



Pacific Harbor Seal (*Phoca vitulina richardii*)

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

2017 - 2018 Monitoring Seasons

Natural Resource Report NPS/SFAN/NRR—2020/2089



ON THE COVER

Pacific harbor seal in Tomales Bay.

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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 2017 and 2018 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 assisted NPS staff in completing 234 surveys in 2017 and 253 surveys in 2018 at eight Marin County sites, contributing approximately 425 hours of monitoring in 2017 and 430 hours in 2018. During the breeding season, the peak count of adult and immature seals recorded at all Marin County monitoring sites was 2,529 seals in 2017 and 2,536 seals in 2018. Both counts are similar to the 16-year average. The Drakes Estero Complex had the most adult and immature seals in both 2017 and 2018 (729 and 690, respectively), followed by Tomales Bay (588 and 453, respectively). During the 2017 breeding season, 950 seal pups were recorded at all Marin County sites, which is less than the 16-year average. During the 2018 breeding season, there was an increase from 2017 with 1,033 pups counted, which is similar to the 16-year average. Typically, the Drakes Estero Complex and Double Point account for the majority of pups at Marin County haul-outs, however, in 2017 and 2018, Bolinas Lagoon and the Drakes Estero Complex made up the majority of pups (58% and 60%, respectively). During the molting season, the peak count of seals recorded at Marin County sites was 3,124 in 2017 and 3,289 in 2018, both of which are lower than the 16-year average. During the monitoring surveys, 97 disturbances to seals were recorded in 2017 and 90 disturbances were recorded in 2018. The most frequent causes in both 2017 and 2018 were motorboats (30% and 29%, respectively), unknown sources (28% and 20%, respectively), and humans on foot (17% and 22%, respectively). Regional surveys were conducted throughout the breeding and molting seasons at locations in San Francisco Bay and Sonoma, Marin and San Mateo counties, with 13 surveys in 2017 and 12 surveys in 2018. Of these areas, Marin County sites accounted for 62% of breeding season adult and immature animals in 2017 (2,516 of 4,032) and 64% in 2018 (2,534 of 3,985), 72% of pups in 2017 (913 of 1,264) and 71% in 2018 (986 of 1,382), and 63% of seals during the molting season in 2017 (3,244 of 5,137) and 63% in 2018 (3,262 of 5,154), all of which are similar proportions to past years.

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Volunteers are the backbone of the harbor seal monitoring program. We thank all the volunteers who hiked many miles to survey harbor seals, including R. Allan, C. Anttila-Suarez, J. Arce, K. Ballinger, K. Berg, J. Berger, F. Booker, M. Burke, C. Cardosi, K. Carolan, R. Catlin, R. Cooper, M. Cox, D. Evanoff, B. Felix, D. Ford, J. Ford, J. Forsell, E. Gutberlet, J. Heusler, E. Kean, G. Kell, K. Khtikian, J. Khudyakov, G. Kell, J. Lamphier, K. Liang, R. McLemore, H. Nelson, W. Pettus, S. Pickton, N. Puranik, H. Rederer, C. Roundey, J. Rudebusch, P. Rudebusch, J. Schick, B. Siegel, S. Snow, E. Sojourner, K. Soroca, C. Steinack, D. Trausch, S. Van Der Wal, J. Vierra, N. Wilson, and J. Winer.

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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 2017 and 2018 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 (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 2017). 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, 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 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 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/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

Surveys were conducted by two NPS staff members, along with trained volunteers. Volunteer observers were trained to monitor harbor seals at designated sites within PORE and GOGA during two classroom sessions and one field trip. Many of the volunteers were previously trained and returned to the 2017 and 2018 seasons with several years of experience. New volunteers were required to be mentored by seasoned 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 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).

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 fixed 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 long enough to generally see disturbances occur. 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
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 in March through July, regional surveys were conducted at all sites included in the regional counts (see Figure 1). 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 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 are defined as high quality data. 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. Built-in 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 the age categories: adult/immature and pup. 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, Cordes and Thompson 2015), 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). 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 2017 and 2018 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 2017, 33 volunteers and two NPS staff members completed 234 surveys at Marin County sites between March 1st and July 31st, with approximately 425 hours of monitoring. In 2018, 37 volunteers and two NPS staff members completed 253 surveys with approximately 430 hours of monitoring. Each location had between 27 and 46 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 in both 2017 and 2018 due to safety concerns at the observation site. At Marin County sites, a maximum of 2,529 adults/immatures and 950 pups were observed during the 2017 breeding season (March-May) and 3,124 individuals were recorded during the 2017 molting season (June-July; Table 2). At Marin County sites in 2018, a maximum of 2,536 adults/immatures and 1,033 pups were recorded during the breeding season and 3,289 individuals were recorded during the molting season (Table 2). More detailed information on site summaries can be found in Appendix A.

Table 2. Summary data of harbor seal colonies for the 2017 and 2018 seasons. All reported numbers reflect the maximum number seen during a single census.

Year	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
2017	Tomales Bay	588	104	343	38	15	0
	Tomales Point	190	68	352	31	3	1
	Point Reyes Headlands	82	27	291	12	0	0
	Drakes Estero Complex	729	318	877	34	20	1
	Double Point	345	177	181	4	4	0
	Duxbury Reef	59	13	112	30	3	0
	Bolinas Lagoon	437	236	766	31	26	1
	Point Bonita	99	7	202	37	5	2
2017 TOTAL		2529	950	3124	217	76	5
2018	Tomales Bay	453	144	305	38	16	0
	Tomales Point	242	73	410	27	4	2
	Point Reyes Headlands	78	35	267	11	1	0
	Drakes Estero Complex	690	362	1067	32	12	1
	Double Point	429	148	341	5	6	0

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.

Table 2 (continued). Summary data of harbor seal colonies for the 2017 and 2018 seasons. All reported numbers reflect the maximum number seen during a single census.

Year	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
2018 (cont.)	Duxbury Reef	94	3	79	34	4	0
	Bolinas Lagoon	438	258	649	37	16	2
	Point Bonita	112	10	171	46	4	4
2018 TOTAL		2536	1033	3289	230	63	9

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 at Marin County sites during the breeding season was 2,529 in 2017 and 2,536 in 2018, both of which are similar to the baseline average (Figure 2). Drakes Estero Complex had the most adults/immatures (729 in 2017 and 690 in 2018), followed by Tomales Bay (588 in 2017 and 453 in 2018; Table 2).

Pups: The combined maximum pup count for all Marin County sites during the breeding season was 950 pups in 2017 and 1,033 in 2018. The pup count in 2017 is less than the baseline average, but the count in 2018 was similar to the average (Figure 2). Typically, the Drakes Estero Complex and Double Point account for the majority of pups at Marin County haul-outs, however, in 2017 and 2018, Bolinas Lagoon and the Drakes Estero Complex made up the majority of pups (58% and 60%, respectively).

The primary pupping locations within the Marin County sites are Tomales Bay, Tomales Point, Drakes Estero, Double Point, and Bolinas Lagoon (Figure 3). The maximum pup number recorded at Bolinas Lagoon in 2017 was almost 50% higher than the count in 2016 and the count in 2018 remained similar to the 2017 count. Large decreases in the pup count were recorded at Double Point in both 2017 and 2018 (-30% and -16%, respectively) and at Tomales Point in 2017 (-40%). Point Bonita, although not a primary pupping site, is noteworthy since pup counts increased following public access restrictions to the site by GOGA in 2007 (Figure 4). The pup counts at Point Bonita were low between 2014 and 2017, which was the trend seen at other Marin County locations, but increased again in 2018.

