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Natural Resource Stewardship and Science

Tule Elk Monitoring and Management at Point Reyes National Seashore

2015–2016 Report

Natural Resource Report NPS/SFAN/NRR—2018/1656



ON THE COVER

Bull tule elk observed thrashing vegetation during the 2016 rut, Point Reyes National Seashore.
Photo courtesy of National Park Service (Tim Bernot).

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2015–2016 Report

Natural Resource Report NPS/SFAN/NRR—2018/1656

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Point Reyes National Seashore
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Executive Summary

Native tule elk (*Cervus elaphus nannodes*) at Point Reyes National Seashore occur in three separate herds at Tomales Point, Drakes Beach, and in the Estero Road/Limantour area. During 2015 and 2016, elk numbers at Tomales Point remained stable, but well below past counts, at 283 and 290 total elk, respectively. Numbers of elk at Tomales Point declined dramatically during drought conditions in 2013 and 2014 and did not recover in 2015 and 2016. Concurrently, elk numbers in the Drakes Beach and the Estero Road/Limantour herds increased from 2015 to 2016, but overall numbers were reduced by the collection of several elk from each herd to test for the presence of Johne's disease. Johne's disease was confirmed in the Drakes Beach herd for the first time. Through visual observations and the deployment of GPS collars, park staff monitored the presence of tule elk on park ranches. In the Drakes Beach area, a maximum of 75.2% of elk locations per year were recorded on park ranches. In the Estero Road area, where only male elk occur, up to 93.2% of elk locations per year were recorded on park ranches. In order to test translocation as a potential future management method, three elk were experimentally re-located from Drakes Beach to Limantour in March 2015 and their movements monitored. All three elk returned to the Drakes Beach herd. Additional tule elk monitoring and management actions implemented by Point Reyes staff in 2015 and 2016 included attempted captures of male elk with antler entanglements, continued water supplementation at Drakes Beach, hazing of elk from park ranches, elk fence maintenance at Tomales Point, cattle fence repair and removal, shed antler collection, development of a water supplementation plan at Tomales Point, and investigation of notable mortalities. The tule elk docent program at Tomales Point was active again in 2015 and 2016, reaching over 6,000 visitors annually. Tule education and outreach at the park also included class field trips from local universities and public presentations at park headquarters as well as a presentation at a scientific conference.

Introduction

The tule elk (*Cervus elaphus nannodes*) is one of three subspecies of elk native to California. Its numbers were severely reduced in the mid-1800s, primarily due to uncontrolled market hunting and displacement by cattle. By some accounts, fewer than 30 animals remained in a single herd near Bakersfield in the mid-1870s. A conservation-minded cattle rancher named Henry Miller preserved this last isolated group discovered on his ranch in 1874. Until this discovery, tule elk were thought to be extinct. All of the estimated 5,700 tule elk present in numerous herds across California in 2017 were derived from this small remnant herd (CDFW 2017).

Tule elk are endemic to California, and Point Reyes National Seashore (PORE) is the only national park unit where tule elk occur. Also native to California, but occurring in other states as well, Roosevelt elk (*C. elaphus roosevelti*) are found in northwestern California, while Rocky Mountain elk occur in northeastern California. Rocky Mountain elk (*C. elaphus nelsoni*) are also a non-native transplant to two areas in the southern part of California.

Tule elk once inhabited the grasslands of the Point Reyes peninsula and the Olema Valley, as well as other grasslands within Marin County. They were the dominant grazers on these lands until their local extirpation in the 1850s. Following state protection (SB 722, 1971) and federal legislation directing the federal government to make suitable lands available for "the preservation and grazing of tule elk" (PL 94-389, 1976), the California Department of Fish and Game, in cooperation with the U.S. Fish and Wildlife Service and the National Park Service (NPS), reintroduced tule elk to the park at Tomales Point. In 1978, 10 animals (8 females and 2 males) were transplanted from an existing reintroduced herd in the San Luis National Wildlife Refuge near Los Banos to a 2,600 acre fenced enclosure on Tomales Point. The site of this release had a long history of cattle ranching, known as Pierce Point Ranch, which was designated as wilderness in 1976 (PL 94-544 and PL 94-567). Cattle were removed in 1979.

Following the recommendations of a scientific advisory panel convened by the park (McCullough et al. 1993) and the release of a Tule Elk Management Plan and Environmental Assessment (National Park Service 1998), an additional free-ranging herd of tule elk was established at Point Reyes National Seashore. In 1999, 28 animals taken from the Tomales Point preserve were released in the wilderness area south of Limantour Beach (Figure 1). A few of the elk soon dispersed from the Limantour area, and by the fall of 2001, a small herd (one bull and four cows) had established itself near Drakes Beach, including in areas permitted for dairy and beef ranching.

As detailed within this report, the Drakes Beach elk occur from the edges of Drakes Estero and southwest towards the Point Reyes Headlands, the Limantour elk range from the wilderness areas near the 1999 release site and northwest to adjacent ranch lands, and the Tomales Point elk remain within the reserve, contained by an elk fence that straddles the peninsula (Figures 1 and 2). Elk are not known to move between the three herds.



Figure 1. General locations of tule elk herds at Point Reyes National Seashore.

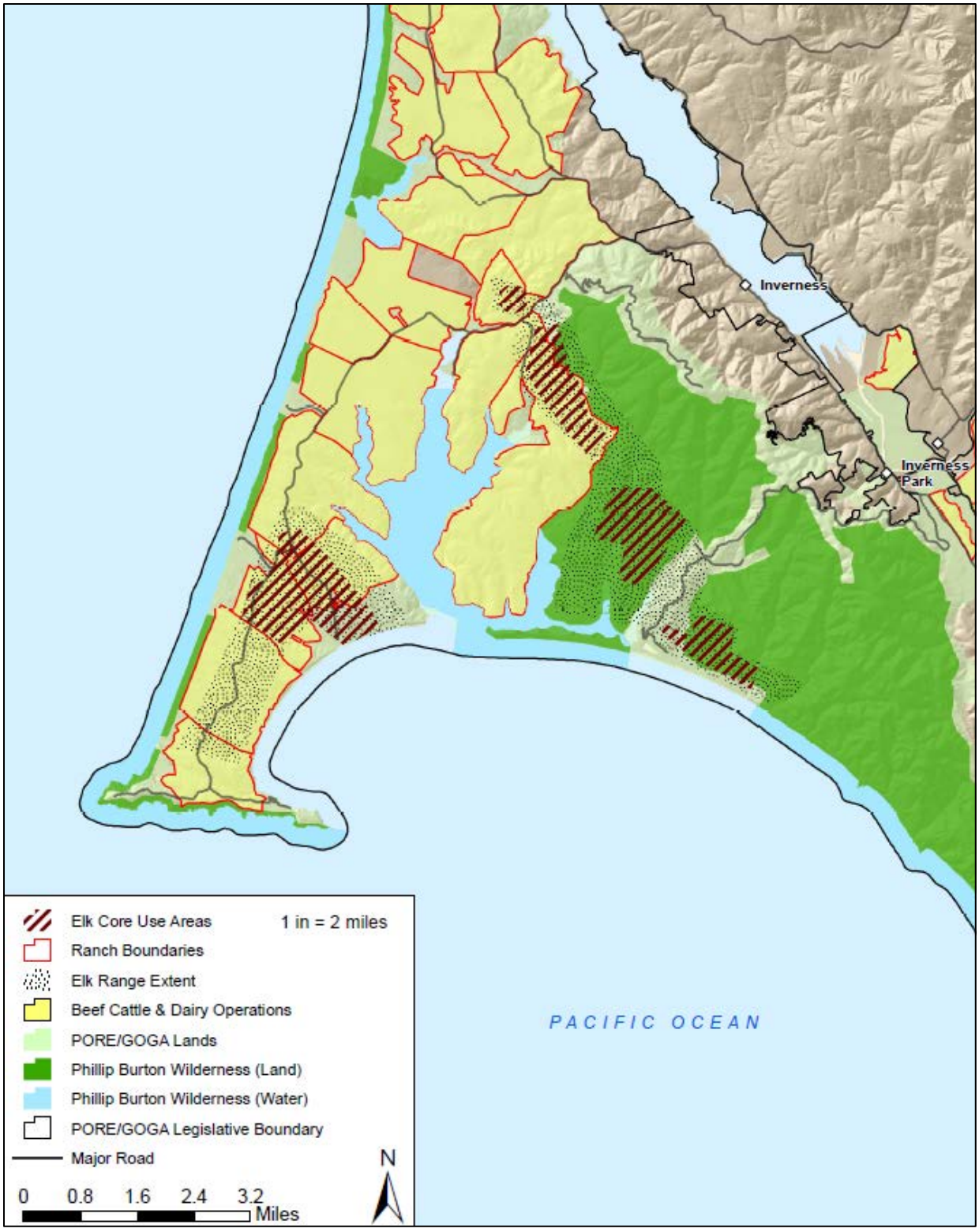


Figure 2. Core use areas of free-ranging elk herds at Point Reyes National Seashore in 2015 and 2016.

Each year Point Reyes National Seashore wildlife staff dedicates significant amounts of time and effort to the monitoring and management of native tule elk within the park. This report provides populations status updates for each of the three herds within the park, and includes sections regarding elk on park ranch lands, antler collections, disease surveillance, fencing, notable mortalities, and education and outreach efforts. The time span for this report is October 2014 through to October 2016. We also report here census data collected in late 2016 and early 2017.

Population Data

Tomales Point

Elk in the Tomales Point elk reserve are censused yearly by a team of 4-6 National Park Service staff and trained volunteers on horses, boat, and foot (Figure 1). The reserve is divided into three sectors with a census team assigned to each sector, allowing for a complete census of the peninsula in a single day. With little tree canopy on the peninsula, the elk are easily located for census. Elk observed outside, if detected, of the reserve boundary are also counted. Elk that escape the Tomales Point Reserve, typically males, never stray far from the elk fence, herd together, and are easily detected. At least two counts are conducted in November – December of each year. A third count may occur, especially if the results of the first two counts are not consistent.

