

Movements of humpback whales in Oceania, South Pacific

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ABSTRACT

To investigate movements of humpback whales among breeding or migratory areas of Oceania in the South Pacific Ocean, comparisons of individually identified whales were undertaken using catalogues from New Caledonia, Tonga, New Zealand, the Cook Islands and French Polynesia. These represent wintering grounds or migratory areas for Area V and VI stocks, as recognised by the IWC for management purposes. Comparisons were also made to small samples of photos from Colombia, Ecuador and the Antarctic Peninsula, representing wintering and feeding grounds of the Area I stock. Overall, the combined catalogues contained photographs of 688 individual whales (587 of which were collected in Oceania). Matches indicated migratory movement between the following areas: New Caledonia and New Zealand (2), New Caledonia and Tonga (3), Tonga and the Cook Islands (1), the Cook Islands and French Polynesia (1), and between Ecuador and the Antarctic Peninsula (1). These results add to previously known connections between eastern Australia and the westerly component of Oceania (New Caledonia, Tonga and New Zealand). They also suggest little or no movement between Oceania and Area I (western South America and the Antarctic Peninsula), although sample sizes for the latter region were too small to state this with certainty. The documented movement of some whales among portions of Oceania indicate that stock assessments based on combining regional estimates of abundance are likely to be positively biased. In contrast with the apparent recovery exhibited in Area IV and in the western portion of Area V, humpback whale abundance appears to remain low in Oceania, presumably because of overexploitation in the feeding grounds of Area VI. The analysis described here resulted from a workshop held at the University of Auckland from 4-7 March, 2000, and represents a preliminary framework for a planned assessment of humpbacks in this region.

KEYWORDS: HUMPBACK WHALE, SOUTH PACIFIC, OCEANIA, NEW ZEALAND, MIGRATION, BREEDING GROUNDS, POPULATION STRUCTURE

INTRODUCTION

Humpback whales migrate into the South Pacific waters of Oceania from summer feeding grounds in the high-latitude waters of the Southern Hemisphere. Humpbacks were subject to intensive commercial exploitation in Antarctic and other austral waters in the 20th century, with more than 200,000 killed over a seven-decade period. Almost a quarter of this total represents previously unreported catches by the Soviet Union, which conducted a massive campaign of illegal whaling following the Second World War (Yablokov *et al.* 1998).

Traditionally, Southern Hemisphere baleen whales (including humpbacks) have been divided into six stocks or management areas (number I - VI), each of which encompasses 60 degrees of longitude (see IWC 1980, p. 582). The relationship among these putative populations of humpback whales remains unclear, although considerably more is known about some areas (notably IV and V, Chittleborough 1965) than others. It has generally been assumed that the humpbacks which winter in Oceania are part of the Area VI stock, with those in the western portion of the region possibly belonging to an eastern component of Area V. The degree of exchange among the various parts of Oceania remains largely unknown.

In the last several years, a number of research projects have been initiated in various parts of Oceania, including New Caledonia, Tonga, the Cook Islands and French Polynesia. These projects have employed photo-id and tissue collection to study the occurrence, distribution, behaviour, abundance, genetics and habitat use of humpbacks at each study site (e.g. Baker *et al.* 1998). We report here the results of a comparison of photographic catalogues from these areas, as well as from New Zealand. We also compared these photos with more distant study sites off South America and the Antarctic Peninsula to investigate whether the range of Oceania animals extends to the easternmost margins of the Pacific. This comparison took place as part of a workshop on humpback whales in the South Pacific held at the University of Auckland from 4-7 March, 2000 (Donoghue and Baker 2000). These results provide the first direct evidence of movement among some regions of Oceania and a preliminary assessment of isolation from regions beyond Oceania.

METHODS

Study areas

For the purpose of this paper, we define Oceania as the large area of islands in the southwestern and south central Pacific Ocean, stretching from New Zealand and New Caledonia in the west to French Polynesia in the east; geographically, however, Oceania includes a much larger area of island groups in both southern and northern hemispheres. Dedicated surveys for humpback whales in this region were conducted during the austral winter in four areas: New Caledonia, Tonga, the Cook Islands and French Polynesia. These areas are described separately below. A small sample of opportunistically collected photographs was also available from New Zealand. It is important to stress that the great majority of islands in Oceania have never been surveyed for the presence of humpback whales, and their use of most of the potentially available habitat is therefore unknown.