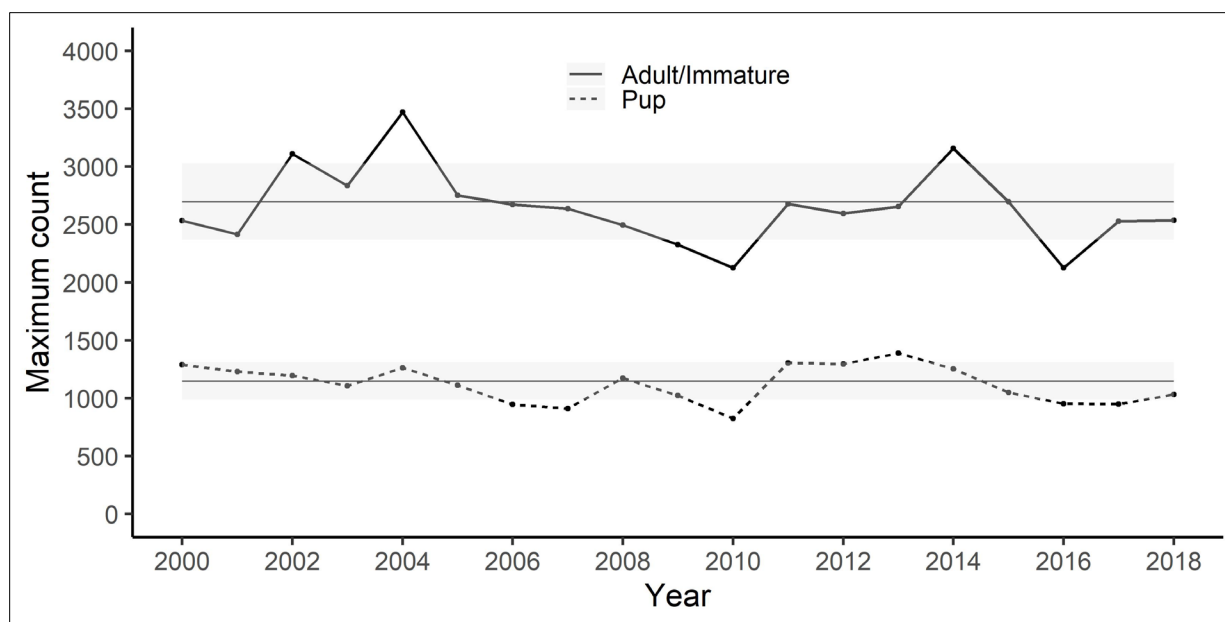


Figure 2. Maximum counts of harbor seal adults and immatures (solid line) and pups (dashed line) during the breeding season (March-May) for 2000-2018 at Marin County sites. The horizontal lines on the graph represent the means of the maximum adult counts (mean = 2,697) and pup counts (mean = 1,148) from 2000-2015 and the gray shaded areas represent one standard deviation from the mean (adult SD = 329.3 and pup SD = 161.1).

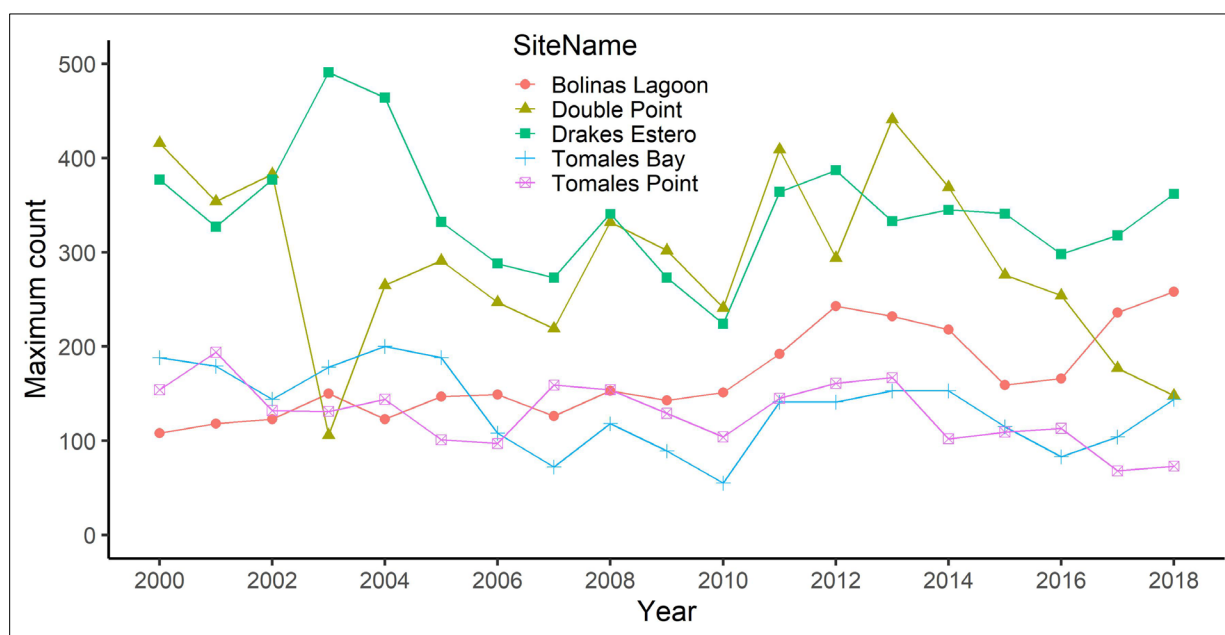


Figure 3. Maximum harbor seal pup counts at the dominant Marin County pupping locations during the breeding season (March – May), 2000-2018. The maximum counts of each site may have been observed on different days.

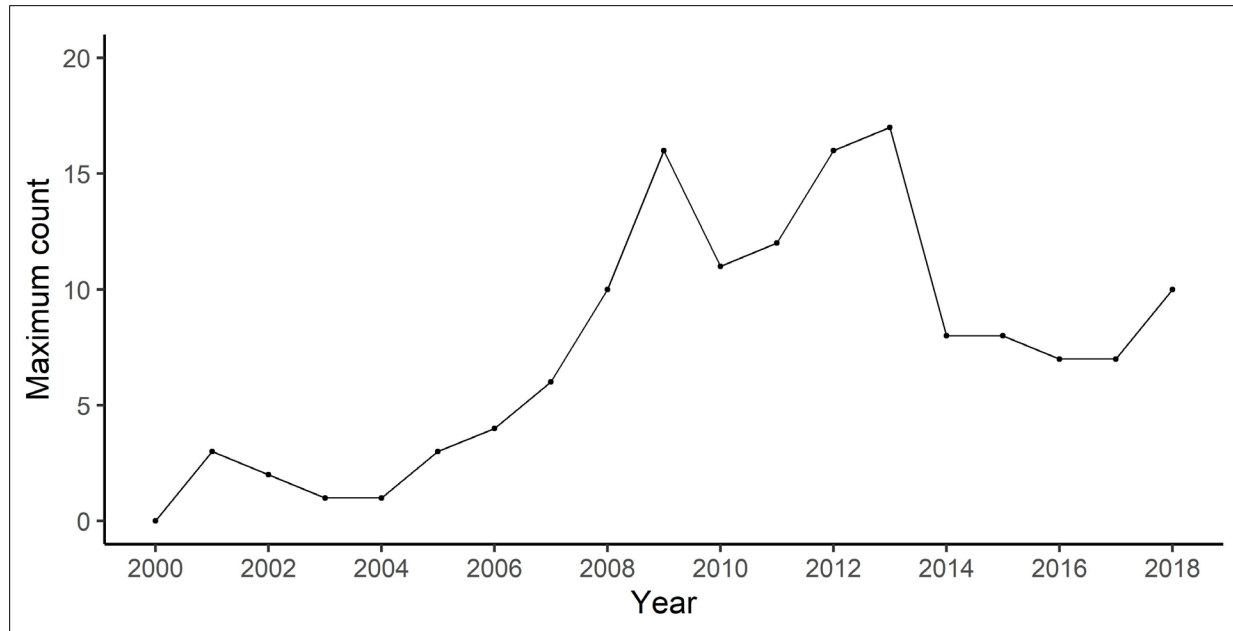


Figure 4. Maximum harbor seal pup counts at Point Bonita during the breeding season (March – May), 2000-2018. Beginning in 2007, public access to this site was restricted to protect harbor seals.

