

Migratory movements of humpback whales (*Megaptera novaeangliae*) between New Caledonia, East Australia and New Zealand

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ABSTRACT

'Discovery' marks and their recoveries from humpback whales in the southwest Pacific provide no evidence of migratory interchange between wintering grounds in New Caledonia and migratory corridors off east Australia (Moreton Island) and New Zealand, or wintering grounds in Tonga. To provide further insight into the migratory connections among these regions, images of 169 individually-identified humpback whales from New Caledonia were compared with the published catalogues of Australian ($n = 1,088$), Tongan ($n = 78$) and New Zealand ($n = 1$) humpback whales. Four of the New Caledonian humpbacks were found to have migrated past east Australia and one past New Zealand in separate years. No movement was found between New Caledonia and Tonga. These data provide the first photographic information on exchanges between regions of the southwest Pacific. Reviewed in light of historical records, these data also highlight the necessity for further research in the South Pacific region to resolve the question of the proposed segregation of the Southern Hemisphere Group V stock into an eastern group (New Zealand and the Pacific Islands) and a western group (east Australia).

KEYWORDS: HUMPBACK WHALE; PHOTO-IDENTIFICATION; MIGRATION; SOUTHERN HEMISPHERE; AUSTRALASIA

INTRODUCTION

Humpback whales that spend the austral summer feeding in Antarctic Area V (130°E to 170°W) migrate north during winter and spring, and have historically been collectively referred to as Southern Hemisphere Group V; they are thought to breed and calve in lower latitudes somewhere in the southwest Pacific (Chittleborough, 1965; Dawbin, 1966). Based on Townsend's (1935) whaling charts, Dawbin and Falla (1949) hypothesised that whales observed moving north along the east coast of Australia during June and July might end up in the vicinity of the Chesterfield Islands, in the Coral Sea northwest of New Caledonia (22°30'S-159°20'E). Despite an extensive programme of 'Discovery' marking¹ throughout the southwest Pacific between 1952 and 1962, Dawbin (1966) found no information from recaptures to provide information on the relationship between animals summering in Antarctic Area V and those wintering from the east coast of Australia to as far east as the Cook Islands. In the context of this paper, Discovery marking also provided no information on the connection between east Australia and the Coral Sea proposed by Dawbin and Falla (1949).

In an earlier analysis of mark recoveries, Dawbin (1959) divided the southwest Pacific into three broad regions, based on localities in which marking and catching of humpback whales occurred. These regions were eastern Australia (Moreton Island), New Zealand (Foveaux Strait, Cook Strait) and Oceania (New Caledonia, Vanuatu, Fiji, Norfolk Island, Tonga, Cook Islands and Niue). Dawbin compared expected and observed mark recoveries between and within the three regions to determine movement between them. He noted two general findings of importance. First, while

eastern Australia and New Zealand showed twice as many within-region recoveries as expected, Oceania showed none. Second, significantly fewer than expected recoveries showed animals marked in one wintering area and caught in another. Dawbin concluded that 'the present evidence is already sufficient to demonstrate a considerable degree of autonomy between those humpback populations which pass East Australia, New Zealand and Oceania', with the possibility of limited exchange between east Australia and New Zealand. Eventually, evidence of one exchange between Fiji and east Australia was found (Dawbin, 1964), but there was no evidence for any exchange between New Caledonia and eastern Australia.

The recovery data led Dawbin (1966) to propose two general sub-divisions of Group V whales instead of three. One was referred to as the 'east Australia group' and the second the 'New Zealand group'. While the east Australia group was considered to include the same geographical areas defined in earlier analyses (Dawbin, 1959; 1964) the New Zealand group was redefined to include Norfolk Island, Tonga, Fiji and adjacent islands. Oceania was no longer represented as a third geographical region.

In the absence of any connection between New Caledonia and either east Australia or New Zealand, Dawbin (1966) thereafter omitted New Caledonia specifically from either group. Southern Hemisphere humpback whales have been protected since 1963 and thus there have been no further tag recoveries to clarify the degree of segregation between wintering areas and the migratory origins of whales observed near New Caledonia.

In recent decades, natural markings on ventral fluke surfaces (Katona *et al.*, 1979) and lateral body surfaces (Kaufman *et al.*, 1987) have been used to study humpback whale migrations, as well as life histories of individual animals (e.g. Glockner and Venus, 1983; Baker *et al.*, 1986).

¹ Discovery marks were numbered stainless steel tubes that were shot into the whale. They could be recovered only if the whale was killed (e.g. see Brown, 1977).