During census surveys, observers record count data using notebooks and topographical maps. Observers approach groups and individual elk as closely as possible without displacing them and use binoculars to count and classify animals. Sightings of black-tailed deer, coyotes, bobcats, and other wildlife of special interest are noted, as are any elk carcasses. All observed elk are counted and classified into one of 5 groups: (1) cows - adult females, (2) calves - young of the year of either sex, (3) spikes - adult males with unbranched antlers, (4) raghorns - adult males with branched antlers having 2 to 4 tines, and (5) prime bulls - adult males with branched antlers having 5 or more tines. Locations of elk are noted on field maps during the census, and at the end of the census, observers review elk locations, especially at sector boundaries, in order to determine whether or not any elk may have been double-counted.

The final minimum population estimate is compiled from the highest daily sum of animals per classification. For example, in the event that the high count of adult cows occurs on a different day than the high count of branched antler males, data from both dates may be used in order to obtain the most accurate annual population estimate.

2015 Census

In 2015, two census events took place. In addition to the usual fall/winter census, a summer census was added to more closely monitor natality in the wake of an elk population decline at Tomales Point observed during the previous two years. The population was surveyed twice during this summer period, on July 16 and July 30. The fall/winter census was performed as usual, with surveys occurring on November 13 and December 16.

The highest total elk count in the summer survey occurred on July 30 with 278 elk observed. The previous count on July 16 was slightly lower, recording 259 elk. The total number of calves observed on the second summer census on July 30 was 32, a small increase in the number of calves observed in 2014 (Table 1), indicating a partial alleviation of negative drought effects on live births and neonate survival.

For the fall/winter census, the highest daily count was on the December 16 survey, with 283 total elk observed. The only carcasses observed was a single example on the December 16 survey, a cow elk found in the middle sector. This represents a reduction in observed carcasses during census events when compared to the last two years, also suggesting an alleviation of drought effects on the elk at Tomales Point. The final herd composition for Tomales Point in 2015 was estimated to be 165 cows, 32 calves, 10 spike males, and 86 branched antler males. Complete results from both winter censuses are included in Appendix A.

On November 13, 14 black-tailed deer, one bobcat and 4 coyotes were noted. Other wildlife species observed during the December 16 census included 34 black-tailed deer and 4 coyotes.

2016 Census

In 2016, summer counts were again performed to closely monitor natality. Surveys occurred on July 16 and August 26, with the second count higher in the number of elk. On August 26, 274 total elk including 43 calves were observed, another improvement in natality over the previous years.

The fall/winter census dates in 2016 were November 4 and December 2. The weather was clear on both dates. The highest total elk count occurred on December 2 with a total of 290 elk. The final herd composition for Tomales Point in 2016 was estimated to be 165 cows, 48 calves, 11 spike males, and 66 branched antler males. Complete results from both censuses are included in Appendix A.

Other wildlife species observed during the November 4 census included 8 black-tailed deer one bobcat and 4 coyotes. On December 2, 9 black-tailed deer and 9 coyotes were noted.

Population Trends

Overall, the population trend at Tomales Point seems to be that the herd size is holding at a steady level following a substantial population decline from 2012 to 2014 (Table 1), which was likely due to drought conditions during this time period. Productivity in elk herds is strongly affected by forage availability, which on the outer coast at Point Reyes is driven by winter rainfall. Rainfall measured near PORE's Bear Valley Headquarters was 24.15 inches in 2014 and increased to 32.23 inches in 2015 and 37.98 inches in 2016 (45 year average is 38.45 inches). The tule elk numbers at Tomales Point did not increase as a result of increased rainfall in 2015 and 2016, which may be explained by a few reasons. First, it is not only the amount of rainfall that can affect productivity in the elk herds but also the timing. Rainfall further into the spring will prolong forage quality during the dry summer months. Second, the effects of low rainfall may have a delayed response on calving rates. Winter rainfall will affect forage conditions during the summer and fall which may in turn then affect calving rates the following spring. Third, the nutritional health of the elk, particularly the known deficit of copper and selenium at Tomales Point, may be limiting calf production. Lastly, we do not

Table 1. Tomales Point elk herd composition since 1999. No census occurred in 2010.

Year	Total Elk	Cows	Calves	Spike	Branch Antler	Total Bull	Calf:Cow	Bull:Cow	% Growth
1998	552	234	65	73	180	253	0.28	1.08	18.7
1999	476	210	92	n/a	n/a	174	0.44	0.83	-13.8
2000	451	260	61	17	113	130	0.23	0.50	-5.3
2001	420	254	50	22	94	116	0.20	0.46	-6.9
2002	416	241	30	18	127	145	0.12	0.60	-1.0
2003	382	241	50	4	87	91	0.21	0.38	-8.2
2004	338	217	40	10	71	81	0.18	0.37	-11.5
2005	430	246	79	20	85	105	0.32	0.43	27.2
2006	518	276	114	45	83	128	0.41	0.46	20.5
2007	585	332	97	35	121	156	0.29	0.47	12.9
2008	459	270	85	17	87	104	0.31	0.39	-21.5
2009	422	247	45	13	117	130	0.18	0.53	-8.1
2011	487	309	38	27	113	140	0.12	0.45	15.4
2012	540	291	101	19	129	148	0.35	0.51	10.9
2013	356	188	46	11	111	122	0.24	0.65	-33.9
2014	286	168	23	10	85	95	0.14	0.57	-19.9
2015	283	165	32	10	76	86	0.19	0.52	-1.0
2016	290	165	48	11	66	77	0.29	0.47	2.5

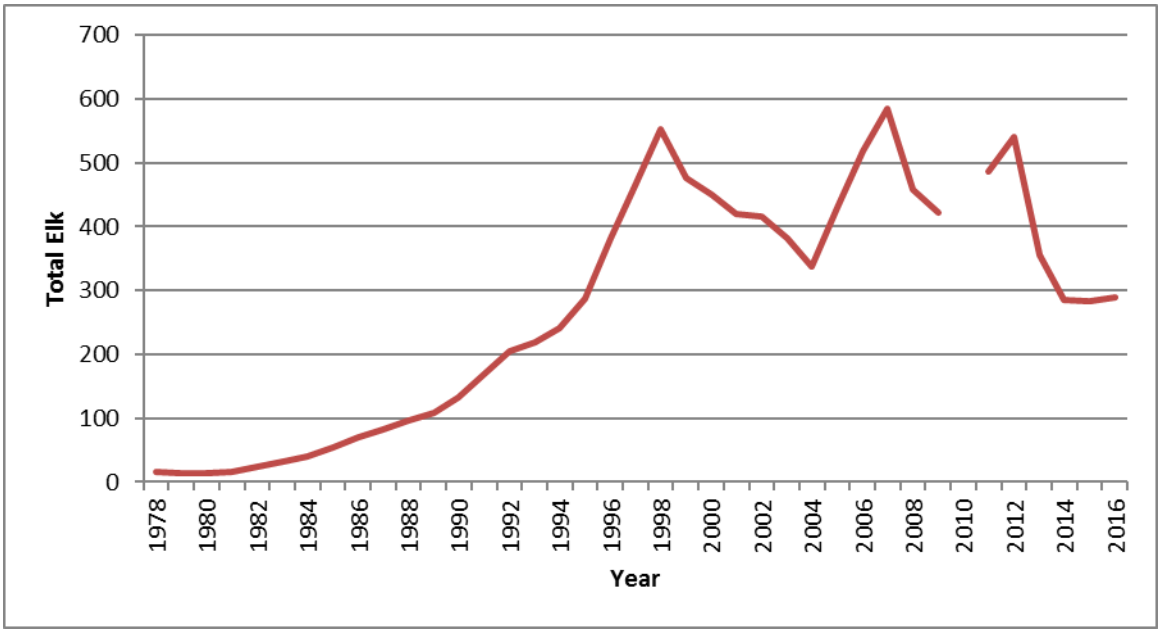


Figure 3. Total elk at Tomales Point since establishment of the herd in 1978. No census occurred in 2010.

know anything about the age structure of the female elk at Point Reyes and it may be that we did not have a high percentage of breeding age females in the herd in 2015 and 2106. Continued long-term monitoring and further research will help to better understand the complex factors controlling the tule elk population at Tomales Point.

Drakes Beach Area

Census of the Drakes Beach herd takes less effort and has a higher level of certainty than the other two herds in the park because of proximity to roads, lack of cover, herd cohesion of both bachelor and harem groups, and general range limitation. In addition, this herd is monitored on a weekly basis and therefore census counts here have inherently more confidence than census of the other two herds which are monitored less frequently.

Calf mortality rates are unknown, but it is likely that a number of young calves born in both 2015 and 2016 did not survive to the date of census. The first spotted (neonate) calves were observed on March 10, 2015 and March 8, 2016.

2015 Census

We counted elk in the Drakes Beach herd during December of 2015. A total of 85 elk was observed. The herd was composed of 43 cows, 15 calves, 5 spike males, 11 raghorn males, and 11 prime bulls (Table 2). This decrease in animals from the 2014 census was attributable to the removal of 14 adult animals prior to the 2015 census for disease surveillance, as described later in the Johne's disease section of the report. Otherwise a trend in population growth would have been observed in this herd.

2016 Census

We counted elk in the Drakes Beach herd during December of 2016. A total of 93 elk was observed. The herd was composed of 50 cows, 12 calves, 7 spike males, 11 raghorn males, and 13 prime bulls (Table 2). This count was an increase of 16 animals over the 2015 census of 85 elk, a single year growth rate for this herd of 9.4% (Table 2, Figure 4). This relatively low growth rate may suggest that the removal of a portion of the breeding age females in 2015 (n = 6) for disease surveillance had a depressive effect on calf recruitment in 2016.

Limantour

Of the three herds in the park, the Limantour herd is the most difficult to census. This herd ranges across three primary core areas (Figure 2). The elk occur near road corridors at times, but the primary use areas are in undeveloped wilderness that must be travelled on foot or by horseback. At this time, census surveys are performed on foot in the roadless wilderness areas. The primary bachelor herd is regularly monitored for most of the year within the adjacent pastoral zone, but most of the elk, including the cows and juveniles, are spread across the wilderness area from its northern boundary to beyond Coast Camp and beyond to the south (Figure 5).