Phenology

Typically, the first viable pup is seen in mid-March at either Drakes Estero or Double Point. The first reported pup of 2017 was seen on March 17 at Bolinas Lagoon and in 2018 the first pups were reported at Drakes Estero and Tomales Bay on March 23 (Figure 5). Although, at Tomales Bay a pup was not seen again until April 9, 2018, so the first pup seen might have been an error in pup identification or the pup did not survive. The dates for the first reported pup at Double Point in 2017 and 2018 are not accurate since fewer surveys were conducted in those years and, therefore, not included in Figure 5. 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 more sophisticated analyses are necessary to determine statistical significance (Figure 5).

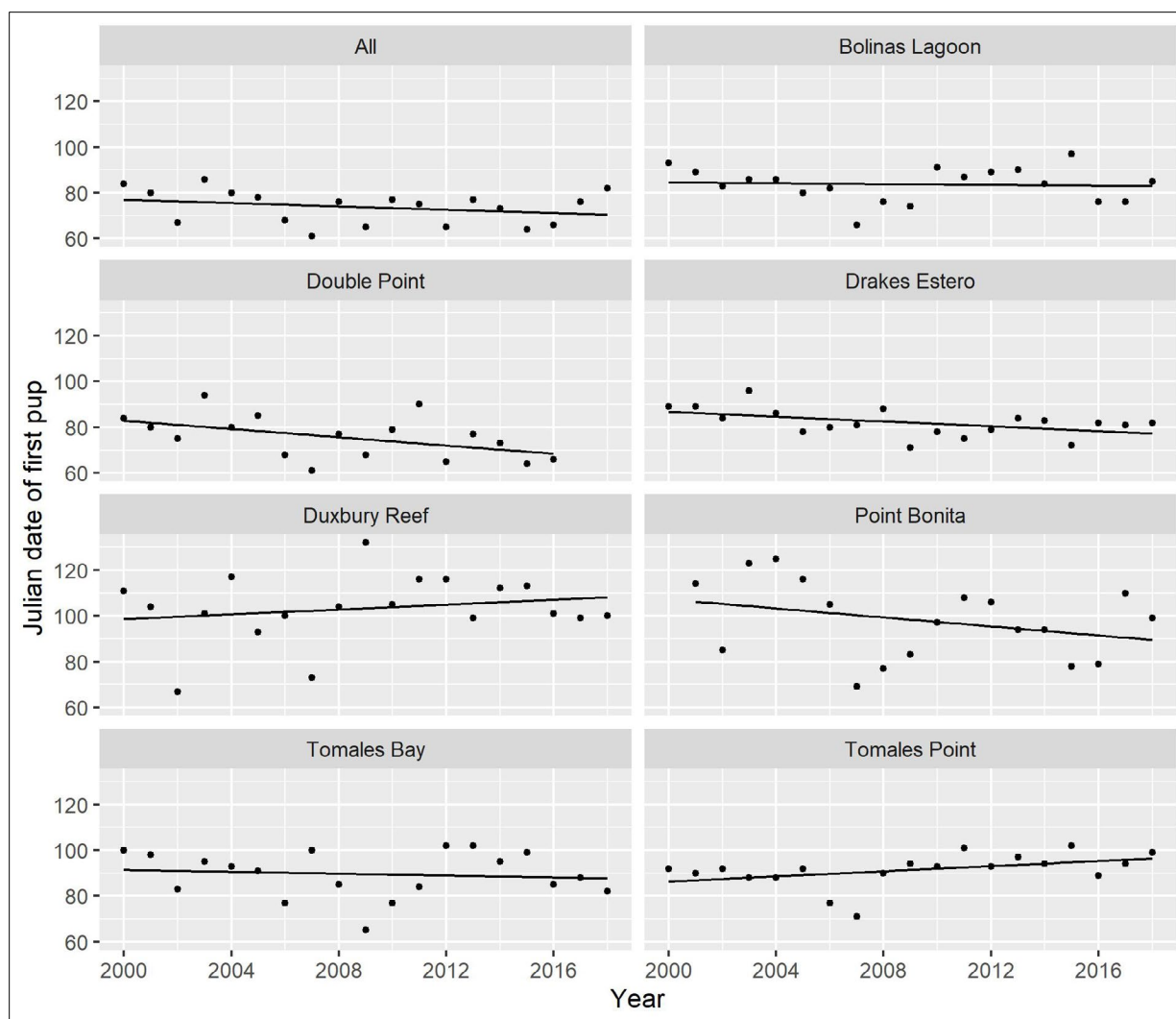


Figure 5. Date of first live pup observed for 2000-2018. A linear trend line was fitted to the data points, however, no analyses were run to determine statistical significance.

Molt Counts

The maximum count of all seals during the molt season for all Marin County sites was 3,124 seals in 2017 and 3,289 seals in 2018. Both of these counts are below average and are the third and fourth lowest counts of the monitoring time series (Figure 6). In past years, Drakes Estero Complex and Double Point comprised the majority of the total seals counted during the molt season. However, since 2016, Bolinas Lagoon and Drakes Estero have made up the majority of the seals counted during the molt season. These two sites combined made up 53% (1,643) of the total seals counted during the molt season in 2017 and 52% (1,716) in 2018 (Table 2). The number of seals recorded during the molt season at Bolinas Lagoon has been increasing since 2014, while the number of seals recorded at Double Point has been declining. In 2017, Bolinas Lagoon had a peak count of 766 molting seals, the second highest count on record, while Double Point had a count of 181 seals, the lowest count on record throughout the 20-year study period and an 80% decrease from the site average of 996 seals. In 2018, Double Point had a count of 341 seals, which is the second lowest count in the study period.

