A note on East Australia Group V Stock humpback whale movement between feeding and breeding areas based on photo-identification

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ABSTRACT

Documentation of humpback whale migratory movements between Australasia and the Southern Ocean has been limited almost exclusively to historical whaling data. This study examines photographic evidence documenting the movements of three individual humpback whales between their breeding grounds on the northeast coast of Australia and feeding grounds in Area V of the Southern Ocean. Although these individuals exhibited marked site fidelity to the same low latitude breeding grounds, their sightings in high latitude feeding grounds vary by 35° longitude, confirming dispersal of Eastern Australia Group V Stock humpback whales in the Antarctic feeding ground.

KEYWORDS: HUMPBACK WHALE; MIGRATION; DISTRIBUTION; PHOTO-ID; AUSTRALASIA; ANTARCTIC

INTRODUCTION

Early historical data from Discovery marks supported the hypothesis that humpback whales (*Megaptera novaeangliae*) wintering off the eastern coast of Australia (East Australia Group V Stock: EAGVS) spend their summer months in Antarctic waters in the vicinity of 150°E-180° (Omura, 1953; Dawbin, 1964; Chittleborough, 1965). However, since the late 1960s, no humpback whales from these stocks have been taken for commercial or scientific purposes and subsequently, recovery rate of these marks has been poor. Of 3,000 marks deployed over a 25 year period in this region, fewer than three percent were recaptured (Dawbin, 1964; Chittleborough, 1965).

The use of photo-identification (photo-ID) methodologies to document movements of humpback whales has since become well established and studies of migratory movement between Australasia and the Southern Ocean, in particular, have increased in recent years (Kaufman *et al.*, 1987; Kaufman *et al.*, 1990; Gill and Burton, 1995; Matsuoka *et al.*, 2001; Allen *et al.*, 2002). Despite this increase in effort, only two publications provide photographic documentation of humpback whale migration between these regions. They detail the movement of just two individual whales; one between western Australia and Antarctic Area IV (70°-130°E; Gill and Burton, 1995) and the other (Animal E0212; Kaufman *et al.*, 1993) between eastern Australia and the boundary area between Area V (130°E-170°W) and Area VI (170°-120°W) (Kaufman *et al.*, 1990). This note reports further photographic evidence for migratory movement of humpback whales between eastern Australia and Area V.

FIELD OBSERVATIONS

Humpback whales frequently congregate in coastal waters off eastern Australia during the austral winter. Hervey Bay, in southern Queensland (QLD≈ 24°S, 153°E; Fig. 1), has historically been one such congregation point and photo-ID has revealed that many individuals frequent this area over multiple years (Kaufman *et al.*, 1993; Forestell *et al.*, 2003), with occasional visits to other important areas of aggregation such as the Whitsunday Islands (≈ 20°S, 150°E), Point Lookout, North Stradbroke Island (≈ 27°S, 153°E) and Eden, New South Wales (NSW,≈ 37°S, 150°E; Fig. 1). This study focuses on three individuals, one that was described previously (Kaufman *et al.*, 1990) and two that are described here for the first time. All three whales have been photographed in QLD, NSW and in Antarctic Area V; two have been photographed multiple times over the past 15 years.

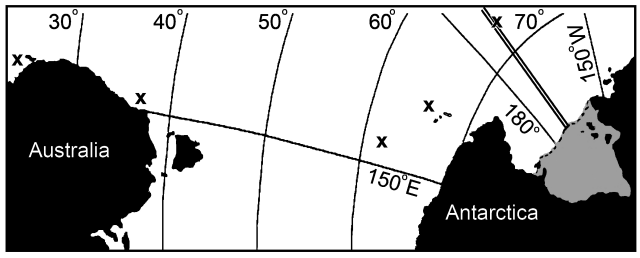

Fig. 1. Documented sightings of humpback whales E0212, E0502 and E1007 in Hervey Bay and off Eden, Australia and in Antarctic Area V. Locations of sightings are marked with dark crosses. Latitudinal markings are degrees south; double line indicates the boundary between Area V and Area VI.

Animal E0212 (Kaufman *et al.*, 1993) was first photographed in the Antarctic in 1986 and the following year was re-sighted over a four-day period in Hervey Bay (Kaufman *et al.*, 1990). Since that time, E0212 has been photographed in Hervey Bay in 1989, 1990, 1992, 1998 and 2002 (Table 1). In 1996 and 1998 it was also photographed off Eden, NSW. Although E0212's gender has not been verified by DNA analysis, behavioural observations off eastern Australia suggest it is a male. On nine of the twelve occasions in Hervey Bay, E0212 was in surface-active groups of four or more whales. On three of those occasions

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there was a mother and calf in the group. While not completely conclusive, such activities during the breeding season are indicative of male competitive mating behaviour (Clapham, 2000). Identifying features of E0212 have previously been published (Kaufman *et al.*, 1990).