Group cohesion in the Limantour herd seems to be less pronounced than in the Drakes Beach herd, therefore females, calves and spikes are not always found in a single group, but may range widely in small groups or singly. The bachelor herd and sub-groups have also been observed on the southwest

Table 2. Drakes Beach area elk herd composition since 1999.

Year	Total Elk	Cows	Calves	Spike	Branch Antler	Total Bull	Calf:Cow	Bull:Cow	% Growth
1999	1	1	0	0	0	0	0.00	0.00	n/a
2000	3	2	1	0	0	0	0.50	0.00	200.0
2001	5	4	0	0	1	1	0.00	0.25	66.7
2002	6	3	2	0	1	1	0.67	0.33	20.0
2003	8	5	2	0	1	1	0.40	0.20	33.3
2004	10	5	2	n/a	n/a	3	0.40	0.60	25.0
2005	15	6	5	n/a	n/a	4	0.83	0.67	50.0
2006	20	9	5	n/a	n/a	6	0.56	0.67	33.3
2007	22	9	5	n/a	n/a	8	0.56	0.89	10.0
2008	32	15	4	3	10	13	0.27	0.87	45.5
2009	38	14	8	4	12	16	0.57	1.14	18.8
2010	50	18	15	2	15	17	0.83	0.94	31.6
2011	54	26	12	6	10	16	0.46	0.62	8.00
2012	66	34	13	5	14	19	0.38	0.56	22.2
2013	76	42	13	5	16	21	0.31	0.50	15.2
2014	92	45	17	7	23	30	0.38	0.67	21.1
2015	85	43	15	5	22	27	0.35	0.63	-7.6
2016	93	50	12	7	24	31	0.24	0.62	9.4

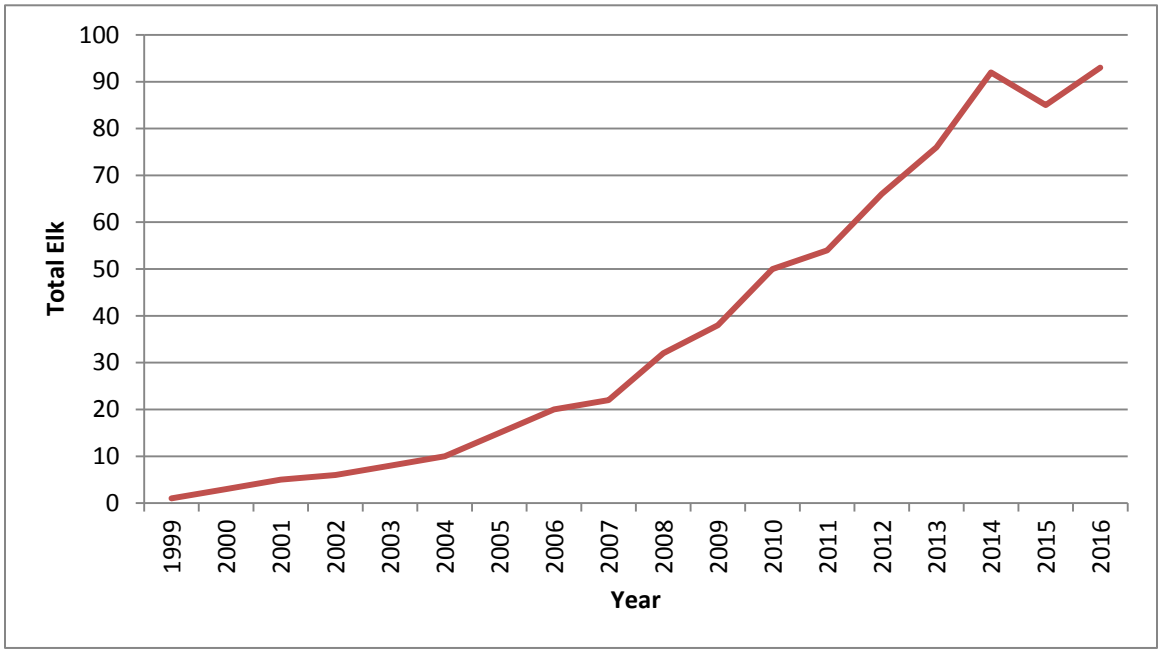


Figure 4. Total elk in the Drakes Beach herd since its establishment in 1999.



Figure 5. Map of Limantour area and Estero Road area locations where tule elk occur.

slope of Mount Vision all the way up to Mount Vision Road and across Sir Francis Drake Boulevard to the west on D. Rogers and M ranch. During the rutting season (July-September), the males will partially integrate with the herd in the wilderness area and thereby become difficult to locate, most becoming solitary in the forested upper areas of the Glenbrook drainage (Figure 5). Census attempts are performed typically after the rut when the males again congregate in the ranch lands and can be counted in groups in readily accessible areas.

2015 Census

Herd cohesion appeared to return to more typical dynamics and census numbers were closer to expected values than in previous years, when drought appeared to fragment the herd and make them more cryptic in their locations. The highest count was on February 12, 2016, when 128 animals were observed. This minimum population estimate was composed of 65 cows, 18 calves, 11 spike males, and 34 branched antler males (Table 3).

2016 Census

The highest count on January 13, 2017 recorded 126 total elk. The elk population was composed of 69 cows, 10 calves, 0 spike males, and 47 branched antler males (Table 3). The Limantour elk minimum population estimate declined slightly from 2015 to 2016 (Figure 6) despite there being 18 new calves in 2015. This decline is likely because some animals were missed during our 2016 census despite our best efforts, particularly those animals occurring within the bishop pine forests on the lower western slopes of the Inverness Ridge.

Monitoring of Elk on Park Ranches

PORE manages more than 28,000 acres of federal National Park Service lands within the Seashore and the northern district of the Golden Gate National Recreation Area for beef and dairy cattle grazing through special use lease permits. Park staff has monitored tule elk on and adjacent to ranches within its boundaries since September 2010 to better understand the potential impacts of elk on ranch operations. Park staff survey areas along or near Drakes Beach Road and Estero Road in order to document numbers, locations, and behavior of tule elk in these areas. Because the elk flush easily, complete counts are not always possible. In many instances, at Drakes Beach especially, the location of the main herd is noted without getting a complete count of the elk. Most observations are conducted in the morning; however, additional surveys may be conducted later in the day in order to verify movement patterns of the elk and to check for unintended bias in the data resulting from a concentration of morning observations. Surveys occur on average one to two days per week year round, however, blocks of time are missing from the dataset due to staff availability. More than one survey can occur on a single day. Elk locations are noted by assigning observed elk to the nearest of many pre-assigned points on the landscape. Elk moving when first sighted were assigned the location closest to where they were first observed rather than their final location. Surveys were often cancelled due to fog and poor visibility.

Table 3. Limantour area elk herd composition since 1999.

Year	Total Elk	Cows	Calves	Spike	Branch Antler	Total Bull	Calf:Cow	Bull:Cow
1999	27	16	9	0	2	2	0.56	0.13
2000	25	14	4	5	2	7	0.29	0.50
2001	21	12	3	2	4	6	0.25	0.50
2002	22	13	2	1	6	7	0.15	0.54
2003	28	14	6	1	7	8	0.43	0.57
2004	30	14	5	3	8	11	0.36	0.79
2005	34	15	7	4	8	12	0.47	0.80
2006	41	20	6	3	12	15	0.30	0.75
2007	41	21	3	6	11	17	0.14	0.81
2008	50	21	10	4	15	19	0.48	0.90
2009	55	32	8	2	13	15	0.25	0.47
2010	54	26	8	2	18	20	0.31	0.77
2011	60	32	9	7	12	19	0.28	0.59
2012	94	53	14	5	22	27	0.26	0.51
2013	71	38	8	5	20	25	0.21	0.66
2014	120	69	15	4	32	36	0.22	0.52
2015	128	65	18	11	34	45	0.28	0.69
2016	126	69	10	0	47	47	0.14	0.68

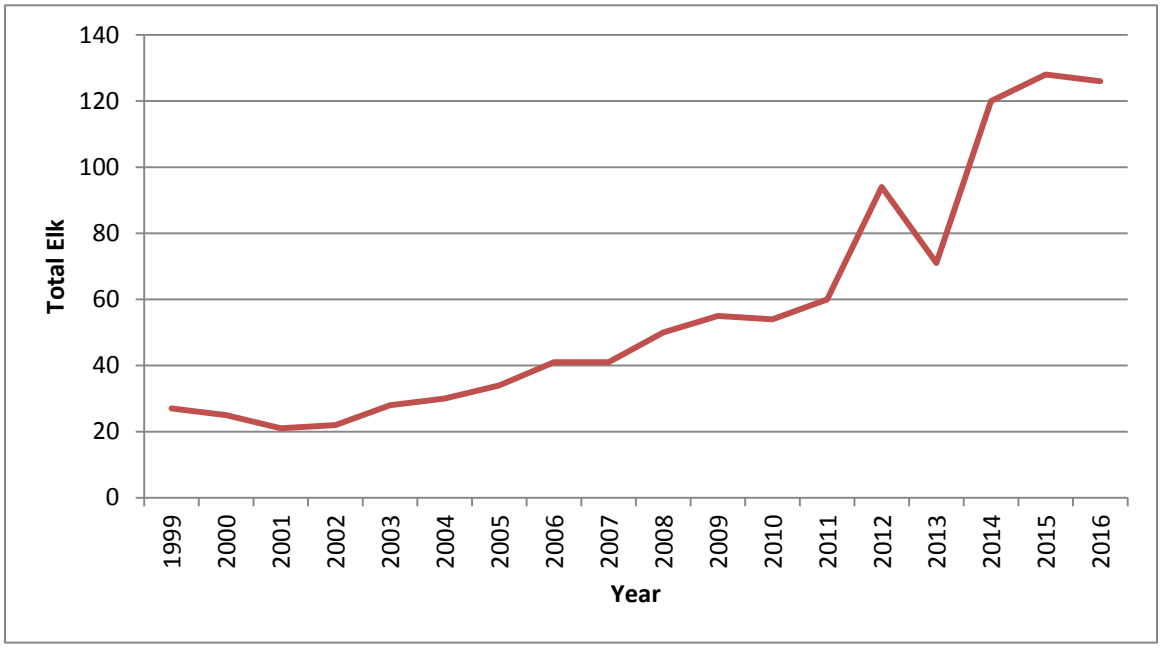


Figure 6. Total elk in the Limantour herd since its establishment in 1999.

