



Pacific Harbor Seal (*Phoca vitulina richardsi*) Monitoring at Point Reyes National Seashore and Golden Gate National Recreation Area

2013 Annual Report

Natural Resource Report NPS/SFAN/NRR—2015/919



ON THE COVER

Pacific harbor seals (*Phoca vitulina richardsi*) hauled out at Drakes Estero in Point Reyes National Seashore, California.
Photograph by: Carlos Porrata

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Contents

	Page
Figures.....	v
Tables.....	v
Abstract.....	vi
Acknowledgments.....	vii
Introduction.....	1
Background.....	1
Objectives	2
Methods.....	3
Study Area	3
Sampling Design	3
Surveys	5
Data Management and Analysis	6
Results.....	8
Overall	8
Adult and Pup Counts During the Breeding Season.....	8
Molt Counts	11
Disturbances	12
Summary by Site	16
Bollinas Lagoon.....	16
Double Point.....	16
Drakes Estero Complex.....	16
Duxbury Reef	16
Point Bonita	16
Point Reyes Headlands.....	17
Tomales Bay	17
Tomales Point.....	17
Regional Sites.....	17
Sonoma County	18

Contents (continued)

	Page
San Francisco Bay	18
San Mateo County	19
Discussion	23
Collaborations	23
Season Highlights	24
Literature Cited	25

Figures

	Page
Figure 1. The remote beach of the Double Point harbor seal colony at Point Reyes National Seashore.	2
Figure 2. Regional harbor seal survey sites in San Francisco Bay and Sonoma, Marin, and San Mateo counties, California	4
Figure 3. Volunteer training at Drakes Estero within Point Reyes National Seashore.	5
Figure 4. Maximum counts of harbor seal adults and immatures during the breeding season (March-May) for 2000-2013 at Marin County locations.	9
Figure 5. Maximum harbor seal pup counts for 2000-2013 at Marin County locations.....	9
Figure 6. Maximum harbor seal pup counts at the dominant Marin County pupping locations during the breeding season (March – May), 2000-2013.....	10
The maximums of each site may have been observed on different days.	10
Figure 7. Maximum harbor seal pup counts at Point Bonita during the breeding season (March – May), 2000-2013.....	11
Figure 8. Maximum harbor seal counts during the molt season (June-July) for 2000-2013 at Marin County locations.....	11
Figure 9. Rates of disturbances per hour at Marin County locations from March 1st through July 31st, 2013.....	14
Figure 10. Rates of disturbances per hour at Marin County locations from March through July of 2000-2013	15
Figure 11. Maximum counts of harbor seal adults and immatures by region during the breeding season for the 2005-2013 regional surveys in central California.....	21
Figure 12. Maximum counts of harbor seal pups by region during the breeding season for the 2005-2013 regional surveys in Central California.	21
Figure 13. Maximum counts of all age classes of harbor seals by region during the molting season for the 2005-2013 regional surveys in central California.	22

Tables

	Page
Table 1. Categories used to record disturbance sources on field datasheets.	6
Table 2. Summary data of harbor seal colonies for the 2013 season.	8
Table 3. Date of first live pup observed in the season by location, 2000-2013.	10

Abstract

Pacific harbor seals (*Phoca vitulina richardsi*) are the most abundant and only year-round resident pinniped in the National Parks of the San Francisco Bay Area, California. Long-term monitoring studies at the largest harbor seal colonies in Point Reyes National Seashore have been conducted intermittently since the mid-1970s by various groups. Annual monitoring by National Park Service (NPS) staff, using peer-reviewed methods, began in 1996 with the current suite of monitoring sites adopted in 2000. The objectives of monitoring each site and the population as a whole are to: i) detect changes in population size, ii) detect changes in reproductive success as indicated by pup production, and iii) identify anthropogenic or environmental factors that may affect the condition of the population (Adams et al. 2009).

Harbor seal surveys were conducted throughout the 2013 breeding and molting seasons (March-May and June-July, respectively) once to twice per week at the largest Point Reyes National Seashore and Golden Gate National Recreation Area harbor seal colonies, collectively referred to as Marin County locations. Members of the Harbor Seal Monitoring Volunteer Program assisted NPS staff in completing 260 surveys at eight Marin County locations, contributing an estimated 470 hours of monitoring. During the breeding season, peak counts of 2,656 adult and immature seals and 1,380 seal pups were recorded at all Marin County monitoring locations. Drakes Estero Complex had the most adult and immature seals (691), followed by Double Point (569). Drakes Estero Complex and Double Point accounted for 55% (764) of pups at Marin County haul-outs. During the molting season, a peak count of 4,288 animals was recorded at Marin County locations. During surveys, 109 disturbances to seals were recorded. The most frequent causes were unknown source (28%), humans on foot (17%), and birds (17%). Twelve regional surveys were conducted throughout the breeding and molting seasons at locations in Sonoma, Marin and San Mateo counties, and San Francisco Bay. Of these areas, Marin County locations accounted for 61% of breeding season adult and immature animals (2,577 of 4,196), 76% of pups (1,383 of 1,816), and 65% of seals during the molting season (4,303 of 6,599).

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Finally, we are grateful for the generous contributions from the Point Reyes National Seashore Association and the San Francisco Bay Area Inventory and Monitoring Program.

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Introduction

The San Francisco Bay Area Inventory and Monitoring Network (SFAN) includes National Park Service (NPS) sites such as Golden Gate National Recreation Area (GOGA), John Muir National Historic Site, Pinnacles National Park, and Point Reyes National Seashore (PORE). SFAN has identified vital signs, indicators of ecosystem health, which represent a broad suite of ecological phenomena operating across multiple temporal and spatial scales. The intent is to monitor an integrated set of vital signs that meets the needs of current park management, as well as indicate environmental conditions over time. Pacific harbor seals (*Phoca vitulina richardsi*) represent a vital sign for SFAN because they are ecologically significant, have protected status through the Marine Mammal Protection Act (P.L. 92-522), and are of high interest to the public (Adams et al. 2006, Adams et al. 2009). Also, pinnipeds, including harbor seals, are good indicators of the potential effects of changes in climate such as sea level rise (Allen et al. 2011).

Harbor seals were also identified as a marine mammal species most likely to benefit from the establishment of marine protected areas (MPAs) in the north central California coast region under the Marine Life Protection Act (CDFG 2009). Five MPAs were designated within Point Reyes National Seashore as well as three special closure areas that may benefit harbor seals. The MPAs were implemented in 2010 by the California Department of Fish and Game¹ in cooperation with the NPS. Monitoring data collected on harbor seals under this program may contribute to the assessment of the MPAs' efficacy.

The information presented in this report is a summary of the harbor seal data collected at PORE and GOGA during the 2013 breeding and molting seasons, March-July. Summary data collected as part of a region-wide survey effort, including adjacent areas (San Francisco Bay, San Mateo County, and Sonoma County), where NPS surveys were conducted in conjunction with other agencies and organizations for 2013, are also presented. This report is not intended to analyze trends in the harbor seal data set, which are more appropriately investigated at long-term intervals (e.g., Sydeman and Allen 1999, Allen et al. 2004, and Becker et al. 2011).

Background

Pacific harbor seals are the most numerous and only year-round resident pinniped in the national parks of the San Francisco Bay Area, California. The population at PORE represents the largest concentration of harbor seals on the mainland of the State of California, and accounts for approximately 20% of the mainland pupping and molting population in the state (Lowry et al. 2005, Sydeman and Allen 1999). Much of the Point Reyes coastal zone remains relatively undeveloped and provides good marine and terrestrial habitat for seals to rest, molt, feed, and breed where human encroachment is minimal (Figure 1). The inaccessibility of much of the area has historically afforded some protection from human disruption during the seals' terrestrial resting and pupping periods; however, some pinniped populations in California are still recovering from a long period of

¹ Name changed to Department of Fish and Wildlife in early 2013.

exploitation that did not end until the passage of the Marine Mammal Protection Act in 1972 (Sydeman and Allen 1999). The NPS is charged with managing and minimizing disturbance to pinniped habitat and activities from the more than 2 million annual visitors at PORE and several million visitors at GOGA (NPS 2014). The NPS may implement visitor management actions to reduce disturbance to seals at colonies, if appropriate.



Figure 1. The remote beach of the Double Point harbor seal colony at Point Reyes National Seashore.

Objectives

Long-term monitoring studies of harbor seals have been conducted intermittently at the largest colonies in PORE since the 1970s (Chan 1979, Allen and Huber 1984, Allen et al. 1989, Sydeman and Allen 1999, Allen et al. 2004). Consistent annual monitoring has been conducted by NPS staff since 1996, using peer-reviewed methods, but not all of the current sites were surveyed until 2000. The objectives of monitoring each site and the population as a whole are to: i) detect changes in population size, ii) detect changes in reproductive success as indicated by pup production, and iii) identify anthropogenic or environmental factors including climate change that may affect the condition of the population. The monitoring objectives and protocol are described in detail in the San Francisco Bay Area Network Pinniped Monitoring Protocol (Adams et al. 2009).

