



Pacific Harbor Seal (*Phoca vitulina richardii*)

Monitoring at Point Reyes National Seashore and Golden Gate National Recreation Area

2019 Monitoring Season

Natural Resource Report NPS/SFAN/NRR—2020/2129



ON THE COVER

Pacific harbor seals with pup at Point Bonita in the Marin Headlands, CA.
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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. 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, including climate change, that may affect the condition of the population (Adams et al. 2009).

Harbor seal surveys were conducted throughout the 2019 breeding and molting seasons (March-May and June-July, respectively) once or 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 and NPS staff completed 190 surveys at eight Marin County sites, contributing approximately 329 hours of monitoring. During the breeding season, the peak count of adult and immature seals recorded at all Marin County monitoring sites was 2,456 seals, which is slightly less than the baseline average (data from 2000 – 2015). The Drakes Estero Complex had the highest peak number of adult and immature seals (675), followed by Tomales Bay (434) and Bolinas Lagoon (408). During the breeding season, 1,106 seal pups were recorded at all Marin County sites, which is similar to the baseline average. The Drakes Estero Complex, Bolinas Lagoon, and Double Point accounted for the majority of pups at Marin County haul-outs in 2019. During the molting season, the peak count recorded at Marin County sites was 2,961 seals, which is lower than the baseline average and is one of the lowest counts on record in the 20-year study period.

During the monitoring surveys, 62 disturbances to seals were recorded. The most frequent causes were motorboats (26%), humans on foot (24%), and unknown sources (21%). Thirteen regional surveys were conducted throughout the breeding and molting seasons at locations in San Francisco Bay and Sonoma, Marin and San Mateo counties. Of these areas, Marin County sites accounted for 60% of breeding season adult and immature animals (2,416 of 4,015), 73% of pups (1,103 of 1,503), and 63% of seals during the molting season (2,839 of 4,526), 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 K. Ballinger, K. Berg, J. Berger, F. Booker, F. Brasfield, M. Burke, C. Cardosi, K. Carolan, R. Catlin, M. Cox, D. Ford, J. Forsell, J. Heusler, E. Kean, K. Khtikian, J. Lamphier, K. Liang, R. McLemore, S. Pickton, H. Rederer, J. Rudebusch, P. Rudebusch, B. Siegel, S. Snow, E. Sojourner, K. Soroca, C. Steinack, S. Van Der Wal, Sue Waber, D. Walker, and J. Winer.

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All monitoring activities were conducted under the National Marine Fisheries Service Permit No. 21425.

Introduction

The National Park Service (NPS) San Francisco Bay Area Network (SFAN) Inventory and Monitoring Program includes 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 meet 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 and variations in timing and magnitude of coastal upwelling (Allen et al. 2011). 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, but not all of the current sites were surveyed until 2000.

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 Wildlife in cooperation with the NPS. Monitoring data collected on harbor seals under this program may contribute to the assessment of the MPAs' efficacy

(<https://www.wildlife.ca.gov/Conservation/Marine/MPAs/Network/North-Central-California>).

The information presented in this report is a summary of the harbor seal data collected at PORE and GOGA during the 2019 breeding and molting seasons, March-July. SFAN surveys were also conducted in conjunction with other agencies and organizations in adjacent areas (San Francisco Bay and San Mateo and Sonoma counties). 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, 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. Other pinniped species commonly present at Point Reyes include northern elephant seals (*Mirounga angustirostris*), California sea lions (*Zalophus californianus*), and Steller sea lions (*Eumetopias jubatus*). The population of harbor seals at PORE represents the largest concentration 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. 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 exploitation that did not end until the passage of the Marine Mammal Protection Act in 1972 (Sydeman and Allen 1999, Carretta et al. 2015). NOAA statewide surveys of harbor seals have noted long-term recovery of the population since the 1980s with a peak in 2004, but that subsequent counts in 2009 and 2012 have been lower than the 2004 maximum count (Carretta et al. 2015). 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 2019). The NPS may implement visitor management actions to reduce disturbance to seals at colonies, if appropriate.



The remote beach of the Double Point harbor seal colony at Point Reyes National Seashore (NPS).

Objectives

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 site use and productivity

The main parameters monitored are reproductive success (defined as the number of pups counted at each site), population size, distribution, phenology, and disturbances (Adams et al. 2009). The

monitoring objectives and methodology are described in detail in the SFAN Pinniped Monitoring Protocol (Adams et al. 2009).

Methods

Study Area

The core study area extends from Tomales Point in the north, to and including San Francisco Bay (SFB; Figure 1). 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 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. 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, 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 1).

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 1). 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 SFAN Pinniped Monitoring Protocol (Adams et al. 2009).



Figure 1. Regional harbor seal survey sites in San Francisco Bay and Sonoma, Marin, and San Mateo counties, California. Map does not show 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/molting population allows surveyors to monitor all sites in PORE and GOGA. Thus, spatial stratification or other sampling techniques were not needed to decide which haul-outs to monitor. SFAN relies upon other monitoring programs, such as the Greater Farallones National Marine Sanctuary Beach Watch program or National Marine Fisheries Service (NMFS) stock assessments that include aerial surveys, as well as 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).

In addition to conducting detailed monitoring at PORE and GOGA, 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 in the central California coast 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 1). Surveys at Fort Ross began again in 2013 after not being conducted since 2006. The monitoring approach used by SFAN is consistent with that used in other surveys, allowing for the interpretation of results in a regional context.

Surveys

Harbor seal surveys were conducted throughout the breeding (March 1st through May 31st) and molting (June 1st through July 31st) seasons once or twice per week at most Marin County locations. The two exceptions are Double Point, which is now surveyed only 4-5 times per year due to safety concerns at the observation spot, and Point Reyes Headlands, which is on the regional survey schedule of surveys on alternating weekends. Surveys were conducted at medium to low tides (below 3 ft) during the day. Surveys were not conducted in heavy fog, winds over 30 mph, or rain because of poor visibility and because harbor seals haul out in lower numbers in the rain (Jemison and Pendleton 2001). Not all seals will be onshore during the surveys; however, with standardized methods, the ground count surveys provide an index of abundance (see more detail in Data Management and Analysis; Adams et al. 2009, Harvey and Goley 2011, Carretta et al. 2015).

Surveys were conducted by two NPS staff members or trained volunteers. All volunteer observers had been previously trained to monitor harbor seals at designated sites within PORE and GOGA and returned to the 2019 season with several years of experience. At most sites, volunteers surveyed for approximately two hours from fixed observation points with all subsites counted approximately every 30 minutes for a total of four counts each survey. Tomales Point, Bolinas Lagoon, and Duxbury Reef had only two counts separated by 30 minutes during each survey due to hiking/traveling time between subsites. 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 on pre-formatted datasheets every half hour. 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.



Volunteer training at Drakes Estero in Point Reyes National Seashore (NPS).

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 categories to assist with summary analyses (Table 1). Due to the distance between subsites, Tomales Point and Point Reyes Headlands surveyors are not at any one subsite for very long and are less likely to observe a disturbance. However, due to the remoteness of these sites, very few visitors frequent these locations.