In October 2012, recognizing that direct visual observations did not include elk locations on nights and weekends, the park worked with a contractor to capture four elk (two cows and two males) from the Drakes Beach herd to fit them with satellite GPS collars . The elk were captured and collared using tranquilizer darts following protocols approved by the National Park Service Institutional Animal Care and Use Committee. The GPS collars selected for this project (Advanced Telemetry Systems GS110E/E2 Iridium GPS Collar) collected location data every three hours with an estimated battery life of up to three years. Collars were programmed to collect positions at 2am, 5am, 8am, 11am, 2pm, 5pm, 8pm, and 11pm. The GPS location data collected by each collar was sent to a satellite system approximately every three days and then transmitted to the park by email.

GPS data for all four collars has been previously reported through October 2014 (see Bernot and Press 2016). During the timeframe of this report, only one female collar was still functional, Red Cow 031739, which finally failed in May 2015.

Drakes Beach Area

Visual Observation Data

In preparing the NPS field observation data for summary, we identified elk groups as a cow group if the group was at least 10 individuals comprised predominantly of adult females. Elk often occurred in the same location throughout the day. When summarizing the data, if more than one survey session occurred in a day, we did not include a repeat location for a group of animals unless the sessions occurred more than 4 hours apart.

Wildlife staff completed a total of 128 surveys of the Drakes Beach herd between November 2014 and October 2015. A total of 472 unique elk locations were recorded during these 128 surveys which all occurred on separate days. Tables 4 and 5 summarize elk locations by ranch lease permit between November 2014 and October 2015, but note that the data in these tables do not give weight to the number of elk observed per location. During this time period, elk were predominantly observed to the southeast of Sir Francis Drake Boulevard, as far east as the ridge above Drakes Estero, and as far west as the border between C Ranch and B Ranch (Figure 7). In addition, a small group of male elk moved farther towards the outer peninsula to A and B ranches during the fall and winter months, and another group of males used a portion of E Ranch on the west side of Sir Francis Drake Boulevard during the fall. This group of 5-8 males on west E Ranch was regularly feeding from supplemental hay left out for the cattle near Sir Francis Drake Boulevard during the morning. Interestingly, while the cattle are fed at this location regularly, the elk were only present in October and November, perhaps indicating a nutritional demand that the hay was meeting at this time of year just before the first rain and first new green grass appeared on the landscape.

Wildlife staff completed a total of 114 surveys of the Drakes Beach herd between November 2015 and October 2016. A total of 393 unique elk locations were recorded during 114 surveys on 110 separate days. Tables 4 and 5 also summarize elk locations by ranch lease permit between November 2015 and October 2016. During this time period, the elk were predominantly observed within the same home range as the prior year as described above, including the male groups on A Ranch, B Ranch, and E Ranch (west of Sir Francis Drake Boulevard).

Table 4. All elk locations collected by field observations in the Drakes Beach area by ranch lease, November 2012 - October 2016. Number of elk per location not taken into account.

	Percent of Total Observations (All Elk)			
Year	**Nov 2012 - Oct 2013 (n = 449)**	**Nov 2013 - Oct 2014 (n = 607)**	**Nov 2014 - Oct 2015 (n = 472)**	**Nov 2015 - Oct 2016 (n = 393)**
Non-permit	23.2	33.6	24.8	31.8
A Ranch (Nunes)	0.0	0.0	0.4	0.8
B Ranch (Mendoza)	0.0	2.3	1.3	8.1
C Ranch (Spaletta)	13.6	13.3	16.5	14.5
West D Ranch (Spaletta)	12.5	9.2	15.0	14.5
E Ranch (Nunes)	7.6	12.7	19.1	11.7
East D Ranch (Nunes)	43.2	28.8	22.9	18.6

Table 5. Cow group elk locations collected by field observations in the Drakes Beach area by ranch lease, November 2012 - October 2016. Number of elk per location not taken into account.

	Percent of Total Observations (All Elk)			
Year	**Nov 2012 - Oct 2013 (n = 154)**	**Nov 2013 - Oct 2014 (n = 210)**	**Nov 2014 - Oct 2015 (n = 136)**	**Nov 2015 - Oct 2016 (n = 152)**
Non-permit	40.9	71.4	60.3	60.5
A Ranch (Nunes)	0.0	0.0	0.0	0.0
B Ranch (Mendoza)	0.0	0.0	0.0	0.0
C Ranch (Spaletta)	25.9	13.8	22.8	17.1
West D Ranch (Spaletta)	10.4	5.7	5.9	13.8
E Ranch (Nunes)	0.0	0.0	1.5	1.3
East D Ranch (Nunes)	22.7	9.0	9.6	7.2

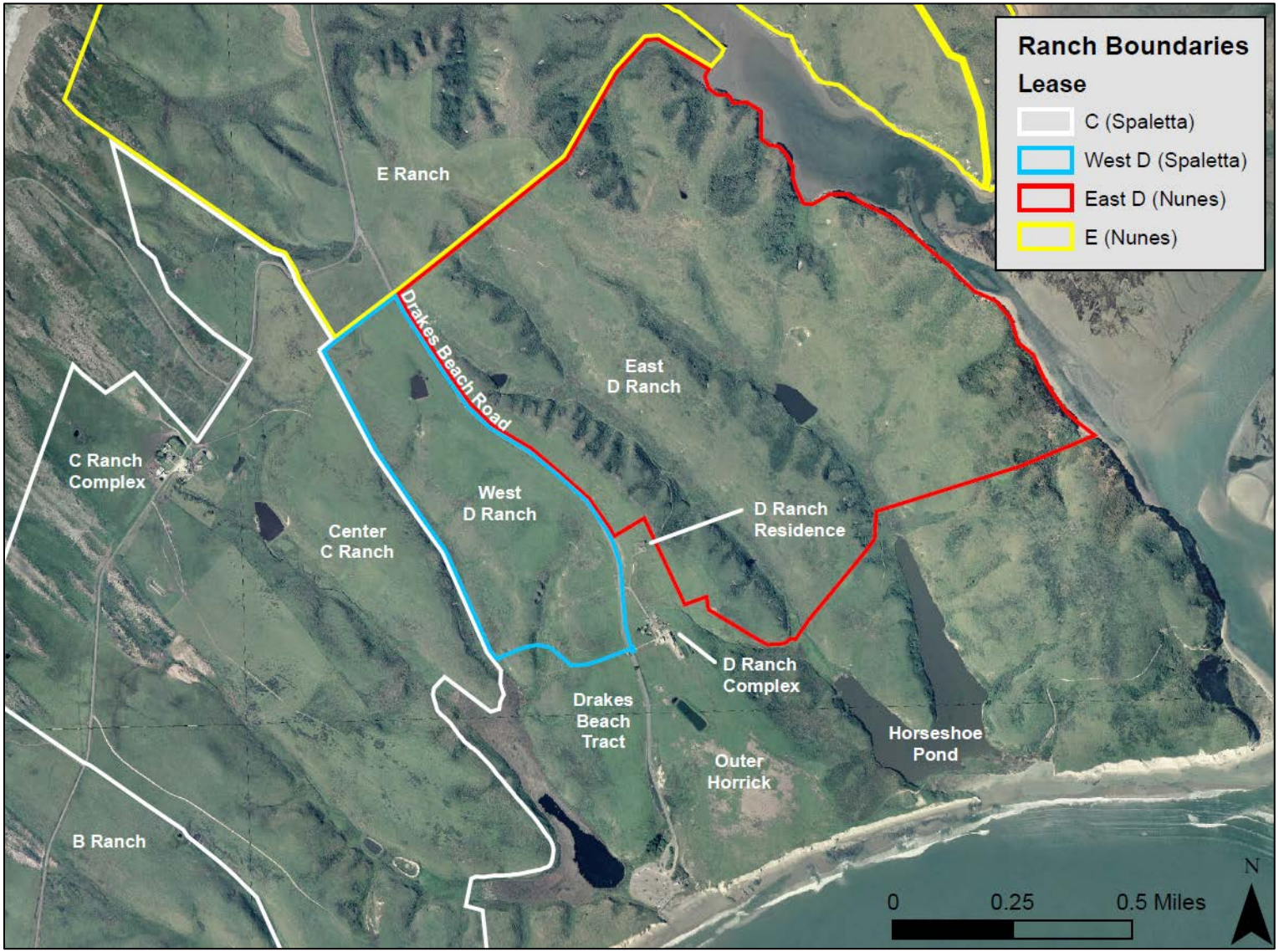


Figure 7. Map of Drakes Beach Road area where tule elk occur.

GPS Collar Data

As already noted, the GPS collar on Red Cow 031739 was the only collar that collected and transmitted data during the timeframe of this report. The collar was damaged somehow and stopped transmitting data on May 5, 2015, although it remained in place around the elk's neck.

At times, the collar collected less data than it was programmed to do. This was a particular issue in late December 2014 and early January 2015 when the collar at times only collected one or two points per day, rather than 8, for unknown reasons. At other times, the collar collected location data outside of the programmed three hour schedule beginning at 2am. For example, when the animal was bedded down for extended periods, an erroneous mortality signal was generated causing the collar to collect location data every half-hour until the animal started to move again and the problem corrected itself. For reporting and summary purposes, we established a consistent data set by excluding all GPS data collected outside of our set time intervals of 2am, 5am, 8am, 11am, 2pm, 5pm, 8pm, and 11pm.

Table 6 summarizes the locations of Red Cow 031739 by ranch lease permit between November 2014 and May 2015, and for the previous two years for comparison. Comparison with previous years must take into account however that the new GPS data set only includes six full months of data. Most notably, the time spent on the C Ranch dairy is not well represented because data is missing from the summer and fall, a time period in which the main herd uses the C Ranch pastures more heavily.

