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ABSTRACT

We found that PCFG whales often migrated together based on a review of identification photographs of migrating gray whales encountered by whale watch naturalists in Southern California operating primarily out of Santa Barbara and Long Beach 2013-15. We identified potential PCFG gray whales on migration and confirmed this by matching all whales associated in a group containing a suspected PCFG whale to Cascadia's catalog. PCFG whales were identified on 21 occasions from as early in the season as 22 November to as late as 18 March. In 15 of 21 cases, multiple animals were reported to be in the group and in most of these (9) multiple PCFG whales were present in the group including five cases involving three to five PCFG whales. Associated PCFG whales occurred in both the southbound and northbound migrations though they were more commonly associated southbound. Of the 27 PCFG whales with known sexes identified on migration, 15 were females and 11 males and in groups with multiple animals of known sex, four of six groups contained animals of mixed sexes. This continued association of PCFG whales on both northbound and southbound migration raises the potential these animals associate on the winter breeding grounds as well and confirms indications that Western gray whales may migrate together as well. This increases the chances for breeding occurring within feeding area groupings even when animals migrate to a mixed wintering area.

INTRODUCTION

The Pacific Coast Feeding Group (PCFG) feeds in coastal waters of the Pacific Northwest from Spring to Fall, though is generally distinguished from migratory whales based on being sighted after 1 June in these waters (Darling 1974, 1984, Calambokidis et al. 2002, 2015). Recent studies have identified differences in mtDNA between these whales and those feeding elsewhere in the Eastern North Pacific (Lang et al. 2014, Frasier et al. 2011). How these feeding area designations impact which animals might associate and interbreed is not as clear. Information on how long whales from a feeding area might associate with each other and if it extends into the migration would be useful for evaluating this. Data from satellite tags has provided information on the migratory timing of individual animals including whales from the PCFG (Mate and Urban 2005, Mate et al. 2010, Ford et al. 2013). Ford et al. (2013) reported that of five whales tagged in late March off Vancouver Island, three were PCFG whales that turned out to be migrating north. Mate et al. (2010) reported that of eight whales documented starting their southbound migration these ranged from 20 November at the earliest and 13 February at the latest.

We examined photographs of whales during their migration off S California to see if PCFG whales were identified in groups and the timing and composition of those groups.

METHODS

Cascadia maintains a catalog of 1,654 uniquely identified gray whales (through the end of 2014 and prior to integration of the 2015 new individuals). The target of photo-ID efforts are animals in the PCFG typically identified in the summer and fall in coastal waters from N California to SE Alaska and most of the 24,867 identifications of animals consist of resightings of this small group. Our catalog also includes identifications from other regions or from early in the season that would not likely be PCFG whales and these make up a small portions of the encounters but contribute a large proportion of the unique identifications since there are few resightings of these whales so the few encounters still make up a large number of unique individuals.

Cascadia receives sighting information and identification photographs of multiple large whale species from two groups, Channel Island Naturalist Corps and Aquarium of the Pacific, who provide naturalists to go out on whale watch boats operating in the Santa Barbara Channel and out of Los Angeles/Long Beach, respectively. The whale watch operations go on year-round going out on most days throughout the year. The primary focus of the photo-IDs they have provided have been the humpback and blue whales that feed in both regions through the spring, summer and fall but they also include effort during the winter during the gray whale migration.

We examined photographs of gray whales obtained during the migration to determine if any of these whales were recognized as PCFG whales (Figures 1 and 2). It was too time consuming to go through trying to match every whale to our catalog, so we relied on our two lead matchers familiarity with the regular PCFG whales (that we encounter frequently and so know well) to scan the photographs for whales they recognized. If they suspected they recognized an individual, they would then compare this photograph to our catalog to verify the match and also compare the rest of the whales that were traveling in the same group to our catalog.

Figure 1. Three PCFG whales migrating together on 12 December 2013 off S California. From left to right IDs are 140, 324, and 107. Photo by Aquarium of the Pacific.

