



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

2014 Annual Report

Natural Resource Report NPS/SFAN/NRR—2015/1082



ON THE COVER

Pacific harbor seals hauled out during the molt season at Double Point in Point Reyes National Seashore, California
Photograph by Sarah Codde

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Abstract

Pacific harbor seals (*Phoca vitulina richardii*) 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 2014 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 sites. Members of the Harbor Seal Monitoring Volunteer Program assisted NPS staff in completing 255 surveys at eight Marin County sites, contributing approximately 467 hours of monitoring. During the breeding season, a peak count of 3,205 adult and immature seals was recorded at all Marin County monitoring sites, which is higher than the 14-year average and the highest count since 2004. The Drakes Estero Complex had the most adult and immature seals (764), followed by Double Point (709). During the breeding season, 1,253 seal pups were recorded at all Marin County sites, which is similar to the 14-year average. The Drakes Estero Complex and Double Point accounted for 57% (714) of pups at Marin County haul-outs. During the molting season, a peak count of 4,237 animals was recorded at Marin County sites, which is similar to the 14-year average. During surveys, 125 disturbances to seals were recorded. The most frequent causes were unknown source (28%) and humans on foot (27%). Thirteen 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 sites accounted for 62% of breeding season adult and immature animals (3,083 of 4,958), 74% of pups (1,193 of 1,613), and 70% of seals during the molting season (4,251 of 6,085), all of which are similar proportions to past years.

Acknowledgments

Volunteers are the backbone of the harbor seal monitoring program. We thank all the volunteers who hiked many miles to survey harbor seals, including G. Blumenthal, D. Broderson, C. Cardosi, K. Carolan, R. Catlin, R. Chen, B. Felix, J. Ford, S. Ford, J. Forsell, A. Irish, K. Irsih, E. Kean, K. Khtikian, J. Khudyakov, J. Lamphier, E. Leite, W. Ludan, R. McLemore, A. Pincetich, C. Pincetich, H. Rederer, V. Rodriguez, C. Roundey, P. Sherry, B. Siegel, M. Smith, E. Sojourner, K. Soroca, J. Thompson, S. Van Der Wal, S. Waber, and E. Wright.

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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.

All monitoring activities were conducted under the National Marine Fisheries Service Permit 17152-00.

Introduction

The San Francisco Bay Area Network (SFAN) Inventory and Monitoring Program 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 condition, 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 richardii*) 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 PORE as well as three special closure areas that while primarily designed to protect marine birds, may also benefit harbor seals. The MPAs were implemented in 2010 by the California Department of Fish and Wildlife¹ 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 2014 breeding and molting seasons, March-July. SFAN surveys were also conducted in conjunction with other agencies and organizations in adjacent areas (San Francisco Bay, San Mateo County, and Sonoma County). Data collected as part of these region-wide surveys are presented within this report. 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 from California Department of Fish and Game in 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 15 million annual 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:

- detect changes in population size
- detect changes in reproductive success as indicated by pup production
- identify sources, frequency and level of effects of natural and anthropogenic disturbances on harbor seal haul out use and productivity

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 core study area extends from Tomales Point to and including San Francisco Bay (SFB; 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 SFB in GOGA. 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). For this report, the Point Reyes peninsula haul-out sites and Point Bonita haul-out site are collectively referred to as Marin County sites. PORE, GOGA, Greater Farallones National Marine Sanctuary², 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. Regional surveys of seals extend from the Sonoma County coastline at 38°44'29" N latitude south to the San Mateo County coastline at 37°31'58" N latitude, and including several sites within SFB. Numerous haul-out sites are distributed along this wider stretch of shoreline north and south of the core study area (see more below in Sampling Design; Figure 2).

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, islets, and sandy beaches. 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). Each colony site is comprised of several “subsites”, or distinct areas of beach, rock outcrops, or sandbars where harbor seals haul out. More details on subsite distribution within each site can be found in SOP 1 of the San Francisco Bay Area Network Pinniped Monitoring Protocol (Adams et al. 2009).

² Name changed from the Gulf of the Farallones National Marine Sanctuary in 2015.



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.

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 also reliant upon other monitoring, such as the Greater Farallones National Marine Sanctuary Beach Watch program (http://www.farallones.org/volunteer/beach_watch.php) or National Marine Fisheries Service (NMFS) stock assessments (<http://www.nmfs.noaa.gov/pr/pdfs/sars/po2011sehr-ca.pdf>) that include 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 provide 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 SFAN 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), SFB (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, and Pebble Beach; Figure 2). Jenner in Sonoma County was not surveyed during the 2014 molting season. Surveys at Fort Ross began again in 2013 after not being conducted since 2006.

Surveys

Volunteer observers were trained to monitor harbor seals at designated sites within PORE and GOGA during two classroom and one field session in February and March 2014 (Figure 3). Many of the volunteers had been previously trained and returned to the 2014 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.

Harbor seal surveys were conducted throughout the breeding (March 1st through May 31st) and molting (June 1st through August 2nd) 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 SFB (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.



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

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 cause seals to react 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 source. 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, Fisher, 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.

Data Management and Analysis

All count and disturbance datasheets from Marin County sites 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. All records were 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 population count analysis. Collection of disturbance data, though, was not affected by weather conditions or surveying all sites, and was summarized regardless of the quality of associated seal count data (see also Becker et al. 2011). Nevertheless, high and poor quality count data were retained in the database.

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. Live and dead 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 higher seal count was used for any regional summaries. A regional population estimate was derived from applying a correction factor of 1.54 (95% CI = 1.16–1.92), calculated in central and northern California to account for seals in the water during the molt season surveys (Harvey and Goley 2011). The correction factor is not used to estimate the population of individual Marin County sites because there is not enough information to determine if the correction factor can be used at an individual site level.

The total maximum counts of breeding season adult and immature seals, pups, and molting season harbor seals were averaged across survey years 2000 to 2013 and compared to the 2014 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 2013 may differ slightly from data summaries published in previous harbor seal reports.

Results

Overall

In 2014, 36 volunteers and two NPS staff members completed 255 surveys at Marin County sites between March 1st and August 2nd, with approximately 467 hours of monitoring. Each location had between 27 and 33 high quality surveys, except for Point Reyes Headlands, which is on the regional survey schedule and only had 13 surveys. At Marin County sites, a maximum of 3,205 adults/immatures and 1,253 pups were observed during the breeding season (March-May) and 4,237 individuals were recorded during the molting season (June-July; Table 2).

Table 2. Summary data of harbor seal colonies for the 2014 season. All reported numbers reflect the maximum number seen during a single census.

