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Very Low Numbers of Endangered Oceania Humpback Whales Seen in Fijian Waters

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Abstract

Intensive commercial whaling caused significant declines in Southern Hemisphere humpback whale (Megaptera novaeangliae) populations. In Fiji, land-based humpback whale surveys undertaken from 1956 to 1958 documented maximum weekly counts of more than 150 humpback whales in parts of the Bligh waters. These records provide an invaluable point of comparison to present-day observations as they occurred immediately prior to very large humpback whale catches in Antarctic waters to the south - and on potential migration routes - of humpback whales breeding in Fijian waters. We report here on a three-year (2010-2012) land-based survey also conducted in the Bligh waters during which a total of 33 individuals over 480 h were counted from Ovalau Island and 68 individuals over approximately 300 h were observed from Makogai Island. These findings suggest a large decrease in numbers of humpback whales seen in Fiji waters since commercial whaling operations.

Keywords: *Commercial whaling, Bligh waters, Pacific cetaceans*

1. Introduction

Humpback whales (*Megaptera novaeangliae*) are found in all oceans of the world (Clapham and Mead, 1999). In the Southern Hemisphere, humpback whales feed in Antarctic waters in the austral summer and migrate to multiple winter breeding grounds in tropical or subtropical waters. The International Whaling Commission (IWC) divides the species' Southern Hemisphere distribution into Antarctic management areas (Areas I-VI) (IWC, 1980) and breeding areas (A-G) (IWC, 2014). Four of these breeding areas (B, C, E and F) have been further divided into sub-stocks. In general, there is support for a roughly north-south connection between Antarctic feeding areas and given breeding areas although there are still some uncertainties and exceptions to this pattern (Fleming and Jackson, 2011).

More than 200,000 humpback whales were killed during commercial whaling operations in the Southern Hemisphere between 1900 and 1999 (Rocha *et al.*, 2014). More than half of these kills occurred in the post-war period and were heavily localized with over 38,000 individuals (Clapham *et al.*, 2009) being taken in IWC Area V i.e. in Southern Ocean and Antarctic waters lying directly south of the eastern coast of Australia and New Zealand (Figure 1). In addition, there was a concentrated period of kills with more than a third of these Area V takes coming from just two seasons: 1959-1960 and 1960-1961. Directly following this intense whaling period immediate declines were seen in the number of humpback whales taken in shore-based whaling stations in the likely breeding areas i.e. IWC Breeding stock E (Figure 1) of IWC Area V, which led to the closure of shore-based whaling stations in eastern Australia, New Zealand and Norfolk Island (Chittleborough, 1965).

One of the regions of Oceania which once hosted abundant humpback whales and may have been a former breeding ground was the Fiji Islands. Land-based humpback whale surveys were undertaken in Fiji from 1956 to 1958 and provide an invaluable point of comparison to present-day observations (Dawbin, 1959) notably because they occurred immediately prior to the huge Soviet illegal Antarctic catches of 1959-1961 (Clapham *et al*,. 2009). These historical surveys were made from a number of lookout points within the Lomaiviti island group (within the Bligh waters), including: (i) 'Springstone' rock, Levuka, Ovalau Island (in all 3 years); (ii) Wakaya Island from the lighthouse at the southern end of the Wakaya reef (in 1956), and half way along the western edge of Wakaya Island (in 1957 and 1958); and (iii) the northwestern corner of Naigani Island (in 1957 only) (Figure 2). As reported in Paton and Clapham (2002), Dawbin's team conducted weekly counts over the 3-year period from May through October. The number of whales seen in 1957 was noticeably higher than the two other years with a maximum count of more than 150 individuals being seen in late August and elevated numbers from late July

to mid-September. Maximum weekly counts of more than 80 individuals were seen in 1956 with a peak migration period covering the months of both August and September. Overall numbers in 1958 were smaller than previous years with maximum weekly counts of fewer than 40 individuals, yet with a general migration period matching the temporal range of the previous two survey years. While the 1956-1958 land-based surveys were being conducted, a total of 142 humpback whales were also tagged with Discovery marks (Dawbin, 1959). There were very few recoveries of these marks with just two being recovered in New Zealand waters, and one being found off the eastern coast of Australia (Dawbin, 1966). Soviet whalers also caught three humpback whales originally marked in Fiji: one off eastern Australia, and two in the high-latitude portions of eastern IWC Area V and western IWC Area VI in the Antarctic (Mikhalev, 2000).