Figure 2. Photo of 3 PCFG whales migrating south together off S California on 6 December 2015. From left to right IDs are 714, 192, and 169.

Results

PCFG whales were identified on 21 occasions on migration along the S California coast from photographs taken by the Channel Islands Naturalist Corps and Aquarium of the Pacific personnel from whale watch vessels (Table 1, Figure 3). This included two re-encounters of the same group of whales at different times on the same day further along their migration. Sightings ranged from as early as 22 November to as late as 18 March with most occurring in December (7) and February (7). In 15 of 21 cases, multiple animals were reported to be in the group and in most of these (9) more than one PCFG whale was identified in the group. In five of these cases three to five PCFG whales were identified in the group. These represent minimums because not all whales were necessarily photographed with suitable quality in each encounter since this was an opportunistic observation from a whale watch vessel.

One of the largest associated groups (estimated to be five whales but at least six present based on photo-IDs) was encountered on two occasions on 12 December 2013 off the Palos Verdes Peninsula. Five different PCFG whales were identified in this group with at least one non-PCFG whale present. One of these (229) was also identified again N bound on 20 Feb 2014 this time solo, passing the same area. This whale had been a regular PCFG whale through 2005 (76 encounters 1994-2005) mostly off central and N BC and then was only seen in SE Alaska in July 2006 prior to the encounters on 12 December 2013 and again on 20 Feb 2014 on migration.

Associated PCFG whales occurred in both the southbound and northbound migrations though in different proportions. In 20 of the sightings multiple locations were obtained that allowed determination of the direction of travel. In all eight cases for 22 November to 2 January the whales were southbound and in all 12 cases covering 22 January to 18 March the whales were northbound. One sighting where multiple positions were not available on 19 December was assigned to Southbound based on the date. Multiple associated PCFG whales were more common during the southbound period (6 of 9 sightings) compared to the northbound period (3 of 12). Sightings of these associated PCFG whales were seen as late as 1 March (2 whales) though PCFG whales either solo or with non-PCFG whales were identified as late as 18 March.

