

Winter 1998-2000 Frog Breeding Survey,
Golden Gate National Recreation Area

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ABSTRACT

This report summarizes field activities that have occurred over the past two winters: Winter 1998-1999 and Winter 1999-2000 for winter breeding amphibians in select wetlands within the legislative boundary of the Golden Gate National Recreation Area. Survey activities focussed mainly on the threatened California red-legged frog (*Rana aurora draytonii*). Surveyed areas included Bolinas-Fairfax Road wetland, lower Redwood Creek, Tennessee Valley, Rodeo Valley, Milagra Ridge, and Sharp Park. Pacific chorus frogs (*Pseudacris regilla*) were encountered at most sites. The California red-legged frog was documented at Bolinas-Fairfax Road, lower Redwood Creek, Rodeo Valley, Milagra Ridge, and Sharp Park. A variety of survey techniques were used including egg mass, night visual, trapping, and night calling surveys. Egg mass surveys worked well in small wetlands without extensive emergent and aquatic vegetation (Milagra Ridge Pond and Bolinas-Fairfax wetland). Night calling surveys were able to detect red-legged frog breeding activity at Rodeo Lake and Big Lagoon, areas with extensive vegetation and large areas of potential breeding sites.

This report summarizes field activities that occurred over the past two winters, Winter 1998-1999 and Winter 1999-2000, for winter breeding frogs in select wetlands within the legislative boundary of the Golden Gate National Recreation Area. Survey activities focussed mainly on the threatened California red-legged frog (*Rana aurora draytonii*). The project objectives are as follows:

Project Objectives

1. To determine the location of California red-legged frog breeding activities within the Golden Gate National Recreation Area.
2. To determine temporal and spatial variability in red-legged frog breeding activity.
3. To engage the public in monitoring and stewardship of aquatic resources.
4. To provide baseline information of red-legged frog breeding activity for project planning and monitoring purposes.
5. To provide baseline information of Pacific chorus frog (*Pseudacris regilla*) breeding activity.
6. To collect incidental observations of other aquatic amphibians during calling surveys.

National Park Service Management Policies

The National Park Service has a few general policies that provide guidance regarding natural resource management issues. National Park Service (NPS) policies require that the primary management objective in natural zones be the protection of natural resources and values for appropriate types of enjoyment while ensuring their availability to future generations. Furthermore, the NPS is required to identify and promote the conservation of all federally listed threatened, endangered, or candidate species. In order to adequately protect natural resource values, especially our federally listed species, adequate inventory and monitoring data are essential.

Our Natural Resource Management Guidelines (NPS-77) identify the initiation of long-term monitoring programs as an essential part of the natural resource management program in order to:

- Determine present and future health of park ecosystems.
- Establish empirical limits of variation in park resources.

- Diagnose abnormal conditions in time to develop effective mitigation.
- Identify potential agents of human-induced change.

Currently, long-term aquatic monitoring programs are underway for several special status aquatic species including coho salmon and steelhead, California freshwater shrimp, and tidewater goby. With the exception of the California freshwater shrimp, all monitoring efforts rely heavily on volunteers to conduct field work.

With respect to threatened or endangered species, Park management policies require us to **"...identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats...."**

Amphibian Work Completed to Date

Information regarding aquatic amphibians found within the Park comes from a variety of sources. The Museum of Vertebrate Zoology at U.C. Berkeley, as well as the California Academy of Sciences, have large collections that are catalogued according to species, date, location and collector. Their records reveal foothill yellow-legged frogs from the Redwood Creek watershed and California red-legged frogs from Rodeo Valley and Mountain Lake, San Francisco (CAS, unpublished data, 1999).

Four herpetological surveys have recently been completed to date within the Park. In 1993, Ed Ely conducted surveys of suitable aquatic habitats at Redwood Creek, Rodeo Valley, Tennessee Valley, and Sweeney Ridge (Ely 1993, PWA 1994). Red-legged frogs were found in all four watersheds, although at very low numbers. From 1994 to 1996, surveys were conducted by staff of Gary Fellers (US Geological Survey-Biological Resources Division) at Redwood Creek, Tennessee Valley, and Sweeney Ridge along with extensive surveys in GOGA north district lands within the Lagunitas Creek watershed managed by Point Reyes National Seashore. In winter-spring 1997-1998, breeding surveys in Rodeo Lake, Big Lagoon, and Tennessee Valley wetland sites were conducted by (Cook 19xx). Red-legged frogs were only found in the Rodeo Lake and Big Lagoon areas. During the summer of 1997, California giant salamander surveys were conducted in upper Redwood Creek watershed by USGS-BRD (Judd Howell) staff and Darren Fong.

Within the Park's legislative boundary, several surveys have been conducted at the City and County of San Francisco's watershed lands at Crystal Springs Reservoir and Sharp Park (San Francisco Planning Department 1999, PWA 1992, Sean Barry, pers. comm., 1999).

METHODS

Our objectives dictated the sampling techniques. Winter breeding surveys were conducted primarily to determine the location of California red-legged frog breeding sites and to document temporal and spatial variability in breeding activity. In addition, we wanted to engage the public in monitoring and stewardship of aquatic resources. The Park lacks sufficient funding to monitor natural resources with Park staff or through contracts. Terrestrial monitoring programs (raptors, snowy plovers, and spotted owls) have successfully used trained volunteers to collect good data. In addition, a volunteer survey program within the Park would allow participants to experience the Park in a way different from casual visitors.

After much discussion, we decided to try both calling and egg mass surveys to see if they provided similar information about frog breeding activity. In some instances, we also visually searched for adults and/or juveniles at night. Volunteers conducted calling surveys on their own while Park biologists were involved with egg mass and night visual surveys.

Volunteers conducted calling surveys along a fixed route and at fixed stations on a weekly basis within three watersheds. All volunteers were required to attend a training session that covered survey procedures and the variety of calls likely to be encountered. They were also provided a training tape (excerpts from Carlos Davidson's Frog and toad calls of the Pacific Coast - vanishing voices) to become more familiar with the frog calls. Misidentification of frog species by trained volunteers was considered unlikely. Only four frog and one toad species are present within the Park and their calls are individually distinct. In addition, the calling surveys, of all potential techniques, are the least intrusive on either habitat or the frogs themselves. Both written guidance for field surveys (USFWS 1997) and personal communications (Mike Westphal, USFWS, pers. comm. 1997) indicate that calling surveys will not "take" red-legged frogs.

Calling stations were established along creeks and wetlands with potential breeding habitat. Survey teams walked this fixed route about a half hour after sundown on a weekly basis. We established stations using a systematic spacing of 200 m from a random starting point. The 200 m spacing was established to prevent any overlap in calls. Volunteers were also required to listen for calls in transit between stations. Physical data included recent weather conditions, moon phase, air and water temperature, and wind speed (using Beaufort scale or Dwyer wind meter). At Sharp Park and Bolinas-Fairfax wetlands, salinity measurements (Yellow Springs Instrument Model 33) were obtained to determine suitability of sites for breeding. Details of the survey procedures and data sheets can be found in our survey manual (Canevaro et al. 1997). Calling surveys protocol were developed using information

from Zimmerman (1994), Jennings (1997, pers. comm), and several on-line papers from the North American Amphibian Monitoring Project sponsored by U.S. Geological Survey - Biological Resources Division (Bishop 1997, Chabot 1997, Geissler 1997, Sargent 1997, and Shirole et al., 1997).

At sites with recent frog occurrences, we conducted night visual surveys and/or egg mass surveys. Visual surveys used flashlights with power supply of 5 "D" cell batteries or fewer. Surveys were generally initiated within an hour of sundown and conducted by walking the perimeter of small wetlands that had clear line of sight. At larger waterbodies (Rodeo Lake and Tennessee Cove Pond), night visual surveys were conducted by boat. Egg mass surveys were conducted during daylight hours and on days where water clarity allowed the surveyor to see the wetland bottom. The sampled area was covered by zig-zagging through the site.

Study Area

Calling stations were established at wetlands within the Marin Headlands, Marin County (Table 1) and Figures 1-2. We also established stations along low gradient creek sections because red-legged frogs have been known to breed in streams (M. Jennings pers. comm. 1997 and M. Westphal pers. comm. 1999). These sites were chosen because of current planning and resource management activities that are proposed for the area. Appendix I contains specific cartographic location information for the calling stations.

Table 1: Distances of call survey routes

WATERSHED -Creek or Pond	No. of Stations	Survey Distance (km) approximate
RODEO VALLEY	15	2.73 (total)
-Rodeo Pond	4	0.43
-Rodeo Creek	7	1.39
-Gerbode Creek	4	0.91
TENNESSEE VALLEY	13	1.62 (total)
-Elk/Tennessee Creek	5	0.99
-Backdoor Pond	2	0.06
-Haypress Pond	2	0.22
-Tennessee Cove Pond	4	0.35
LOWER REDWOOD CREEK	18	1.82 (total)
-Horse Pasture	3	0.3
-Upper Big Lagoon	3	0.3
-Green Gulch Creek	10	1.1

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WATERSHED -Creek or Pond	No. of Stations	Survey Distance (km) approximate
-Green Gulch Hill Pond 2	1	0.06
-Green Gulch Hill Pond 1	1	0.06
-GRAND TOTAL	48	6.21

Egg mass and night visual surveys were conducted at the following locations (Table 2).

Table 2: Locations of Egg Mass and Night Visual Surveys at Golden Gate National Recreation Area, Winter 1998-1999 and 1999-2000.