Location	Max # adults in breeding season ¹	Max # 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	402	218	645	33	16	1	1
Double Point	709	369	881	33	11	2	2
Drakes Estero Complex	764	345	927	32	15	2	1
Duxbury Reef	89	6	67	30	1	0	0
Point Reyes Headlands	168	52	494	13	0	0	0
Tomales Bay	579	153	376	28	20	1	1
Tomales Point	363	102	583	27	5	2	1
Point Bonita	131	8	264	32	10	5	0
TOTAL	3,205	1,253	4,237	228	78	13	6

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

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

³ Only surveys deemed as high quality (see methods)

⁴ The maximum number observed during a single census in March - July.

Adult and Pup Counts During the Breeding Season

Adults: The maximum count of adult and immature seals during the 2014 breeding season was 3,205 and was higher than the normal range of variation [1standard deviation (SD)] for the past 14 years (Figure 4). Drakes Estero Complex had the most adults (764), followed by Double Point (709; Table 2).

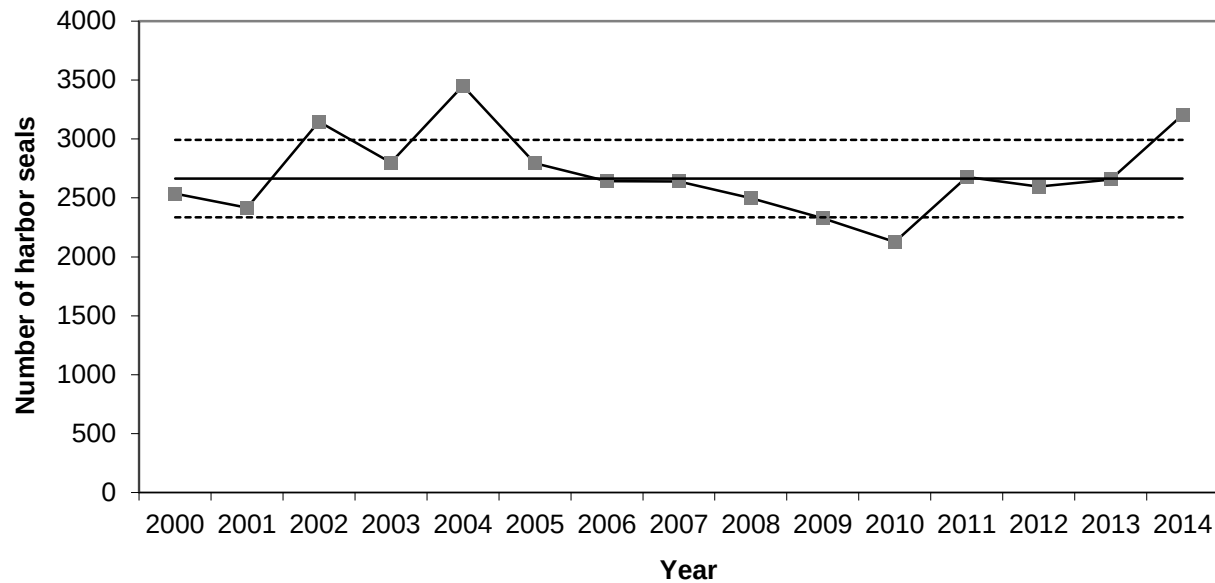


Figure 4. Maximum counts of harbor seal adults and immatures during the breeding season (March-May) for 2000-2014 at Marin County sites. The solid line on the graph represents the mean of the maximum adult counts from 2000-2013 (mean = 2,664) and the dashed lines represent one standard deviation from the mean (SD = 328.2).

Pups: The combined maximum pup count for all Marin County sites during the 2014 breeding season was 1,253 pups and fell within the normal range of variation (1 SD) for the past 14 years (Figure 5). Drakes Estero Complex and Double Point accounted for 57% (714) of pups at Marin County sites, which is consistent with the proportions of pups in the past.

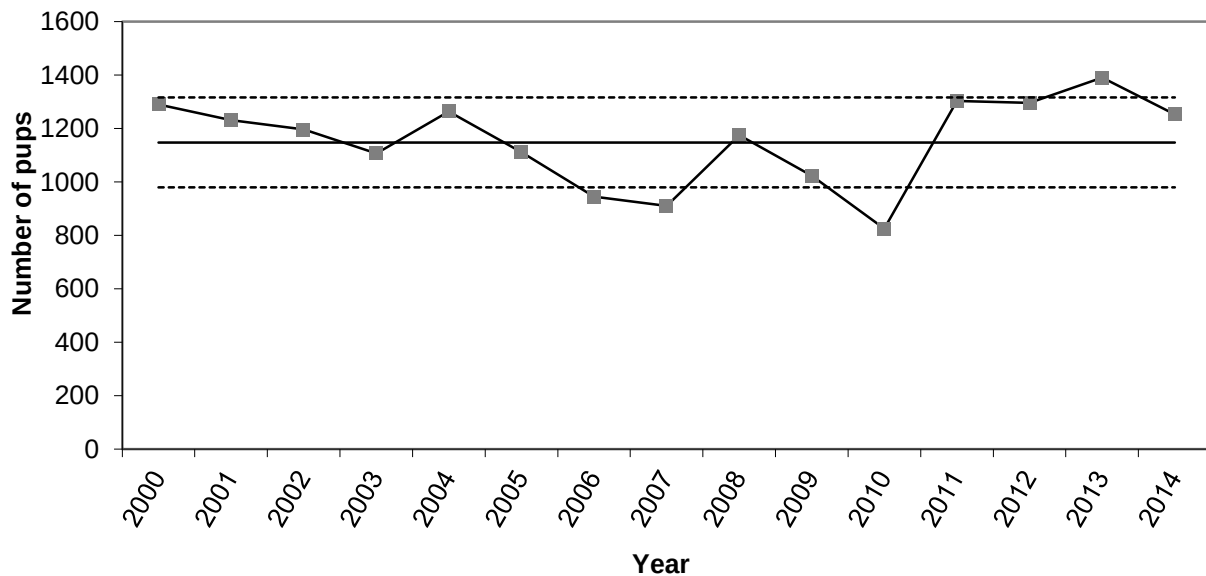


Figure 5. Maximum harbor seal pup counts for 2000-2014 at Marin County sites. The solid line on the graph represents the mean of the maximum pup counts from 2000-2013 (mean = 1,148), and the dashed lines represent one standard deviation from the mean (SD = 168.4).

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 2014 (Table 3). The first reported viable pup of 2014 was seen on March 14 at Double Point.

Table 3. Date of first live pup observed in the season by location, 2000-2014.