Table 6. Percent of GPS locations of Red Cow 031739 in the Drakes Beach area by ranch lease, November 2012 - May 2015.

	Cow 031739		
Year	Nov 2012 – Oct 2013 (n = 2861)	Nov 2013 – Oct 2014 (n = 2829)	Nov 2014 – May 2015 (n = 1139)
Non-permit	49.3	69.6	60.7
C Ranch (Spaletta)	25.5	14.9	1.3
West D Ranch (Spaletta)	6.4	3.7	4.0
E Ranch (Nunes)	0.1	0.0	4.3
East D Ranch (Nunes)	18.6	11.8	29.7

In order to clarify the degree to which Red Cow 031739 represented the movements of a cow group or the main herd, we noted in our observational records every time that this collared elk was observed. Because the collar was not always easy to see (e.g. the elk were bedded down or seen from a distance), we also cross-referenced the observational data with the GPS data to confirm when the GPS data was consistent with recorded elk locations. Cow groups were at times noted more than once during a survey, usually when the elk were broken into smaller but significant groups, as can happen during calving or the rut. These factors were taken into account when cross-referencing and summarizing the data. Out of 44 field surveys where a cow group was observed (Nov 2014 – May 2015), Red Cow 031739 was confirmed as associated with a cow group on 31 (70%) surveys.

Patterns of Movement

Elk within the Drakes Beach area exhibited similar seasonal patterns in their use of the landscape as previously reported (Bernot and Press 2016). The main herd concentrated its activity on C Ranch, D Ranch west, D Ranch east, and areas not permitted for grazing immediately to the north of Drakes Beach and around Horseshoe Pond (Figure 7). The elk did not use their range uniformly, however, but displayed an affinity for particular areas, most notably center C Ranch, lower west D, east D pastures close to Drakes Beach Road, Outer Horrick, Drakes Beach Tract, and above Horseshoe Pond (Figure 7). The latter three areas are areas currently not permitted for dairy or beef grazing.

Besides a spatial pattern with the main herd, a temporal pattern was also observed in how they utilize the landscape. Generally speaking, the following temporal observations were made of the main herd in the two years from November 2014 to October 2016:

- For much of November 2014 until June 2015, the main herd moved almost entirely off of C Ranch. The main herd instead concentrated its time in areas not permitted for grazing, particularly Outer Horrick and less so the Drakes Beach Tract, around the D Ranch complex, and at Horseshoe Pond and further east. The east D and west D pastures were also used to a degree during this time, particularly east D.
- Significant activity by the main herd returned to C Ranch in July 2015 and remained consistent through September 2015. Activity then tapered off, but the main herd was still present on C Ranch occasionally until January 2016, which was later than the previous year.
- The main herd began returning to C Ranch in May 2016, which was earlier than the previous year, and their use of the area continued until through October 2016. However, the main herd's use of the C Ranch in July and August in particular was lower than in 2015, instead favoring non-permit areas at Outer Horrick and the Drakes Beach Tract.

As we have observed previously (Bernot and Press 2016), the older bull males at Drakes Beach remained separate from the main herd during much of the year, often forming a cohesive bachelor group of 10-20 individuals. Bull males were more often associated with the main herd during the rut in July, August, and September and the other males were more likely to be dispersed in several small groups rather than forming one bachelor group during this time. Visual observations most often documented the bachelor group on E Ranch near the intersection of Sir Francis Drake Boulevard and Drakes Beach Road and on East D Ranch along the first ridge to the northeast of Drakes Beach Road. A regular routine for the males was to cross Drakes Beach Road at around sunset, spend the night on C Ranch, cross back over Drakes Beach Road at sunrise, and spend the day to the east of Drakes Beach Road.

Estero Road Area

Visual Observation Data

A total of 62 elk surveys occurred from November 2014 through October 2015 in the Estero Road area. Surveys included along Pierce Point Road to the Abbotts Lagoon Trailhead, the D. Rogers Ranch on the northwest side of Sir Francis Drake Boulevard, and to the edges of Home Ranch at the

wilderness boundary (Figure 5). Elk were observed on 58 of these surveys allowing us to document 132 elk location records.

From November 2015 through to October 2016 a total of 47 elk surveys occurred in the Estero Road area. Elk were observed on 44 of these surveys and 100 elk locations were recorded.

During this two year period, only male elk were observed in the Estero Road area by NPS staff; the larger herds of cows and juvenile elk remained on Glenbrook Head and further to the southeast within designated wilderness. On occasion, however, the operators of Home Ranch reported small groups of elk, including cows and juveniles, crossing over to Drakes Head from the top of Estero de Limantour to within the Home Ranch boundary in the late summer and early fall. The elk did not remain for long on any occasion.

Numbers of male elk in the Estero Road area are at their highest in the winter months and at their lowest during the rut in the summer and early fall. At this time, most males move south closer to the cow groups in the wilderness area looking to participate in this annual breeding opportunity. However, under the elks' dominance hierarchy breeding system, only the strongest, largest bulls win the right to mate with elk cows. Unlike in past years, some males were observed in the ranch areas, but only on Home Ranch nearest the wilderness, during the rut. These males were not dominant bulls and likely moved back and forth between the wilderness and Home Ranch during this time.

While most elk activity in the Estero Road area was concentrated to the south of Sir Francis Drake Boulevard, predominantly on Home Ranch and to some extent on N Ranch, the male elk continued to use the D. Rogers Ranch on the other side of Sir Francis Drake Boulevard during the time frame of this report, with as many as 23 seen on a single survey in March 2016. The elk pass through the forested upper reaches of N Ranch and then drop down to cross Sir Francis Drake Boulevard to reach the D. Rogers Ranch at a single location. The elk move north to D. Rogers Ranch from December to March, and have only been observed there on a few occasions outside of this time period. In the summer of 2016, the male elk began exploring further north, with a single observation of an elk near the north side of Pierce Point Road on H Ranch.

Tables 7 and 8 summarize the elk locations and count data for the Estero Road area by ranch lease permit between November 2012 and October 2016. The data demonstrates that since November 2012, overall elk numbers in the Estero Road area have more or less remained steady with a small increase in the total number of elk in the area at any one time. The increased use of D. Rogers Ranch can be seen over time in the data tables. The elk numbers on Home Ranch do not concurrently decline as elk numbers increase at D. Rogers because the elk regularly move between the two areas.

We should note that without GPS collared elk in the Estero Road area, our elk location data is biased towards weekdays and daylight hours. Although the general results presented in the tables would likely not change significantly with collared elk, we would have a better understanding of how specific areas are used by elk on the ranches at night versus the day. For example, we know that the elk are known to use the bull pastures behind the Home Ranch complex during the night but move up to the adjacent ridges during the day.

Table 7. Percent of observed elk locations in the Estero Road area by ranch lease, November 2012 - October 2016.

Year	Percent of Total Observations (All Elk)			
	Nov 2012 – Oct 2013 (n = 147)	Nov 2013 – Oct 2014 (n = 188)	Nov 2014 – Oct 2015 (n = 132)	Nov 2015 – Oct 2016 (n = 100)
Non-permit	8.2	7.4	6.8	8.0
Home Ranch (Luchessi)	61.2	57.4	72.7	53.0
N Ranch (McDonald)	0.7	6.4	6.1	5.0
D. Rogers (Evans)	29.9	27.6	13.6	33.0
M Ranch (Grossi)	0.0	1.1	0.8	0.0
H Ranch (Evans)	0.0	0.0	0.0	1.0

Table 8. Average (and maximum) numbers of male elk in the Estero Road area by ranch lease, November 2012 - October 2016.

Year	Nov 2012 – Oct 2013	Nov 2013 – Oct 2014	Nov 2014 – Oct 2015	Nov 2015 – Oct 2016
All Areas	13 (29)	13 (33)	14 (30)	15 (35)
Non-permit	7 (12)	7 (14)	4 (11)	5 (8)
Home Ranch (Luchessi)	14 (29)	11 (28)	11 (30)	11 (28)
N Ranch (McDonald)	2 (2)	7 (14)	4 (11)	6 (10)
D. Rogers (Evans)	5 (8)	6 (8)	8 (13)	12 (23)
M Ranch (Grossi)	0 (0)	4 (5)	2 (2)	0 (0)
H Ranch (Evans)	0 (0)	0 (0)	0 (0)	1 (1)

Experimental Relocation

Relocation of elk from Drakes Beach to Limantour has been suggested as a means to manage the size of the Drakes Beach elk herd in order to minimize negative impacts to park ranches. In March 2015, PORE tested the practicality of this management approach by capturing and transporting elk from Drakes to Limantour. Past experience by both the NPS and the CDFW has demonstrated that adult elk, particularly males, have a very high likelihood of moving back to their home ranges when moved to other areas. For this reason, this project focused on the relocation of younger animals that may not be as imprinted on their home ranges as adult animals.

PORE staff was supported in the relocation project by staff from the NPS Biological Resource Division in Fort Collins, CO and from CDFW staff. The goal was to capture and move two young males and two young females from the Drakes Beach herd, fit them with VHF radio collars, and release them on Coast Trail just behind Limantour Beach. During a week long effort, the team successfully moved three animals – an estimated 2 year old male on March 4, a yearling female on March 5, and yearling male on March 6 (Figure 8). An additional female was darted on March 6, but she failed to respond to our attempt to immobilize her, likely due to poor placement of the dart in her lower right leg.



Figure 8. NPS and CDFW staff prepares a male elk for re-location from Drakes Beach to Limantour in March 2015.

BAM, a mixture of butorphanol, azaperone, and medetomidine, was used to immobilize each elk using tranquilizer darts following protocols approved by the NPS Institutional Animal Care and Use Committee and NPS veterinary staff. Vital signs were monitored for the entire time that each animal was down, including temperature, pulse, respiration, and capillary refill time (CRT). We took blood samples and administered prophylactic injections of MuSe (selenium) and penicillin. VHF radio collars were applied and each animal was given a unique identifying ear tag. Each elk was moved into a horse trailer while sedated and then reversal drugs of atipamazole and tolazoline were administered. Each elk was also given a dose of haloperidol to keep them relaxed during transport. The elk were allowed to fully recover and stand inside the closed horse trailer before being moved to Limantour. The elk were released at the former site of the 1998-99 elk enclosure along Coast Trail behind Limantour Beach, where many elk from the Limantour herd reside. The three relocations were successful with no injuries to the elk or to the capture team.