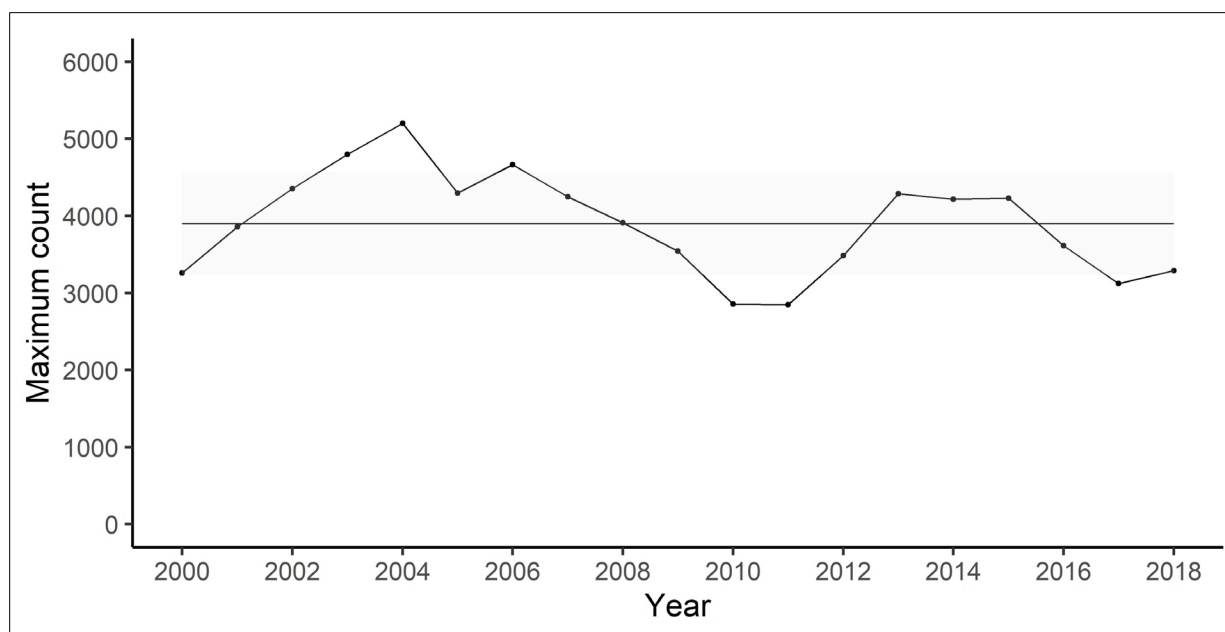


Figure 6. Maximum harbor seal counts during the molt season (June-July) for 2000-2018 at Marin County sites. The horizontal line on the graph represents the mean of the maximum molt counts from 2000-2015 (mean = 4,023) and the gray shaded area represents one standard deviation from the mean (SD = 660.2).

Disturbances

At the Marin County sites, 97 and 90 disturbances that elicited a response from harbor seals were recorded in 2017 and 2018, respectively. Both years were less than the average of 123 disturbances (Table 3). The most common disturbance sources were motorboats (30% in 2017 and 29% in 2018), humans on foot (17% in 2017 and 22% in 2018), and unknown (28% in 2017 and 20% in 2018, Table 3). In 2017, the number of disturbances at Tomales Bay (49) made up 50% of the recorded disturbances throughout all Marin County sites. Clammers (a subset of humans on foot) and motor boats were the main sources of disturbance on Tomales Bay.

Table 3. Number and percentage of identified sources of disturbances (head alert, flush, flush into water) for Marin County sites. 2017 and 2018 data are compared to the 2000 – 2015 mean $\pm$ 1 SD.

Year	Measure	Motorboat	Non-Motor Boat	Vehicle	Dog	Aircraft	Human	Bird	Unknown	Other	Total
2000 - 2015 mean	(#)	16.1 $\pm$ 6.61	10.9 $\pm$ 5.30	3.9 $\pm$ 3.56	0.6 $\pm$ 0.81	7.9 $\pm$ 4.18	36.9 $\pm$ 14.88	11.1 $\pm$ 4.28	30.4 $\pm$ 7.83	5.2 $\pm$ 3.39	123 $\pm$ 31.12
	(%)	13.3 $\pm$ 5.74	8.6 $\pm$ 3.07	3.0 $\pm$ 2.15	0.4 $\pm$ 0.63	6.4 $\pm$ 3.52	29.5 $\pm$ 8.04	9.3 $\pm$ 3.91	24.9 $\pm$ 4.12	4.4 $\pm$ 2.72	–
2017	(#)	29	4	1	0	12	16	6	27	2	97
	(%)	29.9	4.1	1.0	0.0	12.4	16.5	6.2	27.8	2.1	–
2018	(#)	26	8	1	1	11	20	2	18	3	90
	(%)	28.9	8.9	1.1	1.1	12.2	22.2	2.2	20.0	3.3	–



Human activity on Seal Island in Tomales Bay. Harbor seals are hauled out on the tip of the sandbar in the middle of the image. Numerous boats and recreational clammers are in the vicinity of the seals (NPS/JIM FORSELL).

Additionally, the rate of disturbances per hour in 2017 and 2018 was highest in Tomales Bay (0.59 and 0.49 disturbances/hour, respectively; Figure 7). In 2017, slight increases in disturbance rates compared to 2016 were seen at Drakes Estero, Point Bonita, and Tomales Point, and decreases were seen at all other sites (Figure 7). In 2018, decreases in disturbance rates compared to 2017 were seen at all sites except Drakes Estero and Duxbury Reef (Figure 7). The rates of disturbances vary from year to year depending on activities at each location, but trends have not been analyzed.

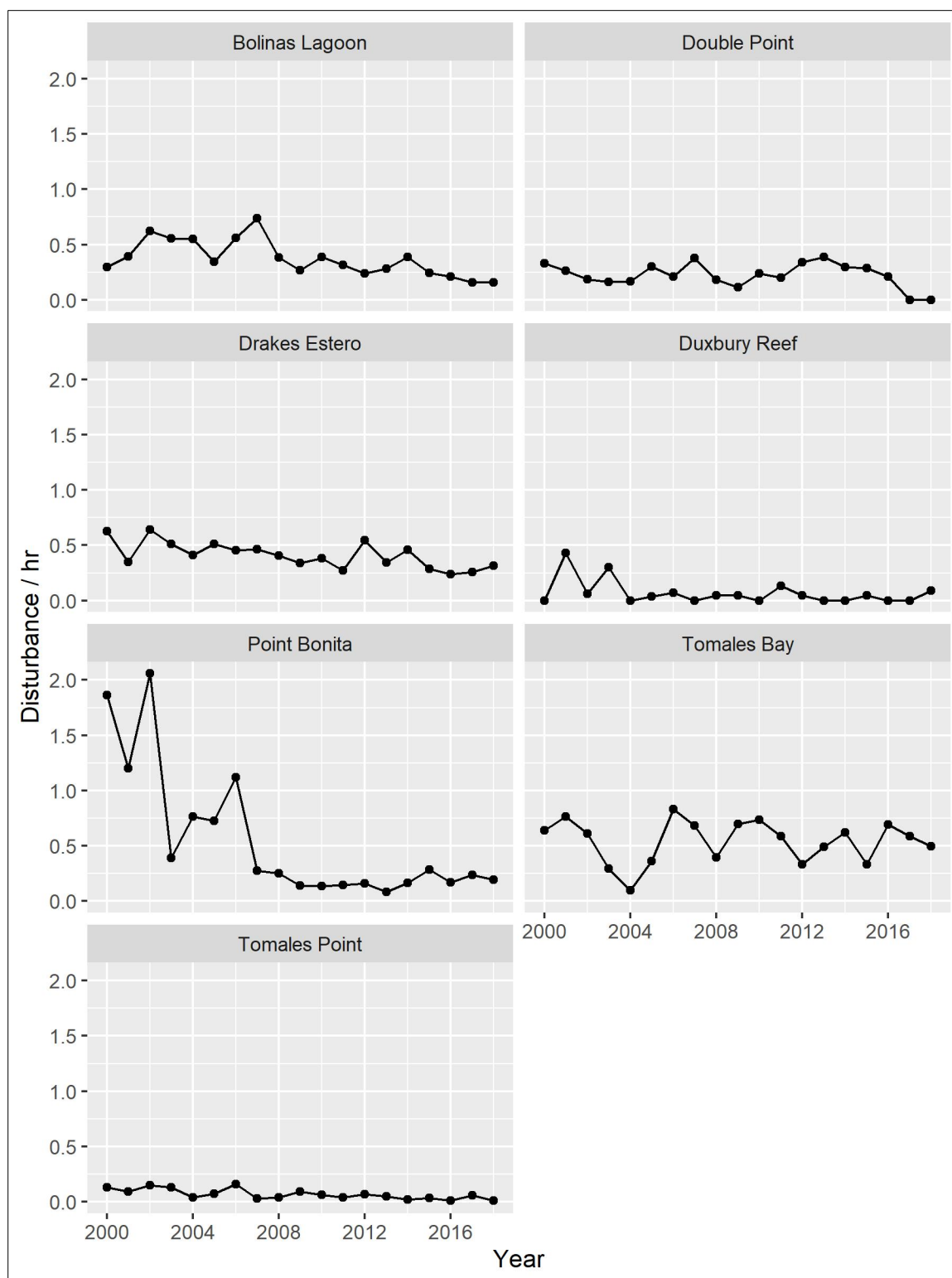


Figure 7. Rates of disturbances per hour at Marin County sites from March through July of 2000-2018. Only actual disturbances (head alert, flush, flush water) were used, and survey time was based on observation time for all complete surveys (with or without disturbances).

