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River Otter (*Lontra canadensis*) Monitoring Report 2019 Marin County, California

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Background

While historical records on river otters in the San Francisco Bay Area are sparse, existing information indicates that river otters had been extirpated from much, if not all, of Marin County by the 1930's when both Grinnell and trapping records indicate no coastal river otters in Marin and southward. Beginning in 1989, river otters were noticed in coastal Marin County, particularly in Rodeo Lagoon, Walker Creek, and Lagunitas Creek.

As apex predators using variety of terrestrial and aquatic habitat types, river otters are sentinel indicators of watershed function and health (Larivière and Walton 1998). They predate a wide variety of native and non-native species in freshwater and marine environments (Penland and Black 2009, Garwood and others 2013). They are susceptible to parasites such as *Cryptosporidium* and *Giardia* spp. (Gaydos and others 2007), and *Vibrio* spp. (Bouley and others 2015), and they may bioaccumulate environmental contaminants such as mercury, metals, organochlorines, and hydrocarbons (Francis and others 1994, Halbrook and others 1996, Bowyer and others 2003). Furthermore, understanding river otter ecology and population status is a critical element of ecosystem management (Bowen 1997, Kruuk 2006, Ben-David and Golden 2009). River otters transport aquatic nutrients to land (Ben-David and others 2004); transmit trophic effects (Crait and Ben-David 2007); and affect the composition and abundance of prey species via trophic subsidy (Garwood and others 2013).

Beginning in 2012, River Otter Ecology Project launched the first study to document current recovery of river otters in the nine counties surrounding San Francisco Bay (Bouley and others 2015) using camera traps and Otter Spotter, a community science initiative to collect river otter sightings. At the same time, we commenced a long-term monitoring project to study the status and ecology of river otters at 14 focal study sites in Marin County.

As Melquist and others have noted, long-term monitoring of river otter populations can help us understand and plan for water quality conditions and other factors that affect all species, and remain critical issues in the San Francisco Bay Area. River otters' ecological status and population trends can be significant indicators of progress in improving water quality and recovering habitat and ecosystem function. Restoration projects may also benefit from an understanding of river otter population changes. In our study area in Marin County, for example, the National Park service has in recent years undertaken three large restoration efforts: at Rodeo Lagoon; Muir Beach; and Giacomini Wetlands. Gauging the progress of those efforts can benefit from understanding the interactive effects of river otter populations and the restoration efforts, and their mutual success. Restoration projects in the wider SF Bay Area can similarly benefit.

Lastly, study of localized changes in population abundance of river otters as they recolonize areas from which they were absent can help to elucidate the spatial, environmental, and anthropogenic factors that influence their habitat choices and ecological success (Barbosa and others 2001, Weinberger and others 2016). Although sensitive to habitat disturbance, river otters are also highly adaptable to human presence on the landscape.

This report includes results from Otter Spotter, health, and population abundance change studies during 2019 and mentions concurrent research projects and those recently completed.