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In the Southern Hemisphere photo-identification has shown its utility by verifying migratory movement, previously elucidated by 'Discovery' marks, between Antarctic Area V and Queensland, Australia (Kaufman *et al.*, 1990) and between Antarctic Area IV and Western Australia (Gill and Burton, 1995) as well as a previously unrecorded migratory connection between the Antarctic Peninsula (Area I) and Colombia (Stone *et al.*, 1990). As the number of photo-identification images has grown, it has provided an excellent opportunity to expand on mark-recovery efforts to determine the rate of exchange between areas of congregation within known wintering grounds in the southwest Pacific. This paper reports on resightings of animals between New Caledonia and both east Australia and New Zealand.

MATERIALS and METHODS

Photo-identification and behavioural studies have been carried out each winter in New Caledonia since 1993 (Forestell *et al.*, 1994). The study site covers part of the southern lagoon of the main island of New Caledonia between 22°20' and 22°40'S, and 166°50' and 167°07'E. The area totals about 1,000km². A land-based team, located at an elevated point (189m), searches for whales using hand-held binoculars (7 × 42mm) and a telescope magnification and field. Most of the boat-based observations have been carried out using small outboard power boats. SLR cameras with 200 and 300mm lenses have been used for photo-identification, usually with 100 or 400 ASA slide film.

A catalogue containing all ($n=169$) the identified humpback whale flukes from New Caledonia has been published (Garrigue and Greaves, 1999). Similar catalogues are available for east Australia ($n=1080$; Kaufman *et al.*, 1993) and Tonga ($n=79$; Patenaude and Baker, 1996) which includes one photograph from New Zealand. These three catalogues were compared independently by three people for resightings of individual whales. A whale was considered 'resighted' if all three observers agreed on numerous points of correspondence between fluke or lateral body markings.

RESULTS

Between 1993 and 1998, a total of 169 humpback whales was identified in New Caledonia by the ventral surface of the fluke alone or combined with dorsal fin/lateral body markings ($n=165$) or by lateral body markings with dorsal fin alone ($n=4$). A comparison of individuals from the New Caledonia catalogue with those from both Australia and Tonga/New Zealand revealed five matches between regions (Fig. 1). Four of them were based on fluke markings and one on lateral body markings. Four matches were found between New Caledonia and east Australia, one animal sighted in New Caledonia matched the single animal sighted at the Bay of Islands, New Zealand (Table 1). No matches have been made between Tongan and New Caledonian flukes. Of the five documented migratory interchanges, two shared a southwestward connection between New Caledonia and the east Australian coast and one showed a southeastward movement between New Caledonia and New Zealand (Fig. 2). None of the resightings between regions showed migratory movement in the same year.

DISCUSSION

The documentation of five whales moving between New Caledonia and other regions, extends Dawbin's (1959; 1964; 1966) analysis of 'Discovery' mark recoveries regarding movement of humpback whales in the southwest Pacific. It confirms for the first time, the previously assumed migratory connections between New Caledonia, east Australia and New Zealand.

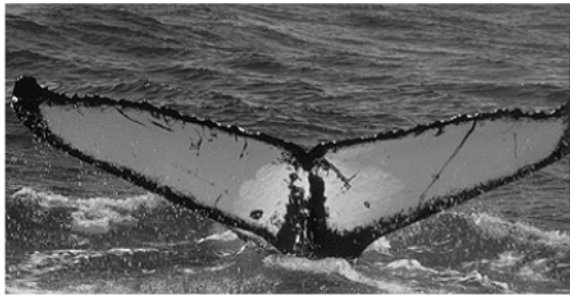
None of the whales were resighted in New Caledonia in the same year that they were identified in east Australia. This does not provide support for the hypothesis (Dawbin and Falla, 1949) that the whales observed moving north along the east coast of Australia during June and July might end up in the vicinity of the Chesterfield Islands (Fig. 2). Furthermore, Paterson and Paterson (1984; 1989) and Simmons and Marsh (1986) reported that an important calving ground for the east Australian population occurs in waters of the Great Barrier Reef in the vicinity of 20°S. One of the four documented interchanges between New Caledonia and east Australia was to that latitude. It is also important to note that the whale catalogued as HNC002/E1000 has been sighted twice in New Caledonia in different years, thus implying that such exchanges between east Australia and New Caledonia do not occur by chance.