Site Name	EGG	NIGHT	UTM N	UTM E	County	Lando wner	Topograph ic Map
Bolinas-Fairfax Floodplain Wetland	x		4198600	526762	Marin	GOGA	Bolinas
Gerbode Creek	x		4187467	542197	Marin	GOGA	Pt. Bonita
Rodeo Lake- South	x	x	4187219	541791	Marin	GOGA	Pt. Bonita
Rodeo Lake- North	x	x	4187348	541758	Marin	GOGA	Pt. Bonita
Marine Mammal Center Wetland	x		4187530	541231	Marin	GOGA	Pt. Bonita
Banducci Ditch	x	x	4190998	537018	Marin	GOGA	Pt. Bonita
Big Lagoon Pasture A	x	x	4190709	537438	Marin	Private	Pt. Bonita
Big Lagoon Pasture B	x	x	4190555	537476	Marin	Private	Pt. Bonita
Big Lagoon Pasture C	x	x	4190428	537494	Marin	Private	Pt. Bonita
Green Gulch Parking Lot Pond	x	x	4191348	538441	Marin	Private	Pt. Bonita
Green Gulch Below Parking Lot	x		4191220	538403	Marin	Private	Pt. Bonita
Green Gulch- Zendo Pond	x	x	4190997	538302	Marin	Private	Pt. Bonita

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Site Name	EGG NIGHT	UTM N	UTM E	County	Lander	Topographic Map
Sutro Bath Area	x	4181525	542839	San Francisco	GOGA	Pt. Bonita
Milagra Ridge Oxidation Pond	x	4165889	546584	San Mateo	GOGA	S.F. South
Sweeney Ridge-South Meadow	x	4160679	548668	San Mateo	GOGA	Montara Mtn
Sweeney Ridge-Discovery Site	x	4161775	548080	San Mateo	GOGA	Montara Mtn
Sharp Park-Horse Pond	x	x	4163952	544585	San Mateo	CCSF Montara Mtn
Sharp Park-Laguna Salada	x	x	4164434	544726	San Mateo	CCSF Montara Mtn, S.F. South
Flood Estate-Hill Pond	x	4144062	563521	San Mateo	Private	Woodside
Flood Estate-House Pond	x	4143800	563303	San Mateo	Private	Woodside

Bolinas-Fairfax Road Wetland (Figure 1). This wetland is formed courtesy of Highway One which cuts across the outlet of Wilkin's Gulch as it empties into the northern end of Bolinas Lagoon. It is small wetland, generally less than a quarter acre during the winter and intermittent, often dry by mid to late summer. The road fill and probably undersized culvert likely form this wetland by ponding water. High tide events may influence the salinity regime in this wetland. The western edge of the wetland adjacent to Highway One and Bolinas Lagoon contain mostly saltgrass and *Juncus* along the perimeter. The wetland is unfenced and grazed by cattle and local residents have called the Park regarding cattle manure inputs into the wetland. Past surveys by Gary Feller's program have found the presence of red-legged frogs in this wetland.

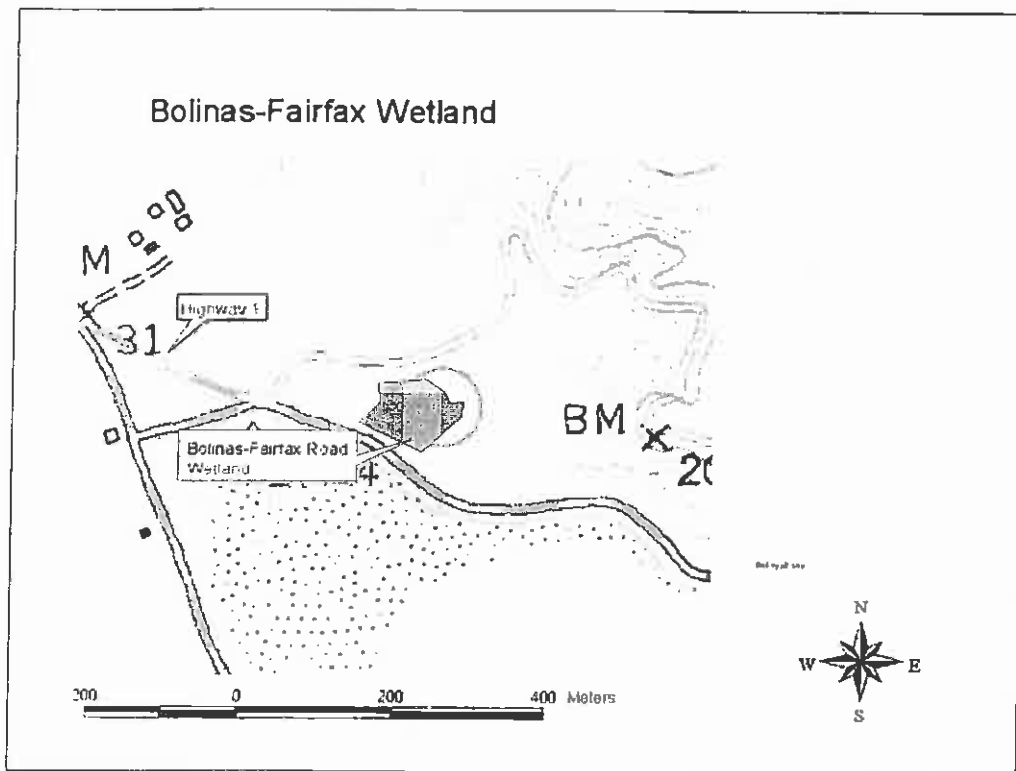


Figure 1: Survey Location at Bolinas-Fairfax Road Wetland, GOGA, Marin Co., Bolinas 7.5 minute USGS quad.

Big Lagoon Environs (Figure 2). The Redwood Creek watershed is a coastal drainage in southern Marin County, California. It covers 7.5 square miles (PWA *et al.* 1994). Before discharging into the ocean, Redwood Creek joins with its last tributary, Green Gulch, to form Big Lagoon, an intermittent tidal lagoon approximately 2.2 acres, and associated backwater areas. Barring uncharacteristic hydrologic events, Big Lagoon is connected to the Pacific Ocean during winter and spring months and closed during the remainder of the year.

Historically, Big Lagoon was a 30-acre wetland complex consisting of a freshwater lagoon, seasonal wetlands, dunes, and an intermittently tidal lagoon (PWA *et al.*, 1994). The historic wetlands were likely characterized by emergent vegetation such as sedges, tules, and cattails along the periphery and open water habitats. This historic habitat was degraded through channelization, levee construction, filling, dune removal, and accelerated sedimentation (PWA *et al.*, 1994). Currently, the historic wetland is overlain by the Muir Beach Parking Lot, picnic facilities, and an abandoned horse pasture. This pasture is flooded during the winter and spring by runoff from Green Gulch Creek and high water table levels. This flooded pasture was the site of a lone red-legged frog egg mass in the winter of 1996-1997. Surveys

excluded areas that were under tidal influence, high velocity flows, and brackish.

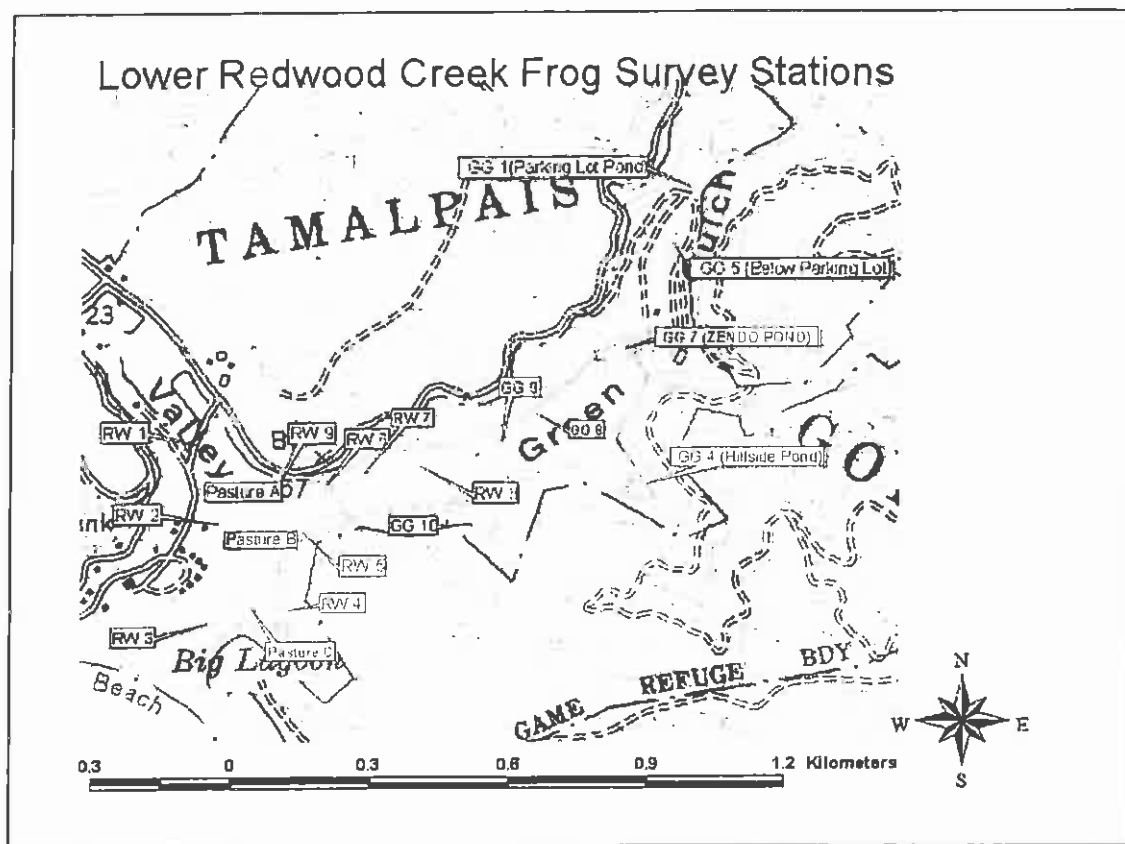


Figure 2: Survey Locations at Lower Redwood Creek (Big Lagoon Environs and Green Gulch), Marin Co., Pt. Bonita 7.5 minute quad. USGS.



