Brent Plater (CA Bar No. 209555)
WILD EQUITY INSTITUTE
PO Box 191695
San Francisco, CA 94119
Telephone: (415) 349-5787
bplater@wildequity.org

Eric R. Glitzenstein (D.C. Bar No. 358287)
Howard M. Crystal (D.C. Bar No. 446189)
Pro Hac Vice
MEYER GLITZENSTEIN & CRYSTAL
1601 Connecticut Ave., N.W., Suite 700
Washington, D.C., 20009
Telephone: (202) 588-5206
eric@meyerglitz.com
hcrystal@meyerglitz.com

Attorneys for Plaintiffs

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.* Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, *et al.*, Defendants.	))))))))))))	Case No.: 3:11-CV-00958 SI **PLAINTIFFS' NOTICE OF FILING OF EXHIBITS IN SUPPORT OF MOTION FOR A PRELIMINARY INJUNCTION** Date: November 18, 2011 Time: 9:00 a.m. Courtroom: 10, 19th Floor Judge: Hon. Susan Illston

Plaintiffs hereby file the attached Exhibits 45 through 53 in support of their Motion for a Preliminary Injunction.

Respectfully submitted,

Dated: November 4, 2011

<u>*/s/ Brent Plater*</u>
Brent Plater (CA Bar No. 209555)
WILD EQUITY INSTITUTE
PO Box 191695
San Francisco, CA 94119
Telephone: (415) 349-5787
bplater@wildequity.org

Attorney for Plaintiffs

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 45

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.* Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, *et al.*, Defendants.	)	Case No.: 3:11-CV-00958 SI **SUPPLEMENTAL DECLARATION OF MARC HAYES, PH.D.**

I, Dr. Marc Hayes, declare as follows:

1. I am submitting this supplemental declaration in support of Plaintiffs' motion for preliminary injunction.

2. This declaration address some discrete statements made by Defendants' and Defendant-Intervenors' experts that are either in error or misleading. Because of these errors, the Defendants' and Defendant-Intervenors' assessments of the proposed injunction on pumping and mowing are inaccurate.

3. In fact, the proposed injunction tailoring pumping and mowing activities at Sharp Park Golf Course until trial will greatly benefit the California Red-legged Frog and the San Francisco Gartersnake. It is my professional judgment that Sharp Park Golf Course's operations and management negatively affects endangered species habitat and causes direct take of the California Red-legged Frog and the San Francisco Gartersnake. By disallowing pumping from Horse Stable Pond, water levels can rise to at least 10 feet NAVD, which would significantly improve habitat conditions for, and reduce take of these species.

4. Moreover, the higher water levels will have no impact whatsoever on San Francisco Gartersnake mortality. The San Francisco Gartersnake, like many species of gartersnake, are especially adept swimmers; they predate predominantly on pond-breeding species of amphibians, which requires them to excel at prey capture and escaping predators in aquatic habitats. Although they aestivate (*i.e.* become summer dormant) and take shelter in burrows

prone to seasonal or storm-event related flooding, I have never observed, nor seen documented in the scientific record, a San Francisco Gartersnake or any other species in the Common gartersnake species complex (the group of gartersnakes to which the San Francisco Garter Snake belongs) killed by such natural events. It is my professional judgment that reducing or eliminating pumping would raise water to an equilibrium level without abrupt changes to habitat conditions, providing San Francisco Gartersnakes ample opportunity to escape flooding, even during aestivation, and even when the snake has a low body temperature.

5. **The Rate of Stranding of California Red-legged Frog Egg Masses at Sharp Park is Atypical**. Unlike species of western North American *ranid* frogs that typically lay unattached egg masses in water having a shallow total depth (7.5-15 centimeters [3-6 inches]) (for example, Cascade Frog [*Rana cascadae*] and Oregon Spotted Frog [*Rana pretiosa*]) and that are, as a consequence, vulnerable to water fluctuations, California Red-legged Frogs (*Rana draytonii*) typically deposit egg masses attached to a vegetation brace where total water depth is somewhat greater (>15 centimeters [>6 inches]). The jelly in which California Red-legged Frog eggs are imbedded is pliant and elastic, and the vegetation braces on which the California Red-legged Frog typically deposits its eggs also have some pliability. In combination, these factors allow California Red-legged Frog egg masses to generally tolerate water fluctuation without stranding. Stranding of California Red-legged Frog egg masses does occur, but rarely; and typically involves few egg masses. I have personally viewed it but three times (each time involving 1 to 3 egg masses) in many observations of many hundreds of California Red-legged Frog egg masses over my years of field work on this species.

6. In 2011 nearly 80% (128) of the 159 California Red-legged Frog egg masses observed by the City of San Francisco at Sharp had to be moved to avoid their becoming stranded. This is an incredibly high rate of egg-mass stranding, much higher than any rate documented in the scientific literature. It cannot be explained by normal variability in rainfall, topography, or drainage—it can only be a product of human agency adversely affecting habitat conditions on the site.

7. **Ceasing Pumping from Horse Stable Pond Will Benefit the California Red-Legged Frog in Several Ways**. Pumping water from Horse Stable Pond to the ocean not only jeopardizes egg masses that are laid in Horse Stable Pond, it also jeopardizes egg masses laid in Laguna Salada; it risks entrainment of hatchling California Red-legged Frog through the Horse Stable Pond pumps, which would result in certain mortality; and it places California Red-legged Frog life stages larger than hatchlings that may wander too close to the intake area of the pump at a level of risk that may range from injury to mortality. As described in my earlier declaration, eliminating pumping from Horse Stable Pond will remove all of these risks.

8. Defendants and Defendant-Intervenors have argued that ceasing pumping will put California Red-legged Frogs at risk because the frog will breed in unspecified areas east of Laguna Salada that are unsuitable habitat for unexplained reasons. Docket No. 66-1, p. 8. It is my professional judgment that these statements are not supported by recent breeding patterns at Sharp Park, nor are they supported by the known breeding behavior of the California Red-legged Frog. All recent records of California Red-legged Frog egg masses and tadpoles on the eastern side of Laguna Salada are associated with marsh-edge vegetation structures. Even when flood waters have exceeded the marsh-edge in previous winter storms, California Red-legged Frog egg masses have kept a close association to the marsh-edge vegetation. These areas are suitable breeding habitat both because of water availability and vegetation structure—a key component of breeding habitat for this species because it braces its egg masses to aquatic vegetation. The combination of these two conditions does not exist away from the marsh edge, and will not be created during the time period covered by the injunction. Therefore, it is highly unlikely that California Red-legged Frogs will begin breeding in these other areas—it is far more likely that the frog will continue to breed in these marsh-edge areas, where it has consistently bred in past winters.

9. One key difference under the Plaintiffs' proposed relief (as compared with current conditions) is that these marsh-edge areas will have a much higher probability of retaining enough water so that eggs laid in the marsh-edge area will hatch before being stranded. A

conservative estimate of time for a California Red-legged Frog egg to hatch is roughly six weeks.

10. To the extent some pumping is necessary during large storms, using mobile pumps near Clarendon Road is superior to allowing any pumping from Horse Stable Pond. Pumping near Clarendon Road will reduce the risks of entrainment and/or impingement of California Red-legged Frogs of all life stages to zero because there are no records of California Red-legged Frog egg masses or other life stages recorded in the vicinity of this pumping area.

11. **Any Recent Increases in the California Red-legged Frog Population at Sharp Park Reflect Habitat Augmentation for the Species at Mori Point, Not the Success of Sharp Park Golf Course's Activities.** One of the defendant's consultants, Dr. Jennings, states, "Over the...past two decades, all available scientific evidence shows that the Frog population at Sharp Park has dramatically increased." Docket No. 68, p. 16. I do not question that the overall California Red-legged Frog population that populates both Mori Point and Sharp Park has increased; egg mass counts seem to show that it has, though some inconsistencies weakens the notion that this increase has been dramatic. What I do dispute, however, is the basis for the increase, which has little, if anything, to do with conditions in Sharp Park and everything to do with conditions at Mori Point, adjacent to Sharp Park. Indeed, Dr. Jennings has stated that Laguna Salada and Horse Stable Pond are now less favorable habitat for the California Red-legged Frog due to succession. Moreover, in a report on California Red-legged Frog surveys at the GGNRA, Fong and colleagues (2010) commented that infrequent surveys were conducted along Sanchez Creek below the housing development south of the golf course because the creek is heavily shaded by riparian trees, which represents poor breeding habitat for the California Red-legged Frog. Exhibit A, p. 5. Hence, given that breeding habitat in Sharp Park has been declining due to succession (in Horse Stable Pond and Laguna Salada) and breeding habitat is lacking on Sanchez Creek, how is it possible that California Red-legged Frogs have increased? The answer lies in an increase in habitat via the creation of new ponds at Mori Point over the same interval, and recognizing the fact that the segment of the California Red-legged Frog

population that occupies Sharp Park is not independent from the segment of the California Red-legged Frog population at Mori Point.

12. Habitat quality conditions and take events make Sharp Park a population sink (*i.e.*, a location adversely affecting the population), while Mori Point's restored habitats are a population source that contributes to California Red-legged Frog production at Sharp Park and Mori Point. This notion strongly contradicts the manner in which the defendants imply that the golf course has contributed to the California Red-legged Frog population at present. In particular, in November 2004, the Fish and Wildlife Service, the Golden Gate National Park Conservancy and the Golden Gate Natural Research Area completed construction of two ponds (Willow and Middle Ponds) at Mori Point to enhance amphibian habitat as well as provide foraging opportunities for the San Francisco Gartersnake (see Fong et al. 2010). Exhibit A. However, both ponds were small (Willow [12 m × 9 m], Middle [11 m × 13 m]) and Middle Pond consistently dried before California Red-legged Frog tadpoles could metamorphose. Middle Pond was not reconfigured to enable it to hold water through the summer, and as a consequence, enable successful California Red-legged Frog recruitment from it, until 2009. In addition, in the fall of 2007 two larger ponds (Wetland Pond [36 m × 12 m] and Southern Pond [18 m × 32 m]), were built at Mori Point. Egg mass count data from these areas reveals a marked jump in 2008 when the two larger ponds first became available for breeding, and another small increase in 2009, after reconfiguration of Middle Pond gave it a hydroperiod long enough to enable California Red-legged Frog metamorphosis.

13. The most telling piece of information, however, is that a statistically significant increase in egg mass numbers exists over the 7-year interval 2003-2009 only if one considers the Mori Point ponds separately from ponds monitored on Sharp Park. Exhibit A., p. 6. Egg mass counts in Horse Stable Pond and Laguna Salada over the same interval showed no significant trend.

14. The increase in egg masses in 2011 over the Sharp Park/Mori Point complex reflects continued increase in recruitment from the Mori Point ponds likely combined with the positive effects of a wet year. In my 2011 visits to Sharp Park and Mori Point, I encountered juvenile California Red-legged Frogs only in the Mori Point ponds. Collectively, these observations

indicate that California Red-legged Frogs currently recruit significantly only in the Mori Point Ponds, but may move to Laguna Salada as young adults to lay eggs. This pattern is easily within the movement scale reported for California Red-legged Frogs (the Mori Point ponds are roughly 0.7 km [0.4 mi] from the most distance oviposition site on Laguna Salada) and would be expected as recruits into the adult population begin to saturate breeding habitat available in the Mori Creek Ponds. The large number of California Red-legged Frog adults crowding into the limited adult habitat along Sanchez Creek, as evidenced from the large numbers I easily observed via the Sanchez Creek boardwalk, also suggest that adult habitat is insufficient for the large number of adults frogs (an estimated over 300 adults based on the 159 egg masses laid in 2011 based on an approximate 1:1 sex ratio) that laid eggs across Sharp Park and Mori Point in 2011.

15. **The Defendants' Position that Habitat on the Golf Course is ideal for the California Red-legged Frog and the San Francisco Gartersnake is Unsupportable**. Dr. Jennings states that: "The development of the golf course from 1928-1932 allowed a transition from a historically brackish and saline wetland (then converted to agriculture) to an ideal freshwater Frog and Snake habitat." No imaginable way exists that terming this conversion "ideal" can be viewed as reasonable; else, I would have to recommend converting all similar brackish and saline wetlands to golf courses by way of an intermediate agricultural transition to produce ideal California Red-legged Frog and San Francisco Gartersnake habitat. It also clearly makes no sense in context of Dr. Jennings' later statements about the successional condition of Laguna Salada and Horse Stable Pond, since he recognizes that the constraints on the processes resulting in the current successional condition of these water bodies is a trajectory to which the presence of the golf course had to contribute at some level.

16. **The San Francisco Gartersnake Will Not Be Jeopardized by the Proposed Relief.** As described in my opening declaration, golf cart and mowing operations are significant sources of mortality for snakes. In that declaration I explained that a 2010 study by Brett DiGregorio and his colleagues on an Outer Banks golf course in North Carolina (attached as Exhibit B), in an area where car-sized vehicle traffic is virtually non-existent, concluded that nearly all of the

more than 200 snakes found road-killed in the study were killed by golf carts or lawn mowers, since no other vehicles are used on golf course grounds. Further, all direct observations by these investigations of a golf cart striking a snake resulted in the death of that snake (B. DiGregorio, personal communication). In a separate study, these same researchers also explained that scavengers, including many corvid (various species of crows, ravens and jays) and larid (various species of gulls) birds and several carnivores (foxes, coyotes, and raccoons), rapidly remove snake carcasses, often within a few hours. Sharp Park golf course has heavy golf cart traffic, minimal car-sized vehicle traffic, and the entire suite of opportunistic scavengers listed above, conditions parallel to those in the North Carolina Outer Banks golf course study. See Hayes Decl., Docket No. 60-3, Exhibit F, p. 2. Hence, rather than be jeopardized by the proposed relief, increasing water levels and eliminating mowing in a band around Laguna Salada will reduce San Francisco Gartersnake mortality from the close proximity of golf cart traffic and mowing.

17. In summary, preliminary injunctive relief requested by the plaintiffs will create unambiguously beneficial habitat conditions for both the California Red-legged Frog and the San Francisco Gartersnake that results in a cascade of positive effects on both species.

Pursuant to 28 U.S.C. § 1746, I hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on this 4th day of November, 2011. /s/ Marc Hayes

Marc Hayes

I, Brent Plater, hereby attest that Marc Hayes' concurrence in the e-filing of this document has been obtained.

Executed on: November 4, 2011 Brent Plater

Brent Plater

EXHIBIT A

Calendar Year 2006-2009 California Red-legged Frog (*Rana draytonii*) Surveys, Golden Gate National Recreation Area

Photo: *Rana draytonii* egg mass at Rodeo Lake, January 18, 2008 (D. Fong)

March 2010

Prepared by

Darren Fong
Aquatic Ecologist
Golden Gate National Recreation Area

Christina Crooker
Susie Bennett
Golden Gate National Parks Conservancy

Ro Lo Bianco
California State University-East Bay

Jon Campo
Natural Areas Program-City & County of San Francisco

Michael Reichmuth
NPS-San Francisco Area Network Inventory and Monitoring

Prepared for the

National Park Service
Golden Gate National Recreation Area
Division of Resource Management

U.S. Fish and Wildlife Service
Endangered Species Permits
Ecological Services
Portland Regional Office

ABSTRACT

This report summarizes field activities that have occurred over the past three years: Winter 2006-2007, Winter 2007-2008, and Winter 2008-2009 for winter breeding amphibians and spring trapping within the Golden Gate National Recreation Area. Egg mass surveys were conducted for the threatened California red-legged frog (*Rana draytonii*). Areas surveyed for egg masses included Big Lagoon, Rodeo Lake/Lagoon, Milagra Ridge, Mori Point and Sharp Park. Additional sites were surveyed during this period by contractors to the GGNRA and contractors to City of San Francisco‟s Natural Areas Program. California red-legged frog egg masses were present at four out of the five sites. In addition to the breeding surveys, other observations of California red-legged frogs occurred during culvert use investigations and aquatic surveys in Olema Creek near Point Reyes Station (Marin Co.).

INTRODUCTION

This report summarizes California red-legged frog (*Rana draytonii*) field activities that occurred over the past three years: 1) egg mass surveys during the winters of 2006-2007, 2007-2008, and 2008-2009, 2) spring trapping activities, and 3) research on culvert use by amphibians. Winter survey activities focused mainly on the threatened California red-legged frog (*Rana draytonii*), although incidental observations of Sierran treefrog (*Pseudacris sierra* formerly Pacific treefrog, *Pseudacris regilla*) and newt (*Taricha* spp.) egg masses were recorded as well. Egg mass surveys were intended to provide long-term monitoring data to assess trends in abundance of winter-breeding frogs, specifically the California red-legged frog at sites within Marin and San Mateo Counties. Monitoring of known red-legged frog populations is consistent with identified recovery plan tasks (USFWS 2002). In addition, trapping surveys were conducted at three streams to determine the presence of amphibian larvae and to capture juvenile salmonids from upstream areas.

METHODS

Egg Mass Surveys

Egg mass surveys were conducted from early to late-winter targeting California red-legged frogs. Initiation of survey activities started once seasonal ponds retained surface water. Surveys are conducted during daylight hours and on days where water clarity allowed the surveyor to see red-legged frog egg masses. Most surveys were conducted on foot, except at Rodeo Lagoon/Lake which was surveyed using an inflatable kayak because of soft sediments. Within the Park, surveys were conducted by NPS staff, Parks Conservancy staff, and contractors authorized under U.S. Fish and Wildlife Service Section 10 permit. Contractor survey activities during this period are summarized in reports (Wood 2008a, 2008b, 2007a, 2007b).

The surveyor typically recorded event-based data including duration of survey, general weather conditions, water clarity, water temperature, and general information about the extent of surveys. Species-specific data included species and number of egg masses (or abundance categories for Sierran treefrog egg masses). The abundance categories that we used for Sierran treefrog egg masses are: 1-5, 6-25, 26-50, 51-100, and >100. Specific to red-legged frogs, we recorded Gosner life stage, approximate volume of egg masses, attachment type, water depth at egg mass, and location of egg mass relative to water surface. Flagging was used to mark vegetation near egg masses to avoid repeat counts in subsequent surveys. For large water-bodies (e.g., Horse Stable Pond/Laguna Salada), the location of egg masses were recorded on paper maps in the field. Red-legged frog egg mass survey data since 2001 have been placed in a Microsoft Access database. Table 1 provides a list of all sample locations and geographic coordinate information. A summary of survey conditions and sample dates for egg masses is provided in Table 2.

Some egg mass surveys in our target watersheds were conducted by contractors. In the Laguna Salada watershed, surveys on Sharp Park golf course were completed by Swaim Biological Inc. for the City of San Francisco in winter 2007-2008. Summary of their data is included in this report; however, their survey methodology and comprehensive data assessment are provided in their final report (Swaim Biological Inc. 2008).

Trapping Surveys

Smolt traps were operated on Olema, Pine Gulch and Redwood Creeks (Marin Co.) during the late spring to document the presence and movement of aquatic animals, particularly salmonid smolts that are leaving for the Pacific Ocean. During these trapping events, amphibians were often encountered. A summary of amphibians captured during trapping activities is provided in Table 6.

Culvert Assessment Survey

At Mori Point and Milagra Ridge, drift fence and culvert arrays were installed along with motion-trigged still and video cameras to determine use of culverts of the size and dimensions proposed as potential mitigation measures in the Marin Headlands Fort Baker transportation plan. The arrays were installed and monitored in 2008-2009. The study was conducted during both the ingress season of adult California red-legged frog to the ponds and the egress season of both adults and metamorphs away from the ponds to non-breeding habitat. The field study lasted nine months at Milagra Ridge and seven months at Mori Point. At each site, two high density polyethylene (HDPE) corrugated culverts, one solid and one slotted at the top to allow for more ambient light and temperature, were placed parallel to each other at ground level. Drift fence 16 inches high was placed on either side of the culvert entrances end to direct frogs toward the culverts. The drift fence length was half the perimeter of each pond to allow for an equal choice of culvert passage or avoidance. Both ends of the double culverts were monitored by Trailmaster passive and active infrared motion detection systems, connected to still or video cameras (Figure 1). Complete description of the study plan and findings are expected in a forthcoming California State University-East Bay master‟s thesis.

Incidental Observations

Visual observations of various life stages of red-legged frogs are generally recorded by all survey teams. These observations are generally incidental to other activities (e.g., tidewater goby sampling).

Study Area

Detailed descriptions of the study areas and location maps are provided in Appendix I. Sites were chosen for egg mass surveys based on past information regarding the presence of juvenile or adult red-legged frogs. At Big Lagoon, survey efforts focused on past locations where eggs were found by U.S. Geological Survey-Biological Resources Division (Fellers and Guscio 2004) and Park staff (Fong 2000). At Mori Point, surveys focused at four created ponds. Infrequent surveys were conducted along adjacent Sanchez Creek, and just at Fairway Drive where the culverted creek daylights into an open pool. Downstream of this location, the creek is heavily shaded by riparian trees and presumed to be poor breeding habitat. At Sharp Park, egg mass surveys focused on predominantly freshwater Horse Stable Pond and upstream slough with infrequent surveys of the more saline Laguna Salada based on past red-legged frog breeding activity (Fong 2000). As in past years, surveys at Milagra Ridge were conducted at the oxidation pond. No surveys were conducted along Milagra Creek. Although perennial streamflow is present, past stream surveys for fish indicate an entrenched, heavily shaded and steep gradient channel. It is unlikely that breeding would occur in the creek under these conditions.

DATA ANALYSIS

Trend analysis in annual egg mass counts by watershed will be conducted using the non-parametric Mann-Kendall test, and significant trends will be identified when p-values are less than $\alpha = 0.10$. A DOS-based program by USGS will be used to run the test (Helsel et al. 2005).

RESULTS

Egg Mass Surveys

Egg mass surveys indicated the continued presence of California red-legged frog breeding activity at Sharp Park/Mori Point complex, Milagra Ridge, and Rodeo Lagoon/Lake complex (Tables 3 & 5). The 2008 breeding season had the highest counts of egg masses for all sites within the past three years. As with prior years small numbers of red-legged frog egg masses were counted in Rodeo Lake in Winter 2006-2007 and 2007-2008, although none were observed in the adjacent Rodeo Lagoon.

There were a few sampling issues that bear mentioning because they have an influence in the interpretation of egg mass trend data by watershed. In Winter 2008-2009, it is likely that egg mass production for the Rodeo Lake locale was an underestimate. Only two surveys were done during the breeding season at Rodeo Lake (December 31, 2008 and March 10, 2009). It is likely that there was breeding during January and early February 2009 as with sites at Milagra and Mori Point and any laid eggs may have been missed. The eggs seen during the March 10 visit were about Gosner stage 9.

The high number of observed egg masses for Breeding Year 2008 at the Laguna Salada/Mori Point sites is influenced in part by the number of sample sites. Swaim Biological Inc. had conducted the field surveys for most of the breeding season and included sampling of sites that are typically not sampled by the City of San Francisco staff. They tallied 85 egg masses for the breeding season. These included the canal connecting Laguna Salada with Horse Stable Pond, the interior of Laguna Salada, and a pond on the east side of Highway One (Arrowhead Lake). The totals for these sites are 4 egg masses for Arrowhead Lake, 4 for the canal, and 20 for Laguna Salada. The bulk of the egg masses for this watershed are from Horse Stable Pond (57) (Swaim Biological Inc. 2008).

Surveys conducted at Big Lagoon in lower Redwood Creek in Winter 2002-2003 by USGS identified small numbers of egg masses (Fellers and Guscio 2004). However, subsequent surveys by our contractor in Winters 2003-2004, 2005-2006, 2006-2007, 2007-2008 (Wood 2004) and Park staff in Winters 2004-2005 and 2008-2009 failed to confirm successful breeding activity. Fellers and Guscio (2004) noted that flood control activities conducted by NPS reduced the ability of the seasonal wetland to pond water of sufficient duration and extent to maintain satisfactory habitat for the development and metamorphosis of red-legged frog tadpoles. Extremely small numbers of California red-legged frogs are still within the watershed. A night survey (March 31, 2009) at Big Lagoon and at a hillside irrigation pond on Green Gulch lands with Gary Fellers (USGS-BRD) indicated the presence of at least one small adult red-legged frog within the watershed.

Egg mass surveys documented the occurrence of stranded egg masses at both Milagra Ridge Oxidation Pond and Horse Stable Pond (Laguna Salada) (San Mateo County) (Table 4). In the past, egg mass strandings at Horse Stable Pond occurred as a result of pumping activities intended to reduce water levels in the Pond to keep the adjacent golf course greens dry (See Appendix I, Sharp Park/Mori Point Site Description). No information is available from the data sheets to indicate whether the egg mass strandings at Horse Stable Pond in 2007 and 2008 were the result of pumping activities as in the past. In any case, the percentage of observed strandings relative to total egg mass counts for the watershed has dropped. In Breeding Years 2004 and 2005, stranded egg masses accounted for 25 and 37% respectively of the observed eggs in the Laguna Salada watershed. In Breeding Years 2007 and 2008, they accounted for 10 and 3% of the observed eggs respectively. In Breeding Year 2009, no stranded egg masses were observed.

Trends in Watershed Egg Mass Observations

A bar chart of egg mass counts by watershed is presented in Figure 6. For the Laguna Salada watershed, no significant trend was present. Only counts for Mori Point, Horse Stable Pond and the Slough were included for the Laguna Salada watershed to ensure consistency between sample years. However, if Mori Point was evaluated separately, there was a significant increasing trend in annual egg masses laid over the sampled period (n=7, Kendall‟s *S* statistic=+17, p=0.01). Conversely, Milagra Ridge had a significant decline in annual egg masses over a similar period (n=8, Kendall"s *S* statistic=-16, p=0.06). No other significant trends were present for other sites.

Trapping Surveys

Olema Creek. Large numbers of red-legged frog adults were captured at the Olema Creek smolt trap above the confluence with Lagunitas Creek in Spring 2006. Adults seem to be consistently captured in late May and early June, and not during early Spring months. Due to the nature of the traps, the adult frogs likely moved in a downstream direction within the creek channel. The smolt trap is downstream of where mainstem Olema Creek had recently avulsed into an adjacent pasture. Stream flows have dispersed over a broader area resulting in development of slow water areas and emergent vegetation. It is likely that this developing wetland area supports breeding habitat for red-legged frogs. It is possible that the adult frogs are dispersing from breeding habitat.

Incidental Observations

Rodeo Lagoon. Juvenile California red-legged frogs were first documented along the shoreline of Rodeo Lagoon during October 2005 fish sampling activities by NPS staff. During tidewater goby sampling activities on September 18, 2007, two juvenile size ranid frogs (one definitely red-legged) were observed near two of our sample sites along the eastern shore of the lagoon.