Methods

Study Area

The study area extends from Tomales Point to San Francisco Bay (Figure 2). The Point Reyes peninsula extends from the mouth of Tomales Bay (Lat. 38° 30'N) south to Bolinas Lagoon (Lat. 37° 30'N). Point Bonita is located in the Marin Headlands, at the mouth of San Francisco Bay in GOGA. For this report, the Point Reyes sites and Point Bonita are collectively referred to as Marin County locations. PORE, GOGA, Gulf of the Farallones National Marine Sanctuary, the California Department of Parks and Recreation, and county parks share jurisdiction over segments of this coastline, but overall, NPS lands account for most of the shoreline.

The topographic diversity of this coastal zone provides a broad range of substrates for harbor seals to come ashore. These include tidal mud flats, offshore and onshore rocky tidal ledges, and sandy beaches. A “haul-out site” is defined as a terrestrial location where seals aggregate for periods of rest, birthing, and nursing of young (Harvey 1987, Thompson 1987). Each colony site, or location, is comprised of several “subsites”, or distinct areas of beach, rock outcrops, or sandbars where harbor seals haul out. Coastal embayment sites include Tomales Bay, Drakes Estero Complex, and Bolinas Lagoon. Coastal sites surveyed include Tomales Point, Point Reyes Headlands, Duxbury Reef, Double Point, and Point Bonita (Figure 2).

Sampling Design

The current distribution of the harbor seal breeding population allows surveyors to monitor all breeding sites in PORE and GOGA. Thus, spatial stratification or other sampling techniques were not needed to decide which haul-outs to include for monitoring. SFAN is reliant upon other monitoring, such as Gulf of the Farallones National Marine Sanctuary Beach Watch program or California Department of Fish and Wildlife aerial surveys, and reports from park visitors, including boaters, kayakers and the birding community, to locate new haul-outs in remote areas of the parks. Survey frequencies and timing capture the date of the first pup, the peak of the breeding and molting seasons, and have been shown to have sufficient ability to detect meaningful population changes over time (Adams et al. 2009). The main parameters monitored are reproductive success, population size, distribution, phenology, and disturbances (Adams et al. 2009). Not all seals will be onshore during the surveys; however, with standardized methods, the ground count surveys can be used as an index of abundance (Adams et al. 2009, Harvey and Goley 2011).

The sampling design enables the data to be integrated with other regional surveys, allowing for the results to be interpreted in a regional context. Annually, the NPS participates in regional harbor seal surveys during the breeding and molting seasons, with PORE coordinating the central California coast surveys. Regional survey sites include colonies in Sonoma County (Sea Ranch, South Sonoma sites, Fort Ross, Jenner, and Bodega Marine Reserve), San Francisco Bay (Castro Rocks, Alcatraz, Yerba Buena Island, Mowry Slough and Newark Slough), and San Mateo County (Fitzgerald Marine Reserve, Point San Pedro, Cowell Ranch Beach, Purisima Creek, Pescadero, Pebble Beach, and Bean Hollow; Figure 2). The Point San Pedro site in San Mateo County was not surveyed in 2013 due to restricted access. Surveys at Fort Ross began again in 2013 after not being conducted since 2006. A

monitoring program was created through the Fort Ross Conservancy and this will allow for more consistent monitoring and incorporation into the regional surveys.



Figure 2. Regional harbor seal survey sites in San Francisco Bay and Sonoma, Marin, and San Mateo counties, California. Map does not present all of the regional survey locations included in Sonoma County. TB = Tomales Bay, TP = Tomales Point, DE = Drakes Estero, PRH = Point Reyes Headlands, DP = Double Point, DR = Duxbury Reef, BL = Bolinas Lagoon, PB = Point Bonita, CR = Castro Rocks, AZ = Alcatraz Island, YBI = Yerba Buena Island, NS = Newark Slough, MS = Mowry Slough, FMR = Fitzgerald Marine Reserve. Geographic coordinates for each monitoring location are maintained by the National Park Service.

Surveys

Volunteer observers were trained to monitor harbor seals at designated sites within Point Reyes and at Point Bonita during two classroom and two field sessions in February and March 2013 (Figure 3). Many of the volunteers had been previously trained and returned to the 2013 season with several years of experience. New volunteers were required to be mentored by returning volunteers at a site one to three times before they conducted a survey on their own.



Figure 3. Volunteer training at Drakes Estero within Point Reyes National Seashore.

Harbor seal surveys were conducted throughout the breeding (March 1st through May 31st) and molting (June 1st through July 31st) seasons once to twice per week at each Marin County location. Surveys were conducted at medium to low tides (below 3 ft) during the day. Surveys were not conducted in heavy fog because of poor visibility or in the rain because harbor seals haul out in lower numbers in the rain (Jemison and Pendleton 2001).

For each subsite, the observer recorded the time, number of adult and immature seals, pups, dead pups, red-pelaged seals, and fresh shark-bitten seals. Red pelage is easily identified and results from the deposition of iron oxide precipitates on the hair shaft; it usually extends from the head down to the shoulder and is of interest due to its rarity outside of the San Francisco Bay Area (Allen et al.

1993). During the molting season (June-July) all animals were counted as adults or immature seals because of the difficulty in distinguishing large pups from immature seals.

Disturbances and potential disturbances were also recorded as they occurred. Disturbances included any events that caused the seals to lift their head (head alert), flush (move towards the water), or flush into water, while potential disturbances were defined as any anthropogenic event within a defined haul-out zone that had the potential to flush seals but was not noted to cause a disturbance. Observers recorded the time, source, and effect of each disturbance. The information on the effect included the reaction of the seals, the number of seals that reacted, and when and where they rehailed if they were flushed into the water. In some cases the disturbance was not directly observed, but surveyors recorded the number of animals affected with an unknown disturbance. Disturbances were recorded by fixed categories to assist with summary analyses (Table 1).

Generally, volunteers surveyed for approximately 2 hours from fixed observation points with all subsites counted approximately every 30 minutes for a total of four counts each survey. Seal counts at each subsite were recorded separately on pre-formatted datasheets and then summed for site totals every half hour. Tomales Point, Bolinas Lagoon, and Duxbury Reef often had only two counts each survey due to hiking/traveling time between subsites.

Table 1. Categories used to record disturbance sources on field datasheets.

Source	Examples
Aircraft	Airplane, Drone, Hang glider, Helicopter, Ultralight
Bird	Eagle, Gull, Raven, Turkey vulture
Dog	Dog, Dog barking
Humans on foot	Clam digger, Hiker, Horse rider, Kite flyer, Oyster worker, Researcher
Motor-boat	Motor-boat, Personal watercraft
Non Motor-boat	Canoe, Kayak, Sailboat, Wind surfer,
Other	Coyote, Other pinniped, Rock slide, etc.
Vehicle	Bus, Car, Motorcycle

On alternating weekends, regional surveys were conducted at all sites included in the regional counts (see Figure 2). Participants in the region-wide surveys included various organizations and volunteers. Regional counts could be conducted at any time between Thursday and Monday over the selected regional survey weekends.

All count and disturbance datasheets from Marin County locations were entered into a relational Microsoft Access database during the course of the field season. At the end of the season, the database records were error-checked against the paper datasheets for accuracy. The records were further reviewed to ensure that only accurate and complete count data were used for analysis. For example, incomplete counts or counts that may have been hampered by poor weather conditions were noted in the database as poor quality surveys and excluded from analysis.

Data Management and Analysis

Although harbor seal data were collected according to subsites within each monitoring location, subsite data are not reported or analyzed within this report. By summing the subsite counts for each

survey time interval, the maximum site total was identified for each survey and used for data summaries and analyses. During the breeding months of March, April, and May, the maximum total site count for each survey included the adult/immature and pup age categories. Only live pups were included in the maximum pup count.

The maximum number of seals counted at a site over the course of the entire season is often used for comparisons between years and sites. Because there is little movement of harbor seals between sites during both the pupping and molting seasons (Lowry et al. 2001, Nickel 2003), it was assumed that individual animals were not counted at more than one site. Additionally, only surveys that occurred during the expected range of the peak breeding season (mid-April through mid-May) were used to determine the maximum counts for adult/immature seals and pups at each site. The maximum total count for each year within the study area was determined by taking the sum of the maximum count at each location. The maximum total count was determined separately for the breeding and molting seasons. Maximum counts at each location may have occurred on separate days (Barlow 2002). When compiling count summaries from the harbor seal data, only records noted as high quality counts were included. During the regional survey weekends, it was not uncommon for a site to be surveyed more than once. In these cases, the survey with the greater seal count was used for any regional summaries. A regional population estimate was derived from applying a correction factor of 1.54, calculated in central and northern California to account for seals in the water during surveys during the molt season (Harvey and Goley 2011). The correction factor is not used to estimate the population of individual Marin County locations because there is not enough information to determine if the correction factor can be used at the individual site level.