Figure 3: Pasture A at Big Lagoon Environs, Marin Co.



Figure 4: Pasture C at Big Lagoon Environs

GOGAGreen Gulch (Figures 2-4). This small watershed supports Green Gulch farms and related facilities. The stream channel has been straightened and realigned to increase farmable lands. Several instream ponds are present (3). In addition, two off-channel ponds are present on the hillslopes. The ponds provide breeding habitat for chorus frogs and newts. Several of the ponds also support fish native to the San Joaquin-Sacramento River system including Sacramento perch and blackfish (PWA 1994).

Tennessee Valley (Figures 5-7). Tennessee Valley is a coastal watershed with a perennial creek that drains to the Pacific Ocean. The drainage area is quite small for a perennial creek (2.4 sq. miles); however, numerous springs are present within the watershed. These perennial waters flow through a riparian forest in the upper watershed comprised mainly of introduced Eucalyptus trees. Much of the channel is well-incised with little or no development of a floodplain. Above Tennessee Cove Pond, a functional floodplain is present along with a more native riparian community of willows and wetland plants. Past electrofishing activities found only native sculpin and three-spine stickleback to be present in the creek.

Within the watershed, three stockponds (Haypress, Backdoor, and Tennessee Cove Ponds) have been formed through the placement of fill across a drainage. 1897 USGS maps of the area show only the presence of intermittent and perennial creeks within this vicinity. The ponds in Tennessee Valley were built around the 1950's to support cattle activities.

The U.S. Fish and Wildlife Service's National Wetland Inventory maps classify several different types of wetland and aquatic sites within the project area. The ponds are predominately Palustrine Unconsolidated Shore (nontidal freshwater wetland with <30% coverage of vegetation, small unconsolidated substrates, and artificially flooded) bordered by fringes of Palustrine Emergent Wetland (nontidal freshwater wetland with rooted hydrophytes).

Unlike Redwood Creek watershed, Tennessee Valley contains numerous introduced aquatic animals and plants. Water lilies, water hyacinth, and *Elodea* are common aquatic plants found in the stockponds here. Introduced fish and aquatic animals known to be present include bullfrogs, mosquitofish, , and red-eared sliders. Past pond draining activities have likely controlled non-native fish in Haypress and Backdoor Ponds, however, largemouth bass, green sunfish, redear sunfish, bluegill may be present in Tennessee Cove Pond.

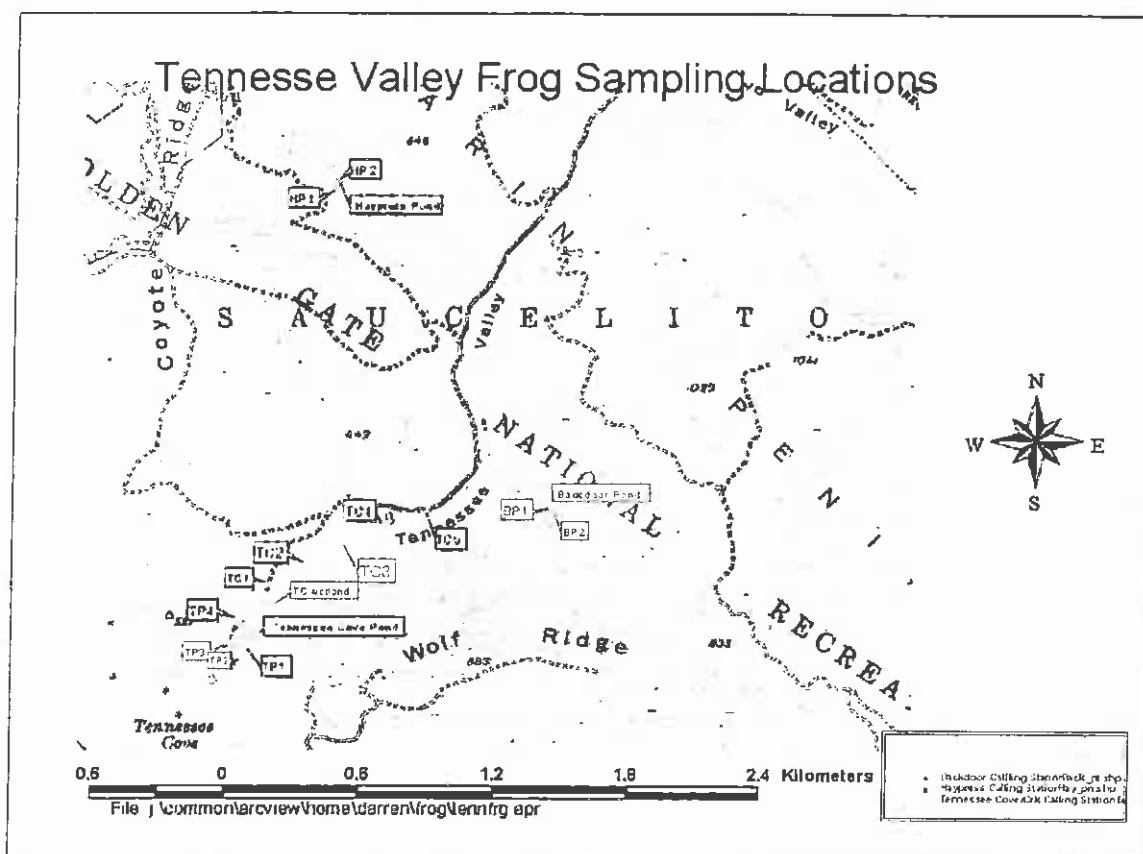


Figure 5: Sampling Locations within Tennessee Valley, GOGA , Marin Co., Pt. Bonita 7.5 minute quad. USGS.

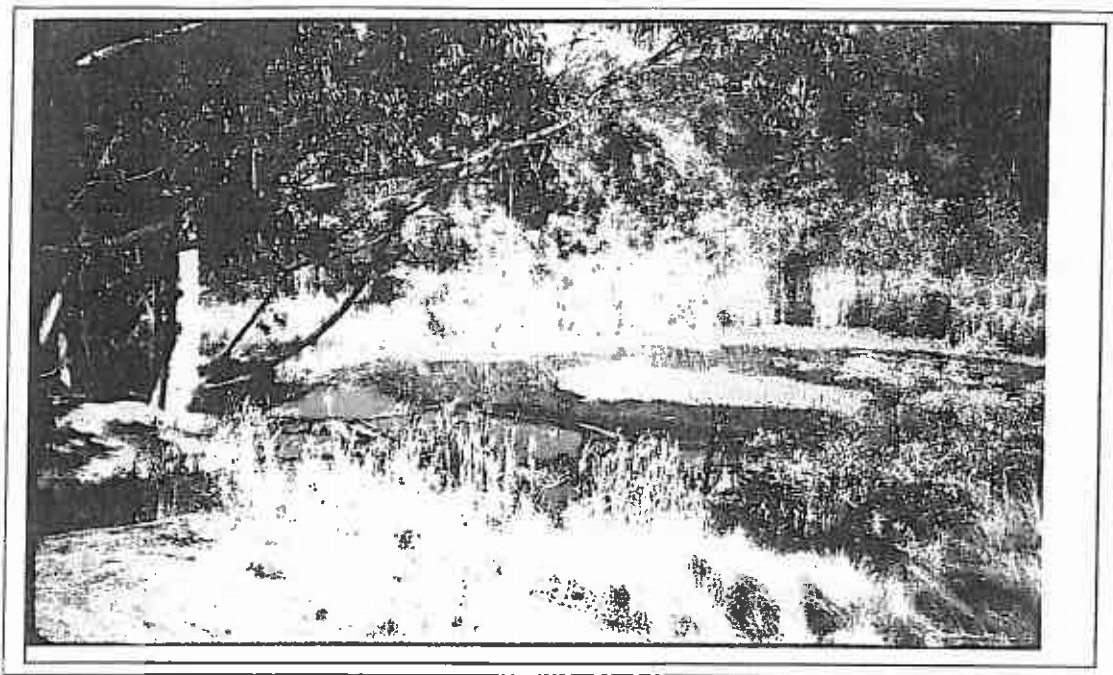


Figure 6: Backdoor Pond at Tennessee Valley, GOGA, Marin Co., Pt. Bonita USGS 7.5 minute quad.