One resighting reported here also provides the first documentation of exchange between New Caledonia and New Zealand. This introduces an important new aspect to the current understanding of migratory pathways. Observations of humpback whales along the coasts of New Zealand are currently rare; indeed, there is only one identification photograph from New Zealand. It seems more than coincidence that this individual from New Zealand was also observed and identified twice in New Caledonia. Such movement between New Caledonia and New Zealand is consistent with a migratory return to Antarctic Area V. In his earlier work on the northern migration of humpback whales passing the east coast of New Zealand's North Island, Dawbin (1956) commented that, 'The trend if continued would take both these groups of whales past Norfolk and New Caledonia towards the known breeding ground in the Coral Sea'. During behavioural observations, outside the Barrier Reef in the southernmost portion of the New Caledonian study area, we have observed solitary humpback whales travelling in a south southeast direction. These animals followed a compass bearing of 150° at a speed of 4-6 knots, blowing at regular intervals of a few minutes. No deviations to their course were noted during the observations, which lasted for up to one hour. If followed continuously, this bearing leads to the North Island of New Zealand close to the Bay of Islands, where the whale HNC113/BoI9401 was first identified in November 1994. This suggests that the migratory route taken by at least some humpback whales from New Caledonia retraces the northbound pathway suggested by Dawbin (1956).

What remains in question is whether New Caledonia forms an extension of the east Australian group or should be considered part of the New Zealand group. Alternatively, segregation into 'groups' could be merely an artifact of the dependence of 'Discovery' mark recoveries on highly localised whaling effort. Using acoustic analysis, Gill *et al.* (1995) and Helweg *et al.* (1998) demonstrated that east Australia and New Caledonia songs were not significantly different. Helweg *et al.* (1998) further suggested that song recorded from Kaikoura in New Zealand was 'eastern Australian' rather than 'Tongan'. The similarity of songs recorded in French Polynesia to those from Area V also

suggest some interchange between Area V and Area VI (170°W–130°W) (A. Gannier, pers. comm.). Analysis of mtDNA variation failed to find significant assortment of maternal lineages between Tonga and the migratory corridor

of east Australia (Baker *et al.*, 1994; 1998) but no samples from New Caledonia have been included in the published analyses. Demographic trends, however, suggest a degree of sub-division between these regions. The number of



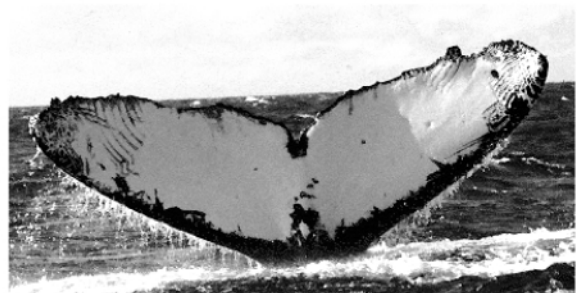
HNC002 / E1000



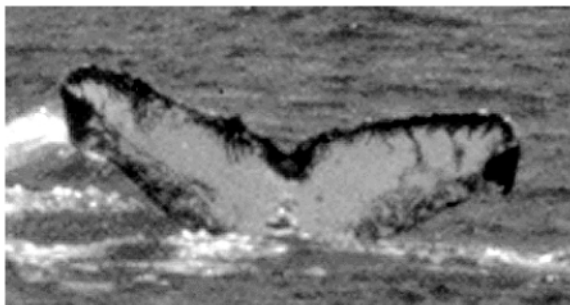
HNC058 / E0299



HNC029 / no number



HNC113 / BoI9401



HNC047 / E0198

Fig. 1. Five humpback whales which provided a photographic resight between New Caledonia and either east Australia or New Zealand. Catalogue numbers are shown.