The total maximum counts of breeding season adult and immature seals, live pups, and molting season harbor seals were averaged across survey years 2000 to 2012 and compared to the 2013 data. For comparisons of past regional surveys, complete data sets for the locations outside of Marin County are only available since 2005. Surveys at Bodega Marine Reserve (Sonoma County) were added in 2010, at Purisima Creek (San Mateo County) in 2012, and at Fort Ross (Sonoma County) in 2013.

When examining disturbance events, only actual disturbances, those that elicited a head-alert or flush reaction from the seals, were used for summary analysis. Disturbance tallies were based on disturbance sources rather than the number of subsites or seals affected. Disturbance rates were calculated from the number of disturbance events that occurred during the time period from the first observation to the end of the final observation period. Because the disturbance data were not analyzed for effects on the seal count data in this report, all actual disturbance data were used for analysis regardless of the quality of the associated seal count data. Potential disturbances (events that could potentially elicit a reaction from seals) were recorded by volunteers to quantify any given type of disturbance recurring at a particular site, but this information is not analyzed in this report. These data may be used to understand potential emerging disturbance issues at each location.

The harbor seal monitoring data may change over time as errors are discovered and fixed, and as data analysis procedures are corrected or improved. For this reason, summary data reported here for 2000 to 2012 may differ slightly from data summaries published in previous harbor seal reports.

Results

Overall

In 2013, 33 volunteers and two NPS staff members completed 260 surveys (228 high and 32 low quality) at Marin County locations between March 1st and July 31st, with an estimated 470 hours of monitoring. Each location had between 11 and 37 high quality surveys, which included 12 regional surveys. At Marin County locations, a maximum of 2,656 adults/immatures and 1,380 pups were observed during the breeding season (March-May) and 4,288 individuals were recorded during the molting season (June-July; Table 2).

Table 2. Summary data of harbor seal colonies for the 2013 season. All reported numbers reflect the maximum number seen during a single census.

Location	Max # adults in breeding season ¹	Max # live pups in breeding season	Max # seals in molting season ²	# Surveys ³	Max # reds ⁴	Max # shark bites ⁴	Max # dead pups ⁴
Bolinas Lagoon	365	232	480	31	14	1	2
Double Point	569	431	1012	35	11	2	10
Drakes Estero Complex	691	333	1122	29	10	0	8
Duxbury Reef	78	4	63	29	1	1	0
Point Reyes Headlands	98	43	429	11	1	0	0
Tomales Bay	390	153	281	32	9	1	1
Tomales Point	351	167	697	24	11	0	0
Point Bonita	114	17	204	37	9	6	0
TOTAL	2,656	1,380	4,288	228	66	11	21

¹ Adults and immatures during the peak of the breeding season, mid-April to mid-May.

² All age classes during the molting season, June - July.

³ Only surveys deemed as high quality

⁴ The maximum number observed March - July.

Adult and Pup Counts During the Breeding Season

Adults: The maximum count of adult and immature seals during the 2013 breeding season was 2,656 (Figure 4). Drakes Estero Complex had the most adults (691), followed by Double Point (569; Table 2).

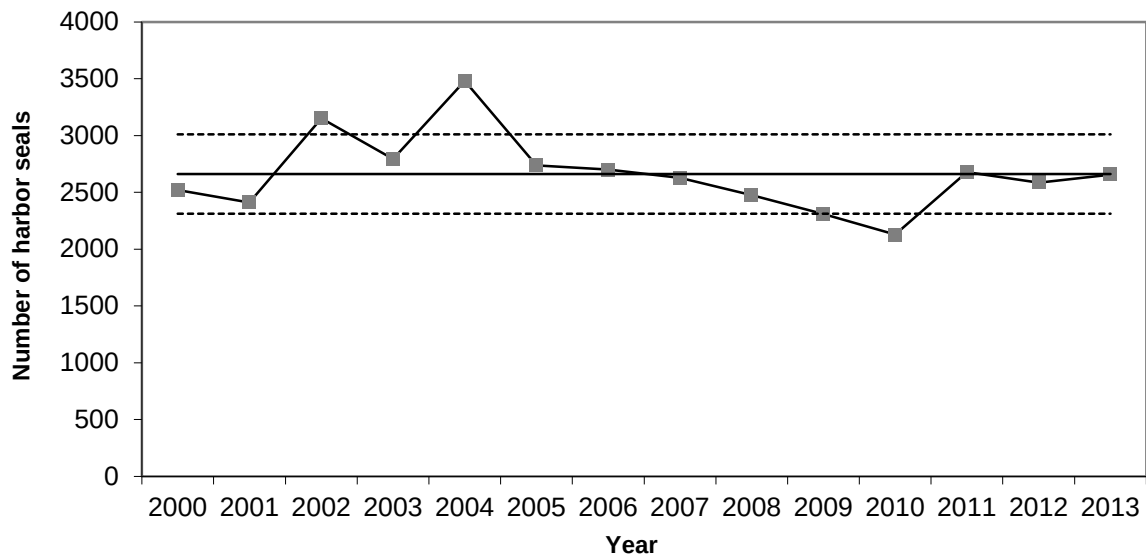


Figure 4. Maximum counts of harbor seal adults and immatures during the breeding season (March-May) for 2000-2013 at Marin County locations. The solid line on the graph represents the mean of the maximum adult counts from 2000-2012 (mean = 2,661) and the dashed lines represent one standard deviation from the mean (SD = 349.7).

Pups: The combined maximum pup count for all Marin County locations during the 2013 breeding season was 1,380 pups (Figure 5). Drakes Estero Complex and Double Point accounted for 55% (764) of pups at Marin County locations, which is consistent with the proportions of pups in the past.

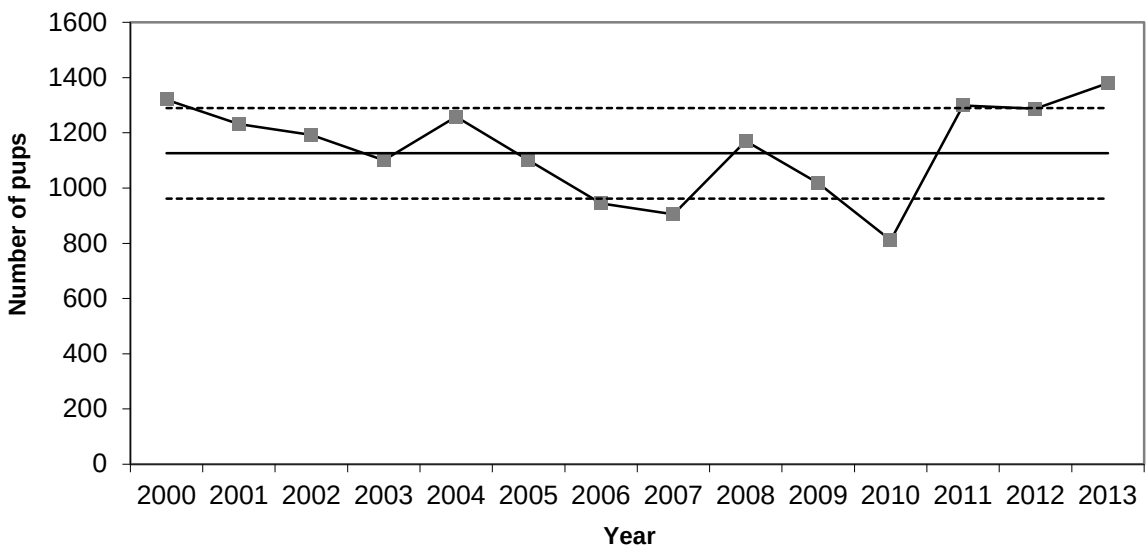


Figure 5. Maximum harbor seal pup counts for 2000-2013 at Marin County locations. The solid line on the graph represents the mean of the maximum pup counts from 2000-2012 (mean = 1,126), and the dashed lines represent one standard deviation from the mean (SD = 163.9).

The date of the first live pup observed has been documented since 2000, and there is no apparent trend in the date or location of the first pup observed from 2000 to 2013 (Table 3). The first reported viable pup of 2013 was seen on March 18 at Double Point.

Table 3. Date of first live pup observed in the season by location, 2000-2013.