Otter Spotter Community Science Project

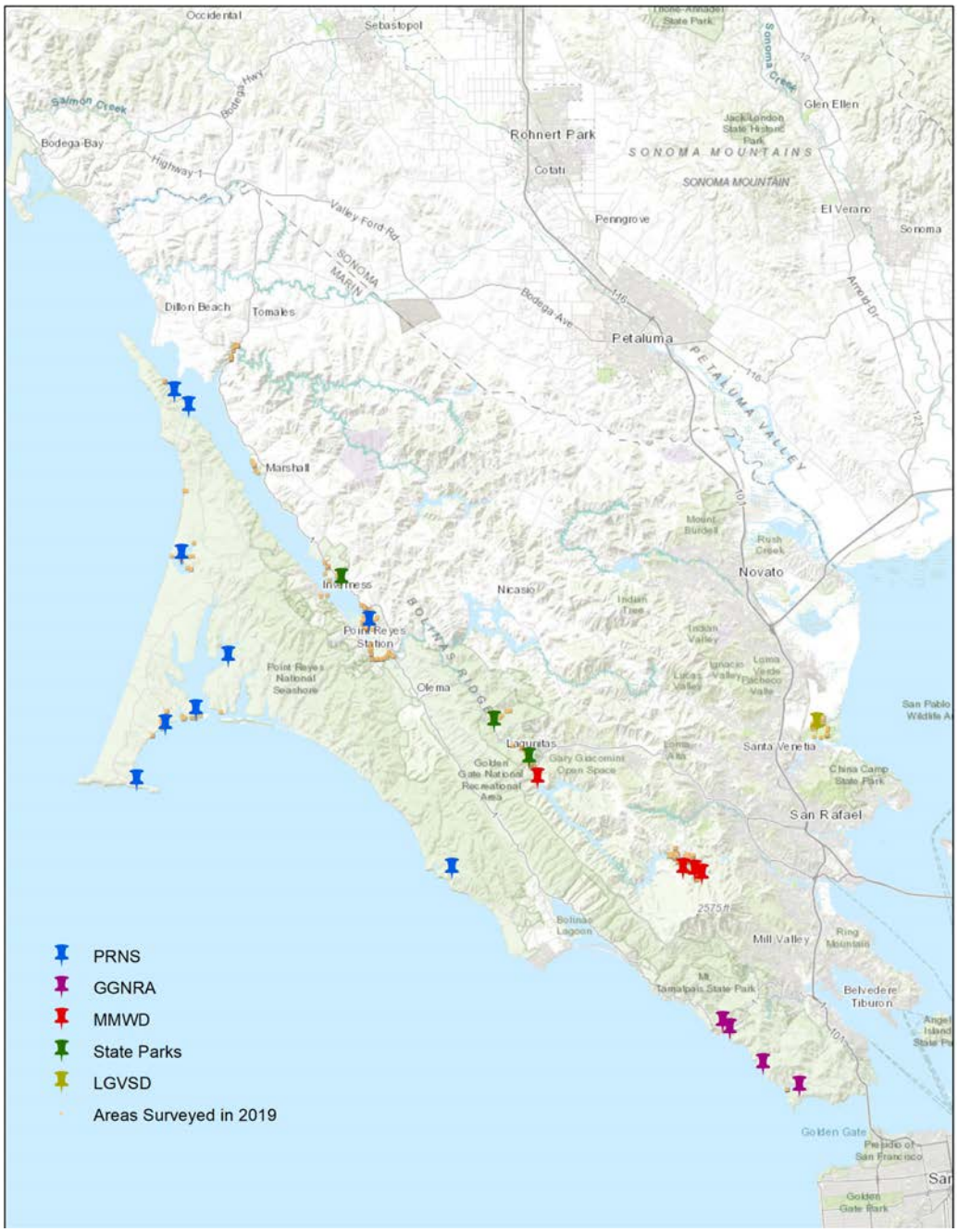
North American river otter (*Lontra canadensis*) were observed in Marin County with some frequency from the early 2000s; however, the distribution and abundance of river otters remained poorly documented at any agency level (Bouley et al., 2015). River Otter Ecology Project collected and documented river otter sightings during 2012 through the present, using a community science initiative called "Otter Spotter," to solicit structured data from the public on river otter sightings from the San Francisco Bay Area and beyond. River Otter Ecology Project presented this dataset to the California Department of Fish and Wildlife (CDFW) in 2017, and CDFW updated their range map in 2019 (Figure 1). The updated range map includes 4,100 square miles of additional river otter range based on Otter Spotter sightings (Melanie Gogol-Prokurat, CDFW, personal communication).

Figure 1: Updated Range Map, 2019

Long Term Monitoring, Focal Study Area

Beginning in 2012, ROEP identified a study area consisting of approximately 225 linear km of coastline, stream, and reservoir spanning an area from the Golden Gate north, through Tomales Bay, including Lagunitas Creek and its tributaries and reservoirs, and parts of the shoreline of San Pablo Bay. We surveyed for active river otter latrines and movement corridors, which indicated ongoing presence of otters. The study area includes land within the Golden Gate National Recreation Area, Point Reyes National Seashore, California State Parks, Marin Municipal Water District and Las Gallinas Valley Sanitary District, and Marin County Parks. We include yearly surveys on additional stretches of shoreline within the study area. Please see Figure 2.