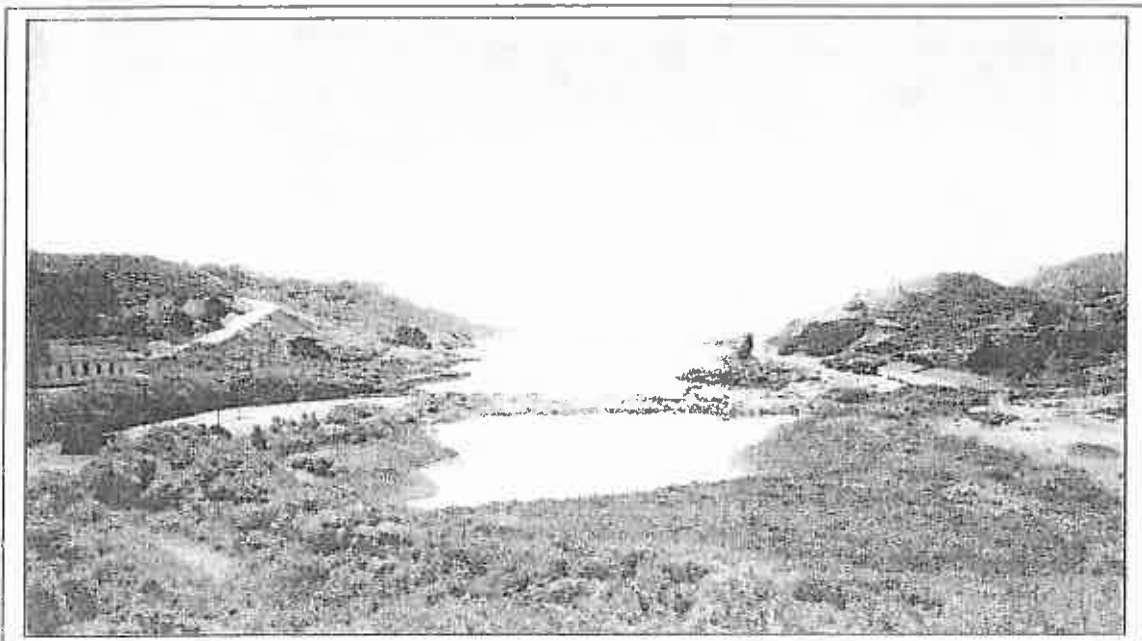
Figure 7: Haypress Pond at Tennessee Valley, GOGA, Marin Co., Pt. Bonita USGS 7.5 minute quad.

Rodeo Valley (Figures 8-9). As with Tennessee Valley, the Rodeo Valley is a small coastal watershed (3.6 sq. miles) that drains to the Pacific Ocean. The two major waterbodies are Rodeo Lagoon and Rodeo Lake. The lagoon is presently a 16.2 ha (40 acre) brackish water lagoon located at the tip of the Marin Peninsula within the management area of the Golden Gate National Recreation Area. Water depths are shallow, ranging between 2-6 feet during the late fall. Winter salinity levels ranged from 1.5 to 9.6 parts per thousand in 1996-1997 along the shoreline of the lagoon (D.Fong, unpublished data, 1997).

Just upstream of the lagoon, Rodeo Lake covers 5.5 acres of open water. Construction of a causeway and weir across the upper end of the lagoon during World War II separated the lagoon into a predominantly freshwater lake (Rodeo Lake) and the existing brackish water lagoon. This hydrologic separation likely restricts upstream movement of aquatic organisms from the lagoon. In addition, water conditions may become less than hospitable for aquatic organisms during the late summer. Recent measurements found dissolved oxygen levels of 0.7 mg/l at the lake bottom during an algal bloom.

Rodeo Lake supports mostly non-native fish including green sunfish (*Lepomis cyanellus*), goldfish (*Carassius auratus*), and golden shiner (*Notemigonus crysoleucas*). Sedimentation and encroachment of emergent and willow riparian vegetation around the lake has reduced the amount of open water area. During the summer, the remaining open water is often filled with an introduced aquatic plant, coontail (*Myriophyllum* sp.).

Rodeo and Gerbode Creeks which drain into the lake are heavily shaded with native riparian trees (mainly willows). During the winter, flows often exceed the channel capacity and flow shallowly over vegetated flats. At Gerbode Creek, fill for a trail crossing (Bobcat-Miwok trail intersection) has caused the development of a seasonal wetland on the upstream side.



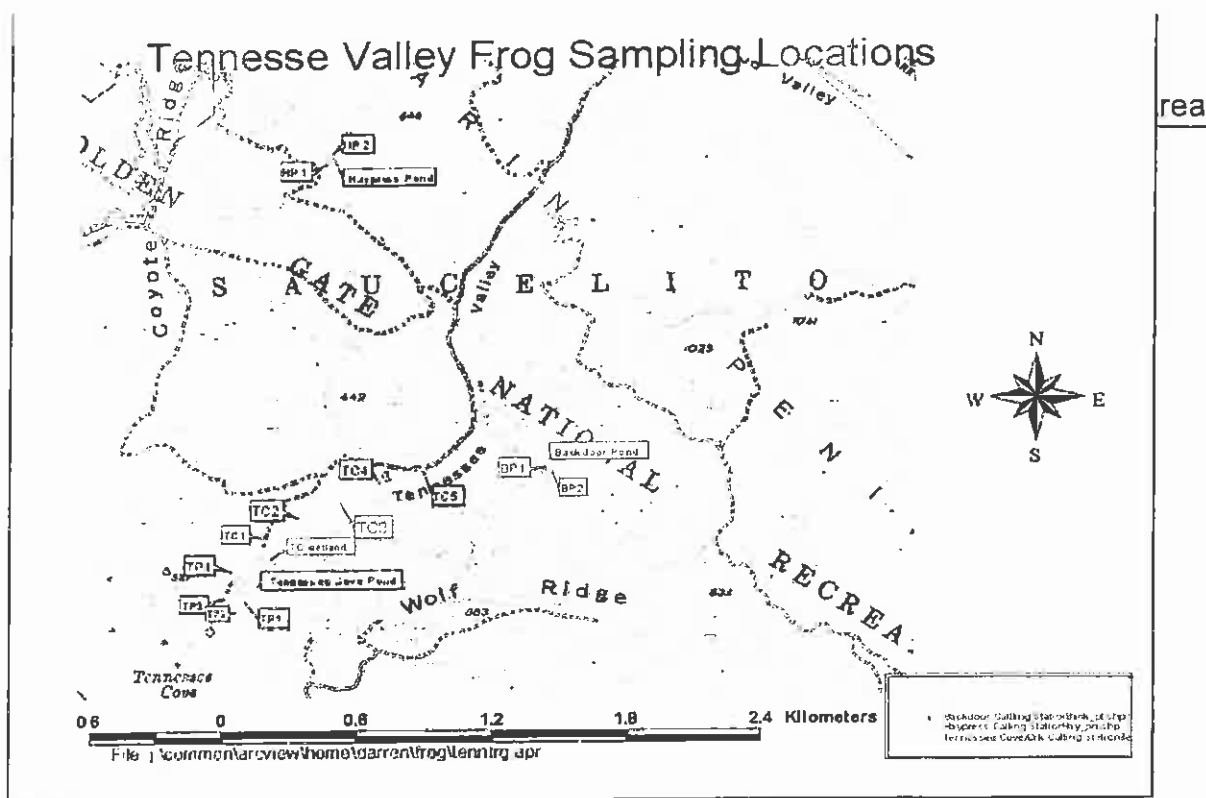


Figure 9: Rodeo Valley Survey Sites, GOGA, Marin Co., Pt. Bonita USGS 7.5 minute quad.

Milagra Ridge (Figure 10). This site was surveyed after our Park planner (Nancy Horner) received a phone call regarding a California red-legged frog that was found dead along Skyline Boulevard, within hopping distance of Milagra Ridge. The site is located in an area that historically supported both California red-legged frogs and San Francisco garter snakes (Sean Barry, pers. comm. 1999). However, almost all of the natural habitats, such as the seismic sag ponds near the current Skyline Boulevard were destroyed during the 1950's and early 1960's by housing and urban development (Banta and Morafka, 1966; Barry, 1978, 1993, 1994).

The survey site is located at an abandoned military oxidation pond shown on construction drawings from our Park archives to have been built prior to 1969 (U.S. Army 1969). The site covers 0.17 acres and is seasonally ponded with water. Because the pond sits atop a knoll, it is believed that there is little surface water runoff contribution and probably no groundwater contribution. A concrete drop inlet structure controls water surface elevation. In 1999, a staff gage was installed to record the height and duration of ponded water. The pond contains relatively shallow nearshore areas that during the winter contain submerged aquatic vegetation, submerged annual grasses, and *Juncus*. In addition, about a quarter of the site contains cattails and bulrushes.

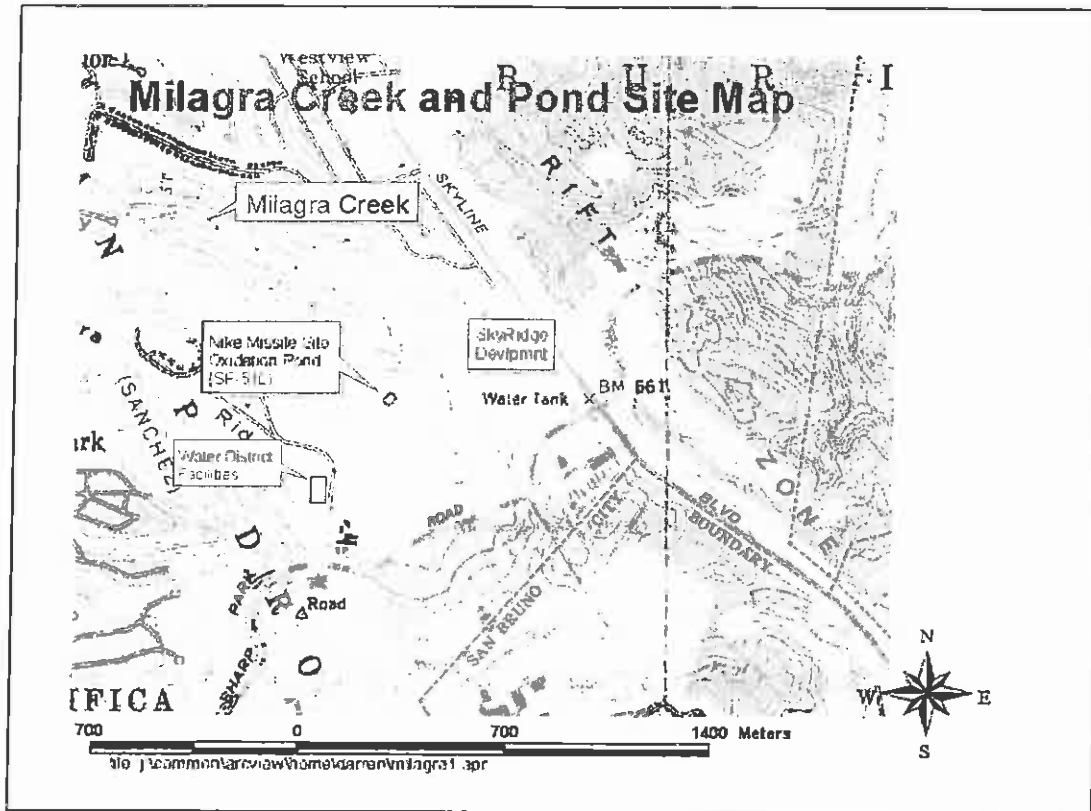


Figure 10: Survey Locale for Milagra Ridge Oxidation Pond, GOGA, San Mateo Co., USGS 7.5 S.F. South.

