The status of humpback whales in New Caledonia (South Pacific)

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ABSTRACT

Data collected from 1995 to 1999 in the south lagoon of New Caledonia show that the island is used as a breeding and calving ground for humpback whales from June to November. Analyses of photo-ID and acoustic recordings suggest that this population is a component of the Group V stock. To date, 182 humpback have been individually identified, 152 skin samples and 129 blubber samples have been collected for analysis and 50 songs have been recorded. The constant increase of re-sighting rates from 1996 suggests that the population is not very large. A population of 287individuals (95% CI: 257-315) has been estimated using the weighted mean of the Petersen estimate. In contrast with the apparent recovery of humpbacks on the east coast of Australia, the New Caledonian population has shown no increase. Further study will be necessary to confirm this result. Migratory movements have been found with Eastern Australia, New Zealand and Tonga. A future study will be carried out in collaboration with researchers working in other areas of the South Pacific in order to improve our knowledge of humpback whales in this region.

Keywords : humpback Whale, South Pacific, New Caledonia, migration, breeding grounds, population structure

INTRODUCTION

The first documented records of humpback whales in New Caledonia date from whaling records of the last century (Townsend, 1935; Pisier, 1975). It is known that whaling occurred in Lifou and Maré of the Loyalty Islands, however, it appears that it was concentrated in the Chesterfield Islands (Fig. 1). Anecdotal reports suggest that reasonable numbers of humpback whales were observed until at least the 1950's around New Caledonia.

Initial field observations and photographic identification of humpback whales began with a five day survey in 1993 followed by a two week survey in 1994. During these surveys, behaviour associated with reproductive activity was observed (Gill *et al.*, 1995). This, in addition to the presence of mother and calf pairs, suggested that New Caledonia was a reproductive zone for this species (Garrigue and Gill, 1994). This preliminary research concluded by identifying New Caledonia as a winter migratory destination for group V humpback whales.

METHODS

Study area

New Caledonia is a part of Melanesia situated just inside the Tropic of Capricorn in the south west of the Pacific Ocean, east of Australia and north of New Zealand (Fig. 1). It lies between 18° and 23°S and 158° and 172°E. The main island of the archipelago, named Grande Terre, is 400 km long and between 50 and 80 km wide. It is surrounded by over 1600 kilometres of barrier reef that bound a lagoon of 24 000 km². The mean depth of the lagoon is 24 m. Two groups of small islands are included in this lagoon, the Belep Islands to the north, and the Isle of Pines to the south. Outside the lagoon, further to the east are the Loyalty Islands composed of Maré, Lifou and Ouvea. Further offshore again are the Huon and Surprise Atolls to the north, the Chesterfield and Bellona Atolls to the west and Matthew, Hunter and Walpole Islands to the south-east. The entire territory of New Caledonia is spread over 1450 000 km². The study area is situated in the southern part of the lagoon around the main island (Fig. 1).

Study periods and survey methods

Since 1991 marine mammal observation forms have been distributed to professional and recreational boat users throughout New Caledonia in order to get information on the occurrence of humpback whales. Two pilot studies were conducted in 1993 and 1994. From 1995 until 1999 two to three month field surveys of humpback whales were carried out each winter. Sampling effort is presented in Table 1. The study site lies between 22°20' and 22°40'S, and 166°50' and 167°07'E. It covers part of the southern lagoon of the main island of New Caledonia, and covers an area of about 1000 km².

During the annual surveys land-based teams, located at an elevated point (189m), searched for whales using hand-held binoculars (7 x 42mm) and a telescope. The position and behaviour of whales sighted were recorded and passed on to the research vessel via VHF radio. Most of the boat-based observations were carried out using a 6 m semi-rigid inflatable boat with 2x40HP outboards.

Surveys were conducted on all days that weather conditions permitted (wind < 20 knots and no rain). There was no *a priori* selection of whale groups of a specific size or composition to approach. At least three-quarters of the pods approached by the boat were initially sighted by the land-based team.