Figure 2: River Otter Ecology Project Focal Study Area with Camera Sites and Areas Surveyed, 2019



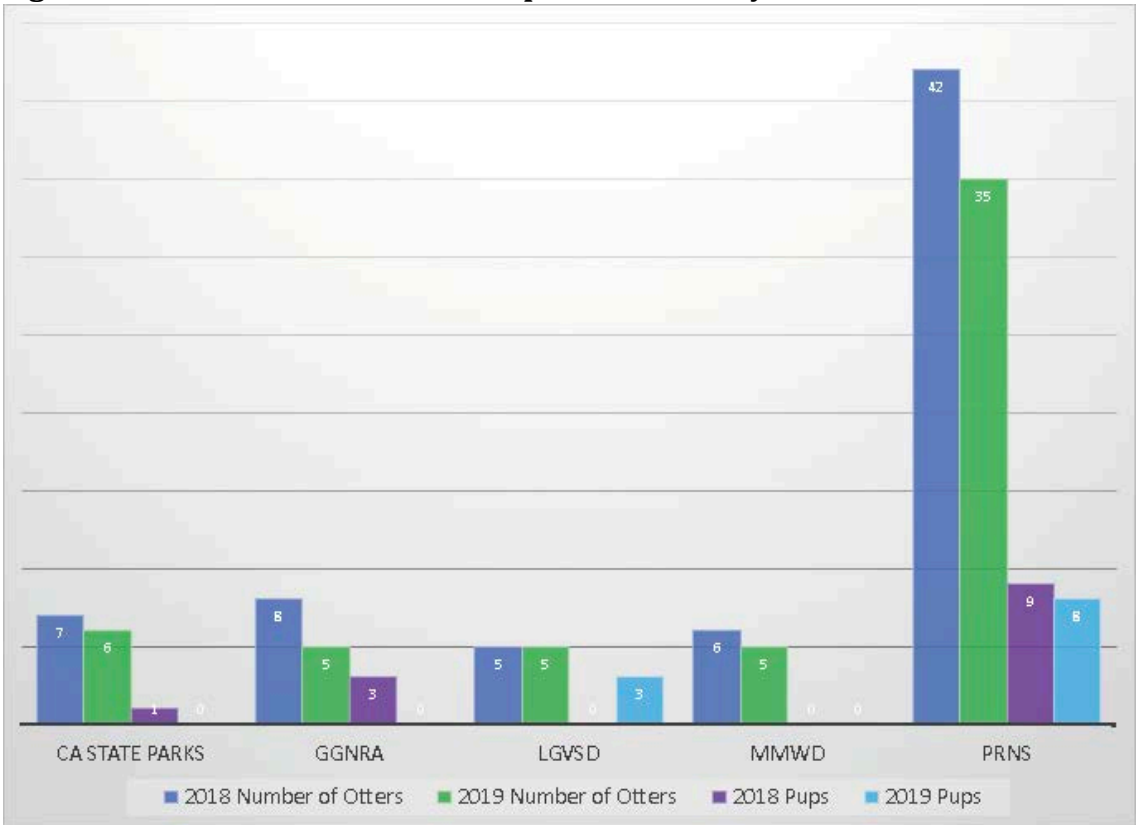
Population Abundance Change

We determined the minimum population at each Focal Study Site (FSS) as the largest grouping of river otters observed together at any one time at that location over the course of a calendar year (Bouley and others 2015). From the camera data for each FSS, we extracted the maximum group size appearing on a single video. From ArcMap, we extracted all credible Otter Spotter reports in the vicinity of that location for the same year. If a mapped Otter Spotter submission reported a larger group size, we based the minimum population at that site on that report, otherwise we used the camera data.