Mortality/Injury

No mortality or injury of California red-legged frogs occurred associated with sampling activities. Dead California red-legged frogs have been observed at two locations: Mori Point and Rodeo Lake. At Rodeo Lake, four road-killed frogs in good condition were collected and frozen (December 14 &21, 2006, February 21, 2007, and January 11, 2008). Three of the four individuals were found on Bunker Road between Rodeo Lake (breeding site) and Rodeo Lagoon (summer-fall rearing habitat) (Figure 2). A dead subadult red-legged frog was found at a pond at Mori Point (LS08) on December 20, 2008. This individual was deposited with Jens Vindum, California Academy of Sciences (Specimen ID CAS 241751). We are intending on sending the other road-killed specimens to California Academy of Sciences.

Water level

Some of our breeding locations for California red-legged frogs are seasonal wetlands. Visits are made infrequently throughout the summer to document the persistence of water. During drought years many of the seasonal wetlands may have little or no red-legged frog production. Extremely low precipitation has been documented over the past two years in Marin County (Figure 3) with similar values for San Mateo County as well. This has resulted in the Milagra Ridge

Pond drying by July. It is unlikely that very many tadpoles had metamorphosed. Table 7 lists the dates when seasonal wetlands had gone dry.

Culvert Assessment Survey

The Trailmaster units did not capture any events of California red-legged frog entering or exiting the culverts at either site during the passive observation phase. A variety of birds and mammals were captured on film and video, however, including sparrows, wrens, brush rabbits, raccoons, skunk, domestic cats, and bobcats. Within the last month of the study, individual California red-legged frogs were captured and placed at the entrance end of the culvert set up at Milagra Ridge, under direct observation, to determine if equipment failure or species avoidance was preventing the camera and video recording of the frogs. Of the 9 individuals that were caught, 7 of them (78%) made a total of 12 approaches into the infrared detection zone of the culvert entrance (several individuals retreated and re-approached), and triggered the Trailmaster to record a passage event 5 times. The detection rate was therefore 42% at the entrance end. Of the 7 individuals that approached, 3 individuals passed through the culvert completely from one end to the other, but no Trailmaster events were recorded at the infrared detection zone of the exit end. It should be noted that 3 of 9 individuals captured initially retreated from the culvert opening and were replaced twice. If only the initial behavior of each frog was taken into account, 4 individuals naturally approached the culvert opening, or 44% of all individuals captured. During observations, no individuals attempted to jump over the drift fencing. Due to the small sample size and unreliability of the Trailmaster equipment to detect anurans, there are no significant results on whether the California red-legged frog will use this type of culvert for migration to and from breeding sites.

DISCUSSION

Evaluation of Created Breeding Habitat

GGNRA and the Golden Gate National Parks Conservancy have constructed several ponds within the park. In the Redwood Creek watershed, a California red-legged breeding pond (Banducci pond) was constructed in Fall 2007 in a floodplain as part of a biological opinion for impacts associated with past flood control activities (Figure 4). At Mori Point, three ponds were created in Fall 2007 (Figure 5) with the intent of creation breeding habitat for both Sierran treefrog and California red-legged frog. Both sites were revegetated with native wetland plants and woody debris have been added to provide immediate shoreline cover for animals as well as immediate attachment sites for eggs.

Since pond construction at the Banducci site, two seasons of winter breeding surveys and some limited night surveys have been conducted to determine the level of use by amphibians. No egg masses have been observed at the Banducci pond within the Redwood Creek floodplain with limited survey effort; although in March 2009 calling adult Sierran treefrogs were found. In addition, no red-legged frogs have been observed during night surveys. The biological opinion states that "Should no use of the breeding habitat be documented within the first year [red-legged frog], the Park will consider the introduction of red-legged frog egg masses from two adjacent areas at Tennessee Valley and Rodeo Valley as well as sites in west Marin County including Point Reyes National Seashore where there is relatively high egg mass production." Based on past two winters of surveys, introduction of red-legged frog masses at this site is recommended. Habitat conditions at the site are suitable for breeding and rearing of red-legged frogs, although Wood (2008) noted that shading of the pond may be causing suboptimally cool temperatures. This shading is caused by a stand of Eucalyptus trees which the Park has identified for removal, pending availability of funds (Figure 4).

At Mori Point, by two seasons after construction, all three constructed ponds had breeding activity (Breeding Years 2008 and 2009). They had 5 red-legged frog egg masses constituting 22% of the observed egg production for Mori Point. By the second year after construction (Breeding Season 2009), there was an increase in the proportion of red-legged frog egg masses from these new ponds and egg masses were found in two of the three constructed ponds. A total of 21 egg masses from the new ponds comprised 70% of the egg mass production for the Mori Point area. Oviposition at the created ponds often occurred on placed small woody debris. The small woody debris provides immediate oviposition substrates until planted vegetation has a chance to mature and expand.

One of the created ponds at Mori Point („Middle Pond," LS06) consistently dried before metamorphosis of red-legged frog tadpoles. While beneficial for those that forage on tadpoles, there was strong interest in providing successful breeding habitat for red-legged frogs as well. Therefore, in summer 2009, a portion of the Middle Pond was deepened less than 4 inches and the bottom lined with bentonite to allow for longer ponding of water.

Evaluation of Egg Mass Trends

Egg mass production declined at Milagra Ridge and Redwood Creek-Big Lagoon wetland. At Big Lagoon, egg mass production was only observed in Breeding Year 2003. Both of these sites are seasonal wetlands. It is likely that number of tadpoles that successfully metamorphose are associated with the type of water year. Based on rainfall data from Muir Woods NM, the past three precipitation years have been drier than normal (Figure 3) and is reflected in these two sites being dry by early summer (Table 7). A seasonally ponded breeding locale near Santa Rosa (Sonoma Co., CA) has also experienced declining egg mass production over the past dry winters (Dave Cook, pers. comm. 2009). Other sites with perennial water (Laguna Salada environs and Rodeo Lake) do not show the same downward trend in egg mass production (Figure 6). In addition, Big Lagoon has had hydrologic alterations due to past flood control activities such that summer groundwater levels have dropped.

Rodeo Lagoon Watershed

The current road network has resulted in road-kill mortalities of California red-legged frogs within the Rodeo Lagoon watershed. The main thoroughfare into the Marin Headlands (destination for Park visitors and staff) is Bunker Road which bisects Rodeo Lagoon and Lake, the main breeding site for red-legged frog.

The Park has developed a transportation plan for the Marin Headlands and mitigation measures are proposed to reduce the incidence of road kills along Bunker Road. Not only are California red-legged frogs hit by vehicles, but California newts as well. Implemented mitigation measures include an awareness program for Park staff and other workers at Fort Cronkhite and seasonal signage installed starting in Breeding Year 2007(Figure 7). In addition, the Park provided logistical support and a stipend to a graduate student (Ro Lo Bianco) to assess the feasibility of using a culvert and drift fence system to pass amphibians, particularly red-legged frogs under roadways. This project was implemented because of a literature review and conversation with local herpetologists indicated that no data were available.

Future Culvert Assessment Work

The recommendation would be to repeat the experiment by identifying and using motion detection equipment better suited to small amphibian movement studies, have culverts with some standing water or damp floor conditions, and create better natural cover of the culvert entrance and exit ends in order to increase the likelihood that California red-legged frog might utilize it for passage.

LITERATURE CITED

Banta, B. H., and D. Morafka. 1966. An annotated checklist of the recent amphibians and reptiles inhabiting the city and county of San Francisco. Wasmann J. Biol. 24:223-238.

Barry, S.J. 1978, The status of the San Francisco garter snake. California Dept. of Fish and Game Inland Fisheries Branch Endangered Species report 78-2.

Barry, S.J. 1993. The San Francisco garter snake: Protection is the key to recovery. Tideline 13:1-3, 15.

Barry, S.J. 1994. The distribution, habitat, and evolution of the San Francisco garter snake, *Thamnophis sirtalis tetrataenia*. Thesis, Library, University of California, Davis.

Fellers, G. and G. Guscio. February 2004. California red-legged frog surveys of lower Redwood Creek, Golden Gate National Recreation Area. U.S. geological survey- Western Ecological Research Center. Unpublished report prepared for the National Park Service. 70 pp.

Fong, D. and J. Campo. 2006. Calendar Year 2003-2005 California red-legged frog (Rana draytonii) surveys, Golden Gate National Recreation Area. Unpublished report prepared for the Golden Gate National Recreation Area. 35 pp.

Fong, D. April 2000. Winter 1998-2000 Frog Breeding Survey. Unpublished report prepared for the Golden Gate National Recreation Area. 33 pp.

Helsel, D.R., D.K. Mueller, and J.R. Slack. 2005. Computer program for the Kendall family of trend tests. U.S.Department of the Interior. U.S. Geological survey. Scientific Investigations Report 2005-5275.

Swaim Biological Inc. 2008. Sharp Park wildlife surveys and special status reptile and amphibian restoration recommendations. Unpublished report prepared for Tetra Tech, Portland, OR.

U.S. Army (Post Engineer, Presidio of San Francisco, CA). November 18, 1969. Milagra Ridge military reservation. Drawing E-757, Sheet 1 of 1. NPS-GGNRA Archives File #ADPWE-6 Box 3.

U.S. Fish and Wildlife Service. 2002. Recovery plan for the California red-legged frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, Oregon. viii+173 pp.

Williams, Phillip and Assoc. (PWA), Wetlands Research Assoc., T. Steiner, and J. Hafernik. June 1992. Laguna Salada resource enhancement plan. Prepared for the City of San Francisco and the State of California Coastal Conservancy.

Williams, Phillip and Assoc. (PWA), Moss Landing Marine Laboratories, J. Smith, John Northmore Roberts and Assoc., and N. Hornor. April 1994. A preliminary environmental assessment of wetland restoration alternatives for Big Lagoon at Muir Beach, Marin County. 127 pp +appendices

Wood, L.L. June 16, 2008a. 2008 California red-legged frog (*Rana draytonii*) studies. Breeding season surveys: Big Lagoon environs GGNRA. Unpublished report prepared for the Golden Gate National Recreation Area. 23 pp.

Wood, L.L. May 7, 2008b. 2008 California red-legged frog (*Rana draytonii*) studies. Breeding season surveys: Milagra Ridge-Mori Point GGNRA. Unpublished report prepared for the Golden Gate National Recreation Area. 21 pp.

Wood, L.L. August 7, 2007a. 2007 California red-legged frog (*Rana draytonii*) studies. Breeding and non-breeding season surveys: Rodeo Lake and Rodeo Lagoon GGNRA. Unpublished report prepared for the Golden Gate National Recreation Area. 17 pp+appendices.

Wood, L.L. June 27, 2007b. 2007 California red-legged frog (*Rana draytonii*) studies. Breeding and non-breeding season surveys: Big Lagoon GGNRA. Unpublished report prepared for the Golden Gate National Recreation Area. 14 pp+appendices

Wood, L.L. August 31, 2005. 2004-2005 California red-legged frog (*Rana aurora draytonii*) studies-breeding and non-breeding season surveys: Rodeo and Tennessee drainages and radiotelemetry study. Unpublished report prepared for the Golden Gate National Recreation Area.

Wood, L.L. July 15, 2004. Final report: GGNRA Tennessee Valley seep and stream amphibian surveys [and] Big Lagoon amphibian surveys. Unpublished report prepared for the Golden Gate National Recreation Area. 71 pp. +appendices

TABLES

Table 1: Location ID codes and geographic coordinates (UTM, NAD83, Zone 10) for California red-legged frog sampling sites, Golden Gate National Recreation Area. See Appendix I for survey site descriptions.

LocationID	Description	Watershed	County	StartUTMX	StartUTMY	StopUTMX	StopUTMY
LS01	Horse Stable Pond	Laguna Salada	San Mateo	544585	4163952		
LS02	Laguna Salada Northwest shoreline	Laguna Salada	San Mateo	544717	4164515		
LS03	Laguna Salada Southwest shoreline	Laguna Salada	San Mateo	544703	4164304		
LS04	Horse Stable Pond Slough	Laguna Salada	San Mateo	544631	4163959	544698	4164018
LS05	Mori Point Pond 'A' or "Willow Pond" nr Sanchez Creek	Laguna Salada	San Mateo	544796	4163900		
LS06	Mori Point Pond 'D' or "Middle Pond" @ Mori's Pt Road	Laguna Salada	San Mateo	544794	4163803		
LS07	Mori Point "Southern Pond" south of Mori's Pt Road	Laguna Salada	San Mateo	544827	4163764		
LS08	Mori Point "Wetland Pond" nr Sanchez Creek at boundary	Laguna Salada	San Mateo	544734.8	4163850.2		
LS09	Sanchez Creek below Fairway Drive	Laguna Salada	San Mateo	544866	4163955		
MC01	Milagra Ridge Oxid. Pond	Milagra Creek	San Mateo	546584	4165889		
RC01	Big Lagoon Environs @ GG weir	Redwood Creek	Marin	537468	4190482		
RC02	Big Lagoon Environs @ GG wetland	Redwood Creek	Marin	537472	4190519	537472	4190588
RC03	Big Lagoon Environs @ GG xditch	Redwood Creek	Marin	537473	4190651	537463	4190676
RC04	Big Lagoon Environs @ former picnic area	Redwood creek	Marin	537366	4190441		
RC05	Big Lagoon Environs @ RW creek backwater	Redwood Creek	Marin	537468	4190482	537396	4190706
RC06	Green Gulch Pond-Zendo	Redwood Creek	Marin	538301	4190993		
RC07	Banducci Pond	Redwood Creek	Marin	536863	4191278		
RC08	Green Gulch Hillside Pond-East	Redwood Creek	Marin	538339	4190729		
RC09	Green Gulch Hillside Pond-West	Redwood Creek	Marin	538021	4190611		
RL02	Rodeo Lake	Rodeo Lagoon	Marin	541789	4187306		
RL03	Lower Rodeo Creek @ Rodeo Lake	Rodeo Lagoon	Marin	541916	4187281		
RL04	Rodeo Lagoon-East shore	Rodeo Lagoon	Marin	541445	4187262	541467	4187130
TV02	Tennessee Valley Cove Pond	Tennessee Valley	Marin	539625	4188647		

Table 2: Summary of event data for amphibian winter breeding surveys at Golden Gate National Recreation Area for breeding year 2007, 2008, 2009. See Appendix I for survey site descriptions.

BRDYEAR	LocationID	Date	Begin Time	TTime (min)	Obsv1	Obsv2	Weather	Wind	Air Temp (°C)	Water Temp (°C)	WaterVis (m)
2007	LS01	12/20/2006	8:30	60	JC	DF	Clear	0	3.33	6.67	
2007	LS01	1/17/2007	15:40		JC		Clear	0		10	
2007	LS01	1/26/2007	8:30		JC		Pt. Cloudy	0	7.78	6.67	
2007	LS01	2/14/2007	11:00	60	JC		Clear	<5	17.78	13.34	
2007	LS01	3/13/2007	11:08	30	JC		Overcast	0			
2007	LS01	3/23/2007	10:00		JC	DF	Clear	0	18.89	15.56	
2007	LS05	12/19/2006	8:47	3	DF		Clear	0			
2007	LS05	1/26/2007	9:00	10	DF		Clear	0			0.4
2007	LS05	2/20/2007	8:25	12	DF		Overcast				0.46
2007	LS05	3/8/2007	15:35	16	DF		Clear	1			0.7
2007	LS05	3/23/2007	9:26	10	DF		Clear	0			0.7
2007	LS06	12/19/2006	8:41	1	DF		Clear	0			
2007	LS06	1/26/2007	9:00		DF		Clear	0			
2007	LS06	2/20/2007	8:40	2	DF						0.3
2007	LS06	3/8/2007	15:55	5	DF		Clear	<5			0.4
2007	LS06	3/23/2007	9:22	2	DF		Clear	0			
2007	MC01	12/24/2006	12:11	10	DF		Overcast	<5			
2007	MC01	1/10/2007	9:38	17	DF		Clear	<5	11		
2007	MC01	1/26/2007	9:30	5	DF		Overcast	<5			
2007	MC01	2/20/2007	9:10	66	DF		Overcast				0.18
2007	MC01	3/8/2007	16:50	47	DF		Pt. Cloudy	<5			0.5
2007	MC01	3/23/2007	9:56	38	DF		Clear	0			0.5

BRDYEAR	LocationID	Date	Begin Time	TTime (min)	Obsv1	Obsv2	Weather	Wind	Air Temp (^oC)	Water Temp (^oC)	WaterVis (m)
2007	RC03	1/1/2007	15:20	55	LW		Clear	0	12.5	9	
2007	RC03	1/18/2007	13:58	50	LW		Pt. Cloudy	0	13	9	1
2007	RC03	2/5/2007	14:20	52	LW		Overcast	5-20	19	13	
2007	RC03	2/20/2007	15:13	37	LW		Mostly Cloudy	<5	14	13.5	
2007	RL02	12/29/2006	10:45	29	DF		Clear	<5	12	8.9	0.46
2007	RL02	1/18/2007	15:50	31	DF		Clear	0	9	5	1
2007	RL02	2/8/2007	13:45	70	LW		Rain	5-20	13	11.5	
2007	RL02	2/15/2007	14:45	53	LW		Clear	5-20	17.5	11	0.25
2007	RL02	2/28/2007	13:52	55	LW		Clear	5-20	11	9	0.1
2007	RL04	12/29/2006	11:35	39	DF		Clear	<5	14	9.8	
2007	RL05	2/28/2007	15:05	40	LW		Clear	5-20	11	13	0.05
2007	RL05	6/13/2007	15:40	60	LW		Clear	<5	19	24.5	
2008	LS01	12/11/2007	7:15	30	JC		Clear	3	6.7	5.6	
2008	LS01	12/21/2007	11:50	5	JC		Clear	3	11.1	10	
2008	LS01	1/4/2008	10:30	60	L		Pt. Cloudy	3	15.6	11.1	
2008	LS01	1/8/2008	11:30	60	JC		Clear	0	14.4	11.1	
2008	LS01	1/9/2008	11:00		SW		Pt. Cloudy	1			
2008	LS01	1/29/2008	14:00	60	L		Rain	3	12.8	15.6	
2008	LS05	1/16/2008	12:30	8	LW	SB	Clear	1	16	8	0.25
2008	LS05	1/30/2008	13:37	20	LW		Clear	1	12.5	11	0.25
2008	LS05	2/12/2008	15:56	17	LW	CC	Clear	0	13	13	0.25
2008	LS05	3/4/2008	14:38	8	LW	MR	Clear	0	15.5	14	0.4
2008	LS06	1/2/2008	12:37	6	LW		Clear	1	14.5	11.5	0.1
2008	LS06	1/16/2008	12:52	7	LW	SB	Clear	1	16	10	0.25

BRDYEAR	LocationID	Date	Begin Time	TTime (min)	Obsv1	Obsv2	Weather	Wind	Air Temp (°C)	Water Temp (°C)	WaterVis (m)
2008	LS06	1/30/2008	14:12	4	LW		Clear	1	12.5	13	
2008	LS06	2/12/2008	16:22	8	LW	CC	Clear	0	13	15	0.25
2008	LS06	3/4/2008	14:05	5	LW	MR	Clear	1	15.5	19.5	0.1
2008	LS07	1/2/2008	12:50	3	LW		Clear	1	14.5	9	
2008	LS07	1/16/2008	13:05	7	LW		Overcast	1	16	11	
2008	LS07	1/30/2008	14:06	3	LW		Clear	1	12.5	11.5	
2008	LS07	2/12/2008	15:47	4	LW		Clear	1	13	15	
2008	LS07	3/4/2008	13:46	5	LW	SB	Clear	1	15.5	18.5	
2008	LS08	1/2/2008	12:19	5	LW		Clear	1	14.5	10.5	
2008	LS08	1/16/2008	13:17	3	LW		Clear	1	16	11	0.1
2008	LS08	1/30/2008	14:25	6	LW		Clear	1	12.5	16	
2008	LS08	2/12/2008	16:37	4	LW	CC	Overcast	0	9.5	14	0.1
2008	LS08	3/4/2008	14:16	11	LW	MR	Clear	1	15.5	18.5	0.25
2008	LS10	1/8/2008	11:15		SW		Pt. Cloudy	6			
2008	LS11	1/8/2008	11:15		SW		Pt. Cloudy	6			
2008	MC01	1/2/2008	14:17	13	LW		Clear	1	13.5	10.5	0.2
2008	MC01	1/16/2008	10:54	38	LW	CC	Clear	1	11	8	0.25
2008	MC01	1/30/2008	12:30	20	LW		Clear	1	9.5	11	0.1
2008	MC01	2/12/2008	14:07	46	LW	CC	Clear	0	13	15	0.1
2008	MC01	3/4/2008	12:05	50	LW	CC	Clear	0	16	14	0.25
2008	RC01	1/17/2008	13:19	86	LW		Clear	1	13	9	1
2008	RC01	1/28/2008	13:25	96	LW		Pt. Cloudy	3	8	10	0.15
2008	RC01	2/27/2008	14:19	59	LW		Clear	3	14.5	13	0.3
2008	RC07	1/17/2008	12:50	10	LW		Clear	0	12	6	

BRDYEAR	LocationID	Date	Begin Time	TTime (min)	Obsv1	Obsv2	Weather	Wind	Air Temp (^oC)	Water Temp (^oC)	WaterVis (m)
2008	RC07	1/28/2008	15:24	8	LW		Pt. Cloudy	3	9	9	
2008	RC07	2/13/2008	16:15	13	LW		Clear	1	15.5	9.5	
2008	RC07	2/27/2008	15:47	3	LW	MR	Clear	3	15	14.5	
2008	RC08	2/13/2008	12:55	33	LW		Clear	1	19	13	
2008	RC08	2/27/2008	12:37	27	LW	MR	Clear	3	16.5	13	0.2
2008	RC08	3/12/2008	14:57	45	LW	MR	Overcast	2	18	13.5	0.25
2008	RC09	2/13/2008	13:56	22	LW		Clear	3	16	11.5	0.4
2008	RC09	2/27/2008	13:24	22	LW	MR	Clear	2	16.5	14	0.2
2008	RC09	3/12/2008	16:17	16	LW	MR	Overcast	2	16	13	0.15
2008	RL02	1/17/2008	16:08	30	DF		Clear	1			0.5
2008	RL02	2/11/2008	10:20	70	DF		Clear	1			0.3
2008	RL02	3/14/2008	10:40	50	DF		Overcast	3	15.4	12.3	0.3
2008	RL04	2/11/2008	11:50	35	DF		Clear	1			0.3
2009	LS01	12/29/2007	12:20	60	L		Overcast	2	15.6	11.1	
2009	LS01	12/15/2008	11:10	90	RZ		Overcast	3	10	8	
2009	LS01	12/16/2008	13:13	60	RZ	DH	Pt. Cloudy	2	9	10	
2009	LS01	12/23/2008	8:50	90	DH		Mostly Cloudy	2	14	8	
2009	LS01	12/24/2008	9:05	1035	DH		Rain	3	13	9	
2009	LS01	12/26/2008	9:00	90	DH		Clear	2	10	9	
2009	LS01	1/3/2009	9:35	30	JC		Clear	0	11	8	
2009	LS01	1/7/2009	10:00	30	JC		Clear	0	14	9	
2009	LS01	1/22/2009	10:35	60	JC		Overcast	0	16	11	
2009	LS01	1/29/2009	10:20	90	JC		Clear	3	18	9	
2009	LS01	2/12/2009	10:00	30	JC		Pt. Cloudy	1	14		

BRDYEAR	LocationID	Date	Begin Time	TTime (min)	Obsv1	Obsv2	Weather	Wind	Air Temp (^{o}C)	Water Temp (^{o}C)	WaterVis (m)
2009	LS01	2/17/2009	9:40	90	DH		Rain	3	13	10	
2009	LS01	2/18/2009	10:00	30	JC		Pt. Cloudy	1	14	11	
2009	LS01	2/19/2009	9:40	70	DH		Pt. Cloudy	1	16		
2009	LS01	2/24/2009	10:00	45	JC		Pt. Cloudy	0			
2009	LS01	3/6/2009	9:00	60	JC		Pt. Cloudy	1			
2009	LS01	3/11/2009	10:00	60	JC		Clear	0	14	9	
2009	LS01	3/26/2009	9:00	60	JC		Clear	4		11	
2009	LS01	4/15/2009	10:30	60	JC		Clear	4	13		
2009	LS03	2/12/2009	10:45	60	JC		Pt. Cloudy	2	14		
2009	LS05	12/31/2008	11:37	9	SB	CC	Clear	0	15	8	0.6
2009	LS05	1/23/2009	11:32	20	CC	SB	Mostly Cloudy	1		10	0.55
2009	LS05	2/12/2009	12:08	16	SB	CC	Clear	1	17.3	11	0.9
2009	LS05	3/9/2009	11:32	19	SB	CC	Clear	1	11.4	10	0.54
2009	LS05	4/4/2009	11:23	10	SB	CC	Clear	1	20.2	14	0.7
2009	LS06	12/31/2008	12:42	6	SB	CC	Clear	1	12.1	14	0.05
2009	LS06	1/23/2009	9:15	8	CC	SB	Overcast	1	13.2	11	1.3
2009	LS06	2/12/2009	13:36	4	SB		Clear	1	11.1		0.02
2009	LS06	3/9/2009	12:01	9	SB	CC	Clear	3	10.4	10	0.3
2009	LS06	4/4/2009	11:37	7	SB	CC	Clear	1	18.8	15	
2009	LS07	12/31/2008	12:52	9	SB	CC	Clear	0	15	10	0.24
2009	LS07	1/23/2009	9:29	39	SB	CC	Overcast	1	14.9		0.15
2009	LS07	2/12/2009	13:19	15	SB		Clear	1	12.8	12	
2009	LS07	3/9/2009	12:13	9	SB	CC	Clear	2	11.6	10	0.13

BRDYEAR	LocationID	Date	Begin Time	TTime (min)	Obsv1	Obsv2	Weather	Wind	Air Temp (^oC)	Water Temp (^oC)	WaterVis (m)
2009	LS07	4/4/2009	11:49	7	SB	CC	Clear	2	15.7	13	0.5
2009	LS08	12/31/2008	11:52	48	SB	CC	Clear	2	13.7	11	0.4
2009	LS08	1/23/2009	10:36	43	CC	SB	Mostly Cloudy	1	13.2	12	0.22
2009	LS08	2/12/2009	12:42	28	SB		Clear	1	12.5	13	0.4
2009	LS08	3/9/2009	12:27	8	SB	CC	Clear	2	11.1	11	0.13
2009	LS08	4/4/2009	12:15	13	SB	CC	Clear	2	14.4	15	0.8
2009	LS09	12/31/2008	12:52	9	SB	CC	Clear	0	15	10	0.24
2009	LS09	3/9/2009	13:00	2	SB	CC	Clear	1			
2009	MC01	12/31/2008	10:39	16	CC	SB	Pt. Cloudy	0	11.1	9	0.1
2009	MC01	1/23/2009	12:20	5	CC	SB	Mostly Cloudy	1			
2009	MC01	2/12/2009	14:16	8	SB	CC	Clear	1	14.6	20	0.02
2009	MC01	3/9/2009	9:34	32	SB	CC	Clear	1	10.6	8	0.13
2009	MC01	4/4/2009	10:28	26	SB	CC	Clear	1	22.1	11	0.48
2009	RC01	3/20/2009	13:05	15	DF		Clear	0			0.75
2009	RC02	12/31/2008	14:08	14	DF		Overcast	1	13	9.1	0.4
2009	RC02	3/20/2009	13:27	12	DF		Clear	0			0.5
2009	RC05	12/31/2008	14:30	7	DF		Overcast	1		7.8	0.2
2009	RC07	2/7/2009	9:30	10	MR		Overcast				
2009	RL02	12/31/2008	15:40	36	DF		Overcast	1			0.3
2009	RL02	3/10/2009	12:39	56	DF		Clear	3	17.8	10.7	0.3
2009	TV02	3/11/2009	10:42	40	DF		Clear	1	17.2	9	0.3

*Beaufort Wind Categories: (0) no wind, (1) 1-3 mph, (2) 4-7 mph, (3) 8-12 mpg, (4) 13-18 mph, (5) 19-24 mph, (6) >25 mph

Table 3: Summary of California red-legged frog egg mass counts by watershed and breeding year.