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
2014	March 14	Double Point

The maximum pup numbers decreased at three of the five primary pupping sites (Bolinas Lagoon, Double Point, and Tomales Point) from 2013 to 2014 (Figure 6). The Drakes Estero Complex pup numbers had a small increase compared to 2013 and Tomales Bay numbers remained the same. 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). However, in 2014 there was a large decrease in the pup count at this site and the lowest count since 2007.

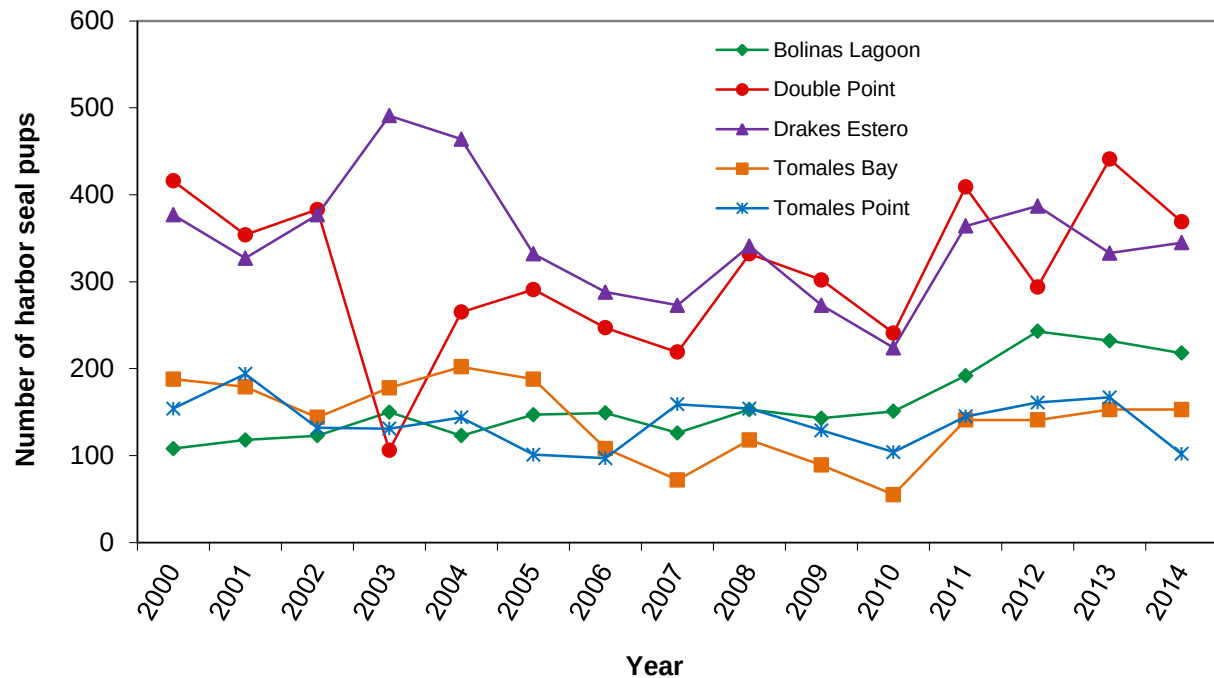


Figure 6. Maximum harbor seal pup counts at the dominant Marin County pupping locations during the breeding season (March – May), 2000-2014. The maximum counts of each site may have been observed on different days.

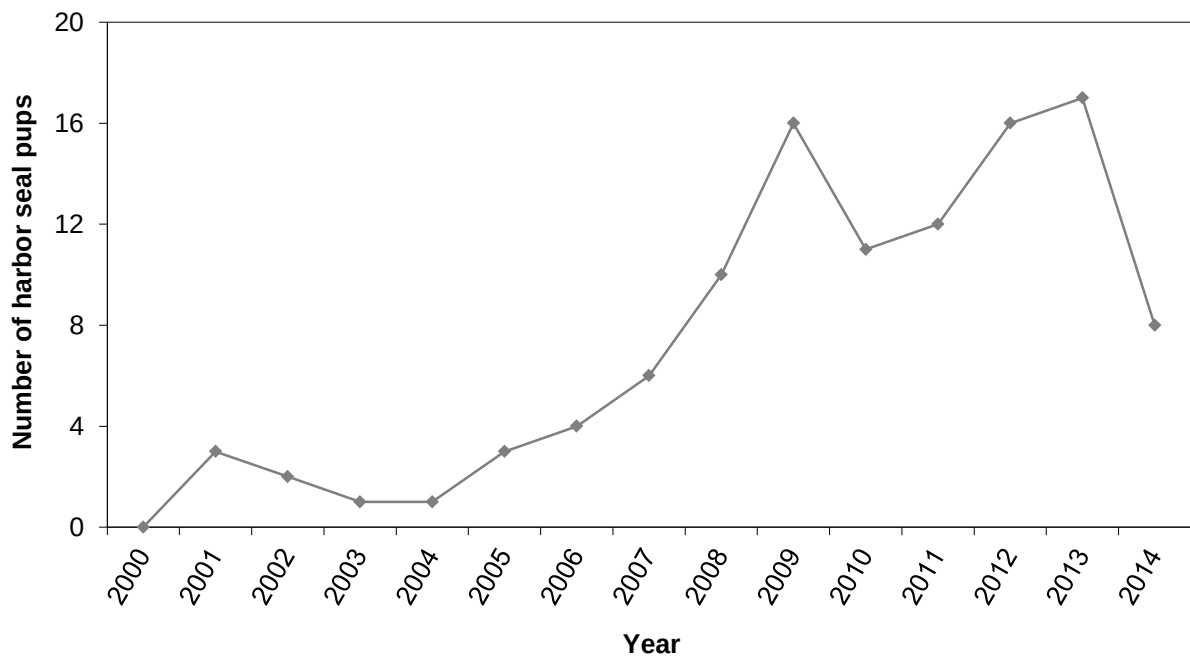


Figure 7. Maximum harbor seal pup counts at Point Bonita during the breeding season (March – May), 2000-2014.

Molt Counts

The maximum count of all seals during the 2014 molt season for all Marin County sites was 4,237 seals and similar to the 14-year average (Figure 8). Drakes Estero Complex and Double Point comprised 43% (1,808) of the total seals counted during the molt season (Table 2). This proportion is consistent with past years.