Table 1: River Otter Abundance at Focal Study Sites 2017 - 2019

Study Site	Landowner	2017 Otters	2018 Otters	2019 Otters	2017 Pups	2018 Pups	2019 Pups
Abbotts Lagoon	PRNS	3	5	6	2	3	2
Northern Tomales Bay	PRNS	8	11	7	2	2	3
Giacomini Wetlands	PRNS	5	7	7	1	0	0
Rodeo Lagoon	GGNRA	4	5	3	3	3	0
Redwood Creek / Muir Bea	GGNRA	1	2	1	0	0	0
Tennessee Valley Lagoon	GGNRA	1	1	1	0	0	0
Drakes Bay	PRNS	8	7	6	3	3	0
Bass Lake	PRNS	0	5	2	0	1	0
MMWD Reservoirs	MMWD	5	6	5	0	0	0
Middle Lagunitas	CA State Parks	5	7	6	2	1	0
Las Gallinas	LGVSD	5	5	5	0	0	3
Drakes Estero	PRNS	4	7	7	2	0	3
Totals		**49**	**68**	**56**	**15**	**13**	**11**

Figure 3: Numbers of Otters and Pups at Focal Study Sites 2018 and 2019



Otter population numbers at focal study sites vary. River otters do not breed in their first year, and males may not breed until their 4th or 5th year. (Reed-Smith, 2012) Additionally, the numbers of otters counted are not precise due to camera trapping methods. Otter numbers are meant to be indicative of trends rather than actual population counts. Some variability is expected, and population changes are further explored in a statistical analysis (publication in preparation).