Year	Date	Location
2000	March 14	Point Reyes Headlands
2001	March 16	Tomales Bay
2002	March 3	Drakes Estero
2003	March 27	Bolinas Lagoon
2004	March 20	Double Point
2005	March 6	Drakes Estero
2006	March 9	Double Point
2007	March 2	Double Point
2008	March 16	Bolinas Lagoon
2009	March 6	Tomales Bay
2010	March 18	Tomales Bay
2011	March 16	Drakes Estero
2012	March 19	Drakes Estero
2013	March 18	Double Point

The maximum pup numbers increased at three of the five primary pupping sites (Double Point, Tomales Bay, and Tomales Point) from 2012 to 2013 (Figure 6). Bolinas Lagoon and Drakes Estero Complex had decreases compared to 2012. Point Bonita, although not a primary pupping site, is noteworthy since pup counts have increased following restrictions to the site by GOGA in 2007 (Figure 7).

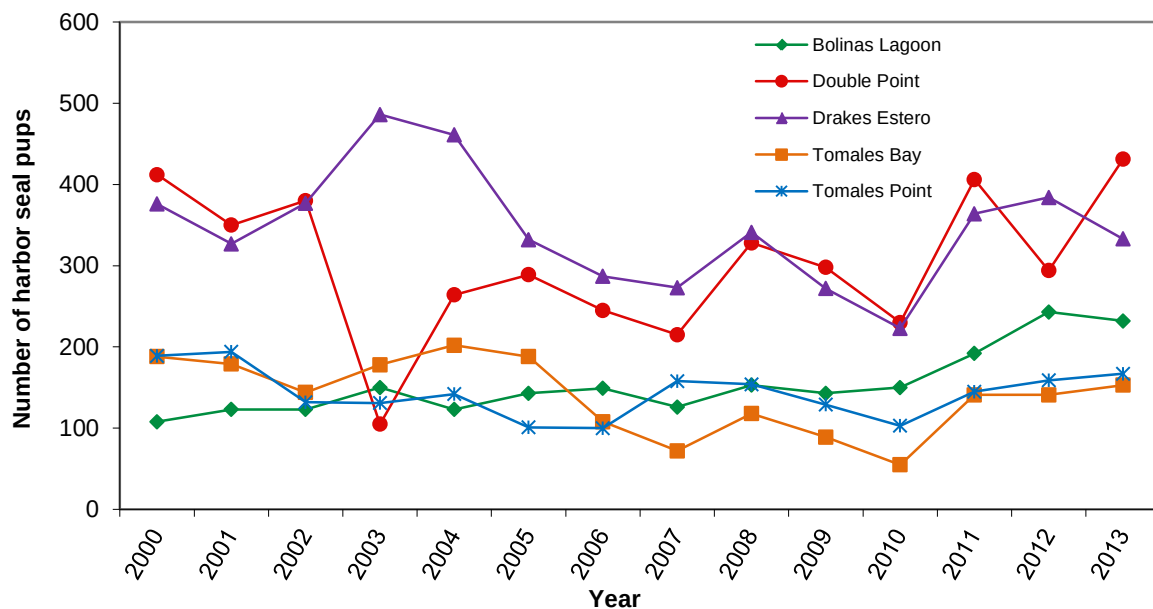


Figure 6. Maximum harbor seal pup counts at the dominant Marin County pupping locations during the breeding season (March – May), 2000-2013. The maximums of each site may have been observed on different days.

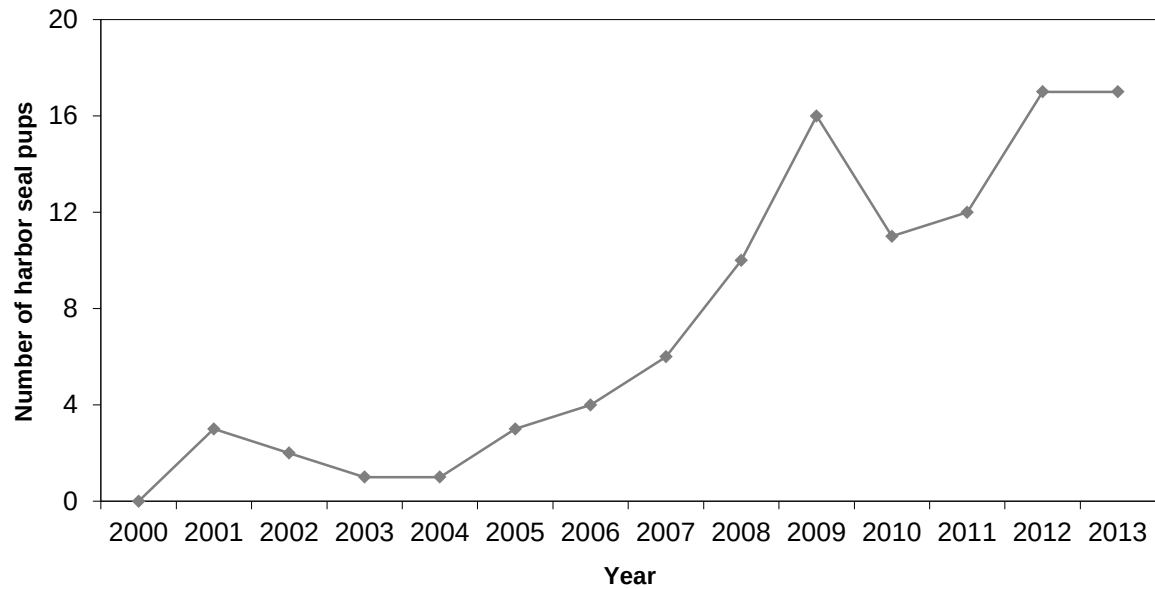


Figure 7. Maximum harbor seal pup counts at Point Bonita during the breeding season (March – May), 2000-2013.

Molt Counts

The maximum count of all seals during the 2013 molt season for all Marin County locations was 4,288 seals (Figure 8). Drakes Estero Complex and Double Point comprised 50% (2,134) of the total seals counted during the molt season (Table 2). This proportion is consistent with past years.

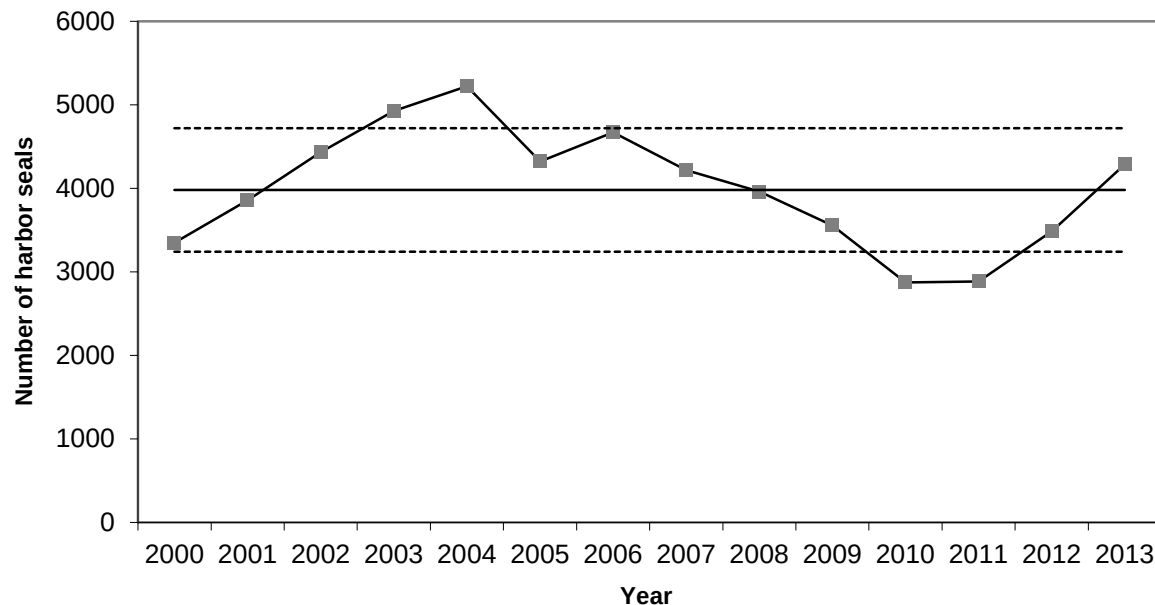


Figure 8. Maximum harbor seal counts during the molt season (June-July) for 2000-2013 at Marin County locations. The solid line on the graph represents the mean of the maximum molt counts from 2000-2012 (mean = 3,981) and the dashed lines represent one standard deviation from the mean (SD = 738.2).