Watershed	Breeding Year	Egg Masses
Laguna Salada	2007	30
Laguna Salada	2008	119[1, 2]
Laguna Salada	2009	87
Milagra Creek	2007	35
Milagra Creek	2008	61[2]
Milagra Creek	2009	12
Redwood Creek	2007	0[2]
Redwood Creek	2008	0*[2]
Redwood Creek	2009	0
Rodeo Lagoon	2007	2[2]
Rodeo Lagoon	2008	11
Rodeo Lagoon	2009	5

[1] Surveys conducted by City of San Francisco contractor (Swaim Biological Inc.) which included Laguna Salada and Arrowhead Lake
[2]Surveys conducted by NPS contractor (Leslie Wood)

Table 4: Summary of partly stranded and stranded California red-legged frog egg masses at Laguna Salada and Milagra Creek watershed sites by breeding year.

Breeding Year	LocationID	Date	Egg Masses
2007	LS01	2/14/2007	3
2008	LS01	1/29/2008	3
2009	LS01		0
2007	MC01	3/8/2007	1
2008	MC01	2/12/2008	2
2008	MC01	3/4/2008	1
2009	MC01		0

Table 5: Summary of egg mass counts by sampling event, by species, watershed, and breeding year 2007-2009.

BRDYEAR	LocationID	Date	SpeciesID	Number of Egg Masses	Range of Egg Masses
2007	LS01	2/14/2007	PSSI	1	
2007	LS01	2/14/2007	RAAU	25	
2007	LS01	3/13/2007	RAAU	2	
2007	LS05	1/26/2007	RAAU	2	
2007	LS05	2/20/2007	PSSI		>100
2007	LS05	3/8/2007	RAAU	1	
2007	LS05	3/8/2007	PSSI		26-50
2007	LS05	3/23/2007	PSSI	10	
2007	LS06	2/20/2007	PSSI		26-50
2007	MC01	1/10/2007	RAAU	3	

BRDYEAR	LocationID	Date	SpeciesID	Number of Egg Masses	Range of Egg Masses
2007	MC01	2/20/2007	RAAU	24	
2007	MC01	2/20/2007	PSSI		>100
2007	MC01	3/8/2007	RAAU	5	
2007	MC01	3/8/2007	PSSI		6-25
2007	MC01	3/23/2007	RAAU	3	
2007	MC01	3/23/2007	PSSI		26-50
2007	RC03	2/20/2007	TATO	5	
2007	RL02	1/18/2007	RAAU	1	
2007	RL02	2/15/2007	RAAU	1	
2008	LS01	1/29/2008	RAAU	11	
2008	LS01	1/22/2009	RAAU	11	
2008	LS05	1/16/2008	PSSI	30	
2008	LS05	1/16/2008	RAAU	8	
2008	LS05	1/30/2008	PSSI	110	
2008	LS05	1/30/2008	RAAU	2	
2008	LS05	2/12/2008	PSSI	20	
2008	LS05	2/12/2008	RAAU	8	
2008	LS05	3/4/2008	PSSI	5	
2008	LS06	1/2/2008	PSSI	78	
2008	LS06	1/16/2008	PSSI	270	
2008	LS06	2/12/2008	PSSI	59	
2008	LS06	2/12/2008	RAAU	1	
2008	LS06	3/4/2008	PSSI	19	
2008	LS08	1/16/2008	PSSI	1	
2008	LS08	2/12/2008	PSSI	7	
2008	LS08	3/4/2008	PSSI	130	
2008	LS08	3/4/2008	RAAU	4	
2008	MC01	1/16/2008	PSSI	150	
2008	MC01	1/16/2008	RAAU	38	
2008	MC01	1/30/2008	PSSI	12	
2008	MC01	2/12/2008	PSSI	50	
2008	MC01	2/12/2008	RAAU	16	
2008	MC01	3/4/2008	RAAU	7	
2008	RC01	1/17/2008	PSSI	24	
2008	RC01	1/28/2008	PSSI	3	
2008	RC01	1/28/2008	TATO	1	
2008	RC01	2/27/2008	PSSI	10	
2008	RC01	2/27/2008	TATO	2	
2008	RC08	2/27/2008	TATO	1	
2008	RC08	3/12/2008	PSSI	1	
2008	RC08	3/12/2008	TATO	20	
2008	RC09	2/13/2008	TATO	9	
2008	RC09	2/27/2008	PSSI	10	
2008	RC09	2/27/2008	TATO	10	
2008	RC09	3/12/2008	TATO	20	
2008	RL02	1/17/2008	RAAU	1	

BRDYEAR	LocationID	Date	SpeciesID	Number of Egg Masses	Range of Egg Masses
2008	RL02	2/11/2008	RAAU	8	
2008	RL02	3/14/2008	RAAU	2	
2009	LS01	1/3/2009	RAAU	1	
2009	LS01	1/29/2009	RAAU	35	
2009	LS01	2/12/2009	RAAU	7	
2009	LS01	2/19/2009	RAAU	1	
2009	LS01	3/11/2009	RAAU	2	
2009	LS03	2/12/2009	RAAU	11	
2009	LS05	1/23/2009	RAAU	6	
2009	LS05	2/12/2009	RAAU	1	
2009	LS05	3/9/2009	RAAU	1	
2009	LS06	2/12/2009	PSSI	6	
2009	LS06	3/9/2009	PSSI	10	
2009	LS07	12/31/2008	RAAU	1	
2009	LS07	1/23/2009	RAAU	5	
2009	LS07	3/9/2009	PSSI	14	
2009	LS07	4/4/2009	PSSI	2	
2009	LS08	12/31/2008	RAAU	6	
2009	LS08	2/12/2009	PSSI	10	
2009	LS08	2/12/2009	RAAU	9	
2009	LS08	3/9/2009	PSSI	16	
2009	LS08	4/4/2009	PSSI	10	
2009	LS09	3/9/2009	RAAU	1	
2009	MC01	3/9/2009	RAAU	12	
2009	RL02	3/10/2009	RAAU	5	

KEY: PSSI: *Pseudacris sierra*, RADR: *Rana draytonii*, TAGR: *Taricha granulosa*, TATO: *Taricha torosa*

Table 6: Summary of red-legged frog trapping data for 2006-2009 [1]

Location	UTM N	UTM E	Survey Date (mm/dd/yyyy)	Trap Type (number of traps)	CRLF Life Stage	Count of Species	Notes
Olema Creek Mainstem	4212461	517111	5/18/2006	Smolt pipe trap (1)	Adult	3	
			5/20/2006	“	Tadpole	2	
			5/20/2006	“	Adult	1	
			5/21/2006	“	Adult	6	
			5/21/2006	“	Tadpole	3	
			5/22/2006	“	Tadpole	2	1 dead
			5/22/2006	“	Adult	6	
			5/23/2006	“	Adult	3	
			5/23/2006	“	Tadpole	1	
			5/24/2006	“	Adult	4	
			5/25/2006	“	Adult	2	
			5/30/2006	“	Adult	1	
			5/30/2006	“	Tadpole	1	
			6/1/2006	“	Adult	1	
			6/2/2006	“	Adult	8	
			6/3/2006	“	Adult	4	
			6/4/2006	“	Adult	1	
			6/5/2006	“	Adult	1	
			6/6/2006	“	Adult	1	
			6/7/2006	“	Adult	1	
	4211562	517695		“			
			5/5/2007		Tadpole	1	
			3/20/2008	“		1	
			5/13/2008	“	Tadpole	1	
			5/19/2008	“	Tadpole	1	
			5/25/2008	“	Tadpole	1	
			5/26/2008	“		1	
			5/30/2008	“	Adult	1	
			4/23/2008	“		1	

[1]Trap operation for April 10-June 9, 2006; March 14-May 27, 2007; 2008.

Table 7: Duration of ponding for California red-legged frog breeding survey sites

Watershed	Calendar Year	Location ID	Date Became Dry
Redwood Creek	2006	RC01	>8/16/2006 (at weir)
	2007	RC01	7/5/2007 (at weir)
	2008	RC01	6/10/2008 (at weir)
	2009	RC01	6/22/2009
	2008-2009	RC07	Perennial
Rodeo Lagoon	2006-2009	RL02	Perennial
Milagra Creek	2006	MC01	> 8/18/2006
	2007	MC01	No data
	2008	MC01	7/3/2008 (muddy)
	2009	MC01	End of July 2009
Laguna Salada	2006	LS06	6/24/2006
	2007	LS06	5/23/2007
	2008	LS06	6/18/2008
	2009	LS06	
	2006-2009	LS05	Perennial
	2008-2009	LS07, LS08	Perennial

FIGURES

Figure 1: Drift fence, culvert and camera array setup at Milagra Ridge, San Mateo County, CA. Photo: R. Lo Bianco

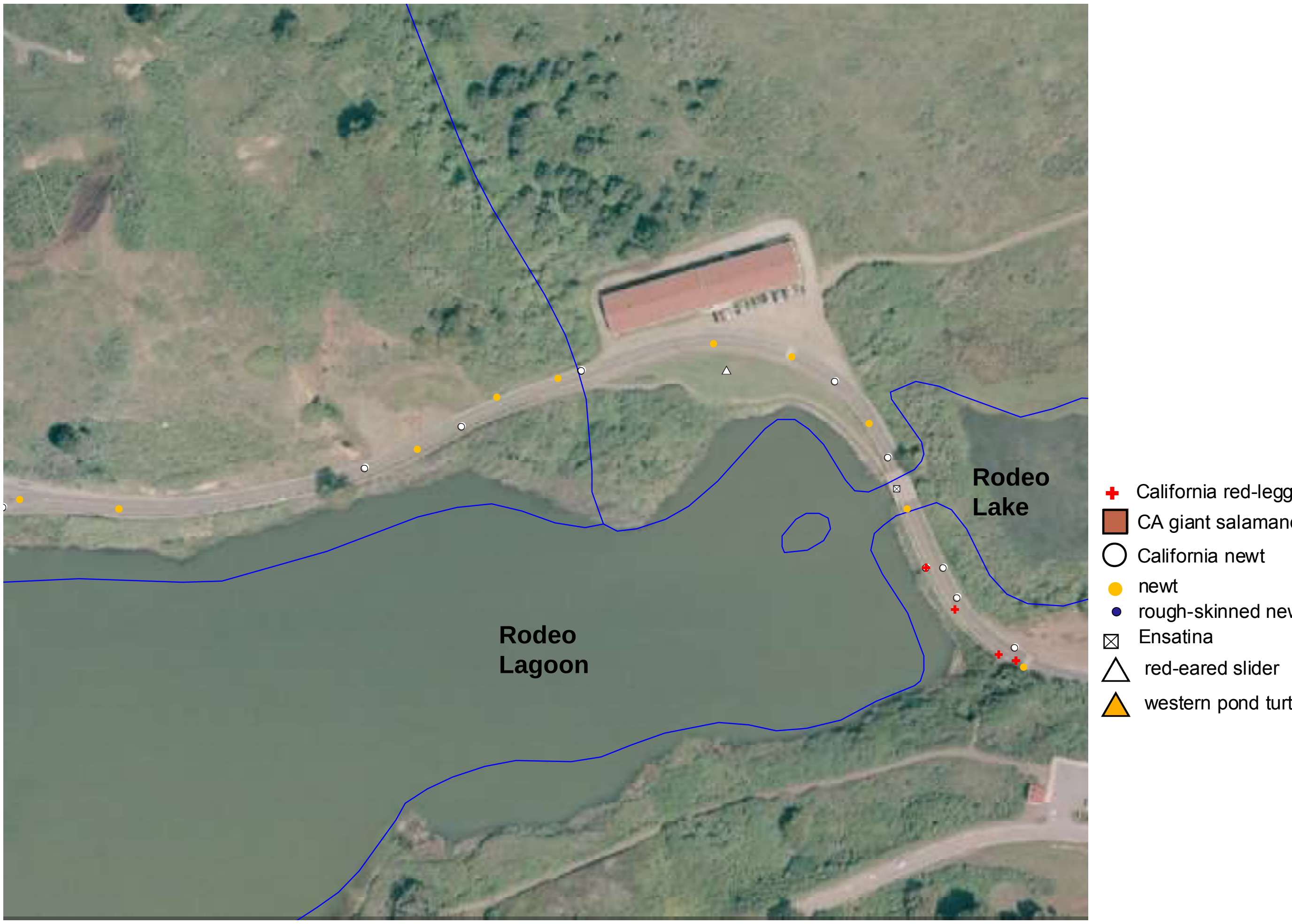


Figure 2: Location of observed road-killed and rescued amphibians along Bunker Road in Rodeo Lagoon watershed, Marin Co., CA (2003-2008)

Figure 2a: Road-killed red-legged frog on Bunker Road. Photo: D.Fong, 10Jan 2008

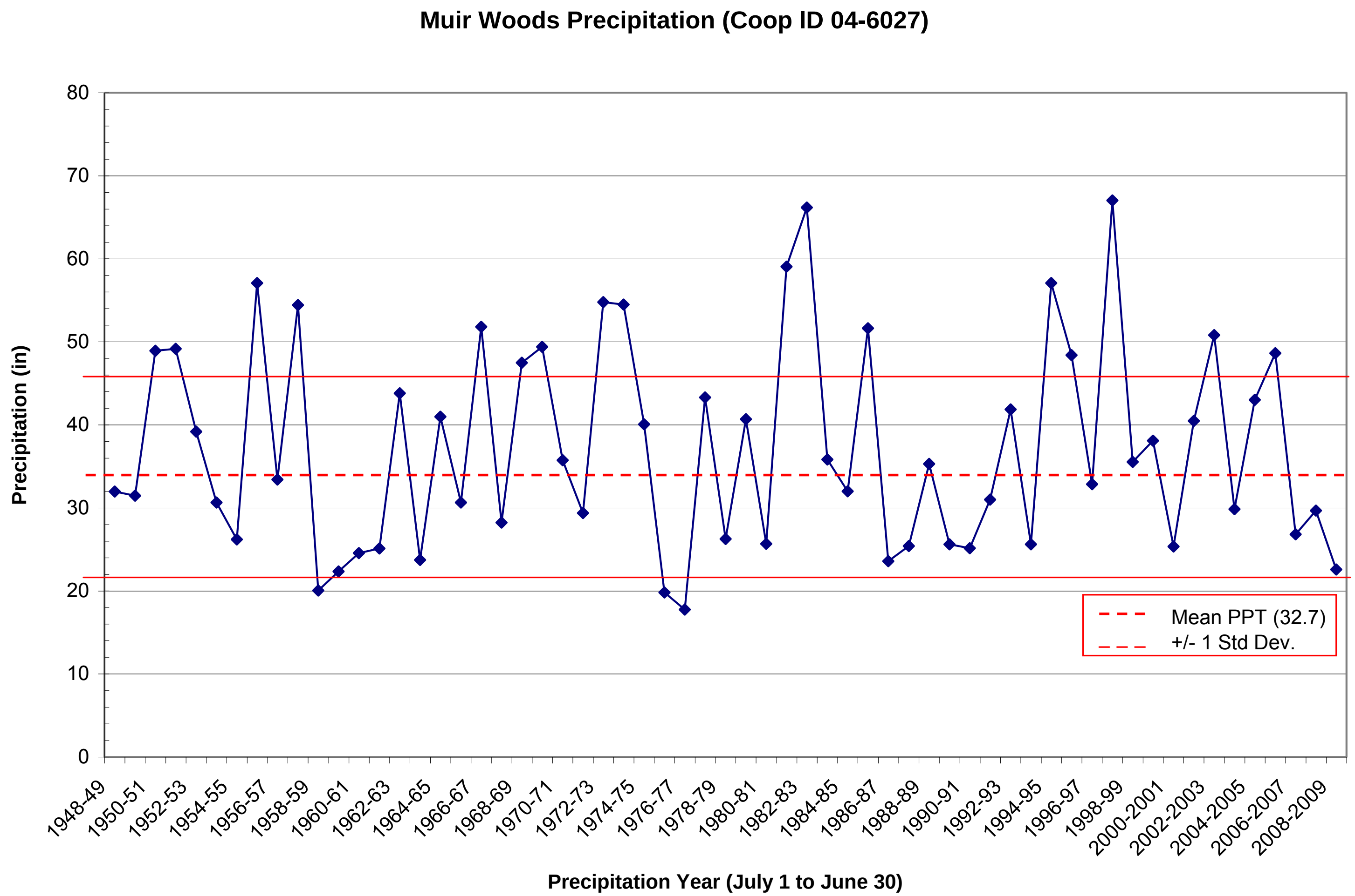


Figure 3: Annual precipitation from Muir Woods, Marin County, CA (1948 to present)

Figure 4: Banducci Floodplain Pond near Redwood Creek (shading by Eucalyptus stand), Marin Co., CA. Photo: D.Fong, March 13, 2008

Figure 5: Mori Point Ponds under construction, San Mateo Co., CA. Photo: San Mateo County Mosquito Abatement District, September 18, 2007

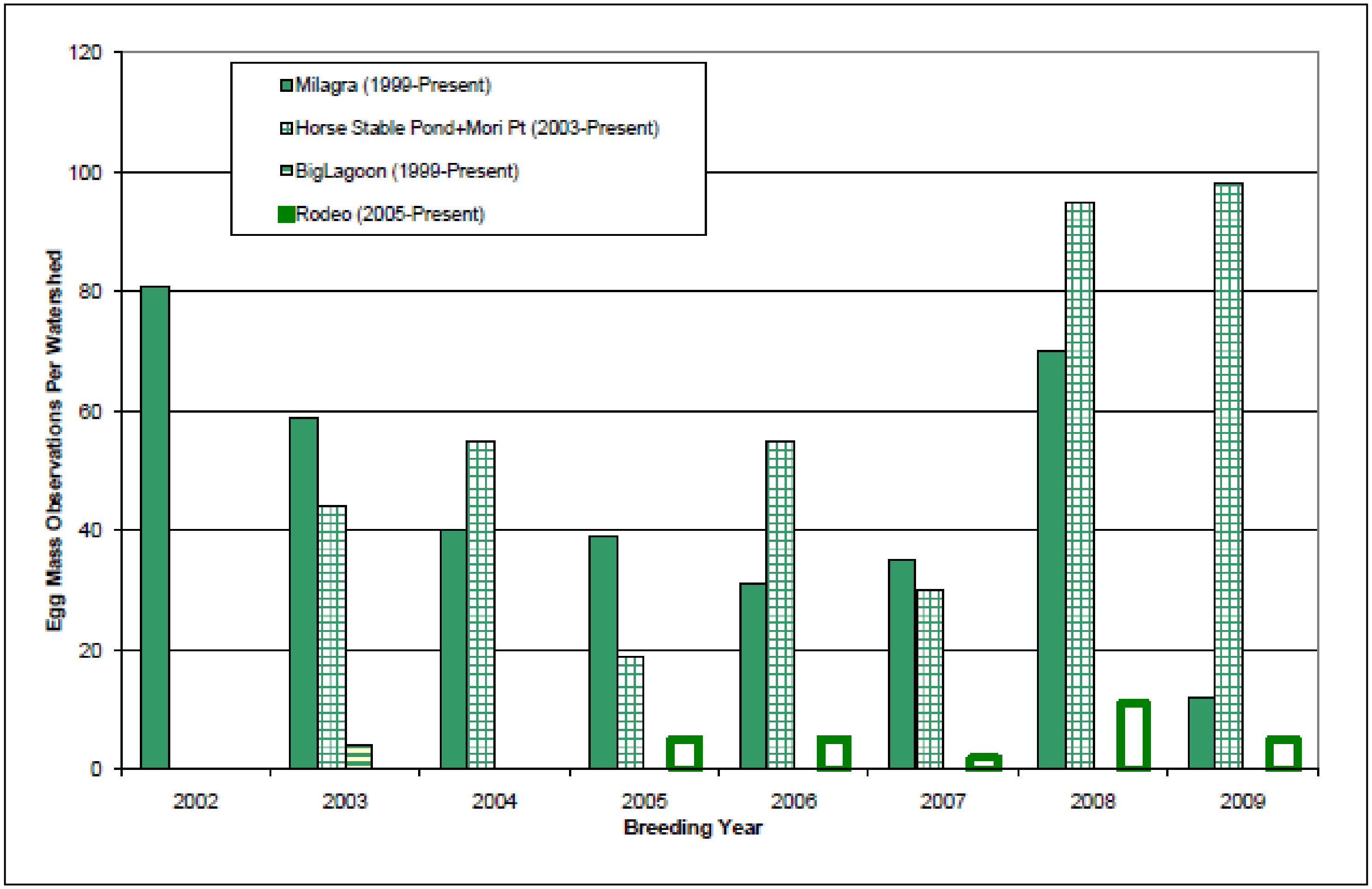
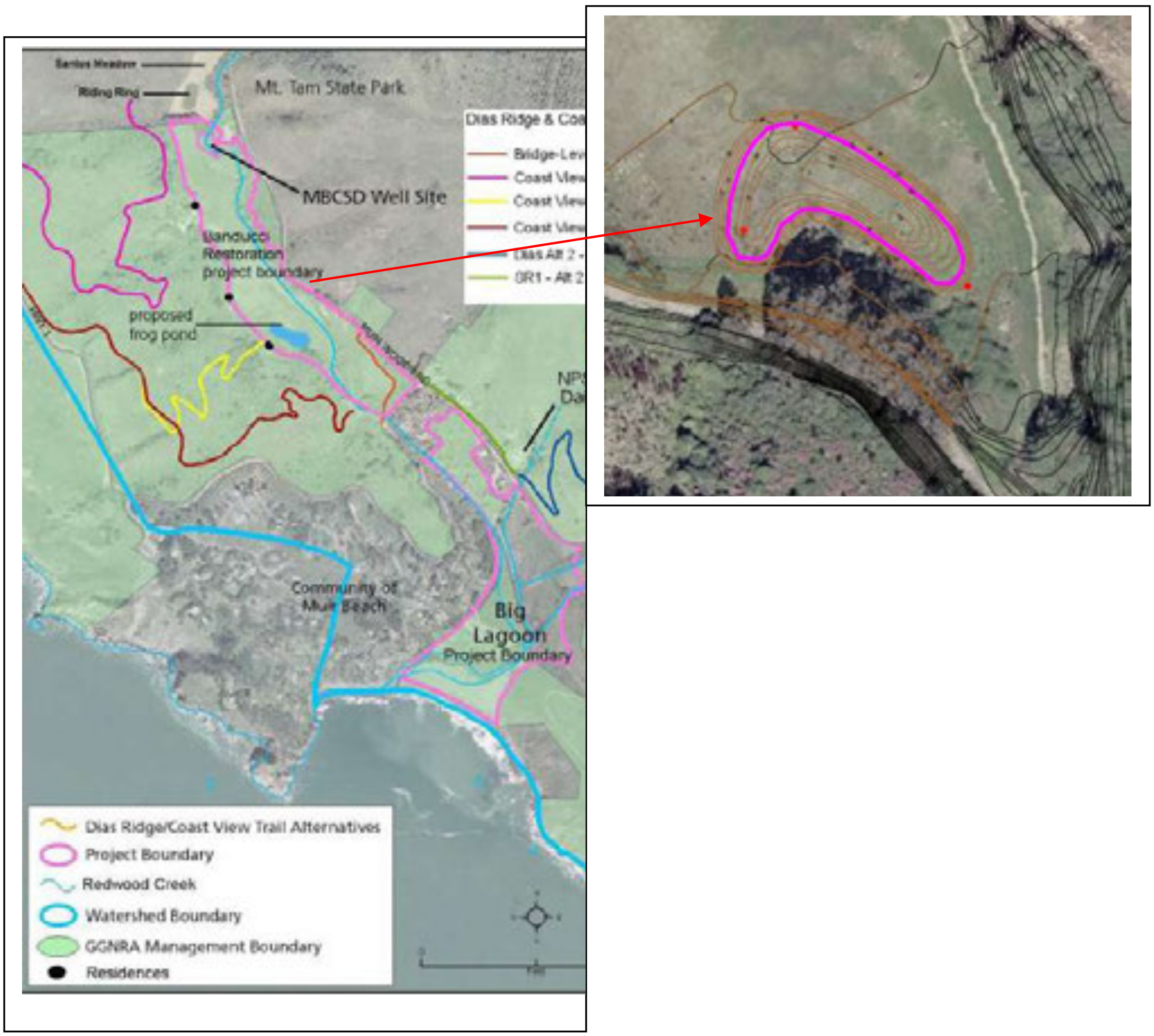


Figure 6: Trend in counts of California red-legged frog egg masses, 2002-2009.

