

COMPARISON OF AERIAL PHOTOGRAPHIC AND LAND-BASED SURVEYS OF NORTHERN FUR SEALS ON THE SOUTH FARALLON ISLANDS, 1998-2013



Report to U.S. Fish and Wildlife Service
Farallon National Wildlife Refuge

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EXECUTIVE SUMMARY 2013

- (1) Under Cooperative Agreement with USFWS/Farallon NWR, Point Blue has monitored the rookery of Northern Fur Seals (NFS), *Callorhinus ursinus* on the South Farallon Islands (SFI; specifically, West End Island; WEI), California since NFS recolonized the islands in 1996. However, incomplete views of the colony from land-based vantage points provide only partial counts. Because of conservation concerns for the species, and unique nature of this colony – only the 2nd south of Alaska, more complete counts are desirable, especially of pups, to provide more accurate assessments of rookery size and production and to assess the accuracy of land-based counts.
- (2) On 6 August 2013, we conducted the first ever aerial photographic survey specifically targeting the Farallon NFS colony. Photographs were analyzed later to determine total counts of NFS by age and sex class.
- (3) Of the more than 500 close-up photos taken during the survey there were 5 of the main NFS breeding colony that proved most useful. Using Adobe Photoshop Extended version software, conservative counts from these photos resulted in 401 pups (the highest pup count ever recorded on SFI), 207 adult females/immatures, 24 adult males and 34 sub-adult males for a total of 666 individuals.
- (4) Seasonal land-based peak counts from the lighthouse included 30 adult males (11 July), 254 pups (1 August), and 492 total NFS (20 August). On the dates closest to the aerial survey (1 and 8 August), counts from the lighthouse included 14 and 12 adult males, 254 and 183 pups, as well as 467 and 331 total NFS, respectively. This indicates that counts from aerial photographic surveys are considerably higher than counts from the lighthouse, but the peak number of adult males may have occurred earlier in the breeding season prior to the aerial survey.
- (5) Each year, visits to the NFS colony on WEI are conducted in late summer to early fall following the cessation of the seabird breeding season to conduct more complete ground counts and read flipper tags. In 2013, three such surveys were conducted between 8 September and 7 October. The peak counts of NFS from these surveys occurred on 13 September 2013 with 164 pups, 10 adult males and 496 non-id (age and sex not determined) animals for a total of 670 individuals. Thus, the total count was similar to the aerial count but the pup count was 59% lower than the aerial count. On these surveys, pups and other immatures were combined into one category because of potential issues distinguishing pups from yearlings.
- (6) We also assessed NFS counts from biennial aerial photographic surveys targeting the Farallon Steller sea lion and California sea lion rookery, taken by the National Marine Fisheries Service in mid-July between 1998 and 2012. While these surveys were too early to provide peak NFS counts, in more recent years (2009, 2011) aerial counts

surpassed peak land-based counts for adult males and total numbers of individuals. In earlier years, land-based counts were greater even on similar dates to the aerial survey. This suggests that either: a) as the colony has grown, a greater proportion of NFS is out of view of the lighthouse vantage point; and/or b) differences in counts were affected by daily variation in numbers of NFS present.

- (7) Additional comparisons will be needed to better assess accuracy of the various survey techniques and best timing to obtain peak NFS pup counts. In 2014, we plan to conduct two aerial photographic surveys between late July and mid-August to compare with land-based counts and help determine best survey timing.

INTRODUCTION

The Northern Fur Seal (*Callorhinus ursinus*; NFS) is a pelagic-feeding, polygynous otariid that currently ranges across the North Pacific Ocean and Bering Sea (Kajimura 1984; Ream *et al.* 2005) as far south as 34°N latitude (Kenyon and Wilke 1953). Approximately 70% of the current world population breeds on the Pribilof Islands (~750,000 animals; Testa 2007), but recent declines at the Pribilofs, where pup production has fallen by ~50% over the past 3 decades have elevated concern for this species (Towell *et al.* 2006). Fur seals likely numbered at least in the tens of thousands at the South Farallon Islands (SFI), California before being locally extirpated by American, British, and Russian sealers during the early 19th century 1800s (Starks 1922; Townsend 1931; Scheffer and Kraus 1964). The first confirmed pup born on SFI since extirpation was in 1996 (Pyle *et al.* 2001). Since the 1960s, other rookeries have been re-colonized at San Miguel Island, California, and Bogoslof Island in the eastern Aleutians, Alaska (York *et al.* 2005).

Newly established, growing NFS colonies are crucial to the range expansion and population health of the species. Ground based survey efforts and standardized weekly pinniped censuses from the top of Lighthouse Hill at SFI over the past 15 years have revealed an exponentially increasing population fueled largely by immigration from San Miguel Island (Point Blue, unpublished data). Prior to 2013, the recent peak count numbered 521 individuals in 2012 (Tietz 2013). However, while these surveys have been effective in assessing overall population growth and resighting tags of immigrant animals, they have limitations. Location of the current fur seal colony on West End Island (WEI) precludes extensive ground-based examination of the colony at peak breeding, due to disturbance concerns with breeding seabirds. Lighthouse based censuses cannot see a large portion of the fur seal colony area. Therefore, we proposed a new annual aerial assessment of the fur seal colony at SFI to produce more accurate estimates of peak adult abundance and pup production – metrics of great interest to managers at National Marine Fisheries Service (NMFS) and the Farallon National Wildlife Refuge.