Regional Sites

Thirteen regional surveys occurred between March 2 and July 31, 2017 and 12 regional surveys occurred between March 8 and July 30, 2018 at 23 different locations. Not all sites were surveyed on all scheduled days due to weather conditions or scheduling conflicts. During the 2017 breeding season, a maximum of 4,032 adults/immatures and 1,264 pups were observed, although the maximum counts may have occurred on different days for each location (Table 4). During the 2018 breeding season, a maximum of 3,985 adults/immatures and 1,382 pups were recorded. During the molt season, the combined maximum count of all seals from each site was 5,137 in 2017 and 5,154 in 2018. Of these areas, Marin County sites accounted for 62% of breeding season adult and immature animals in 2017 (2,516 of 4,032) and 64% in 2018 (2,534 of 3,985), 72% of pups in 2017 (913 of 1,264) and 71% in 2018 (986 of 1,382), and 63% of seals during the molting season in 2017 (3,244 of 5,137) and 63% in 2018 (3,262 of 5,154), 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 2017 molt season was 7,911 (95% CI = 5,959–9,863) and 7,937 (95% CI = 5,979 – 9,896; Harvey and Goley 2011) during the 2018 molt season.

Table 4. Regional surveys of harbor seal numbers in central California, March 2 – July 31, 2017 and March 8 – July 30, 2018. In 2017, 13 surveys were scheduled on alternating weekends, eight during the breeding season and five during the molt season. In 2018, 12 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).

Regional Area	Location	2017 Breeding Season					2017 Molting Season				2018 Breeding Season					2018 Molting Season			
		N	Adult Mean ¹	SE	Adult Max ²	Pup Max	N	Mean ³	SE	Max ³	N	Adult Mean ¹	SE	Adult Max ²	Pup Max	N	Mean ³	SE	Max ³
Sonoma County	Sonoma Coast	8	131	8.0	158	62	5	213	10.7	242	7	148	6.6	171	53	5	150	22.2	215
	Fort Ross	3	71	11.0	92	5	1	–	–	132	5	85	13.2	92	13	3	144	19.2	182
	Jenner	8	187	32.5	204	12	5	140	37.4	219	6	179	12.8	179	22	5	198	22.8	260
	Bodega Marine Reserve ⁴	6	42	6.0	61	9	4	63	8.4	82	6	37	4.9	45	9	1	–	–	67
Marin County	Tomales Bay	8	399	47.6	588	108	5	266	7.3	268	7	433	30.9	453	109	4	250	21.7	305
	Tomales Point	8	136	16.2	182	68	5	287	29.7	352	7	178	16.7	242	73	3	281	65.7	410
	Point Reyes Headland ⁴	6	59	6.0	82	27	4	188	56.2	291	7	57	7.1	78	35	4	160	44.0	267
	Drakes Estero Complex	8	430	70.2	729	317	5	676	84.1	877	7	498	61.1	690	354	4	737	121.5	1067
	Double Point	1	–	–	345	139	1	–	–	341	3	289	83.2	429	148	1	–	–	341
	Duxbury Reef	8	41	9.2	54	13	5	89	23.4	112	7	63	9.7	94	3	5	45	20.4	79
	Bolinas Lagoon	8	261	36.8	437	236	5	529	75.7	732	7	338	46.8	438	258	5	406	82.6	641
	Point Bonita ⁴	8	56	13.4	99	5	5	204	18.1	271	7	99	12.0	110	6	5	120	17.9	152
San Francisco Bay	Alcatraz	8	2	0.8	2	0	2	1	0.5	1	6	8	2.1	15	0	3	3	1.2	5
	Castro Rocks ⁴	8	172	16.0	191	56	5	213	18.3	267	7	235	25.5	220	78	4	228	34.5	313
	Yerba Buena Island	8	80	14.7	143	29	5	94	17.4	155	7	125	13.8	135	32	3	122	19.9	149
	Newark Slough ⁴	3	32	12.3	51	42	1	–	–	5	2	48	14.0	62	19	1	–	–	16
	Mowry Slough ⁴	3	55	26.7	103	50	1	–	–	45	2	88	7.0	95	19	1	–	–	12
San Mateo County	Point San Pedro ⁴	5	0	0.0	0	0	3	11	5.7	19	6	8	3.6	14	0	4	9	8.9	36
	Cowell Ranch ⁴	8	40	5.5	57	16	4	46	19.8	93	6	42	5.8	50	15	4	51	12.0	77
	Purisima Creek ⁴	7	50	6.3	78	22	4	59	16.8	91	7	55	6.1	65	27	4	87	6.9	98
	Pescadero ⁴	8	53	3.5	61	9	4	48	6.4	59	7	44	6.0	46	13	4	36	5.1	45
	Pebble Beach ⁴	8	47	4.0	64	7	4	85	3.4	91	7	37	7.3	59	15	4	62	10.1	85
	Fitzgerald Marine Reserve ⁴	7	122	29.6	251	32	5	264	39.5	392	7	187	23.1	203	81	5	263	18.2	332
ALL SITES	–	–	–	–	4,032	1,264	–	–	–	5,137	–	–	–	3,985	1,382	–	–	–	5,154

¹Adults and immatures during the breeding season, March 3 – May 31.
²Adults and immatures during the peak of the breeding season, mid-April to mid-May.
³All age classes during the molt season, June 1 – July 25.
⁴Includes surveys that occurred outside of regional weekend period.

Sonoma County

The 2017 and 2018 maximum adult/immature and pup counts during the breeding season at Sonoma County sites were lower than the counts recorded since 2013 when Fort Ross was added into the surveys (Figures 8 and 9). Among Sonoma County sites, Jenner had the high count of adults/immatures and Sonoma Coast had the high count of pups (Table 4). The 2017 and 2018 Sonoma County molt counts were lower than the counts since 2013; however, 2018 had an increase compared to 2017 (Figure 10). Sonoma Coast had the highest molt counts among Sonoma County sites in 2017 and Jenner had the highest molt counts in 2018 (Table 4). There were no known disturbances at Sonoma County sites in 2017. A potential disturbance occurred at a Sonoma Coast site when visitors were seen walking on rocks at a known harbor seal haul-out, but no seals were present. In 2018, Sonoma Coast had one disturbance caused by beach walkers and a potential disturbance caused by fishermen who were at a haul-out, but no seals were present. Fort Ross had a few disturbances caused by fishermen, divers, kayakers, and beach walkers. Most disturbances in Sonoma County resulted in head alerts and only one known disturbance resulted in seals retreating to the water.

San Francisco Bay

The 2017 and 2018 maximum adult/immature and pup counts at SFB are among the highest counts recorded in this region (Figures 8 and 9). The 2017 and 2018 molt counts are also high counts for this region and continue the increasing trend seen since 2015 (Figure 10). Newark and Mowry Sloughs only had one survey completed during each of the 2017 and 2018 molt seasons and these were conducted early in the season when maximum counts would not have occurred. These counts were still included in the summarized data for the SFB region, but it is assumed that the overall regional count would have been much higher if surveys had been conducted at Newark and Mowry Sloughs during the peak of the molt season. Within SFB, the high counts for adults/immatures, pups, and molting seals occurred at Castro Rocks (Table 4). In SFB, multiple disturbances occurred at all sites except Newark and Mowry Sloughs. Disturbance sources included aircraft, motorboats, birds, harbor seal monitors, and unknown sources. In 2017, most disturbances resulted in seals retreating into the water, whereas in 2018, most disturbances resulted in head alerts.