Figure 7: Seasonal signage on Bunker Road to reduce amphibian road-kill.
Photo: D.Fong, 26Jan2007

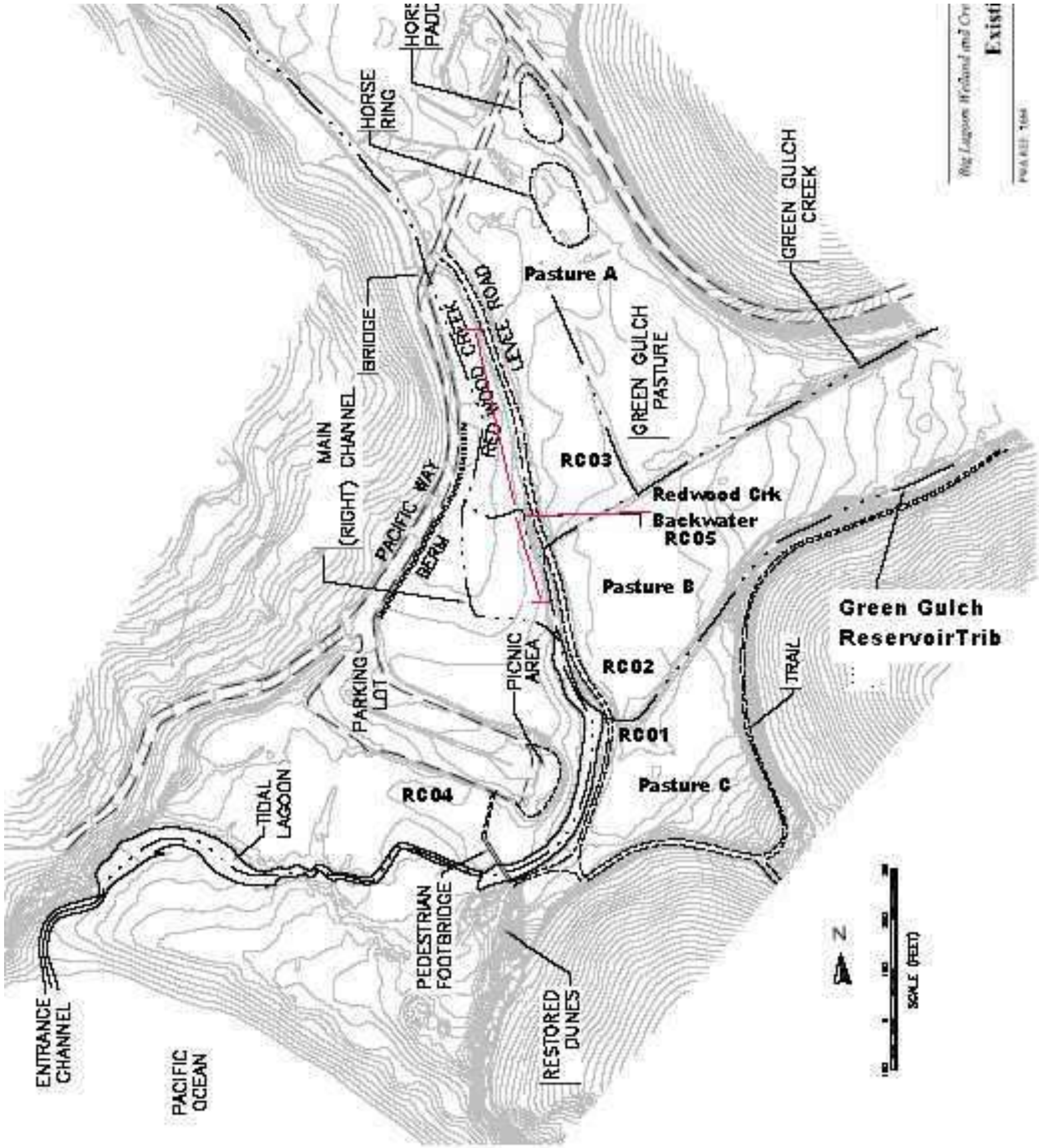
APPENDIX I: DESCRIPTION OF SURVEY SITES

Banducci Floodplain Pond (Marin Co.). The Redwood Creek watershed is a coastal drainage in southern Marin County, California. It covers 7.5 square miles (PWA *et al*. 1994). As a requirement of a Biological Opinion, a 0.52 acre floodplain pond was created in Fall 2007 to provide breeding habitat for the California red-legged frog. A berm was constructed around the pond to prevent floodwater from bringing sediments and fish into the pond up to a Q_{10} event. Based on recent field surveys, the pond is perennial although very shallow in the fall. Breeding surveys were initiated for Breeding Season 2008.



Big Lagoon Environs (Marin Co.). 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. Extensive emergent vegetation dominated mainly by cattails is present. Small areas of open water bordered by emergent vegetation are found along drainage ditches. The first documented breeding activity at Big Lagoon was during the Winter 1996-1997 where a lone red-legged frog egg mass was encountered. Subsequent breeding surveys by USGS and contractors have identified egg masses, adult, and juvenile California red-legged frogs (Fellers and Guscio 2004, Wood 2005). Routine egg mass surveys have been conducted since Breeding Year 1998.



Survey Locales for Big Lagoon Environs, GOGA, Marin Co.

Typical Winter Conditions at Seasonally Flood Pasture in Green Gulch from Levee (RC01), March 20, 2009

Rodeo Lake/Lagoon (Marin Co.): The Rodeo Lagoon watershed is a small coastal watershed (3.6 sq. miles) that drains to the Pacific Ocean. Rodeo 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. A narrow band of emergent wetland vegetation encircles the lagoon. Submergent vegetation is dominated by *Potamogeton* sp., although frequent algal blooms within the Lagoon may suppress the extent of submergent vegetation. Frog surveys have focused on the east end of the lagoon due to the greater freshwater influence.

Just upstream of the lagoon, Rodeo Lake covers 5.5 acres of open water and emergent and mats of submergent vegetation. 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 swimming organisms from the lagoon. Poor water quality conditions may be present during the late summer. Measurements found dissolved oxygen levels of 0.7 mg/l at the lake bottom during an algal bloom.

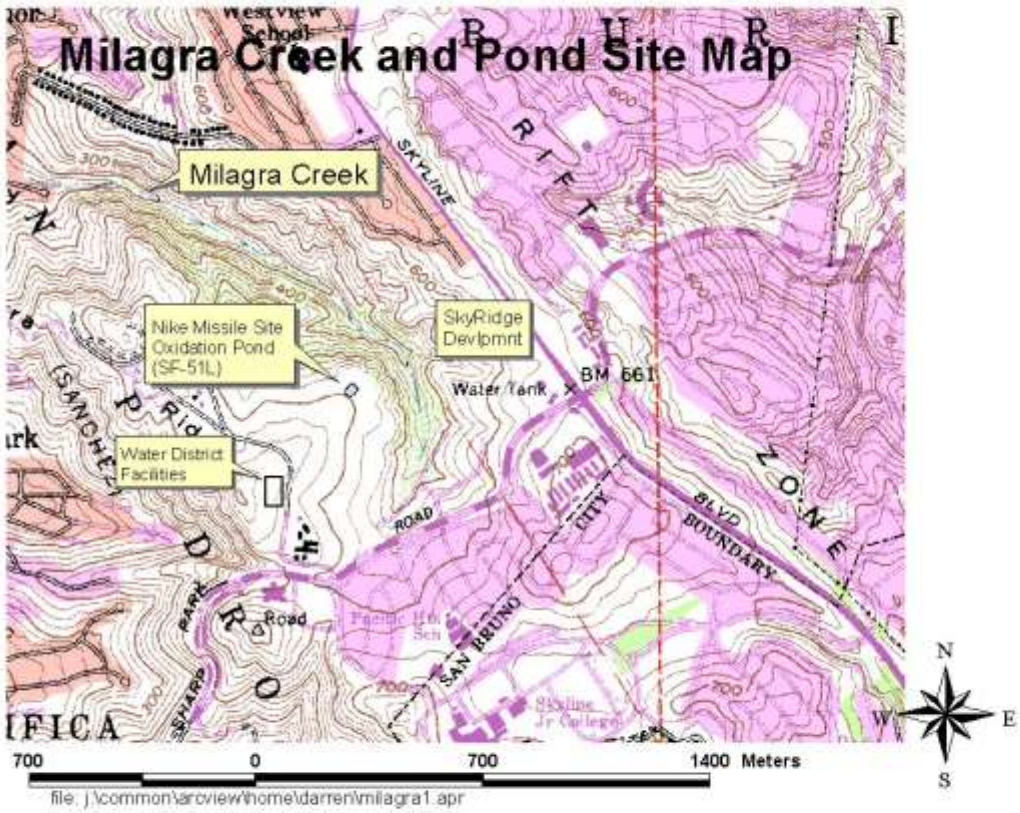
Rodeo Lake supports mostly non-native fish including green sunfish (*Lepomis cyanellus*), goldfish (*Carassius auratus*), and golden shiner (*Notemigonus crysoleucas*). Sedimentation and encroachment of emergent and willow riparian vegetation around the lake has reduced the amount of open water area. During the summer, the remaining open water is often filled with an introduced aquatic plant, coontail (*Myriophyllum* sp.). Mats of submergent vegetation composed mainly of *Hydrocotyle* sp. ring the open water areas of the lake year-round. Routine breeding season surveys were initiated in Breeding Year 2005 within the interior of Rodeo Lake. Infrequent surveys of the shoreline of Rodeo Lake were conducted by consultants and Park staff and interns in prior years.

Typical Winter Conditions along South Rodeo Lake Shoreline Looking West, February 8, 2005 (concentric bands of willow, cattail, and *Hydrocotyle*)

Milagra Ridge (San Mateo Co.). 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. The Park modified a concrete drop inlet structure that controls water surface elevation to prolong ponding of water. 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 half of the site contains cattails and bulrushes.

Initial surveys for California red-legged frogs occurred in 1999 after Nancy Hornor, the Park planner, received a report of a dead red-legged frog along an adjacent road. Routine egg mass surveys have been conducted since Breeding Year 1999.



Milagra Ridge Oxidation Pond, GOGA, San Mateo Co.

Typical Winter Conditions at Milagra Ridge Oxidation Pond Looking Southwest from Drop Inlet, February 20, 2009 (pink flagging denotes red-legged frog egg masses)

Sharp Park/Mori Point (San Mateo Co.). Sharp Park Golf Course and Mori Point are two contiguous sites is within the Sanchez Creek watershed area which covers 844 acres (1.3 sq. miles) (PWA et al., 1992). This area includes several wetland features (Laguna Salada, Horse Stable Pond, Sanchez Creek) that have been documented by a variety of studies to contain both California red-legged frogs and San Francisco garter snakes. The City and County of San Francisco manages the golf course and natural areas on the site including Laguna Salada and Horse Stable Pond. Interest in protecting and restoring natural resources on the site has led to the development of a restoration plan (PWA 1992).

Originally part of the Spanish San Pedro Land Grant, Mori Point has been the site of many enterprises over the past 120 years. The Mori family originally farmed the area in the 1890‟s and from 1920-1950‟s was the site of the Mori Point Tavern. Part of Mori Point has also been used as a rock quarry and signs of this former use are evident on the hillsides. In 2000, the 105-acre parcel was added to the GGNRA. In November 2004, USFWS, Golden Gate National Park Conservancy and GGNRA completed the construction of two ponds (Willow Pond or Pond A, and Middle Pond or Pond D) at Mori Point to provide for amphibian use and foraging opportunities for the San Francisco garter snake. In Fall 2007, two additional ponds were constructed on the site (Wetland Pond and Southern Pond). The Southern Pond was constructed in the location of the Mori Point Bowl Wetlands in the figure below. Additionally, an instream pool in Sanchez Creek near Fairway drive is monitored. In 2009, the Middle Pond was reconfigured to allow it to hold water through the summer. 2008 and 2009 data indicate that the Wetland, Willow, and Southern Pond hold water year-round while the Middle Pond is seasonal.

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. The watershed is a mixture of urban uses such as residences, roads and golf course while open space areas such as Sweeney Ridge are under management of GGNRA. Stormwater runoff as well as water from the City‟s Hetch Hetchy reservoir (used as irrigation water for golf course) flows into Sanchez creek and is pumped out and discharged to the ocean at Horse Stable Pond (PWA *et al.,* 1992). Pumps are typically operated during winter months although protective measures have been enacted during the Winter 2005-2006 to prevent eggs from becoming stranded before they hatch.

Egg mass surveys for California red-legged frogs started in 1999 at Laguna Salada and at Mori Point in 2004. Survey site locations prior to and after Fall 2007 are indicated in the figures below.

Sampling Locales for Sharp Park/Mori Point, GOGA and City of San Francisco, San Mateo Co (Pre-2007).

Discharge of Sanchez Creek/Horse Stable Pond to the Pacific Ocean, Jan 16, 2004.

Typical Winter Conditions at Seasonal Mori "Bowl" Wetlands (LS07) prior to pond enhancement work, January 16, 2004

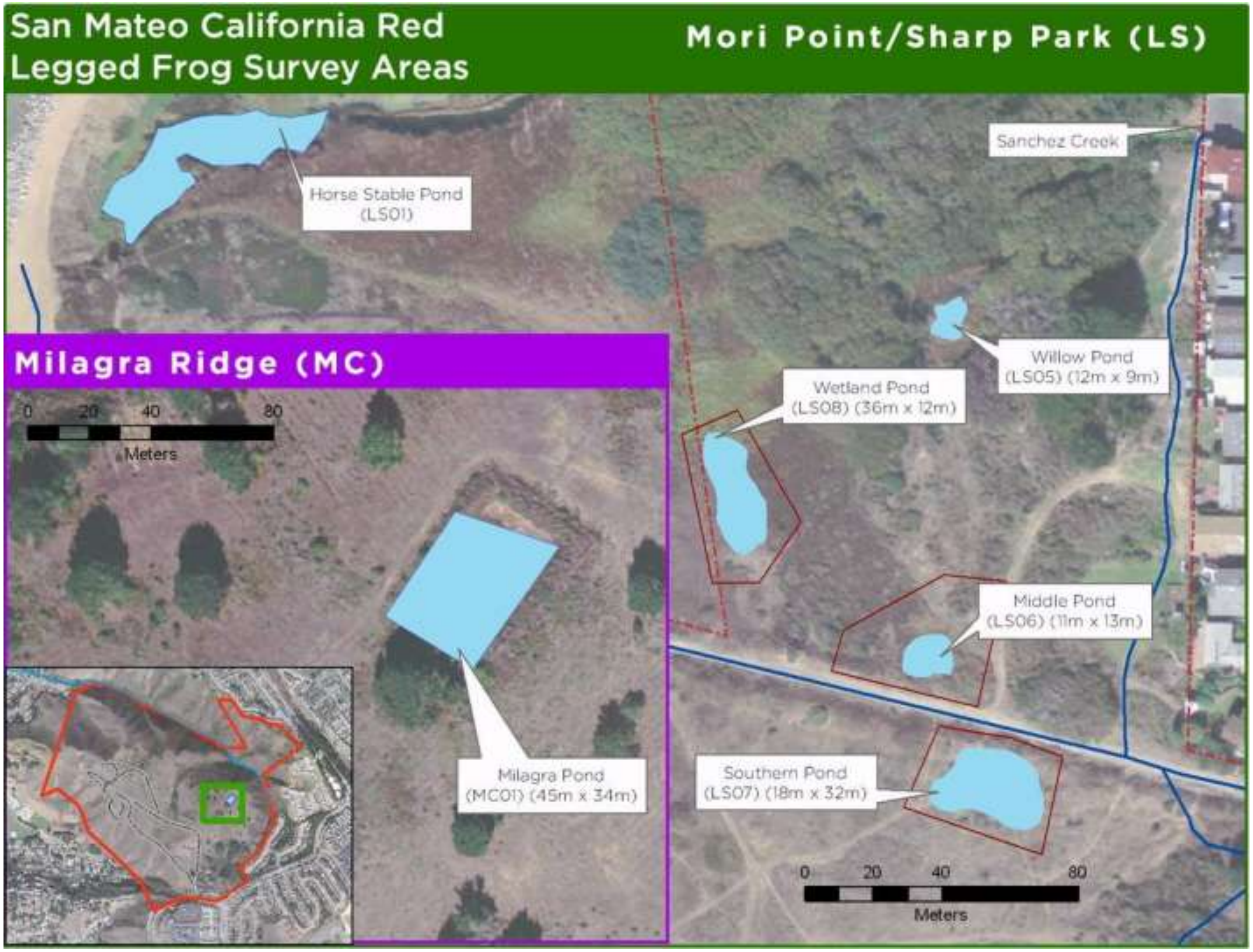
Winter Conditions at Created, “Willow Pond” or “Pond A” (L505) Adjacent to Sanchez Creek after construction, December 15, 2004

Current Winter Conditions at Created, “Willow Pond” or “Pond A” (L505) Adjacent to Sanchez Creek, March 6, 2008

Typical Conditions at Created Pond, “Wetland Pond” (LS08) Near Sanchez Creek, May 4, 2009

Conditions at Created Pond, “MiddlePond” (LS06), October 28, 2009


Sanchez Creek below Fairway Drive (LS09), August 14, 2008



Sampling Locales for Sharp Park/Mori Point, GOGA and City of San Francisco, San Mateo Co (Post-2007).

EXHIBIT B

Herpetological Conservation and Biology 5(3):441–448.
Submitted: 9 February 2010; Accepted: 3 September 2010.

PATTERNS OF SNAKE ROAD MORTALITY ON AN ISOLATED BARRIER ISLAND

BRETT A. DEGREGORIO[1,2], ERIC J. NORDBERG[1], KATHERINE E. STEPANOFF[1], AND JACOB E. HILL[1]

[1]Bald Head Island Conservancy, 7000 Federal Road, PO Box 3109, Bald Head Island, North Carolina 28461, USA
[2]Savannah River Ecology Lab, University of Georgia, Drawer E, Aiken, South Carolina 29802, USA,
e-mail: Baretta66@hotmail.com

***Abstract*.—Road mortality can have severe impacts on wildlife populations. However, the degree of impact is not uniform across all taxa as some possess life-history strategies that render them especially vulnerable to vehicle collisions. As a group, snakes are greatly impacted by road mortality. However, susceptibility to vehicular mortality on roads can vary with species, age, and/or reproductive class. We present data on 186 snakes of five species (*Coluber constrictor, Opheodrys aestivus, Pantherophis alleghaniensis, Cemophora coccinea,* and *Nerodia fasciata*) killed on roads on Bald Head Island, an isolated barrier island with traffic consisting primarily of slow-moving electric golf carts. *Coluber constrictor* was the snake we most frequently found dead on the road. Neonate snakes of all species comprised the majority (59%) of our collected specimens. We observed male-biased sex ratios in collected specimens for three of the species (*C. constrictor, C. coccinea*, and *N. fasciata*). Mortality varied significantly across the study period, with the greatest number of kills recorded in early- to mid-August. Mortality was not strongly correlated with the number of visitors on the island. Instead, we suggest that susceptibility to road mortality is likely related to life-history characteristics (including activity patterns). We recommend attempting to reduce mortality of snakes during their peak activity periods with a combination of public education, heightened awareness via snake crossing signs, and reduced speed limits.**

Key Words.—activity patterns; barrier island; *Coluber constrictor*; golf carts; road mortality; species-specific mortality; traffic

INTRODUCTION

The United States currently contains more than 6.4 million km of roads with 84% of land being located within 1 km of a road (Forman et al. 2003). Roads can have severe indirect impacts on wildlife populations by fragmenting and isolating habitat (Ashley and Robinson 1996), creating barriers to dispersal (Aresco 2005), and degrading habitat quality (Andrews 1990; Reijnen et al. 1995; Forman and Alexander 1998). However, direct mortality is often the result when animals encounter roads (Bernardino and Dalrymple 1992; Gibbs and Shriver 2002; Puky 2006) and may be the single greatest source of non-natural mortality within natural areas (Andrews et al. 2008). Yet, not all taxa of wildlife nor age and reproductive classes of those taxa are equally susceptible to direct road mortality.

Annually, tens to hundreds of millions of snakes are killed by vehicles on roads in the United States (Rosen and Lowe 1994). Snakes are often highly vulnerable to road mortality due to their morphology, behavior (Rosen and Lowe 1994; Andrews and Gibbons 2005), and movement patterns (Caldwell et al. 1956; Seigel and Pilgrim 2002). Furthermore, snakes may be intentionally targeted by motorists (Langley et al. 1989; Ashley et al. 2007), thus increasing the number of snakes killed on roads relative to other wildlife. Road mortality of snakes is well-documented (Klauber 1939; Bernardino and Dalrymple 1992; Smith and Dodd 2003; Jochimsen 2006) and in some cases temporal, spatial, and demographic patterns in mortality have emerged (Bonnet et al. 1999; Enge and Wood 2002; Ciesiolkiwicz et al. 2006; Andrews and Gibbons 2008). More specifically, patterns in snake road mortality can vary spatially and are dependent upon community composition (Andrews et al. 2008). A better understanding of the processes determining susceptibility across a wide geographic range is necessary before impacts of roads on snake populations or communities can be effectively elucidated. Thus, we must quantify the degree of risk experienced by individual species and by different reproductive and age classes among species in different ecosystems. Only with this understanding can we begin to extrapolate results to other systems (Bonnet et al. 1999), and begin to formulate effective management plans to ameliorate road effects.

To our knowledge, no published studies have examined snake road mortality on a barrier island. Barrier islands can support dense populations of snakes with restricted immigration and emigration, and typically harbor a limited number of species (Lewis 1946; Tuberville et al. 2005). Therefore, the objective of our study was to elucidate patterns in species, size, and

TABLE 1. Life-history characteristics of five species of snakes encountered dead on the road (DOR) on Bald Head Island, North Carolina, USA, from 25 April to 1 October 2009. Values (means) were derived from the geographically closest reported studies: Nelson and Gibbons 1972; Gregory et al. 1987; Macartney et al. 1988; Gibbons and Dorcas 2005.

Trait	*Coluber constrictor*	*Pantherophis alleghaniensis*	*Opheodrys aestivus*	*Cemophora coccinea*	*Nerodia fasciata*
Reproductive mode	Oviparous	Oviparous	Oviparous	Oviparous	Viviparous
Clutch size	4–36 (12)	4–44 (15)	3–12	2–19 (5)	6–80 (22)
Foraging mode	Active	Active	Active	Active	Active
Home range size (ha)	9-11	10-15	< 1	Unknown	5
Activity season	Mar - Nov	Mar - Nov	Mar - Nov	May - Aug	Mar - Nov
Activity period	Diurnal	Nocturnal (summer)	Diurnal	Nocturnal	Nocturnal (summer)

reproductive class-specific susceptibility of snakes to road mortality on an isolated barrier island in North Carolina, USA. We also explored seasonal changes in mortality patterns and examined possible correlations between mortality rates and trends in tourist visitation.

METHODS

Study site.—Bald Head Island (BHI), is an 800 ha barrier island located in southeastern North Carolina. The majority of the island was forested and contained large tracts of intact maritime forest including the Bald Head Island Maritime Reserve, a 75 ha forest preserve free of development. The island was bordered to the north by 4,000 ha of protected salt marsh habitat with the Atlantic Ocean to the east and south and the Cape Fear River to the west. Much of the western portion of BHI had been converted to a golf course with 15 freshwater lagoons and large expanses of managed lawn. The southern portion of the island was largely sand dune with sparse low-growing vegetation and little to no tree canopy. There were 1000 homes on the island when we conducted our study; however, a town ordinance required that the natural habitat around each house must not be cleared and there were < 200 year-round residents.

Approximately 35 km of paved road existed on the island. Roads had two lanes, which were often separated by a median of dune or maritime forest vegetation. BHI is separated from mainland North Carolina by a 5-km wide section of the Cape Fear River and could only be accessed via passenger ferry departing Southport, North Carolina. Vehicular traffic on island was restricted to electric golf carts and the rare gas-powered vehicle used by public emergency personnel and private contractors. Posted speed limits on island did not exceed 31 km/hr.

Sampling methods.—From 25 April to 1 October 2009, all snakes encountered by investigators or volunteers while driving golf carts on BHI roads were collected. We surveyed a 4.59 km section of the main island road slowly by golf cart at least once per day. During each trip, we collected all snakes, live or dead. We staggered the timing of the survey throughout a 24 hour period, with transects being conducted based upon vehicle and staff availability. We also collected all snakes encountered opportunistically when driving outside of established surveys. We concentrated surveys on the main island road, which traverses mature maritime forest. However, we frequently drove on all of the islands roads throughout the study period. We attempted to keep the frequency of surveys, timing of surveys, and number of workers participating in surveys as constant as possible throughout the survey period.

We recorded the location and time of observation and brought the snake back to the lab for processing. All snakes were identified to species, weighed, measured, and sexed by probing. We assessed the reproductive status of each snake via palpation (live) or dissection (dead). We determined age class of each snake as adult or neonate based on its snout to vent length, with young of the year snakes being <300 mm for *Coluber constrictor* (Black Racer) and *Pantherophis alleghaniensis* (Yellow Rat Snake) and <200 mm for *Opheodrys aestivus* (Rough Green Snake), *Cemophora coccinea* (Scarlet Snake) and *Nerodia fasciata* (Banded Water Snake; Gibbons and Dorcas 2005). Live snakes were given unique identification brands (Winne et al. 2006) and were subsequently released at their capture location. We released all snakes within 24 hours and released many within an hour following capture. We derived clutch-size and home range data from the available literature (Table 1) and used these parameters to examine patterns in species-specific susceptibility to road mortality using linear regression. We used chi square tests to compare proportions of dead versus live snakes observed. We used a Kruskal-Wallis test to examine differences in mortality occurences throughout the study period looking at the total number of dead snakes collected in two week intervals.

TABLE 2. Number of snakes of five species encountered dead or alive on roads on Bald Head Island, North Carolina, USA, between 25 April and 1 October 2009.

Species	Total dead on road	Adults dead on road	Neonates dead on road	Total alive on road
Coluber constrictor	101	22	79	8
Pantherophis alleghaniensis	17	8	9	26
Opheodrys aestivus	46	32	14	10
Cemophora coccinea	11	11	0	3
Nerodia fasciata	11	3	8	3
Total	186	76	110	50

Traffic volume may be directly related to road mortality (Bernardino and Dalrymple 1992); however traffic data were not available for BHI. Therefore, we used information provided by the passenger ferry operators regarding the number of people visiting the island on a daily basis throughout the study period as an index of traffic volume. We used a Pearson's rank correlation to explore relationships between road mortality and this index of traffic volume. All tests were performed using SPSS 15.0 (SPSS Inc. Chicago, Illinois, USA) and alpha levels were set at 0.05.