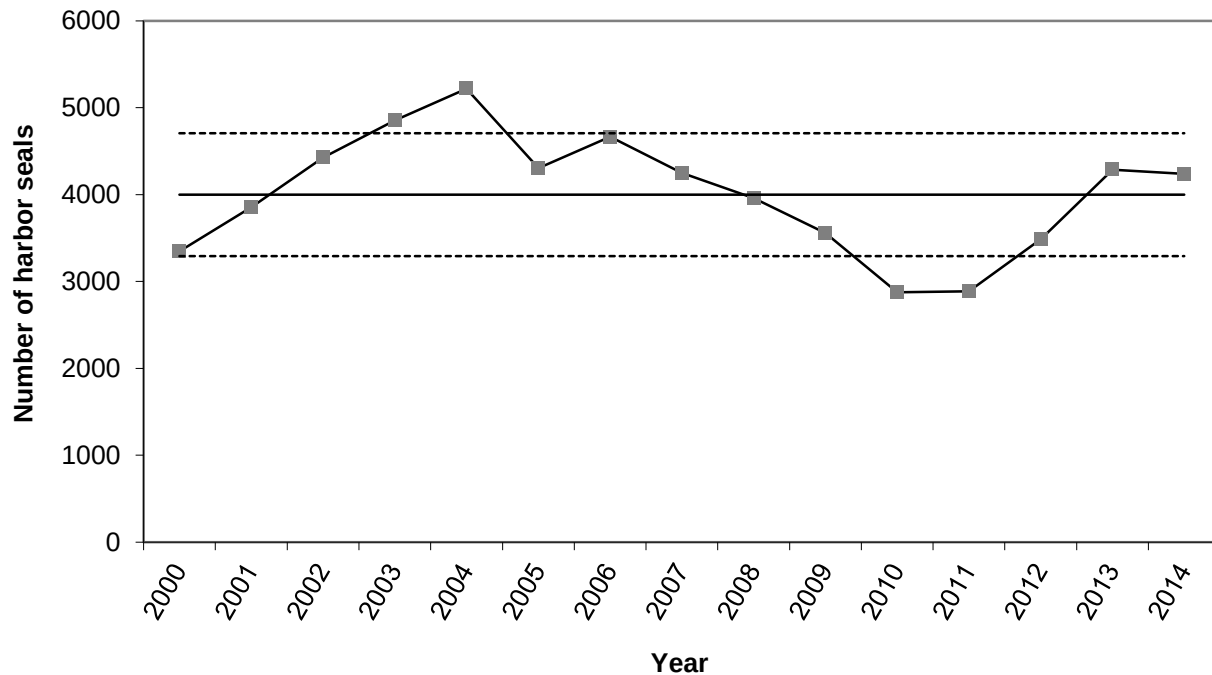


Figure 8. Maximum harbor seal counts during the molt season (June-July) for 2000-2014 at Marin County sites. The solid line on the graph represents the mean of the maximum molt counts from 2000-2013 (mean = 3,999) and the dashed lines represent one standard deviation from the mean (SD = 706.9).

Disturbances

At the Marin County sites in 2014, 125 disturbances were recorded that elicited a response from harbor seals (Table 4). The most common disturbance sources were unknown (28%) and humans on foot (27%, Table 4). Disturbances caused by unknown sources occurred at each site, but primarily at Bolinas Lagoon, Drakes Estero Complex, and Double Point. Humans on foot disturbed seals at Bolinas Lagoon, Drakes Estero Complex, and Tomales Bay where some seal haul-out sites are located on or near beaches accessible to humans.

Table 4. Identified sources of disturbances (head alert, flush, flush into water) for Marin County sites, from March through July, 2000-2014. The mean includes disturbance sources from 2000 – 2013.

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
2014	10	8.0	13	10.4	0	0.0	34	27.2	16	12.8	11	8.8	2	1.6	35	28.0	4	3.2	125
2000-2013																			
Mean	7.4	5.7	10.9	9.0	0.6	0.5	38.6	30.5	16.3	13.3	11.1	8.6	4.1	3.1	30.6	24.7	5.5	4.6	125

The rate of disturbances per hour in 2014 was highest at Tomales Bay (0.62 disturbances/hr), followed by the Drakes Estero Complex (0.46 disturbances/hr) and Bolinas Lagoon (0.39 disturbances/hr; Figure 9). Increases in disturbance rates compared to 2013 were seen at Bolinas Lagoon, the Drakes Estero Complex, Point Bonita, and Tomales Bay. Decreases in disturbance rates were seen at Double Point 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.

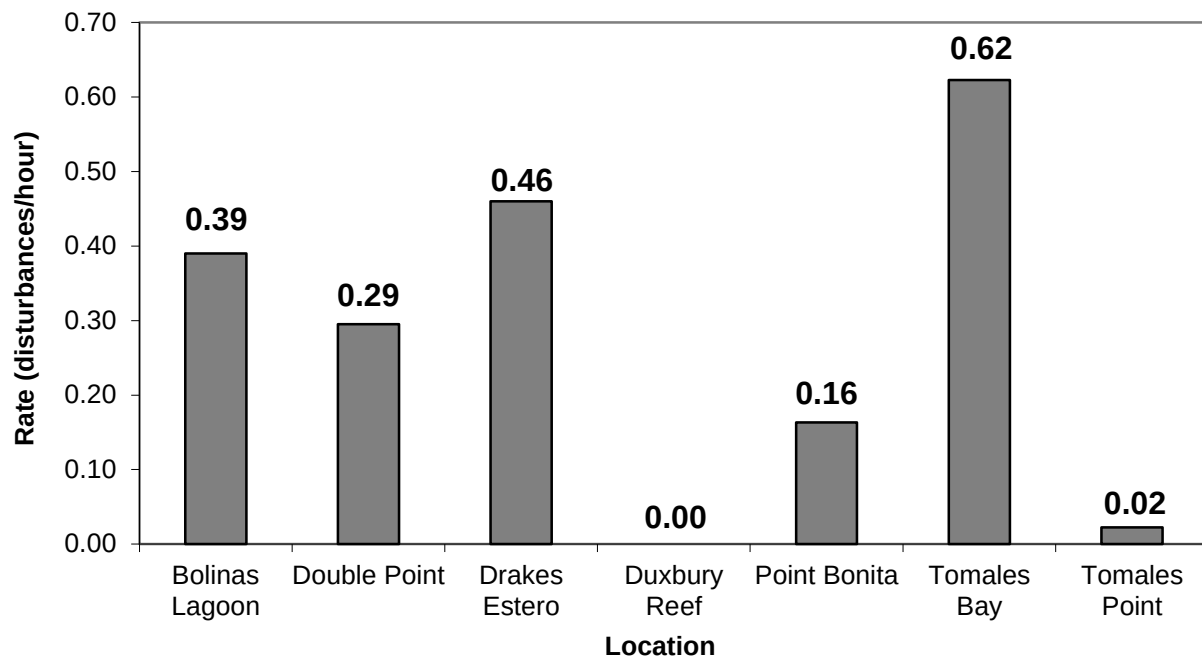


Figure 9. Rates of disturbances per hour at Marin County sites from March 1st through August 2nd, 2014. Only actual disturbances (head alert, flush, flush water) were used and survey time was based on observation time for all complete surveys (with or without disturbances).