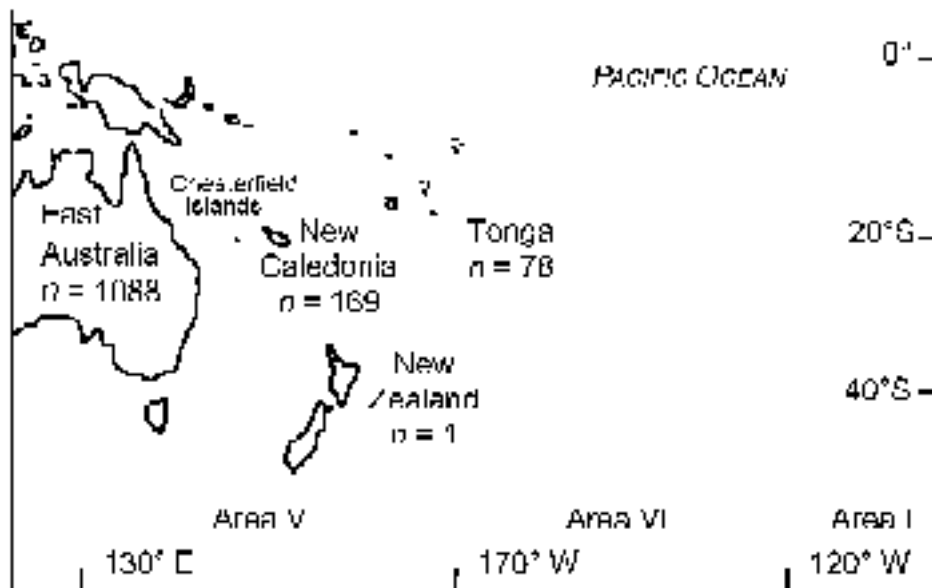


Fig. 2. The southwest Pacific Ocean, showing the number of photo-identified animals per location (n) in this study.

Table 1
Date, location and ID numbers of the resighted whales.

First sighted	ID No.	Years	Resighted	ID No.	Years
East Australia	E1000	1991	New Caledonia	HNC002	1993 and 1998
East Australia	No number	1984	New Caledonia	HNC029	1994
East Australia	E0198	1985 and 1993	New Caledonia	HNC047	1995
East Australia	E0299	1987	New Caledonia	HNC058	1995
New Zealand	Bo19401	1994	New Caledonia	HNC113	1997

humpback whales passing along the coast of east Australia has increased markedly over the last decade, whereas this has not been the case for New Caledonia or Tonga where numbers remain low.

Available data are insufficient to draw firm conclusions about the degree of demographic or genetic isolation among wintering grounds in the southwest Pacific. An expansion of effort to increase the number and geographic coverage of photo-identification images from throughout the South Pacific would do much to clarify the patterns of movement among the wintering areas. Photo-identification continues in New Caledonia (Garrigue and Gill, 1994; Garrigue and Greaves, 1999) and Tonga (Patenaude and Baker, 1996; R. Constantine and M. Donoghue, pers. comm.), and began recently in French Polynesia (M. Poole, pers. comm.) and the Cook Islands (N. Hauser and H. Peckham, pers. comm.). However, the vast size of this region and the relatively low density of whales is an obstacle to a fine-grain analysis of migratory interchange. Efforts underway to understand the geographic distribution of mtDNA haplotypes should also help shed light on this migration and stock structure (Baker *et al.*, 1998). Due to the high rate of resightings, New Caledonia represents a location critical to the understanding of the migratory movement of humpback whales in the southwest Pacific.

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REFERENCES

Baker, C.S., Herman, L.M., Perry, A., Lawton, W.S., Straley, J.M., Wolman, A.A., Kaufman, G.D., Winn, H.E., Hall, J.D., Reinke, J.M. and Ostman, J. 1986. Migratory movement and population structure

of humpback whales *Megaptera novaeangliae* in the central and eastern North Pacific. *Mar. Ecol. Prog. Ser.* 31:105-19.

Baker, C.S., Slade, R.W., Bannister, J.L., Abernethy, R.B., Weinrich, M.T., Lien, J., Urban, J., Corkeron, P., Calambokidis, J., Vasquez, O. and Palumbi, S.R. 1994. Hierarchical structure of mitochondrial DNA gene flow among humpback whales, *Megaptera novaeangliae*, world-wide. *Mol. Ecol.* 3:313-27.

Baker, C.S., Flórez-González, L., Abernethy, B., Rosenbaum, H.C., Slade, R.W., Capella, J. and Bannister, J.L. 1998. Mitochondrial DNA variation and maternal gene flow among humpback whales of the Southern Hemisphere. *Mar. Mammal Sci.* 14(4):721-37.

Brown, S.G. 1977. Whale marking: a short review. pp. 569-81. In: M. Angel (ed.) *A Voyage of Discovery: George Deacon 70th Anniversary Volume*. Pergamon Press, Oxford.

Chittleborough, R.G. 1965. Dynamics of two populations of the humpback whale, *Megaptera novaeangliae* (Borowski). *Aust. J. Mar. Freshwater Res.* 16:33-128.

Dawbin, W.H. 1956. The migration of humpback whales which pass New Zealand. *Trans. R. Soc. NZ* 84(1):147-96.

Dawbin, W.H. 1959. New Zealand and South Pacific whale marking and recoveries to the end of 1958. *Norsk Hvalfangsttid.* 48(5):213-38.

Dawbin, W.H. 1964. Movements of humpback whales marked in the southwest Pacific Ocean 1952 to 1962. *Norsk Hvalfangsttid.* 53(3):68-78.