RESULTS

From 25 April to 1 October 2009, we collected 186 dead on road (DOR) snakes of five species from the roads of BHI (Table 2). We captured and marked an additional 50 snakes of the same five species alive on road (AOR). We never subsequently encountered marked snakes as DOR, although we could have missed marks on severely mutiliated specimens. Seventy-nine percent of snakes we encountered were DOR and 21% were AOR. Encounters of both live and dead snakes differed significantly by species from expected if all encounter probabilities were considered to be equal (χ^2 = 13.25, df = 4, P <0.001). The snake we most often encountered DOR was *C. constrictor* (Table 1), and the snake we most often encountered AOR was *P. alleghaniensis*. Proportions of dead snakes differed significantly from proportions of live snakes we encountered (χ^2 = 13.87, df = 4, P <0.001).

Visitation to the island, which was used as an index of traffic volume, increased from under 200 to over 2000 visitors during summer weekends and holidays; but, was not significantly correlated with snake road mortality (r^2 = 0.013, P = 0.19). The total number of DOR snakes we encountered varied significantly across the study period (Fig. 2: χ^2 = 52.03, P <0.001). The greatest number of DOR snakes we encountered was found in early- to mid-August. The majority of DOR snakes we collected (79%) were the diurnal species: *C. constrictor* and *O. aestivus*. Adult *C. constrictor* road mortality was male-biased (Fig. 1: 70%); 67% of female *C. constrictor* encountered on roads were gravid (Fig. 1). Overall, 34% of female snakes we found on roads were gravid. Neonates accounted for 59% of all DOR snakes, with 78% of DOR *C. constrictor* and 73% of DOR *N. fasciata* being neonates. The only species for which we did not encounter neonates either DOR or AOR was *C. coccinea*. Encounter rates of snakes were positively related to reported home range sizes (r^2 = 0.47, P = 0.02), however, our encounters with neonates were not related to reported clutch sizes (r^2 = 0.04, P = 0.12).

DISCUSSION

Despite the limited duration of the study (five months), the small size of the study site, and the fact that the majority of the traffic consisted of slow-moving golf carts, we documented 186 DOR snakes. Paved roads and vehicles clearly can have a negative impact upon snake populations and communities (Klauber 1939; Bernardino and Dalrymple 1992; Andrews et al. 2008). However, quantifying the degree of the impact can be difficult (Dodd et al. 1989). In a study similar to ours, Rosen and Lowe (1994) projected that observed snake road mortality amounted to the removal of five km^2 of snake population over the duration of the study. Although the snake population levels on BHI are unknown, the large number of DOR snakes documented during this limited time period warrant conservation concern.

Assessment of the degree of impact is dependent upon not only the numbers of dead snakes but also on the sex, reproductive condition, and life stage of the individuals killed. This study, in addition to others (e.g., Bonnet et al. 1999; Ciesiolkiwicz et al. 2006; Row et al. 2007; Andrews and Gibbons 2008), suggests that not all species, ages, or reproductive classes are equally susceptible to direct road mortality and that these patterns may change seasonally. In an expansive 54-year road survey of snakes in South Carolina, Andrews and Gibbons (2008) reported a male bias for nearly half of the species encountered on roads. We report a male bias for three of the five species (*C. coccinea*, *N. fasciata*, and *C. constrictor*) found on roads on BHI. While Andrews and Gibbons (2008) also reported a tendency for snakes encountered on roads to be larger than snakes found off-road, we observed that over half of the snakes found DOR on BHI were neonates. While we do not have data on the average size of off-road snakes on BHI, this suggests the possibility of a different

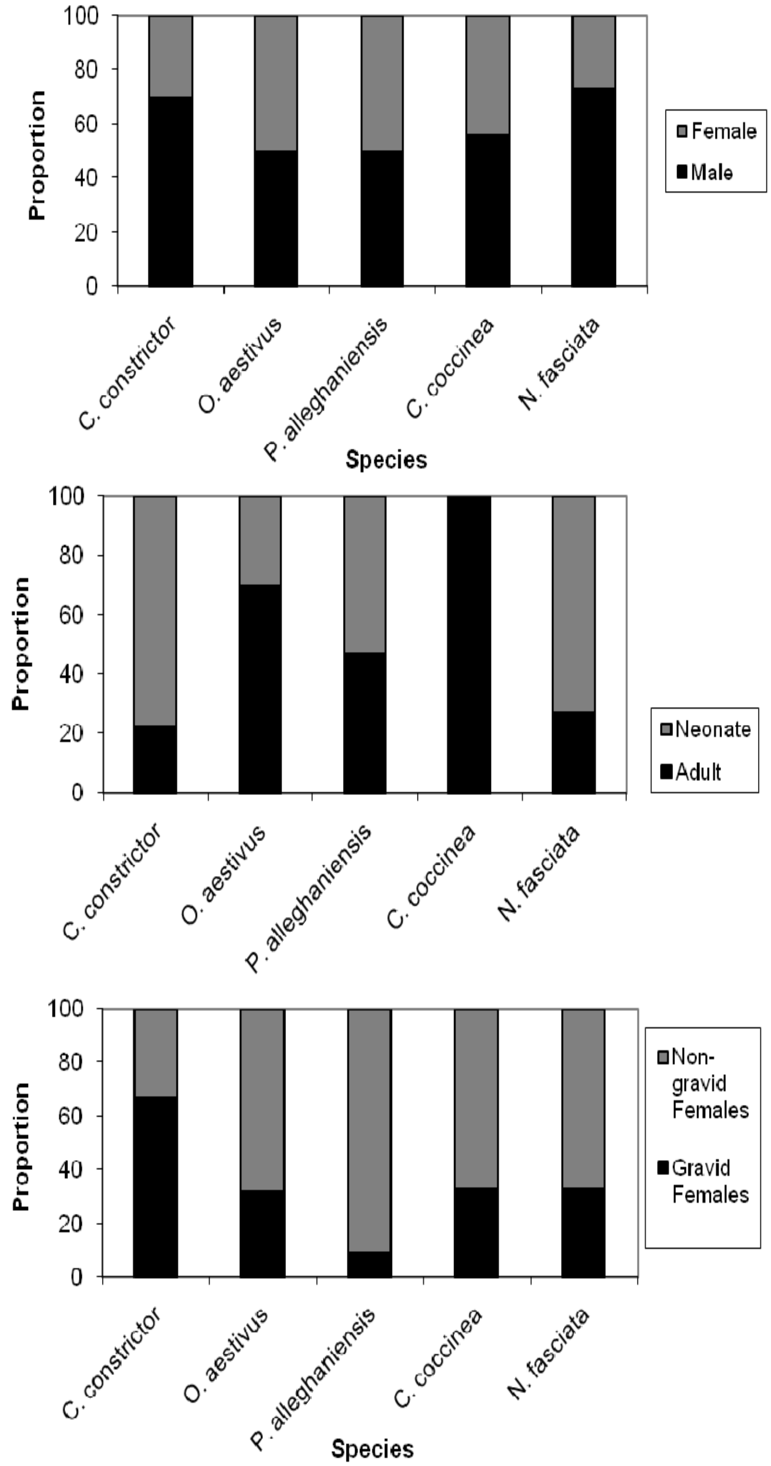


FIGURE 1. Relative proportions of male and female (top), neonate and adult (center), and gravid and non-gravid female (bottom) snakes encountered dead on the road on Bald Head Island, North Carolina, USA between 25 April and 1 October 2009.

pattern. Roads with high traffic volume and speed limits, like many of the roads surveyed in Andrews and Gibbon (2008), likely reduces the number of small snakes observed due to lowered obervability and rapid carcass degradation from repeated collisions. Conditions on BHI, low traffic volume, and surveying via slow-moving golf carts are ideally suited for detection of small-bodied snakes.

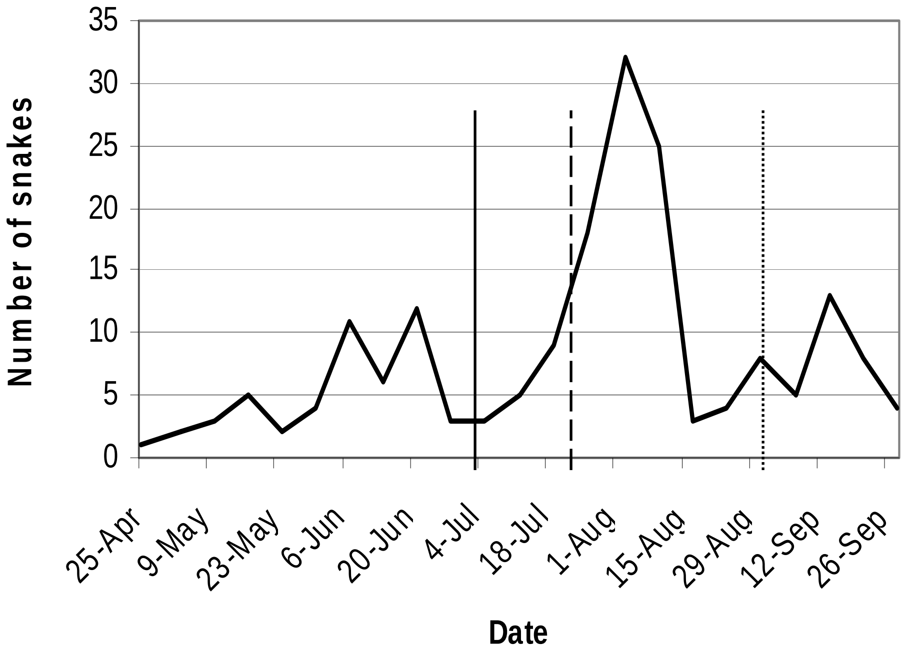


FIGURE 2. Number of dead on road snakes encountered on Bald Head Island, North Carolina, USA from 25 April to 1 October 2009. Vertical lines indicate first encounters with neonates of *Coluber constrictor* (solid), *Opheodrys aestivus* (dashed), and *Pantherophis alleghaniensis* (dotted).

The majority of DOR snakes found in this study were neonates of three species: *C. constrictor, N. fasciata,* and *P. alleghaniensis*. Neonate snakes may have been represented in large numbers due to the propensity of this life stage for long distance and erratic dispersal movements often characterized by a single large burst of travel (Gregory et al. 1987; Blouin-Demers et al. 2007). Snakes making longer movements are more likely to encounter roads so are more prone to being killed by a vehicle (Bonnet et al. 1999). Furthermore, the small size and cryptic coloration of many young snakes likely reduces their detectability, potentially increasing their probability of being struck. The large number of neonates recorded in this study may also be a reflection of higher detection probabilities from surveying via a slow-moving open-sided golf cart, whereas studies employing standard vehicles are prone to overlook the small bodies of DOR neonate snakes (Enge and Wood 2002). Demographically, the preponderance of DOR neonate snakes in our study may be less of a concern for the persistence of snake populations on BHI than other age and reproductive life stages because neonates naturally experience high mortality rates and may be less important from a population standpoint than certain other age and reproductive classes (Parker and Plummer 1987). However, a reduction or elimination of juvenile recuitment into the population can have serious demographic impacts for snake populations (Kingsbury and Attum 2009; Shine and Bonnet 2009).

Despite our limited knowledge of population demographics for many snake species, mortality of gravid females may have serious ecological impacts for a population (Parker and Plummer 1987; Bonnet et al. 1999; Row et al. 2007). Mortality of gravid females results in a reduction of the reproductive output for the entire population (Shine and Bonnet 2009). Equal levels of mortality of neonates or adult males will likely have a less significant effect in most situations (Bonnet et al. 1999). We observed that a large proportion of *C. constrictor* (67%) found DOR during our study were gravid. Gravid *C. constrictor* may be more likely to encounter roads as a result of this species' large home range size and propensity for gravid females to make long movements prior to nesting (Gregory et al. 1987; Macartney et al. 1988). Despite the importance of gravid females on a population level, mortality to other segments of snake population should not be overlooked. In some snake species, large, physically fit males make long mate-searching movements during the reproductive season increasing their risk of encountering roads (Madsen et al. 1993). High mortality rates to adult males can limit population growth by hindering genetic diversification (Shine and Bonnet 2009).

The majority (79%) of snakes we found DOR on BHI were the two diurnal species, *C. constrictor* and *O. aestivus*. This high proportion of diurnal species may be a reflection of relative abundance or the overlap of snake activity with the periods of the greatest golf cart activity on BHI. Most golf cart traffic on BHI is beach-related and thus, confined to daylight hours. *Pantherophis alleghaniensis* was the species most often found AOR. When approached by vehicles, *P. alleghaniensis* tend to freeze for long periods of time (Andrews and Gibbons 2005) leaving them vulnerable to being struck. Although not all drivers may actively avoid striking snakes (Langley et al. 1989), *P. alleghaniensis* may be more easily detected than other species due to their large size and immobility, thus allowing some drivers to avoid them. Furthermore, some drivers that may intentionally strike snakes when driving in cars or trucks may be hesitant to do so when in open-sided, slow-moving golf carts.

The number of daily visitors to BHI increases from less than 200 during April and early-May to over 2000 during summer weekends and holidays. Most visitors rent golf carts presumably leading to an increase in traffic volume as visitation increases. Road mortality rates on BHI were not correlated with visitor numbers, which was used as an index of traffic volume. Although not the case on BHI, increased traffic volume has been correlated with increased snake road mortality in another study (Bernardino and Dalrymple 1992). We suggest that patterns in snake road mortality may be driven more by snake activity patterns than traffic volume (Jochimsen 2006). For instance, *C. coccinea* is only active above ground during the hottest months of the summer (Nelson and Gibbons 1972), thus *C. coccinea* was only found DOR during those active months. The most dramatic increase in mortality occurred following the emergence of neonate *C. constrictor*, presumably making large dispersal movements. *Opheodrys aestivus* and *P. alleghaniensis* neonates emerged shortly afterward, contributing significantly to the number of DOR snakes. Interestingly, road mortality surveys may provide unique insight into reproductive timing for certain snake species (e.g. Klauber 1939), especially in understudied ecosystems such as barrier islands.

Our data must be interpreted in light of the fact that we were not able to quantify survey effort throughout the season because we relied heavily upon opportunistic encounters with DOR snakes. We typically conducted surveys once daily, with effort applied towards staggering surveys at all times of the day and night. This was supplemented by opportunistic encounters with DOR snakes from the authors, co-workers, and volunteers. We were not able to quantify volunteer effort throughout the study; however, because volunteers contributed less than 5% of the DOR snakes analyzed in this study, we do not believe that changes in volunteer effort obscured our ability to make accurate inferences about trends in snake mortality. Despite our inability to quantify effort, we attempted to keep the number of surveys per day, number of surveys conducted at different times of the day and night, and number of observers as constant as possible. We believe that the timing and number of surveys conducted were arrayed in such a way as to accurately describe seasonal patterns in road mortality and not simply increases in survey effort.

This study provided preliminary evidence that many snakes are being killed by slow-moving golf carts on a small, isolated barrier island. Patterns in mortality rates varied seasonally and by species. Within a species, susceptibility to road mortality varied by both reproductive class and age. Although a myriad of threats face species inhabiting rapidly developing coastal habitats, road mortality may constitute the greatest direct threat to snake communities on developed barrier islands such as BHI. Managers must take into account variation in species, reproductive class, and age-specific susceptibility to road mortality when designing management plans for snakes. Fortunately, during our study, snake movments were temporally constrained and predictable allowing for effective planning to minimize road mortality. Suggested mitigation measures include snake crossing signs, temporary road closures, and speed limit reductions coupled with public education and outreach.

Acknowledgements.—We thank the Bald Head Island Conservancy staff for logistical support. Thanks to Suzanne Dorsey and Thomas Hancock for their support and enthusiasm. We are indebted to everyone who collected a dead snake on our behalf, especially our vulture crew consisting of Kara Campbell, Daniel Myers, Jeff Harms, Brianna Elliott, Kevin Coon, Edward Wright, Meredith Atwood, Meredith Wilson, Rachel Shain, Kat Lillie, Leigh Anne Harden, Anna Frankel, and Paul Hearty. Bald Head Island Limited graciously provided ferry occupancy information. All work was conducted under NC Scientific Collections license # 10-SC00408.

LITERATURE CITED

Andrews, A. 1990. Fragmentation of habitat by roads and utility corridors: A review. Australian Zoologist 26:130–141.

Andrews, K.M., and J.W. Gibbons. 2005. How do highways influence snake movement? Behavioral responses to roads and vehicles. Copeia 2005:772–782.

Andrews, K.M., and J.W. Gibbons. 2008. Roads as catalysts of urbanization: Snakes on roads face differential impacts due to inter- and intraspecific ecological attributes. Pp. 145–153 *In* Urban Herpetology. Mitchell, J.C., R.E. Jung Brown, and B. Bartholomew (Eds.). SSAR Books, Salt Lake City, Utah, USA.

Andrews, K.M., J.W. Gibbons, and D.M. Jochimsen. 2008. Ecological effects of roads on amphibians and reptiles: a literature review. Pp. 121–143 *In* Urban Herpetology. Mitchell, J.C., R.E. Jung Brown, and B. Bartholomew (Eds.). SSAR Books, Salt Lake City, Utah, USA.

Aresco, M.J. 2005. The effect of sex-specific terrestrial movements and roads on the sex ratio of freshwater turtles. Biological Conservation 123:37–44.

Ashley, P.E., and J.T. Robinson. 1996. Road mortality of amphibians, reptiles and other wildlife on the Long Point Cause, Lake Erie, Ontario. Canadian Field Naturalist 110:403–412.

Ashley, P.E., A. Kosloski, and S.A. Petrie. 2007. Incidence of intentional vehicle-reptile collisions. Human Dimensions of Wildlife 12:137–143.

Bernardino, Jr., F.S., and G.H. Dalrymple. 1992. Seasonal activity and road mortality of the snakes of the Pa-hay-okee wetlands of Everglades National Park, USA. Biological Conservation 61:71–75.

Blouin-Demers, G., L.P.G. Bjorgan, and P.J. Weatherhead. 2007. Changes in habitat use and movement patterns with body size in Black Ratsnakes (*Elaphe obsoleta).* Herpetologica 63:421–429.

Bonnet, X., G. Naulleau, and R. Shine. 1999. The dangers of leaving home: dispersal and mortality in snakes. Biological Conservation 89:39–50.

Caldwell, N.J., R.E. Hellman, and S.R. Telford, Jr. 1956. Notes on a large number of Red-Bellied Mudsnakes, *Farancia a. abacura*, from northcentral Florida. Copeia 1956:257–258.

Ciesiolkiwicz, J., G. Orlowski, and A. Elzanowski. 2006. High juvenile mortality of Grass Snakes *Natrix natrix* on a suburban road. Polish Journal of Ecology 54:465–472.

Dodd, Jr., C.K, K.M. Enge, and J.N. Stuart. 1989. Reptiles on highways in North-central Alabama, USA. Journal of Herpetology 23:197–200.

Enge, K.M., and K.N. Wood. 2002. A pedestrian road survey of an upland snake community in Florida. Southeastern Naturalist 1:365–380.

Forman, R.T.T., and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29:207–231.

Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine, and T.C. Winter. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D.C., USA.

Gibbs, J.P., and W.G. Shriver. 2002. Estimating the effects of road mortality on turtle populations. Conservation Biology 16:1647–1652.

Gibbons, J.W., and M.E. Dorcas. 2005. Snakes of the Southeastern United States, University of Georgia Press, Athens, Georgia, USA.

Gregory, P.T, J.M. Macartney, and K.W. Larsen. 1987. Spatial patterns and movements. Pp. 366–386 *In* Snakes: Ecology and Evolutionary Biology. Seigel, R.A., J.T. Collins, and S.S. Novak (Eds.).. Blackburn Press, Caldwell, New Jersey, USA.

Jochimsen, D. 2006. Ecological effects of roads on herpetofauna: A literature review and empirical study examining seasonal and landscape influences on snake road mortality in eastern Idaho. M.S. Thesis. Idaho State University, Boise, Idaho, USA. 199 p.

Kingsbury, B.A., and O. Attum. 2009. Conservation strategies: captive rearing, translocation and repatriation. Pp. 201–220 *In* Snakes: Ecology and Conservation. Mullin, S.J., and R.A. Seigel (Eds.). Cornell University Press, Cornell, New York, USA.

Klauber, L.M. 1939. Studies of reptile life in the arid southwest, Part 1. Night collecting in the desert with ecological statistics. Bulletin of Zoological Society of San Diego 14:2–64.

Langley, W.M., H.W. Lipps, and J.F. Theis. 1989. Responses of Kansas motorists to snake models on a rural highway. Transactions of the Kansas Academy of Science 92:43–48.

Lewis, T.H. 1946. Reptiles and amphibians of Smith Island, N.C. American Midland Naturalist 36:682–684.

Macartney, J.M., P.T. Gregory, and K.W. Larsen. 1988. A tabular survey of data on movements and home ranges of snakes. Journal of Herpetology 22:61–73.

Madsen, T., R. Shine, J. Loman, and T. Hakansson. 1993. Determinants of mating success in male Adders, *Vipera berus*. Animal Behavior 45:491–499.

Nelson, D.H., and J.W. Gibbons 1972. Ecology, abundance, and seasonal activity of the Scarlet Snake, *Cemophora coccinea*. Copeia 1972:582–584.

Parker, W.S., and J.V. Plummer. 1987. Population ecology. Pp. 253–289 *In* Snakes: Ecology and Evolutionary Biology. Seigel, R.A., J.T. Collins, and S.S. Novak (Eds.). Blackburn Press, Caldwell, New Jersey, USA.

Puky, M. 2006. Amphibian road kills: a global perspective. Pp. 325–338 *In* Proceedings of the 2005 International Conference on Ecology and Transportation. Irwin, C.L., P. Garrett, and K.P. McDermott (Eds.). Center for Transportation and the Environment, North Carolina State University, Raleigh, North Carolina, USA.

Reijnen, R., R. Foppen, C. TerBraak, and J. Thissen. 1995. The effects of car traffic on breeding bird populations in woodland: Reduction of density in relation to the proximity to main roads. Journal of Applied Ecology 32:187–202.

Rosen, P.C., and C.H. Lowe. 1994. Highway mortality of snakes in the Sonoran Desert of southern Arizona. Biological Conservation 68:143–148.

Row, J.R., G. Blouin-Demers, and P.J. Weatherhead. 2007. Demographic effects of road mortality in Black

Ratsnakes (*Elaphe obsoleta*). Biological Conservation 137:117–124.

Seigel, R.A., and M.A. Pilgrim. 2002. Long-term changes in movement patterns of Massasaugas (*Sistrurus catenatus*). Pp. 405–412 *In* Biology of the Vipers. Schuett, G.W., M. Hoggren, M.E. Douglas, and H.W. Greene (Eds.). Eagle Mountain Publishing, Eagle Mountain, Utah, USA.

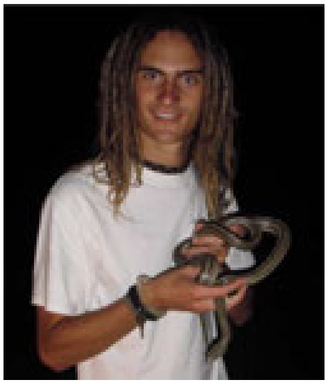
Shine, R., and X. Bonnet. 2009. Reproductive biology, population viability, and options for field management. Pp. 172–200 *In* Snakes: Ecology and Conservation. Mullin, S.J., and R.A. Seigel (Eds). Cornell University Press, Cornell, New York, USA.

Smith, L.L., and C.K. Dodd, Jr. 2003. Wildlife mortality on U.S. highway 441 across Payne Prairie, Alachua County, Florida. Florida Scientist 66:128–140.

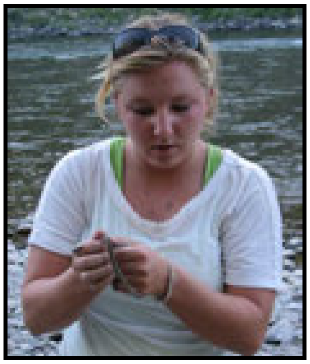
Tuberville, T.D., J.D. Willson, M.E. Dorcas, and J.W. Gibbons. 2005. Herpetofaunal species richness of southeastern national parks. Southeastern Naturalist 4:537–569.

Winne, C.T., J.D. Willson, K.M. Andrews, and R.N. Reed. 2006. Efficacy of marking snakes with disposable ophthalmic cautery units. Herpetological Review 37:52–54.

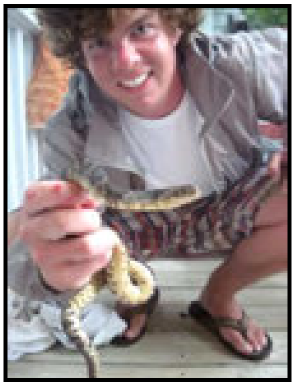
Brett A. DeGregorio was an undergraduate at the University of Massachusetts at Amherst and a graduate student at Indiana-Purdue University at Fort Wayne. His research interests include population dynamics and anthropogenic impacts upon herpetofauna and how thermal ecology of reptiles influences their habitat selection and activity patterns. He hopes to continue pursuing research that is directly applicable to the conservation of imperiled herpetofauna. (Photographed by Matthew Godfrey)



Eric J. Nordberg is a recent graduate from Penn State University with a B.S. in Wildlife and Fisheries Science. His passion for reptiles has led him to jobs working with sea turtles in North Carolina and along the gulf coast of the Florida. More recently he has started working where his passion lies; conducting timber rattlesnake surveys across Pennsylvania. Eric hopes to attend graduate school to pursue a Master's degree in the ecology of rattlesnakes. (Photographed by Daniel Myers)



Katherine E. Stepanoff graduated from Penn State University with a B.S. in Wildlife and Fisheries Sciences. Her interest in reptiles has allowed her to work with snakes, alligators, and sea turtles in North Carolina and with that knowledge better create reptile educational programs for the public. Although her ultimate goal is to attend graduate school, she is currently looking for local environmental education work to accommodate her Olympic rugby training schedule. (Photographed by Daniel Myers)



Jacob E. Hill recently earned his B.A. in Biology from the University of North Carolina at Chapel Hill. He has worked with many species of snakes, semi-aquatic turtles, and marine turtles. His research interests include the nesting ecology of turtles and anthropogenic impacts on barrier island herpetofauna. (Photographed by Brett DeGregorio)

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 46

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.* Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, *et al.*, Defendants.	Case No.: 3:11-CV-00958 SI **DECLARATION OF STEVE SALISBURY**

I, Steve Salisbury, declare as follows:

1. I am a resident of Pacifica, California, residing within a few blocks of Sharp Park Golf Course. I have lived in Pacifica for over 30 years.