Disturbances

At the Marin County locations in 2013, 109 disturbances were recorded that elicited a response from harbor seals (Table 4). The most common disturbance source was unknown (28%, Table 4). Humans on foot, birds, and motorboats were the next most common sources, each causing 17% of the disturbances. Aircraft accounted for 11% of the disturbance sources, which is a higher proportion than in most previous years. Double Point had the highest number of disturbances in 2013 with 32, followed by Tomales Bay (29) and Drakes Estero Complex (23). The disturbances at Double Point were primarily caused by unknown sources and birds. The majority of disturbances at Tomales Bay were caused by motorboats that are frequently seen in the area of the harbor seal haul-out site. Drakes Estero Complex disturbances were primarily caused by unknown sources.

Table 4. Identified sources of disturbances (head alert, flush, flush into water) for Marin County locations, from March through July, 2000-2013. The mean includes disturbance sources from 2000 – 2012.

Year	Aircraft		Bird		Dog		Human		Motorboat		Non-Motor Boat		Vehicle		Unknown		Other		Total
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
2000	14	11.3	19	15.3	0	0.0	23	18.5	14	11.3	9	7.3	0	0.0	43	34.7	2	1.6	124
2001	4	3.1	9	6.9	1	0.8	45	34.6	14	10.8	12	9.2	2	1.5	28	21.5	15	11.5	130
2002	9	5.7	11	7.0	0	0.0	48	30.6	19	12.1	15	9.6	9	5.7	39	24.8	7	4.5	157
2003	10	7.5	10	7.5	0	0.0	38	28.6	13	9.8	20	15.0	3	2.3	32	24.1	7	5.3	133
2004	2	2.2	7	7.5	1	1.1	35	37.6	2	2.2	9	9.7	7	7.5	23	24.7	7	7.5	93
2005	10	8.1	10	8.1	2	1.6	43	35.0	9	7.3	14	11.4	1	0.8	31	25.2	3	2.4	123
2006	8	5.1	13	8.3	1	0.6	57	36.3	14	8.9	16	10.2	5	3.2	35	22.3	8	5.1	157
2007	14	6.7	13	6.2	2	1.0	70	33.3	29	13.8	21	10.0	14	6.7	45	21.4	2	1.0	210
2008	4	3.7	5	4.6	0	0.0	51	47.2	11	10.2	10	9.3	5	4.6	18	16.7	4	3.7	108
2009	3	3.1	6	6.3	0	0.0	21	21.9	22	22.9	11	11.5	2	2.1	27	28.1	4	4.2	96
2010	5	4.4	5	4.4	2	1.8	35	30.7	27	23.7	5	4.4	3	2.6	30	26.3	2	1.8	114
2011	5	5.3	11	11.7	0	0.0	27	28.7	20	21.3	3	3.2	3	3.2	19	20.2	6	6.4	94
2012	3	2.9	15	14.4	0	0.0	28	26.9	16	15.4	4	3.8	2	1.9	29	27.9	7	6.7	104
2013	12	11.0	19	17.4	0	0.0	19	17.4	18	16.5	7	6.4	1	0.9	30	27.5	3	2.8	109
Mean	7.0	5.3	10.3	8.3	0.7	0.5	40.1	31.5	16.2	13.0	11.5	8.8	4.3	3.2	30.7	24.5	5.7	4.7	126

The rate of disturbances per hour in 2013 was highest at Tomales Bay (0.49 disturbances/hr), followed by Double Point (0.39 disturbances/hr) and the Drakes Estero Complex (0.35 disturbances/hr; Figure 9). Increases in disturbance rates compared to 2012 were seen at Bolinas Lagoon, Double Point, and Tomales Bay. Decreases in disturbance rates were seen at the Drakes Estero Complex, Point Bonita, and Tomales Point (Figure 10). The rates of disturbances vary from year to year depending on activities at each location, but trends have not been analyzed.

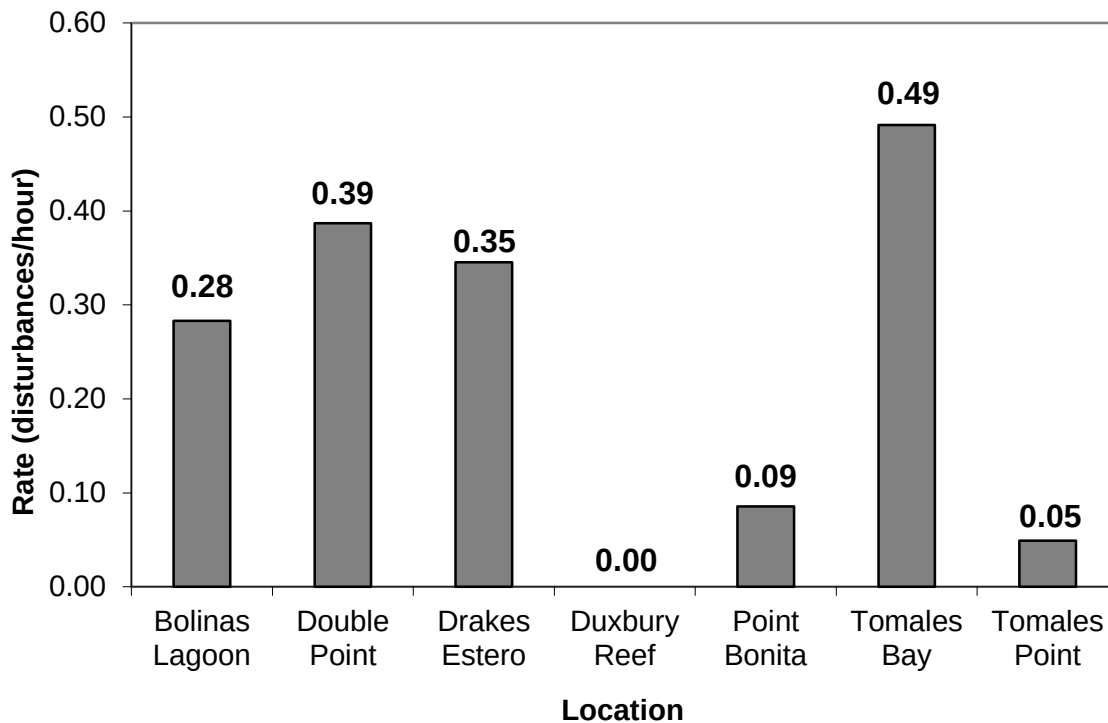


Figure 9. Rates of disturbances per hour at Marin County locations from March 1st through July 31st, 2013. Only actual disturbances (head alert, flush, flush water) were used and survey time was based on observation time for all complete surveys (with or without disturbances).