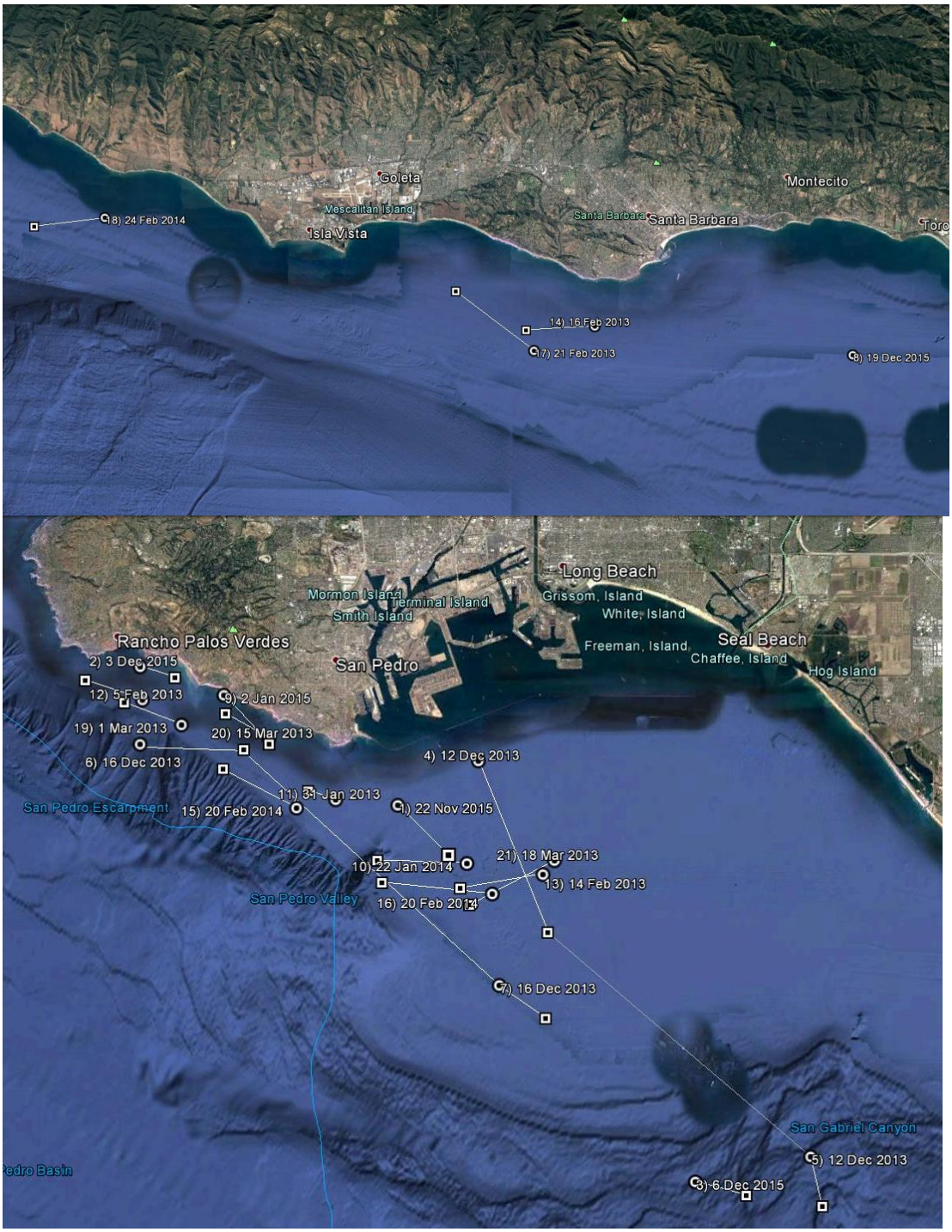

Figure 3. Map Santa Barbara Channel (top) and waters off Los Angeles (bottom) showing beginning (circle with label) and ending positions (square) of the 21 migrating groups that included PCFG whales. First number corresponds with group number in tables 1 and 2.

In 17 of the 21 sightings with a PCFG whale, the sex of one or more of these whales was known from past biopsy collections (see Lang et al. 2014). Of the 27 whales with known sexes 15 were females and 11 males. In only six cases was the whale reported to be alone, in all four cases where the sex was known for that individual it was female. In eight sightings of six groups where

the sex was known of multiple animals, these included mixed sexes for four of six groups with the other two consisting of a pair of two males, and a trio of two females with a third unknown sex whale.

There were several cases where PCFG whales were identified shortly before or after their encounter on migration:

- An encounter of two PCFG whales on 1 March 2013 including an individual (510) that was resighted on 30 March 2013 off Grays Harbor about 1,500 km farther up the coast though now apparently alone.
- A PCFG whale (254) identified on 21 February 2013 migrating N with a non-PCFG whale was identified again on 23 March 2013 off S Vancouver Island.
- One whale (561) in a group of three PCFG whales seen on 16 February 2013 was seen 24 April 2013 off northern Washington.

There were also indications of some of the same PCFG whales seen together on migrating being associated together on the feeding grounds. For example, a group of three PCFG whales seen migrating north together on 16 February 2013, were also seen associated in different combinations together along the southern Vancouver Island coast in August and September 2013. Perhaps this familiarity both on feeding grounds and in migration facilitates these whales staying associated or re-associating on the breeding grounds prior to the northward migration.

Four of the PCFG gray whales identified in migration were individuals that had been satellite tagged previously. This included three whales tagged by Oregon State University with implant satellite tags in the Fall of 2009 off Oregon and Northern California, one of which (537) did not migrate S that year (Mate et al. 2010). On other whale (135) had been tagged with a LIMPET satellite tag on 24 March 2011 as it appeared to be migrating north, it only transmitted 8 days but the whale continued 1,141 km north to SE Alaska during that period (Ford et al. 2012).