2. I regularly walk trails at Mori Point and Sharp Park. While walking these trails, I try to observe wildlife.

3. On or about May 20, 2005, I was walking near Hole 12 of Sharp Park Golf Course. As I walked past the western-most portion of the mowed areas near Hole 12, I observed a dead San Francisco gartersnake on the mowed area of the course. Attached to this declaration as Exhibit A is a satellite photo of Hole 12 with the place I found the dead snake clearly marked.

4. I was not able to observe this dead snake until I was almost on top of it—it was not clearly visible from even a few feet away. The snake appeared to have been chopped in several places on its body.

5. After observing this dead snake, I walked back to Mori Point and informed staff working on restoration activities there that I had observed the dead snake. A staff member asked me to retrieve it, which I did and brought it to their work site. It is my understanding that this snake was then collected by an intern of the Golden Gate Parks Conservancy, who held the snake until it was transferred to Karen Swaim. Ms. Swaim and I subsequently exchanged voicemails about my observation of the dead snake and I explained precisely where I had found the dead snake.

Pursuant to 28 U.S.C. § 1746, I hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on this 29 day of October, 2011.

Steve Salisbury

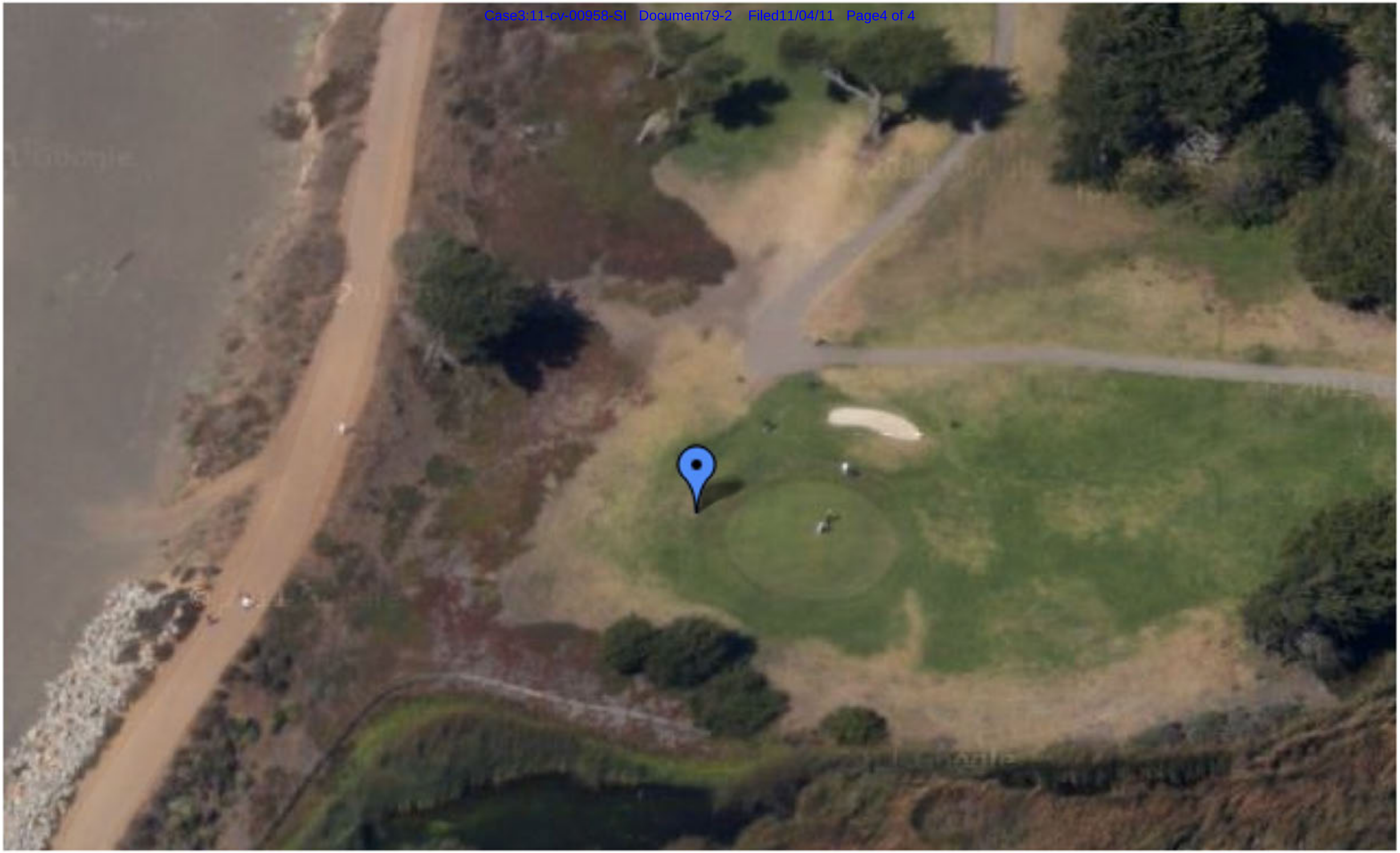


EXHIBIT A
Marked Location of Dead San Francisco Gartersnake
Found by Steve Salisbury
May 20, 2005

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 47

Brent Plater (CA Bar No. 209555)
WILD EQUITY INSTITUTE
PO Box 191695
San Francisco, CA 94119
Telephone: (415) 349-5787
Facsimile: N/A
bplater@wildequity.org

Eric R. Glitzenstein (D.C. Bar No. 358287)
Howard M. Crystal (D.C. Bar No. 446189)
Pro Hac Vice
MEYER GLITZENSTEIN & CRYSTAL
1601 Connecticut Ave., N.W., Suite 700
Washington, D.C., 20009
Telephone: (202) 588-5206
Facsimile: (202) 588-5049
eric@meyerglitz.com
hcrystal@meyerglitz.com

Attorneys for Plaintiffs

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, CENTER FOR BIOLOGICAL DIVERSITY, a non-profit corporation, NATIONAL PARKS CONSERVATION ASSOCIATION, a non-profit corporation, SURFRIDER FOUNDATION, a non-profit corporation, SEQUOIA AUDUBON, a non-profit corporation, and SIERRA CLUB, a non-profit corporation, Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, ED LEE, Mayor of the City and County of San Francisco, PHIL GINSBURG, Director, City and County of San Francisco Recreation and Park Department, Defendants.	Case No.: 3:11-cv-958-SI **SUPPLEMENTAL DECLARATION OF BRENT PLATER IN SUPPORT OF PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION**

I, Brent Plater, hereby declare:

1. My name is Brent Plater, and I am a resident of San Francisco, CA.

2. The facts stated herein are true and correct of my own personal knowledge, and I could and would competently testify thereto if called and sworn as a witness.

3. I am counsel of record in this case and in that capacity I forwarded Defendants' Opposition to Plaintiffs' Motion for Preliminary Injunction to the U.S. Fish and Wildlife Service. As counsel of record I also had a subsequent conversation with the solicitor for the Department of Interior, Kerry O'Hara, requesting that the U.S. Fish and Wildlife Service address the City's characterization of the 2008 Biological Opinion, and the 2010 Amendment to the Biological Opinion. In response to that request, and on behalf of the U.S. Fish and Wildlife Service, Ms. O'Hara sent me the October 27, 2011 email attached as Exhibit A.

4. Attached as Exhibit B is a February 24, 2011 letter I sent to the FWS notifying them about the egg mass that Jewel Snavley discovered exposed to the air near Horse Stable Pond, which Dr. Vance Vredenberg also witnessed exposed to the air and identified as a California red legged frog egg mass.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: November 4, 2011

Brent Plater

Brent Plater

EXHIBIT A

From: "O'Hara, Kerry" <Kerry.O'Hara@sol.doi.gov>
Subject: RE: Sharp Park
Date: October 27, 2011 5:18:52 PM PDT
To: 'Brent Plater' <bplater@wildequity.org>
Cc: "Goude, Cay" <cay_goude@fws.gov>, "Olah, Ryan" <ryan_olah@fws.gov>

Brent,

As you requested, I asked the Service about providing a statement in connection with the ongoing Sharp Park lawsuit. The Service does not consider it appropriate to provide a declaration or clarifying letter in response to the assertions in the City's brief. In response to that brief, the Service indicates that the quoted language on page 14 of the City's brief was, as you mentioned, merely the Service's recitation of the project description that was provided in the City's November 3, 2010, request for informal consultation, and does not represent any conclusions or analysis by the Service. Moreover, the Service relied upon the City's representation, on page 2 of its November 3, 2010, request, that "[t}his project is designed as a one time event. The repaired weir system is expected to provide enough protection from sediment intrusion into the pumps until the restoration at Sharp Park is implemented." (The Service's BO repeats this language, with modification to read: "until the more extensive restoration at Sharp Park is implemented." P.2) Both the 2008 BO (which involved the "urgent repair of a storm drain outfall that drains stormwater from the golf course through an earthen seawall/berm to the Pacific Ocean" (2008 BO at 2)) and the 2010 Amendment (which was "to remove accumulated sediment at the entrance to the pump house and to repair the weir system" (2010 Amendment at 1)) were for limited purposes and covered projects of limited duration.

Kerry O'Hara

EXHIBIT B

Building a healthy and sustainable global community for people and the plants and animals that accompany us on Earth

February 24, 2011

SENT VIA ELECTRONIC AND CERTIFIED MAIL

Chris Nagano
Ryan Olah
David Lee Kelly
US Fish and Wildlife Service
2800 Cottage Way, W-2605
Sacramento, CA 95825

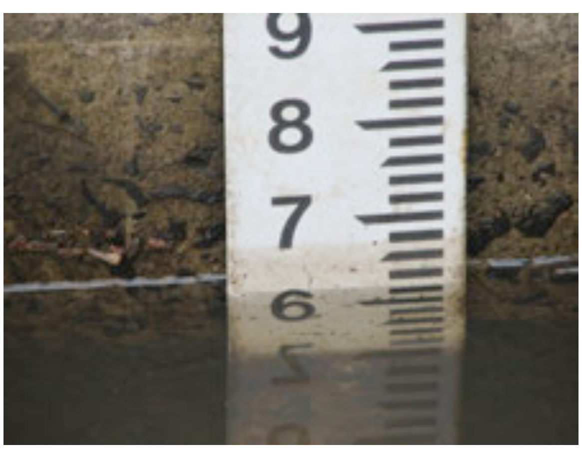
RE: Ongoing Take of ESA Listed Species at Horse Stable Pond, Sharp Park, Pacifica, CA.

Dear Mr. Nagano, Mr. Olah, and Mr. Kelly:

As you know, the Wild Equity Institute has sent to the City and County of San Francisco several formal notices concerning their ongoing, unlawful take of species protected under the Endangered Species Act at Sharp Park Golf Course. Apparently due to these notice letters, the City Attorney has directed that the Wild Equity Institute not contact City or County officials or employees directly about these ongoing legal violations.

Accordingly, we are writing to apprise you that yesterday, February 23, 2011, on a visit to Horse Stable Pond on the Sharp Park Golf Course, I, along with an expert on the California red-legged frog, located a California red-legged frog egg mass that is completely exposed to the air, apparently due to pumping operations that were still occurring after the previous weeks' storms inundated the Golf Course.

The pictures below show the water level and the egg mass.



Horse Stable Pond Water Level, February 23, 2011, 11:04 a.m. (approximately 2.6 meters)

California Red-legged Frog Egg Mass, Southern Edge of Horse Stable Pond February 23, 2011, 10:54 a.m.

Brent Plater, Executive Director ❧ P.O. Box 191695 ❧ San Francisco, CA ❧ 94119
O: 415-349-5787 ❧ C: 415-572-6989 ❧ bplater@wildequity.org ❧ http://wildequity.org

This is not the only egg mass that local residents and others have seen in danger of desiccation in recent weeks. It appears that some other egg masses in danger of desiccation have been removed, although that may also have proceeded in violation of the Act.

The Fish and Wildlife Service should take immediate action to address the City and County's ongoing violations of the ESA at Sharp Park Golf Course, and to prevent the ongoing take of ESA listed species there. Regardless of whether this particular egg mass can survive, as we have explained in our notice letters, since the Golf Course's operations are inevitably resulting in ongoing take of the Frog, the City and County must obtain an incidental take permit under the ESA, and unless and until they do so, they remain in continuing violation of the Statute.

Please feel free to contact me if there is any further information we can provide, and thank you for your immediate attention to this urgent matter.

Sincerely,

Brent Plater

Brent Plater

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 48

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.* Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, *et al.*, Defendants.	Case No.: 3:11-CV-00958 SI **SUPPLEMENTAL DECLARATION OF GREG KAMMAN**

I, Greg Kamman, declare as follows:

1. I submit this declaration in support of Plaintiffs' Motion for a Preliminary Injunction. This declaration address several issues that, in my professional judgment, were mischaracterized by the Defendants' and the Defendant-Intervenor's filings in opposition to Plaintiffs' Motion. Specifically, this declaration explains why mobile pumping units may be secured by the City in advance of storm events, and further explains why using these units near Clarendon Road can ensure that lagoon levels will not flood surrounding communities. This declaration also explains why, in my professional judgment, the Plaintiffs' proposed relief will ensure that areas where California red-legged frogs have been known to breed at Laguna Salada retain sufficient water depth to permit egg masses to hatch and tadpoles to reach deeper areas of the lagoon without risk of stranding.

2. **Comments on Mobile Pumping.** In my professional opinion, mobile pumps of sufficient capacity can be secured by the City and County of San Francisco in advance of any storm events this winter, and placed along Clarendon Road to draw down water at Laguna Salada as needed. These pumps can ensure that infrastructure is not flooded, even if water levels are permitted to reach 12 NAVD 88 before pumping is initiated. 12 NAVD 88 is approximately the water level expected for the 10-year storm event scenario as mapped in Figure 12 in *Report for the Hydrologic Assessment and Ecological Enhancement Feasibility Study: Laguna Salada Wetland System*, which my firm authored for the City of San Francisco in 2009. See Exhibit A.

Our report forms the basis for most hydrological calculations presented by Defendants, although as described below, in some cases Defendants made calculation errors.

3. The ability to pump from any given elevation is controlled by access and reasonable distances associated with discharge piping/hose. Because the elevation on the north and eastern sides of Sharp Park along Clarendon Road are relatively high, the pump intake elevation is similarly limited. Nonetheless, it is my professional opinion that pumping from Clarendon Road can bring water levels to approximately 10 NAVD 88. This is approximately the water level expected for the 2-year storm event scenario as mapped in Figure 12. See Exhibit A.

4. It is my understanding that Sharp Park Golf Course floods in the winter on a regular basis. Flood waters range from 10-12 NAVD 88 in response to large storm events (see Exhibit A). Thus, the level of water retention proposed by the Plaintiffs Preliminary Injunction Motion is similar to the flooding events that occur at Sharp Park under existing management. Unlike the City's existing management regime—which routinely draws water down below 7 feet NAVD 88—it is my professional opinion that the Plaintiffs' proposed relief will ensure that water levels remain well above 7 feet for at least a six week period, a conservative estimate of the duration needed for California red-legged frog egg-masses to hatch and tadpoles to swim to deeper waters.

5. **Comments on Pond Recession Analysis.** Based on Defendants' shaded relief map presented as Figure 1 of Exhibit 2 of the Vandivere declaration, Docket No. 66-2, isolated pond areas only occur when water levels drop below approximately 7-feet in elevation. The isolated areas identified through cross-section analysis by Vandivere appear entirely within the tule marsh at Laguna Salada. Based on my review of available maps indicating egg mass observation in 2008 and 2011, the vast majority of egg masses were located at elevations between 7.0- and 8.0-feet NAVD88. Attached as Exhibit B.

6. Above 7-feet in elevation, Figure 1 of Exhibit 2 of the Vandivere declaration depicts all of Laguna Salada—including the areas that are considered isolated when water levels fall below 7-feet in elevation—as one large, contiguous, hydrologically connected water body.

7. To determine how long hydrologically connected water would remain at Sharp Park under Plaintiffs' Preliminary Injunction proposal, I've completed a simple pond recession analysis (spreadsheet model) similar to the groundwater seepage computation presented in Vandivere's declaration. However, my analysis was improved in several ways, providing more accurate information:

8. First, after reviewing the Vandivere declaration, I realized that his calculation contained a conversion error. Lines 9-10 on page 6 indicates the upper elevation of the seepage face at the edge of the Pacific Ocean is 6-ft *NAVD88*. But Figure 4 of Exhibit 5 of Vandivere's declaration indicates this elevation at 6-ft *NGVD29* – a different measurement unit that has a 2.1-foot conversion factor. This inconsistency leads to an incorrect hydraulic gradient (i) calculation. This error is corrected in my seepage computations, yielding a steeper initial gradient (0.0126 ft/ft when the Laguna water level is 12-ft NAVD88) along the seepage front and higher groundwater outflow rates.

9. Second, Vandivere uses a hydraulic conductivity (K) value of 10,000 gallons per day per ft^2 (gpd/ ft^2) for the assumed homogeneous and clean beach sands that groundwater seeps through under the western levee. This value is biased towards the highest K-values published for sand. Exhibit C presents published ranges for K as reported from a number of different publications related to groundwater flow hydraulics. For purposes of my pond recession analysis, the 10,000 gpd/ft^2 rate was used but it should be recognized that a more conservative or median value would yield much slower seepage rates causing a longer recession in ponded water levels after flooding.

10. Third, Vandivere's analysis only considers groundwater outflow, yet there is a significant component of groundwater inflow to Laguna Salada wetland as documented in our report, Docket 57-2, p. 7, and the PWA 1992 report. In order to account for this groundwater inflow, we assume the following: a constant hydraulic gradient (i) of 0.0058 ft/ft (calculated from seasonal groundwater elevations presented on Figure 24 of the PWA 1992 report; a constant saturated area of 12,000 ft2 (saturated aquifer thickness of 6-feet and seepage front of 2000 linear feet);

and initial hydraulic conductivity of 100 gpd/ft2 for the upgradient "medium grained sand" aquifer as reported on Figure 22 of PWA's 1992 report. Attached as Exhibit D.

11. By incorporating known groundwater inflows into the model and fixing the conversion error, it is my professional judgment that my pond recession analysis more accurate than those presented by Defendants in this matter. Furthermore, because I use the same (K) rate as Defendants' experts—which as explained above is biased towards the highest rates published in the relevant literature—it is likely that to the extent the model creates conservative estimates.

12. The results of the pond recession analysis are presented in Exhibit E. The analysis assumes a starting Laguna Salada water level of 12-feet, daily Laguna volumes and ponded surface area are listed along with the ending daily Laguna water level, volume and area after accounting for seepage losses/gains. The hydraulic gradient and saturated thickness of the seepage front are recalculated each day based on the adjusted water volumes and associated water surface elevation. Seepage calculations were performed for a 365-day period. Exhibit F presents the water level-volume-surface area relationships used to translate between Laguna water level, volume and surface area. These values were calculated from the project topographic map completed by Lee, Inc. for Tetra Tech, Inc. as part of the Sharp Park Conceptual Restoration Alternatives Report (Tetra Tech, 2009). The groundwater seepage model is validated to some extent by the equilibration of the late season Laguna water levels at an elevation between 6.0- and 6.5-feet, the approximate static pond level observed during PWA's monitoring in 1990-91 and KHE's monitoring in 2008.

13. Exhibit G presents the recession analysis results as a plot of changing water surface elevation and ponded area versus days since the water level reached 12-feet NAVD 88 at Sharp Park. This analysis assumes no further inflows after the peak rain event. Highlights of these results include:

- Day 1 flooding to an elevation of 12-feet yields 56-acres of ponded area;
- Ponding recedes to 11-feet and 47-acres after 9 days;

- Ponding receded to 10-feet and 39-acres after 20 days;[1]
- Ponding recedes to 9-feet and 32-acres after 35 days;
- Ponding recedes to 8.6-feet and 30-acres after 42 days (6 weeks);
- Ponding recedes to 8.0-feet and 26-acres after 59 days;
- Ponding recedes to 7.0-feet and 19-acres after 120 days;
- Ponding recedes to 6.5-feet and 15-acres after 234 days.

14. These results indicate that under the proposed injunction if egg masses are laid in the same areas they have been laid over the past several years during a rain event that places the high water mark at 12 NAVD 88, and even if no further rain or other water inputs are provided, the eggs and tadpoles would remain submerged in waters hydrologically connected to the deeper areas of Laguna Salada for more than six weeks.

Pursuant to 28 U.S.C. § 1746, I hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on this 4th day of November, 2011. ______________________________

Gregory R. Kamman

[1] If the starting water level were 10 NAVD 88 instead of 12 NAVD 88, any particular water level below 10-feet would be reached 20 days sooner. For example, if the starting water level were 10 NAVD 88, water levels would recede to 9.0 NAVD 88 in 15 days, 8.6 NAVD 88 in 22 days, 8.0 NAVD 88 in 39 days, etc. See Exhibit E for full results of the model.

References

American Society of Civil Engineers (ASCE), 1996, Hydrology handbook, second edition. ASCE Manuals and Reports on Engineering Practice No. 28, ASCE, New York, NY, 784p.

Domenico, P.A. and Schwartz, F.W., 1990, Physical and chemical hydrogeology. John Wiley & Sons, New York, NY, 824p.

Driscoll, F.G., 1986, Groundwater and wells. Johnson Screens, St. Paul, MN, 1089p.

Freeze, A.R. and Cherry, J.A., 1979, Groundwater. Prentice Hall, Inc., Upper Saddle River, NJ, 604p.

Heath, R.C., 1987, Basic ground-water hydrology. U.S. Geological Survey (USGS) Water-Supply Paper 2220, 84p.

Kamman Hydrology & Engineering, Inc., 2009, Report for the Hydrologic Assessment and Ecological Enhancement Feasibility Study, Laguna Salada Wetland System, Pacifica, CA. Prepared for Tetra Tech, Inc., San Francisco, CA, 30p.

Philip Williams & Associates, Ltd., (PWA), 1992, Draft Laguna Salada Resource Enhancement Plan. Prepared for the City of San Francisco and The State of California Coastal Conservancy, 42p.

Tetra Tech, Inc., 2009, Sharp Park Conceptual Restoration Alternatives Report. Prepared for San Francisco Recreation and Parks Department, San Francisco, CA, 64p.

EXHIBIT A

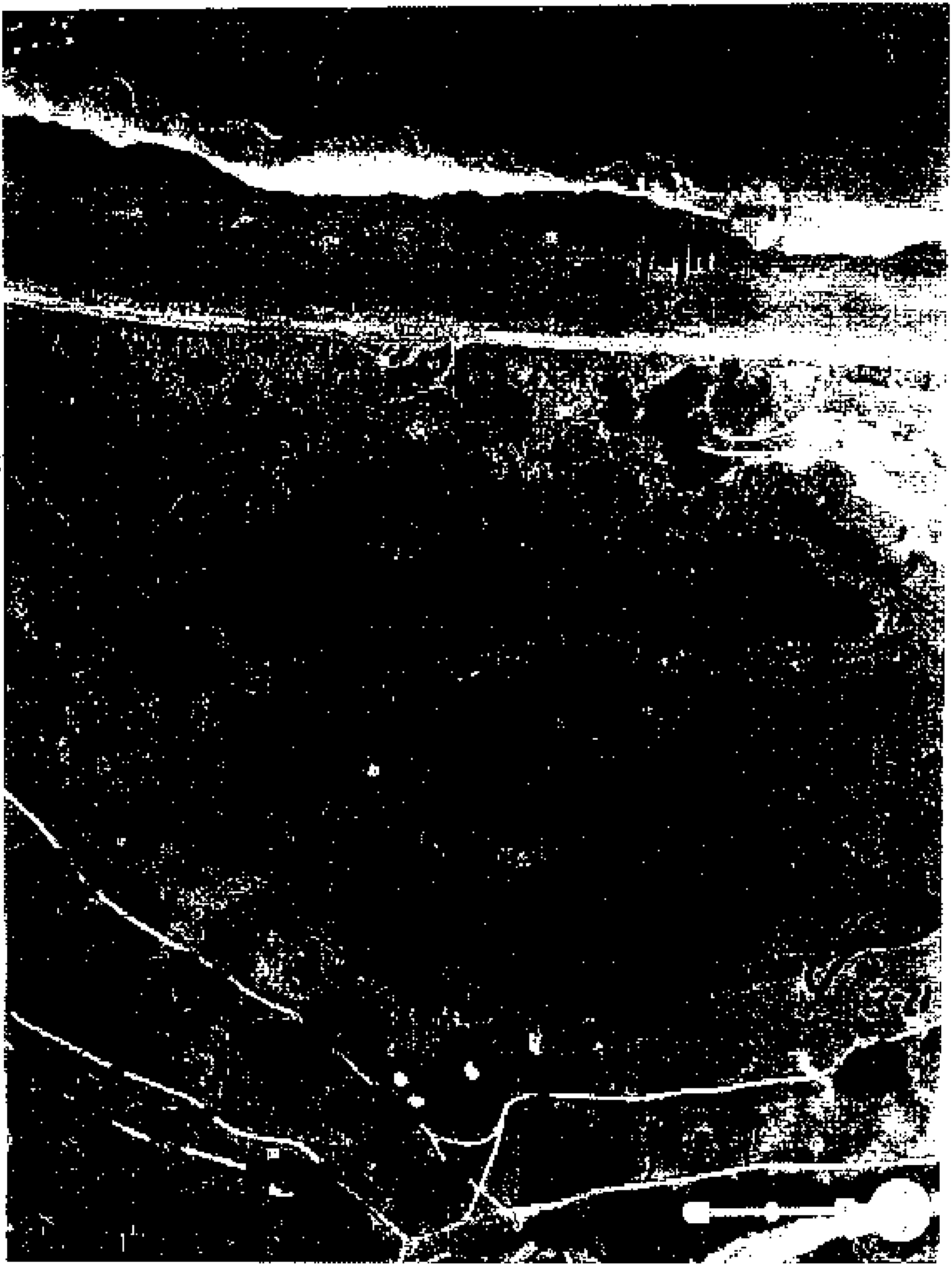
KAMMAN HYDROLOGY & ENGINEERING, INC.