For each pod sighted the time, location (GPS position), group size, pod composition and behaviour were noted. The pod composition included: single, pairs, mother and calf, mother-calf and escort and competitive group defined following Tyack & Whitehead (1983), Baker & Herman (1984) and Clapham *et al.* (1992). The data were recorded using micro-cassette recorders that were transcribed each night onto data forms for later entry into the database.

Individual humpback whales were identified as often as possible using photographs of the unique markings on the ventral surface of their tail flukes (Katona *et al.*, 1979). SLR cameras with 200 and 300mm lenses were used for photo-identification, usually with 100 or 400 ASA slide film.

Tissue samples were collected using a crossbow and specially adapted bolt. At the tip of the bolt is a biopsy tip, a small tubular shaped attachment that on contact with the whale takes a small plug of skin and fat. The bolt is prevented from piercing the animal by the float, which acts as a stopper and causes the bolt to bounce off the whale on impact so that it can be recuperated from the sea surface. The skin and fat were treated separately for later analysis. The skin was placed into ethanol and the fat was wrapped in aluminium foil (which had been pre-heated to 550°C) then deep frozen. The skin samples are analysed and kept at the School of Biological Sciences of the University of Auckland, New Zealand.

Humpback whale songs were recorded using a hydrophone with preamplifiers and an analogue cassette tape recorder (Sony WM-D6C). Some acoustic comparisons have already been done (Helweg *et al.*, 1998).

Data analysis

Some of the available data have been analysed, other analyses are in progress. The humpback whales presence and occurrence, and the pod composition and size have been determined, the crude birth rate has been calculated and the population abundance estimated using mark-recapture with only good quality photographs.

The weighted mean of the Petersen estimate (Seber, 1982) was used across the five-year study to estimate abundance. The crude birth rates were calculated following Clapham and Mayo (1990).

RESULTS

Sample and data collection

Individual identification

A total of 182 humpback whales have been identified in New Caledonia by the ventral surface of the fluke alone or combined with dorsal fin/ lateral body markings (N = 178) or by lateral body markings with dorsal fin alone (N = 4) (Garrigue and Greaves, 1999).

Comparisons have been done between 182 individually-identified humpback whales from New Caledonia and the published catalogues of humpback whales from east Australia (N = 1088) (Kaufman *et al.*, 1993), Tonga (N = 247) (Patenaude and Baker, 1996; unpublished data) and New Zealand (N = 4) (Patenaude and Baker, 1996; unpublished data). During a workshop on humpback whales in the South Pacific held at the University of Auckland from 4-7 March, 2000 (Donoghue and Baker 2000) the New Caledonian whales were also compared to humpbacks identified in French Polynesia (N=138) (M.Poole, unpublished data), the Cook Islands (N=23) (Hauser and Peckham, unpublished data), Colombia (N=20) (Fundacion Yubarta, unpublished data), Ecuador (N=59) (INACH, unpublished data) and the Antarctic Peninsula (N=23) (INACH, unpublished data). A total of five of the New Caledonian humpbacks have been found to have migrated past east Australia, two past New Zealand and three to Tonga in separate years (Garrigue *et al.*, 2000a and b). One individual was photographically identified in New Caledonia in July 1996 and in east Australia in October of the same year (unpublished data).

Skin and blubber samples

A total of 152 skin samples have been collected since 1995. All of the samples have been divided into two parts. One set of samples is kept by Operation Cetaces in New Caledonia, the other has been sent for analysis to the Ecology and Evolution Group at the University of Auckland (New Zealand). Some of the samples have already been analysed (Rosenbaum *et al.*, 1998), further analyses are in progress.

A total of 143 blubber samples have been collected since 1995. The samples are kept by Operation Cetaces in New Caledonia. Analysis of these samples is yet to be carried out.

Song recordings
Humpback whale song has been recorded in New Caledonia since 1992. Approximately 50 acoustic song recordings have been collected. An analysis of songs recorded in 1994 from New Caledonia, east Australia, New Zealand and Tonga (Gill *et al.*, 1995 ; Helweg *et al.*, 1998) demonstrated that east Australia and New Caledonia songs were not significantly different. Helweg *et al.* (1998) also suggested that song recorded from Kaikoura in New Zealand was 'eastern Australian' rather than 'Tongan'.

