

Update on Humpback Whale Research in the Gulf of Chiriqui, Western Panama, 2013

KRISTIN RASMUSSEN¹ AND DANIEL M. PALACIOS²

¹ *Panacetacea, 376 Ramsey Street, Saint Paul, MN 55102, USA*

² *Marine Mammal Institute, Oregon State University, Hatfield Marine Science Center, 2030 SE Marine Science Drive, Newport, OR 97365, USA*

ABSTRACT

Research in the last decade in the Gulf of Chiriqui (82°W, 8°N) in western Panama has revealed this as an important reproductive area for southern hemisphere humpback whales belonging to Breeding Stock G. Here we report on our 11th field season in the Gulf of Chiriqui to assess distribution, relative abundance and linkages to other breeding and feeding areas of whales sighted in this area during the austral winter (July-October). We conducted 28 surveys between 7 August and 13 September 2013 and surveyed 2,289km. A total of 203 sightings were made of 455 individual whales, including 91 calves. The overall encounter rate (whales seen per km surveyed) was 0.199. Almost half (45%) of all sightings included calves, which is a notably high proportion compared to other breeding areas. Photographic identifications were obtained for 129 individual whales. Of these, 23 have been seen in previous years. The encounter rates, group sizes, and number of identification photographs were all larger compared to previous years. This breeding area off Panama is notable because whales arriving here undertake an unusually long-distance, cross-equatorial migration from Antarctica and Chile. The Gulf of Chiriqui is also used by other baleen whales, and here we report on sightings of Bryde's and minke whales in our study area collected since the project started in 2002. Considering the tourism boom currently experienced by Panama and the proposed mega-developments for the Gulf of Chiriqui, fully describing the importance of this area for baleen whales will be crucial in ensuring that the proper conservation measures are taken.

KEYWORDS: HUMPBACK WHALE, BREEDING STOCK G, BREEDING GROUND, PHOTO-ID, DISTRIBUTION, MIGRATION

INTRODUCTION

Humpback whales (*Megaptera novaeangliae*) have been previously documented off the Pacific coast of Central America during the austral breeding season (Townsend 1935; Acevedo and Smultea 1995; Florez-González et al. 1998; Rasmussen et al. 2007; Best 2008). These whales have been linked to feeding areas off Chile and Antarctica (Acevedo et al. 2007; Rasmussen et al. 2007) as well as to adjacent breeding areas off Colombia (Florez-González et al. 1998), as part of the IWC-designated "Breeding Stock G" (BSG). Central America is unique because it harbors the northernmost breeding area of any southern hemisphere humpback whale population, with whales migrating approximately 8,300km from the feeding areas (Acevedo et al. 2007; Rasmussen et al. 2007). Whales migrating from feeding areas off California-Oregon-Washington in the Eastern North Pacific also use Central America as a breeding area between December and April (Steiger et al. 1991, Calambokidis et al. 2000, Rasmussen et al. 2012), making this is the only known breeding area in the world that hosts two populations from distinct hemispheres.

Panacetacea continued a long-term monitoring study of humpback whales in the Gulf of Chiriqui, Panama (82°W, 8°N) in August and September of 2013. Our objectives were to assess whale distribution, relative abundance, and group composition, and to determine linkages to other breeding and feeding areas through photo-identification. Long-term monitoring at this site will be useful for understanding the trends and patterns of population recovery of BSG in relation to intrinsic demographic parameters and environmental conditions, both at the breeding and feeding areas. These efforts will also provide essential information for local management and conservation actions for an area that is important for breeding activities for this population.