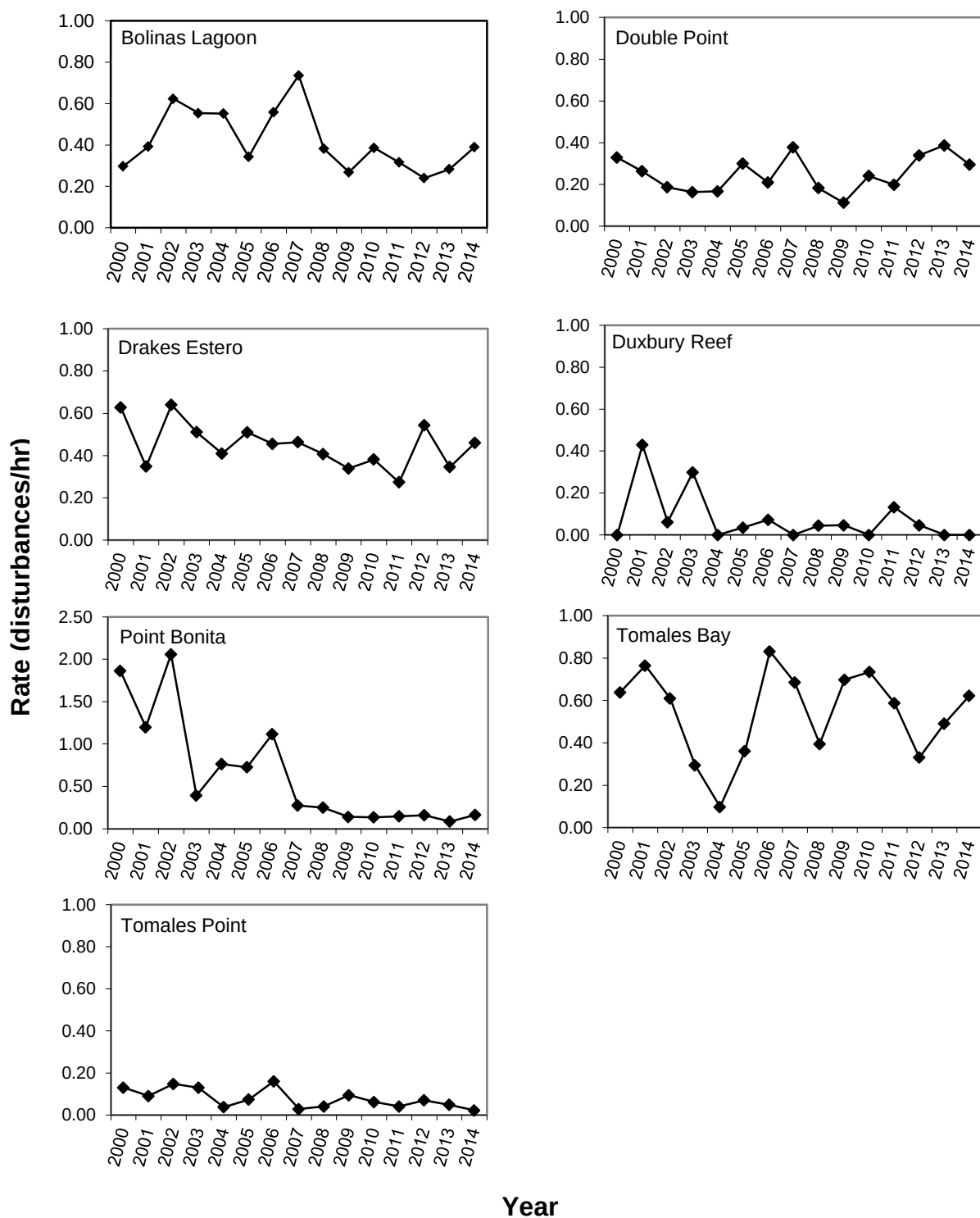


Figure 10. Rates of disturbances per hour at Marin County sites from March through July of 2000-2014. Only actual disturbances (head alert, flush, flush water) were used, and survey time was based on observation time for all complete surveys (with or without disturbances). Note different rate scale for Point Bonita.

Summaries by Site

Bolinas Lagoon

Observers completed 33 high quality surveys at Bolinas Lagoon between March 1st and August 2nd, 2014. The maximum counts during the breeding season were 402 adults/immatures and 218 pups (Table 2). The maximum adult/immature count in 2014 is the highest count at this site in the past 15 years. The 2014 maximum pup count is lower than the record high counts in 2012 and 2013, but still higher than the site's 14-year average of 158 pups. The first viable pup was recorded on March 25th. During the molting season, the maximum count was 645 seals. This peak molt count is the highest count recorded in the past 15 years at this site and a large increase over the 14-year average of 461 seals. The primary causes of disturbances at this site were unknown sources and humans on foot, which included visitors along Highway 1. The 2014 disturbance rate for Bolinas Lagoon increased from 2013 (0.28 to 0.39 disturbances/hr; Figure 10).

Double Point

Observers completed 33 high quality surveys at Double Point between March 1st and August 2nd, 2014. The maximum counts during the breeding season were 709 adults/immatures and 369 pups (Table 2). The 2014 adult/immature count is the second highest count recorded in the past 15 years at this site. The first viable pup of the season out of all the Marin County sites was recorded at Double Point on March 14th. The molt season yielded a maximum count of 881 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 2014 decreased from 2013 (0.39 to 0.29 disturbances/hr; Figure 10).

Drakes Estero Complex

Observers completed 32 high quality surveys in the Drakes Estero Complex, which includes Limantour Spit, between March 1st and August 2nd, 2014. The maximum counts during the breeding season were 764 adults/immatures and 345 pups (Table 2). These maximum counts are similar to their respective 14-year averages. The first viable pup was recorded on March 24th. The maximum molt count was 927 seals, which is an increase compared to the previous four years. The majority of disturbances were caused by hikers on Limantour and Drakes Beaches, each of which are easily accessible, and by unknown sources. In 2014, a new seasonal closure was enacted at Limantour Spit prohibiting human access during the breeding season, although hikers were still seen in the closure area. 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 increased from 2013 (0.35 to 0.46 disturbances/hr; Figure 10).