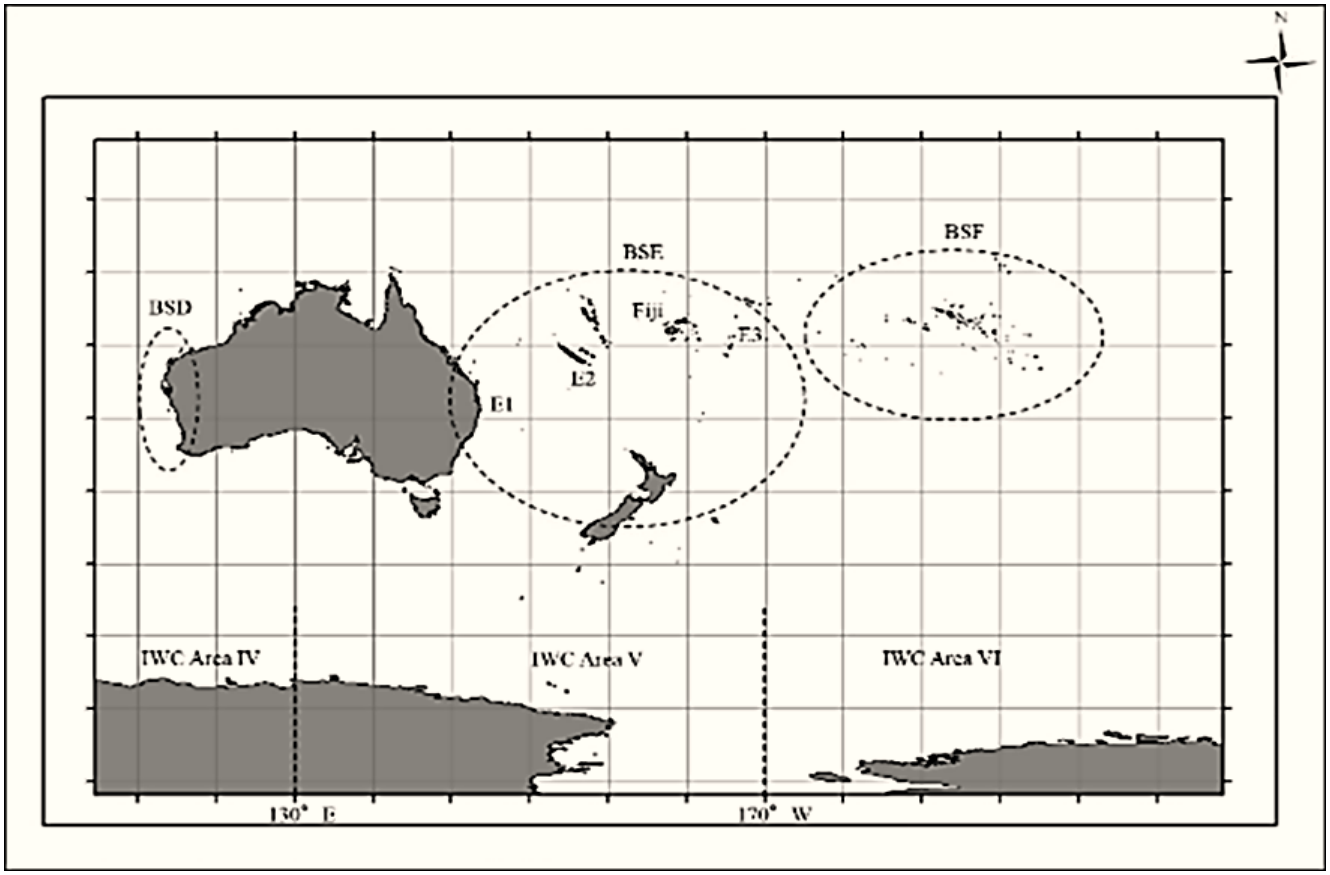

Figure 1. Representation of International Whaling Commission management areas (IV, V and VI) for Southern Hemisphere humpback whales in the Southern and Antarctic Oceans is shown. The approximate locations of Breeding stock D (BSD), Breeding stock E (BSE) (with sub-stocks E1, E2 and E3) and Breeding stock F (BSF) for Southern Hemisphere humpback whales are also indicated. Breeding stocks E and F are collectively listed as the Oceania humpback whale subpopulation on the IUCN Redlist.

In 2002 and 2003, Gibbs *et al.* (2006) replicated aspects of Dawbin's land-based surveys. Surveys were primarily conducted from one location within the town of Levuka, although in 2002 investigations of additional sites within Levuka as well as on Naigani Island were undertaken. During 29 h of effort this pilot study documented only one individual. Survey effort was significantly increased the following year to 257.5 h (246 on land, 11.5 on water) yet only 4 confirmed individuals were observed. Gibbs *et al.* (2006) attempted to compare their findings to historical records but noted numerous uncertainties in calculating the total effort of Dawbin's surveys. However, using a number of assumptions they estimated an approximately ten-fold decrease in the number of humpback whales seen during their surveys relative to the historical survey period. Additional surveys were conducted in 2008 and 2009 (Batibasaga and Sharma-Gounder, 2009; Paton *et al.*, 2009) that indicated a slight increase in the number of individuals observed relative to the surveys

conducted in the early 2000's (22 and 16 whales, respectively). This present paper reports on three years (2010-2012) of systematic land-based surveys of humpback whales moving through a possible historic migration corridor and breeding area within Fijian waters. These surveys were intended to build on the valuable work undertaken in the Lomaiviti passage during the last 15 years as well as to provide a further comparison to the Dawbin surveys of the late 1950's.