Figure 4: River Otter Abundance by Focal Study Site, 2017 - 2019

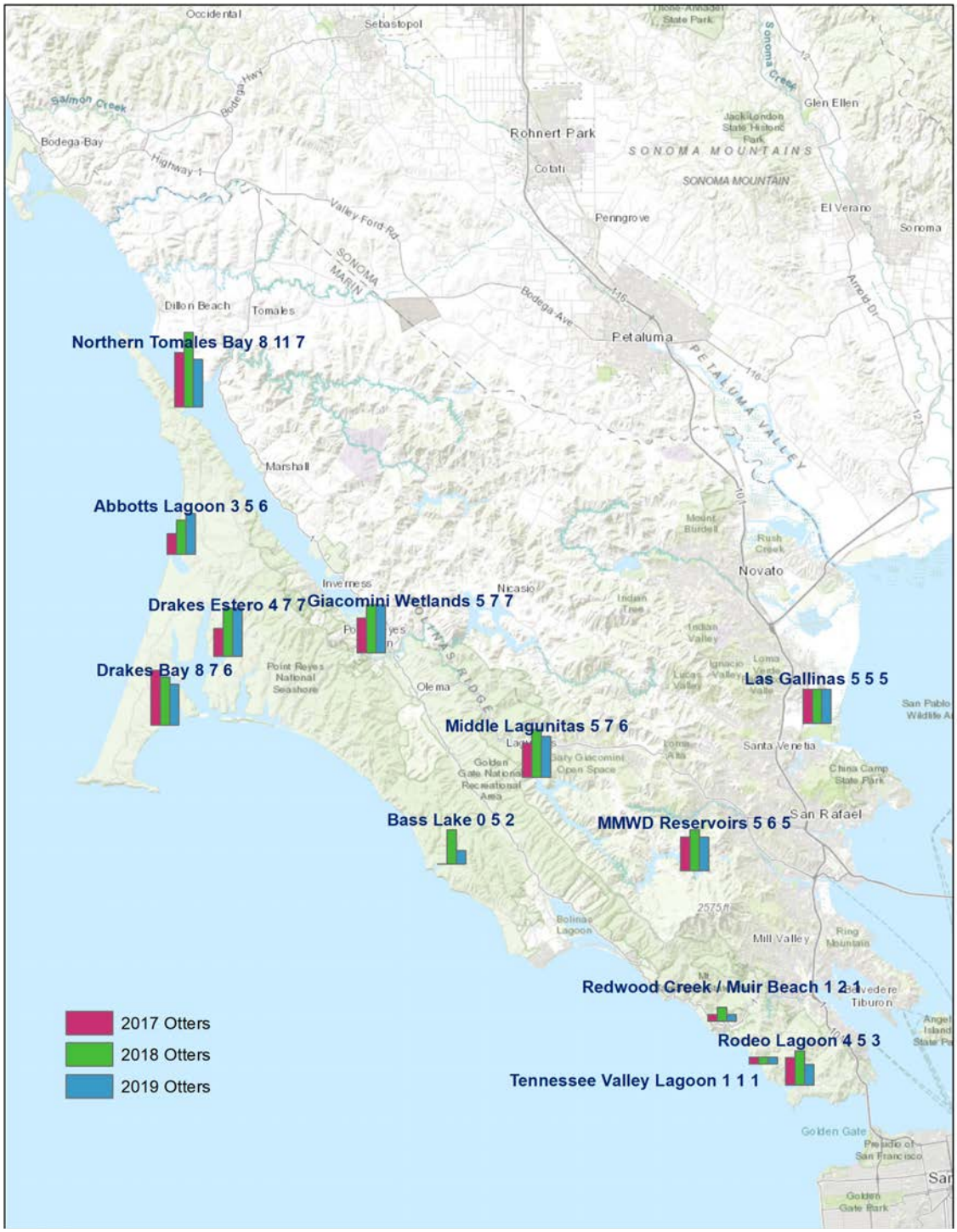
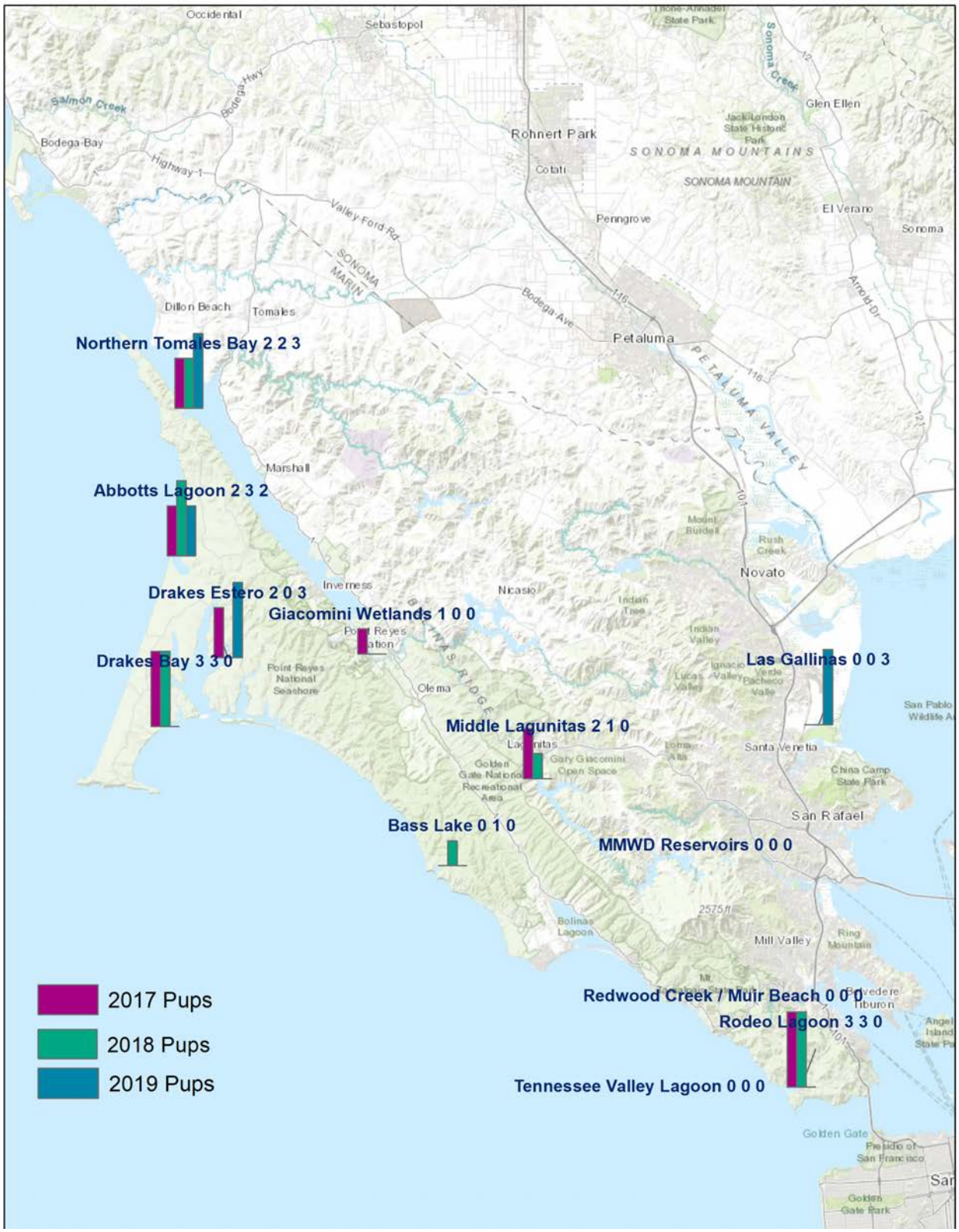