METHODS

The Gulf of Chiriqui lies in the western part of Panama, and is bordered by the Azuero Peninsula to the east, and Punta Burica to the west (7°18'-8°18'N, 82°54'-81°36'W; Fig. 1). This gulf is characterized by generally shallow waters (< 300m) and many island groups. Daily surveys were conducted from a 7m open-hulled boat with twin outboard engines. Surveys were conducted at an average speed of 15 knots, with 2-4 observers on board. Data collected for every cetacean sighting included GPS location, behaviors, group composition, bottom depth, and sea surface temperature. Photo-identification techniques (Katona and Whitehead 1981) were used in which whales were approached slowly from behind, and the undersides of the tail flukes were photographed with

a *Nikon* digital SLR camera in order to identify individuals. Surveys were opportunistic in design, aiming at maximizing the number of whales to be sampled. Encounter rates (whales seen per kilometer surveyed) were calculated to give an index of relative abundance, while adjusting for bias in areas of greater effort.

In addition to the visual effort, a hydrophone on a 10m cable (Cetacean Research Technology, sensitivity: 180dBV/uPa \pm 4dB, frequency response: 0.02-60kHz and 100-250kHz) was lowered in the water at regular intervals (every 30-60min) with the boat stationary to determine acoustically if any humpback whales were present. A minimum of one minute of sounds was recorded for each dipping station, and if humpback whale vocalizations were heard, longer recordings were made.

Identification photographs from all years were entered into a catalog for Panama. The catalog was also shared with other researchers in the region, including the Antarctic Humpback Whale Catalogue (Allen et al. 20011).

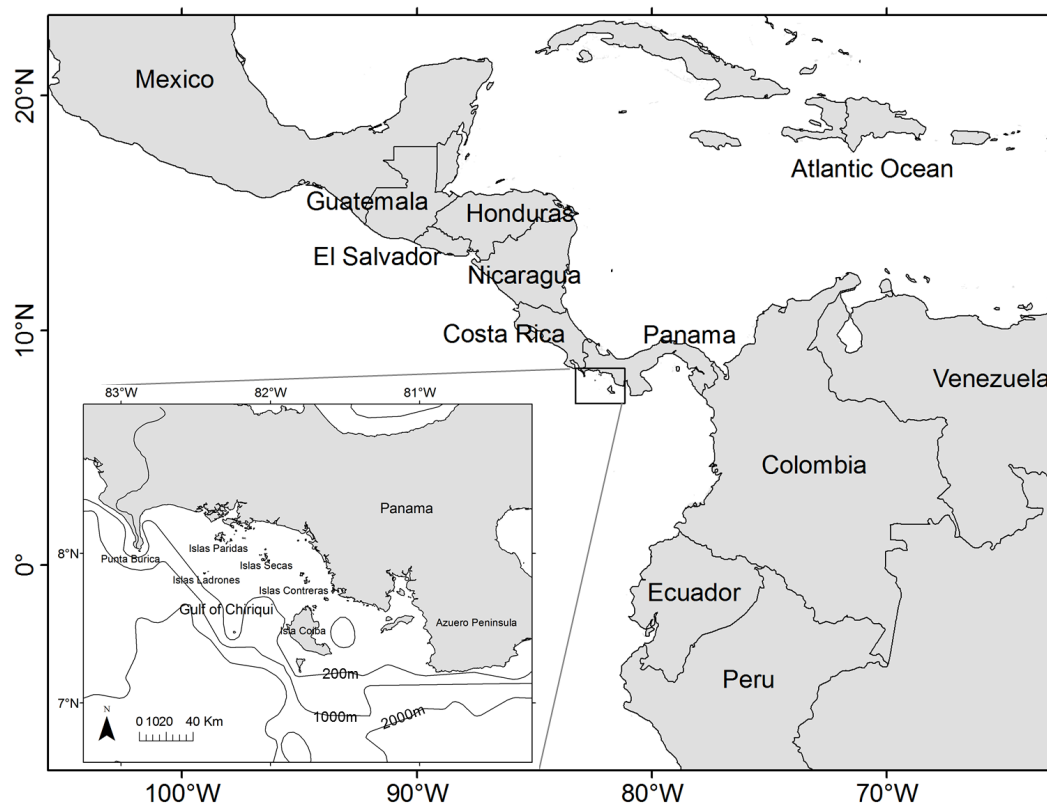


Figure 1. Study area of humpback whale surveys in Gulf of Chiriqui, western Panama.