Sharp Park (Figures 11-12). Laguna Salada and Horse Pond, two natural but modified water features at the Sharp Park golf course, have been documented by a variety of studies to contain both California red-legged frogs and San Francisco garter snakes. However, no information was available regarding red-legged frog breeding sites from these areas. The City and County of San Francisco manages the golf course and natural areas on the site. Interest in protecting and restoring natural resources on the site has led to the development of a restoration plan (PWA 1992). Along the east side of Laguna Salada, vegetation is relatively wide and continuous comprised mainly of tules and cattails. Along the west side, vegetation is more sparse with open coves containing low saltgrass and Monterey cypresses.

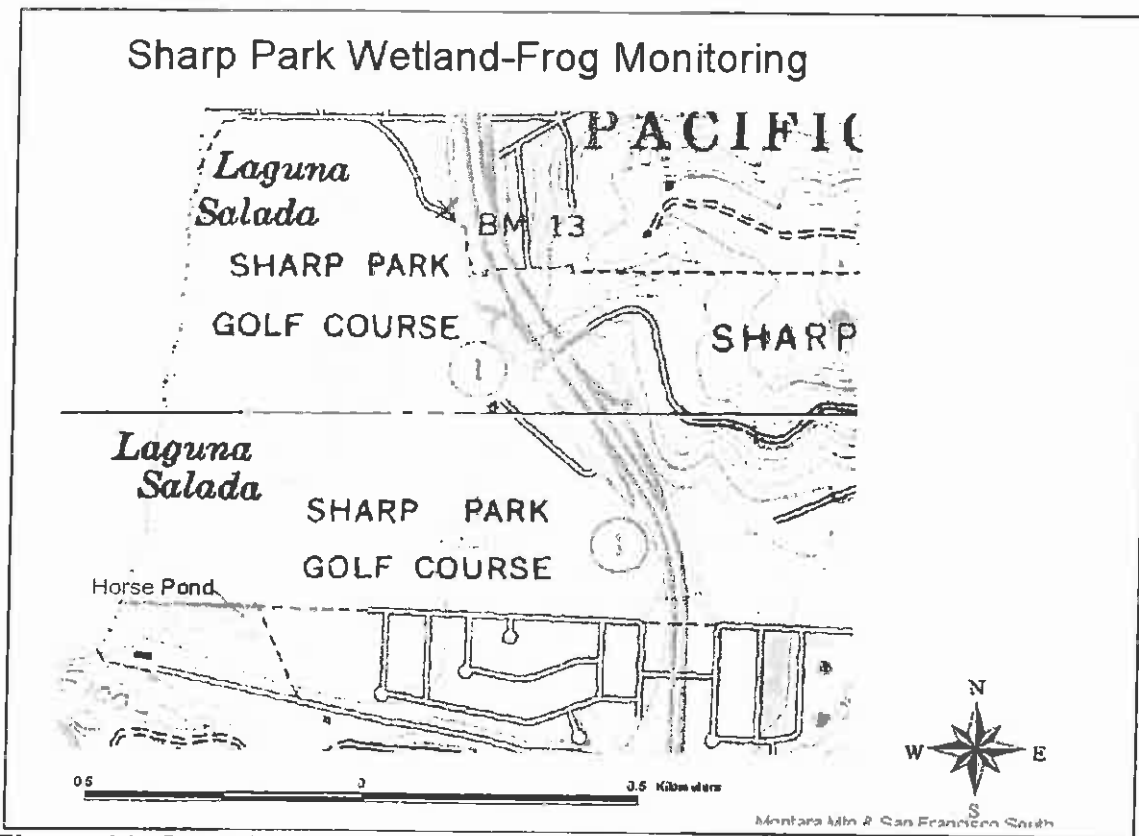


Figure 11: Sampling Locales for Sharp Park, City and County of San Francisco, Montara Mtn and San Francisco South USGS 7.5 minute quads.

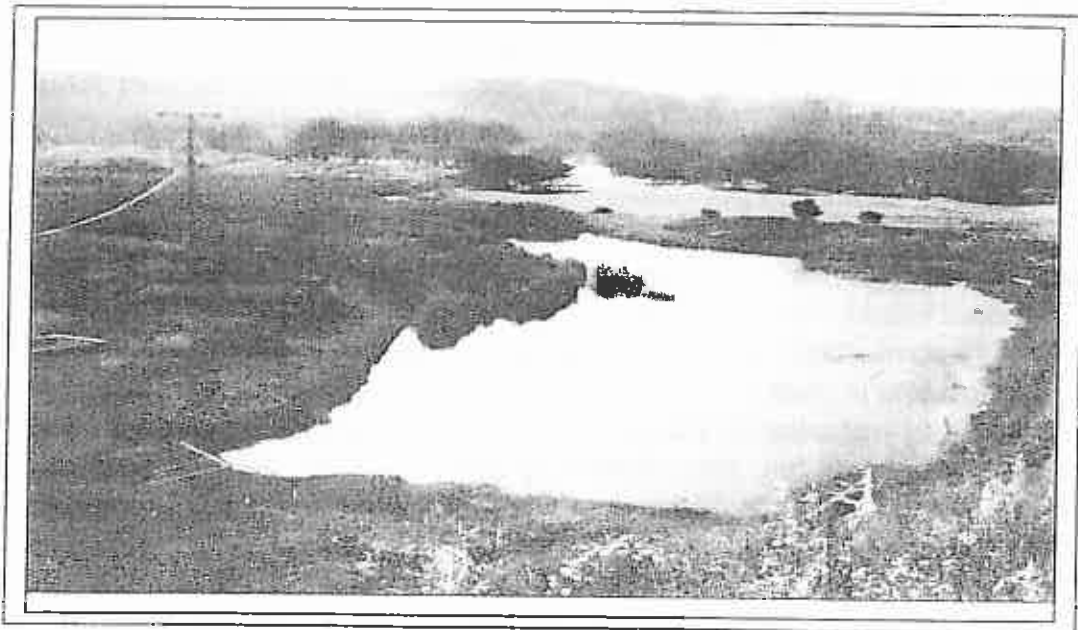


Figure 12: Horse Pond at Sharp Park (looking north)

RESULTS

Calling surveys.

Two years of winter calling surveys were conducted: Winter 1997/1998 and Winter 1998/1999. Survey data collected during the winter of 1997/1998 has been reported previously by Cook (1998). In general, all surveyors expressed excitement in the opportunity to collect data during the winter at night, despite often cold temperatures. Many noted that the process of standing and listening in one place provided a personal experience of natural sounds, as well as a better understanding of the influence of mundane activities, such as vehicular traffic, on natural "aural-scapes." Appendix II includes information on survey dates and mean conditions for each watershed per survey date.

All observed calling activity for red-legged frogs occurred from mid-January to early February for all sites. Unfortunately, we ended the calling survey by the end of February. It is possible that reproductive activities for the red-legged frogs may have extended into April. Jennings and Hayes (1989) note that California red-legged frogs typically breed from late November to early April. Chorus frog calling activity was generally minimal in December and increased until the cessation of survey activities. Individual summaries of calling activity by general location are provided below.

Bolinas-Fairfax Wetland. During the winter of 1998/1999, Rudi Ferris, a local resident conducted calling surveys on five occasions during January 1999. Unfortunately, no calling surveys were done during the last week of January through February when egg masses were seen. No red-legged frog calls were heard. Rudi noted loud choruses of Pacific chorus frog and vehicular traffic from the adjacent Highway One.

Big Lagoon Environs. During the winter of 1998/1999, surveys were conducted weekly from December 9, 1998 to February 24, 1999. The surveyors felt pretty comfortable with enumerating the number of frogs until a full chorus was heard and in these cases we assumed that more than 10 frogs were calling. As with other watersheds, Pacific chorus frogs were the key species heard during survey activities. The following graph (Figure 13) represents an index of calling activity. Similar to Tennessee Valley, chorus frog calling activity was minimal prior to early-mid January.

This was one of the few sites where we had calling red-legged frogs. The surveyor reported hearing between "two to four frogs" about "50 paces" from the calling station at the Big Lagoon horse pasture (RW-2, January 27, 1999, Air

Temp 4.3°C, Wind <1 mph). The calling red-legged frogs were located in the same location as calling frogs and an egg mass in February 1997.