In 2013, we conducted the first ever aerial photographic survey of the Farallon NFS colony during the peak of the NFS breeding season. The main purposes of the aerial

survey were to: 1) provide a more complete count of the NFS colony, especially pups, using a technique that would not disturb breeding seabirds or pinnipeds; and 2) compare the aerial survey count with the two land-based survey techniques to assess survey timing and the relative accuracy of each technique. We also examined archived aerial photos of the NFS colony taken by the NMFS during surveys targeting the Farallon Steller sea lion and California sea lion colonies to assess their value for tracking NFS population trends. This information will be critical for more accurately estimating the size of the Farallon NFS colony and for tracking population changes which can in turn guide management actions related to this sensitive species.

METHODS

Research was conducted on the 120 acre SFI (comprised of Southeast Farallon Island or SEFI, West End Island or WEI, and other islets) which reside 43 km west of San Francisco, CA and 32 km southwest of Point Reyes, CA (37° 40' N, 123° 00' W). SFI is part of the Farallon National Wildlife Refuge (FNWR), managed by the U.S. Fish and Wildlife Service (FWS). Since 1968, biologists from Point Blue (*formerly* PRBO) Conservation Science have been collecting data on the wildlife that inhabit the islands.

Aerial Photographic Survey

We planned to conduct two aerial photographic surveys of the SFI NFS colony between 25 July and 15 August 2013 when annual pup numbers were expected to be at peak. However, because of extremely foggy conditions through the period, only one survey was conducted on 6 August between 1527 and 1618 h. The survey was conducted in a fixed-wing, high-wing Partenavia PN68 aircraft (Aspen Helicopters, Inc.). All coastlines and other pinniped breeding and haul-out areas of SFI were photographed from a height of 1,200 feet ASL. Weather conditions were clear with light wind. We had planned on photographing the NFS colony at multiple altitudes between about 700 feet to 1,200 feet but were unable to conduct the lower altitude passes because of time constraints.

Two photographers took near-vertical handheld photographs through a belly port in the aircraft. The lead photographer (McChesney) took photos with a Canon EOS 60D digital SLR camera and a 200 mm lens. The goal of the lead photographer was to obtain good quality close-up photos of all pinniped areas. The overview/backup photographer (Bradley) took photos with a Canon EOS 30D digital SLR camera and a 17-85 mm zoom lens. The goal of this photographer was to obtain overview photos of all pinniped areas to help identify locations of close-up photos taken with the lead camera and to provide backup for areas potentially missed by the lead photographer. A third observer (Crystal Bechaver) kept a flight and photograph log.

A total of 528 photos were taken with the lead camera while 446 photos were taken by the overview camera. Photographs were then downloaded from the cameras to two external hard drives which are being archived at the USFWS San Francisco Bay NWRC

headquarters in Fremont, CA and at Point Blue headquarters in Petaluma, CA. The files also have been saved on the shared drive at Point Blue's headquarters. Photos were examined later by Berger for quality and to determine the location of NFSs. In early November 2013 Berger spent 3 days with pinniped aerial survey expert, Mark Lowry (NMFS), learning the software program (Adobe Photoshop Extended) to properly census NFS from aerial surveys. Once the best photos were selected, they were stitched together using the Adobe Photoshop Extended software package which created a canvas that showed the entire breeding colony. More detailed instructions of creating mosaics in Photoshop can be examined in Appendix A.

From the aerial photograph canvas, NFS were identified and marked by age/sex class, then tallied using the programs counting tool. Age/sex classes were: adult male (AM); sub-adult male (SAM); adult female or immature (AF/Imm); or pup. AM were determined by their large size and location in the middle of the colony. SAM were determined by their relatively large size and location on the fringes of the colony. AF/Imm were categorized together because they are difficult to distinguish based on size unless a pup was by a female's side (Bob DeLong, pers. comm.). However, a minimal estimate of adult females can be made by accounting for the total number of live pups detected. Pups were easily distinguished by their very small size. With the ability to zoom in and out on a high resolution photograph along with behavioral cues, we were able to place all individuals into an age/sex class of AM, SAM AF/Imm, and pups.

Land-based Surveys

To compare survey methods, the weekly pinniped census data that is collected from the top of Lighthouse Hill on SEFI is included in the results. Island wide pinniped censuses have been conducted once a week since 1970. NFS were counted at haul-out and breeding sites from vantage points located at Lighthouse Hill. During each census the age and sex (if distinguishable), location of haul out area and number of individuals were recorded. Because of the long viewing distance, it is too difficult to age and sex most of the NFSs. Typically, only AM and pups can be aged and sexed confidently. Most other animals were categorized simply as Non-ID. It is also important to note that counts conducted from the lighthouse do not allow for full view of the main NFS breeding colony located at Indian Head Beach (IHB) on WEI.