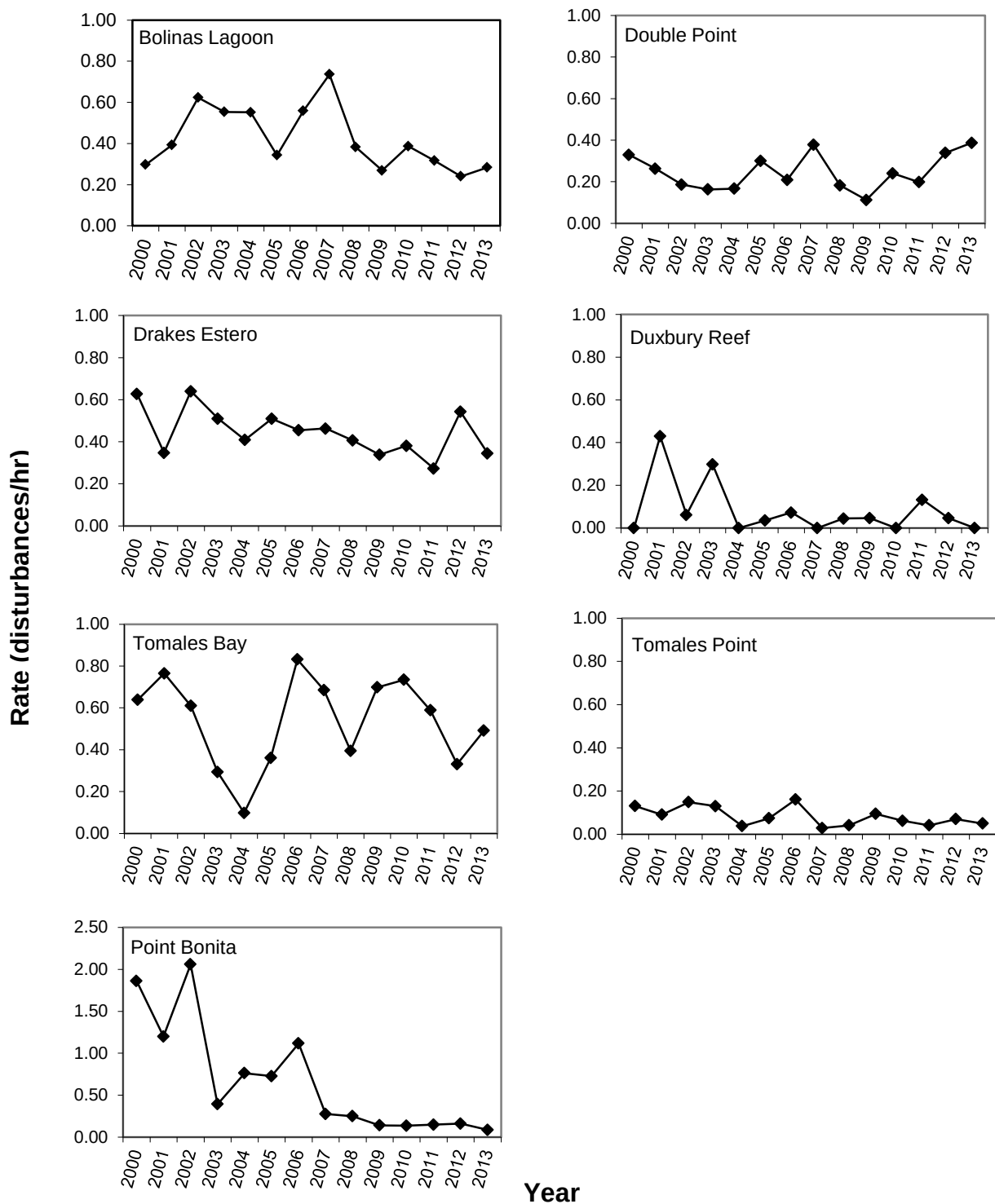


Figure 10. Rates of disturbances per hour at Marin County locations from March through July of 2000-2013. Only actual disturbances (head alert, flush, flush water) were used, and survey time was based on observation time for all complete surveys (with or without disturbances). Note change in rate scale for Point Bonita.

Summary by Site

Bolinas Lagoon

Observers completed 31 surveys at Bolinas Lagoon between March 1st and July 31st, 2013. The maximum count during the breeding season was 365 adults/immatures and 232 pups (Table 2). The maximum pup counts in 2012 and 2013 are the highest counts at this site in the past 14 years. The first viable pups were recorded on March 31st, when two pups were seen. During the molting season, the maximum count was 480 seals. The primary cause of disturbances at this site was humans on foot, which included visitors along Highway 1. The 2013 disturbance rate for Bolinas Lagoon had a small increase from 2012 (0.24 to 0.28 disturbances/hr; Figure 10).

Double Point

Observers completed 35 surveys at Double Point between March 1st and July 31st, 2013. The maximum count during the breeding season was 569 adults/immatures and 431 pups (Table 2). The 2013 pup count is the highest count recorded at this site in the past 14 years. The first viable pup of the season out of all the Marin County locations was recorded at Double Point on March 18th. The molting season yielded a maximum count of 1,012 seals. Disturbances to seals at Double Point were primarily caused by unknown sources and birds. Unknown disturbances may have been caused by small rockslides from the eroding cliffs above the beaches that observers could not see or hear. The disturbance rate in 2013 had a small increase from 2012 (0.34 to 0.39 disturbances/hr; Figure 10).

Drakes Estero Complex

Observers completed 29 surveys in the Drakes Estero Complex, which includes the Limantour Spit, between March 1st and July 31st, 2013. The maximum count during the breeding season was 691 adults/immatures and 333 pups (Table 2). The first viable pups were recorded on March 25th, with two pups seen. A stillbirth was witnessed by observers on April 22nd. The maximum molt count was 1,122, which is an increase compared to the previous four years. The majority of disturbances were caused by unknown sources and by hikers on Limantour and Drakes Beaches, each of which are easily accessible. The estuary is seasonally closed to kayaking from March through June during the critical pupping period and no kayaks were reported during this time. The disturbance rate decreased from 2012 (0.54 to 0.35 disturbances/hr; Figure 10).

Duxbury Reef

Observers completed 29 surveys at Duxbury Reef between March 1st and July 31st, 2013. During the breeding season, the maximum counts were 78 adults/immatures and 4 pups (Table 2). The first day a pup was recorded at this site was on April 9th. Few pups are seen here, and they possibly come from nearby Bolinas Lagoon. During the molting season the maximum seal count was 63. Duxbury Reef had the lowest number of seals and no disturbances recorded. Disturbances are rarely recorded at Duxbury Reef, possibly due to the poor accessibility for humans at this location.

Point Bonita

Observers completed 37 surveys at Point Bonita between March 1st and July 31st, 2013. During the breeding season, the maximum counts were 114 adults/immatures and 17 pups and the maximum molt count was 204 (Table 2). The first pup was recorded here on April 4th. The maximum pup count

at Point Bonita has been increasing over the past few years and this year's count, along with the count in 2012, is the highest thus far, though still a low number. This might be due to the decrease in disturbances caused by humans since the area below the paved walkway was closed to visitors in mid-June 2007. The disturbances at Point Bonita were caused by humans on foot, kayakers, and motorboats. The 2013 disturbance rate was a decrease from 2012 (0.16 and 0.09 disturbances/hr, respectively; Figure 10).

Point Reyes Headlands

Observers completed 11 surveys at Point Reyes Headlands between March 1st and July 31st, 2013. Surveys at this site were only conducted during regional survey periods. During the breeding season, the maximum adult/immature count was 98 and the maximum pup count was 43, while during the molting season the maximum seal count was 429 (Table 2). The estimated date of the first viable pups is not reliable because of the low number of surveys completed at this site. No disturbances were recorded in 2013. This site rarely has disturbances because of its remoteness and inaccessibility. Most of the harbor seals were seen at a large northern elephant seal colony pocket beach.

Tomales Bay

Observers completed 32 surveys at Tomales Bay between March 1st and July 31st, 2013. During the breeding season, the maximum adult/immature count was 390 and the maximum pup count was 153 (Table 2). The first pups at this site were recorded on April 12th, when six were seen. During the molting season, the maximum seal count was 281. The maximum molting counts at Tomales Bay have been consistently low the previous three years. The disturbances at Tomales Bay were primarily caused by motorboats traveling around the sandbars and people clamming near the seals, as the sandbars in Tomales Bay are a very popular spot for recreational clamming. The disturbance rate was the highest out of all the Marin County sites and increased from 2012 (0.33 to 0.49; Figure 10). At Hog Island, one of the subsites in Tomales Bay, seals have re-colonized the island after it was abandoned, most likely due to human disturbances, in the early 1990s. The NPS acquired the property in 1997 and enacted a partial closure to humans on the island, which included the harbor seal haul-out area. Since 2009, harbor seals have consistently hauled out at Hog Island and the numbers have been increasing every year.

Tomales Point

Observers completed 24 surveys at Tomales Point between March 1st and July 31st, 2013. During the breeding season, the maximum adult/immature count was 351 and the maximum pup count was 167 (Table 2). The first pup was recorded at this site on April 7th. The maximum seal count during the molting season was 697. This count is the highest count at Tomales Point in the past 14 years. Tomales Point experienced a small number of disturbances caused by aircraft and people fishing in the area. Due to its remoteness, the Tomales Point location is generally not frequented by visitors. However, due to the distance between the subsites, observers cannot stay in one location long enough to see if other disturbances occur.

Regional Sites

Twelve regional surveys occurred between March 1st and July 31st, 2013 at 22 different locations. Not all sites were surveyed on all scheduled days due to weather conditions or scheduling conflicts.

In 2013, there were multiple locations that had maximum counts in early March: Jenner, Bodega Marine Reserve, Alcatraz, Castro Rocks, Purisima Creek, and Pebble Beach. These counts were not included in determining the maximum breeding season count since they did not fall within the expected range of the peak breeding season (mid-April to mid-May). These early peaks most likely included seals that were still moving in and out of areas.

During the 2013 breeding season, a maximum of 4,196 adults and 1,816 pups were observed, although the maximum counts may have occurred on different days for each location (Table 5). During the molting season, the combined maximum count of all seals from each site was 6,599. Marin County locations accounted for 61% of the maximum adult and immature seal breeding count, 76% of the maximum pup count, and 65% of the maximum molt count. A population estimate for the regional population of harbor seals for the molt season was 10,162 based on a correction factor of 1.54 ($1.54 \times 6,599$; Harvey and Goley 2011).

Sonoma County

The addition of Fort Ross to the Sonoma County sites greatly increased the count numbers, as this site is comparable to the top two sites that make up Sonoma County. It would be misleading to compare the 2012 Sonoma County counts to those in 2013 with Fort Ross included. Thus, for this annual report the Fort Ross site will not be included when comparing to previous years. However, in future annual reports the Sonoma County baseline data will include Fort Ross since data will exist across multiple years. The data from Fort Ross will still be included in this annual report when maximum numbers are reported for 2013 only.