RESULTS

Twenty-eight surveys were conducted between 7 August and 13 September covering 2,289km. Most surveys originated from the Islas Secas, and covered the Islas Secas, Paridas, Ladrones, and Contreras, as well as some coastal areas (Table 1, Fig. 2). Humpback whales were encountered throughout the survey area. We sighted 203 groups of with a total of 455 individuals, including 91 sightings with a mother/calf pair (Table 1, Fig. 3). The overall encounter rate (whales seen per kilometer surveyed) was 0.199 (Table 1). Of the 203 groups sighted, 17 (8%) were of five whales or more, including one group of 12 and one of 18 individuals. Average group size was 2.3 animals (SD \pm 1.6).

Table 1. Summary of whale surveys in August and September 2013 in the Gulf of Chiriqui, Panama.

Date	Total Hours	Total Km Surveyed	Sightings	Animals	Calves	ID photos	Whales/km
7-Aug-13	3.37	49	2	5	1	2	0.102
8-Aug-13	7.20	106	3	4	0	3	0.038
9-Aug-13	6.88	101	5	11	5	1	0.109
10-Aug-13	8.25	89	7	18	2	9	0.203
11-Aug-13	3.67	42	4	8	3	2	0.188
13-Aug-13	5.03	64	16	34	0	14	0.535
14-Aug-13	5.98	85	4	21	2	15	0.248
15-Aug-13	4.23	48	8	15	3	5	0.311
17-Aug-13	3.52	81	2	2	0	1	0.025
18-Aug-13	3.85	84	4	7	0	1	0.083
19-Aug-13	4.02	49	6	15	1	8	0.306
20-Aug-13	4.60	54	4	13	2	15	0.243
21-Aug-13	6.30	72	9	23	4	14	0.318
22-Aug-13	7.45	86	17	29	7	10	0.337
24-Aug-13	5.02	56	12	20	7	1	0.355
25-Aug-13	9.00	142	15	28	4	9	0.197
26-Aug-13	3.35	44	5	9	3	1	0.203
27-Aug-13	8.05	113	7	11	2	3	0.097
28-Aug-13	8.35	135	9	15	4	6	0.111
29-Aug-13	6.90	85	11	24	5	7	0.281
30-Aug-13	4.72	93	6	11	4	4	0.118
7-Sep-13	4.23	113	8	18	7	3	0.159
8-Sep-13	7.02	75	12	34	9	21	0.450
9-Sep-13	4.57	49	7	28	4	24	0.569
10-Sep-13	6.20	89	8	11	3	8	0.124
11-Sep-13	5.03	59	4	7	3	1	0.119
12-Sep-13	7.90	94	5	23	4	12	0.245
13-Sep-13	5.87	130	3	11	2	2	0.084
TOTALS	160.55	2,289	203	455	91	202	0.199

Table 2. Results of photographic identification of humpback whales in the Gulf of Chiriqui between 2002 and 2013. Total IDs is the number of identifications including resights, Unique Whales is the total number of unique whales identified each year, New Whales are whales that had not been identified in previous years, Seen Prev. Years is the number that had been sighted in previous years, % Prev. Seen is the percentage of whales identified in previous years, Km Surv. is total kilometers surveyed that year.

Year	Total IDs	Unique Whales	New Whales	Seen Prev. Years	% Prev. Seen	Km Surv.
2002	4	4	4	0	0%	872
2003	11	9	9	0	0%	441
2004	6	6	4	2	33%	402
2006	4	4	4	0	0%	536
2007	35	34	34	0	0%	2,104
2008	35	31	28	3	10%	1,631
2009	43	40	35	5	13%	1,493
2010	12	12	12	0	0%	205
2011	42	40	35	5	13%	1,336
2012	98	87	79	8	9%	2,245
2013	202	129	106	23	18%	2,289
All Years	492	396	350	46	13%	13,553