Humpback whales presence and occurrence
Of the 466 marine mammal observation forms returned over the 9-year period, 269 reported humpback whales. Analysis of the data resulting from these observation forms indicates that humpback whales are mainly present during the winter months, and can be observed all around New Caledonia. The earliest sightings occur in June and the latest in December (Fig. 2). There are occasional sightings at other times of the year (Fig. 2). The peak season occurs during the winter months of July, August and September.

During the scientific study 301 pods, comprising 480 whales, were sighted from land. At sea, a total of 433 whales were encountered in 212 pods during the 5-year survey. The monthly occurrence of pods and whales is summarised in Table 2. The peak of the season is always situated in August, over 50% of the whales are observed during this month. It worth noting that the number of sighted whales decreased during the last four years of the survey (Fig. 3). The number of whales observed during the 1999 survey was especially small.

Pod composition, pod size and estimated "age" structure
The social composition of 201 of the 212 pods sighted was recorded. The results are presented in Table 3. Over the five years of the survey the most commonly observed pod type was single whales (39%), followed by pods of two whales (32%). Reproductive groups represented 17% of the pods observed and mother and calf pairs accounted for a further 11%. The least represented group was the mother-calf and escort groups, comprising only 1% of the encountered pods. The mean pod size is 2.04 whales/pod.

The size of the whales was estimated using the following classifications: small (for calf), medium (about 8 m or smaller) and large (bigger than 8 m). The results, which must be taken with caution as the size of whale is a difficult parameter to estimate, are presented in Table 4. Most of the year the structure of the population was dominated by large whales, representing more than 80% of the population (except in 1999). In 1999 large whales represented only 65% of those observed, while medium-sized whales were seen in greater numbers than the previous years (23%).

Estimation of abundance and crude birth rate
From 1996 the year-to-year re-sighting rate increased to reach more than 29% in 1998 (Fig. 4). 40% of the individually identified whales have been re-sighted on at least one occasion. Not only are the same individual whales sighted year after year, but they can be observed several times over a single season within the same year. These observations suggest that the size of population is small. The population estimate is N = 287 (95% CI: 257-315) using the weighted mean of the Petersen estimate (Table 4). The crude birth estimated following Clapham and Mayo (1990) ranges from 3.4 to 10 % depending on the year (Table 5).

DISCUSSION

The presence of mother and calf pairs suggests that the lagoon in the South of New Caledonia is used as a calving ground. The observation of reproductive groups and the acoustic detection of many singers provide evidence that the zone is also used as a mating area. The results of the five-year survey clearly show that the southern part of the New Caledonian lagoon is a breeding ground for humpback whales during the austral winter. It is likely that others parts of the huge lagoon that bounds the main island could also be used by humpback whales during winter. The isolated atolls, such as the Chesterfield area cited by Townsend as a whaling grounds, and Surprise and, Ouvea are also possible breeding grounds. Future work will be required to confirm these hypotheses.

From the Photo-ID comparison and the acoustic analyses it is clear that the population of humpback whales located around New Caledonia is a component of the Area V stock. 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 as described by Dawbin (1966). The comparison of Photo-ID was not helpful in resolving this question as exchanges were found with Eastern Australia (6), New Zealand (2) and Tonga (3). Acoustic analysis demonstrated that east Australia and New Caledonia songs were not significantly different. However, demographic trends and the high re-sight rate within New Caledonia suggest a degree of subdivision between these regions. Genetic analyses that are currently in progress will hopefully contribute to answering the question.

The constant increase of the re-sighting rate from 1996 to 1998 suggests that the local population is not very large. This is supported by the results of the population estimate. The estimate must of course be interpreted with some caution as it assumes that the population is closed and that there is no immigration or emigration, yet know that there is some exchange between breeding grounds (Garrigue *et al.*, 2000 a and b). Equal catchability of individuals in the population is another assumption that is likely violated, as not all whales raise their flukes systematically. For instance, mothers with small calves seldom perform a fluke-up dive, which renders them temporarily unavailable for sampling. In any case, the estimator indicates that the abundance of humpbacks in New Caledonia remains relatively low, numbering only a few hundred individuals. This is in stark contrast to the situation off eastern Australia where the number of humpback whales passing along the coast has increased markedly over the last decade (Paterson *et al.* 1994). The smaller than usual percentage of large whales observed in 1999 probably explains the low number of competitive groups that were observed. This phenomenon corroborates the weak acoustic detection rate over the same period.