Duxbury Reef

Observers completed 30 high quality surveys at Duxbury Reef between March 1st and August 2nd, 2014. During the breeding season, the maximum counts were 89 adults/immatures and 6 pups (Table 2). The first day a pup was recorded at this site was on April 22nd. Few pups are seen here, and they possibly come from nearby Bolinas Lagoon. During the molt season the maximum seal count was 67.

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 32 high quality surveys at Point Bonita between March 1st and August 2nd, 2014. During the breeding season, the maximum counts were 131 adults/immatures and 8 pups and the maximum molt count was 264 seals (Table 2). The first pups were recorded here on April 6th, with 2 pups observed. While Point Bonita is not a primary pupping site, the pup numbers have been increasing since 2008. However, the 2014 maximum pup count is the lowest count since 2007. The maximum molt count was the highest count recorded at this site in the past 15 years. The disturbances at Point Bonita were caused by aircraft, unknown sources, and motorboats. The 2014 disturbance rate had a large increase from 2013 (0.09 to 0.16 disturbances/hr; Figure 10). Although, the number of disturbances that occurred during 2014 is lower than most of the other monitoring sites.

Point Reyes Headlands

Observers completed 13 high quality surveys at Point Reyes Headlands between March 1st and August 2nd, 2014. Surveys at this site were only conducted during regional survey periods. During the breeding season, the maximum adult/immature count was 168 and the maximum pup count was 52, while during the molting season the maximum seal count was 494 (Table 2). The maximum breeding season adult/immature count and molt count were the largest counts recorded at this site in the past 15 years. The estimated date of the first viable pup is not reliable because of the low number of surveys completed at this site. No disturbances were recorded in 2014. This site rarely has human 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 28 high quality surveys at Tomales Bay between March 1st and August 2nd, 2014. During the breeding season, the maximum adult/immature count was 579 and the maximum pup count was 153 (Table 2). The adult/immature count is the largest count recorded at this site in the past 15 years. However, the pup count is similar to the 14-year average of 141 pups at this site. The first pup at this site was recorded on April 5th. During the molting season, the maximum seal count was 376. While the maximum molt count is below the 14-year average of 407 seals, it is a large increase from the counts of the past 4 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 2013 (0.49 to 0.62; Figure 10).

Tomales Point

Observers completed 27 high quality surveys at Tomales Point between March 1st and August 2nd, 2014. During the breeding season, the maximum adult/immature count was 363 and the maximum pup count was 102 (Table 2). The maximum pup count is the third lowest count recorded at this site in the past 15 years. The first pup was recorded at this site on April 4th. The maximum seal count during the molting season was 583, which is greater than the 14-year average of 480 seals. Tomales

Point experienced only two disturbances: one caused by hikers on the beach and another from an unknown source. Due to its remoteness, the Tomales Point location is generally not frequented by visitors. However, due to the distance between the subsites, surveyors do not stay at one subsite long enough to see if other disturbances might occur.

Regional Sites

Thirteen regional surveys occurred between March 6th and August 4th, 2014 at 23 different locations. Not all sites were surveyed on all scheduled days due to weather conditions or scheduling conflicts. In 2014, there were multiple locations that had maximum counts in March: Fort Ross, Jenner, Bodega Marine Reserve, Alcatraz, Castro Rocks, Cowell Ranch, and Purisima Creek. 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 prior to the breeding season.

During the 2014 breeding season, a maximum of 4,958 adults/immatures and 1,613 pups were observed, although the maximum counts may have occurred on different days for each location (Table 5). During the molt season, the combined maximum count of all seals from each site was 6,085. Marin County sites accounted for 62% of the maximum adult and immature seal breeding count, 74% of the maximum pup count, and 70% of the maximum molt count. Using a correction factor of 1.54 (95% CI = 1.16–1.92), a regional harbor seal population estimate calculated during the molt season was 9,371 (95% CI = 7,059–11,683; Harvey and Goley 2011).

Table 5. Regional surveys of harbor seal numbers in central California, March - July, 2014. Thirteen surveys were scheduled on alternating weekends, seven during the breeding season and five during the molt season. 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	8	174.9	20.8	251	98	5	229.6	23.6	295
Fort Ross	7	147.2	19.6	187	21	5	120.4	16.0	167
Jenner	4	172.3	59.9	157	12	ND	ND	ND	ND
Bodega Marine Reserve	5	66.0	12.7	86	11	4	80.8	11.5	101
Marin County									
Tomales Bay	8	409.9	27.8	579	115	5	292.8	25.7	354
Tomales Point	8	299.0	23.3	363	102	5	499.6	63.2	583
Point Reyes Headland	8	95.3	13.5	168	52	5	281.4	63.1	494
Drakes Estero Complex⁴	8	613.4	52.0	764	345	5	734.6	65.2	927
Double Point	8	424.8	46.5	634	369	5	600.8	152.9	879
Duxbury Reef	8	66.4	10.9	42	6	4	62.8	15.9	105
Bolinas Lagoon	8	311.5	26.0	402	196	5	485.6	60.9	645
Point Bonita	8	95.4	16.2	131	8	5	226.8	12.1	264
San Francisco Bay									
Alcatraz	8	1.4	0.6	1	0	5	1.2	1.0	5
Castro Rocks	8	180.6	19.6	237	40	5	94.8	15.1	124
Yerba Buena Island	8	69.0	5.9	93	29	5	69.8	7.0	94
Newark Slough⁴	4	24.5	9.0	49	27	5	3.8	2.6	13
Mowry Slough⁴	4	72.0	22.6	124	50	4	75.3	21.0	111
San Mateo County									
Point San Pedro	3	28.0	4.5	37	5	5	22.8	8.4	49
Cowell Ranch	8	54.1	3.4	59	17	5	27.6	13.6	68
Purisima Creek	8	108.4	15.3	129	39	5	62.6	16.7	95
Pescadero	8	44.4	6.8	76	14	5	58.6	11.1	93
Pebble Beach	8	82.8	7.4	112	20	5	134.4	29.1	224
Fitzgerald Marine Reserve	8	216.1	13.3	277	37	5	320.0	29.6	395
ALL SITES				4,958	1,613	6,085			

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 molt season, June - July.

⁴Includes surveys that occurred outside of regional weekend period.

Sonoma County

The addition of Fort Ross to the Sonoma County sites in 2013 greatly increased the count numbers for Sonoma County, as this site is comparable to the top two sites that make up Sonoma County. It would be misleading to compare the Sonoma County counts from previous years to those in 2013 and 2014 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 2014 only.