Table 1

Documented sighting history of E0212, E0502 and E1007 in Eastern Australia and Antarctica.

Individual	Date	Location	Latitude (S)	Longitude (E)
E0212	07/02/1986	AN*	68° 46' 00"	170° 52' 00" W
	10/09/1987	HB*	24° 58' 00"	153° 06' 00"
	11/09/1987	HB*	24° 58' 00"	153° 06' 00"
	12/09/1987	HB*	24° 58' 00"	153° 06' 00"
	13/09/1987	HB*	24° 58' 00"	153° 06' 00"
	21/08/1989	HB*	24° 58' 00"	153° 06' 00"
	05/09/1990	HB*	24° 58' 00"	153° 06' 00"
	07/09/1990	HB*	24° 58' 00"	153° 06' 00"
	08/09/1990	HB*	24° 58' 00"	153° 06' 00"
	22/08/1992	HB*	24° 58' 00"	153° 06' 00"
	24/08/1992	HB	24° 45' 68"	153° 03' 82"
	15/10/1996	ED	37° 20' 00"	150° 02' 70"
	27/09/1998	HB	24° 59' 46"	153° 10' 35"
	22/10/1998	ED	37° 06' 66"	150° 04' 11"
	24/10/1998	ED	37° 05' 50"	149° 58' 16"
	21/09/2002	HB*	24° 58' 00"	153° 06' 00"
E0502[1]	27/09/1988	HB*	24° 58' 00"	153° 06' 00"
	25/09/1991	HB	25° 01' 45"	153° 11' 30"
	04/09/1996	HB	24° 59' 45"	153° 09' 07"
	07/09/1996	HB	24° 58' 13"	153° 09' 78"
	05/08/1997	HB	24° 59' 97"	153° 06' 54"
	06/08/1997	HB	24° 55' 78"	153° 07' 92"
	30/07/1998	WI	20° 04' 16"	148° 54' 22"
	19/09/1998	HB	24° 55' 37"	153° 11' 14"
	20/09/1998	HB	24° 55' 43"	153° 12' 99"
	23/09/1998	HB	24° 53' 87"	153° 10' 17"
	24/09/1998	HB	24° 55' 96"	153° 13' 30"
	20/02/1999	AN*	66° 11' 00"	163° 14' 00"
	19/09/1999	HB	24° 58' 24"	153° 12' 36"
	22/09/1999	HB	24° 54' 62"	153° 10' 19"
	02/11/1999	ED	37° 06' 40"	149° 57' 61"
	05/10/2000	HB	24° 56' 15"	153° 11' 15"
	06/10/2000	HB	24° 55' 06"	153° 08' 44"
	07/10/2000	HB	24° 57' 90"	153° 12' 77"
	10/10/2000	HB	24° 59' 15"	153° 11' 36"
	15/09/2002	HB	25° 06' 27"	153° 03' 12"
	16/09/2002	HB	25° 07' 73"	153° 04' 33"
	19/09/2002	HB	25° 00' 15"	153° 10' 91"
	24/09/2002	HB	25° 02' 38"	153° 09' 06"
E1007[2]	02/08/1991	PL*	27° 25' 58"	153° 33' 47"
	16/01/1995	AN*	62° 49' 00"	155° 55' 00"
	10/11/2002	ED*	37° 04' 75"	149° 57' 05"

Notes: [1]AHWC #0978; [2]AHWC #0958. *Represents locations for which generalized approximations are given (although data are available for each observation with regard to the general location, exact GPS fixes were not determined); AN = Antarctica; WI = Whitsunday Islands; HB = Hervey Bay; PL = Point Lookout; ED = Eden.

The humpback whale individual E0502 (Kaufman *et al.*, 1993) was first identified in Hervey Bay in 1988 and was re-sighted in 1991, 1996-2000 and 2002 (Table 1). E0502 was also photographed in the Whitsunday Islands (1998) and in Eden, NSW (1999). Identifying features of this individual are shown for the ventral fluke and both left and right dorsal fin/flank regions in Figs 2a-c, respectively. Pigmentation patterns on both fluke and flank remained relatively unchanged over the fifteen-year re-sight period (Pacific Whale Foundation (PWF), unpublished data), however the animal suffered significant injury to the left side of its dorsal fin in 2002. E0502 was photographed in association with a calf in every year of its sighting history in eastern Australia, a total of eight seasons, including a period spanning five consecutive years (1996-2000). In all but one of those years the calf was newborn (<one year old); in 1997 a yearling, assumed to be the calf born the previous season, was in accompaniment.