To further compare counts found in the aerial survey, Point Blue biologists made three trips in the Fall of 2013 to WEI (Fig. 1) to count pinnipeds and improve our understanding of their demographics. Surveys were conducted on 8 September, 13 September, and 7 October. The objectives were to count NFS to determine the age and sex class when possible, and to read tags and brands to determine animal origins. On all three surveys, we followed the same route and visited the same vantage points. We stopped frequently to count pinnipeds and search for tagged and branded animals along the way. Most survey time was spent at IHB and Shell Beach where the majority of pinnipeds haul out and bear pups. Because of the closer viewing distance, a higher

proportion of NFSs can be identified to age/sex class than from surveys conducted from the lighthouse.

Examination of archived photos from Steller sea lion/California sea lion surveys

Aerial photographic surveys of the Farallon Steller sea lion (SSL) and California sea lion (CSL) rookery as well as other pinniped breeding and haul out areas have been conducted in mid-July (early in the NFS breeding season) by M. Lowry intermittently since 1998. To determine the potential value of those surveys for examining NFS population trends, we reviewed previous counts conducted by Lowry and photos from other years archived at the NMFS's Southwest Fisheries Science Center in La Jolla, California. Because of the time intensity involved with reviewing data on film and knowledge of the timing of NFS breeding on SFI, a cut-off date of mid-July was used to reduce the number of years reviewed. Dates of Farallon SSL/CSL aerial surveys reviewed were conducted on 18 July 1998, 11 July 2001, 14 July 2003, 19 July 2004, 24 July 2005, 18 July 2007, 11 July 2009, 14 July 2011 and 4 July 2012.

RESULTS

Of the photos taken during the aerial survey, focus was given to those areas that were likely to have NFS. These specific locations around the islands include IHB, Pastel Cave Highlands (PCH) and Jordan Channel (JC), which can be further examined in Figure 1. Photos of other locations of the islands were scanned but no NFS were detected. However, it is possible that scattered individuals were present but not detected. Figure 2 shows the best photo of the main portion of the NFS colony at IHB. As indicated by the white text boxes, some overlapping photos also included NFS in adjacent areas. More detail of photos 052, 056, 089 and 128 can be viewed in Figure 3. A few individuals also were counted in photos 070-072 and 255. The only NFS away from the main rookery were 2 SAMs at JC; one each on the WEI and SEFI sides.

Table 1 provides the details of the age/sex class distribution for NFS counted from the aerial survey. The totals for AM, AF/Imm, Pup and SAM are 24, 207, 401 and 34, respectively, for an overall total of 666 individuals. This is the highest pup count to date and is over 1.5 times greater than the maximum count of 254 pups from the SEFI Lighthouse pinniped census on 1 August 2013 (Table 2).

With respect to SEFI lighthouse counts, Table 2 indicates that first pup detection was in late June with peak numbers occurring in early August and declining sharply thereafter until no pups were detected in early October. AM numbers reached peak by late June and began declining in early August. Because of the distance at which lighthouse surveys are conducted, determining the age/sex class of many individuals was difficult and resulted in many animals being labeled in the non-id category. The total count of 666 from the aerial survey is 1.4 times greater than the maximum total count from the lighthouse of 492 individuals on 20 August 2013.

NFS counts from WEI ground-based surveys are in Table 3. Pup counts varied from a low of 29 (7 October) to a high of 164 (13 September). Total counts ranged from 482 (8 September; incomplete survey) to 670 (13 September), the latter of which was similar to the aerial survey count on 6 August. Lower counts of AFs, SAMs, and possibly other age categories on 8 September compared to 13 September were due (at least in part) to an incomplete survey. The corresponding lower pup and higher immature counts on 7 October were related (at least in part) to difficulty in separating the rapidly growing pups from yearlings.

Counts of NFS from sea lion aerial photographic surveys conducted in early to mid-July 1998-2012 are compared to the closest LH survey date and the maximum LH and Ground pup, AM and total counts for that year in Table 4. These surveys were conducted prior to peak pup numbers for NFS and at least one month earlier than the maximum total counts seen from the LH or Ground. In early years when NFS numbers were lower, counts of fur seals detected from the LH were higher than from aerial photos. However, by 2009 aerial counts in mid-July surpassed counts from nearest dates and even maximum annual lighthouse counts for certain categories including AM and total (all years except 2012). This apparent change may have been affected by one or more of at least two factors: a) as the population has increased and the breeding area has expanded, a greater proportion of the rookery may now be hidden from the lighthouse vantage point; and/or b) differences in counts may have reflected daily variation in numbers present.

Furthermore, throughout the Fall season on SFI Point Blue biologist, Jim Tietz, conducted regular WEI ground counts where there is considerable effort given to reading tags applied to the fore flippers of NFS. In the autumn of 2013 there were a total of 17 tags resighted (Table 5). These data are shared in a collaborative effort with Bob DeLong at the National Marine Mammal Lab (NMML). All legible tagged NFS identified on SFI were born on San Miguel Island off southern California, with multiple observations of certain individuals. This suggests that recruitment of San Miguel Island NFSs continues to enhance the Farallones rookery.