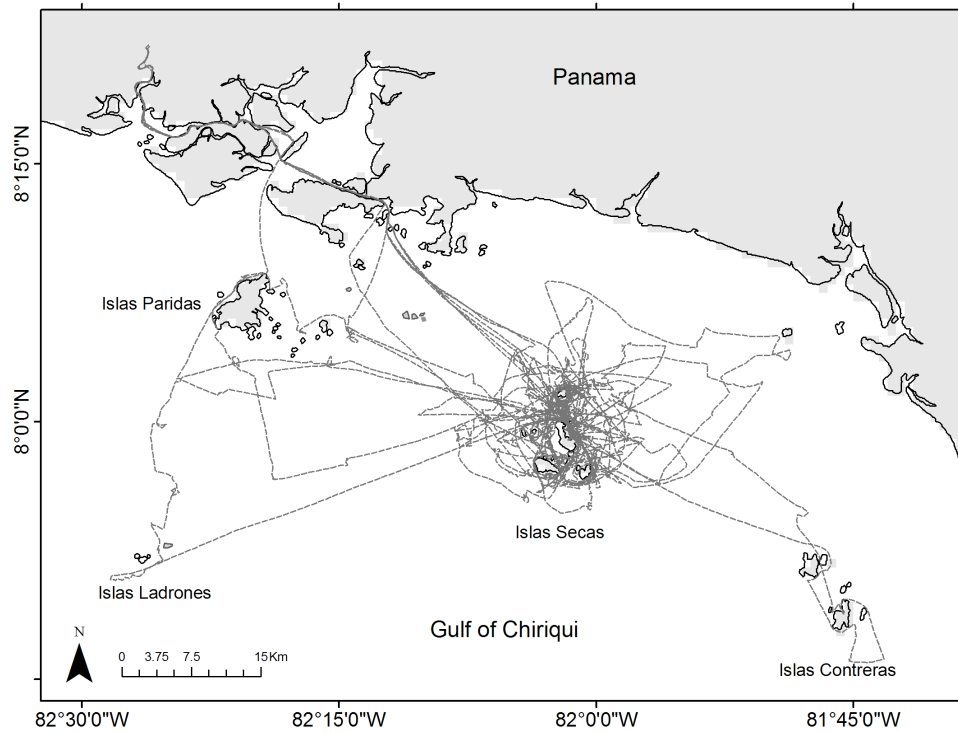


Figure 2. Survey effort for August-September 2013. Dashed lines represent boat tracklines during effort.