The humpback individual E1007 was first identified at Point Lookout, ≈ 160 n.miles south of Hervey Bay in 1991 (Table 1; Kaufman *et al.*, 1993) and was re-sighted in Eden in 2002. Identifying features are shown for ventral fluke and left dorsal fin/flank region in Figs 3a-b; there is little sign of modification over the 11 year re-sight period.

Fig. 2. Identifying features of E0502 including, (a) fluke (2002) and both left (b) and right (c) dorsal fin/flank areas (2002 and 1997, respectively) in Hervey Bay, Australia and (d) fluke (1999) in Antarctic Area V.

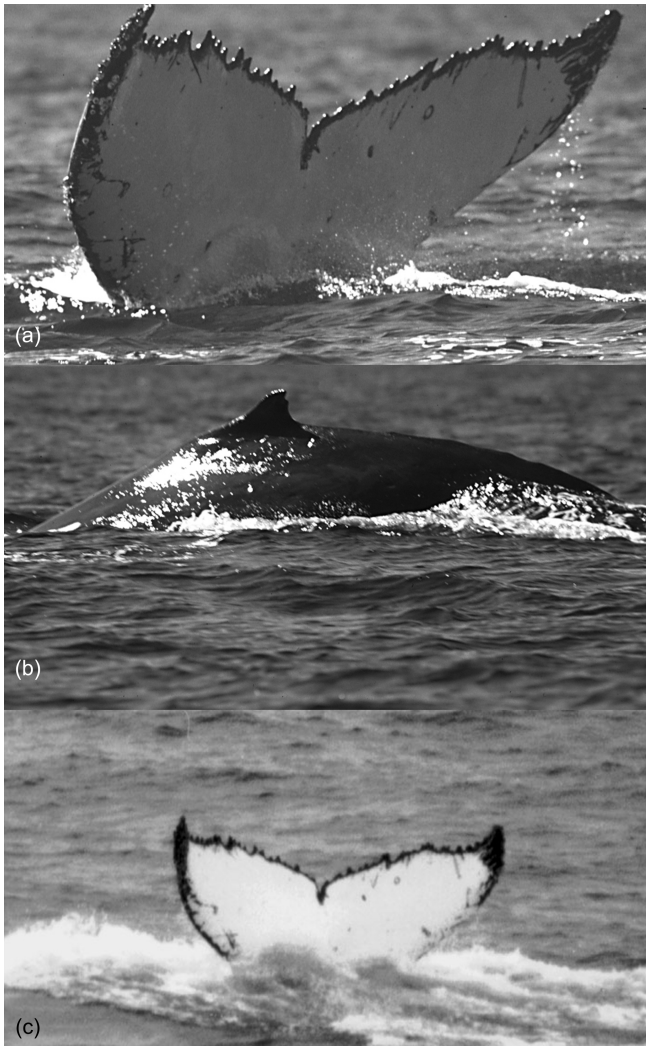

Fig. 3. Identifying features of E1007 including, (a) and (b) fluke and left dorsal fin/flank area (both 1991) in Australia and (c) fluke (1995) in Antarctic Area V.

As was the case with E0212, both E0502 and E1007 were photographed in Antarctic Area V of the Southern Ocean. Animal E0212 was photographed at 68°46'S, 170°52'W on 7 February 1986 (Kaufman *et al.*, 1990). Animal E0502 was sighted at 66°11'S, 163°14'E (Fig. 1) on 20 February 1999, during the 1998/1999 JARPA cruise (Japanese Whale Research Program under Special Permit in the Antarctic). Animal E1007 was sighted at 62°49'S, 155°55'E (Fig. 1) on 16 January 1995 during the 1994/1995 JARPA cruise. As was done earlier with animal E0212, ventral fluke photographs of E0212 and E1007 (Figs 2d, 3c) were submitted to the Antarctic Humpback Whale Catalogue (AHWC; curated at Allied Whale, College of the Atlantic, Maine, USA). The flukes of all three animals were compared with catalogued individuals from Antarctic sectors I-VI (n=696), as well as Western Australia (n=239), East Australia (n=2250), Oceania (n=2), Gabon (n=46), Brazil (n=288), Costa Rica (n=38), Colombia (n=102), Ecuador (n=252) and Chile (n=8). No further matches were made between E0212, E0502 or E1007 and catalogued individuals from these regions; E0502 and E1007 were assigned AHWC catalogue numbers 0978 and 0958, respectively.