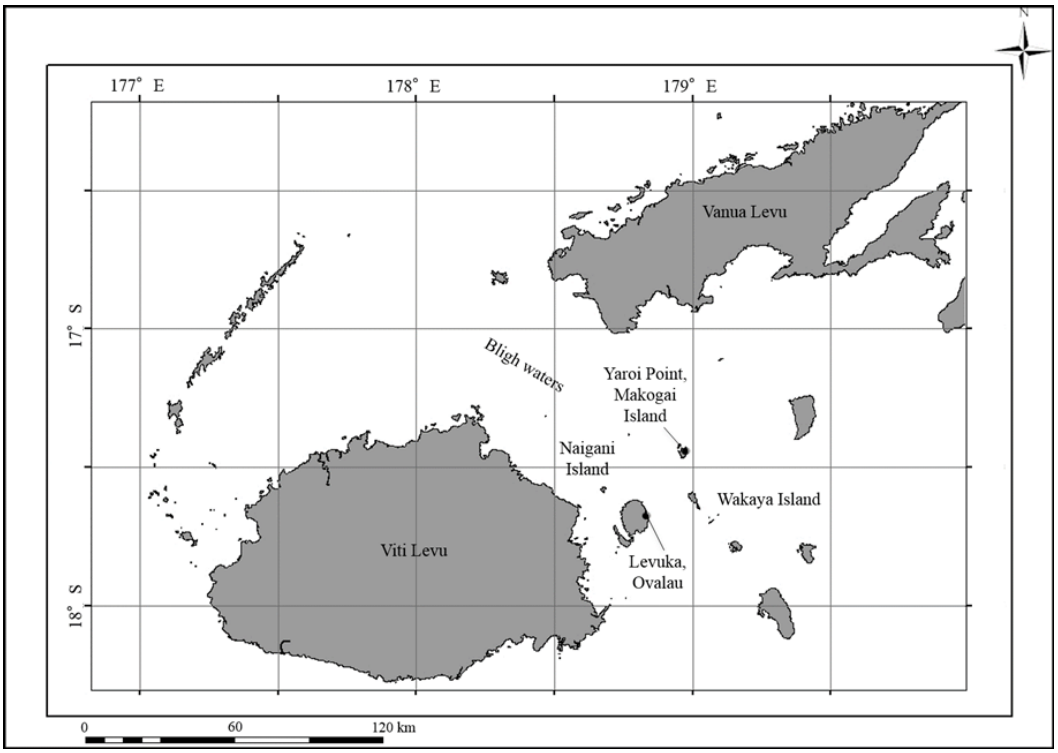

Figure 2. Land-based observation stations of Levuka, Ovalau Island, and Yaroi Point, Makogai Island. In addition, major islands as well as those used for historical surveys are shown.

2. Methodology

Three years of land-based observations were conducted from Ovalau and Makogai Islands in the Lomaiviti island group, Bligh waters, Fiji (Figure 2). Makogai Island has an area of approximately 8.4 km^2 and land-based observations took place from Yaroi Point (17.43S, 178.95E altitude 35 m) located on the south-western side of the island. Ovalau Island is approximately 102.3 km^2 and land-based observations took place from two locations close to the main town of Levuka located on the eastern side of the island. In 2010 and 2011 observations were made from the cliffs directly behind Levuka Vakaviti village (17.67S, 178.83E, altitude 70 m), whereas in 2012 observations were made from a dwelling within Levuka town (17.68S, 178.83E, altitude 40 m). The survey location for the Ovalau surveys in 2012 was changed due to a chiefly funeral that prevented activities being undertaken in Levuka Vakaviti village. Observations of 180^0 were available from both of the Ovalau sites as well as Makogai Island.

During each year of observation, land-based cetacean surveys were made during 3 weeks within the months of August and September of 2010 and 2011 (for both locations) and 2012 (for Ovalau only). Surveys were conducted from 0700 to 1700 each day except during inclement weather. At least four experienced observers were on watch at any given time and were rotated regularly to limit fatigue. Systematic scanning using binoculars (7 x 50) and the naked eye were used to make observations. When an individual or pod of humpback whales was sighted the following information was recorded: physical description of the animals seen, number of individuals, presence of calve/s, behaviour, distance to animal, bearing of animal(s) from sighting platform, direction