The 2014 maximum adult/immature and pup counts during the breeding season at Sonoma County sites were similar to previous years' counts (Figures 11 and 12). Jenner was only surveyed twice during April and May and this could have resulted in the peak count being missed at this site. Among Sonoma County sites, Sonoma Coast had the high counts of adults/immatures and pups (Table 5). During the molt season, Jenner was unable to be surveyed. This site is typically the peak site during the molt season and, therefore, the Sonoma County molt count is lower than would normally be expected. Of the remaining sites, Sonoma Coast had the high molt count.

Visitors with a dog accounted for the only disturbance recorded at Sonoma County sites during regional count surveys. There were also three potential disturbances reported at the Sonoma Coast sites. The potential disturbances included kayakers, boaters, and divers at known harbor seal haul-outs; however, when observers arrived, there were few or no seals present and the surveyor could not determine if a disturbance had occurred.

San Francisco Bay

The 2014 maximum adult/immature and pup counts during the breeding season at SFB sites were some of the highest counts recorded in the past 10 years (Figures 11 and 12). Within the SFB, the high count for adults and immatures occurred at Castro Rocks, whereas, the high count for pups occurred at Mowry Slough (Table 5). After a large increase in 2013, the molt count for SFB decreased to a count more similar to past years (Figure 13). During the molt season, Castro Rocks had the high count of seals among SFB sites (Table 5). In SFB, disturbances only occurred at Alcatraz where very few seals haul out. Disturbance sources included helicopters and birds. There were also potential disturbances of boats anchored near the haul-out site and no seals were observed.

San Mateo County

The 2014 maximum adult/immature count during the breeding season at San Mateo County sites is the largest count recorded for this region in the past 10 years (Figure 11). Although, it should be noted there are many years where some sites were not surveyed and a new site was added in 2012. The 2014 maximum pup count is similar to the count in 2013 (Figure 12). The pup counts in this region have been increasing since 2011. Among San Mateo County sites, Fitzgerald Marine Reserve had the high count of adults/immatures, while Purisima Creek had the high pup count (Table 5). Purisima Creek had the second highest adult/immature count during the breeding season and this site was only recently added to the regional surveys in 2012, when access became available. During the molt season, the 2014 maximum seal count cannot be compared to the count in 2013 since one of the sites was not surveyed in 2013. However, the 2014 count did increase from the count in 2012 when

all the same sites were surveyed (Figure 13). In San Mateo County, the highest concentration of seals during the molt season was at Fitzgerald Marine Reserve (Table 5). Four disturbances were reported in San Mateo County, all occurring at Pebble Beach. Sources included fishermen, beach visitors, and a hang glider. Two potential disturbances occurred at Pebble Beach and Fitzgerald Marine Reserve when people were located in areas where harbor seals normally haul out and seals were recorded in other areas.

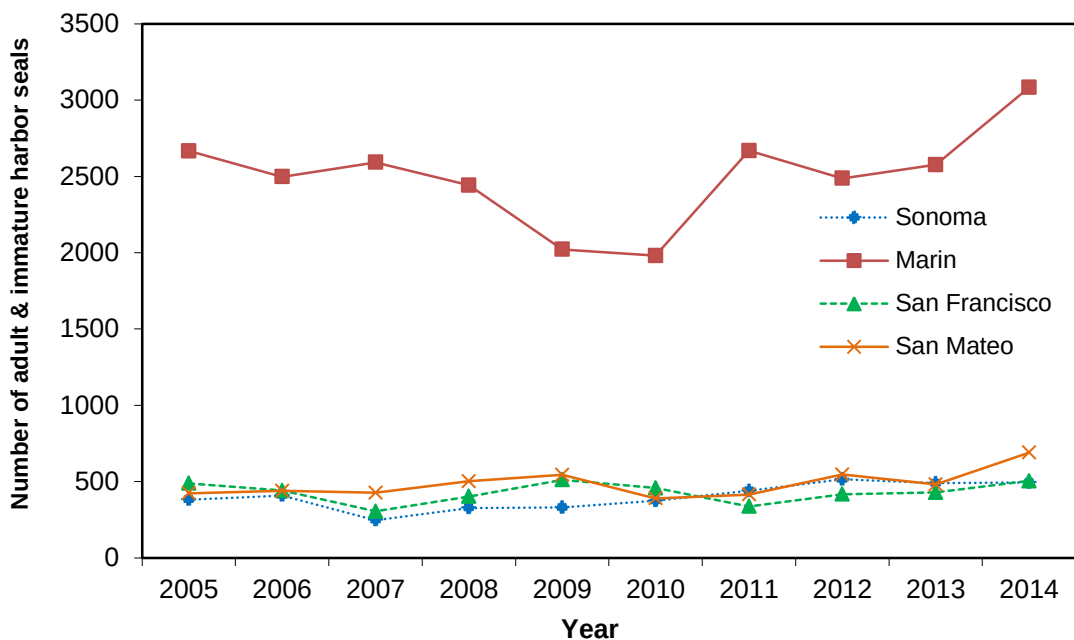


Figure 11. Maximum counts of harbor seal adults and immatures by region during the breeding season for the 2005-2014 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010 and Purisima Creek was added to San Mateo County in 2012. Fort Ross in Sonoma County is not included in this graph. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007.