DISCUSSION

Comparisons of counts obtained from aerial and land-based techniques in 2013 indicate that aerial photographs provided a more complete survey of the Farallon NFS colony. The 6 August aerial photographic survey resulted in the highest number of pups (401) recorded on SFI since the islands were recolonized in 1996 and was nearly 1.5 and 2.5 times greater than the peak pup counts obtained from Lighthouse and WEI surveys, respectively. The total aerial count was also substantially greater than the peak total counts from the lighthouse but was similar to the peak count obtained from WEI. The quality of the aerial photographs also allowed for better aging and sexing than surveys from the lighthouse. Unfortunately, only one aerial survey was conducted instead of the planned two, so no variability was obtained with this method.

Several factors affected NFS counts during 2013 surveys, including: 1) on the day of and days immediately preceding the 6 August aerial survey, mid-day temperatures were unusually warm. On 6 August, noon day temperature reached 15.5 °C with a maximum wind speed of 3 knots. In response, the majority of NFS were congregating near the water's edge to thermoregulate. NFS in dark shadows of intertidal areas were sometimes difficult to distinguish, and small numbers in intertidal areas may have been missed. Also, observations from the island indicated many animals were entering the water on the days surrounding the aerial survey; animals in the water were not detected in aerial photographs and are only estimated during land-based surveys; 2) nursing female NFS begin foraging bouts at sea when the pup is 8-10 days old with trips lasting two to 10 days. They return to the colony for one to two days between trips to nurse the pup (Reeves et. al, 2002). Thus, many AFs can be away from the colony foraging on any given survey day beginning about 1 week into the pupping season. After 3-4 months females abruptly wean their pups and return to sea. Adult males remain at the colony for the duration of the breeding season and may lose up to 20% of their body weight. Non-breeding adults and immatures also come and go from the colony frequently and thus numbers present on any particular day may vary considerably; 3) pups that did not survive to the survey day may not be detected. This number likely varies from year to year depending on prey supplies and other potential factors such as disease, but would probably be most affected on late season counts; 4) counts in late summer did not distinguish pups from immatures; and 5) numbers decline in late summer and early fall as animals depart the colony for winter foraging grounds offshore.

We believe aerial surveys can be used to provide more accurate estimates of seasonal NFS pup production and total size of at least the breeding portion of the colony. In 2013, given a peak count of 401 pups, the colony contained at least as many AFs. Adding this AF estimate to the peak seasonal count of 30 AMs provides an estimate of at least 431 breeding age animals, or 471 if the peak count of 40 SAMs is included.

Based on 2013 results, it is clear that aerial photographic surveys provide better counts of NFS pups on SFI than current land-based surveys. By combining aerial counts with land-based counts, we were able to demonstrate that the aerial survey was conducted when numbers of pups and AMs were near peak as well as certain factors that affected counts. In the future, conducting greater than one aerial survey in the 25 July to 15 August period would help evaluate daily variation in NFS numbers on the colony and help determine best timing for future once-annual surveys.

Aerial surveys conducted earlier in the season (mid-July) targeting Steller sea lions and California sea lions were generally too early to capture peak NFS pup and total counts. However, in more recent years (2009-2012) these counts surpassed ground-based counts for certain age/sex categories including AMs and even totals. This reflected the inability to view much of the expanding colony from the lighthouse. Given that peak

NFS numbers may not have occurred for another 1-3 weeks after the sea lion aerial survey dates, it also demonstrates that actual peak numbers were considerably greater than recorded by either method.

Also of great importance is developing a standardized aerial survey protocol of transect flying, fixed camera lens length, and determining a best survey altitude. By performing surveys in this manner the quality of photos should increase and analysis in Adobe Photoshop will be much easier as mosaics can be created quickly with one of the program's functions. More detail of the steps involved in creating mosaics through Adobe can be found in Appendix A. In 2014, we plan to conduct two aerial photographic surveys; one in early or mid-July to get peak AM numbers at sub-colony harems and one in early to mid-August to get peak pup counts, develop a transect methodology, and test photographing the colony at multiple altitudes.

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TABLES**Table 1.** Numbers of Northern Fur Seals counted from an aerial photographic survey of the South Farallon Islands, 6 August 2013. AM, adult male; AF/Imm, adult female/immature; SAM, subadult male.

AM	AF/Imm	Pup	SAM	Total
24	207	401	34	666

Table 2. Pupping season counts of Northern Fur Seals on the South Farallon Islands from weekly pinniped censuses conducted from the Lighthouse. Blue highlighted rows indicate the peak number of pups detected from the lighthouse and correspond to the aerial survey period. AM, adult male; Non-ID, unidentified age/sex.