of travel, and weather conditions (including Beaufort sea state (BSS)). Distance to animal was estimated using a Bushnell Legend 1200 rangefinder although some distances proved to be out of range of this device. When animals were further away than 1 km their distance from the observation point was estimated using the reticules within the binoculars. Bearing of the given

sighting from the observation point was made using the compass within the binoculars. Notes on weather conditions, cloud cover and glare were made at hourly intervals throughout the day. For analysis purposes only sightings made in BSS of 3 or less were included. In addition to humpback whale sightings, all additional cetacean species observed during the surveys were documented. Small boat surveys were also conducted to collect photo identification and acoustic recordings, but will not be discussed in this paper.

The two field sites used in this study are located approximately 28.5 km apart and on clear days the outline of the island on which the other field site was located was visible from both sites. This proximity makes it possible that animals may have come into the observation area for both sites on the same day. To eliminate the possibility of double counting we decided not to sum our data within a given year but rather calculated summary statistics of occurrence on a weekly basis for each of the two sites separately. These calculations are intended to serve as simple indices of occurrence and daily movement of animals within the given sighting area during the given survey period.

3. Results

Land-based surveys were conducted from 2010 to 2012 from Ovalau Island and from 2010 to 2011 from Makogai Island (Figure 2). Hours of observation for a given survey location and year were dependent upon weather conditions and travel logistics and ranged from a minimum of 141 h to maximum of 180 h (Table 1).

Table 1. Summary of survey effort undertaken and other cetaceans observed from 2010 to 2012.