Simulated Water Surface Elevation and Area of Inundation
Laguna Salada Wetlands

FIGURE 12

EXHIBIT B

2008 California Red-legged Frog Egg Mass Observations



GGNRA Egg Mass Datasheet

Date (mm/dd-yyyy): 1/12/1[illegible] Begin Time (PST-Military): [illegible] Total Time (Min): 45 min

Observer(s): [illegible]

General Location: LAGUNA SALADA NPS Location ID:

County: UTM:

Weather: Clear / Overcast/Fog / Pt. Cloudy / Mostly Cloudy / Rain | Beaufort Wind: <1 1-3 4-7 8-12 13-18 19-24 >24 | Air Temp: 67 | Water Temp: (0.5 m depth) 58

Habitat: Natural / Altered 1 2 3 4 5 | Type: Lake / Pond / Seasonal Wetland / Ditch / Stream / Seep/Spring | Drainage: Permanent / Seasonal

Watershed: Natural / Grazed / Logged / Urban / Agriculture / Other | Substrate: Silt / Sand / Pebble (2-75 mm) / Cobble (75-300 mm) / Boulder (>300 mm) / Bedrock

Survey Length: m | Survey Width: m | Aver. Depth: m | Max Depth: m | Water Flow: 0 / <1 fps / 1-5 fps / 5-10 fps / >10 fps

Visibility (m): 25 cm | Emergent Vegetation: % | Submergent Vegetation: % | Open Water: %

Dominant Emergent Vegetation: | Dominant Submergent Vegetation:

Fish Present: Yes No | Species and Approx. Number:

Species	ID#	# Egg Masses	Mass Shape	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth (cm) / Stranded?	Egg Attachment Type	Gosner's Stage	Comments
RLF	1	1	SPH	15 x 16	14	14 Y N	Korisy?	4-7	
	2	1	1/2 SPH	25 x 10	19	19 Y N	"	4-7	
	3	1	SPH	10 x 10	15	15 Y N	"	4-7	
	4	1	SPH	25 x 10	17	15 Y N	"	4-7	
	5	1	1/2 SPH	20 x 10	16	15 Y N	"	4-7	
	6	1	1/2 SPH	20 x 10	15	14 Y N	"	4-7	
	7	1	SPH	10 x 10	15	13 Y N	"	1-3	
	8		1/2 SPH	20 x 10	15	14 Y N	"	4-7	
	9		1/2 SPH	15 x 10	15	14 Y N	"	4-7	
	10		1/2 SPH	10 x 5	14	14 Y N	"	4-7	
	11	1	SPH	10 x 10	15	15 Y N	Scirpus	4-7	
	12	1	SPH	10 x 10	13	13 Y N	"	4-7	
	13	1	SPH	15 x 10	19	15 Y N	"	4-7	
	14	1	SPH	15 x 10	18	17 Y N	"	1-3	
	15	1	SPH	15 x 15	11	11 Y N	"	1-3	

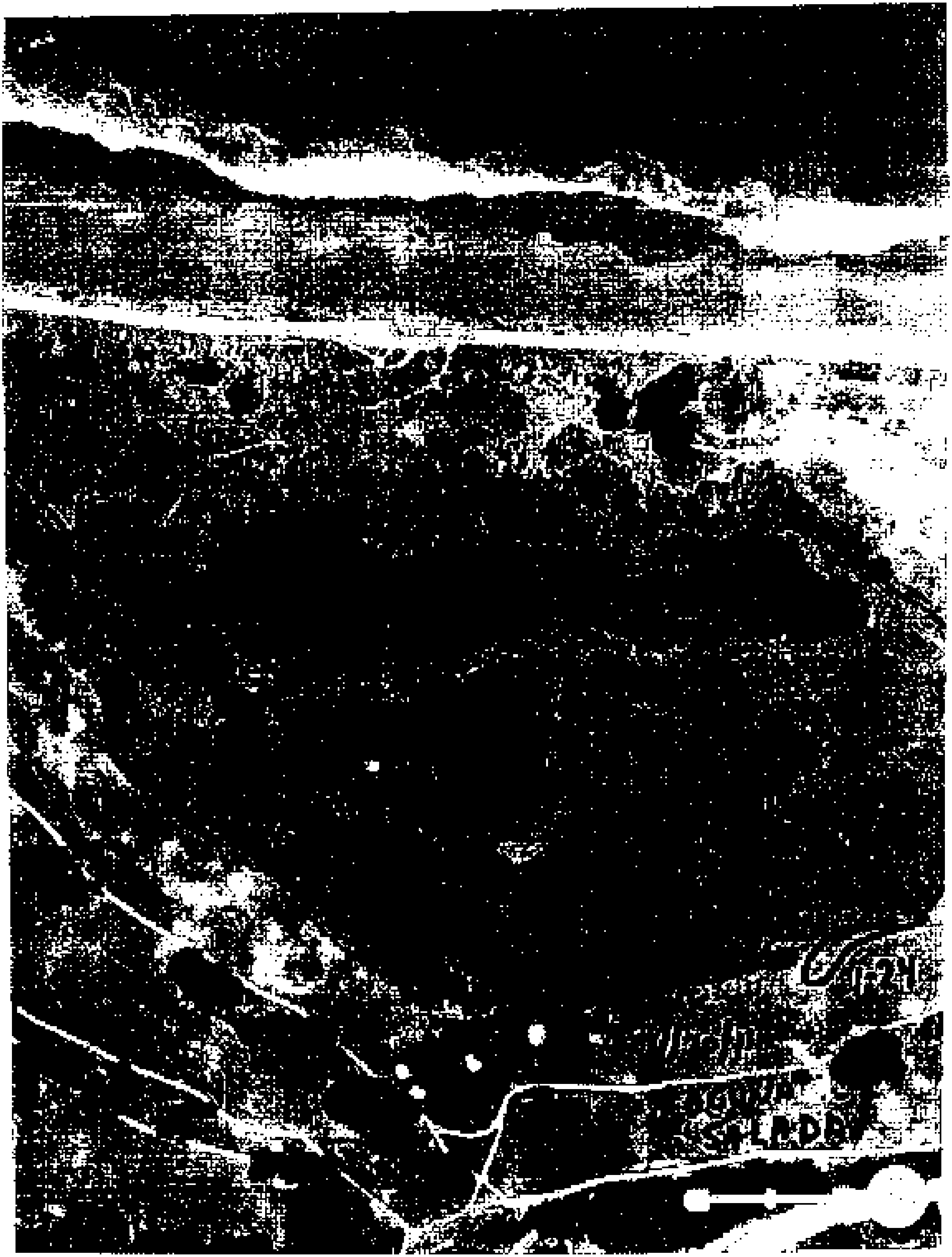
[illegible] Rev. [illegible]

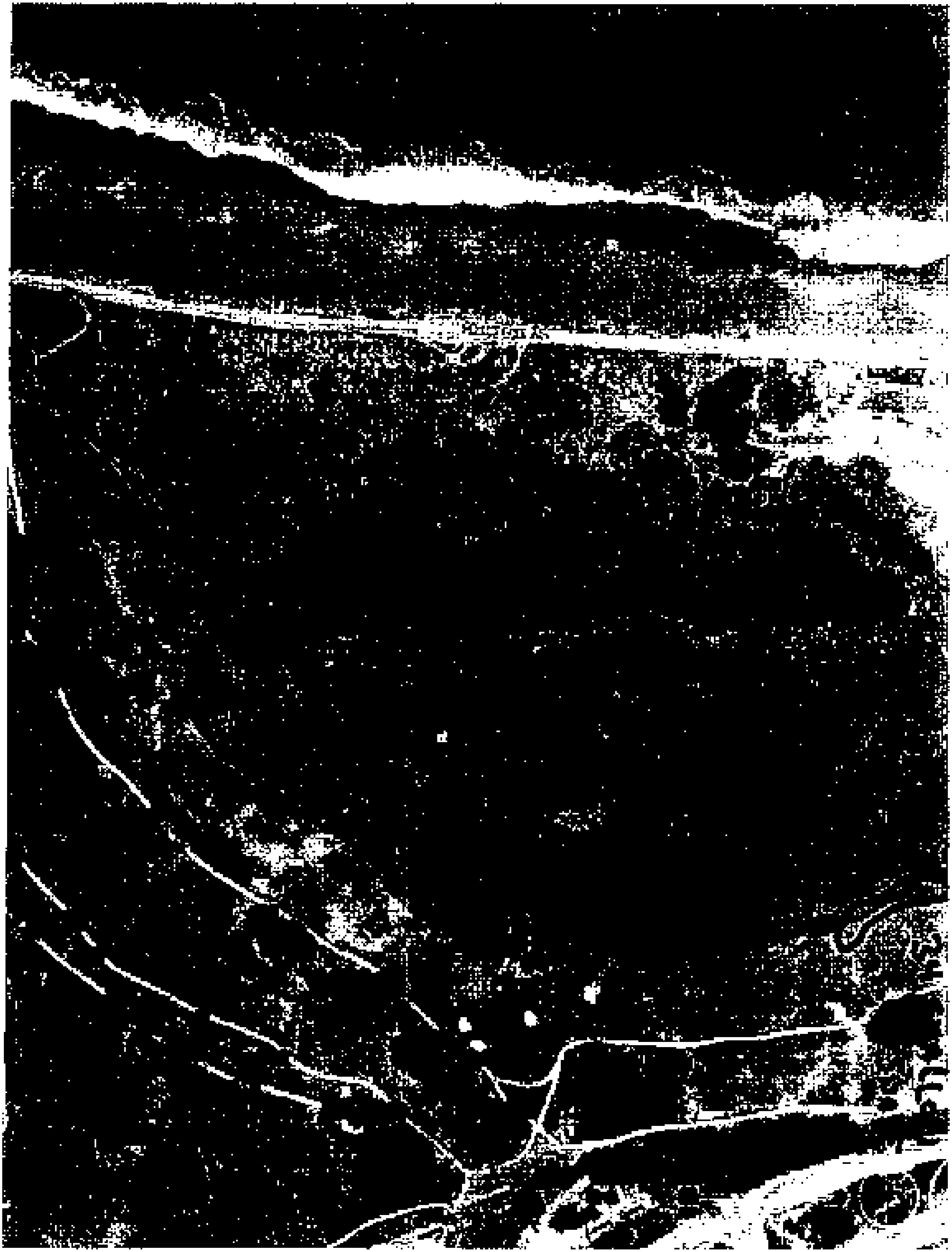
Species	Egg Mass ID	Ring Marker	Mass Shape	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth	Y/N	Egg Attachment Type	Gosner Stage	Comment
RLF	16	1	SPH	15x14	14	13	Y N	Scirpus	1-3	
	17	1	½ SPH	15x15	11	11	Y N	"	1-3	
	18	1	SPH	25x15	11	11	Y N	"	4-7	
	19	1	SPH	18x14	19	18	Y N	"	4-7	
	20	1	SPH	20x10	18	15	Y N	Juncus	4-7	
	21	1	SPH	25x20	20	14	Y N	Scirpus	4-7	
	22	1	SPH	20x20	22	20	Y N	"	4-7	
	23	1	SPH	20x20	22	21	Y N	"	1-3	
	24	1	SPH	20x15	22	20	Y N	"	1-3	
	25						Y N			
	26						Y N			
	27						Y N			

COMMENTS (e.g., surveyed route, habitat conditions, observation conditions):

1/31/11

MOVED ON 2/21/11 TO SITE #6 (14 EGGMASSES)
AND SITE #1 (15 EGG MASSES)
ADDITIONAL EGGMASSES WERE FOUND AT ... OF
REGEGARAN






1/21/11
6
SMALL
SWAL

GGNRA Egg Mass Datasheet

Date (mm-dd-yyyy): 1/26/11 Begin Time (PST/Military): 11:00 Total Time (Min): 60 min

Observer(s): [illegible]

General Location: MS

NPS Location ID:

County:

UTM:

Weather: Clear Overcast/Fog | Beaufort Wind | Air Temp. (1.5 m): 65 °C | Water Temp. (10 cm): 52 °C

Pt Cloudy Mostly Cloudy Rain

Habitat: Natural 1 2 3 4 5 Altered | Type: Lake Pond Emerg. Wetl. Ditch Stream Seep/Spring Gravel Unpaved | Drainage: Permanent Seasonal

Watershed: Natural Urban Agriculture Other | Substrate: Silt Sand (<2mm) Pebble (2-75 mm) Cobble (75-300 mm) Boulder (>300 mm) Bedrock

Survey Length: m | Survey Width: | Ave. Depth: m | Max Depth: m | Water Flow: 0 <1 fps 1-5 fps 5-10 fps >10 fps

Visibility (m): 25 cm | Emergent Vegetation % | Submergent Vegetation % | Open Water %

Dominant Emergent Vegetation: | Dominant Submergent Vegetation:

Fish Present: Yes No | Species and Approx. Number:

Species	ID#	# Egg Masses	Mass Stage	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth (cm)	Stranded?	Egg Attachment Type	Gosner Stage	Comments
RLF	1	1	SPH	15 x 10	29	26	Y N	SCIRPUS	1-3	
	2	1	SPH	15 x 10	28	27	Y N	"	1-3	
	3	1	SPH	15 x 10	29	29	Y N	"	4-7	
	4	1	SPH	15 x 15	29	29	Y N	"	4-7	
	5		SPH	15 x 10	28	26	Y N	CATTAIL	1-3	
	6		SPH	10 x 10	22	20	Y N	CATTAIL	1-3	
	7	1	SPH	10 x 10	29	26	Y N	"	4-7	
	8		SPH	6 x 10	24	20	Y N	SCIRPUS	1-3	
	9		SPH	10 x 10	25	23	Y N	JAMAVEN	1-3	
	10	1	SPH	10 x 10	25	24	Y N	JAMAVEN	1-3	
	11	1	SPH	12 x 10	24	24	Y N	SCIRPUS	1-3	
	12	1	"	14 x 10	25	24	Y N	"	1-3	
	13	1	"	10 x 14	25	23	Y N	"	1-7	
	14	1	"	10 x 10	25	25	Y N	"	1-3	
	15	1	"	10 x 10	20	19	Y N	JAMAVEN	1-3	

Species	ID#	# Egg Masses	Mass Stage	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth		Egg Attachment Type	Gosner Stage	Comments
RLF	16	1	SPH	20x20	30	27	N	Carex	4-7	
	17	1	SPH	10x10	21	21	N	Juncus	1-3	
	18	1	SPH	10x10	29	26	N	Juncus	1-3	
	19	1	SPH	10x10	35	31	N	Scirpus	1-3	
	20	1	SPH	15x10	25	24	N	Scirpus	4-7	
	21	1	SPH	10x10	23	21	N	Juncus	4-7	
	22	1	SPH	10x10	24	23	N	Juncus	1-3	
	23	1	½ SPH	5x10	27	25	N	"	1-3	
	24	1	½ SPH	5x10	26	24	N	"	4-7	
	25	1	SPH	10x10	29	28	N	"	1-3	
	26		SPH	10x10	20	19	N	"	1-3	
	27		SPH	10x10	20	19	N	"	1-3	
	28		SPH	10x10	~~24~~ 31	31	N	"	1-3	
	29		SPH	10x10	31	31	N	"	1-3	

COMMENTS (e.g., surveyed route, habitat conditions, observation conditions):

[illegible] Rev 2002

GGNRA Egg Mass Datasheet

Date (mm-dd-yyyy): 1/28/11 Begin Time (PST/MDStay): 12:10 Total Time (Min): 60
Observer(s): DC
General Location: HS SLOUGH
County: NPS Location ID:
UTM:

Weather: Clear / Partly Cloudy / Fog / Windy / Rain Air Temp: Water Temp:

Habitat / Watershed / Survey Length / Survey Width / Avg Depth / Max Depth / Water Flow / Emergent Vegetation / Submergent Vegetation / Open Water / Fish Present: Yes / No

Species	ID#	# Egg Masses	Mass Shape	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth or Stranded		Egg Attachment Type	Gosner Stage	Comment
RLF	30	1	SPH	15 x 10	25	25	Y N	Juncus	1-3	
	31	1	SPH	14 x 20	24	22	Y N	Scirpus	1-3	
	32	1	SPH	14 x 10	20	19	Y N	"	1-3	
	33	1	"	10 x 5	21	21	Y N	"	1-3	
	34	1	"	10 x 5	25	23	Y N	"	1-3	
	35	1	"	15 x 10	27	21	Y N	"	1-3	
	36	1	1/2 SPH	20 x 10	29	28	Y N	"	1-3	
	37	1	SPH	10 x 12	29	27	Y N	CATTAIL	1-3	
	38	1	1/2 SPH	20 x 10	25	21	Y N	CATTAIL	4-7	
	39	1	SPH	20 x 15	29	28	Y N	CATTAIL	4-7	
							Y N			
RLF	40	1	SPH	25 x 20	15	15	Y N	DISTICHLIS	1-3	SLOUGH
							Y N			
							Y N			
							Y N			

SLOUGH


HORSE
JC


Jon Camp
SLOUGH
1/4/11

GGNRA Egg Mass Datasheet

Date (mm-dd-yyyy): 1/4/11 Begin Time (PST-Military): 1[illegible] Total Time (Min): 45

Observer(s): JS

General Location: RS Slough

County: SM NPS Location ID:

UTM:

Weather: Air Temp: 6[illegible] Water Temp: 5[illegible]

Habitat: Natural / Type: Pond / Slough / Seep/Spring / Drainage: Permanent / Seasonal

Watershed: Natural / Grazed / Urban / Agriculture / Other

Survey Length: m / Survey Width: / Avg. Depth: / Max Depth: / Water Flow: 0, <1 fps, 5-10 fps, >10 fps

Visibility: 15

Emergent Vegetation: / Submergent Vegetation: / Open Water: %

Fish Present: Yes No

Submergent Vegetation Species and Percent Number: Smm / Pymp / 2 / 7.1

Species	EM	# Egg Masses	Mass Shape	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth (cm)	Stranded?	Egg Attachment	Gosner Stage	Comment
RLF	1	1	½ sph	15 x 12	25	29	Y/N	[illegible]	1-3	
	2	1	½ sph	13 x 11	19	9	Y/N		1-3	
	3	1	½ sph	12 x 11	19	13	Y/N		1-3	
	4	1	sph	15 x 15	17	17	Y/N		1-3	
							Y/N			
Slough	1	1	sph	15 x 12	16	19	Y/N	Rush	1-3	
	2	1	sph	15 x	16	16	Y/N		1-3	
	3	1	sph	15 x 12	13	13	Y/N		1-3	

EGG MASSES 1-3 SLOUGH WERE MOVED TO RS ON 1/7/11


SEASONAL

Page 1 of 3

GGNRA Egg Mass Datasheet

Date (mm-dd-yyyy): [illegible] Begin Time (PST-Military): [illegible] Total Time (Min): [illegible]

Observer(s): [illegible]

General Location: [illegible]

County: [illegible]

NPS Location ID:

UTM:

Weather: Overcast / Partly cloudy / Sunny. Rain: Recent / Current / None. Beaufort Wind: 0-1 / 2-5 / 6-10 / 11-18 / 19-24 / >24. Air Temp (at 1 m): [illegible] °C/°F. Water Temp (0.5 m only): [illegible] °C/°F

Habitat: Natural 1 2 3 4 Altered 5. Type: Marsh / Lake / Stream / Pond / Ditch / Seep/Spring / Ephemeral Wet. Drainage: Permanent / Seasonal

Watershed: Urban / Natural / Agriculture / Grazed / Other / Mixed

Substrate: Silt / Sand (<2mm) / Cobble (75-250mm) / Pebble (2-75mm) / Boulder (>250mm) / Bedrock

Survey Length: m. Survey Width: m. Avg. Depth: m. Max Depth: m. Water Flow: 0 / <1 fps / 1-5 fps / 5-10 fps / >10 fps

Visibility (m):

Emergent Vegetation %: Submergent Vegetation %: Open Water %:

Dominant Emergent Vegetation:

Dominant Submergent Vegetation:

Fish Present: Yes / No. Species and Approx. Number: [illegible]

Species	UID	# Egg Masses	Mass Shape	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth (cm below surface) / Stranded?	Egg Attachment Type	Gosner Stage	Comments
[illegible]			[illegible]	[illegible]	[illegible]	Y N	[illegible]		

GGNRA Egg Mass Datasheet

Date (mm-dd-yyyy): [illegible] Begin Time (PST-Military): [illegible] Total Time (Min): [illegible]
Observer(s): [illegible]
General Location: [illegible] NPS Location ID: [illegible]
County: [illegible] UTM: [illegible]

Weather: Sunny Overcast Fog / Partly Cloudy Drizzle Rain | Beaufort Wind Scale: 0-1 mph, 2-7 mph, 8-12 mph, 13-18 mph | Air Temp: [illegible] °C | Water Temp: [illegible] °C

Habitat: Natural / Artificial | Type: Lake, Pond, Ditch, Stream, Lagoon, Seep/Spring, Marsh/Wet Meadow | Drainage: Permanent, Seasonal
Watershed: Natural, Grazed, Urban, Agriculture, Other | Substrate: Silt, Sand (<2mm), Gravel (2-75mm), Cobble (75-250mm), Boulder (>250mm), Bedrock

Survey Length: m | Survey Width: m | Ave Depth: m | Max Depth: m | Water Flow: 0, <1 fps, 1-5 fps, 5-10 fps, >10 fps

Visibility (m): [illegible] | Emergent Vegetation %: | Submergent Vegetation %: | Open Water %:

Dominant Emergent Vegetation: | Dominant Submergent Vegetation Species and Approx. Number:

Fish Present: Yes No

Species	ID#	# Egg Masses	Mass Shape	Mass Dimensions (cm)	Water Depth (cm)	Egg Mass Depth (cm)	Egg Attachment Type	Gosner Stage	Comment
RLF	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible] Y N	[illegible]	[illegible]	
	2	[illegible]	[illegible]	[illegible]	15	[illegible] Y N	[illegible]	[illegible]	
	3	[illegible]	[illegible]	[illegible]	15	5 Y N	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Y N	[illegible]	[illegible]	
	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Y N		[illegible]	
	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Y N	[illegible]	[illegible]	
						Y N			
						Y N			
						Y N			
						Y N			
						Y N			
						Y N			
						Y N			
						Y			

RLF summary of data

Fist noted that eggmasses were being stranded on Jan 17, 2003
Last known occurrence of 3 partially stranded eggmases was on Feb 14, 2007 (the pumps were shut off immediately and the eggmasses were re-submerged)

First recorded date indicates the first eggmasses found within that season, not the first survey

2003
1/17/03-1/28/03 incomplete seasonal data
Peak Jan 17

2004
2/6/04-3/5/04
Peak Feb 6

2005
2/11/05-3/9/05 surveys started late in season
Peak Feb 11

2006
1/6/06-2/16/06
Peak Jan 25

2007
2/14/07-3/13/07
Peak Feb 14

2008
1/22/08-2/26/08
Peak Feb 5-20 (swarm data)

2009
1/4/09-2/19/09 (to date)
Peak Jan 29

SALINITY DATA

* seep in from levee

Horsestable

2007

12/29/07	4ppt, 4ppt
1/17/07	6ppt, 7ppt, 12ppt

1/26/07	2ppt, 22ppt*, 12ppt, 35ppt*
2/14/07	3ppt
2/28/07	2ppt
3/13/07	3ppt
3/23/07	3ppt

2008

11/15/07	3ppt, 3ppt, 3ppt
12/20/07	3ppt, 3ppt
1/4/08	4ppt, 5ppt
1/5/08	24ppt*, 16ppt*, 20ppt*
1/8/08	4ppt, 2ppt, 21ppt*
2/28/08	1ppt

2009

1/3/09	3ppt

Laguna Salada

2007

12/29/07	4ppt
1/17/07	5ppt, 5ppt
1/26/07	5ppt, 5ppt
2/28/07	2ppt

EXHIBIT C

	gpd/ft^2 lower	gpd/ft^2 upper
1 Freeze & Cherry 1979 clean sand	10.00	60,000
2 USGS, 1987 clean sand	10.00	5,000
3 Driscoll, 1986 fine to coarse sand	0.80	30,000
4 ASCI., 1995 fine to coarse	0.25	24,537
5 Domenico & Schwartz, 1990, coarse sand	1.91	12,720
6 Domenico & Schwartz, 1990, medium sand	1.91	1,000
7 Domenico & Schwartz, 1990 fine sand	0.42	424