DATE	AM	Pup	Non-ID	Total
6/20/2013	28	0	74	102
6/29/2013	28	21	115	164
7/4/2013	19	52	115	186
7/11/2013	30	142	288	460
7/25/2013	27	219	232	478
8/1/2013	14	254	199	467
8/8/2013	12	183	136	331
8/20/2013	6	167	319	492
8/27/2013	5	32	143	180
9/5/2013	3	29	116	148
9/11/2013	13	88	249	350
9/17/2013	6	29	222	257
9/24/2013	4	18	153	175
10/1/2013	4	0	212	216
10/8/2013	6	0	265	271

Table 3. Northern Fur Seal counts conducted during three visits to the West End Island colony in 2013. AM, adult male; AF, adult female; SAM, subadult male; Imm, immature; Non-ID, unidentified age/sex. Numbers in brackets [] indicate an incomplete survey.

DATE	AM	AF	Pup	SAM	Imm	Non-ID	Total
9/8/2013	13	[1]	79	[6]	[3]	[380]	[482]
9/13/2013	10	83	164	40	0	373	670
10/7/2013	11	72	29	5	173	296	586
Average	11.33	52.00	90.67	17.00	58.67	349.67	579.33
Std Dev	1.5	44.5	68.3	19.9	99.0	46.6	94.2

Table 4. NFS counts recorded from SSL aerial surveys conducted by Mark Lowry (NMFS) compared to LH and max counts (from LH and Ground) 1998-2012. Prior to 2006 counts of age/sex class of NFS were not conducted and only total count was performed. LH are the closet dates to the aerial survey from the Lighthouse. Max counts are the peak annual totals recorded for each age/sex class and are represented by count (top) and date (bottom; mm/dd). AM, adult male; AF/Imm, adult female/immature; SAM, subadult male; Non-ID, unidentified age/sex. Cells with a period indicate those animals were likely present during the survey but from the LH were indistinguishable and therefore considered in the Non-ID category. N/A indicates those age/sex classes were not considered during the survey.

Date	Survey Type	AM	SAM	AF/Imm	Pup	Non-ID	Total
7/4/2012	Aerial	50	19	188	101	0	358
7/13/2012	LH	18	.	.	124	115	257
2012	Max LH	29 07/05	.	.	213 08/15	257 10/01	375 08/15
2012	Max Ground	5 08/28	.	.	201 08/28	.	521 08/28
7/14/2011	Aerial	38	17	143	150	10	358
7/14/2011	LH	18	.	.	97	110	225
2011	Max LH	18 07/14	.	.	180 08/13	136 07/28	251 07/28
2011	Max Ground	16 09/26	.	.	170 10/28	.	476 09/06
7/11/2009	Aerial	22	12	63	63	20	180
7/9/2009	LH	15	.	.	17	39	68
2009	Max LH	15 07/09	.	.	80 08/06	80 09/04	132 08/06
2009	Max Ground	9 09/27	.	.	77 09/11	.	185 09/12
7/18/2007	Aerial	5	7	18	28	5	63
7/19/2007	LH	6	.	.	20	72	98
2007	Max LH	7 07/12	.	.	62 10/18	72 7/19	114 10/18
2007	Max Ground	8 10/11	.	.	45 09/02	.	174 10/11
7/24/2005	Aerial	1	3	3	0	0	7
7/21/2005	LH	.	.	.	.	.	35
2005	Max LH	N/A	N/A	N/A	N/A	N/A	90 08/19
2005	Max Ground	3 08/25	.	.	24 08/25	.	90 08/25
7/19/2004	Aerial	2	0	5	0	0	7
7/29/2004	LH	.	.	.	.	.	9
2004	Max LH	N/A	N/A	N/A	N/A	N/A	17

							10/09
2004	Max Ground	2 09/01	.	.	11 09/01	.	38 09/01
7/14/2003	Aerial	3	0	3	0	0	6
7/10/2003	LH	.	.	.	.	.	0
2003	Max LH	N/A	N/A	N/A	N/A	N/A	12 09/25
2003	Max Ground	2 09/01	.	.	8 09/01	.	22 09/01
7/11/2001	Aerial	0	0	0	0	0	0
7/12/2001	LH	.	.	.	.	.	3
2001	Max LH	N/A	N/A	N/A	N/A	N/A	11 07/20
2001	Max Ground	2 09/21	.	.	5 09/21	.	16 09/21
7/18/1998	Aerial	0	0	0	0	0	0
7/15/1998	LH	.	.	.	.	.	1
1998	Max LH	N/A	N/A	N/A	N/A	N/A	2 08/19
1998	Max Ground	1 10/01	.	.	1 10/01	.	4 10/01

Table 5. Northern Fur Seal tags read on trips to West End Island during 2013. All seals were tagged on San Miguel Island. Six other tags were seen, but were illegible due to wear.