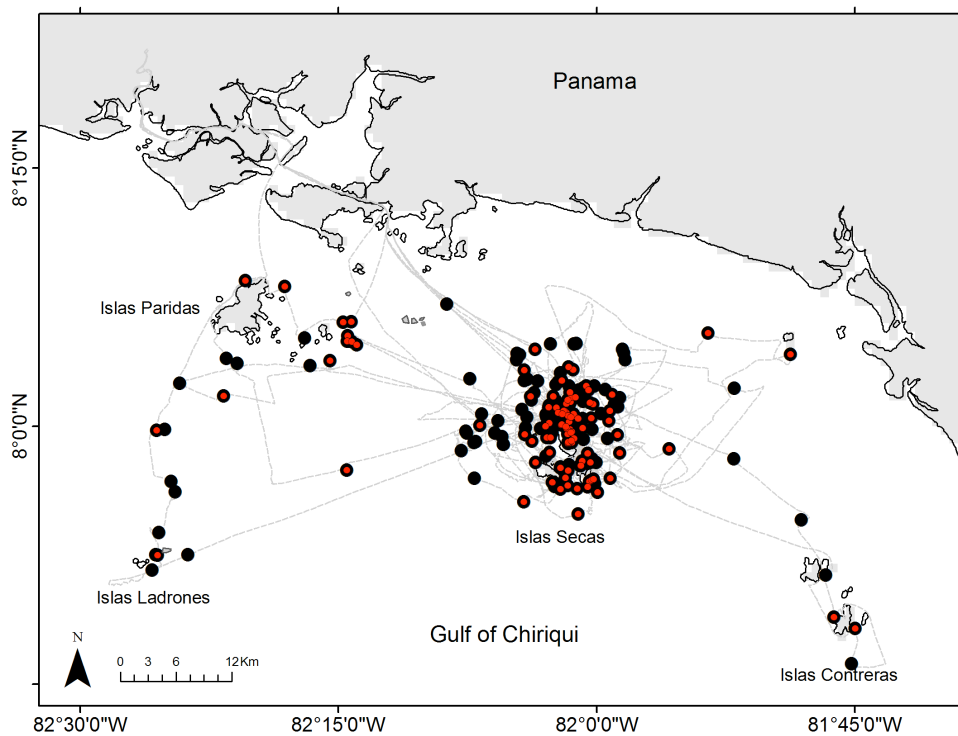


Figure 3. Humpback whale sightings, August-September 2013. Black circles represent sighting locations, red circles mark sightings that included a mother/calf pair, and dashed lines are the boat tracklines during effort.

One hundred and twenty-nine individual whales were photographically identified on 202 occasions. Of these, 34 individuals were identified on more than one day, with the majority seen on two days, and one whale seen on eight different days. The average period of time between the first sighting of an individual whale and the last sighting was seven days, and the longest span was 32 days. Twenty-three (18%) of these whales had been identified previously off Panama and the remaining 106 were new to our catalog. Of these 23, 17 (74%) were seen in one other year, three (13 %) were seen in two other years, two (9%) were seen in three other years, and one was seen during four other years.

Due to equipment failure we were only able to use the hydrophone on 12 of the 28 survey days. On these days the hydrophone was dipped 28 times and song was heard on 24 of these stations (86%). Song was heard throughout much of the survey area (Fig. 4).

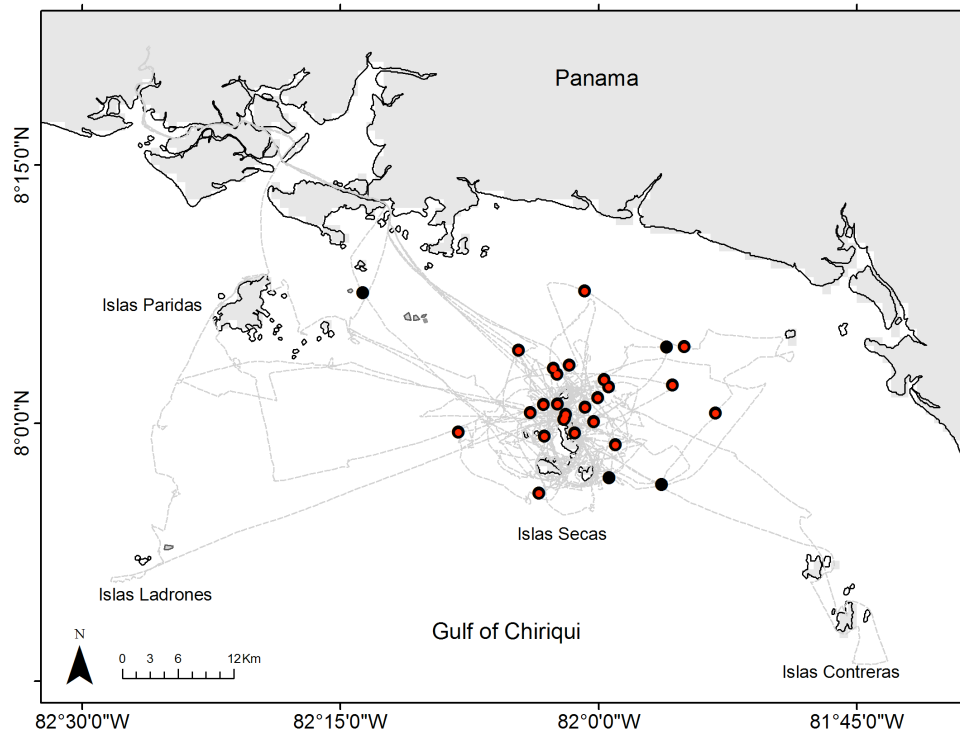


Figure 4. Locations of hydrophone dipping stations and where vocalizations were heard in the Gulf of Chiriqui, August 2013. Black circles represent dipping stations, red circles represent where vocalizations were heard, and dashed lines are the boat tracklines during effort. Due to equipment failure, hydrophone stations only covered the period 7-19 August of the survey.