San Mateo County

The maximum adult/immature counts during the 2017 and 2018 breeding seasons at San Mateo County sites are similar to the counts in previous years (Figure 8). Although, it should be noted there are many years where some sites were not surveyed and a new site, which contributes substantial numbers to the county totals, was added in 2012. The 2017 maximum pup count was a large decrease compared to recent years, however, the pup count in 2018 was the highest recorded for this region (Figure 9). The molt counts in 2017 and 2018 are similar to the counts in 2015 and 2016, but are a decrease from a peak in 2014 (Figure 10). Among San Mateo County sites, Fitzgerald Marine Reserve had the high counts of adults/immatures, pups, and molting seals (Table 4). Only one disturbance was recorded in 2017; it was caused by tidepoolers at Fitzgerald Marine Reserve. No disturbances were recorded in 2018 at the San Mateo County sites.

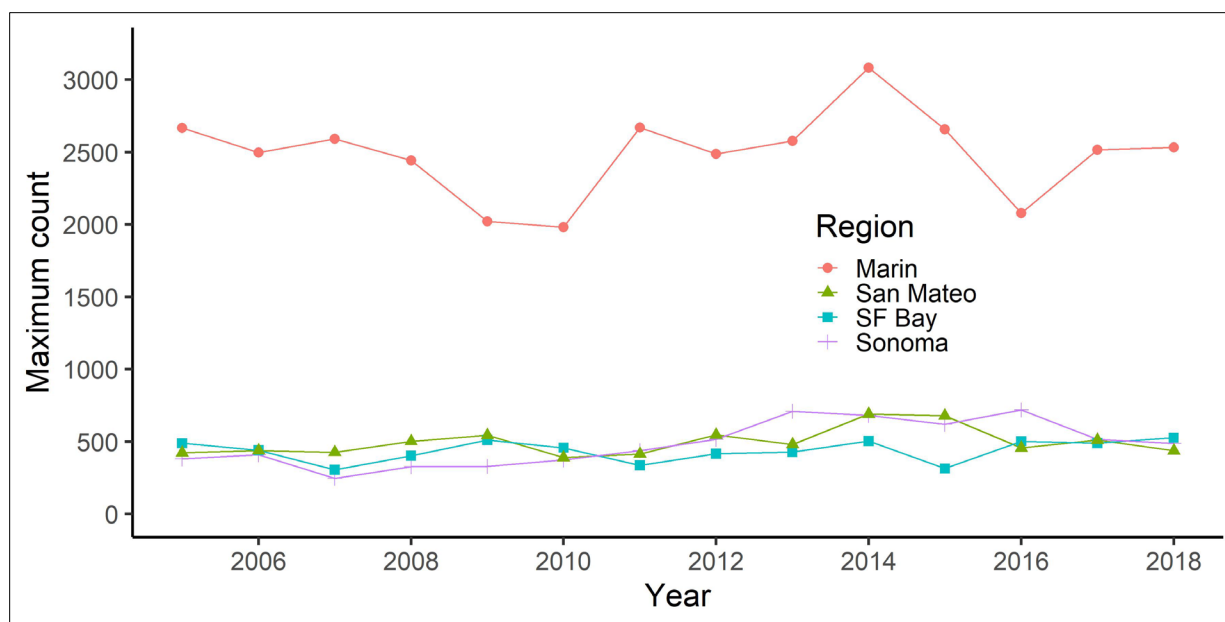


Figure 8. Maximum counts of harbor seal adults and immatures by region during the breeding season for the 2005-2018 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010, Purisima Creek was added to San Mateo County in 2012, and Fort Ross was added to Sonoma County in 2013. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007.

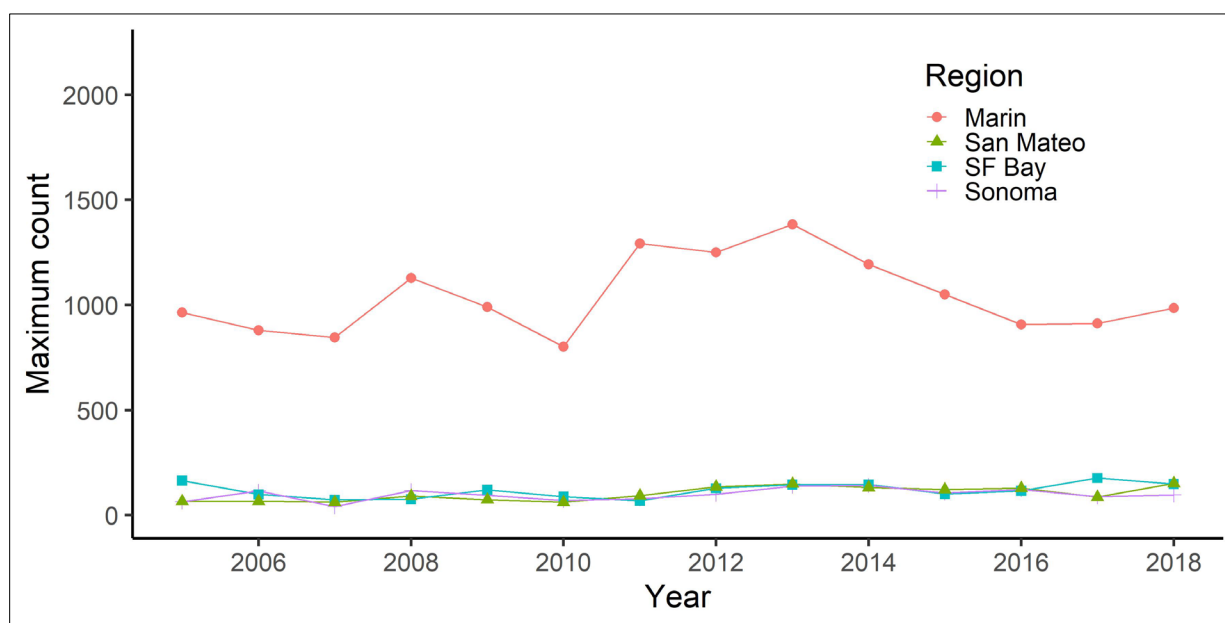


Figure 9. Maximum counts of harbor seal pups by region during the breeding season for the 2005-2018 regional surveys in Central California. Bodega Marine Reserve was added to Sonoma County in 2010, Purisima Creek was added to San Mateo County in 2012, and Fort Ross was added to Sonoma County in 2013. Incomplete surveys occurred in San Mateo County in 2006 and 2013 and San Francisco Bay in 2007.