Date	Tag #	Year first sighted	# years sighted	Observer sex ID	Observer age ID	Photo	Tag sex ID	Year tagged
Sep 8	A4366	2006	4	female	adult	no	female	2004
Sep 8	A6102	2013	1	female	immature	no	female	2011
Sep 8	A5765	2013	1	unknown	immature	no	female	2010
Sep 8	A4319	2008	3	female	adult	no	female	2004
Sep 8	A5814	2013	1	unknown	immature	no	female	2010
Sep 8	A6133	2013	1	unknown	immature	no	male	2011
Sep 8	A5845	2013	1	unknown	immature	no	male	2010
Sep 13	A5756	2013	1	male	immature	no	male	2010
Sep 13	A5327	2009	3	male	subadult	no	male	2007
Sep 13	A5836	2013	1	unknown	immature	no	male	2010
Sep 13	A5928	2013	1	unknown	unknown	no	female	2011
Sep 13	A4793	2008	1	female	adult	no	female	2005
Oct 7	A5387	2013	1	male	adult	yes	male	2008
Oct 7	C1612	2013	1	unknown	unknown	no	????	????
Oct 7	A3585	2013	1	female	adult	yes	female	2000
Oct 7	1297	2013	1	female	adult	yes	female	2002
Oct 7	A5760	2013	1	unknown	unknown	yes	female	2010

FIGURES

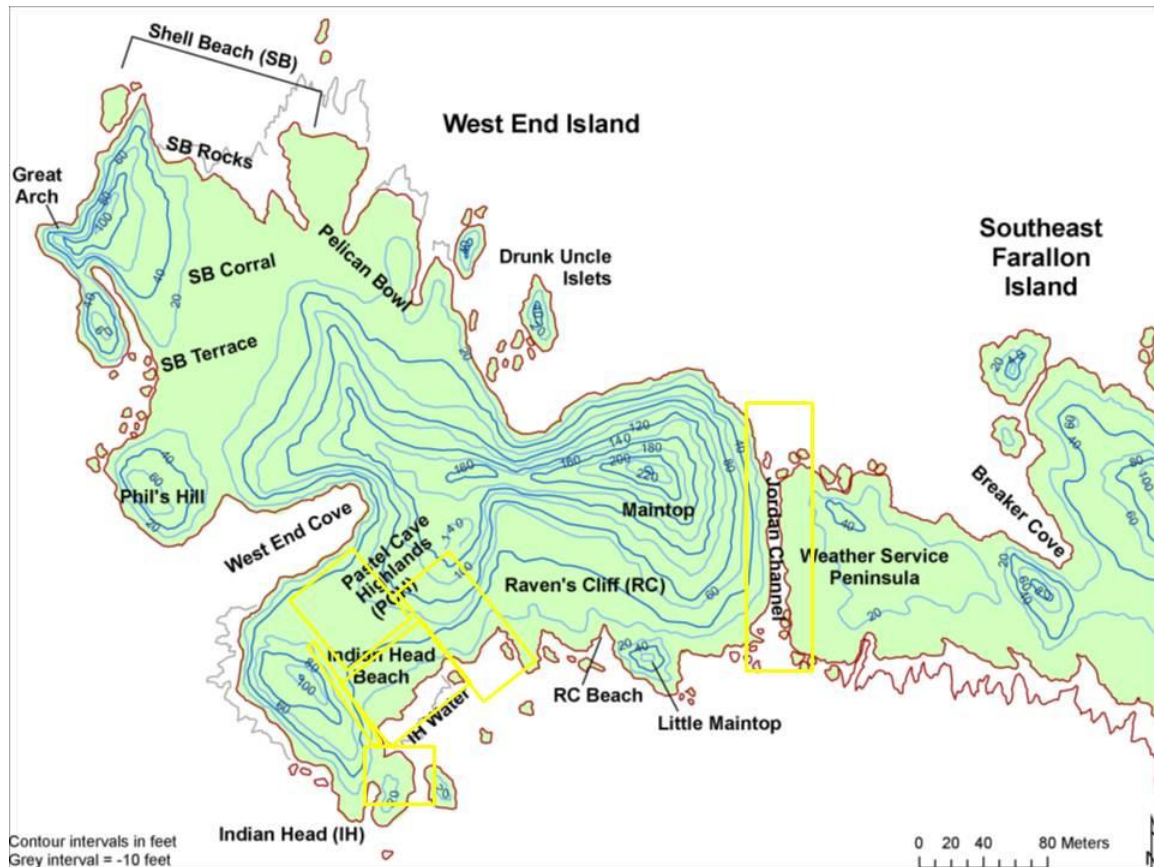


Figure 1. Map of WEI. Most NFS are found at the breeding colony at Indian Head Beach with some individuals on higher ground at Pastel Cave Highlands. From the aerial survey only 2 animals were observed at Jordan Channel. Yellow boxes indicate the area of photos examined that contained NFSs.