We began monitoring the three elk the week following their re-locations. The female quickly settled in with elk residing within the Glenbrook Creek drainage, an area further to the west of where she was released and nearing the western edge of the wilderness boundary. The males were detected within the Limantour area using VHF on March 12, but on March 16, both male elk were observed back with the Drakes Beach herd. As the observation occurred on a Monday morning, after the two elk had not been tracked in three days, it is unknown precisely when they returned or if they traveled together on their return. Because the elk were not equipped with GPS collars, we also do not know what route the two elk took to return to Drakes Beach.

The VHF radio collars fitted to the elk were equipped with timed devices to release the collars. Because the necks of male elk swell during the rut, which can cause a collar to then become too tight around the neck, the male collars were programmed to release on August 1, 2015. The female collars were programmed for release on March 1, 2016. Unfortunately, however, there was an error in the documentation provided by the manufacturer, causing us to place the collars opposite of the way we had intended, with the female collar set to release on August 1 and the males set to release on March 1. The error was not realized until the males collars failed to release on August 1 as anticipated. The male collars instead released six months later on March 1.

The female's VHF collar released on August 1, 2015 after she was seen still residing in the Glenbrook area eight days earlier. From that point forward we were no longer able to confirm her location using radio telemetry from a distance and subsequently abandoned our monitoring efforts. In order to confirm her location, we would have had to hike into the wilderness area and identify her by the small pink tag that had been applied to her right ear. In the fall of 2016, a renewed effort to confirm the location of this female revealed that she had at some point returned to the Drakes Beach herd. She was observed with the main herd at Drakes Beach on October 12, 2016. Because we usually observed the Drakes Beach herd from a distance, making it difficult to observe the ear tag, we believe that the female may have been present at Drakes Beach for several months prior to being identified.

Antler Entanglements

Bull tule elk at PORE have the potential to have their antlers entangled with several types of debris, including fencing materials, abandoned electrical and telephone wiring, hay twine, and marine debris. Park staff will intervene when the entanglement appears detrimental to the health and welfare of the animal and if it appears that the entanglement will not resolve itself without assistance.

In November 2014 a bull was observed by wildlife staff attempting to jump over a fence which resulted in an entanglement of the back legs by ‘scissoring’ between the two top strands. Wildlife staff and a ranch permittee worked together to successfully release the animal with no apparent injury to the animal.

In March 2015, a bull elk was observed in the area around Home Ranch with a wad of thin white electric fencing wire and two electric fence support poles in his antlers. Although park staff was unsuccessful in tranquilizing the elk to remove the material, the antler was subsequently shed and found with the wire and poles intact.

In August 2015, a bull elk in the Drake’s Beach area was seen by park staff with a 6 to 8 foot section of woven fence wire in his antlers and dragging behind him (Figure 9). An intervention was planned, and although park staff could not approach the bull closely enough to place a tranquilizer dart, the wire was snagged and pulled off his antlers as the bull fled through dense brush.



Figure 9. Bull elk with woven wire antler entanglement in August 2015.

In January 2016, a bull elk was observed in the Home Ranch area with thin strand electric fence wire in his antlers (Figure 10). No attempt was made to capture the animal and the antlers were subsequently shed and found with the entanglement intact in both attached antlers. In the same month and area, another male was known to have become entangled in a small amount of thin strand electric fence wire based on a single photo captured by one of our wildlife cameras. We never actually observed this entangled young male, and we therefore suspect that the entanglement quickly resolved itself on its own.



Figure 10. Bull elk with thin strand electric fence wire antler entanglement. Photo taken with a wildlife camera placed at D. Rogers Ranch.

In August 2016, a bull elk in the Drake's Beach area with an entanglement of stiff black utility wire in both antlers was observed and reported by park visitors (Figure 11). Park staff located and successfully tranquilized the animal following PORE's approved elk capture protocol. The wire was quickly removed and the animal recovered fully. The wire was determined to be abandoned telephone cable from the D Ranch compound.

In December 2016, a bull elk was observed with thin white electric fence wire entangling one antler in the Home Ranch area. The entanglement was contained to a single antler and did not appear to have portions dangling down that might endanger his safety. No attempt was made to capture him, and after a short period of monitoring, the entanglement appeared to have resolved itself.



Figure 11. Bull elk with utility wire antler entanglement in August 2016.

Drakes Beach Water Supplementation

Seasonal water supplementation to selected ponds in the non-permit areas near D ranch that were initiated in September 2013 continued during the period of this report. The design of the water supplementation system to benefit the Drakes Beach herd and the reasoning behind the approach has been previously reported (Bernot and Press 2016).

In 2015, 165,600 gallons of water were added to the ponds between May and October. The return of significant winter rain 2016 alleviated local drought conditions, and therefore the frequency, duration, and overall volume of pond supplementation was concurrently decreased. In 2016, water supplementation began in August and ended in October with only 78,610 gallons delivered. By comparison, 173,760 gallons were delivered from September 2013 to January 2014 and 167,970 gallons were delivered from May 2014 to November 2014.

Johne's Disease Testing

In order to better inform elk management, Point Reyes began testing for Johne's disease in the Drakes Beach and Limantour elk herds in May 2014. Testing continued in 2015 and 2016. Johne's disease, or paratuberculosis, is an infectious and incurable gastrointestinal disease caused by a bacterium found in domestic and wild ungulates. The disease has been documented in tule elk at

Tomales Point since 1980 (Jessup et al. 1981, Cobb 2010), and considerable effort was made to quarantine the tule elk at Limantour in 1998-1999 and test them repeatedly for Johne's disease prior to releasing and creating the park's first free-range tule elk herd (Manning et al. 2003). However, very little Johne's disease testing has occurred in the free-range elk since that time.

Beginning in May 2014, park staff began regular collections of fresh fecal samples from the free-range elk, alternating each month between elk in the Drakes Beach area and elk in the Limantour/Estero Road area. The samples are immediately sent to the Johne's Testing Center (JTC) at the University of Wisconsin for culture analysis. After approximately eight weeks of incubation, the cultures are analyzed for the presence of *Mycobacterium avium paratuberculosis (MAP)*, the bacterium that cause Johne's disease. Very few elk are marked with collars or ear tags, but efforts were made to repeatedly sample from these animals when possible. Although most of the collections were taken from "unknown" elk, considerable effort was made to sample unique individuals during every sampling effort in order to prevent instances in which an animal was double-sampled within the same sampling event. In order to accomplish this in the field, the elk herds were tracked very carefully during sampling efforts in order to watch for and visually mark fresh fecal droppings occurring from different individual elk within the herd. When the elk herd moved on, the staff would then move in with collection bags to collect the separate samples.

Between May 2014 and October 2016, park staff collected 637 fecal samples, with 441 samples from Drakes Beach and 196 from Limantour/Estero Road. In consultation with the JTC, PORE decided to stop collecting regular fecal samples from the Limantour/Estero Road elk after August 2015 but continued sampling at Drakes Beach every other month.

In fecal samples, an animal may be infected but not actively shedding the MAP bacterium at the time of sampling, creating a false negative result. A more definitive test is of the gut tissue itself, which can be obtained through the lethal removal, collection, and necropsy of an animal.

By the fall of 2015, all fecal samples collected to date were negative for MAP from both the Drakes Beach and Limantour/Estero Road elk. In collaboration with the JTC, CDFW, and the California Animal Health and Food Safety Laboratory at the University of California, Davis (CAHFS), 27 elk were collected between October 2015 and March 2016 for higher sensitivity Johne's testing. Fifteen elk were collected from the Drakes Beach herd (eight males, seven females) and twelve elk were collected from Limantour/Estero Road (six males, six females). An additional bull elk suspected of Johne's disease was later collected in December 2016. The euthanized elk were taken immediately to CAHFS for full necropsy, which included histological examination of the gut tissue. For each animal, CAHFS sent up to twelve tissue samples and one fecal sample to the JTC for Johne's disease testing through culture analyses. Of the elk collected and submitted for testing, White Cow (named for her white ear tag) was the only elk to die of natural causes at an age of at least 19 years old. White Cow was one of the animals captured at Tomales Point in December 1998 and subsequently released near Limantour Beach in June 1999 when the free range herd was initially established. She moved over to Drakes Beach in October 2001, joining a small group of elk that had already moved to that area. In October 2012, she was one of four elk captured from the Drakes Beach herd and fitted with a GPS collar.

As noted, up until the fall of 2015 all fecal samples sent to the JTC tested negative for MAP. However, in November 2015 three samples collected from the Drakes Beach herd, all from male elk, tested positive for MAP. An additional male tested positive for MAP from the Drakes Beach in May 2106. On necropsy, two of eight male elk tested positive for MAP from the Drakes Beach herd; one from fecal culture and one from culture of the cecum. The bull collected from Drakes Beach in December 2016, an animal observed with diarrhea scouring the hind legs for several weeks, did not test positive for Johne's disease. Through both fecal collections and necropsies, none of the animals from the Estero Road/Limantour area have tested positive for MAP.

The elk collection efforts garnered additional valuable information on the free-range elk through necropsy. Weights were collected on all but three of the animals. The tule elk bulls weighed an average of 488 lbs. (n=14), with a range of 365-592 lbs. The tule elk cows weighed an average of 341 lbs. (n=11), with a range of 296-404 lbs.

Toxicology analyses in the necropsy reports noted that all animals were either low or deficient in both copper and selenium levels. Copper levels averaged 3.87 parts per million (ppm) whereas selenium averaged 0.15 ppm. As noted in the necropsy reports copper deficiency can "contribute to illthrift, poor production, decreased resistance to other diseases, diarrhea, ataxia in neonates, and at extremely low levels, death may occur". Selenium deficiency may lead to "muscle damage (eg. white muscle disease), illthrift, poor production (including reproduction), and decreased resistance to other diseases". Copper and selenium deficiencies have previously been reported in Point Reyes tule elk (Gogan et al. 1989, Cobb 2010), but the extent to which these deficiencies are influencing individual elk survival and population dynamics within the elk herds at Point Reyes is unknown.