E0502 was confirmed as a female by genetic analysis of a biopsy skin sample obtained in Area V (Pastene *et al.*, unpublished data). At the time of sampling in Area V, E0502 was observed in a group of three individuals that included a yearling. The estimated length of each whale was 13.4m (E0502), 11.9m (genetic analysis indicated this animal was also female) and 10.4m. They were observed to be swimming slowly, approximately 25 n.miles from the edge of the pack ice. No feeding activities were observed and the animals spent periods of time resting with just the blowhole region of the rostrum at the surface. Although E0502 had been observed approximately 8 months earlier in Hervey Bay with a calf, it is not certain at this point that this animal, rather than the second female in the group of three whales, was the mother of the accompanying yearling in the Antarctic.

DISCUSSION OF MOVEMENTS BETWEEN FEEDING AND BREEDING GROUNDS

Photographs of E0212, E0502 and E1007 along the QLD coast during the breeding season (at Hervey Bay and Point Lookout), the NSW coast during the southward migration (near Eden) and in the Southern Ocean during the feeding season at 155°E-170°W, provides further documentation that humpback whales wintering along the east coast of Australia spend their summer months feeding in the Southern Ocean in Area V (Dawbin, 1964; Chittleborough, 1965). The latter two sightings add to the only other photo-documentation of a humpback whale moving between eastern Australia and the Area V region (E0212, photographed in Hervey Bay and in the Ross Sea, Kaufman *et al.*, 1990). These sightings are compared with respect to their significance to our understanding of the longitudinal distribution of humpback whales in the Southern Ocean.

Animals E0212, E0502 and E1007 were photographed at similar locations in the low latitude breeding grounds (i.e. in Hervey Bay and Point Lookout during the breeding season and near Eden late in the southward migration). They were also documented at similar latitudes in Area V of the Southern Ocean (68°46'S, 66°11'S and 62°49'S respectively). There is, however, a marked longitudinal difference of 35° (approximately 817 n.miles) between the sightings of these humpback whales in Area V. Animal E0502 was observed at 163°14'E and E1007 was observed at 155°55'E, in the vicinity of the Balleny Islands. In contrast, E0212 was photographed far to the east at 170°52'W, in the open Ross Sea region on the boundary between Area V and Area VI. These data provide photographic evidence that East Australia Group V Stock (EAGVS) humpback whales tend to disperse more widely in their high latitude feeding grounds, as first concluded by Chittleborough (1965) and Dawbin (1966).

In general, little is known about the movements of Southern Hemisphere humpback whales within their summer feeding grounds. Data from Discovery marks document longitudinal movements of individuals within Areas I (120°-60°W), III (0°-70°E) and VI across years (IWC, 1998). Additional, more comprehensive, data come from long-term photo-ID efforts in Area I of the Antarctic Peninsula (Stevick *et al.*, 2004). Here, some individual humpback whales are regularly re-sighted at similar latitudes and longitudes in different years (AHWC, unpublished data). Little other information exists on the movements of individual humpback whales within other areas of the Southern Ocean, where there are few or less significant landmasses to concentrate the resources that contribute to feeding site fidelity. In Area VI, one individual has been photo-documented twice in similar geographic positions, with a span of six years between sightings

(JARPA, 1 January 1997 at 65°33'S, 167°29'W; IWC, 3 January 1991 at 64°56'S, 171°43'W, AHWC, unpublished data). There is also a single case of a molecular marker match for a female humpback whale first sampled in the western part of Area V (January 1995) that was subsequently re-sampled in the eastern part of Area IV (January 2000; Pastene *et al.*, 2002).