The 2013 maximum adult/immature and pup counts during the breeding season at Sonoma County sites were similar to the counts in 2012 (Figures 11 and 12). Among Sonoma County sites, Sonoma Coast had the high counts of adults/immatures and pups (Table 5). During the molting season, the maximum seal count increased from the count in 2012 (Figure 13) and Jenner had the highest count among the Sonoma County sites (Table 5).

Four disturbances occurred at Sonoma County sites during regional count surveys, three caused by visitors at Fort Ross and one caused by visitors at Jenner. At the Sonoma Coast sites, there were also two potential disturbances reported. The potential disturbances included fishermen and divers in known harbor seal haul-outs, however, when observers arrived there were no seals present and it was unknown if a disturbance occurred.

San Francisco Bay

The 2013 maximum adult/immature and pup counts during the breeding season at San Francisco Bay sites were similar to the counts in 2012 (Figures 11 and 12). Within the San Francisco Bay, the high count for adults and immatures occurred at Castro Rocks, whereas, the high count for pups occurred at both Mowry Slough and Castro Rocks (Table 5). The molt count for San Francisco Bay had an increase from the count in 2012; however, the magnitude of the increase is likely due to Mowry and Newark Sloughs not being surveyed during the molt in 2012 (Figure 13). When those two sites are removed from the 2013 count, an increase from 2012 is still observed. During the molting season, Castro Rocks had the high count of seals among San Francisco Bay sites (Table 5). In San Francisco

Bay, there was one disturbance at Castro Rocks caused by two motorboats and multiple disturbances by motorboats and helicopters at Alcatraz that resulted in head alerts.

San Mateo County

The 2013 maximum adult/immature count during the breeding season at San Mateo County sites declined from 2012, but part of that decrease is attributed to Point San Pedro not being surveyed in 2013 (Figure 11). The 2013 maximum pup count was similar to the count in 2012 (Figure 12). The lack of Point San Pedro surveys did not affect the pup count for San Mateo because that site is not a pupping site. During the molting season, the maximum seal count increased from the count in 2012 (Figure 13). In San Mateo County, the highest concentration of seals was at Fitzgerald Marine Reserve during both seasons (Table 5). Four disturbances were reported in San Mateo County: one disturbance caused by visitors at Pescadero and one at Fitzgerald Marine Reserve, one disturbance caused by fishermen at Purisima Creek, and one disturbance caused by an ultralight at Cowell Ranch.

Table 5. Regional surveys of harbor seal numbers in central California, March - July, 2013. Twelve surveys were scheduled on alternating weekends, seven during the breeding season and five during the molt. Values reported as number of surveys (N), mean, standard error (SE), and maximum (Max). ND = No data.

Location	Breeding Season					Molting Season			
	N	Adult Mean ¹	SE	Adult Max ²	Pup Max	N	Mean ³	SE	Max ³
Sonoma County									
Sonoma Coast	7	173.0	15.8	223	73	5	233.8	15.7	288
Fort Ross⁴	7	150.7	20.8	219	33	2	172.0	65.0	237
Jenner	7	200.1	7.0	212	19	5	226.0	39.3	339
Bodega Marine Reserve	6	44.5	7.4	55	14	4	117.0	10.5	138
Marin County									
Tomales Bay	7	309.0	30.59	390	153	5	244.0	18.8	281
Tomales Point	7	248.7	25.15	351	167	4	416.5	96.4	697
Point Reyes Headland⁴	5	53.0	13.18	98	43	5	277.6	56.9	429
Drakes Estero Complex	7	435.9	74.82	633	333	5	764.4	126.1	1122
Double Point	7	373.3	52.74	569	441	5	670.4	115.7	1012
Duxbury Reef	7	41.4	6.58	57	2	5	39.8	17.7	92
Bolinas Lagoon	7	265.4	36.11	365	232	5	343.0	44.0	466
Point Bonita	7	67.3	13.7	114	12	5	163.0	13.5	204
San Francisco Bay									
Alcatraz	7	1.1	0.70	2	0	4	0.5	0.3	1
Castro Rocks⁴	7	124.1	17.19	156	49	5	170.2	12.8	209
Yerba Buena Island	7	88.1	8.62	117	21	5	86.2	13.4	127
Newark Slough⁴	4	20.0	4.60	31	24	4	14.8	3.8	25
Mowry Slough⁴	4	71.5	20.29	123	51	4	86.5	16.5	116
San Mateo County									
Point San Pedro	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cowell Ranch	7	60.6	5.39	83	25	5	61.8	23.3	114
Purisima Creek	6	71.8	6.62	81	31	5	87.2	22.2	149
Pescadero	7	29.4	4.09	48	15	5	55.0	7.6	77
Pebble Beach	7	57.1	6.93	69	17	5	116.8	13.2	146
Fitzgerald Marine Reserve	7	130.4	20.89	200	61	5	269.6	21.6	330
ALL SITES				4,196	1,816				6,599

¹Adults and immatures during the breeding season, March - May.

²Adults and immatures during the peak of the breeding season, mid-April to mid-May.

³All age classes during the molting season, June - July.

⁴Includes surveys that occurred outside of regional weekend period.

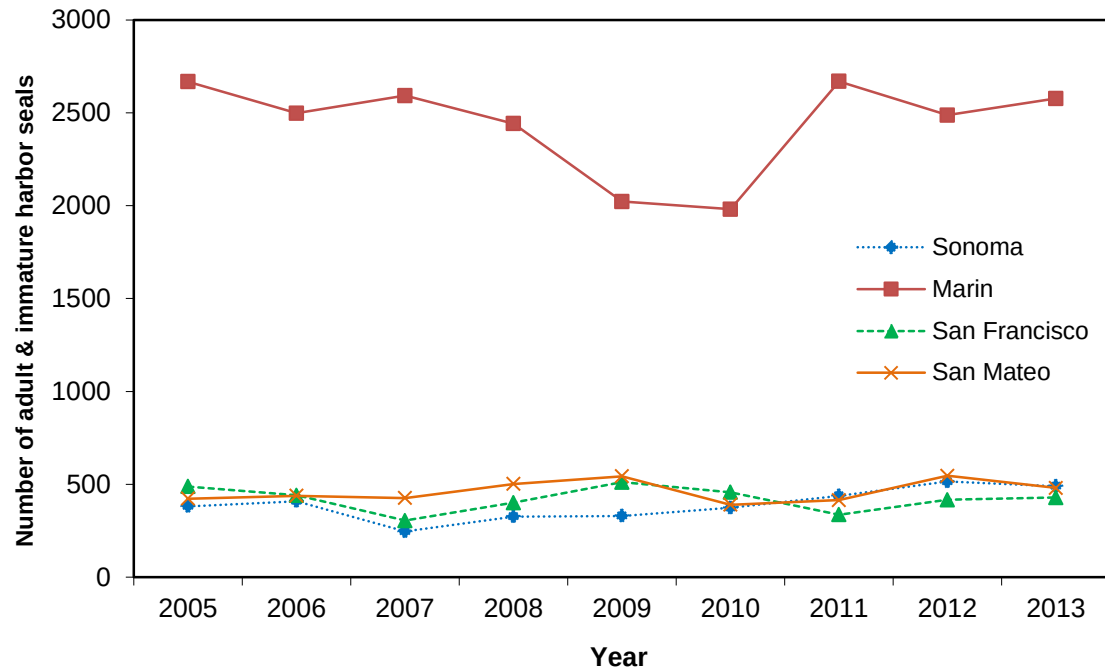


Figure 11. Maximum counts of harbor seal adults and immatures by region during the breeding season for the 2005-2013 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010 and Purisima Creek was added to San Mateo County in 2012. Fort Ross in Sonoma County is not included in this graph. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007.

