals from ventral fluke photographs. Additional features elsewhere on the body are visible during underwater observations, and many of these were used to identify individuals in this study. However, the lack of a single standardised, highly variable feature (such as the fluke pattern) and the need for underwater observations, compromises the utility of photographic identification in this region. Although this method will be continued in future work in the area, it is recommended that biopsy-based genotyping with microsatellite DNA (Palsbøll *et al.*, 1997) also be used to identify individual humpback whales in the South Pacific. Biopsy samples also provide a wealth of data for genetic analysis, and can be used to easily determine the sex of each sampled whale (Bérubé and Palsbøll, 1996).

Future work

The intention is to return to the Cook Islands for at least four more humpback breeding seasons to determine population identity. The focus will be on collecting photo-identification data, skin biopsies, song recordings and behavioural data for contribution to a recently undertaken synoptic survey of humpbacks in the tropical South Pacific (Garrigue *et al.*, 2000). The survey will involve comparison of genotypic and photographic humpback samples collected in Eastern Australia, New Zealand, New Caledonia, Tonga, the Cook Islands and French Polynesia.

ACKNOWLEDGMENTS

We are very grateful to Iain Kerr of *Ocean Alliance/WCI* and Bill Pinney of *S/V Rachel J. Slocum*, who initially alerted us to the presence of whales at Palmerston. We are indebted to Tap Pryor for his encouragement and support in the Cook Islands; Gerald McCormack for his enthusiasm and for giving access to the Cook Islands Natural Heritage Trust's records; the Government of the Cook Islands and to I. Tuakeu-Lindsay for permission to conduct this study; Mike Donoghue for initiating the South Pacific synoptic humpback survey; Karen Steuer of the International Fund for Animal Welfare for financial support; Society Expeditions, Zegraham Expeditions and the crew of the *World Discoverer* who conveyed NH and HP to Palmerston Atoll (and brought them back); COMSAT Corp. for a satellite phone and airtime; Gerard Sullivan of InverteDesign and Alex

Bartholomew of *À la Carte Services* for Web site and database expertise. We also thank Jim Darling and Meagan Jones for catalysing the South Pacific humpback survey; Richard Merrick, Fred Serchuk, Scott Baker and one anonymous referee for helpful editorial comments; and Melissa Groo for help with Cook Islands literature searches. Most of all, we thank the people of Palmerston for the considerable assistance they so enthusiastically gave to this work, and for their extraordinary kindness and hospitality.

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