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River Otter (*Lontra canadensis*) Monitoring Report 2023 Marin County, California

**River Otter Ecology Project
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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 (1937) and trapping records (Schempf and White, 1977; Kirk, 1975) indicate no coastal river otters in Marin and southward. Beginning in 1989, river otters were observed in coastal Marin County, particularly in Rodeo Lagoon, Walker Creek, and Lagunitas Creek.

As apex predators using a 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 et al. 2013). They are susceptible to parasites such as *Cryptosporidium* and *Giardia* spp. (Gaydos et al., 2007), and *Vibrio* spp. (Bouley et al., 2015), and they may bioaccumulate environmental contaminants such as mercury, metals, organochlorines, and hydrocarbons (Francis et al., 1994; Halbrook et al., 1996; Bowyer et al., 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 et al., 2004); transmit trophic effects (Crait and Ben-David, 2007); and affect the composition and abundance of prey species via trophic subsidy (Garwood et al., 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 et al., 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 et al. (2003) 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 population trends in river otters as they reinhabit 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 et al., 2001, Weinberger et al., 2016). Although sensitive to habitat disturbance, river otters are also highly adaptable to human presence on the landscape (Weinberger et al., 2016).

This report includes new information and results our Otter Spotter community science program, and long-term monitoring and health studies. The report also summarizes other findings of interest and ongoing research.

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 (CDFW BIOS, 2019).

As of the end of 2023, we have received approximately 5,800 reports of river otter sightings from the SF Bay Area and beyond, throughout much of the United States.

The River Otter Salvage Network, our collaborative effort with CDFW and California Academy of Sciences to collect and necropsy road-killed river otters reported through our Otter Spotter platform, reported its first results in 2023. See the Pathogen and Contaminant Monitoring section of this report for more information.

Through a partnership with [FieldScope](#), we have expanded Otter Spotter to the [Verde River](#) in Arizona, and the [Elizabeth River](#) in Norfolk, Virginia.

River Otter Ecology Project produced an ArcGIS Story Map, [Supporting Conservation, One Otter Sighting at a Time](#) to help the public understand why and how we collected the sightings and to whom they matter. A [Spanish-language version](#) is also available.