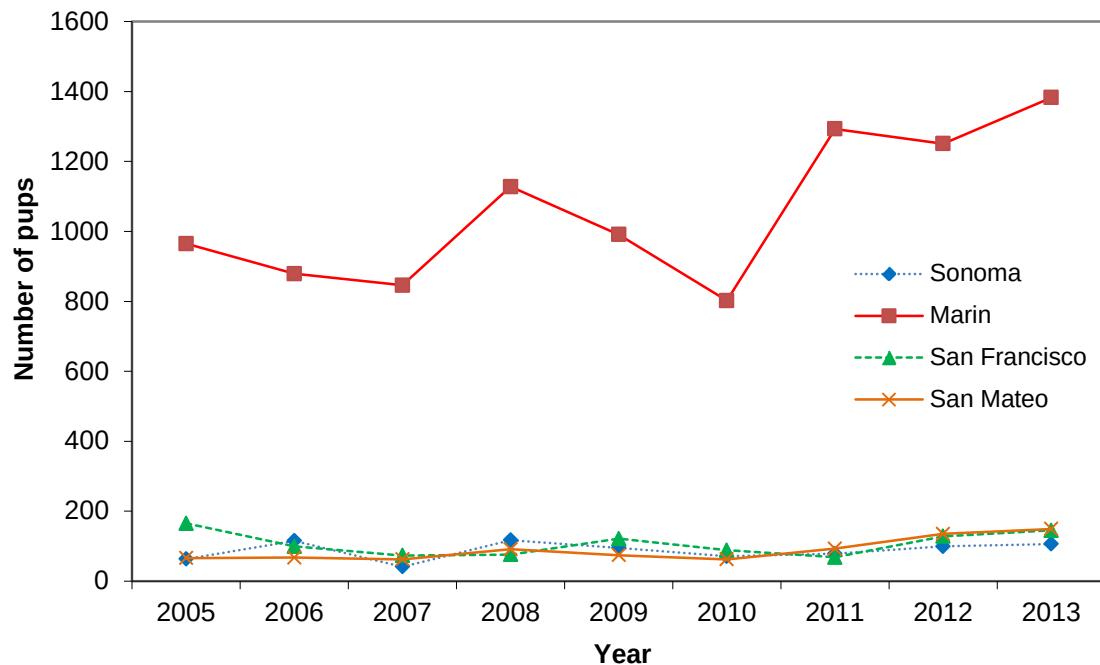


Figure 12. Maximum counts of harbor seal pups by region during the breeding season for the 2005-2013 regional surveys in Central California. Bodega Marine Reserve was added to Sonoma County in 2010 and Purisima Creek was added to San Mateo County in 2012. Fort Ross in Sonoma County is not included in this graph. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007.

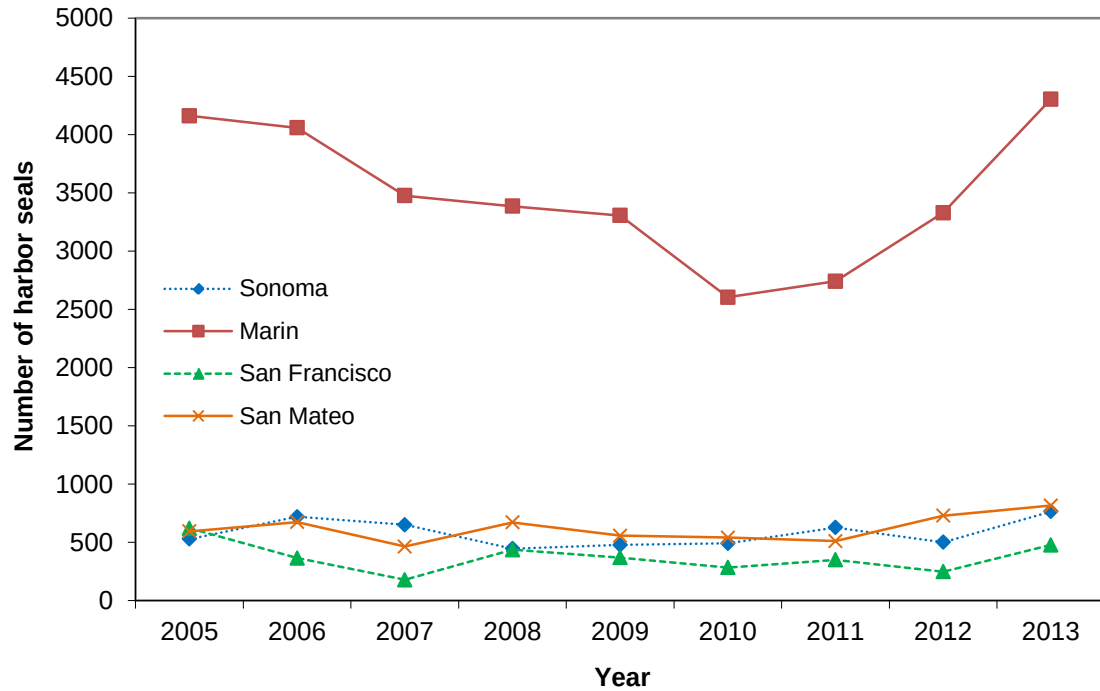


Figure 13. Maximum counts of all age classes of harbor seals by region during the molting season for the 2005-2013 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010 and Purisima Creek was added to San Mateo County in 2012. Fort Ross in Sonoma County is not included in this graph. Incomplete surveys occurred in San Mateo County in 2006 and 2013, San Francisco Bay in 2007 and 2012, and Marin County in 2010.

Discussion

Harbor seals are high trophic level predators in the marine ecosystem, and numerous dynamic processes have the potential to affect their abundance and distribution. Harbor seals are sensitive to changes in the marine ecosystem, especially El Niño events, and respond quickly to changes in prey abundance and distribution, and to human disturbance (Allen et al. 1985, Thompson and Miller 1990, Trillmich and Ono 1991, Thompson et al. 1998, Sydeman and Allen 1999). Information gained at Point Reyes National Seashore and Golden Gate National Recreation Area contributes to understanding how recovered populations may influence regional marine ecosystems. Studying trends and alterations in habitat also may provide insights into the potential or real effects of climate change on harbor seal distribution and abundance.

The 2013 maximum count of adult and immature seals in the breeding season was similar to the 13-year average; whereas, the maximum pup count of 2013 was one of the highest counts recorded. The maximum pup counts in the past three years have increased after a decrease in 2010. The maximum count during the molting season of 2013 was similar to the 13-year average and the highest count since 2007. The molting season numbers have been declining since 2005, but in 2012 and 2013 the counts increased. More robust analysis is required to determine if these differences are biologically or statistically significant.

From 2000 to 2013, Drakes Estero Complex and Double Point annually produced the highest numbers of harbor seal pups and together are the primary breeding and molting sites for harbor seals of Marin County. In 2013, these two sites combined produced 55% of the pups observed during the breeding season and 50% of the seals recorded during the molting season at Marin County sites.

The 2013 season had a low count of disturbances compared to the 13-year average. Throughout the study area from 2000-2013, the primary sites that experienced disturbances were Bolinas Lagoon, Double Point, Drakes Estero Complex, and Tomales Bay. In 2013, Tomales Bay had the highest disturbance rate recorded for the year, with the majority of disturbances caused by motorboats and clammers. In most years, the highest disturbance rate occurred at Tomales Bay as this is a popular recreational area for fishing, clamming, and kayakers. The most common source categories of disturbance for all Marin County locations in 2013 were unknown, humans on foot, birds, and motorboats. Birds are not a common disturbance source at most locations, but at Double Point birds were a primary source in 2013. The other sources (unknown, humans on foot, and motorboats) are consistently the major causes for disturbance at Marin County sites over the past decade.

Collaborations

NPS staff assisted with training of volunteers monitoring harbor seals for the Stewards of the Coast and Redwoods Seal Watch program. NPS staff continued to coordinate the central California coast regional surveys which include collaborations with multiple government agencies, universities, and non-profit groups including US Fish and Wildlife Service, Gulf of the Farallones National Marine Sanctuary, Moss Landing Marine Laboratories, University of California at Davis, Farallones National Marine Sanctuary Association, the Fort Ross Conservancy, and Stewards of the Coast and Redwoods Seal Watch program.

Season Highlights

- A maximum of 2,656 adult and immature seals were counted onshore during the breeding season.
 - The highest number of adults hauled out at Drakes Estero Complex (691), followed by Double Point (569).
- A maximum of 1,380 pups were observed at Marin County colonies.
 - This is one of the highest pup counts surveyed between 2000 and 2013.
 - The Drakes Estero Complex and Double Point accounted for 55% (764) of pups at Marin County colonies.
- A maximum of 4,288 animals were counted during the molting season at Marin County haul-out sites.
 - Drakes Estero Complex and Double Point accounted for 50% (2,134) of the total seals counted during the molt season.
- 109 disturbances were recorded during surveys.
 - The most frequent disturbance categories were unknown sources (28%), humans on foot (17%), birds (17%), and motorboats (17%).
 - The highest disturbance rate (0.49 disturbances/hour) occurred at Tomales Bay.
- Regional surveys occurred 12 times throughout the breeding and molt seasons (March-July), which include Sonoma, Marin, San Francisco, and San Mateo counties. Twenty-five volunteers participated in these surveys.
 - Marin County locations accounted for 61% of breeding season adult and immature seals, 76% of pups, and 65% of seals during the molting season.
- 33 volunteers and two NPS staff members completed 260 surveys at Marin County locations between March 1st and July 31st, 2013, contributing approximately 470 survey hours.

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