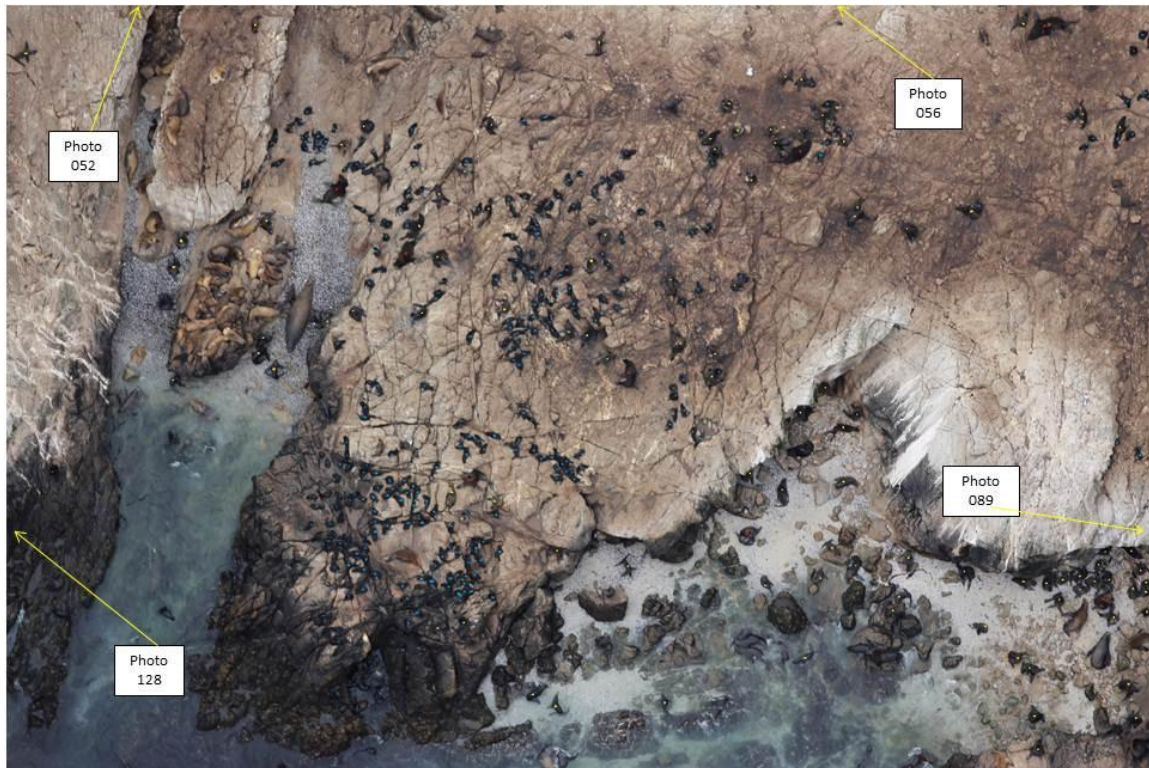


Figure 2. Aerial photo 049 from the lead camera on 6 August 2013, showing the main portion of the Farallon NFS colony on Indian Head Beach, West End Island. Photos 052, 056, 089 and 128 overlapped with portions of photo 049 and were counted separately. Photos 070-072 and 255 were also counted but only had a few SAM NFSs scattered throughout.