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	Clammer, Fisherman, Hiker, Horse rider, Kite flyer, Researcher
Motorboat	Motorboat, Personal watercraft
Non-Motorboat	Canoe, Kayak, Sailboat, Wind surfer,
Other	Coyote, Other pinniped, Rock slide, etc.
Vehicle	Bus, Car, Motorcycle

On alternating weekends in March through July, regional surveys were conducted at all sites included in the regional counts (see Figure 1). Due to staffing and volunteer constraints, surveys could not be conducted at Mowry and Newark Sloughs in San Francisco Bay in 2019. Participants in the region-wide surveys included various organizations and volunteers (see Appendix B). 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 stored and managed in a relational Microsoft Access database. At the end of the season, the electronic 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 and were defined as high quality data (Adams et al. 2009). 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, all count data were retained in the database, regardless of quality.

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. Customized tools in the database were used to summarize the data. During the breeding months of March, April, and May, the maximum total site count for each survey included two age classes: adult/immature and pup. Live and dead pups were included in the maximum pup count.

There is little movement of harbor seals between sites during both the pupping and molting seasons (Lowry et al. 2001, Nickel 2003, Cordes and Thompson 2015), therefore 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 and we 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. During the molt season, only surveys that occurred after June 10 were used to determine the maximum counts for total seals due to the movement of seals during the time between the breeding and molt seasons that could cause a false peak. 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). 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 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 2015 and compared to the 2019 data. For this and future reports, data from 2000 to 2015 will be used as a baseline comparison due to the low variability during this date range and the range encompasses a long enough time series for the data to go through high and low cycles. 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 those that elicited a head-alert or flush reaction from the seals were used for 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 corrected, and as data analysis procedures are improved. For this reason, summary data reported here for 2000 to 2015 may differ slightly from data summaries published in previous harbor seal reports.

Results

Overall

In 2019, 30 volunteers and two NPS staff members completed 190 surveys at Marin County sites between March 1st and July 31st, with approximately 329 hours of monitoring. Each location had between 22 and 34 high quality surveys, except for Point Reyes Headlands, which is on the regional survey schedule, and Double Point, which had a reduced number of surveys due to safety concerns at the observation site. At Marin County sites, a maximum of 2,456 adults/immatures and 1,106 pups were observed during the breeding season (March-May) and 2,961 individuals were recorded during the molting season (June-July; Table 2).

Table 2. Summary data of harbor seal colonies for the 2019 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
Tomales Bay	434	122	236	28	16	0
Tomales Point	291	108	302	28	3	1
Point Reyes Headlands	116	43	139	10	2	1
Drakes Estero Complex	675	368	946	22	15	3
Double Point	298	218	367	5	6	2
Duxbury Reef	96	9	142	28	3	1
Bolinas Lagoon	408	227	614	30	22	2
Point Bonita	138	11	215	34	3	2
TOTAL	2456	1106	2961	185	70	12

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 10 – July 31.

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 at Marin County sites during the 2019 breeding season was 2,456, which is slightly less than the baseline average, but still within one standard deviation (Figure 2). Drakes Estero Complex had the most adults/immatures (675), followed by Tomales Bay (434) and Bolinas Lagoon (408; Table 2). In past years Double Point was a primary site for breeding adults, however, the counts have been declining since 2015 (Figure 3). The count recorded at Double Point in 2019 (298) was one of the lowest counts on record at this site in the past

20 years and is far below the site average (542). The maximum count at Bolinas Lagoon has been steadily increasing over the study period (Figure 3).

Pups

The combined maximum pup count for all Marin County sites during the 2019 breeding season was 1,106 pups, which is very similar to the baseline average (Figure 2). The primary pupping locations within the Marin County sites are Tomales Bay, Tomales Point, Drakes Estero, Double Point, and Bolinas Lagoon (Figure 3). Drakes Estero had the most pups (368), followed by Bolinas Lagoon (227) and Double Point (218; Table 2). The maximum pup count at Bolinas Lagoon continues to be higher than average - a trend that has been seen since 2012 (Figure 3). Double Point pup counts have been far below average since 2017, but a small increase compared to the 2017 and 2018 counts was seen in 2019 (Figure 3).

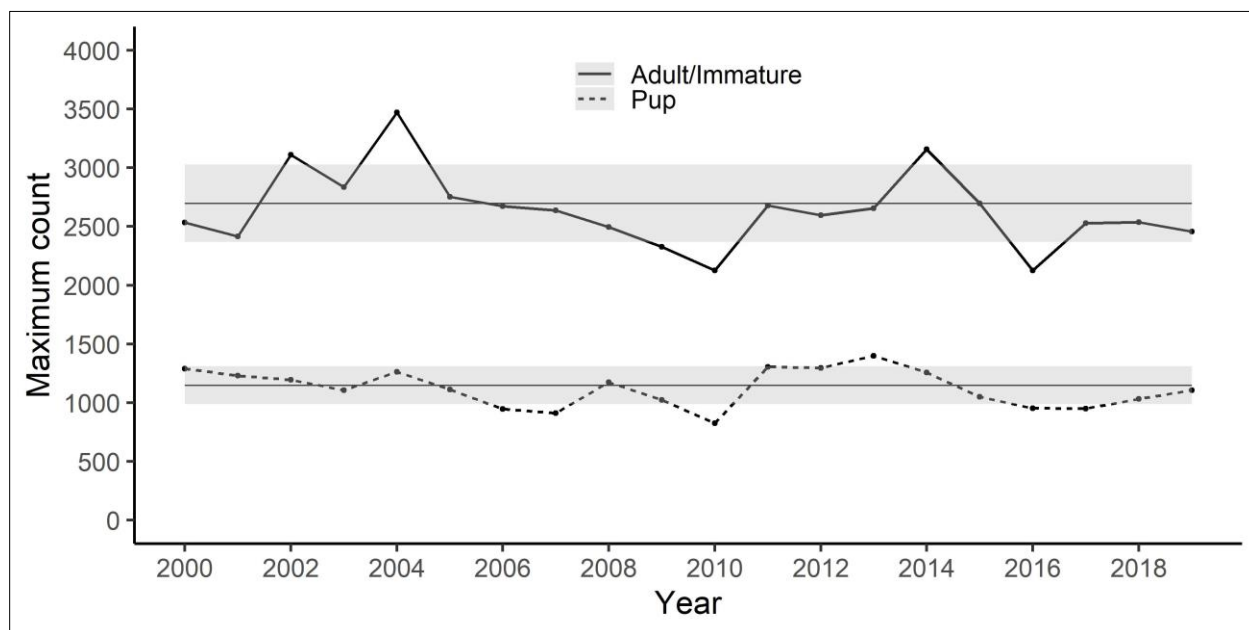


Figure 2. Maximum counts of harbor seal adults and immatures (solid line) and pups (dashed line) during the breeding season (March-May) for 2000-2019 at Marin County sites. The horizontal lines on the graph represent the means of the maximum adult counts (mean = 2,697.2) and pup counts (mean = 1,148.8) from 2000-2015 and the gray shaded areas represent one standard deviation from the mean (adult SD = 329.3 and pup SD = 162.0).