Year	Site	Effort (hours)	Other cetacean species seen
2010	O	160	Spinner dolphin, short finned pilot whale, minke whale, sperm whale, diminutive sperm whale
	M	167	Spinner dolphin, short-finned pilot whale
2011	O	180	Spinner dolphin
	M	155	None
2012	O	141	Spinner dolphin

O = Levuka, Ovalau Island
M = Yaroi Point, Makogai Island

Humpback whales were seen during each period with a maximum of 56 individuals (from 42 sightings) being observed from the Makogai field site in 2010 (Table 2). The number of individuals seen at the same site in the following year was relatively low (12) as was the case at Levuka (Ovalau Island) with totals ranging from 7 to 15 individuals in the three different years of survey observations. Adjusting for the variable number of observation hours undertaken at each site and study period the average number of individuals (± 1 standard error (SE)) seen per hour of observation is 0.125 ± 0.136 and the average number of groups (± 1 SE) per hour of observation is 0.081 ± 0.096. Mother-calf pairs were seen during all surveys except from Ovalau in 2011. A peak of seven mother-calf pairs was seen from Makogai in 2010. It was noted that mother-calf pairs were generally seen in shallower waters (less than 200 m in depth). In addition, a number of other cetacean species were also seen during the surveys, with notable diversity reported from Ovalau in 2010 (Table 1).

4. Discussion

Between 1956 and 1958, Dawbin (1959) documented maximum weekly counts of more than 150 humpback whales in the waters between the eastern side of Ovalau Island (Levuka), western side of Wakaya Island, and the eastern side of Naigani Island within the Bligh waters of Fiji (Figure 2). Dawbin's surveys were conducted immediately before more than 25,000 humpback whales were killed in waters south of Fiji. Surveys conducted in August and September, 2003, sighted just 4 individuals in these waters despite more than 250 h of survey effort (Gibbs *et al.*, 2006). This current study counted 33 individuals over 480 h (across a 3-year period) from Ovalau Island and 68 individuals from approximately 300 h at a field site on Makogai Island. These findings suggest that there has been a decrease in the number of humpback whales seen in Fiji waters since commercial whaling operations. However, it is uncertain whether these low numbers might be due to a lack of recovery of populations or a change in breeding destination. Clapham and Zerbini (2015) propose that the social aggregation hypothesis provides plausibility for the latter. Their simulation approach is generally consistent with the high population growth rates of humpback whales seen in eastern Australian waters (Breeding sub-stock E1) as well as the low counts seen in locations such as Fiji and New Zealand (Clapham and Zerbini, 2015).

In 2008, the IUCN redlist registered the conservation status of the Oceania humpback whale subpopulation as Endangered (Childerhouse *et al.*, 2008). Regional analyses' indicate that the Oceania humpback whale subpopulation shows degrees of both substructure as well as connectivity. Olavarria *et al*. (2007) used

mtDNA differentiation as support for separation of New Caledonia, Tonga, Cook Islands, and French Polynesian stocks. Garrigue *et al*. (2011) investigated photo-identification fluke images from the same region over a six year period (1999-2004 inclusive) and found just 28 records of individual animal movement between breeding regions. This level of interchange was estimated to be relatively low as compared to within-region resightings and provided additional support for subdivision within sub-stock E and sub-stock F. However, the documentation by Garland *et al*. (2011) of the horizontal unidirectional transmission of humpback whale song from east to west across this region suggests that there is consistent movement of individuals from the Eastern Australian sub-stock into the Oceania region and/or individuals from different regions might be intermingling on migration routes. More recently, Constantine *et al.* (2012) undertook a population estimate for Oceania inclusive of IWC breeding stocks E2-F2 only. This analysis which included four primary study areas of Oceania (New Caledonia, Tonga, the Cook Islands, and French Polynesia) as well as a number of secondary Pacific Island countries and territories (where less effort had been undertaken) found the Oceania humpback whale subpopulation to be the smallest in the Southern Hemisphere with an estimated population size (for 2005) of 4,329 whales (95% confidence interval = 3,345 – 5,313). Samples from Fiji have not always been included in the above regional analyses and/or only with low sample sizes so it is difficult to assess how Fiji humpback whales fit within this broader scale.

Table 2. A summary of the number of humpback whale sightings (groups or individuals), individuals seen, and mother-calf pairs present. The rate of sightings and number of individuals was also calculated based on the hours of surveys undertaken during each field period.