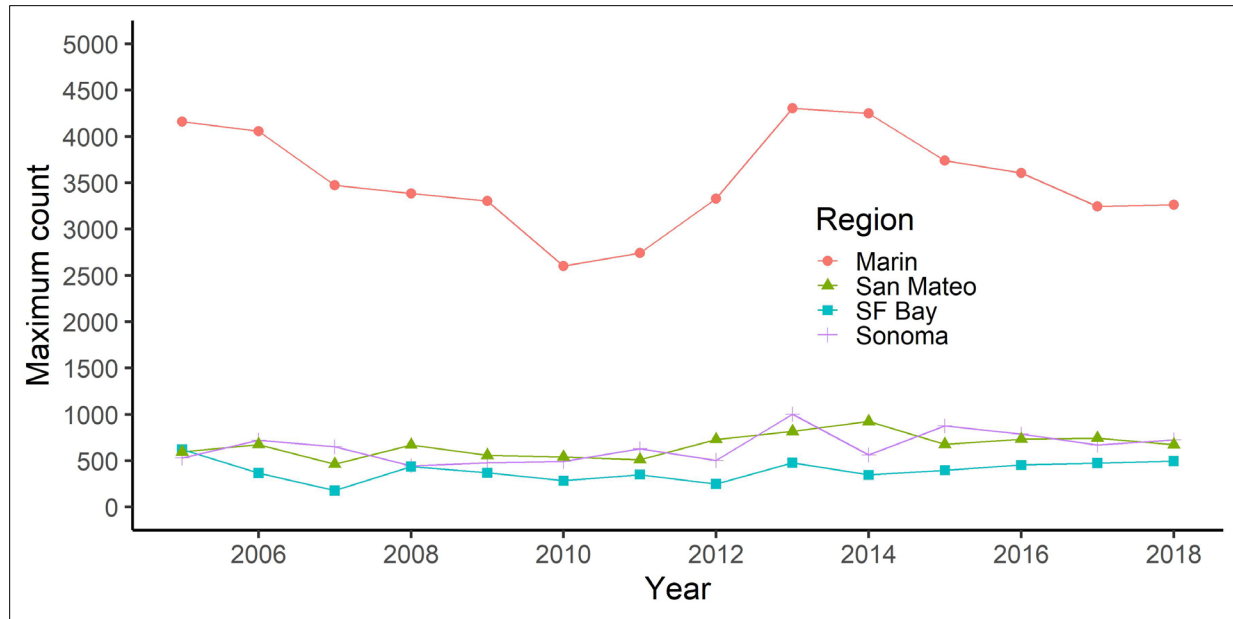


Figure 10. Maximum counts of all age classes of harbor seals by region during the molting season for the 2005-2018 regional surveys in central California. Bodega Marine Reserve was added to Sonoma County in 2010, Purisima Creek was added to San Mateo County in 2012, and Fort Ross was added to Sonoma County in 2013. Incomplete surveys occurred in San Mateo County in 2006 and 2013, San Francisco Bay in 2007, 2012, and 2015, Marin County in 2010, and Sonoma County in 2014.

Discussion

The adult/immature counts for Marin County sites during the 2017 and 2018 breeding seasons were similar to the baseline average. The pup count in 2017, however, was slightly below average, whereas the pup count in 2018 was more similar to the baseline average. El Nino/Southern Oscillation (ENSO) conditions were unsettled in recent years, which may have had a negative effect on pup production in 2017 (NOAA 2019). The molt season counts for 2017 and 2018 were both below average, with Double Point being the site with the largest decrease compared to its average.

From 2000-2015, the Drakes Estero Complex and Double Point annually produced the highest numbers of harbor seal pups and together were typically the primary breeding and molting sites for harbor seals of Marin County and the region. However, starting in 2017 and continuing into 2018, the peak pupping sites were Bolinas Lagoon and the Drakes Estero Complex with those sites combined comprising approximately 60% of the pups recorded. The pup counts at Double Point in 2017 and 2018 were an approximate decrease of 50% from the site's average. Since 2016, Bolinas Lagoon and Drakes Estero have been the primary molting sites and in 2017 and 2018 the sites combined made up 52% of the seals recorded in Marin County during the molt season. The molt counts at Double Point in 2017 and 2018 were approximately 70% 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. Due to safety concerns at the observation site at Double Point, we had to reduce the number of surveys conducted at this site and, therefore, only four surveys were conducted in 2017 and five surveys in 2018. There is a possibility that the peak count was missed, however, the dates of the surveys were picked based on past peak dates at that site.

Throughout the study area from 2000-2018, the primary sites that experienced disturbances were Tomales Bay, the Drakes Estero Complex, Bolinas Lagoon, and Double Point. Tomales Bay had the highest disturbance rates recorded for 2017 and 2018 (0.59 and 0.49 disturbances/hour, respectively), and the rate was much higher than all other survey sites (range 0.01 – 0.31 disturbances/hour). The disturbance sources at Tomales Bay were primarily motorboats and clambers. Throughout most of the study period, Tomales Bay 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. The most common source categories of disturbance for all Marin County sites in 2017 and 2018 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 B.1).

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 both in 2017 and 2018. SFAN 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, Greater Farallones National Marine Sanctuary, UC Davis Bodega Marine Laboratory, Greater Farallones National Marine Sanctuary Association, Fort Ross Conservancy, Stewards of the Coast and Redwoods Seal Watch program, and other volunteers.

Season Highlights

- In 2017, 33 volunteers and two NPS staff members completed 234 surveys at eight Marin County sites between March 1 and July 31, 2017, with approximately 425 monitoring hours. In 2018, 37 volunteers and two NPS staff members completed 253 surveys at eight Marin County sites between March 1 and July 31, 2018, with approximately 430 monitoring hours.
- A maximum of 2,529 adult and immature seals in 2017 and 2,536 adult and immature seals in 2018 were counted onshore during the breeding season.
 - The highest number of adults/immatures hauled out at Drakes Estero Complex (729 in 2017 and 690 in 2018).
 - Higher than average counts were recorded at Bolinas Lagoon in 2017 and 2018.
- A maximum of 950 pups were recorded in 2017 and 1,033 pups in 2018 at Marin County colonies.
 - The Drakes Estero Complex and Bolinas Lagoon accounted for 60% of pups at Marin County colonies in both 2017 and 2018. This is a change from previous years in that Double Point and Drakes Estero usually comprise the majority of pups in Marin County.
 - An approximate 50% decrease in pups was recorded at Double Point.
- During the molt season a maximum of 3,124 seals (all age classes) were counted in 2017 and 3,289 seals in 2018 at Marin County haul-out sites.
 - In 2017 and 2018, Bolinas Lagoon and the Drakes Estero Complex accounted for 52% of all seals surveyed at Marin County sites.
 - The counts at Double Point in 2017 and 2018 are the lowest counts on record at this site and much less than the site's average of 996 seals.
- In 2017, 97 disturbances were recorded during surveys and in 2018, 90 disturbances were recorded.

- The most frequent causes in both 2017 and 2018 were motorboats (30% and 29%, respectively), unknown sources (28% and 20%, respectively), and humans on foot (17% and 22%, respectively)
- The highest disturbance rate (0.59 disturbances/hour in 2017 and 0.49 disturbances/hour in 2018) occurred in Tomales Bay.
- Regional surveys occurred 13 times throughout the breeding and molt seasons (March-July) in 2017 and 12 times in 2018. The sites include locations in San Francisco Bay and Sonoma, Marin, and San Mateo counties.
 - In 2017, Marin County sites accounted for 62% of breeding season adult and immature seals, 72% of pups, and 63% of seals during the molting season. In 2018, Marin County sites accounted for 64% of breeding season adult and immature seals, 71% of pups, and 63% of seals during the molting season.

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Appendix A. Summaries by Site

Tomales Bay

Observers completed 38 high quality surveys at Tomales Bay between March 1 and July 31, 2017, and 38 high quality surveys between March 1 and July 31, 2018. The maximum breeding season adult/immature count was 588 seals in 2017 and 453 seals in 2018 (Table 2). The 2017 count was one of the highest counts on record at Tomales Bay, but the 2018 count was similar to the baseline average of 438 seals. The maximum pup count in 2017 was 104 pups, which is less than the baseline average (139 pups), whereas the 2018 pup count was 144 and is similar to the average. The first pups of the year at this site were recorded on March 29, 2017 and March 23, 2018. The first pups recorded in 2018 were seen at Tomales Bay and Drakes Estero. During the molting season, the maximum seal count was 343 in 2017 and 305 in 2018, both of which are less than the average (409 seals). The disturbances at Tomales Bay were primarily caused by motorboats and clambers on the sandbars, as the bay is a very popular spot for fishing and clamming. There were multiple incidents of boats landing directly on the sandbar where seals were hauled out and of clambers walking towards seals causing them to flush into the water. The disturbance rates for both 2017 and 2018 (0.59 and 0.49 disturbances/hr, respectively; Figure 7) were similar to the average of 0.53 disturbances/hr.