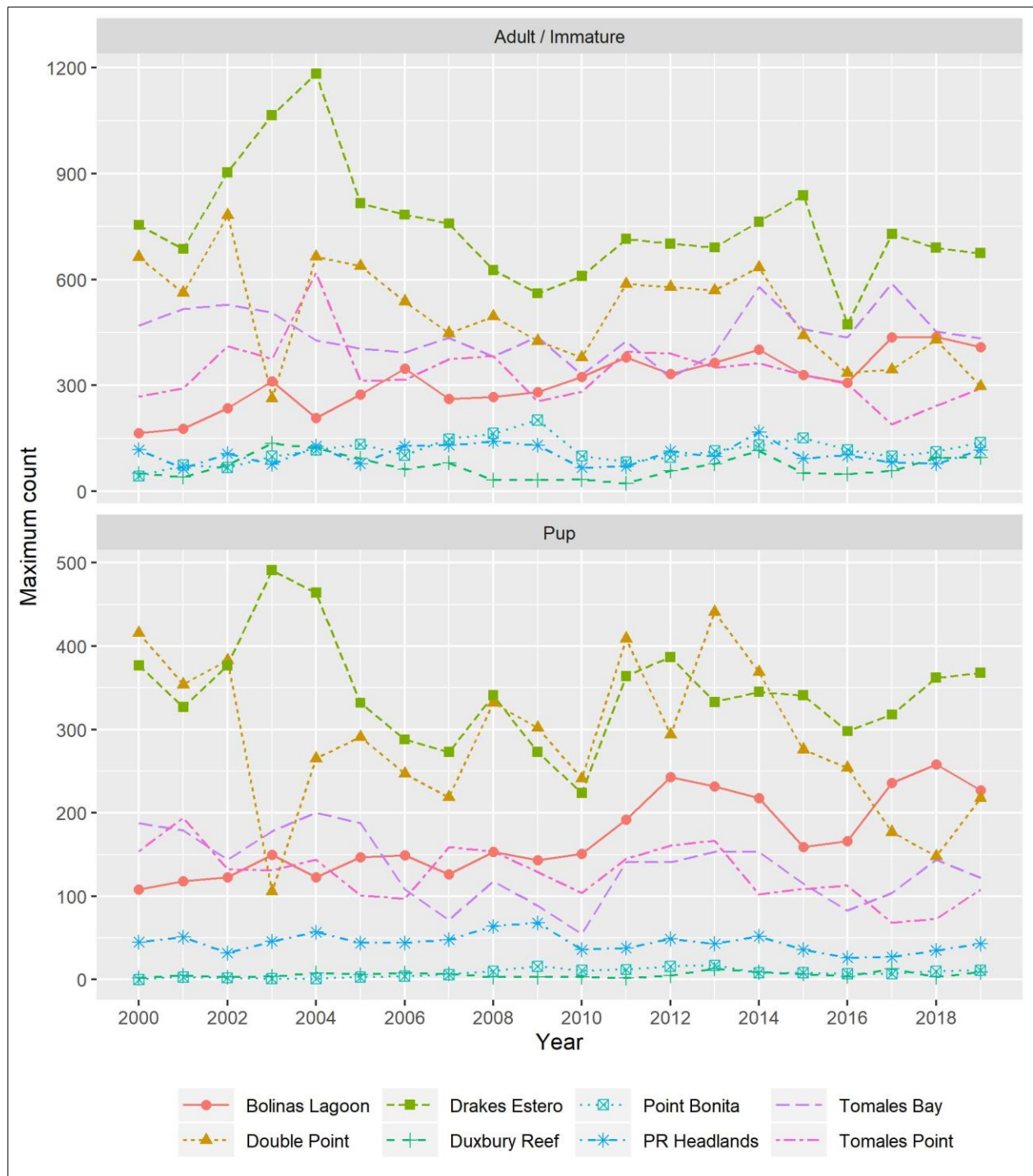


Figure 3. Maximum harbor seal adult/immature and pup counts at each of the Marin County locations during the breeding season (March – May), 2000-2019. The maximum counts of each site may have been observed on different days.

Phenology

Typically, the first viable pup is seen in mid-March at either Drakes Estero or Double Point. The first reported pup of 2019 was seen on March 26 at Point Bonita (Figure 4), which is the first time in the

study period the first pup of the season has been recorded at this site. The dates for the first reported pup at Double Point have not been accurate since 2017 due to fewer surveys being conducted and are, therefore, not included in Figure 4. A slight downward trend (i.e., earlier pupping) in phenology is seen when all sites are combined, but each site independently has varying trends and additional analyses are necessary to determine statistical significance (Figure 4).

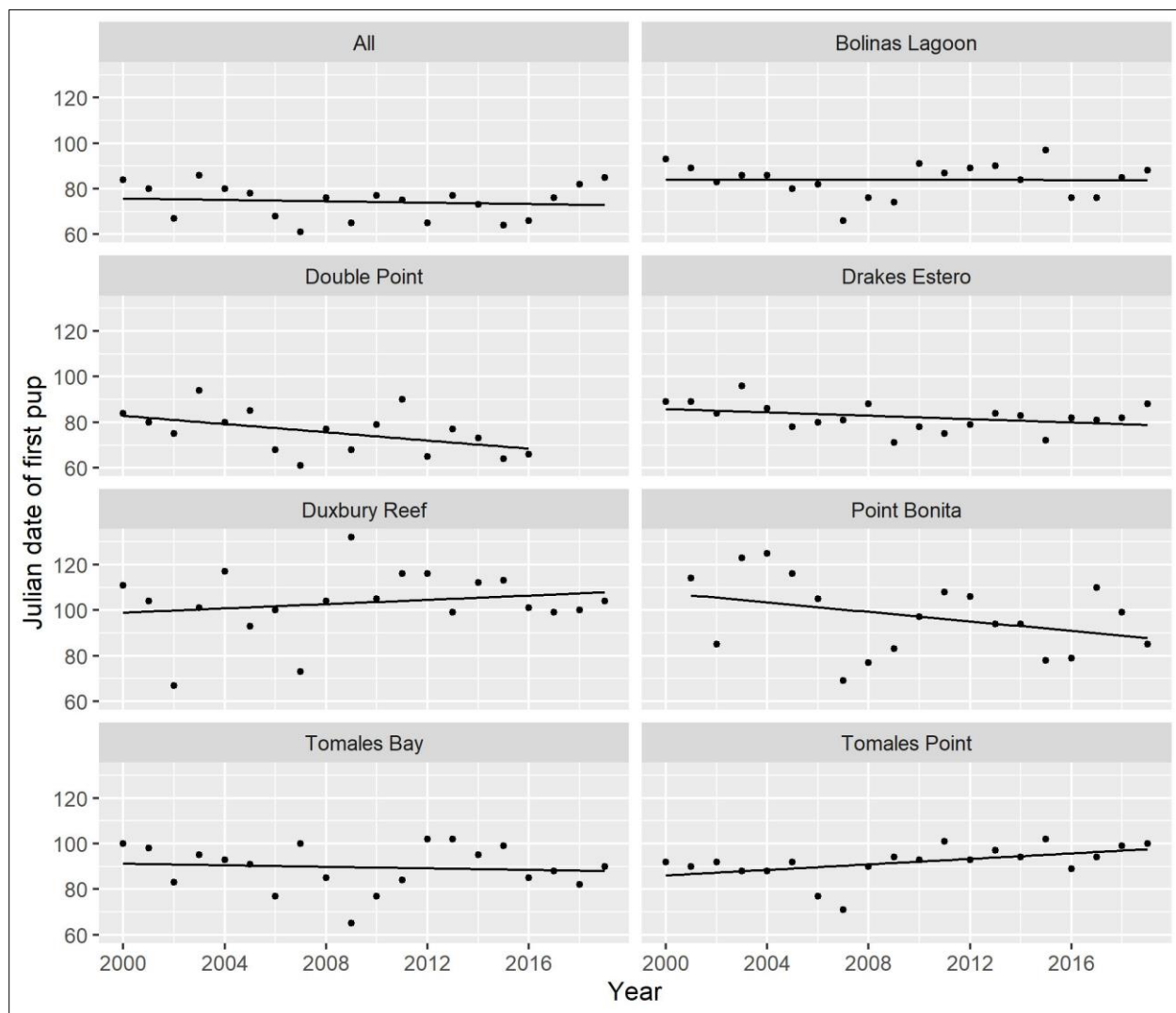


Figure 4. Date of first live pup observed for 2000-2019. A linear trend line was fitted to the data points, however, no analyses were run to determine if the slope was different from zero.