Discussion

These associations indicate that gray whales from the same feeding area appear to associate and often migrate together. The PCFG whales are estimated to number only about 200 (Calambokidis et al. 2012, 2014) out of an overall eastern North Pacific population of about 20,000. This would make these encounters of multiple PCFG whales together extremely unlikely to occur by random chance. It was more common that PCFG whales were associated during the southbound migration and this makes sense given these whales were together on the feeding ground and so could easily start the migration together. That they were still together off S California indicates these associations during migrations may not break up during the migration. While associated PCFG whales were less common during the northbound migration, the occurrence of three of these groups, again way more than would occur by chance, is more surprising. This included two pairs of PCFG whales and one group with three PCFG whales. Whether this indicated these whales remained associated through the breeding season or became associated just for the migration we do not know.

An important implication of this work is that it extends the time PCFG whales would be associated through the year and would increase the potential for breeding with other whales from

the same feeding group. Even if they did not remain together on the winter breeding ground, it would appear PCFG whales would be together often into January. With their northbound migration and return to feeding areas beginning in February and March, this would suggest these whales could be associated for 10 or more months of the year.

These findings also have important implications for Western North Pacific gray whales where recent results have raised some questions about their status. Significant differentiation has been found in both mtDNA and nuclear DNA markers between western North Pacific (WNP) and eastern North Pacific (ENP) gray whale populations (LeDuc et al. 2002, Lang et al. 2011). Recent results, however, have shown both extensive photo-ID matches between WNP gray whales and migrating whales along the US West Coast and breeding areas in Baja (Weller et al. 2012) and satellite tagged WNP gray whales have migrated to the eastern North Pacific (Mate et al. 2015). Six reported sightings of migrating WNP gray whales off Vancouver Island, occurred on only two different days with animals appearing to be associated together, three WNP gray whales in are group and two in another, suggesting WNP may migrate together (Weller et al. 2012). Our findings of PCFG whale migrating together both northbound and southbound demonstrates whales may associate on migration with other animals from their feeding area. This would potentially contribute to WNP gray whale's genetic differentiation from ENP gray whales even if they were using the same breeding area. There is evidence some WNP gray whales migrate to breeding areas south of Japan (Weller et al. 2008) so this also would contribute to differentiation between WNP and ENP gray whales.

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Table 1. Summary of sightings and histories of PCFG whales identified on migration off Southern California ordered by date in the migration (regardless of year). Green highlights some of the resightings discussed in text. Included are details of sighting history of the individuals in group including total number of sightings of those individuals in database and earliest year documented. Group number corresponds to those shown in Figure 3.