It seems that the ability to detect calling frogs from single sampling dates is very low. On February 10, 1999, surveyors heard loud choruses of chorus frogs but did not hear red-legged frog calls either enroute or at stations along the Big Lagoon horse pasture. However, during a night visual survey conducted about an hour after the calling surveys, I detected single calls coming from two different locations between Stations RW-2 and RW-3. Unfortunately, I did not record the level of chorus frog calling activity that may have been in the foreground.

Green Gulch. Unlike the prior winter, Green Gulch Zen center staff were unable to participate in the calling survey. Therefore, surveys were sporadically conducted by folks doing the Big Lagoon area surveys. No red-legged frog calls were heard during three survey dates (when more than one station was surveyed).

Tennessee Valley. During the winter of 1998/1999, volunteers from the Urban Watershed Project conducted calling surveys on close to a weekly basis from December 7, 1998 to March 1, 1999. Pacific chorus frogs were the key species heard during survey activities. The only other frog or toad heard was a single calling bullfrog at Tennessee Cove Pond on a relatively warm winter night (12°C, January 18, 1999). Chorus frogs were heard ubiquitously at almost all stations after January 18, 1999, with one exception. At Haypress Pond, only a single individual chorus frog was heard on two occasions. This site also has had the highest counts of metamorphosed bullfrogs during summer night surveys.

The surveyors felt pretty comfortable with enumerating the number of frogs until a full chorus was heard and in these cases we assumed that more than 10 frogs were calling. The following graph (Figure 14) represents an index of calling activity. Backdoor Pond consistently had the highest indices of calling activity. Peak activity for the sites within the watershed occurred on the last day of the survey, March 1, 1999.

Rodeo Valley. During the winter of 1998/1999, surveyors conducted seven surveys between December 7, 1998 and February 1, 1999. As with other watersheds, Pacific chorus frogs were the key species heard during survey activities. However, red-legged frogs were heard on two separate occasions at two sites along the southern part of Rodeo Lake (Single frog @ sites RL 0,2: January 4, 1999, Air 10.5°C, Wind 4-7 mph, Clear/few clouds, $\frac{3}{4}$ Moon; One or two frogs @ site RL 2: January 18, 1999, Air 11°C, Wind <1 mph, Drizzle, No Moon).

Surveyors also listened enroute to stations upstream of Rodeo Lake. However, no red-legged frogs were heard on Gerbode or Rodeo Creek calling routes and

stations. Peak calling activity by Pacific chorus frogs for all sites occurred on the last survey date, February 1, 1999 (Figure 15).

Egg Mass Surveys

Rainfall patterns for both winters were similar. Minimal rain occurred prior to January, with the bulk of rainfall for Winter 1999-2000 coming during February 2000. Surveys were typically conducted only after ponding of water.

We tried to conduct egg mass surveys at all sites with calling stations along with sites at Sharp Park and Milagra Ridge in Winter 1998-1999. During the Winter 1999-2000, we only conducted egg mass surveys at Gerbode, Big Lagoon, and Milagra Ridge wetlands. Unfortunately, we were not able to visit sites during Winter 1999-2000 on a routine basis partly because of interference with other work items and poor visibility conditions after rain events. It is likely that we may have missed egg masses that were laid between site visits due to the disintegration of the egg mass or through masking of egg masses by algae or silt.

At the Bolinas-Fairfax wetland, we used colored wire flags to mark the sites of recently laid egg masses (envelopes clear, embryo dark). Subsequent site visits were made to see how long the egg masses would remain visible. Four of six new egg masses laid just prior to January 28, 1999 were seen again on February 11, 1999 site visit. No egg masses lain close to the February 11 site visit (one) or the January 28 visit were seen on the March 15 site visit. So, it would seem that egg masses at the Bolinas-Fairfax Road wetland remained visible for probably 3-4 weeks. It should be noted that this wetland is unfenced and fresh cattle hoofprints and horse and cattle dung were observed along the periphery on January 7, 1999 on November site visits.

For Winter 1998-1999, red-legged frog egg masses were observed at Milagra Ridge Oxidation Pond, Bolinas-Fairfax wetland, and Sharp Park (Table 3). For Winter 1999-2000, red-legged frog egg masses were observed again at Bolinas-Fairfax wetland and Milagra Ridge Oxidation Pond.

Salinity measurements obtained at six sites (January 20, 1999) along the shoreline of Laguna Salada ranged from 0.5 to 3.5 parts per thousand (ppt). The lone salinity measurement at Horse Pond was 1.0 ppt. There is no obvious surface connection with the adjacent ocean and it is likely that wave overwash or groundwater contributions are responsible for the slightly brackish conditions at Laguna Salada. No egg masses were found at Laguna Salada during the March 1, 1999 sampling activities while nine were found at Horse Pond.

No egg-masses were observed at Big Lagoon Environs, despite hearing and seeing calling frogs. Similarly, no egg masses were observed along the

periphery of Rodeo Lake despite hearing calling red-legged frogs. Both sites are extremely large and densely vegetated and hence, the probability of missing egg masses (particularly at low densities) is high.

Many of the artificial ponds surveyed during this period had extremely high numbers of California newt egg masses (Flood Estate and Green Gulch) (Table 3). Chorus frog eggs were abundant in vegetated, shallow water habitats such as Bolinas-Fairfax wetland, Big Lagoon, and Gerbode Creek floodplain (Table 3).

Night Visual Surveys

California red-legged frogs were detected at Big Lagoon and Sharp Park during night surveys during the Winter 1998-1999 (Table 4). Survey conditions were poor during a single survey event conducted during the Fall 1999 because of dense vegetative growth. No night visual surveys have been conducted during the Winter 1999-2000.

We also conducted 3 trap days and 5 nights of visual and gig surveys at Tennessee Valley to control bullfrogs during the Spring and Summer of 1999. During the gigging and night visual surveys, only juvenile and adult bullfrogs (*Rana catesbeiana*) and chorus frogs were observed. Trapping activities at Tennessee Cove, Haypress, and Backdoor Ponds collected sculpin (*Cottus* sp., likely *Cottus asper*), threespine stickleback (*Gasterosteus aculeatus*), bullfrog tadpoles, and newts.

Summary

Egg mass surveys worked well in small wetlands without extensive emergent and aquatic vegetation (Milagra Ridge Pond and Bolinas-Fairfax wetland). Very limited calling surveys in Winter 1998-1999 at Bolinas-Fairfax wetland did not identify presence of California red-legged frogs despite likely breeding activity as documented by the presence of egg masses around the calling survey dates. Night calling surveys were able to detect red-legged frog breeding activity at Rodeo Lake and Big Lagoon, areas with extensive vegetation and large areas of potential breeding sites. Using calling, night visual and egg mass surveys, no red-legged frogs were detected at Tennessee Valley, Gerbode wetland, and Green Gulch during our sampling period.

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Table 3: Amphibian Egg Mass Data for Surveys Conducted During Winter 1998-1999 and 1999-2000, GOGA.

LOCATION	SURVEY DATE (mm/dd/yy)	RLF* EGGS (new)	PCF* EGGS	CA NEWT EGGS	Water Visibility (m)	Note
Bolinas-Fairfax	02/17/00	5	63	0	0.2	*pcf: Pacific chorus frog
Bolinas-Fairfax	01/09/00	0	0	0	0.2	Only 1/3 area surveyed
Bolinas-Fairfax	03/15/99	0	0	0		
Bolinas-Fairfax	02/11/99	1*	3	0	0.3	*Exclude eggs counted 1/28/99
Bolinas-Fairfax	01/28/99	6	0	0		
Bolinas-Fairfax	01/07/99	0	0	0	0.15	Salinity along shore 1 ppt
Bolinas-Fairfax	11/12/98	0	0	0		
South Rodeo Lake	03/23/99	0	0	0		Outer shoreline
South Rodeo Lake	03/02/99	0	0	0	0.25	Outer shoreline
North Rodeo Lake	03/02/99	0	0	0		Outer shoreline
Rodeo Lake	01/29/99	0	0	0	0.3	Inner perimeter via infl. boat
South Rodeo Lake	01/27/99	0	0	0		Outer shoreline
Gerbode Creek	03/20/00	0	5	0		
Gerbode Creek	02/10/00	0	40	0	0.2	
Gerbode Creek	03/23/99	0	2	0		
Gerbode Creek	03/02/99	0	3	0	0.2	
Gerbode Creek	01/26/99	0	29	0		
Gerbode Creek	01/11/99	0	0	0		
Marine Mammal Center	03/02/99	0	7	0		
Tennessee Cove Wetland	03/01/99	0	0	0	0.1	
Tennessee Cove Wetland	02/01/99	0	0	0		
Tennessee Cove Pond	02/01/99	0	0	0	0.2	Inner perimeter via infl. boat
Backdoor Pond	02/01/99	0	0	0		partial survey
Haypress Pond	02/01/99	0	0	0		partial survey
Big Lagoon Pasture C	03/29/00	0	0	0		
Big Lagoon Pasture B	03/29/00	0	0	0		

Table 3: Amphibian Egg Mass Data for Surveys Conducted During Winter 1998-1999 and 1999-2000, GOGA.