Molt Counts

The maximum count of all seals during the 2019 molt season for all Marin County sites was 2,961 seals, which is less than the baseline average and is one of the lowest counts during the study period (Figure 5). The Drakes Estero Complex and Bolinas Lagoon comprised 53% (1,560; Table 2) of the total seals counted during the molt season in 2019. These two sites have made up the majority of the seals counted during the molt season since 2017. Prior to 2017, the two major sites were the Drakes

Estero Complex and Double Point. However, the maximum count of total seals at Double Point has been very low since 2016 (Figure 6). The count at Double Point in 2019 (367) is the third lowest count on record throughout the 20-year study period and a 66% decrease from the site average of 996 seals. Bolinas Lagoon, on the other hand, has had greater than average counts during the molt season since 2014 (Figure 6).

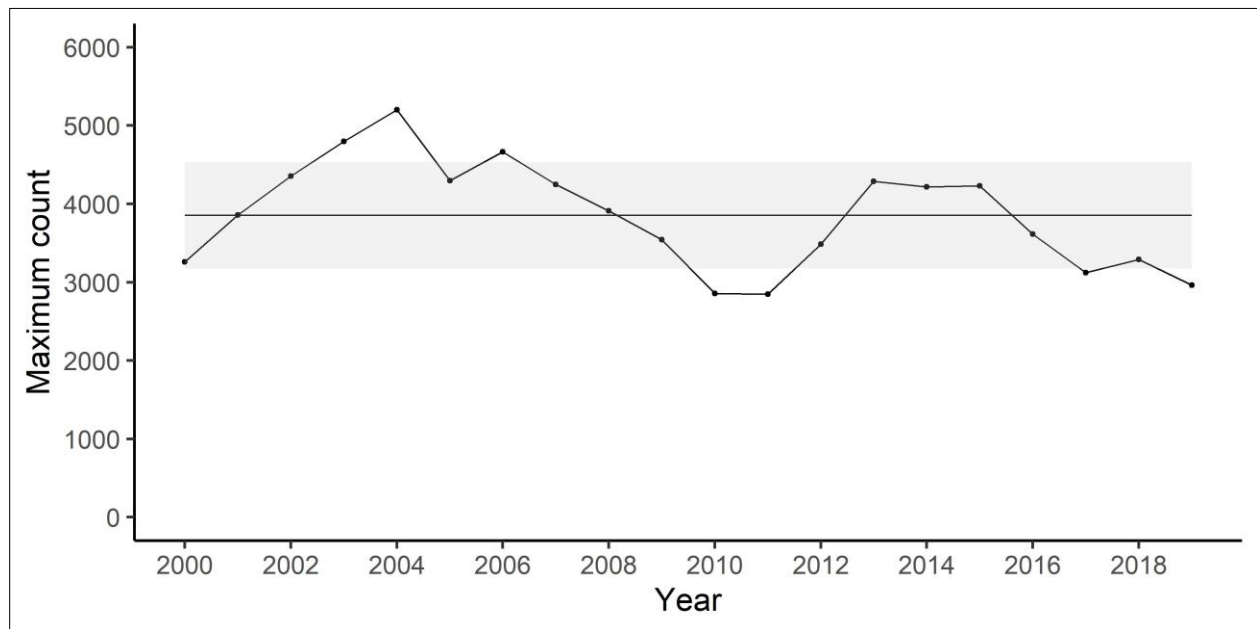


Figure 5. Maximum harbor seal counts during the molt season (June-July) for 2000-2019 at Marin County sites. The horizontal line on the graph represents the mean of the maximum molt counts from 2000-2015 (mean = 3,852.1) and the gray shaded area represents one standard deviation from the mean (SD = 678.0).

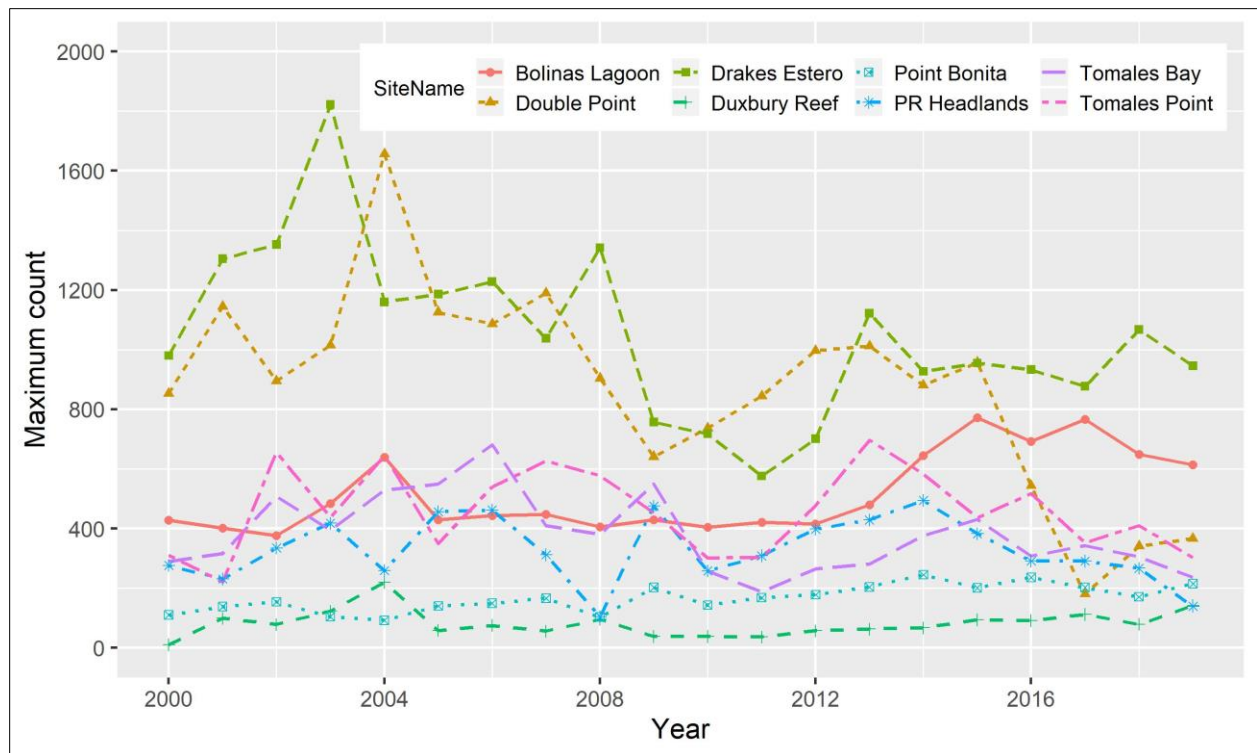


Figure 6. Maximum harbor seal counts at each of the Marin County sites during the molt season (June – July), 2000-2019. The maximum counts of each site may have been observed on different days.