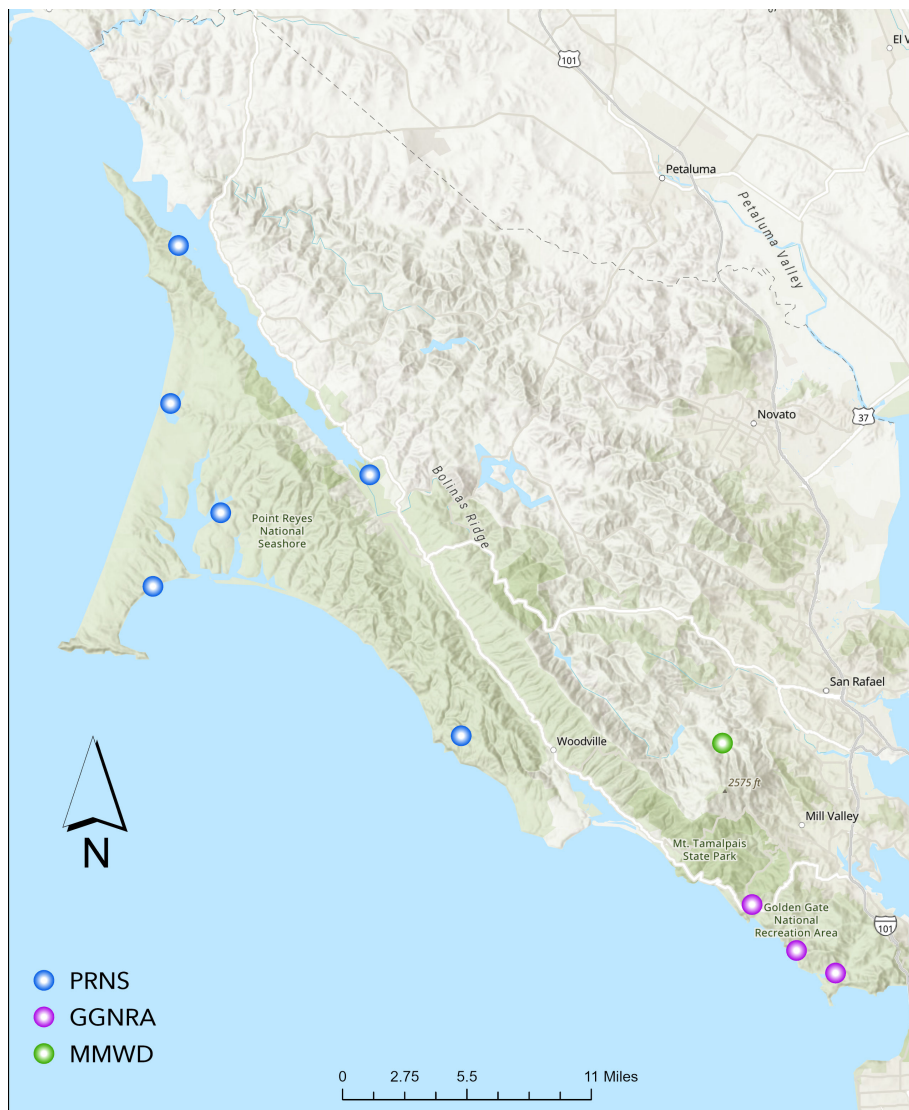


Long Term Monitoring, Focal Study Areas

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. Please see Figure 1.

In 2023, we did not monitor any sites on State Parks land, and we discontinued monitoring at Las Gallinas.

Figure 1: River Otter Ecology Project Focal Study Areas, 2023



Change in Abundance

We determined the minimum abundance 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 ArcGIS Pro 2.9, we extracted all 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 abundance at that site on that report, otherwise we used the camera data. We did not collect data in 2020 due to Covid-19 restrictions.

Table 1: River Otter Abundance at Focal Study Sites 2012 – 2023

Focal Study Site	Agency	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022	2023	Mean
	Jurisdiction												
Abbotts Lagoon	PRNS	6	6	6	6	6	6	5	6	8	7	9	6.45
Northern Tomales Bay	PRNS	7	6	5	8	9	8	11	7	11	9	10	8.27
Southern Tomales Bay	PRNS	4	8	7	8	9	5	7	7	4	5	6	6.36
Rodeo Lagoon	GGNRA	4	6	4	4	4	4	5	3	6	7	4	4.64
Redwood Creek	GGNRA	NA	3	3	1	1	1	2	1	3	0	2	1.70
Tennessee Valley	GGNRA	1	2	3	1	1	1	1	1	1	5	5	2.00
Drakes Bay	PRNS	5	4	4	4	7	8	7	6	7	6	6	5.82
Bass Lake	PRNS	NA	4	5	5	4	NA	5	2	NA	4	2	3.88
MMWD Reservoirs	MMWD	NA	4	5	6	7	5	6	5	7	6	4	5.50
Drakes Estero	PRNS	NA	NA	6	4	4	4	7	7	6	7	11	6.22
Totals		27	43	48	47	52	42	56	45	53	56	59	

Table 2: River Otter Pup Abundance at Focal Study Sites 2012 – 2023

Focal Study Site	Agency	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022	2023	Mean
	Jurisdiction												
Abbotts Lagoon	PRNS	3	3	2	4	2	2	3	2	5	2	6	3.09
Northern Tomales Bay	PRNS	5	2	2	1	3	2	2	3	3	4	3	2.73
Southern Tomales Bay	PRNS	0	4	3	3	0	1	0	0	0	0	0	1.00
Rodeo Lagoon	GGNRA	1	3	2	0	0	3	3	0	3	3	0	1.64
Redwood Creek	GGNRA	NA	2	1	0	0	0	0	0	2	0	0	0.50
Tennessee Valley	GGNRA	0	0	2	0	0	0	0	0	0	2	3	0.64
Drakes Bay	PRNS	2	2	3	1	5	5	3	0	3	3	3	2.73
Bass Lake	PRNS	NA	0	0	0	0	NA	1	0	NA	0	0	0.13
MMWD Reservoirs	MMWD	NA	3	3	0	2	0	0	0	0	0	0	0.80
Drakes Estero	PRNS	NA	NA	0	0	2	2	0	3	2	2	3	1.56
Totals		11	19	18	9	14	15	12	8	18	16	18	