	Number of humpback whale			Rate per hour of field effort	
Site and year	Sightings	Individuals	Mother-calf pairs	Sightings	Individuals
Ovalau 2010	9	15	1	0.056	0.094
Makogai 2010	42	56	7	0.251	0.335
Ovalau 2011	4	7	0	0.022	0.039
Makogai 2011	6	12	2	0.039	0.077
Ovalau 2012	5	11	2	0.035	0.078

Although the number of individuals seen during our surveys was relatively low, it was slightly higher than some of the surveys that had been conducted in the last decade (Batibasaga and Sharma-Gounder, 2009; Gibbs *et al.,* 2006; Paton *et al.,* 2009). Point estimates for sighting rates of number of humpback whales seen per hour for 2002 and 2003 was 0.03 and 0.01 respectively (Gibbs *et al.,* 2006). Estimates for the same parameter in our study was 0.094 (Levuka 2010), 0.335 (Makogai 2010), 0.039 (Levuka 2011), 0.077 (Makogai 2011), and 0.078 (Levuka 2012). These site-year estimates yielded a mean ± 1 SE of 0.125 ± 0.136 individuals seen per hour of observation. Direct comparison of these sighting rates' to historical observations made by Dawbin (1959) is difficult for a number of reasons, including: (1) Daily and weekly effort were not specifically detailed in published accounts including the method by which data from different sites and platforms may have been collated, and (2) Qualified rates as reported in Gibbs *et al.* (2006) were estimated based upon the entire season (May through October) rather than the hypothesized peak migration period. Nevertheless, Dawbin's (1959) summary data revealing maximum counts of 150 individuals per week in some cases is obviously much higher than was observed during our surveys.

Analysis of land-based cetacean surveys has sometimes revealed that observer-, site-, and year-specific biases as well as difficulty in assessing detectability may decrease the robustness and usefulness of the given data (Tonachella *et al.,* 2012). We tried to address these issues in a number of ways. In terms of observers our surveys relied in part on team members with varying levels of experience. Both the Ovalau and Makogai field sites had the same team

leader during our surveys and training with the same manual and resource materials was undertaken throughout the survey period. Furthermore, a number of team members participated in two or more surveys. The timing and geographic locations used in our surveys were relatively consistent with previous surveys (Dawbin, 1959; Gibbs *et al.,* 2006). However it is difficult to assess whether our unavoidable change of location for the Levuka field station in the third year had any impact on sighting rates. As noted by periodic assessment of BSS conditions and weather assessments throughout the survey periods we experienced relatively consistent environmental conditions among years. Furthermore, temporal coverage intending to match the hypothesized peak in migration was consistent with anecdotal trends noted in the Fiji national sightings database (Fiji Fisheries Department, 2012). The Fiji national sightings database does include humpback whales seen in locations outside the Bligh waters yet overall the highest number of reports came from areas proximal to our study sites (Fiji Fisheries Department, 2012). Reports to this database however are voluntary and therefore include bias in effort and area of sighting information.

A number of important protection measures are already in place (or in progress) for humpback whales in Fiji. These initiatives include the Declaration of a national Economic Exclusive Zone whale sanctuary (Fiji Government, 2003), the Oceania humpback whale recovery plan (SPWRC and SPREP, 2011), and the current development of the Fiji Cetacean Conservation and Management Plan (Fiji Fisheries Department, *In Prep*). Furthermore, since Fiji is both a member of the Secretariat of the Pacific Regional Environment Programme (SPREP) and a signatory to the Convention of Migratory Species (CMS) Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region, Fiji has also endorsed the 2013-2017 Pacific regional whale and dolphin action plan (SPREP, 2012) that serves SPREP members and this CMS agreement. However, prioritization of activities within these action plans and initiatives is still required. Our findings of low numbers of humpback whales being present in Fijian waters suggest that direct threats to humpback whales should be given priority. Such work could also provide additional conservation benefit for the other cetacean species and relatively high biodiversity that has been documented within the Bligh waters and associated ecosystems (Smith *et al.,* 2011; WWF, 2004).

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