New Caledonia

New Caledonia is spread over 1.450.000 km² between 18° and 23° S and between 158° and 172° E. It consists of a main island called “Grande Terre” and three groups of smaller ones : the Loyalty Islands to the east, the Belep Islands to the north and the Isle of Pines to the south. There are many uninhabited atolls further from the main groups, including Huon, Surprise, Chesterfield, Bellona, Matthew, Hunter and Walpole. The main island is 400 km in length, between 50 and 80 km wide, and is surrounded by over 1600 km of barrier reefs bounded by a 26,000 km² lagoon. Prevailing winds throughout the region are easterly and southeasterly trades. Some whaling is known to have occurred in the Loyalty Islands, although most of the effort was concentrated in the Chesterfield Atoll area (Townsend 1935).

Humpback whale surveys were conducted sporadically beginning in 1991 (Garrigue and Gill 1994), and for three months each austral winter from 1995 on (Garrigue and Greaves 2000). The study site covers approximately 1000 km² and is located in the southeastern portion of the lagoon off the main island. A total of 227 days have spent at sea since 1995.

Tonga

The Tongan archipelago is a series of volcanic islands and coral atolls extending from Ata in the south to Nuia in the north. The primary area of humpback whale density is thought to be the three major island groups; Tongatapu in the south, the Ha'apai group in the middle and the Vava'u group in the north. Substantial areas of shallow water, defined by the 200 m isobath, occur north of the Tongatapu group, around the Nomuka and Ha'apai groups and south of the Vava'u group. A dense barrier reef extends along the eastern fringe of the Ha'apai group, protecting

waters on its western side from south-easterly trade wind swells. To the eastern side of this reef the bottom drops precipitously. An expanse of water less than 200 m deep surrounds the atolls and shoals on the western side of the barrier reef and is bounded by the Tofua trench. Some hunting of humpback whales is known to have occurred in Tonga during the 19th century by American whaling ships (Townsend 1935), and hunting continued at a low level by local whalers until banned by royal decree in 1978 (see below).

Vessel-based surveys and the collection of individual identification photographs were initiated in 1991 (Abernethy *et al.* 1992). Each of the three main island groups has been surveyed in at least one year but most of the field effort from 1994-99 was concentrated around Vava'u. The majority of field work was conducted in August and early September, although work in some years included late July and early October.

Cook Islands

The Cook Islands are a group of islands and atolls scattered over approximately 2,000,000 km² of the southwestern South Pacific. These islands are divided into two groups, the Northern Cooks and the Southern Cooks; the latter include nine islands and atolls lying between latitudes 18°S and 22°S. Little or no whaling took place in this region in the 20th century and records of earlier (historical) catches there are sparse. Except for occasional opportunistic observations, there have been no field studies of cetaceans in the area. Consequently, very little is known about the biology and behaviour of humpback whales in the region.

Surveys for humpback whales in the Southern Cook Islands began with an exploratory three-week project in 1998 and continued with a three-month field effort in 1999 (Hauser *et al.* 2000). To date the survey has been focused on three locations: (i) Palmerston Atoll, a small atoll lying at 18° 04' S, 163° 10' W on the northwestern margin of the Southern Cook group; (ii) Aitutaki, an island located at 18° 55' S, 159° 47' W, roughly 300 km east of Palmerston; and (iii) Rarotonga, an island located at 21° 14' S, 159° 48' W, roughly 430 km southeast of Palmerston. Since all three islands are the surface peaks of large volcanoes, the bathymetry around the islands rapidly drops to abyssal depths exceeding 4000 m. Palmerston consists of small areas of land extending inward from an encircling barrier reef to a central, cratered lagoon. Surface water temperatures around the three islands approximately 25-26° C with little seasonal variation. Local weather is dominated by often strong easterly trade winds; thus, rough seas and large swells are common.