In any given year river otter abundance varies considerably among the Focal Study Sites. At any given site, however, abundance generally does not vary considerably from year to year (Carroll et al., 2020). River otters do not breed in their first year, and males may not breed until their 4th or 5th year. (Reed-Smith, 2012). The numbers of otters counted are not precise due to camera trapping methods (Bouley et al., 2015). Otter numbers are meant to be indicative of trends rather than actual population counts (Carroll et al., 2020).

Pathogen and Contaminant Monitoring

Salmonella and Vibrio spp.

From 2013 through 2022, 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 alginolyticus*, *Vibrio parahaemolyticus*, *Vibrio cholera*, *Vibrio diazotrophicus*, *Vibrio metschnikovii* and possible *Vibrio fluvialis* (Table 2).

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

Results for samples collected in 2021 are not yet available. The study is now complete.

Table 2: Cumulative Vibrio Detections at Study Sites

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

Pesticides and Heavy Metals

The River Otter Salvage Network, a collaboration among ROEP, CDFW, and California Academy of Sciences, collected 20 river otter carcasses in the San Francisco Bay/Delta region in 2021 and 2022. Necropsies, which included toxicology testing for pesticides and heavy metals were performed on all carcasses.

Preliminary partial test results made available in 2023 indicated:

- 31% of the tested river otters showed trace exposure to 1st and 2nd generation anticoagulant rodenticides. Rodenticide toxicosis was not determined to be the cause of death of any of the tested otters.

- Lead was detected in the livers of 2 river otters. Concentration levels of lead associated with toxicosis are not well-defined.
- Mercury was detected in 63% of the tested otters. The concentration levels of mercury found were not likely to be of clinical significance.