A broad distribution of humpback whales at high latitudes increases the likelihood of an overlap of breeding populations, resulting in the mixing of discrete low latitude populations, as suggested by Omura (1953) and Chittleborough (1959). Mixing between stocks is less likely to occur through within-season changes in breeding locations; such movements have been documented only rarely and in populations not separated by large landmasses (e.g. movements of an individual between Mexico and Hawaii (PWF, unpublished data) and between eastern Australia and New Zealand (Dawbin, 1964)). Thus the primary site for population stock mixing is most likely to occur in the Southern Ocean. Such mixing of stock has been documented, by a variety of methodologies, between EAGVS and both western Australia Area IV stock and Oceania Area VI stock. Historical whaling data shows that a small percentage (5%) of marks deployed in EAGVS were recovered in animals in western Australia (Chittleborough, 1965; Dawbin, 1966) and several mark recaptures of EAGVS have occurred well into Area VI (160°W; Dawbin, 1966). At least eight marks deployed in New Zealand/Oceania animals have also been recaptured in Area V (between 162-177°E; Dawbin, 1964). Further evidence for interchange has been established more recently by the discovery of overlap in song characteristics between eastern and western Australian stocks (Noad *et al.*, 2000), photographic documentation in Hervey Bay of an animal also identified near Perth, Western Australia (Pacific Whale Foundation and D. Coughran, unpublished data) and photographic matches between eastern Australia and western Oceania (including New Caledonia and Tonga; Garrigue *et al.*, 2000; 2002). Genetic studies have also confirmed that Southern Hemisphere humpback populations are generally more discrete in their breeding grounds than in their feeding grounds (Pastene and Baker, 1997).

Mark recapture results do not necessarily suggest mixing of stocks on an ongoing basis, but may indicate transitory patterns associated with unusual fluctuations in prey distribution in the Southern Ocean (Chittleborough, pers. comm.). The proclivity of humpback whales to shift distribution in response to changes in prey availability has been well documented in the North Atlantic (Weinrich *et al.*, 1997). In the Southern Ocean, the distribution of baleen whales is highly correlated with availability of euphasiids and humpback whales, in particular, have been shown to follow prey concentrations irrespective of bottom topography (Murase *et al.*, 2002). Matsuoka *et al.* (2003) demonstrated that high-density areas of humpback whales occur along the large (and temporally flexible) meander of the southern boundary of the Antarctic Circumpolar Current. Large-scale changes in prey distribution, such as those associated with significant El Niño-Southern Oscillation events, would set the stage for animals converging on areas of dense prey availability to include transitory whales from relatively distant feeding groups (Chaloupka *et al.*, 1999; Forestell *et al.*, 2003). Such an event may have occurred, for example, in 1958 when one of the strongest El Niños on record in the last 55 years occurred (International Research Institute for Climate Prediction, 2004) and mark recoveries documented expansion of the EAGVS feeding range into Area IV, with some EAGVS individuals migrating north with the western Australia breeding population (Chittleborough, 1965).

The present data, in combination with previously published photographic evidence (Kaufman *et al.*, 1990), show examples of broad dispersal in high latitude feeding grounds for EAGVS whales, providing support for the earlier findings based on Discovery mark analyses. The data do not exclude the possibility that breeding populations from both eastern and western Australia and Oceania are subject to some low level of mixing on the feeding grounds during summer months. Clearly, continued effort to photo-ID humpback whales in the Southern Ocean (particularly in Areas II-VI) and collaborative exchange between the disparate international groups expending effort in high latitudes, are necessary to clarify important questions about the population biology of Southern Hemisphere humpback whales.

ACKNOWLEDGEMENTS

Research in Australia was conducted by the Pacific Whale Foundation (PWF) between 1984 and 2002 under permits from the Commonwealth of Australia, the States of Queensland and New South Wales and the Great Barrier Reef Marine Park Authority. The members of PWF, the QLD Environmental Protection Agency (Parks and Wildlife Service) and a number of whale watch vessels including FantaSea Cruises, Lady Musgrave, Matilda Cruises, Sea Spray and Cat Ballou Cruises provided financial and logistical support. R. Butts and C. Smith provided additional photographs from NSW; B. Lagerquist, P. Naessig and A. Hellrung curated the Australian catalogue and L. de la Paz assisted in matching. We thank countless individuals who facilitated research in Australia by working as volunteers and research assistants and by contributing identification photographs. In Antarctica, research was conducted by JARPA under special permit in the Antarctic (Matsuoka and Ohsumi, 1995). We would like to thank JARPA researchers H. Murase, S. Otose and S. Machida who took the pictures in the Antarctic with assistance of captains K. Matsuzaka and M. Yamada of *Kyoshin Maru No 2* and *Toshio Maru No 25*, respectively. The AHWC receives curation support from the IWC under Research Contract 16. Its maintenance also relies on considerable support donated by C. Carlson (International Fund for Animal Welfare) and by staff and students at Allied Whale (College of the Atlantic), among whom we particularly thank R. Seton and B. Holm, as well as S. Katona and P. Stevick for their contributions to this manuscript.

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Date received: January 2005
Date accepted: November 2005