Disturbances

At the Marin County sites in 2019, 62 disturbances were recorded that elicited a response from harbor seals (Table 3). The most common disturbance sources were motorboats (26%), humans on foot (24%), and unknown (21%; Table 3). The rate of disturbances per hour in 2019 was highest at Double Point (0.62 disturbances/hour; Figure 7). There were only five surveys conducted at Double Point in 2019 and six disturbances were recorded in four of the surveys. Most of the disturbance sources were unknown at this site, but one disturbance was caused by a coyote and another disturbance was caused by a sea lion. Double Point is inaccessible to people except at very low tides and is in a remote part of the park and, therefore, it is rare to have anthropogenic disturbances. The site with the second highest disturbance rate was Tomales Bay (0.51 disturbance/hour; Figure 7) and the primary sources of disturbance were motorboats and clammers (a subset of humans on foot).

Table 3. Number and percentage of identified sources of disturbances (head alert, flush, flush into water) for Marin County sites. 2019 data are compared to the 2000 – 2015 mean $\pm$ 1 SD.

Year	Measure	Motorboat	Non-Motorboat	Vehicle	Dog	Aircraft	Human	Bird	Unknown	Other	Total
2019	(#)	16	2	2	1	6	15	2	13	5	62
	(%)	26	3	3	2	10	24	3	21	8	–
2000 - 2015 mean	(#)	16.1 $\pm$ 6.6	10.9 $\pm$ 5.3	3.9 $\pm$ 3.6	0.6 $\pm$ 0.8	7.9 $\pm$ 4.2	36.9 $\pm$ 14.9	11.1 $\pm$ 4.3	30.4 $\pm$ 7.8	5.2 $\pm$ 3.4	123 $\pm$ 31.1
	(%)	13.3 $\pm$ 5.7	8.6 $\pm$ 3.1	3.0 $\pm$ 2.1	0.4 $\pm$ 0.6	6.4 $\pm$ 3.5	29.5 $\pm$ 8.0	9.3 $\pm$ 3.9	24.9 $\pm$ 4.1	4.4 $\pm$ 2.7	–

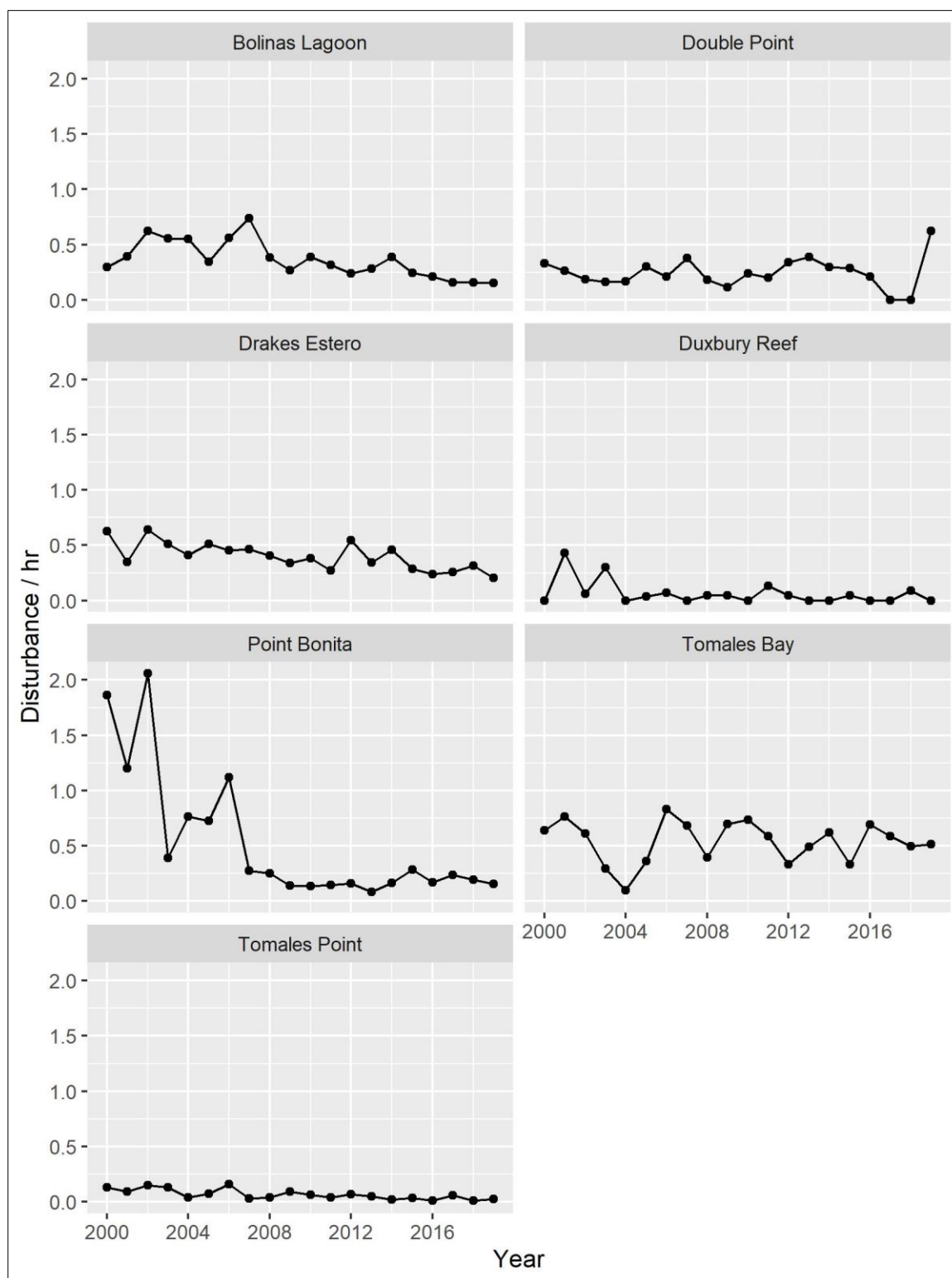


Figure 7. Rates of disturbances per hour at Marin County sites from March through July of 2000-2019. Only actual disturbances (head alert, flush, flush water) were used, and survey time was based on observation time for all complete surveys (with or without disturbances).



Fishermen that had been setting crab pots travel very closely past the harbor seals and cause a disturbance in Tomales Bay. Clammers can be seen at the top of the photo. (NPS/JIM FORSELL).