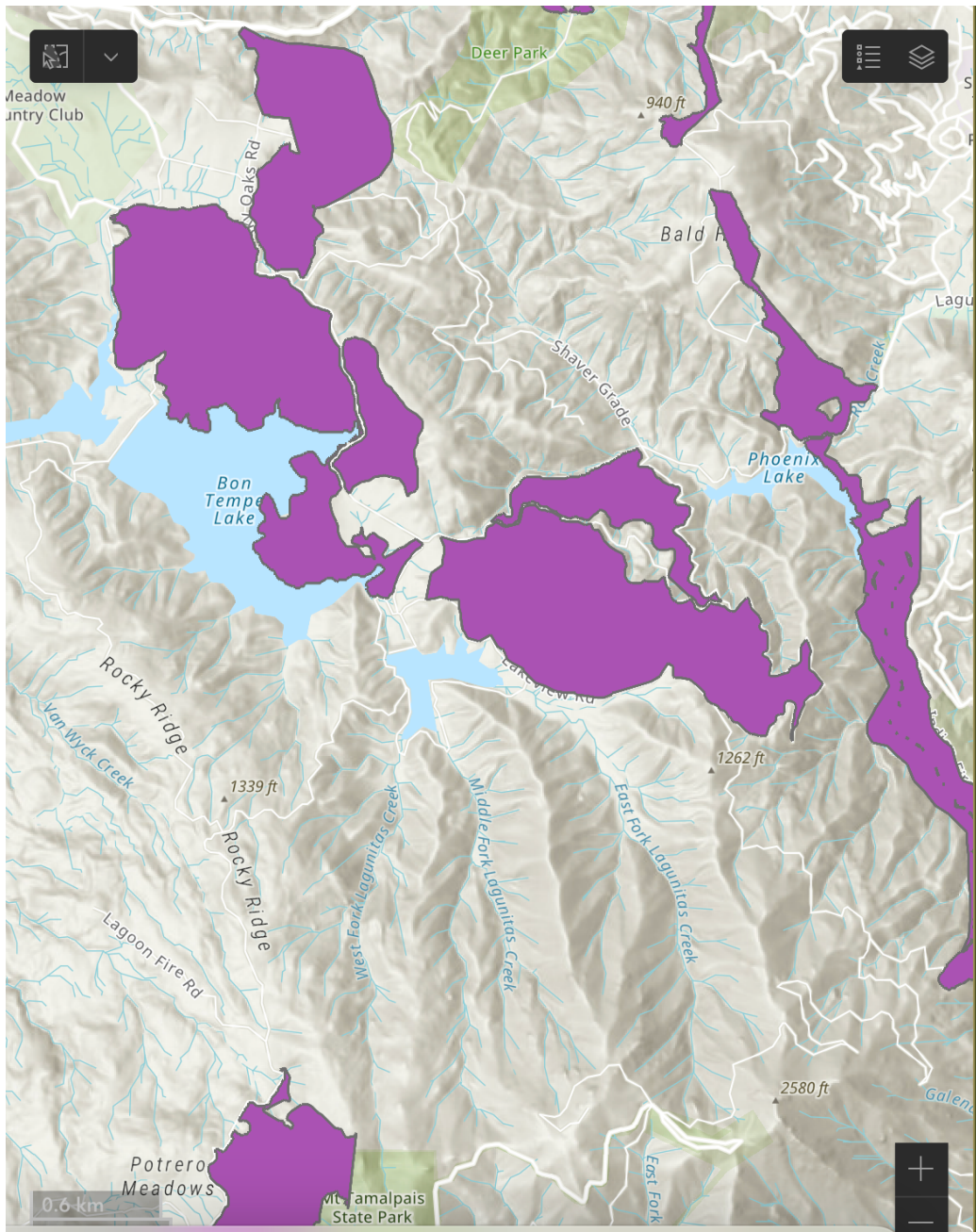
The preliminary data suggest that river otters are not uniquely exposed to the pesticides that were tested for. In addition, background levels of lead and mercury have been documented in other piscivorous species, and are not uncommon. However, establishing normative baseline levels for river otters would require larger sample sizes from geographically differentiated populations.



Other Findings and Results

- In June 2023, our research camera at Tennessee Beach recorded an adult river otter with 3 pups. These are the first pups known to have been born in the Tennessee Valley area since 2014.
- Through our Otter Spotter program, we obtained documented observations of river otter pups at the northern end of Bolinas Lagoon. These are the first documented observation of pups in the area since 2013. We also received the first reports of a river otter in the area of Agate Beach.
- At our MMWD Reservoirs sites in 2023, we found that the resident river otters had changed their established pattern of habitat use. Our research cameras did not detect any river otter activity at latrine sites and travel corridors that over previous years had been regularly used. Over the prior year, resource agencies had carried out fire fuel reduction projects involving mechanical and hand thinning of vegetation across a large area adjacent to Lake Lagunitas and Bon Tempe Lake (Figure 2). Our prior research at sites in Martinez and at Drakes Beach suggests that projects involving vegetation removal can fragment river otter habitat, resulting in changes in river otters' frequency and pattern of use of that habitat. Further study is required to investigate the extent and persistence of these effects on habitat use.

Figure 2. Recent fire fuel Reduction Projects in the Vicinity of Lake Lagunitas and Bon Tempe Lake. Project areas are shown in purple.



Source: [CA Wildfire & Forest Resilience Task Force Interagency Treatment Dashboard](#)

Additional Research

- We completed work on Pixels v. Nucleotides, a comparative study of demographic results gained from camera trapping and DNA analysis of fecal samples. The final report of results is available [here](#).
- In 2023, we completed data collection for a baseline study of river otter predation of Brown pelicans (*Pelecanus occidentalis*) at Abbotts Lagoon.

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