LOCATION	SURVEY DATE (mm/dd/yy)	RLF* EGGS (new)	PCF* EGGS	CA NEWT EGGS	Water Visibility (m)	Note
Big Lagoon Pasture A	03/29/00	0	0	1		
Big Lagoon nr Picnic Area	03/29/00	0	0	0		
Big Lagoon Pasture C	02/07/00	0	14	0	0.5	
Big Lagoon Pasture B	02/07/00	0	16	1	0.5	
Big Lagoon Pasture A	02/07/00	0	0	0	0.5	
Big Lagoon nr Picnic Area	02/07/00	0	0	0	0.5	
Big Lagoon Pasture C	04/14/99	0	0	0	0.2	
Big Lagoon Pasture B	04/14/99	0	0	0	0.2	
Big Lagoon Pasture A	04/14/99	0	0	0		
Big Lagoon nr Picnic Area	04/14/99	0	0	0	0.1	
Big Lagoon Pasture C	03/25/99	0	0	0	0.2	
Big Lagoon Pasture B	03/25/99	0	0	0	0.2	
Big Lagoon Pasture A	03/25/99	0	0	0	0.2	
Big Lagoon nr Picnic Area	03/25/99	0	0	0	0.2	
Big Lagoon Pasture C	03/05/99	0	>25	>25		
Big Lagoon Pasture B	03/05/99	0	5-10	5-10		
Big Lagoon Pasture A	03/05/99	0	5	0		
Big Lagoon nr Picnic Area	03/05/99	0	1	0		
Big Lagoon Backwater	03/05/99	0	1	0		
Big Lagoon Pasture C	01/29/99	0	0	0		
Big Lagoon Pasture B	01/29/99	0	0	1		
Big Lagoon Pasture A	01/29/99	0	0	0		
Big Lagoon nr Picnic Area	01/29/99	0	0	0		
Big Lagoon nr Picnic Area	12/28/99	0	0	0		
Big Lagoon Pasture C	12/28/99	0	0	0		
Big Lagoon Pasture B	12/28/99	0	0	0		

Table 3: Amphibian Egg Mass Data for Surveys Conducted During Winter 1998-1999 and 1999-2000, GOGA.

LOCATION	SURVEY DATE (mm/dd/yy)	RLF* EGGS (new)	PCF* EGGS	CA NEWT EGGS	Water Visibility (m)	Note *rlf: Calif. red-legged frog *pcf: Pacific chorus frog
Big Lagoon Pasture A	12/28/99	0	0	0		
Big Lagoon Backwater	12/28/99	0	0	0		
Banducci Ditch	01/29/99	0	0	0		
Green Gulch Creek Below Parking Lot	03/10/99	0	0	1		
Green Gulch Parking Lot Pond	03/10/99	0	0	110		
Green Gulch Hillside Pond#1	03/10/99	0	0	0		
Green Gulch Zen Center Pond	03/10/99	0	0	0	0.3	
Flood Estate-Upper Pond	03/11/99	0	0	>100		
Flood Estate-Mansion Pond	03/11/99	0	0	4		
Sweeney Ridge-South Meadow	01/03/99	0	0	0		
Sweeney Ridge-Discovery Site	01/03/99	0	0	0		
Milagra Ridge	04/22/00	0	2	0	0.3	
Milagra Ridge	03/26/00	1	13	0		
Milagra Ridge	03/08/00	0				
Milagra Ridge	02/25/00	0				bank survey only
Milagra Ridge	02/11/00	0				bank survey only
Milagra Ridge	01/27/00	0				bank survey only
Milagra Ridge	01/12/00	0				bank survey only
Milagra Ridge	12/16/99	0				bank survey only
Milagra Ridge	12/02/99	0	0	0		
Milagra Ridge	05/23/99	0	0	0		3 rlf about 50 mm SNV length
Milagra Ridge	03/01/99	44	0	0	0.2	single adult rlf
Milagra Ridge	03/11/99	0*	0	0		*no new eggs
Sharp Park-Horse Pond	03/01/99	9				
Sharp Park-Laguna Salada	03/01/99	0*				*double check w/MikeWestphal

Table 4: Night Visual Survey for Frogs at GOGA.

LOCATION	SURVEY DATE	RLF*	PCF*	Newt Notes
Big Lagoon nr Picnic Area	10/22/99	0	2	0
Big Lagoon Pasture C	10/22/99	0	0	0 low detect prob., veg dense
Big Lagoon Pasture B	10/22/99	0	0	0 low detect prob., veg dense
Big Lagoon Pasture A	10/22/99	0	0	0 low detect prob., veg dense
Green Gulch-Parking Lot Pond	2/10/99	0	0	0
Green Gulch- Zendo Pond	2/10/99	0	0	0
Big Lagoon Pasture C	2/10/99	0	0	0
Big Lagoon Pasture B	2/10/99	0	0	0
Big Lagoon Pasture A	2/10/99	2	0	0 Saw 1 frog eyeshine and 2 calling sites
Big Lagoon nr Picnic Area	1/18/99	0	0	0
Big Lagoon Pasture C	1/18/99	0	0	0
Big Lagoon Pasture B	1/18/99	0	0	0
Big Lagoon Pasture A	1/18/99	0	0	0
Big Lagoon nr Picnic Area	1/6/99	0	0	0
Big Lagoon Pasture C	1/6/99	0	0	0
Big Lagoon Pasture B	1/6/99	0	0	0
Big Lagoon Pasture A	1/6/99	0	0	0
Big Lagoon Backwater	1/6/99	0	0	0
Banducci Ditch	1/18/99	0	3	0
Tennessee Pond	1/11/99	0	0	1 inner perimeter by boat
South Rodeo Lake	1/19/99	0	0	0
South Rodeo Lake	1/7/99	0	0	0
Rodeo Lake	12/21/98	0	0	0 inner perimeter by boat
Cliff House/Sutro Bath	11/11/98	0	0	0
Sharp Park-Horse Pond	3/1/99	0	0	0 See egg mass data
Sharp Park-Laguna Salada	3/1/99	3	0	0 Need to check totals with Rich Seymour/Mike Westphal
Sharp Park-Horse Pond	1/20/99	0	x	0 x- 3 to 4 calling sites along pond, full chorus (>10) at channel by Fairway Dr.
Sharp Park-Laguna Salada	1/20/99	0	0	0 Only surveyed west side

Figure XX: Index of Pacific chorus frog calling activity, lower Redwood Creek, Golden Gate National Recreation Area, Marin Co., Winter 1998-1999.

Note: Index Values 1-9 for est. # of calling frogs, value 10 for full chorus

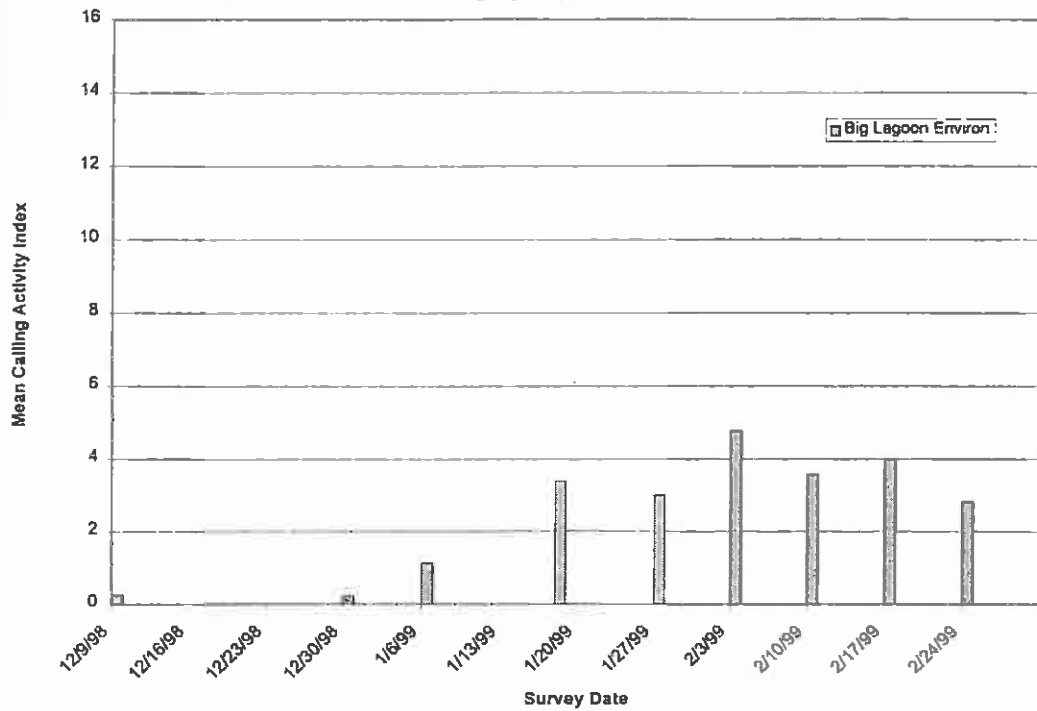


Figure XX: Index of Pacific chorus frog calling activity, Tennessee Valley, Golden Gate National Recreation Area, Marin Co., Winter 1998-1999.