Regional Sites

Thirteen regional surveys occurred between March 1 and July 22, 2019 at 23 different locations. Not all sites were surveyed on all scheduled days due to weather conditions or scheduling conflicts. During the 2019 breeding season, a maximum of 4,015 adults/immatures and 1,503 pups were observed, although the maximum counts may have occurred on different days for each location (Table 4). During the molt season, the combined maximum count of all seals from each site was 4,526. Of these areas, Marin County sites accounted for 60% of breeding season adult and immature animals (2,416 of 4,015), 73% of pups (1,103 of 1,503), and 63% of seals during the molting season (2,839 of 4,526), all of which are similar proportions to past years. Using a correction factor of 1.54 (95% CI = 1.16–1.92), a regional harbor seal population estimate calculated during the 2019 molt season was 7,191 (95% CI = 5,417–8,966; Harvey and Goley 2011).

Table 4. Regional surveys of harbor seal numbers in central California, March 1 – July 22, 2019. Thirteen surveys were scheduled on alternating weekends, nine during the breeding season and four during the molt season. Values reported as number of surveys (N), mean, standard error (SE), and maximum (Max). ND = No data.

Regional Area	Location	Breeding Season					Molt Season			
		N	Adult Mean ¹	SE	Adult Max ²	Pup Max	N	Mean ³	SE	Max ⁴
Sonoma County	Sonoma Coast	9	125.1	11.5	167	56	3	137.0	13.6	157
	Fort Ross	7	116.7	17.6	208	21	2	108	37.5	145
	Jenner	9	184.6	14.7	199	47	4	158.5	38.6	260
	Bodega Marine Reserve	7	40.4	9.1	63	17	3	49.3	1.5	52
Marin County	Tomaes Bay	8	287.6	38.4	394	122	4	232.3	15.8	270
	Tomaes Point	8	190.5	16.1	291	108	4	258.5	15.1	290
	Point Reyes Headland	8	74.3	9.0	116	43	2	106.5	32.5	139
	Drakes Estero Complex	8	509.1	48.0	675	368	4	698.0	121.8	946
	Double Point	3	278	19.3	298	218	1	–	–	243
	Duxbury Reef	9	58.0	9.4	96	9	4	87.8	17.2	122
	Bolinas Lagoon	9	265.1	35.1	408	227	4	499.0	97.2	614
	Point Bonita	9	115.0	17.5	138	8	4	137.3	30.9	215
San Francisco Bay	Alcatraz	8	9.4	2.1	13	0	3	3.0	1.5	5
	Castro Rocks	6	196.8	18.6	242	94	3	237.3	39.2	291
	Yerba Buena Island	8	130.1	29.6	217	35	4	164.8	56.3	187
	Newark Slough	0	ND	ND	ND	ND	0	ND	ND	ND
	Mowry Slough	0	ND	ND	ND	ND	0	ND	ND	ND
San Mateo County	Point San Pedro	7	21.3	6.7	35	3	4	15.0	6.8	17
	Cowell Ranch	9	52.7	10.5	72	18	4	46.3	11.6	75
	Purisima Creek	9	40.4	4.6	56	19	4	35.8	14.0	72
	Pescadero	9	33.3	5.4	35	9	4	30.5	2.7	36
	Pebble Beach	9	45.1	4.3	52	14	4	71.3	14.8	115
	Fitzgerald Marine Reserve	8	205.1	15.8	240	67	4	188.8	36.0	275
ALL SITES	–	–	–	–	4,015	1,503	–	–	–	4,526

¹ Adults and immatures during the breeding season, March 1 – May 31.

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

³ All age classes during the molt season, June 1 – July 22.

⁴ Maximum counts occurring between June 10 – July 22.

Sonoma County

The 2019 maximum adult/immature and pup counts during the breeding season at Sonoma County sites were greater than the previous two years (Figures 8 and 9). Among Sonoma County sites, Fort Ross and Jenner had the high counts of adults/immatures and Sonoma Coast and Jenner had the high counts of pups (Table 4). The 2019 Sonoma County molt count was the lowest count since 2014 (Figure 10). Jenner had the highest molt count among Sonoma County sites in 2019 (Table 4). In Sonoma County, only Fort Ross had recorded disturbances. The few disturbances at Fort Ross were caused by beach walkers and resulted in mostly head alerts from the seals, with very few seals retreating into the water.

San Francisco Bay

Mowry and Newark Sloughs were not surveyed in 2019. However, the SFB breeding and molt season maximum counts were similar to previous years even without those two sites included (Figures 8, 9, and 10). Increases at both Yerba Buena Island and Castro Rocks accounted for the high counts in 2019. Within SFB, the high counts for adults/immatures, pups, and molting seals occurred at Castro Rocks (Table 4). Disturbances were recorded during many of the surveys at Alcatraz and Yerba Buena Island. At Alcatraz, the sources of disturbance included motorboats and aircraft and primarily resulted in head alerts, although there were a couple of incidents that resulted in the seals either moving around on land or retreating into the water. At Yerba Buena Island, the sources of disturbance included motorboats, sailboat, birds, aircraft, maintenance workers, and unknown sources. A few of the disturbances at this site resulted in large flushes into the water, but most of the disturbances resulted in head alerts.

San Mateo County

The maximum adult/immature and pup counts during the 2019 breeding season at San Mateo County sites were similar to the counts in previous years (Figure 8). A small decrease was seen in the molt count in 2019 and lower numbers at Purisima Creek, Pescadero, and Fitzgerald Marine Reserve account for this decrease (Figure 10). Among San Mateo County sites, Fitzgerald Marine Reserve had the high counts of adults/immatures, pups, and molting seals (Table 4). No disturbances were recorded at San Mateo County sites in 2019. However, two potential disturbances were noted when a fisherman was in a restricted area where seals usually haul out at Cowell Ranch Beach and a fisherman and a beach walker with two dogs were in the harbor seal haul-out area at one of the Pebble Beach subsites. These people were at the sites before the observer arrived and there could have been disturbances prior to his arrival.