French Polynesia

French Polynesia comprises five archipelagos (the Marquesas, the Tuamotu atolls, the Gambiers, the Society Islands, and the Australs) in the central South Pacific Ocean. Together they are spread over an area of ocean (2,500,000 km²) that is the size of Europe, but their combined total land mass is a mere 4,000 km². The predominant winds are tradewinds coming from the northeast, east or southeast at speeds of 18-36 km/hr. During the austral winter, SE tradewinds often blow at 36-60 km/hr. There is a year-round, nearly continuous oceanic swell from the southeast to southwest which, during the austral winter, ranges from 3 m to 5 m in height. Sightings of humpback whales in French Polynesia's waters have been submitted to the sighting and stranding network run by one of the authors (MP) since 1988.

Mo'orea: The primary study area for fieldwork encompasses the nearshore waters of the high island of Mo'orea in the Society Islands, lying at 17° 30' S and 149° 50' W, 18 km northwest of Tahiti. An encircling barrier reef protects a shallow lagoon around most of the island. This barrier reef-lagoon system is breached by 12 passes through the reef. Several bays within the reef-lagoon system are 25-45 m deep. Natural drainage channels 10-35 meters deep cut across the shallow lagoon parallel to the reef, and run perpendicular to the bays. Observational surveys of humpback whales in the nearshore waters of Moorea began in 1991.

Rurutu: Additional shore and boat-based observations of humpback whales were begun in 1999 at Rurutu in the Austral Islands. Rurutu lies at 22° 30' S and 151° 15' W, approximately 570 km SSW of Moorea, and is a raised volcanic island with steep limestone cliffs. It is surrounded by a fringing reef rather than a barrier reef, and therefore has no real lagoon.

Photoidentification

Humpback whales were individually identified from photographs of the ventral fluke pattern (Katona and Whitehead 1981). Although some of the research projects concerned used variation in other markings (notably dorsal fin shape or lateral pigmentation) to recognise individuals, only fluke photos were employed in the comparisons described here. Photos were taken with 35 mm cameras equipped with zoom or telephoto lenses and either black and white print or colour slide film.

Regional photographic catalogues as well as some digital video images from the four principal study sites were compared by participants at a 4-day workshop convened at the University of Auckland, New Zealand in March 2000. In order to attempt to establish the eastern extent of movement among whales seen in Oceania, additional comparisons were made between some of these sites and small sample sizes of photos from the eastern Pacific (Ecuador and Colombia) and the Antarctic Peninsula. All matches were confirmed by at least three participants at

the workshop. A large catalogue of individual identification photographs from Eastern Australia was not considered at the workshop because of constraints on time (Kaufman *et al.* 1993). However, previous comparisons to this catalogue have established interchange between eastern Australia and New Caledonia (see below, Garrigue *et al.* 2000)

RESULTS AND DISCUSSION

The number of individual identification photographs varied considerably across regions (Table 1). The largest catalogues available for the comparison were for Tonga ($n = 247$ unique individuals), New Caledonia ($n = 182$) and French Polynesia ($n = 138$). The smallest catalogue was for New Zealand ($n = 4$). Larger catalogues exist for Colombia and the Antarctic Peninsula but, for reasons of logistics, were unavailable for the current comparison.

Comparison of the total of 688 individual identification photographs represented by the regional catalogue revealed seven matches among the five regions of Oceania. There were no matches between Oceania and Ecuador, Colombia or the Antarctic Peninsula. These results add to previously established connections between eastern Australia and the westerly component of Oceania; to date, three matches between eastern Australia and New Caledonia (Garrigue *et al.* 2000), one match between New Caledonia and New Zealand (Garrigue *et al.* 2000) and one between eastern Australia and Tonga (V. Amante-Helweg and C.S. Baker, unpublished data). The data also suggest little or no movement between Oceania and Area I (western South America and the Antarctic Peninsula), although sample sizes for the latter region were too small to state this with confidence. The direct evidence of movement within Oceania but not between Oceania and Area I is consistent with previous analyses of mitochondrial (mt)DNA gene flow among humpback whales in the Southern Hemisphere (Baker *et al.* 1998; Rosenbaum *et al.* 1998). Since no photographs were available of humpback whales from the high-latitude portions of Areas V and VI, we are unable to clarify the relationship between Oceania and the feeding grounds of the Antarctic. We can say only that existing data do not refute the assumption that humpbacks wintering in Oceania are part of the Area VI or eastern Area V group.