The study of humpback whales in New Caledonia (including collection of Photo-ID, skin and blubber samples collection, song recordings and behavioural data) will continue in order to contribute to the larger survey of humpback whales in the tropical South Pacific. A comparison of genetic samples and Photo-ID collected over a wide area, including Eastern Australia, New Zealand, New Caledonia, Tonga, Cook Islands and French Polynesia, will be realised.

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Table 1. Sampling effort land-based and sea-based.

Years	Months	Days at sea	Hours at sea	Nautical miles	Days on land	Hours of land observation
1995	July	3	10:45	90	1	2:00
	August	14	63:45	484	12	40:35
	September	15	72:35	482	19	85:57
	TOTAL 95	**32**	**147:05**	**1056**	**32**	**128:32**
1996	July	16	105:34	687	15	75:12
	August	27	195:27	1223	27	139:09
	September	13	79:46	651	10	63:22
	TOTAL 96	**56**	**380:47**	**2561**	**52**	**277:43**
1997	July	15	93:30	333	14	67:08
	August	27	192:53	1325	27	146:47
	September	1	6:19	50	1	4:50
	TOTAL 97	**43**	**292:42**	**1708**	**42**	**218:45**
1998	July	25	162:3	1280	27	115:27
	August	16	114:01	857	14	71:41
	September	9	63:35	549	10	47:04
	TOTAL 98	**50**	**340:06**	**2687**	**51**	**234:12**
1999	July	22	139:02	1186	22	100:09
	August	23	169:03	1341	21	122:29
	September	1	4:00	54	0	0
	TOTAL 99	**46**	**308:05**	**2581**	**43**	**222:38**
TOTAL		**227**	**1468:05**	**10593**	**220**	**1080:7**

Table 2. Occurrence of humpback whales sighted.

Years	Months	Number of pods at sea	Number of whales at sea	Number of pods from land	Number of whales from land
1995	July	4	7	4	7
	August	16	34	24	34
	September	6	18	19	36
	TOTAL 95	**26**	**59**	**47**	**77**
1996	July	22	50	29	43
	August	39	68	67	103
	September	3	9	8	15
	TOTAL 96	**64**	**127**	**104**	**161**
1997	July	25	47	32	46
	August	27	57	33	51
	September	2	4	2	3
	TOTAL 97	**54**	**108**	**67**	**100**
1998	July	11	27	13	25
	August	19	43	26	48
	September	10	19	16	27
	TOTAL 98	**40**	**89**	**55**	**100**
1999	July	10	16	9	13
	August	18	34	19	29
	September	0	0	0	0
	TOTAL 99	**28**	**50**	**28**	**42**
TOTAL		**212**	**433**	**301**	**480**

Table 3. Composition of the sighted pods (SN : single, PR : pair, MC : mother and calf, MCE : mother, calf and escort, MC in CG : mother and calf in competitive group, CG : competitive group).

Years	Months	Sighted pods	Sighted whales	SN	PR	MC	MCE	MC in CG	CG
1995	July	4	7	1	2	0	0	0	1
	August	16	34	6	5	1	0	1	3
	September	6	18	1	2	0	1	0	2
	TOTAL	**26**	**59**	**8**	**9**	**1**	**1**	**1**	**6**
1996	July	22	50	11	4	1	0	0	5
	August	39	68	15	13	5	0	0	3
	September	3	9	0	0	1	1	1	0
	TOTAL	**64**	**127**	**26**	**17**	**7**	**1**	**1**	**8**
1997	July	25	47	11	9	0	0	0	2
	August	27	57	7	10	5	0	0	3
	September	2	4	1	2	0	0	0	0
	TOTAL	**54**	**108**	**19**	**21**	**5**	**0**	**0**	**5**
1998	July	11	27	2	4	1	0	0	2
	August	19	43	9	3	1	0	0	6
	September	10	19	4	3	1	0	0	3
	TOTAL	**40**	**89**	**15**	**10**	**3**	**0**	**0**	**11**
1999	July	10	16	4	3	2	0	0	0
	August	18	34	6	4	3	1	0	3
	September	0	0	0	0	0	0	0	0
	TOTAL	**28**	**50**	**10**	**7**	**5**	**1**	**0**	**3**
TOTAL		**212**	**433**	**78**	**64**	**21**	**3**	**2**	**33**

Table 4. Size structure of the different encountered humpback whales.