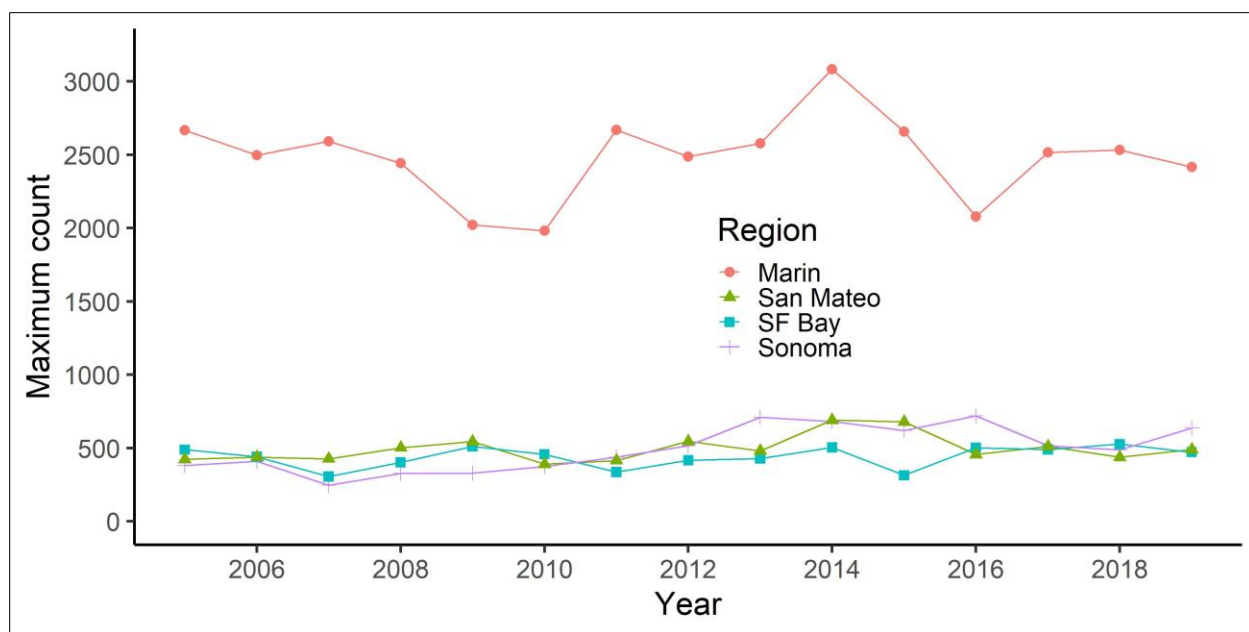


Figure 8. Maximum counts of harbor seal adults and immatures by region during the breeding season for the 2005-2019 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010, Purisima Creek was added to San Mateo County in 2012, and Fort Ross was added to Sonoma County in 2013. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007 and 2019.

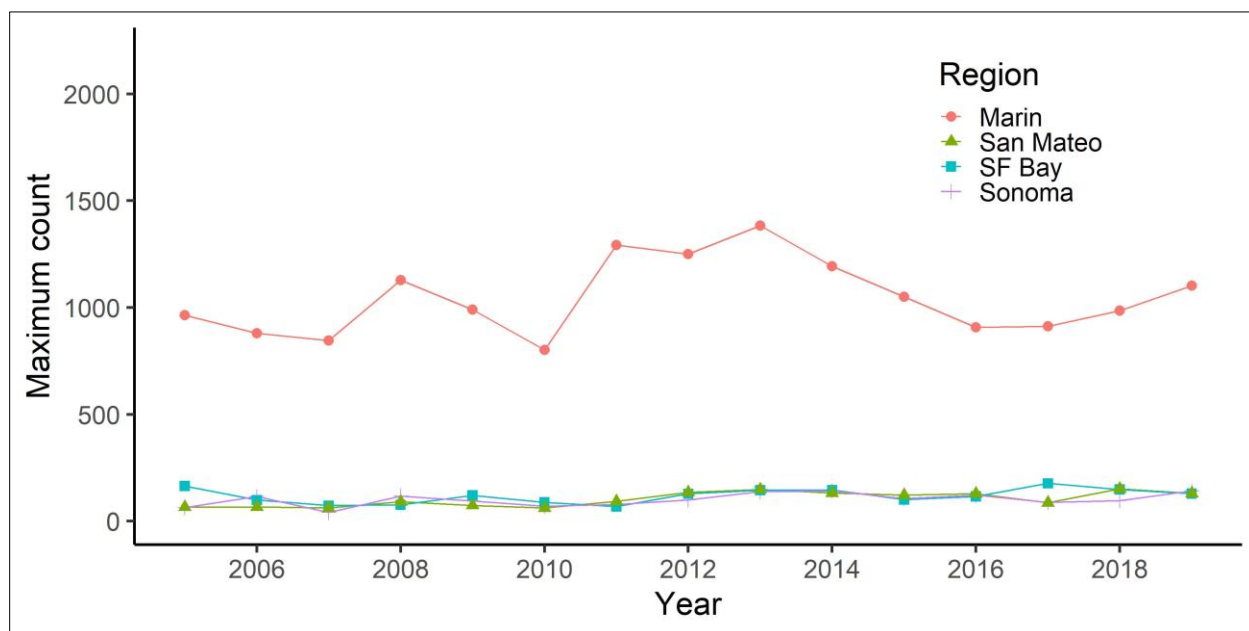


Figure 9. Maximum counts of harbor seal pups by region during the breeding season for the 2005-2019 regional surveys in Central California. Bodega Marine Reserve was added to Sonoma County in 2010, Purisima Creek was added to San Mateo County in 2012, and Fort Ross was added to Sonoma County in 2013. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007 and 2019.

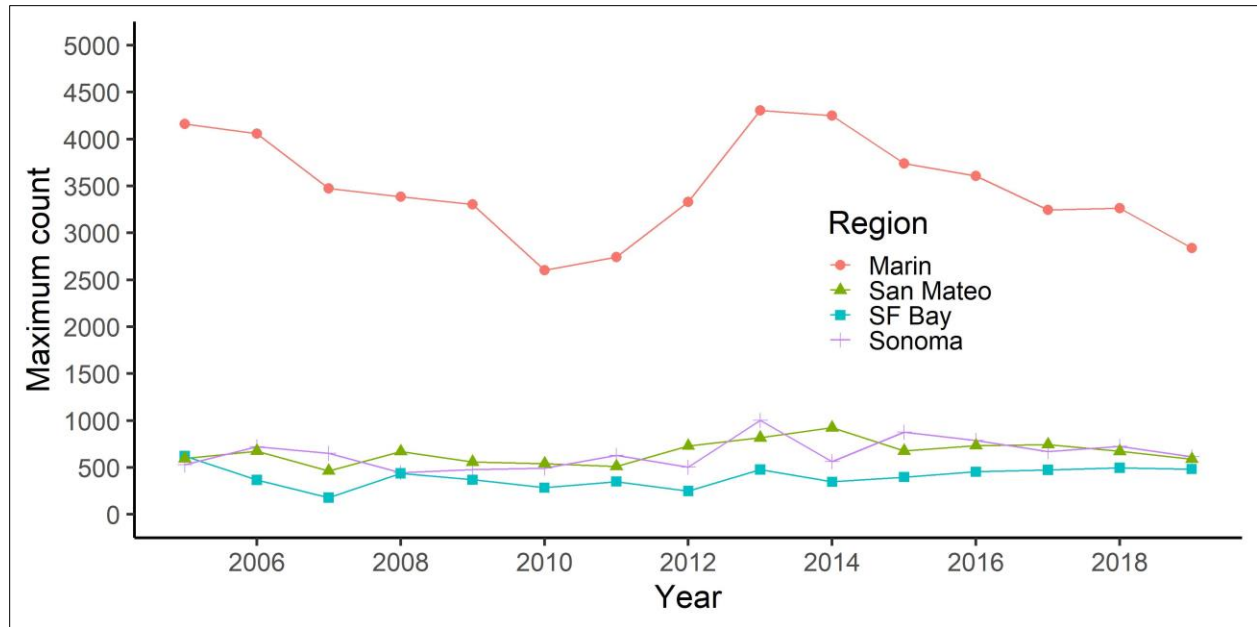


Figure 10. Maximum counts of all age classes of harbor seals by region during the molting season for the 2005-2019 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010, Purisima Creek was added to San Mateo County in 2012, and Fort Ross was added to Sonoma County in 2013. Incomplete surveys occurred in San Mateo County in 2006 and 2013, San Francisco Bay in 2007, 2012, 2015 and 2019, Marin County in 2010, and Sonoma County in 2014.

Discussion

The adult/immature count for Marin County sites during the 2019 breeding season was slightly less than the baseline average, but the 2019 pup count was very similar. The molt season count for 2019 was one of the lowest counts of the study period and continues a decline seen since 2016. The low molt season count this year might be due, in part, to low pup production in 2016 and 2017.