The movements documented here indicate some degree of interchange or migratory movement among the breeding grounds of Oceania. This finding has important implications for stock assessment. In particular, it implies that assessments which are based upon combining regional estimates of abundance will likely be positively biased because of the potential for whales to move among regions and be recorded more than once overall.

All of the observers working in Oceania note that the abundance of humpbacks in this region remains relatively low, and is clearly well below the levels that once supported large-scale commercial whaling on this stock. The research projects whose work is used here employed varying levels of effort in each of the four study areas, but in all cases effort was sufficient to gain an overall impression of the numbers of whales using each location. The apparent lack of recovery in Oceania contrasts sharply with the situation for neighbouring eastern Australia (western Area V), as well as Areas III and IV, where sighting surveys have recorded consistently high rates of increase in recent years (Bannister 1994, Best 1993, Bryden *et al.* 1990, Paterson *et al.* 1994, IWC 2000).

Survey effort relative to humpback whales in New Zealand waters has been largely opportunistic; however, studies that focussed primarily on other cetaceans have consistently surveyed several areas of the coast which were previously host to large numbers of humpbacks prior to 1964 (Dawbin 1966), and it is clear that this species remains rare locally (Gibbs and Childerhouse 2000). Indeed, New Zealand appears to be one of several examples of populations of mysticetes that were virtually extirpated by whaling, and which have not been repopulated by immigration from other areas; this may be due to the effective loss of the cultural memory of a particular location or migratory route (Clapham and Hatch 2000).

With the exception of New Zealand, which was the focus of an intensive humpback hunt from numerous shore stations (Dawbin 1997), little whaling was conducted on the wintering grounds of Oceania itself. Humpbacks were taken in Tonga and near New Caledonia by 19th century whaling vessels and, following European introduction, by Tongan people from the 1890's until 1978, using open boats and hand harpoons. Tongan whaling was small in scale, with annual catches prior to the early 1960's probably not exceeding 30-40 whales (Dawbin 1959). No reliable data are available on the numbers taken by the more recent local Tongan hunting, but it is known that the hunt focused on mothers and calves, and struck and lost rates of up to 3:1 have been estimated (Anonymous 1981). However, it is now clear that many thousands of humpbacks were removed from the Area VI population by illegal Soviet hunting in the Antarctic and it is therefore not surprising that abundance in Oceania (which may represent the primary wintering area for this stock) remains low. Until the locations of the many illegal Soviet catches have been published, the total number of humpbacks killed in Area VI will remain uncertain.

In light of this, we suggest that an assessment of this population of humpback whales is urgently required; the work summarised here represents the preliminary framework for such an assessment.

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Table 1. Results of comparisons of photo-id catalogues among areas, with sample sizes of identified individuals (*n*) and years of effort.

Area	<i>n</i>	Years	NZ	TG	CI	FP	AP	CO	EC
New Caledonia (NC)	182	1991-99	2*	3	0	0	0	0	0
New Zealand (NZ)	4	1994-99		0	0	0	0	0	0
Tonga (TG)	247	1991-99			1	0	0	0	0
Cook Islands (CI)	23	1998-99				1	0	0	0
French Polynesia (FP)	138	1992-99					0	0	0
Antarctic Peninsula (AP)	23	1994-95						0	1
Colombia (CO)	20	1992-98							0
Ecuador (EC)	59	1996							

Non-systematic comparison to the published catalogue for eastern Australia resulted in four matches to New Caledonia.

*Includes one match reported by Garrigue *et al.* 2000.

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Figure 1. Map of Oceania, showing the principal study areas.