On 27 August we observed a pair of Bryde's whales (*Balaenoptera edeni*) near the Islas Contreras. This is the fourth sighting we have made of this species since 2002 (Fig. 5). Previous sightings included a mother/calf/escort trio in 2004, and single animals seen in 2007 and 2009. One minke whale (*Balaenoptera acutorostrata*) was sighted in 2009 (Fig. 5).

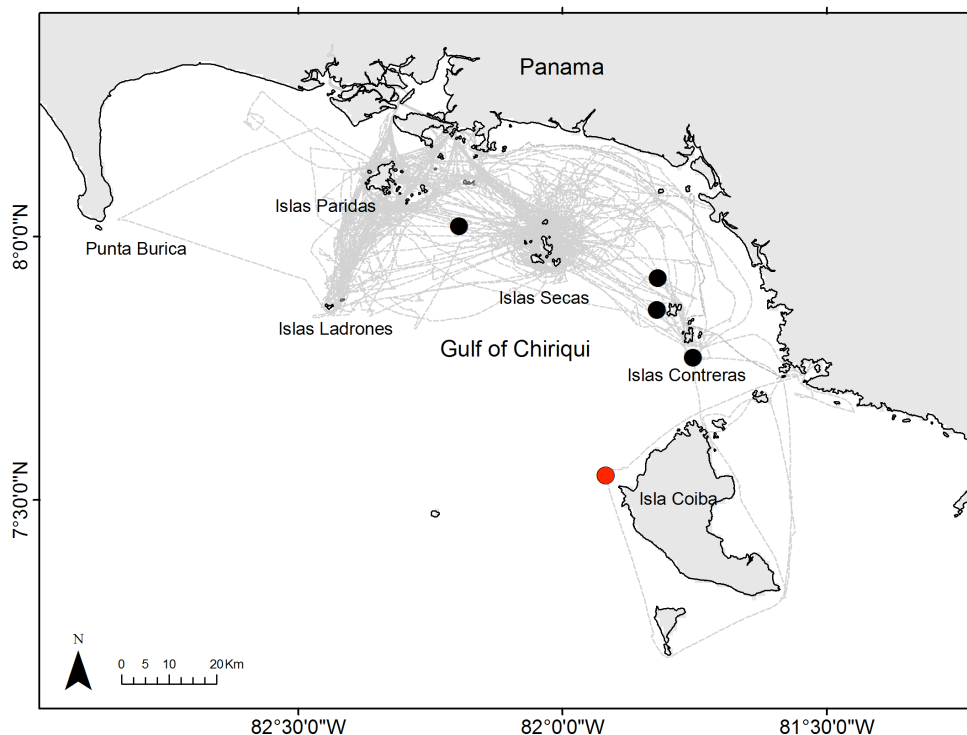


Figure 5. Locations of other baleen whale sightings between 2002-2013. Black circles indicate Bryde's whales, red circle represents a minke whale sighting in 2009, and dashed lines are the boat tracklines during effort in all years.

DISCUSSION

This year represented the highest level of effort and most whales sighted since this project began. The encounter rate for 2013 (0.199 whales/km) was higher than previous years, and more than twice as high as the overall encounter rate for the combined years of 2002-2012 (0.088) (Rasmussen and Palacios 2013). One potential bias this year was that the surveys were conducted closer to the Islas Secas, and not as much time was spent transiting to other island groups, such as the Ladroneas and Contreras, as in other years (Fig. 1). Typically, fewer animals are seen in the open waters between these island groups, so the encounter rate is likely to be lower during years when we have expended more effort in open waters.