Years	Number of whales	% Small size (calf)	% Medium size	% Large Size
1995	**35**	8.5	8.5	83
1996	**72**	11	6	83
1997	**72**	5.5	14	80.5
1998	**63**	5	3	92
1999	**41**	12	24	64
TOTAL	***283***	***8***	***9***	***83***

Table 4. Population estimate.

	1995	1996	1997	1998	1999	
ni = marked whales in the current year	**29**	**51**	**52**	**49**	**20**	
mi = number of recaptures	**3**	**11**	**20**	**20**	**6**	
Mi = marked whales from previous years	**27**	**53**	**93**	**125**	**154**	
N						**287**

Table 5. Crude birth rate.

Years	Tc : Number of Calf	Ti : number of sighted whales	Tc/Ti %
1995	3	59	5.1
1996	8	127	6.3
1997	4	108	3.7
1998	3	89	3.4
1999	5	50	10.0
Mean	**5**	**87**	**5.7**

Figure 1. Location of New Caledonia, Lifou, Ouvéa and the Chesterfield islands.

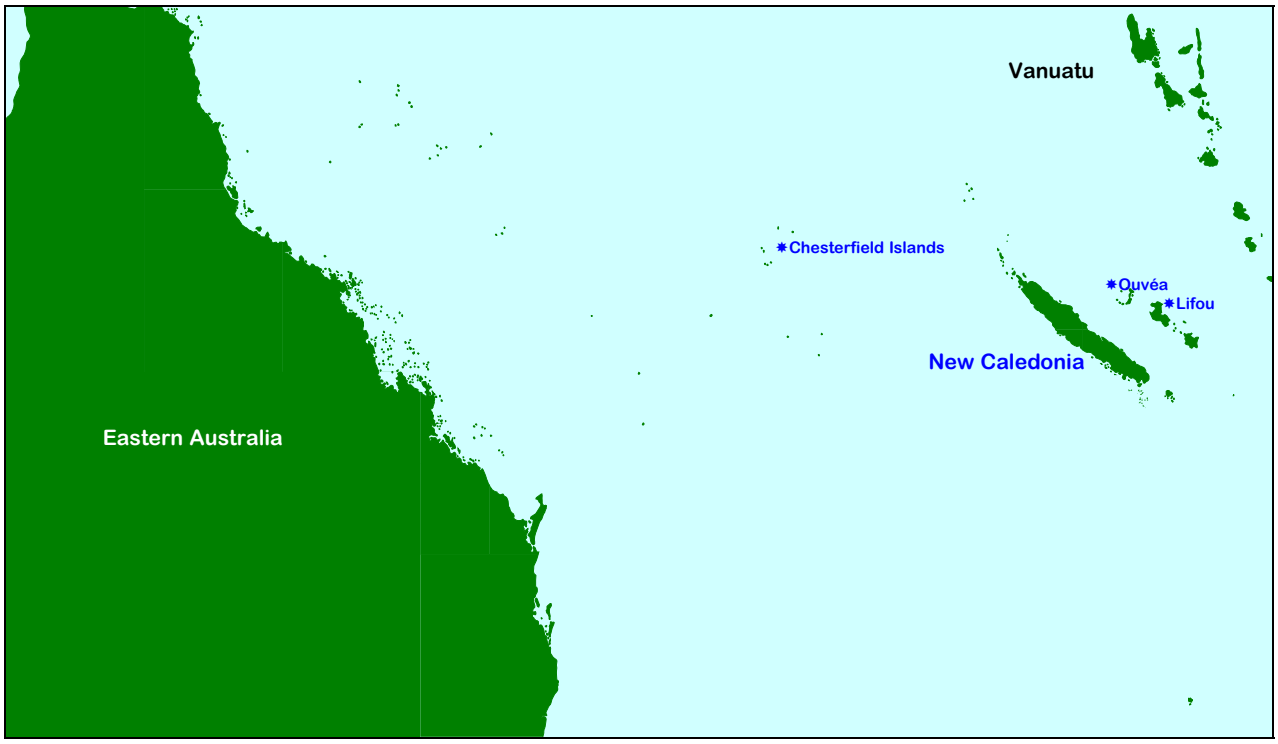

Figure 2. Period of presence of humpback whales identified using sightings forms.