In recent years, major changes have been recorded in the number of seals at Bolinas Lagoon and Double Point. The maximum pup counts at Double Point have been far below average since 2017, while the pup counts at Bolinas Lagoon have increased since 2017. During the molt season, the number of seals at Double Point started to decline in 2016, but the counts at Bolinas Lagoon dramatically increased as early as 2014. Bolinas Lagoon and the Drakes Estero Complex now host the majority of the seals during the molt season, with both sites combined making up approximately 53% of the seals in Marin County since 2017. The molt counts at Double Point since 2017 have ranged between 60 – 80% less than the site's average. It is unknown why this site is declining, but could be due to an increase in coyotes and changes in habitat from the large storms in 2017. Coyote sightings at Double Point have increased in the last five years and large landslides in 2017 have appeared to allow easier access by coyotes to this site. It is also possible that the beach morphology changes from large storms have affected how the seals use the beach, making it a less desirable haul-out site. We are not tracking individual seals, so it is not possible to determine if some seals leaving Double Point are now using Bolinas Lagoon.

Throughout the study area from 2000-2019, the primary sites that experienced disturbances were Tomales Bay, the Drakes Estero Complex, Bolinas Lagoon, and Double Point. In 2019, Double Point had the highest disturbance rate. However, this could be due to the low number of surveys conducted at this site. Only five surveys were conducted at Double Point this year, but six disturbances occurred in four of the surveys and the disturbance sources were unknown (4), coyote (1), and sea lion (1). Tomales Bay had the second highest disturbance rate in 2019 and the highest number of anthropogenic disturbances with most sources being motorboats or clambers. Throughout most of the study period, Tomales Bay has consistently experienced the highest disturbance rate because it is a popular recreational area for fishing, clamming, and boating (motorboats and kayaks) and is adjacent to a boat launching site. In contrast, the disturbance rate was high at Point Bonita until GOGA restricted public access to the site in 2007 and, as a result, all subsequent years have had a low disturbance rate. The most common source categories of disturbance for all Marin County sites in 2019 were motorboats, humans on foot, and unknown sources. These sources are regularly the major causes for disturbance at Marin County sites over the past decade (Appendix Table A).

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.

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 in 2019. SFAN staff continued to coordinate the central California coast regional surveys, which include collaborations with multiple government agencies, universities, and non-profit groups including California Department of Transportation, US Fish and Wildlife Service, Greater Farallones National Marine Sanctuary, UC Davis Bodega Marine Laboratory, Greater Farallones Association, Fort Ross Conservancy, Stewards of the Coast and Redwoods Seal Watch program, Sea Ranch Coastal Stewardship Task Force, the Sea Ranch Harbor Seal Docent Program, and other volunteers (see Appendix B).

Season Highlights

- In 2019, 30 volunteers and two NPS staff members completed 190 surveys at eight Marin County sites between March 1 and July 31, with approximately 329 monitoring hours.
- A maximum of 2,456 adult and immature seals were counted onshore during the 2019 breeding season at Marin County locations.
 - The highest number of adults/immatures hauled out at Drakes Estero Complex (675).
 - Higher than average count was recorded at Bolinas Lagoon.
 - Double Point had one of the lowest counts recorded at this site during the 20-year study period and was far below the site average.
- A maximum of 1,106 pups were recorded in 2019 at Marin County colonies.
 - The highest number of pups was recorded at the Drakes Estero Complex (368)
- During the molt season a maximum of 2,961 seals (all age classes) were counted in 2019 at Marin County haul-out sites. This is one of the lowest counts on record during the 20-year study period.
 - The highest number of seals hauled out at the Drakes Estero Complex (946).
 - The count at Double Point is one of the lowest counts on record at this site and much less than the site's average.
- In 2019, 62 disturbances were recorded during surveys.
 - The most frequent causes in 2019 were motorboats (26%), humans on foot (24%), and unknown sources (21%).
 - The highest disturbance rate (0.62 disturbances/hour) occurred at Double Point.
- Regional surveys occurred 13 times throughout the breeding and molt seasons (March-July) in 2019. The sites include locations in San Francisco Bay and Sonoma, Marin, and San Mateo counties.

- The regional harbor seal population estimate calculated during the 2019 molt season was 7,191 (95% CI = 5,417-8,966).
- Marin County sites accounted for 60% of breeding season adult and immature seals, 73% of pups, and 63% of seals during the molting season.

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Appendix A. Identified sources of disturbances for Marin County sites from March through July, 2000-2019

Table A.1. Identified sources of disturbances (head alert, flush, flush into water) for Marin County sites from March through July, 2000-2019. The mean includes disturbance sources from the baseline period 2000 – 2015.

Year	Aircraft		Bird		Dog		Human		Motorboat		Non-Motorboat		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
2015	13	14.6	11	12.4	0	0.0	16	18.0	13	14.6	7	7.9	3	3.4	22	24.7	2	2.2	89
2016	9	8.9	8	7.9	2	2.0	26	25.7	21	20.8	4	4.0	1	1.0	23	22.8	7	6.9	101
2017	12	12.4	6	6.2	0	0.0	16	16.5	29	29.9	4	4.1	1	1.0	27	27.8	2	2.1	97
2018	11	12.2	2	2.2	1	1.1	20	22.2	26	28.9	8	8.9	1	1.1	18	20.0	3	3.3	90
2019	6	9.7	2	3.2	1	1.6	15	24.2	16	25.8	2	3.2	2	3.2	13	21.0	5	8.1	62
2000-2015 Mean	7.9	6.4	11.1	9.3	0.6	0.4	36.9	29.5	16.1	13.3	10.9	8.6	3.9	3.0	30.4	24.9	5.2	4.4	123

Appendix B. Lead Organizations for Regional Sites

Table B.1. List of lead organizations responsible for data collection at each regional site in 2019.

Region	Site	Organization
Sonoma County	Sonoma Coast	Sea Ranch Coastal Stewardship Task Force and the Sea Ranch Harbor Seal Docent Program
	Fort Ross	Fort Ross Conservancy
	Jenner	Stewards of the Coast and Redwoods
	Bodega Marine Reserve	U.C. Davis Bodega Marine Laboratory
San Francisco Bay	Alcatraz	Golden Gate National Recreation Area
	Castro Rocks	California Department of Transportation
	Yerba Buena Island	D. Greig *
Marin County	Tomales Bay	Point Reyes National Seashore
	Tomales Point	Point Reyes National Seashore
	Point Reyes Headlands	Point Reyes National Seashore
	Drakes Estero Complex	Point Reyes National Seashore
	Double Point	Point Reyes National Seashore
	Duxbury Reef	Point Reyes National Seashore
	Bolinas Lagoon	Point Reyes National Seashore
	Point Bonita	Point Reyes National Seashore
San Mateo County	Point San Pedro	Greater Farallones National Marine Sanctuary (GFNMS) and Greater Farallones Association (GFA)
	Cowell Ranch	GFNMS and GFA
	Purisima Creek	GFNMS and GFA
	Pescadero	GFNMS and GFA
	Pebble Beach	GFNMS and GFA
	Fitzgerald Marine Reserve	GFNMS and GFA

* Individual not affiliated with an organization.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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