However, we believe this bias in effort does not entirely account for the higher encounter rate and that more whales visited Gulf of Chiriqui in 2013. The characteristics of the groups seen in 2013 support this: the largest group size was 18, while in previous years it was nine. Average group size was 2.3 (SD \pm 1.6) whales, while in previous years it was 2.07 (SD \pm 0.05). In 2013, 8% of sighted groups were larger than five individuals compared to 4% for previous years. These larger group sizes are likely a result of more whales being present in the area. The higher encounter rates and larger group sizes in 2013 could be due to a shift in habitat use, an increase in population size, survey biases, or possibly a combination of all these factors.

The percentage of sightings that contained a calf was slightly lower this year. Of the 203 sightings, 91 (45%) included a mother/calf pair, which is less than our overall average from previous years (52%) (Rasmussen and Palacios 2013). However, this still remains one of the highest percentages of calf sightings reported for most other humpback whale wintering areas (other studies ranged from 8% to 28%: Mobley and Herman 1985; Mattila and Clapham 1989; Mattila et al. 1989; Garrigue et al. 2001; Hauser et al. 2000; Zerbini et al. 2004; Felix and Botero-Acosta 2011). This could be an artifact of where the surveys take place, with an upward bias resulting from the island groups and inshore waters where calves are typically found being surveyed more than

deeper offshore waters. It is clear, however, that the locations being surveyed are an important nursery area for mother and calves, regardless of whether calves are found in a broader geographical range.

The increased effort this year also yielded a higher number of identification photographs. The 106 new identifications increased our catalog by 43%, bringing the total to 350 individuals. The relatively low percentage of whales previously seen (18%) indicates that we have not yet sampled the majority of this population. Whales identified off Panama have previously been linked to whales seen in the breeding area off Colombia (Florez-González et al. 1998), and whales seen off Colombia had been linked to feeding areas off Antarctica (Stone et al. 1990). During the previous 10 years of this study, photographic matches were made from this catalog to the Straits of Magellan (Chile) and to the Antarctic Peninsula (Acevedo et al. 2007; Rasmussen et al. 2007). With the addition of over 300 new identifications since these comparisons were conducted, new comparisons should further elucidate the relationship between Panama and the breeding and feeding areas of BSG. All photo-identifications will be shared with other researchers in Antarctica, Chile, Peru, Ecuador, Colombia and Costa Rica to determine if they have also seen any of these whales, which will help to clarify migratory destinations.

Since 2012 also showed high values for encounter rates and number of new individuals identified, additional years of surveys are needed to determine if this is an on-going trend for this population. In addition, since 2014-2015 is anticipated to be a strong El Niño year (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensو_advisory/ensodisc.pdf), it will be particularly valuable to continue our monitoring efforts over the next two years to determine how anomalously warm environmental conditions influence the patterns of humpback whale occupation in the Gulf of Chiriqui.

In coming years we also plan to expand our research in the following areas: genetic analysis to further elucidate the relationship to other South Pacific breeding and feeding areas (six sloughed skin samples have been collected, and we hope to start collecting biopsy samples); comparison of mother-calf habitat use to other breeding areas in the Southeast Pacific (Colombia, Ecuador, Perú and Costa Rica) to determine the role this area plays for calving; and long-term acoustic monitoring to examine the temporal dynamics of area occupancy between the two distinct populations that migrate to Panama from the northern and southern hemispheres.

Having a long-term data set of baseline data in this location will be valuable to this particular population of whales. These data can be used to assess the demographic trends as well as any migratory shifts that may occur. Both of these aspects could be affected by natural and human-induced climate variability, or by other anthropogenic pressures such as increased boat traffic and pollution. Considering the tourism boom currently experienced by Panama and the proposed mega-developments for the Gulf of Chiriqui, fully describing the importance of this area and maintaining a long-term data set will provide crucial information toward ensuring that the proper conservation measures are taken.

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