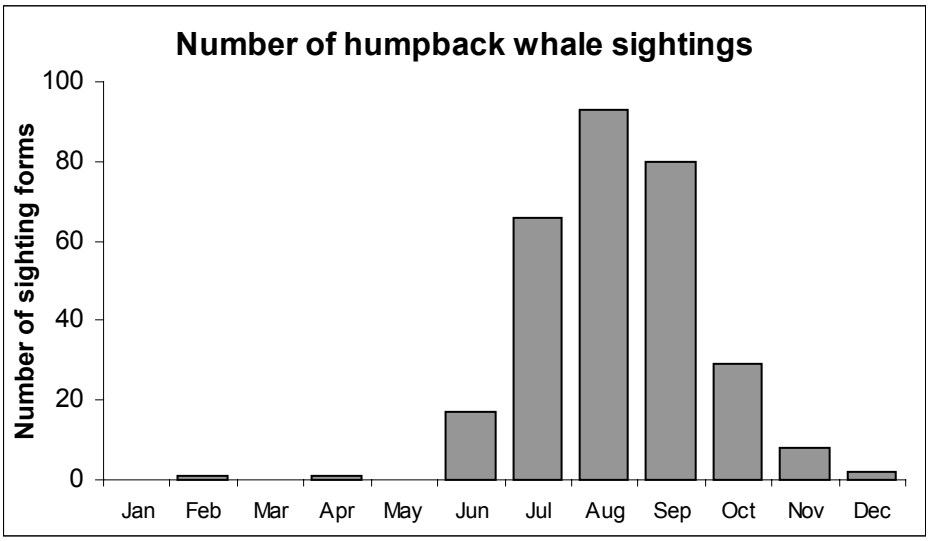

Figure 3. Monthly occurrence of humpback whales

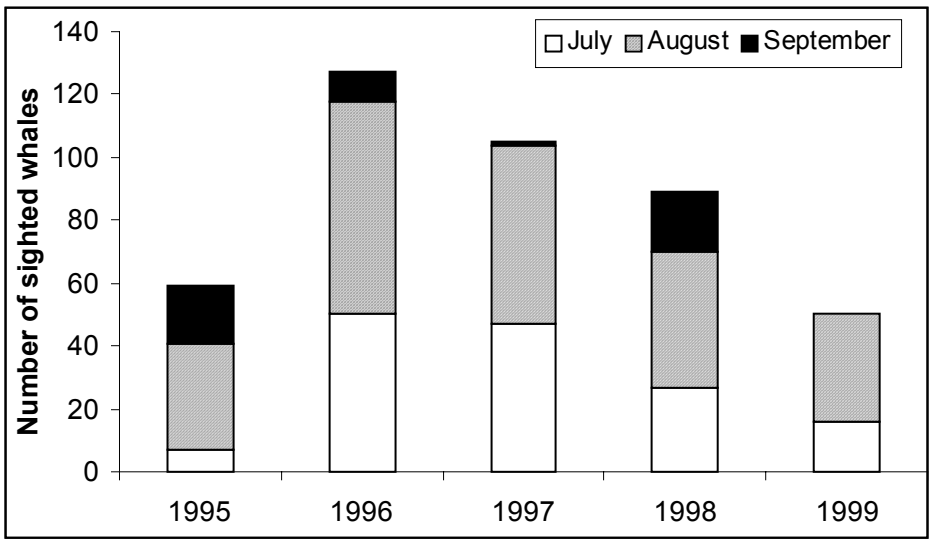

Figure 4. Year to year re-sighting rates.