Tomales Point

Observers completed 31 high quality surveys at Tomales Point between March 1 and July 31, 2017, and 27 high quality surveys between March 1 and July 31, 2018. During the breeding season, the maximum adult/immature count was 190 seals in 2017 and 242 seals in 2018. Both counts are below the average of 358 seals, with the 2017 count being the lowest count on record at this site. The maximum pup count in 2017 was 68 and in 2018 was 73 (Table 2). Both of these counts are the lowest counts recorded at this site and are much lower than the average (136 pups). The first pup at this site in 2017 was recorded on April 6 and in 2018 on April 9. The maximum seal count during the molting season was 352 in 2017 and 410 in 2018, both of which are less than the average of 477 seals. Very few disturbances were recorded at Tomales Point (six in 2017 and one in 2018). Due to its remoteness, the Tomales Point location is generally not frequented by visitors. However, because of the distance between the subsites, surveyors are not at any one subsite long enough to generally see disturbances occur.

Point Reyes Headlands

Observers completed 12 high quality surveys at Point Reyes Headlands between March 1 and July 31, 2017, and 11 high quality surveys between March 1 and July 31, 2018. Surveys at this site were only conducted during regional survey periods. During the breeding season, the maximum adult/immature count was 82 in 2017 and 78 in 2018, both of which are less than the average count of 107 seals. The maximum pup count was 27 in 2017 and 35 in 2018, and these two counts were also lower than the average count (47 pups). The maximum molt season seal count was 291 in 2017 and 267 in 2018 (Table 2), and both of these counts are less than the average of 350 seals. 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 during the 2017 and 2018 seasons. 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.

Drakes Estero Complex

Observers completed 34 high quality surveys in the Drakes Estero Complex, which includes Limantour Spit, between March 1 and July 31, 2017, and 32 high quality surveys between March 1 and July 31, 2018. The maximum counts during the breeding season were 729 adults/immatures and 318 pups in 2017 and 690 adults/immatures and 362 pups in 2018 (Table 2). All counts are similar to their respective site averages (779 adults/immatures and 346 pups). The first pup at Drakes Estero was recorded on March 22, 2017, and March 23, 2018. The maximum molt count was 877 seals in 2017 and 1,067 seals in 2018 (Table 2). The count recorded in 2017 is lower than the average of 1,073 seals, but the count in 2018 was back up to being similar to the average. The majority of disturbances at Drakes Estero were caused by unknown sources. The estuary is seasonally closed to kayaking from March 1 through June 30 during the critical pupping period, however, there was one incident of a kayak in the estuary during the closure. Multiple sightings of a coyote near the harbor seal haul-outs in the estuary are part of an increasing trend the last few years of more coyote caused disturbances. The disturbance rates in 2017 and 2018 (0.26 and 0.31 disturbances/hr, respectively; Figure 7) were both increases from 2016, but are still less than the average of 0.44 disturbances/hr.

Double Point

Observers completed 4 high quality surveys at Double Point between March 1 and July 31, 2017, and 5 high quality surveys between March 1 and July 31, 2018. Due to recent landslides near the observation spot and other safety concerns, the number of surveys conducted at this site has been reduced to only occur during the peaks of the breeding and molt seasons. The maximum adult/immature count during the breeding season in 2017 was 345 seals and in 2018 was 429 seals (Table 2), both of which are less than the average of 542 seals. The 2017 pup count of 177 and the 2018 pup count of 148 are among the lowest counts on record and are much lower than the average count of 309 pups. The estimated date of the first viable pup is not reliable because of the low number of surveys completed at this site. The molt season in 2017 yielded a maximum count of 181 seals and in 2018 there were 341 seals recorded. Both of these counts are the lowest on record and much lower than the average of 996 seals, with the count in 2017 being 82% less than the average and the 2018 count being 66% less. However, with the low number of surveys during the molt season and the peak of the season being less predictable than during the breeding season, the peak might have been missed. There were no disturbances recorded in 2017 and 2018, which is most likely due to the low number of surveys conducted.

Duxbury Reef

Observers completed 30 high quality surveys at Duxbury Reef between March 1 and July 31, 2017, and 34 high quality surveys between March 1 and July 31, 2018. During the breeding season, the maximum counts were 59 adults/immatures and 13 pups in 2017 and 94 adults/immatures and 3 pups in 2018 (Table 2). The adult/immature count in 2017 is similar to the site's average count of 68 seals, but the 2018 count is higher than average. The pup count in 2017 is more than the average of 5 pups, while the 2018 count is close to average. The first day a pup was recorded at this site in 2017 was on

April 9 and in 2018 the first pup was seen on April 10. Few pups are seen here, and they possibly come from nearby Bolinas Lagoon. During the molt season, the maximum seal count in 2017 was 112 seals, which is greater than the average of 78 seals; while the count in 2018 was 79 seals, which is the same as the average. In 2017, there were no disturbances recorded, but in 2018 there were two disturbances. Disturbances are rarely recorded at Duxbury Reef, possibly due to the poor accessibility for humans at this location.

Bolinas Lagoon

Observers completed 31 high quality surveys at Bolinas Lagoon between March 1 and July 31, 2017, and 37 high quality surveys between March 1 and July 31, 2018. The maximum adult/immature count during the breeding season was 437 seals in 2017 and 438 seals in 2018. Both of these counts are the highest recorded at this site and are greater than the average of 291 seals. The maximum pup count was 236 pups in 2017 and 258 in 2018 (Table 2). Similar to the adult count, these pup counts are among the highest recorded at this site and greater than the average of 158 pups. The first viable pups were recorded on March 17, 2017 and March 23, 2018. During the molt season, the maximum count was 766 seals in 2017 and 649 seals in 2018. These molt counts are greater than the average of 476 seals and the count in 2017 was one of the highest counts on record at this site. Higher than average molt counts have been recorded at Bolinas Lagoon since 2014. Both in 2017 and 2018, there were fewer disturbances recorded at this site than in previous years. The disturbance rate in 2017 and 2018 was 0.16 disturbances per hour, which is lower than the average rate of 0.44 (Figure 7). The disturbances were caused by various sources and included humans on foot, kayakers, stand up paddle boarders, aircraft, and unknown sources.

Point Bonita

Observers completed 37 high quality surveys at Point Bonita between March 1 and July 31, 2017, and 46 high quality surveys between March 1 and July 31, 2018. The maximum adult/immature count during the breeding season was 99 seals in 2017 and 112 in 2018 (Table 2), both of which are similar to the average (114 seals). The 2017 pup count was 7 seals and the 2018 pup count was 10 seals. The pup count in 2017 was the same as the site's average of 7 pups, but the 2018 pup count was higher than the average. The first pups were recorded on April 20, 2017 and April 9, 2018. The maximum molt count in 2017 was 202 seals, which is greater than the baseline average of 163 seals. In 2018, the maximum molt count was 171 seals, which is similar to the average. The disturbances at Point Bonita were primarily caused by motorboats, aircraft, school groups, and unknown sources. The disturbance rate for 2017 was 0.24 disturbances per hour and for 2018 was 0.2 disturbances/hr (Figure 7). Both of these rates are higher than most of the annual disturbance rates from the past 10 years.

Appendix B. Identified sources of disturbances for Marin County sites from March through July, 2000-20018

Table B.1. Identified sources of disturbances (head alert, flush, flush into water) for Marin County sites from March through July, 2000-2018. The mean includes disturbance sources from the baseline period 2000 – 2015.

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
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
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

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