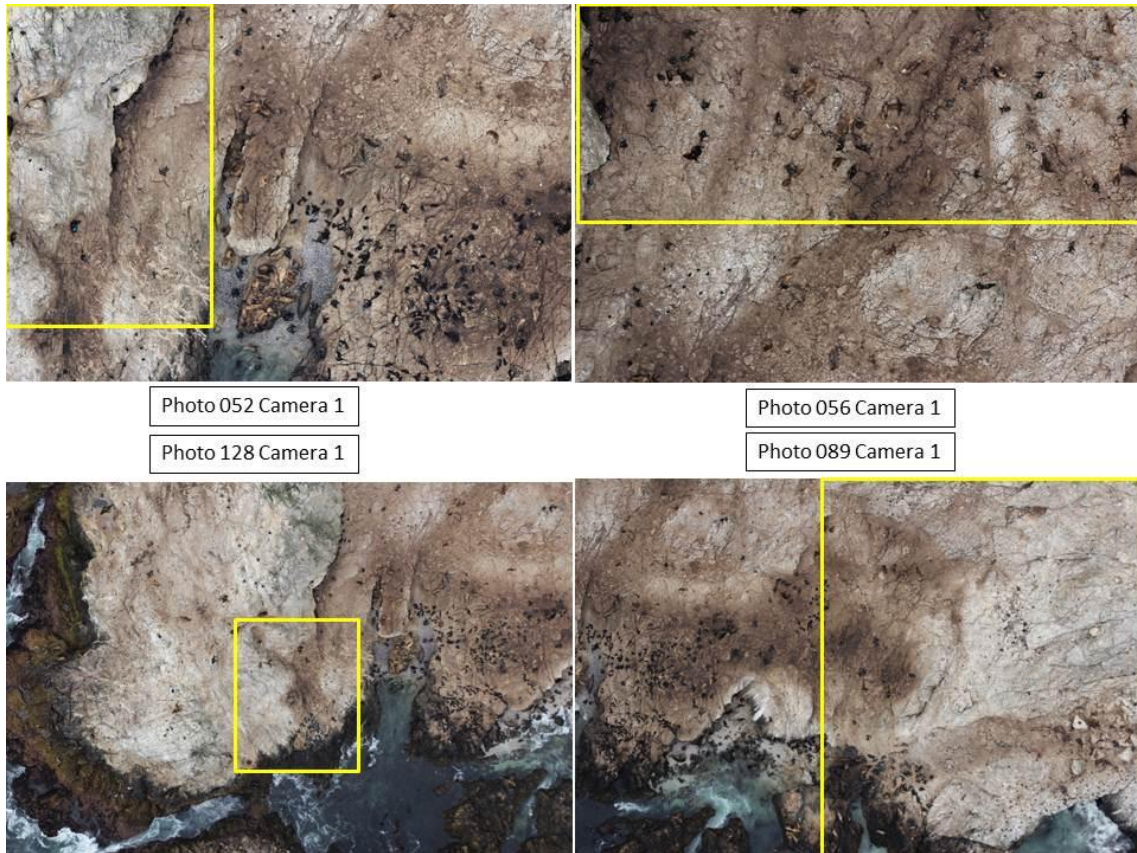


Figure 3. Aerial photos 052, 056, 089 and 128 from the Lead Camera during the survey conducted on 6 Aug 2013. This figure gives reference to areas examined just outside the view in photo 049. Yellow boxes indicate NFS count areas for the particular photo. Photo 056 is of the Pastel Cave Highlands (PCH) subarea.

Appendix A.**Notes from visit to La Jolla, CA with Mark Lowry (NMFS) Nov 2013: NFS Aerial Survey Photography**

- Use fixed lens camera so that quality of photos come out better.
 - This helps tremendously when stitching photos together with Photo Shop
- Over expose photos by 1/3 or 2/3 of a stop from the normal setting
 - This helps in the contrast of the dark NFS to the lighter background of the island
- Fly transects to make documentation of photos more straight forward and more accurate
 - See Lowry's protocol for flying and his set up with the camera
 - Essentially every photo taken on his set up is associated with: Date, Time, Lat, Lon, Altitude, Wind speed, Ground speed
- He is using Adobe Photoshop Extended version (has the counting tool)
 - Upload main/best photo of IHB breeding colony (this will be used as the background for your canvas and what you will "stitch" other photos to
 - The canvas is under the "Image" tab and then "Canvas Size" which allows you to adjust your canvas based on where you want to add more photos to complete the mosaic (max size is about 300x300)
- Then find nearby photos in the Bridge software program that comes with the PS extended package (just need to double click on the photo to get it to come into PS)
- Once the new photo comes in it is uploaded to its own tab within PS which allows you to crop the photo to the size you need allowing for some overlap between your background photo and it so you can match it up.
- Once you have adjusted the photo you upload it to your canvas by going to the "Layer" tab and hitting "Duplicate Layer". This allows you to name the new photo (usually the frame number of the original photo) and then which canvas you want to up load it to.
 - Note after cropping and adjusting the photos to be added to the mosaic when closing it out do not save the changes or you will lose the original photo
- Now the new photo is on the canvas and you can use the opacity button on the right side to "see through" the photo and match up landmarks to help in the stitching process. From there you can make the photo larger or smaller and rotate to help match. Also can use a tool that allows you to distort or "stretch"

- the photos in grid line pieces in order to get the photos to match up better. Once done you can increase the opacity again.
- After that you hit transform (which is the check mark icon on the top tool bar). Then you can go to the “Image” tab and then “Adjustments” which allow you to adjust brightness and contrast to help animals stand out more.
 - Then upload more photos like this until your area of interest is complete in your canvas/mosaic.
 - Next step is to click on the eye drop icon on the tool bar to the left. This allows you to select a count function. From here you can hit the new folder icon on the top tool bar which allows you to create categories for your counts (bulls, cows, pups, etc). You can color code and it keeps a count for each category and an overall count. You can delete counts by holding the Alt key down and hovering over the count you want to delete (for example if you count a *Zalophus* accidentally or mis-label the age/sex of an animal).
 - Once count is done you can save the file as a psd, jpeg, or tiff. You will get the best resolution and it will save your counting dots in the psd but you need to have PS extended to open this file. The Jpeg or Tiff file will allow you to view the mosaic/canvas you created but will not show the counts.
 - As a follow up with Mark: he has found a function/tool within the Adobe program to select desired pictures and have the actual program “stitch” or create the mosaic for you. This is a huge time saver and emphasizes the need to take photos that are at a fixed focal length/lens.
 - After Ryan visited NMFS, Mark found out how to automatically merge photographs. Simply select 2 or more photographs (there is a limit) in Bridge; then in the tools click on photomerge. It usually works seamlessly, but sometimes you may have to use manual. During this procedure, Bridge sends the photos to PhotoShopExtended and a window opens up where you select how you want the program to merge the photos.
 - Mark’s process is to look at the film under a back light and microscope and tapes a layer of acetate over the film to color code and mark seals by age/sex class. This is difficult for a beginner as the quality of images is not the greatest. Mark uses clickers to keep count of each age/sex category.