Dawbin, W.H. 1966. The seasonal migratory cycle of humpback whales. pp. 145-70. In: K.S. Norris (ed.) *Whales, Dolphins, and Porpoises*. University of California Press, Berkeley and Los Angeles. xv+789pp.

Dawbin, W.H. and Falla, R.A. 1949. A contribution to the study of the humpback whale based on observation at New Zealand shore stations. *Proc. Seventh Pac. Sci. Congr.* 4:373-82.

Forestell, P.H., Naessig, P.J. and Brown, E.K. 1994. *Humpback whale research conducted under permit from the Department of Environment and Heritage during the 1993 season*. Report to the Department of Environmental Heritage, Brisbane, Queensland, Australia. 16pp.

Garrigue, C. and Gill, P.C. 1994. Observations of humpback whales, *Megaptera novaeangliae* in New Caledonian waters during 1991-1993. *Biol. Conserv.* 70(3):211-8.

Garrigue, C. and Greaves, J. 1999. *New Caledonia, a Rendezvous for the Humpback Whale*. C. Ledru (ed.), New Caledonia. 160pp.

Gill, P.C. and Burton, C.L.K. 1995. Photographic resight of a humpback whale between Western Australia and Antarctic Area IV. *Mar. Mammal Sci.* 11(1):96-100.

Gill, P.C., Eyre, E.J., Garrigue, C. and Dawbin, W.H. 1995. Observations of humpback whales (*Megaptera novaeangliae*) on a cruise to New Caledonia and the Chesterfield Reefs. *Mem. Queensl. Mus.* 38(2):505-11.

Glockner, D.A. and Venus, S.C. 1983. Identification, growth rate, and behavior of humpback whale (*Megaptera novaeangliae*) cows and calves in the waters off Maui, Hawaii, 1977-1979. pp. 223-58. In: R. Payne (ed.) *Communication and Behavior of Whales*. AAAS Selected Symposium 76. Westview Press, Colorado. xii+643pp.

Helweg, D.A., Cata, D.H., Jenkins, P.J., Garrigue, C. and McCauley, R.D. 1998. Geographic variation in South Pacific humpback whale songs. *Behaviour* 135:1-27.

Katona, S., Baxter, B., Brazier, O., Kraus, S., Perkins, J. and Whitehead, H. 1979. Identification of humpback whales by fluke photographs. pp. 33-44. In: H.E. Winn and B.L. Olla (eds.) *Behavior of Marine Animals*. Vol. 3. *Cetaceans*. Plenum Press, New York and London. i-xix + 438pp.

Kaufman, G.D., Smultea, M.A. and Forestell, P.H. 1987. Use of lateral body pigmentation patterns for photographic identification of East Australian (Area V) humpback whales. *Cetus* 7:5-13.

Kaufman, G.D., Osmond, M.G., Ward, A.J. and Forestell, P.H. 1990. Photographic documentation of the migratory movement of a

- humpback whale (*Megaptera novaeangliae*) between East Australia and Antarctic Area V. *Rep. int. Whal. Commn* (special issue) 12:265-7.
- Kaufman, G.D., Lagerquist, B.A., Forestell, P.H. and Osmond, M.G. (eds.). 1993. *Humpback Whales of Australia: a Catalogue of Individual Whales Identified by Fluke Photographs*. 1st Edn. Queensland Department of Environment and Heritage, Brisbane, Queensland, Australia. 207pp.
- Patenaude, N. and Baker, C.S. 1996. An individual identification of humpback whales (*Megaptera novaeangliae*) in Tonga 1991-1995. Report to the Whale and Dolphin Conservation Society, Pacific Development Trust and the South Pacific Regional Environment Program. (Unpublished). 10pp. + appendix. [Available from: info@wdcs.org].
- Paterson, R. and Paterson, P. 1984. A study of the past and present status of humpback whales in East Australian waters. *Biol. Conserv.* 29(4):321-43.
- Paterson, R. and Paterson, P. 1989. The status of the recovering stock of humpback whales *Megaptera novaeangliae* in East Australian waters. *Biol. Conserv.* 47(1):33-48.
- Simmons, M.L. and Marsh, H. 1986. Sightings of humpback whales in Great Barrier Reef waters. *Sci. Rep. Whales Res. Inst., Tokyo* 37:31-46.
- Stone, G.S., Flórez-Gonzalez, L. and Katona, S. 1990. Whale migration record. *Nature, Lond.* 346:705-6.
- Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. *Zoologica (NY)* 19(1-2):1-50+6 maps.