The elk collections in 2015 and 2016 were also the first time that tule elk at Point Reyes have been tested for Chronic Wasting Disease (CWD). CWD is a contagious neurological disease that degenerates the brains of infected animals, resulting in emaciation, abnormal behavior, loss of bodily functions and death. CWD belongs to a group of diseases known as transmissible spongiform encephalopathies (TSEs), and is currently only known to infect species within the deer family. CWD has impacted elk populations, and subsequently elk management, in several western states, including Wyoming and Colorado, but has not yet been documented in California. From all tule elk collected at Point Reyes (n=28), the obex tissue of the brain, retropharyngeal lymph node, or both were tested for CWD using the immunohistochemistry (IHC) test. CWD was not detected in any of the elk.

Fences

Tomales Point

The elk herd at Tomales Point is contained within the tule elk preserve by a 2.2 mile, 8 foot high woven wire fence that transects the entire peninsula. This fence has been in place since the late 1970s and is in varying states of condition. PORE wildlife staff inspects and repairs the fence regularly, attempting to keep elk from leaving the preserve.

Elk, particularly males, have been observed to escape from the Tomales Point containment fencing, usually in groups. Up to 18 have been observed at any one time outside the fence. It is sometimes possible to detect a breach in the fence and repair it, but at other times elk are observed on the south side of the fence with no apparent breach. It is possible that the elk cross the cattle guards installed at the elk fence on Pierce Point Road, they may swim or wade around the outer perimeter of the fence at Tomales Bay, or they may climb along the steep terrain on the western side of the peninsula where fencing cannot be erected. Cattle have also been observed to breach the fence and escape into the tule elk preserve.

When escapement occurs, wildlife staff attempts to replace the elk or cattle to the designated side of the fence. In all cases where cattle have breached the fence, they can usually be immediately replaced and the breach repaired, as they do not travel far from the fence and they are trained to be herded. In the case of escaped elk, attempts to replace them must be made when the elk are in locations where they may be hazed back towards the fence and guided into opened gates in the containment fence (3 gates on the west stretch, 1 on the east). Attempts to haze elk back into opened gates have only been successful when elk are spending time very close to the fence, when a technician can open the gates without being detected, and when they can be run without panic along the fence directly in front of the opened gates. Successful attempts usually involve 1-3 persons on foot, coordinating with hand held radios and slowly coaxing the elk towards the fence, keeping a distance to prevent panic and fleeing behavior. Attempts during rutting season are most successful, as the male elk primarily stay close to the fence and are more apt to return to the reserve when possible. Past attempts using multiple personnel, vehicles and horses to more aggressively haze them back into the preserve have proven unsuccessful, as they quickly become panicked, run past the hazers, and ignore the gated openings even when very close to them.

In 2015 and 2016 several dozen elk again were returned to the reserve. In addition, there was one occasion when at least 30 cattle were returned to pastures on the south side of the fence.

Natural flows of water and other erosive processes next to and under the fence on the ocean side of the peninsula, particularly in the bottom of the gulch and along the cliff edge, have undermined significant areas of the earthen footing for the fence, necessitating relocation and repair of the fence line several times over the years. A major portion of the materials for a complete rebuild and re-route of the western portion of this fence have been purchased and planning for this reroute are in progress with a target date for completion in 2018.

Fence Repairs

Barbed wire fences along Drakes Beach Road prevent cattle from entering the roadway from adjacent leased pastures for most of the length of the road with the exception of the stretch between the D ranch compound and Drakes Beach parking lot. C Ranch grazes the west side of the road while the operators of A and E Ranches graze cattle to the east. Elk have been observed in all of the pastures next to Drakes Beach Road and frequently cross the road, requiring the elk to clear barbed wire fences on both sides of the road. The elk are known to damage the fences when jumping over if

they are unable to clear the top fence wire. Continued pressure from elk can lead to more structural failures, particularly to fences that are not in good condition.

The operators of A and E Ranches have granted park wildlife staff permission to repair damaged or degraded cattle boundary fencing in these areas. Repairs are performed by wildlife staff when it is observed that the fence has lost effectiveness or aesthetics, regardless of evident causation, thus damage from weathering and cattle is repaired in these areas when detected. From November 2014 to October 2016, approximately 240 linear feet of boundary fencing along Drake's Beach road and Sir Francis Drake Boulevard were repaired to some degree, including replacement or repair of sagged or broken barbed wire, and replacement of degraded fence posts. The most often observed damage was a sagged top strand. Less often observed, but also repaired commonly, were broken top and or/second strands. No completely breached sections were detected or repaired.

Fence Crossings

Elk, particularly males, have been observed frequently crossing Drake's Beach road at crepuscular times (near sunrise and sunset) by jumping over the cattle boundary fences that surround the road. When elk are undisturbed by vehicle traffic or other threats, they have been observed to seek out the lowest areas of fence to traverse. In response to these observations, the profile of the existing fence in a preferred crossing area was lowered by removing the top strand over 2 consecutive sections then reinforcing the second strand with a horizontal 4" wood beam at a height of 36-40 inches. Two pair of crossings were originally erected in June 2010 at two locations along Drake's Beach road and three single crossings were erected on boundary fences not along the road. These modifications were made in an attempt to reduce the possibility of fence damage when elk cross the fence while retaining effectiveness for cattle containment.

Elk were observed and photographed using the crossings multiple times in 2015 and 2016 and no cattle were known to have escaped a ranch permit boundary due to the presence of these facilitated wildlife crossings. Other areas where crossings would facilitate elk passage and reduce fence damage have been identified, and work continues to construct these facilitated crossings. A portion of fence at the intersection of Drake's Beach Road and Sir Francis Drake Road was fitted with 3 discrete crossings in late 2016 and attempts were made to enhance visibility of fencing in this area experimentally. A single crossing was erected in April of 2016 on the Rogers ranch boundary fence at Sir Francis Drake Boulevard where elk have been crossing Schooner Creek from wilderness areas to the Rogers pastures and beyond for several years.

Fence Removal

Removal of abandoned or discarded fencing continued through 2015 and 2016. A large portion of the internal boundary fence on the East D Ranch permit area was replaced by ranch operators, NPS staff helped remove and dispose of the discarded wire and posts. A stretch of abandoned fencing pre-dating the current operator's lease was identified in the Home Ranch area on a ridge where elk were often observed. NPS staff and the operators of the ranch worked together to remove and discard this material as well. An 8 foot pickup bed full of barbed wire was removed in a single day.

Hazing

A practice of hazing elk was instituted in late-summer 2012. When observed in the central pasture on the C ranch permit area or around the stock pond, elk groups, typically the entire main herd was hazed towards the non-permitted areas closer to Drakes Beach and the D Ranch Outer Horrick area (Figure 5). Hazing during the time period of this report was performed in the early morning hours, generally as soon as there was enough light to locate the herd. Attempts at preventing movement of animals into undesired areas at sunset proved unsuccessful and were discontinued.

A method of hazing from center C Ranch has developed since first implemented in 2012. Hazing was performed by a single wildlife technician approaching the elk on foot, never by vehicle, from the direction of Sir Francis Drake walking at a normal rate using no other devices or distractors. Elk were directed towards the canyon to the east toward their preferred entry route until they moved over and below the top contour of the C ranch central pasture, at which time staff would disengage and return to Sir Francis Drake. This early disengagement was to allow the elk to continue out of the central pasture at their own pace, minimizing the possibility that hazing might injure the elk or exacerbate fence damage. Hazing was also discontinued if the elk persistently travelled in a non-desired direction or if the technician did not feel that the movements of the elk group were directed or controlled. Detection of an injured elk in the herd was also a criterion by which a hazing attempt was terminated. If elk appeared to settle in the north-east pasture of the C ranch permit area adjacent to Drakes Beach Road, the technician would, at his discretion, approach them again from Drakes Beach Road to encourage them to exit the permit area entirely. Hazing was kept to the minimum disturbance that would cause the elk to move in the desired direction. After repeated efforts, the elk are more prone to move in the desired direction immediately, and then continue to travel back to the non-permit areas without further hazing. Elk were not approached or disturbed when they were in the non-permit areas to further reinforce the desirability of remaining in those locations.

As previously noted, a small group of bull elk became attracted to hay being left for cattle on the west side of Sir Francis Drakes Boulevard on E Ranch in October 2015. The bulls were hazed off of the hay pile on several occasions during this time. These animals were directed downhill towards South Beach, where the bulls spent much of their time during this period anyways. With a smaller number of animals, a shorter distance to travel, no fences in their way, and no calves to consider, hazing of these bulls required less time and caution than hazing the main herd off of center C Ranch.

During the time period of this report, elk were hazed in the Drakes Beach area at total of 42 times. Hazing occurred primarily from July until October 2015, first directed at the main herd at center C Ranch and then shifting to the bulls on the E Ranch hay pile. In 2016, most hazing occurred in September 2016 to push the main herd of off center C Ranch. Hazing of elk did not occur in any other areas of the pastoral zone between November 2014 and October 2016.

Antler Protection

Antlers on male tule elk are shed and regrown annually, representing a significant investment of energy and resources and a key factor in the behavioral life cycle of the species. Tule elk at Point Reyes begin to shed their antlers in late January and early February, with the free range herds starting in advance of the elk on Tomales Point. Antler re-growth begins almost immediately, with velvet covered buds becoming visible within days of the antler shed. At this time, bachelor groups travel together seeking more mineral rich feed (forbs and other non-grasses) to nourish the rapid bone growth necessary to form a useful set of antlers. The formation of bachelor groups may also serve to prevent injury to the growing antlers, which would lead to deformation and loss of function in the fully developed appendages. In the midsummer, usually in July, the blood filled spongy antlers begin to solidify and lose vascularity. Eventually the velvet is sloughed off revealing fully formed and hardened bone.