Figure 5: River Otter Pup Abundance by Focal Study Site, 2017 - 2019



Disease Monitoring results
Since 2013, in partnership with The Marine Mammal Center, ROEP has collected fecal samples to monitor for *Salmonella* and *Vibrio spp.* within our focal study areas.

No *Salmonella* has been detected during the course of the study.

Five species of *Vibrio* have been detected, including:
Vibrio algynoliticus, Vibrio parahemolyticus, Vibrio cholera, Vibrio diazotrophicus, Vibrio metschnikovii and possible *Vibrio fluvialis.*

During 2019, *Vibrio diazotrophicus* was isolated from a tested sample at Walker Creek.

Table 2: Bacterial Detection Results

2019 Study Sites with Vibrio Detections (Cumulative)				
Key Location	**Latitude**	**Longitude**	**Landowner**	**Description**
Abbotts Lagoon	38.1192	-122.9511	PRNS	7/29/2015 *Vibrio algynoliticus* isolated
Northern Tomales Bay	38.198664	-122.946028	PRNS	8/23/2016 Possibility of *Vibrio fluvialis*
Northern Tomales Bay	38.198635	-122.946098	PRNS	4/1/2013 *Vibrio algynoliticus* isolated
Northern Tomales Bay	38.2228	-122.9202	PRNS	9/19/2019 *Vibrio diazotrophicus* isolated
Giacomini Wetlands	38.066144	-122.82051	PRNS	9/22/2014 Possibility of *Vibrio fluvialis*
Giacomini Wetlands	38.08298	-122.82192	PRNS	11/17/2016 Possibility of *Vibrio fluvialis*
Rodeo Lagoon	37.831972	-122.525914	GGNRA	9/10/2017 Possibility of *Vibrio fluvialis*
Rodeo Lagoon	37.831879	-122.526194	GGNRA	11/24/2013 *Vibrio metschnikovii* isolated
Redwood Creek / Muir Beach	37.866574	-122.579298	GGNRA	
Tennessee Valley Lagoon	37.843365	-122.550858	GGNRA	
Drakes Bay	38.028878	-122.96422	PRNS	8/3/2017 *Possibility of Vibrio fluvialis*
Bass Lake	37.951746	-122.765278	PRNS	10/16/2014 Possibility of *Vibrio fluvialis*
Marin Municipal Water District	37.94805555	-122.5981951	MMWD	
Middle Lagunitas	37.99878	-122.70682	CA State Parks	11/25/2017 *Possibility of Vibrio fluvialis*
Las Gallinas Valley Sanitary District	38.02801	-122.514	LGVSD	
Drakes Estero	38.06417	-122.919032	PRNS	

Interesting Findings and Results

- Results of a Prey Species Analysis of 550 samples from Tomales and Drake's Bays. (Oates, et. al. 2019).
- Statistical Study of five years of population monitoring, paper accepted for publication in *Northwestern Naturalist.*
- Trailcam video capture of a river otter predating a gray smoothhound shark (*Mustelus californicus*)
- Three trail cameras were either stolen or vandalized by humans in the national parks during 2019. Theft is increasing, anecdotally due to the public becoming aware that trail cameras can be used by anyone.

Additional Research

- Current additional research includes Pixels v. Nucelotides, a comparative study of demographic results gained from camera trapping and DNA analysis from fecal samples.

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