Group	Date	Reported Group #	# photoIDed	# PCFG identified	Direction	PCFG IDs	Sexes	Closest date prior	Closest date after	# Sight	Earliest Yr	Tag history	Comments on other sightings	Comment from migration
1	22-Nov-15	1	1	1	S	127	F	2/17/2015 NCA	NA	134	1986		Multiple yrs SVI, OR, and NCA, SEEN 28 Dec 2014 NCA	solo
2	3-Dec-15	1	1	1	S	842	F	11/9/2015 SVI	NA	140	2004		Mostly seen SVI and SJF	solo
3	6-Dec-15	4	4	4	S	169, 192, 615, 714	192-F, 615-M, 714-M	11/9/2015 SVI (169)	NA	601	1995 (169)	ID 615 tagged in 2009 PTT 5223033	All PCFG multi-Year but different regions, 169 &192 together in 2006, 192 & 714 together in 2012, 714 seen 1/24/2011 NCA	
4	12-Dec-13	5	5	4	S	107, 140, 324, 597	107-M, 324-F	See below					See below	with 1 unk (1627)
5	12-Dec-13	5	6	5	S	107, 140, 229, 324, 597	107-M, 324-F	9/11/2013 SVI	2/20/2014 off LA	588	1994(107 & 229)		All PCFG multi-Year but different regions, 229 not seen since 2006 Glacier Bay sightings	diff ves and 1 unk (1627)
6	16-Dec-13	4	4	2	S	135, 789	135-M, 789-F	9/26/2013 SVI (789)	5/20/2014 SVI (135)	280	1995	135 DFO tag #3 3/24/2010 N-bound	789 seen as late as 13 Dec 2011 off Trinidad, both primarily SVI and WVI	789 and 135 with 2 unk
7	16-Dec-13	3	3	2	S	135, 789	135-M, 789-F						See above	789 and 135 and 1 unk
8	19-Dec-15	3	3	3	S	89, 327, 1509	89-M, 1509-F	10/15/2015	NA	377	1993	89 OSU tagged in 2009 PTT 5223029	1509 seen 17 Dec 2013 & 17 Feb 2015 off Crescent City, 89 stayed in N California past 27 Jan 2010	
9	2-Jan-15	2	2	1	S	141	F	Not seen 2014	NA	91	1990		Many out of season sight: IDed 27 Jan 2010 off Crescent City and then starting on 26 March 2010 off SVI, also 26 Feb 2011 in SVI and 17 Mar 2012 SVI	With calf
10	22-Jan-14	2	1	1	N	719		8/27/2013 NBC	4/2/2014 SVI	95	2002		Often seen starting early to mid March off SVI, 1st seen 2 April 2014 after migration sight	solo
11	31-Jan-13	2	2	1	N	718	F	9/22/2012 SVI	7/13/2013 SVI	85	2001		Mostly SVI WVI NBC, seen 16 Dec 2008 SVI, 27 Jan 2010 off CC, and 7 Dec 2011 off CC	with 1 unk
12	5-Feb-13	2	2	1	N	657	F	11/23/2012 NCA	6/16/2013 NCA	45	2002		seen as late as 10 Jan 2011 off CC	with 1 unk
13	14-Feb-13	1	1	1	N	1105	F	9/14/2012 SVI	6/14/2013 WVI	51				solo
14	16-Feb-13	4	4	3	N	303, 561, 878	561-F, 878-F	11/15/2012 NCA 303	4/24/2013 NWA 561	337	1998		303 seen 28 Dec 2014 NCA, 303 & 878 seen together 8/30/2013, 9/26/2013. 303 &561 seen together 9/2/2013	1 unk(1661)
15	20-Feb-14	1	1	1	N	229		12/12/2013 S off LA	5/29/2014 SVI	79	1994			solo
16	20-Feb-14	1	1	1	N	1154		12/16/2013 NCA	6/13/2014 NCA	39	2009		Seen 23 Dec 2014, 21 Jan 2011, 27 Jan 2010 off CC	solo
17	21-Feb-13	2	2	1	N	254	M	11/15/2012 NCA	3/23/2013 SVI	86	1996		5 Dec2011 CC	with 1 unk (1570)
18	24-Feb-13	3	2	2	N	227, 804	227-M	8/26/2012 227 NBC	7/11/2013 SVI	181	1996		227 frequent SVI, 804 only only 5 times total inl SEAK in 8/17/2001 & 6/15/2007 also 12/7/2011 NCA, 804 not regular PCFG no sight outside NCA and SEAK	
19	1-Mar-13	2	2	2	N	510, 537	510-M, 537-M	11/16/2012 NCA	3/30/2013 GH 510	164	2000	537 OSU tag in 2009 5200831	Both seen late season Dec-Jan in NCA multiple yrs	Documented N based on positions
20	15-Mar-13	1	1	1	N	1053	F	10/25/2012 NWA	6/28/2013 SJF	35	2008		All NWA and SJF	solo
21	18-Mar-13	2	2	1	N	1067		1/6/2013 NCA	1/19/2014 NCA	59	2008		1/6/2013, 1/19/2014, 12/23/2014 all off CC	1067 with 1 unk