In a male elk's second year of life, antlers are typically composed of a single tine, or spike. Subsequent years show further morphometric development of antlers, typically attaining a mature formation of seven or more tines and weighing up to 9 lbs. per side. Older bulls tend to show more asymmetry in antler morphology, with non-linear tines, palmate formations, and non-typical sub-branchings of the main beam and tines.

The illegal removal, or poaching, of elk antlers by the public has been a significant resource management issue at Point Reyes for many years. While visitors may take antlers without realizing it is unlawful, many individuals have been apprehended over the years with clear intent to take as many antlers as possible and evade park law enforcement. The level of poaching appears to be very high, as evidenced by the few antlers found by wildlife staff after the shed season each year. NPS biologists have also documented the removal of antlers from elk carcasses.

Antlers play an important role in the ecosystem's nutrient cycling, providing minerals that are both limited and crucial for mammals, plants and birds. Tomales Point soils in particular are naturally deficient in a number of trace minerals, such as copper and selenium (Gogan et al. 1989). Removal of antlers from the system depletes it further, similar to extractive mining of minerals. In response, the park has conducted an annual antler round-up since at least 2006 using both park staff and volunteers to locate and collect as many antlers from the field as possible. The antlers are then cut into pieces and re-distributed by hand back out into the elk ranges. Antler collection attempts are initiated when shedding is first detected and maintained until all male elk have shed and there are no longer antlers being recovered. Antlers are collected by surveying areas with spotting scopes and binoculars and through ground surveys of areas where bull elk tend to predictably congregate.

Tomales Point

In 2015, of the possible 170 branched antlers (85 branch antler bulls census 2014), 37 antlers were recovered for a recovery rate of 21.8% The low recovery was possibly due to lower effort, but may also reflect an increase in illegal removal. Antler poaching seems to be occurring in most areas of the reserve, but may be most acute in the southern portion near Pierce Point Road and the northern area

easily accessed by boat from across Tomales Bay, both areas where male elk congregate in larger groups and are easily observed.

In 2016, 11 antlers were recovered from Tomales Point of 152 possible branched antlers for a recovery rate of 7.2%. Antlers in this area were primarily discarded in the field in areas not accessible by visitors rather than recovered for later chipping and distribution.

Drakes Beach Area

An attempt was made to collect all the antlers shed from the Drakes Beach herd in early 2015 and 2016. In total, 25 branched antlers were collected for a recovery rate of 54.3%. In 2016, 18 antlers were recovered in the Drakes Beach area, for a recovery percentage of 40.9%. Ease of visibility and increasing public awareness of elk locations and habits may be the cause for a decreased recovery here as effort by park staff to collect antlers is similar in each year for this area.

Estero Road Area

Branch antlered males of the Limantour herd are typically found near Home Ranch during the shed season, and most antlers recovered come from this area. In 2015, wildlife staff recovered 20 new antlers of a possible 64 (32 branch antlered bulls observed 2014 census) for a recovery of 31.3%. In 2016, 14 antlers were recovered in this area, for a recovery rate of 20.5%. The presence of these bulls near roads and trails has become increasingly apparent and the range has expanded, likely making the shed antlers more vulnerable to illegal removal each successive year.

Tomales Point Water Availability

In response to the 2013-2014 elk population decline at Tomales Point during drought conditions, a contingency plan was developed in July 2015 as a measure that might be taken to provide drinking water for elk and other wildlife within the Tomales Point Elk Reserve. One of the known springs feeding the creek that leads to McClure’s Beach was chosen for placement of a 300 gallon plastic cattle trough that could be filled by a water truck from the paved road above the site. The northern portion of Tomales Point was not planned for supplemental water because the largest pond at the Lower Pierce Ranch site was known to have persisted even through the extended drought period of 2012 to 2015. There are no records of this pond that potentially serves the majority of the elk in the northern half of the reserve going dry.

During the 2015 and 2016 dry seasons, the conditions for activation of the supplemental water plan (that no surface water, pond or spring, was available during an extended period of time) was not apparent and so there was no need to implement this contingency plan. It is notable that seeps and springs supply the more conspicuous man-made ponds, which persist as important water sources for wildlife even after the ponds seasonally dry up.

To gauge the conditions for activation of the irrigation plan, in July 2015 four known seep/spring sites in the southern portion of the Tomales Point reserve had automated cameras placed in proximity to them to detect use by elk and other wildlife at times when the man-made ponds were dry. Cameras

were motion activated and had infrared illumination so photos were obtained at all hours. Photos showed frequent use by elk and other wildlife including but not limited to fox, coyote, bobcat, owl, quail, skunk, badger and assorted rodents and small birds.

Summer conditions at Tomales Point in 2015 and a sampling of the wildlife photos captured were reported to the PORE website, and are available here:

https://www.nps.gov/pore/learn/nature/tule_elk_tomales_point_faq.htm

Mortalities

Between November 2014 and October 2016, the following notable elk mortalities occurred:

On 11/17/2014, a cow elk was found next to the driveway of the D ranch complex. The carcass was in an advanced state of decay and the cause of death was therefore not determined. The carcass appeared to have been placed there by a tractor and most likely died in a separate location.

On 11/22/2014, a cow elk carcass was retrieved from C ranch that had finally died after being observed for several weeks as a solitary animal that appeared to be diminishing in health. A field necropsy revealed signs of pleuropneumonia, a common cause of aged animal mortality, and death was therefore most likely due to natural causes

On 11/30/2014, a bull elk was reported to be lying on the shoulder of Mount Vision Road. The bull was found to be alive but unable to stand and move away. Law enforcement and wildlife staff euthanized the bull and performed a field necropsy, which showed no abnormalities. The bull had an ear tag, indicating that the bull was from the original Limantour release and was therefore in excess of 15 years of age.

On 3/8/2015, a spike male elk was discovered injured inside pastures along Drake's Beach Road. Given that there were fractures to several bones and moderate road rash on the skin, he appeared to have been road struck. Law enforcement and wildlife staff euthanized the animal and collected tissue and fecal samples. The animal was negative for both CWD and Johne's disease.

On 5/4/2015, a spike male elk just outside the Tomales Point elk fence was struck by a vehicle and euthanized by NPS law enforcement. The carcass was transported to CAHFS for necropsy. The animal was in a severe state of malnutrition and showed signs of selenium and copper deficiency and heart disease. The animal was negative for both CWD and Johne's disease.

On 9/15/2015, a cow elk carcass was discovered on the C ranch in a moderate state of decay. No cause of death was determined; however, she appeared to be in poor body condition and of advanced age.

On 10/5/2015, a cow elk was discovered on the southern stretch of Drake's Beach, and appeared to have dropped from the cliffs above. She had an ear tag identifying her as a previously captured animal.

On 10/19/2015, a bull elk was discovered on the East D ranch area in a moderate state of decay. Inspection revealed signs of bleeding from the nasal cavity indicating a likely road strike.

Education and Outreach

For over 10 years, the Division of Interpretation and Resource Education at Point Reyes National Seashore has hosted a Tule Elk Docent Program at Tomales Point. The goals of the program are to:

- Provide opportunities for the general public to view tule elk at Tomales Point.
- Provide opportunities for the general public to interact with volunteers and park staff to learn about the many stories surrounding tule elk during the rut season.

The docent program runs from August through October and typically includes two training days in July. The docents station themselves at the Tomales Point Trailhead and Whites Gulch on weekends only, prepared with telescopes, antlers, and interpretive materials to teach the visiting public about the tule elk.

During the 2015 season, 17 docent volunteers contributed 981 hours to the docent program. The docents made an average of 326 visitor contacts per day, and 9133 visitor contacts for the entire 2015 season.

During the 2016 season, 15 docent volunteers contributed 610 hours to the docent program. The docents made an average of 237 visitor contacts per day, and 6409 visitor contacts for the entire 2016 season.

Point Reyes National Seashore wildlife staff presented a lecture and slideshow on past and present elk management in the park as a portion of both docent trainings in 2015 and 2016.

In addition, wildlife staff gave the following presentations regarding the history, management, and ecology of tule elk in the park to:

- April 2015 – Santa Rosa Junior College, Range Management class
- July 2015 – Rocky Mountain Elk Foundation
- November 2016 – UC Berkeley, Mammalogy class

Lastly, Point Reyes co-authored a presentation on Point Reyes tule elk with Dr. McCrea Cobb (US Fish and Wildlife Service), Dr. Peter Gogan (US Geological Survey), and Dr. Reginald Barrett (UC Berkeley). The presentation was largely derived from Cobb's dissertation work on the spatial ecology and population dynamics of tule elk at Point Reyes (2010). The presentation was given at the "Science for Parks, Parks for Science" conference hosted by UC Berkeley in March 2015.

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Appendix A: Tomales Point Census Results, 2015 and 2016

2015 Census Data

11/13/2015	Total	Cows	Calves	Spike Bulls	Raghorn Bulls	Prime Bulls	Total Bulls
South	72	43	11	5	0	13	18
Middle	69	55	9	2	1	2	5
North	99	49	12	5	12	21	38
Total	**240**	**147**	**32**	**12**	**13**	**36**	**61**

12/16/2015	Total	Cows	Calves	Spike Bulls	Raghorn Bulls	Prime Bulls	Total Bulls
South	102	61	10	3	2	26	31
Middle	58	45	8	2	2	1	5
North	123	59	14	5	14	31	50
Total	**283**	**165**	**32**	**10**	**18**	**58**	**86**

2016 Census Data

11/4/2016	Total	Cows	Calves	Spike Bulls	Raghorn Bulls	Prime Bulls	Total Bulls
South	93	57	9	3	6	18	27
Middle	70	45	18	3	3	1	7
North	122	61	21	3	6	31	40
Total	**285**	**163**	**48**	**9**	**15**	**50**	**74**

12/2/2016	Total	Cows	Calves	Spike Bulls	Raghorn Bulls	Prime Bulls	Total Bulls
South	97	62	8	5	4	18	27
Middle	70	46	17	3	3	1	7
North	123	64	16	3	6	34	43
Total	**290**	**172**	**41**	**11**	**13**	**53**	**77**

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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