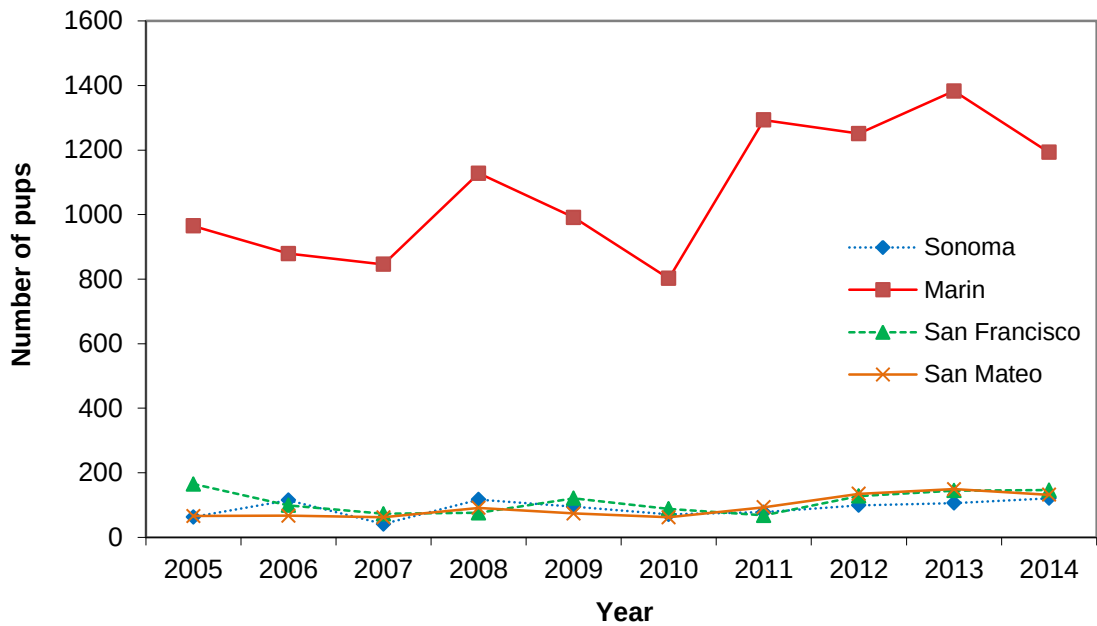


Figure 12. Maximum counts of harbor seal pups by region during the breeding season for the 2005-2014 regional surveys in Central California. Bodega Marine Reserve was added to Sonoma County in 2010 and Purisima Creek was added to San Mateo County in 2012. Fort Ross in Sonoma County is not included in this graph. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007.

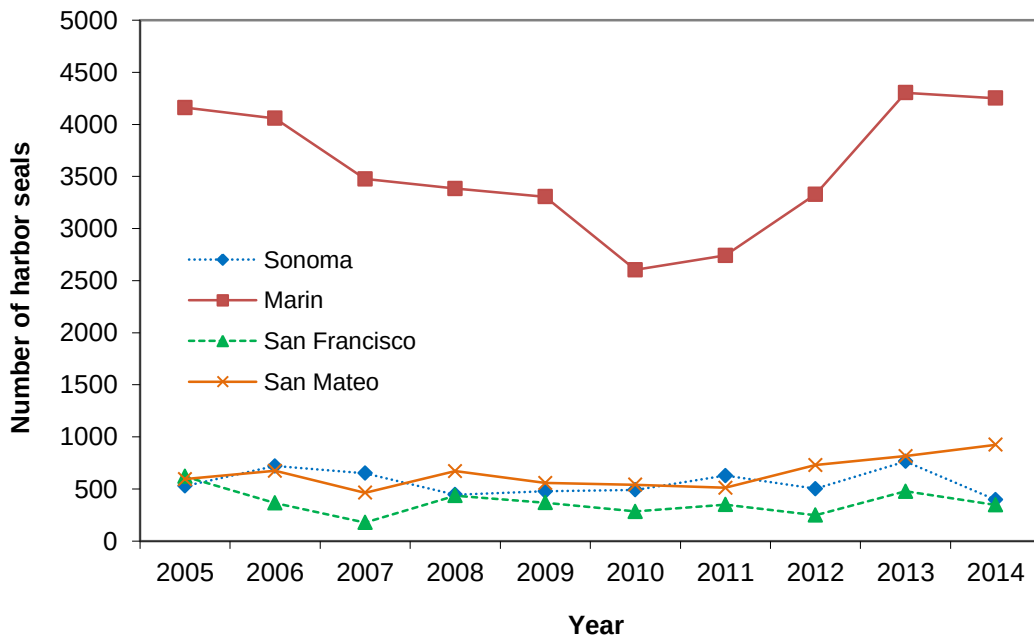


Figure 13. Maximum counts of all age classes of harbor seals by region during the molting season for the 2005-2014 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010 and Purisima Creek was added to San Mateo County in 2012. Fort Ross in Sonoma County is not included in this graph. Incomplete surveys occurred in San Mateo County in 2006 and 2013, San Francisco Bay in 2007 and 2012, Marin County in 2010, and Sonoma County in 2014.

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, Gible and Harvey. 2015). Information gained at PORE and GOGA 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 2014 maximum count of adult and immature seals in the breeding season is greater than one standard deviation above the 14-year average and the highest count since 2004. The maximum pup count of 2014 is similar to the 14-year average, but a small decrease from the 2013 pup count. The maximum count during the molting season of 2014 was similar to the 14-year average. The molt season counts have been increasing since 2012, following a long period of decline that began in 2005. More robust analysis is required to determine if these differences are biologically or statistically significant.

From 2000 to 2014, the 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 2014, these two sites combined produced 57% of the pups observed during the breeding season and 43% of the seals recorded during the molting season at Marin County sites. Drakes Estero and Double Point usually contain at least 50% of the seals recorded during the molting season, however, in 2014 Bolinas Lagoon accounted for a higher proportion (15%) than previous years (14-year average is 11%).

The number of disturbances that occurred during the 2014 season was the same as the 14-year average. Throughout the study area from 2000-2014, the primary sites that experienced disturbances were Tomales Bay, Drakes Estero Complex, Bolinas Lagoon, and Double Point. In 2014, Tomales Bay had the highest disturbance rate recorded for the year, with the majority of disturbances caused by motorboats and recreational clam diggers. In the past nine years, one of the highest disturbance rates consistently occurred at Tomales Bay as this is a popular recreational area for fishing, clamming, and boating (motorboats and kayaks). The most common source categories of disturbance for all Marin County sites in 2014 were unknown sources and humans on foot. These sources, along with 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 in Sonoma County. 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, the Greater Farallones

National Marine Sanctuary, UC Davis Bodega Marine Laboratory, Farallones National Marine Sanctuary Association, the Fort Ross Conservancy, Stewards of the Coast and Redwoods Seal Watch program, and other volunteers.

Season Highlights

- A maximum of 3,205 adult and immature seals were counted onshore during the breeding season.
 - The highest number of adults/immatures hauled out at Drakes Estero Complex (764), followed by Double Point (709).
- A maximum of 1,253 pups were observed at Marin County colonies.
 - The Drakes Estero Complex and Double Point accounted for 57% (714) of pups at Marin County colonies.
- A maximum of 4,237 animals (all age classes) were counted during the molting season at Marin County haul-out sites.
 - Drakes Estero Complex and Double Point accounted for 43% (1,808) of the total seals counted during the molt season.
- 125 disturbances were recorded during surveys.
 - The most frequent disturbance categories were unknown sources (28%) and humans on foot (27%).
 - The highest disturbance rate (0.62 disturbances/hour) occurred at Tomales Bay.
- Regional surveys occurred 13 times throughout the breeding and molt seasons (March-July), and include San Francisco Bay and Sonoma, Marin, and San Mateo counties. Twenty-four volunteers participated in these surveys.
 - Marin County sites accounted for 62% of breeding season adult and immature seals, 74% of pups, and 70% of seals during the molting season.
- 36 volunteers and two NPS staff members completed 255 surveys at Marin County sites between March 1st and August 2nd, 2014, contributing approximately 467 survey hours.

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