Note: Index Values 1-9 for est. # of calling frogs, value 10 for full chorus

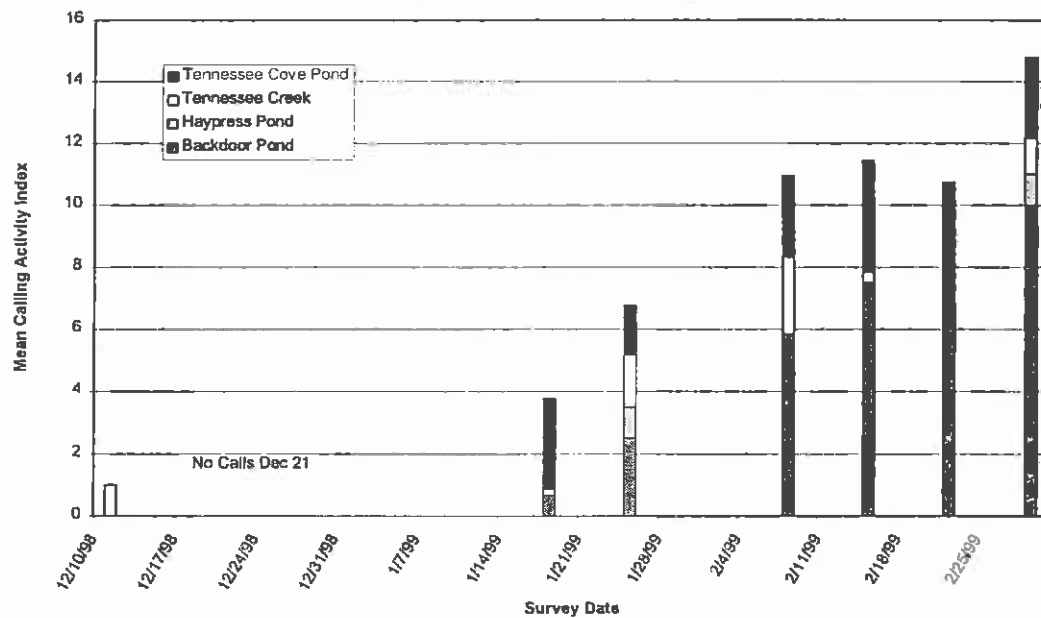
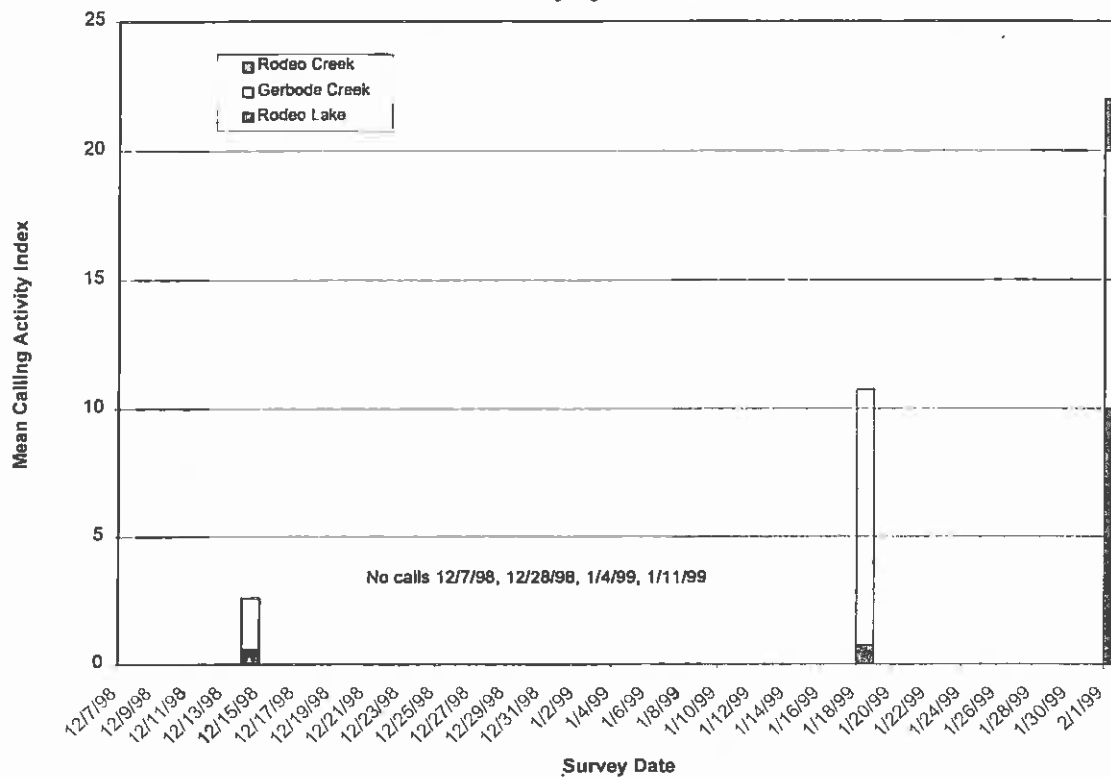


Figure xx: Index of Pacific chorus frog calling activity, Rodeo Valley, Marin Co., Golden Gate National Recreation Area, Winter 1998-1999

Note: Index Values 1-9 for est. # of calling frogs, value 10 for full chorus



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APPENDIX I: Calling Site Codes and Coordinates, Golden Gate National Recreation Area

Watershed	Call Site	UTM N	UTM E
Rodeo Valley	RL1	4187257	541907
	RL2	4187219	541791
	RL3	4187348	541758
	RL4	4187368	541818
	GC1	4187637	542318
	GC2	4187727	542467
	GC3	4187908	542469
	GC4	4188061	542554
	RC1	4187497	542026
	RC2	4187467	542197
	RC3	4187411	542331
	RC4	4187416	542492
	RC5	4187336	542656
	RC6	4187265	542815
	RC7	4187391	542945
Tennessee Valley	TP1	4188546	539586
	TP2	4188518	539547
	TP3	4188579	539505
	TP4	4188664	539564
	TC1	4188830	539685
	TC2	4188953	539837
	TC3	4189019	540024
	TC4	4189110	540198
	TC5	4189171	540385
	HP1	4190655	539961
	HP2	4190692	539971
	BP1	4189176	540930
	BP2	4189159	540963
Lower Redwood Creek	RW1	4190759	537367
	RW2	4190578	537438
	RW3	4190385	537407
	RW4	4190431	537568
	RW5	4190596	537614
	RW9	4190709	537563
	RW6	4190689	537663
	RW7	4190717	537745
	RW8	4190736	537862
	GG1	4191348	538441
	GG4	4190689	538349
	GG5	4191220	538403
	GG7	4190997	538302
	GG8	4190850	538112
	GG9	4190793	538039
	GG10	4190703	538351

APPENDIX II: Weather Conditions at Start of Calling Surveys, GOGA

Locations	Sample # Date	Mean Weather Obs.	Mean Wind Spd (mph)	Mean Temp. (oC)	Mean Moon Phase
Lower Redwood	12/09/98	4 Clear/few clouds	4-7	6.0	No Moon
	12/16/98	13 Clear/few clouds	<1	10.0	No Moon
	12/23/98	2 Clear/few clouds	8 - 12	8.0	No Moon
	12/30/98	9 Cloudy/overcast	<1	11.0	No Moon
	01/06/99	10 Cloudy/overcast	<1	5.7	No Moon
	01/18/99	19 Drizzle	<1	12.5	No Moon
	01/27/99	7 Clear/few clouds	1 - 3	4.3	3/4
	02/03/99	9 Clear/few clouds	<1	10.3	Full
	02/08/99	2 Drizzle	8 - 12	12.0	
	02/10/99	8 Cloudy/overcast	1 - 3	10.0	No Moon
	02/17/99	3 Cloudy/overcast	<1	7.0	No Moon
	02/24/99	6 Drizzle	4 - 7	11.0	
Gerbode and Rodeo Creeks	12/07/98	4 Cloudy/overcast	<1	11.0	No Moon
	12/14/98	7 Clear/few clouds	<1	8.0	No Moon
	12/28/98	5 Clear/few clouds	<1	1/2	
	01/04/99	9 Clear/few clouds	1 - 3	10.5	1/4
	01/11/99	7 Clear/few clouds	<1	4.0	No Moon
	01/18/99	2 Cloudy/overcast	<1	11.0	No Moon
	02/01/99	6 Clear/few clouds	<1	5.0	No Moon
Rodeo Lake	12/07/98	4 Cloudy/overcast	<1	11.0	No Moon
	12/14/98	5 Clear/few clouds	<1	8.0	No Moon
	01/04/99	4 Clear/few clouds	4 - 7	10.5	3/4
	01/11/99	4 Clear/few clouds	<1	4.0	No Moon
	01/18/99	4 Cloudy/overcast	<1	11.0	No Moon
	02/01/99	4 Clear/few clouds	<1	5.0	No Moon
Tenn. Vall. Ponds	12/11/98	3 Clear/few clouds	1 - 3	9.0	No Moon
	12/21/98	2 Clear/few clouds	<1	1/4	
	01/04/99	4 Clear/few clouds	1 - 3	No Moon	
	01/18/99	5 Cloudy/overcast	1 - 3	12.0	No Moon
	01/25/99	5 Cloudy/overcast	4 - 7	10.0	No Moon
	02/08/99	4 Drizzle		12.0	No Moon
	02/15/99	5 Cloudy/overcast	1 - 3	9.0	No Moon
	02/22/99	6 Partly cloudy	<1	8.0	1/2
	03/01/99	4 Clear/few clouds	1 - 3	12.0	Full
Tenn. Vall. Crk	12/11/98	1 Clear/few clouds	1 - 3	9.0	No Moon
	12/21/98	1 Clear/few clouds	<1	1/4	
	01/04/99	6 Clear/few clouds	1 - 3	No Moon	

Locations	Sample Date	# Obs.	Mean Weather	Mean Wind Spd (mph)	Mean Temp. (oC)	Mean Moon Phase
	01/18/99	5	Cloudy/overcast	1 - 3	12.0	No Moon
	01/25/99	3	Cloudy/overcast	4 - 7	10.0	No Moon
	02/08/99	3	Drizzle		12.0	No Moon
	02/15/99	3	Cloudy/overcast	1 - 3	9.0	No Moon
	03/01/99	3	Clear/few clouds	1 - 3	12.0	Full
Bolas-Fairfax Wetlands	01/03/99	1	Partly cloudy	8 - 12	12	
	01/10/99	1	Clear/few clouds	4 - 7		
	01/12/99	1	Partly cloudy	4 - 7	10	
	01/20/99	1	Partly cloudy	1 - 3	15	
	01/22/99	1	Partly cloudy	8 - 12	12	