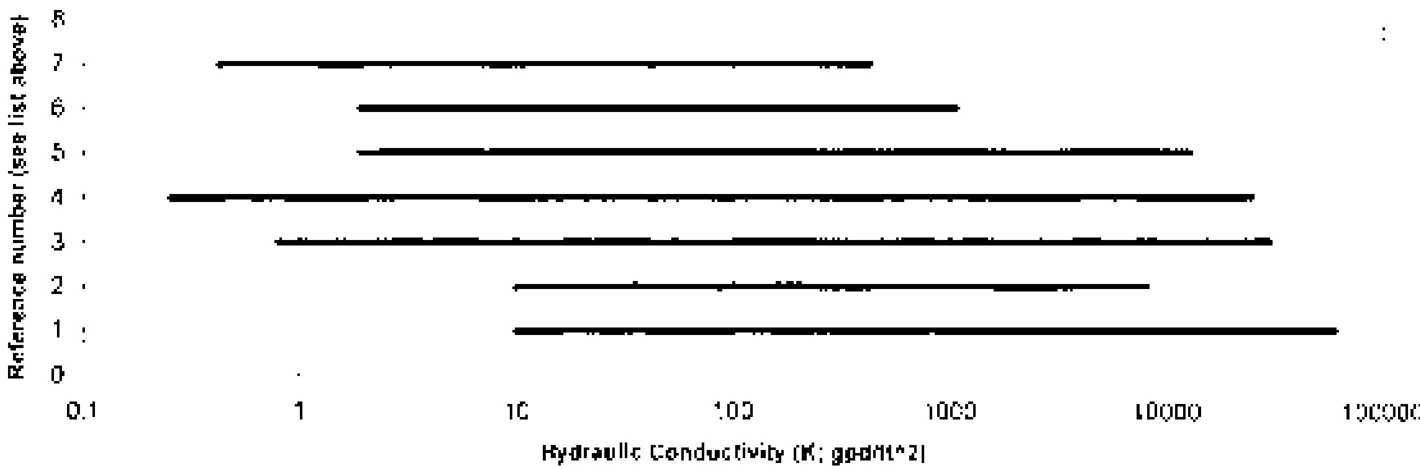
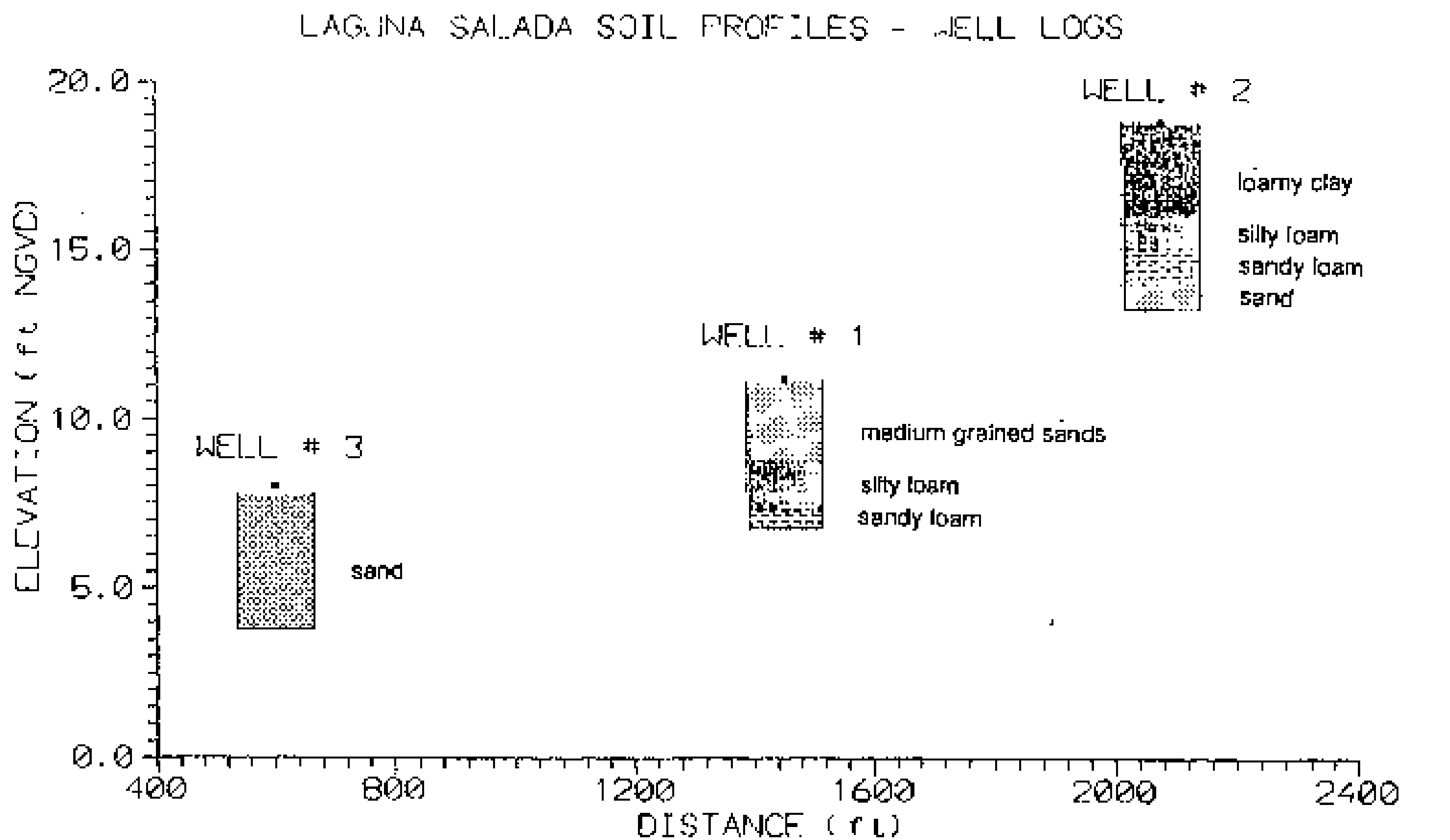
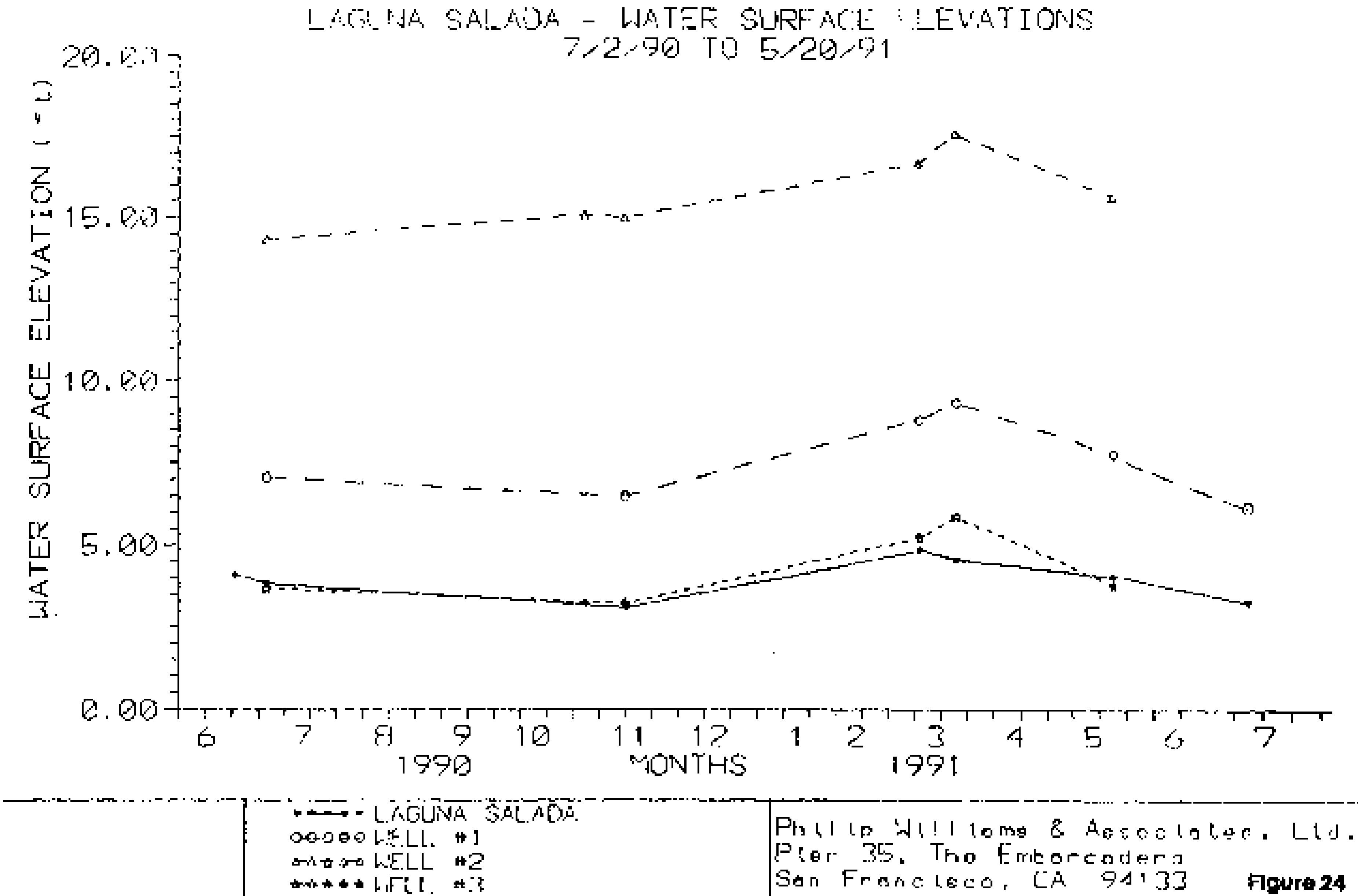


EXHIBIT D



Philip Williams & Associates, Ltd.
Pier 35, The Embarcadero
San Francisco, CA 94133

Figure 22



Philip Williams & Associates, Ltd.
Pier 35, The Embarcadero
San Francisco, CA 94133

Figure 24

EXHIBIT E

Day	Start Pond Level (feet)	Start Volume (AF)	Start Wetted Area (Ac)	GW Outflow - Beach Seepage area (ft^2)	gradient	seepage (AF)	GW inflow (AF)	End Volume (AF)	End Pond Level (feet)	End Wetted Area (Ac)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	52.0	16,544	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
5	[illegible]	152.7	51.5	16,132	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	11.37	147.6	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	11.27	49.3
[illegible]	11.27	[illegible]	[illegible]	15,532	[illegible]	3.38	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	15,202	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	14,804	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	45.9	14,914	0.0104	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	157.3	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	44.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
20	10.02	[illegible]	[illegible]	[illegible]	0.0086	[illegible]	0.02	124.8	9.92	[illegible]
[illegible]	9.92	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6,090	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	68.0	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	24.4

day	Start Pond Level (feet)	Start Volume (AF)	Start Wetted Area (Ac)	GW Outflow - Beach Seepage area (ft^2)	gradient	seepage (AF)	GW inflow (AF)	End Volume (AF)	End Pond Level (feet)	End Wetted Area (Ac)
67	[illegible]	[illegible]	[illegible]	[illegible]	0.0057	[illegible]	[illegible]	[illegible]	[illegible]	24.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.79	[illegible]	24.0	[illegible]	[illegible]	0.57	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	23.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.69	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.45	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.42	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.47	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.40	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.31	[illegible]	[illegible]	[illegible]	0.0029	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	47.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	46.8	[illegible]	3.739	0.0027	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	46.4	[illegible]	[illegible]	0.0024	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
104	[illegible]	[illegible]	[illegible]	[illegible]	0.0024	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
105	[illegible]	[illegible]	[illegible]	[illegible]	0.0024	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
122	6.97	42.0	18.0	2.806	[illegible]	[illegible]	[illegible]	[illegible]	6.97	18.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	6.89	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

day	Start Pond Level (feet)	Start Volume (AF)	Start Wetted Area (Ac)	GW Outflow + Beach Seepage area (ft^2)	gradient	seepage (AF)	GW inflow (AF)	End Volume (AF)	End Pond Level (feet)	End Wetted Area (Ac)
[illegible]	[illegible]	[illegible]	[illegible]	2 006	[illegible]	[illegible]	[illegible]	[illegible]	6.85	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	2 583	[illegible]	[illegible]	[illegible]	40.8	6.87	[illegible]
[illegible]	6.87	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	6.30	[illegible]	17.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.4
[illegible]	6.86	[illegible]	17.4	2 495	0.0016	[illegible]	[illegible]	[illegible]	6.84	17.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.82	17.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.84	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.81	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.03	[illegible]	[illegible]	6.81	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0017	[illegible]	[illegible]	[illegible]	[illegible]	17.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	2 330	0.0017	[illegible]	0.02	39.5	6.78	[illegible]
147	[illegible]	39.5	[illegible]	[illegible]	0.0017	[illegible]	0.02	[illegible]	6.75	[illegible]
148	[illegible]	39.4	[illegible]	2 308	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.5
149	[illegible]	[illegible]	16.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.5
150	[illegible]	[illegible]	15.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	6.70	[illegible]	[illegible]	2 252	0.0016	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	6.70	[illegible]	[illegible]	2 236	0.0016	[illegible]	[illegible]	[illegible]	[illegible]	16.6
[illegible]	[illegible]	[illegible]	[illegible]	2 220	[illegible]	[illegible]	[illegible]	[illegible]	6.75	16.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.2	[illegible]	16.3
[illegible]	[illegible]	[illegible]	16.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	16.2	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
164	[illegible]	[illegible]	16.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.65	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
173	6.66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	6.63	15.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	15.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

day	Start Pond Level (feet)	Start Volume (AF)	Start Wetted Area (Ac)	GW Outflow - Beach Seepage area (ft^2)	gradient	seepage (AF)	GW Inflow (AF)	End Volume (AF)	End Pond Level (feet)	End Wetted Area (Ac)
[illegible]	6.58	[illegible]	15.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	6.58	[illegible]	15.2	1,663	0.0012	0.06	[illegible]	36.0	6.57	[illegible]
[illegible]	6.57	36.0	15.1	1,661	[illegible]	0.06	0.02	36.0	6.57	15.1
202	6.57	36.0	15.1	[illegible]	0.0012	[illegible]	0.02	35.9	6.57	[illegible]
[illegible]	6.57	36.0	15.1	1,676	[illegible]	[illegible]	[illegible]	35.9	6.57	15.1
[illegible]	6.57	[illegible]	15.1	1,668	[illegible]	[illegible]	[illegible]	35.9	6.56	15.0
[illegible]	6.56	35.9	15.0	1,661	[illegible]	[illegible]	[illegible]	35.9	6.56	15.0
[illegible]	6.56	35.9	15.0	1,664	[illegible]	[illegible]	[illegible]	35.8	6.56	15.0
[illegible]	[illegible]	35.8	15.0	1,647	[illegible]	0.05	[illegible]	35.7	6.56	15.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.56	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	35.6	[illegible]	1,618	0.0012	0.06	0.02	35.5	6.54	[illegible]
[illegible]	6.54	35.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
214	6.54	35.5	14.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
215	6.54	35.5	14.9	1,594	[illegible]	0.06	[illegible]	35.4	6.54	[illegible]
216	6.54	35.4	14.8	[illegible]	[illegible]	[illegible]	[illegible]	35.4	[illegible]	[illegible]
217	6.54	35.4	14.8	[illegible]	[illegible]	[illegible]	[illegible]	35.4	6.53	[illegible]
[illegible]	6.53	35.4	14.8	1,576	[illegible]	[illegible]	0.02	35.3	6.53	14.8
[illegible]	6.53	35.3	[illegible]	1,572	[illegible]	[illegible]	0.02	35.3	6.53	14.8
[illegible]	[illegible]	[illegible]	14.8	1,564	[illegible]	0.05	0.02	35.2	6.53	14.8
[illegible]	[illegible]	35.2	14.8	1,568	[illegible]	0.05	0.02	35.2	6.53	[illegible]
[illegible]	[illegible]	35.2	14.7	[illegible]	[illegible]	0.05	[illegible]	35.2	6.52	[illegible]
[illegible]	[illegible]	[illegible]	14.7	[illegible]	[illegible]	[illegible]	[illegible]	35.2	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.2	[illegible]	14.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.1	[illegible]	[illegible]
[illegible]	6.52	[illegible]	14.7	[illegible]	[illegible]	[illegible]	0.02	35.1	[illegible]	14.7
[illegible]	[illegible]	35.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.6
[illegible]	[illegible]	35.1	14.6	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	14.6
[illegible]	[illegible]	35.0	14.6	1,513	[illegible]	[illegible]	[illegible]	35.0	6.51	14.6
[illegible]	[illegible]	[illegible]	14.6	[illegible]	[illegible]	[illegible]	[illegible]	35.0	6.51	[illegible]
[illegible]	[illegible]	35.0	14.6	[illegible]	[illegible]	0.05	0.02	35.0	[illegible]	[illegible]
[illegible]	[illegible]	35.0	14.6	1,492	[illegible]	[illegible]	0.02	34.9	[illegible]	14.6
[illegible]	6.51	34.9	14.6	1,487	[illegible]	[illegible]	[illegible]	34.9	6.50	14.6
[illegible]	[illegible]	34.9	14.6	1,485	[illegible]	0.05	[illegible]	34.9	6.50	14.6
[illegible]	[illegible]	34.9	14.5	1,488	[illegible]	0.05	[illegible]	34.8	6.50	14.5
[illegible]	[illegible]	34.8	14.5	1,475	[illegible]	0.05	[illegible]	34.8	6.50	14.5
[illegible]	[illegible]	[illegible]	14.5	[illegible]	[illegible]	[illegible]	[illegible]	34.8	[illegible]	14.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.5
[illegible]	[illegible]	34.7	14.5	1,452	[illegible]	[illegible]	0.02	[illegible]	[illegible]	14.4
[illegible]	6.49	34.7	14.5	1,445	[illegible]	0.05	0.02	34.7	6.49	14.4
[illegible]	6.49	[illegible]	14.4	[illegible]	[illegible]	[illegible]	0.02	[illegible]	[illegible]	14.4
[illegible]	6.49	[illegible]	14.4	1,454	[illegible]	[illegible]	0.02	[illegible]	[illegible]	14.4
244	6.48	[illegible]	14.4	1,427	[illegible]	0.04	[illegible]	[illegible]	6.48	[illegible]
245	[illegible]	34.6	14.4	1,427	[illegible]	0.04	0.02	34.6	6.48	[illegible]
246	6.48	34.6	[illegible]	1,415	0.0012	[illegible]	0.02	34.6	[illegible]	[illegible]
247	6.48	34.6	[illegible]	1,400	0.0012	[illegible]	[illegible]	[illegible]	6.48	[illegible]
248	6.48	34.5	[illegible]	1,408	[illegible]	0.04	0.02	34.5	6.47	[illegible]
[illegible]	6.47	34.5	14.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.47	[illegible]
[illegible]	6.47	[illegible]	14.3	[illegible]	[illegible]	0.04	0.02	34.5	6.47	14.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.04	0.02	[illegible]	6.47	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0012	0.04	0.02	34.4	6.47	[illegible]
[illegible]	[illegible]	34.4	[illegible]	[illegible]	0.0012	0.04	0.02	34.4	6.46	14.2
[illegible]	6.46	34.4	14.2	1,375	[illegible]	0.04	0.02	34.4	6.46	14.2
255	6.46	34.4	14.2	1,365	[illegible]	0.04	0.02	34.4	6.46	14.2
[illegible]	6.46	34.4	14.2	[illegible]	[illegible]	[illegible]	0.02	34.4	6.46	[illegible]
[illegible]	6.46	34.4	14.2	1,358	[illegible]	0.04	[illegible]	34.3	6.46	[illegible]
[illegible]	6.46	34.3	14.2	[illegible]	[illegible]	0.04	[illegible]	34.3	6.46	14.1
[illegible]	6.46	34.3	14.1	1,346	[illegible]	0.04	[illegible]	34.3	6.46	14.1
[illegible]	6.45	34.3	14.1	1,341	[illegible]	0.04	0.02	34.3	6.45	14.1
[illegible]	6.45	34.3	14.1	1,332	[illegible]	0.04	0.02	34.3	6.45	14.1
262	6.45	34.3	14.1	1,331	[illegible]	0.04	0.02	34.3	6.45	14.1
[illegible]	6.45	34.2	14.1	1,327	[illegible]	0.04	0.02	34.2	6.45	14.1
[illegible]	6.45	34.2	14.1	[illegible]	[illegible]	0.04	0.02	34.2	6.45	14.1

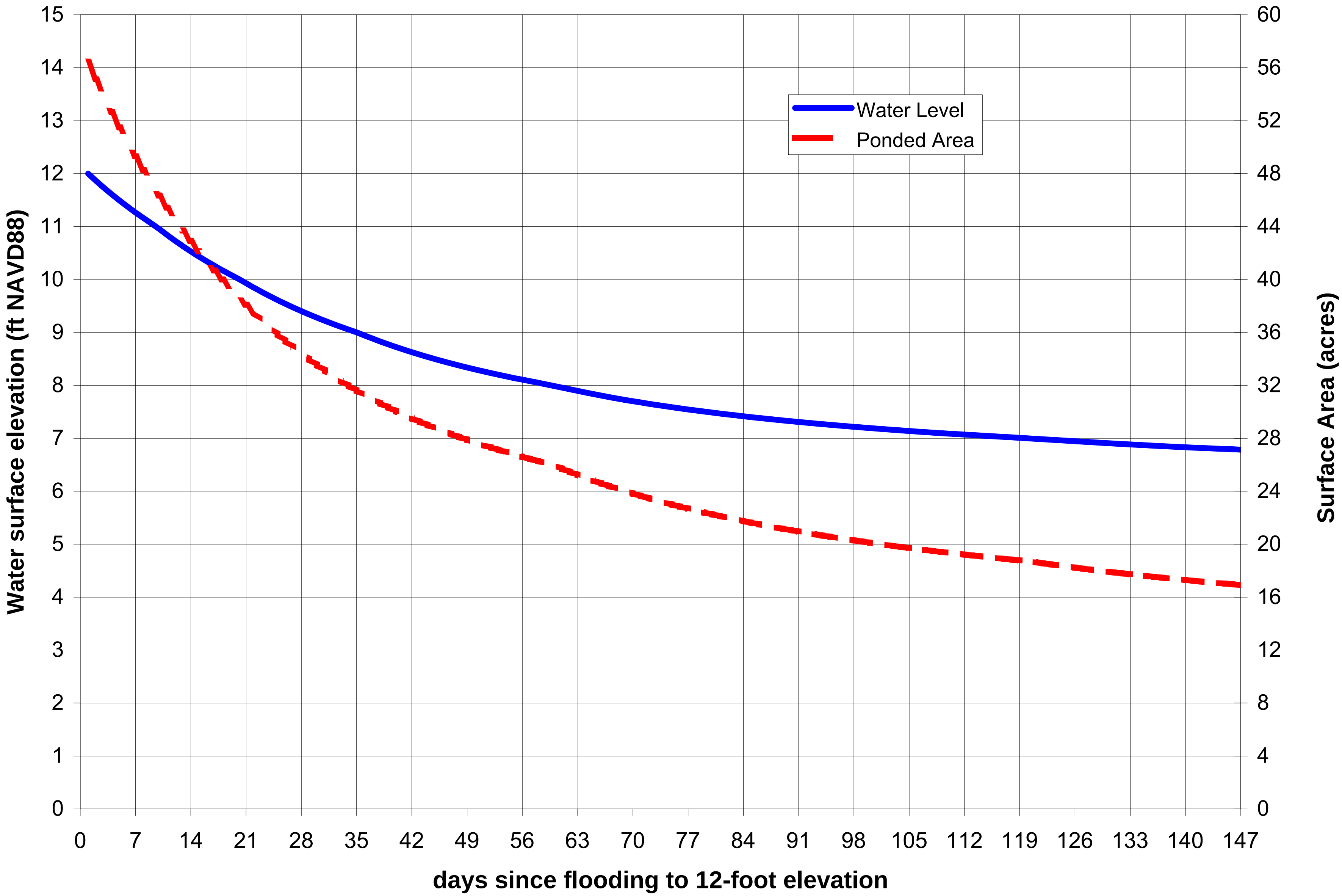
day	Start Pond Level (feet)	Start Volume (AF)	Start Wetted Area (Ac)	GW Outflow - Beach Seepage area (ft^2)	gradient	seepage (AF)	GW inflow (AF)	End Volume (AF)	End Pond Level (feet)	End Wetted Area (Ac)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

day	Start Pond Level (feet)	Start Volume (AF)	Start Wetted Area (Ac)	GW Outflow - Beach Seepage area (ft^2)	gradient	seepage (AF)	GW inflow (AF)	End Volume (AF)	End Pond Level (feet)	End Wetted Area (Ac)
[illegible]	6.38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.5	6.38	[illegible]
332	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.5	[illegible]	[illegible]
333	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.5	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.38	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.38	[illegible]
[illegible]	6.38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
340	6.38	[illegible]	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
341	6.38	[illegible]	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
342	[illegible]	[illegible]	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
343	[illegible]	33.4	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.39	[illegible]
344	[illegible]	33.4	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.30	[illegible]
[illegible]	6.38	[illegible]	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
346	[illegible]	33.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	[illegible]
347	6.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	[illegible]
[illegible]	6.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	[illegible]
[illegible]	6.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
354	6.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	[illegible]
[illegible]	6.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
357	6.37	[illegible]	13.4	[illegible]	[illegible]	[illegible]	[illegible]	33.4	[illegible]	[illegible]
[illegible]	[illegible]	33.4	13.4	[illegible]	[illegible]	[illegible]	[illegible]	33.4	6.37	13.4
[illegible]	[illegible]	[illegible]	13.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.37	13.4
[illegible]	[illegible]	33.3	13.4	[illegible]	[illegible]	[illegible]	[illegible]	33.3	6.37	13.4
[illegible]	[illegible]	33.3	13.4	[illegible]	[illegible]	[illegible]	[illegible]	33.3	6.37	13.4
[illegible]	6.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.3	6.37	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	33.3	13.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.37	13.4
[illegible]	[illegible]	33.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.37	13.4

EXHIBIT F

stage (ft)	volume ft^3	area ft^2	volume AF	area acres
0	0	0	0.0	0.0
1	6,000	42,100	0.1	1.0
2	97,000	157,200	2.2	3.6
3	293,000	227,700	6.7	5.2
4	551,000	289,600	12.6	6.6
5	874,000	358,200	20.1	8.2
6	1,271,000	449,400	29.2	10.3
6.5	1,517,000	632,400	34.8	14.5
7	1,870,000	814,700	42.9	18.7
8	2,820,000	1,133,000	64.7	26.0
9	4,048,000	1,376,100	92.9	31.6
10	5,540,000	1,680,500	127.2	38.6
11	7,329,000	2,035,100	168.3	46.7
12	9,510,000	2,459,300	218.3	56.5
13	12,100,000	2,854,800	277.8	65.5
14	15,090,000	3,214,400	346.4	73.8
15	18,440,000	3,553,700	423.3	81.6
16	22,100,000	3,778,500	507.3	86.7
17	25,960,000	3,953,600	596.0	90.8

EXHIBIT G


Water Level
Ponded Area
Water surface elevation (ft NAVD88)
Surface Area (acres)
days since flooding to 12-foot elevation
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60
0 7 14 21 28 35 42 49 56 63 70 77 84 91 98 105 112 119 126 133 140 147

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 49

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.* Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, *et al.*, Defendants.	Case No.: 3:11-CV-00958 SI **SECOND DECLARATION OF JEWEL SNAVELY**

I, Jewel Snavely, declare as follows:

On September 23, 2011 I submitted a declaration in this matter explaining my observations at Sharp Park earlier this year. In paragraph 3 I explained that on February 21, 2011 I observed a frog egg-mass near the water surface in Horse Stable Pond, and in paragraph 5 I explained that on March 1 "I relocated the egg mass I first discovered on February 21, 2011." By "relocated," I meant that I found the same egg mass a second time. I never touched that egg mass or moved it to another location.

Pursuant to 28 U.S.C. § 1746, I hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on this 30th day of October, 2011. /s Jewel Snavely

Jewel Snavely

I, Brent Plater, hereby attest that Jewel Snavely's concurrence in the e-filing of this document has been obtained.

Executed on: October 30, 2011 Brent Plater

Brent Plater

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 50

1

Egg Mass Data Sheet

Sheet: 1 of ___

Date: 3/5/04	Begin Time: 9:10	Total Time (Min): 10:45	Observers: JE, RZ, CT, LW
Locality: HORSESTABLE POND			

Weather Conditions

Weather: Clear Overcast Rain Pt. Cloudy Mostly Cloudy	Wind: 0 5-20 (mph) <5 >20	Air Temp: C° F° (at 1 m)	Water Temp: 10 C° F° (0.5 m out)

Comments

TREE FROG IN MARSH N OF CULVERT

PUMP ON

FROG JUMPED FROM BANK 300' N OF CULVERT

Red-legged Frog Egg Mass Data

Mass ID	Mass Dimensions (cm)	Egg Dia. (mm)	Dominant Veg.	Water depth (cm)	Attachment	Stage	Comments
1	x 10 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: / Mass:	SCIRPIS		STRANDED
2	x 5 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: / Mass:	SCIRPIS		STRANDED TRAMPLED
3	x 10 x	Sphere / 1/2 sph. / Cube	2 % / % / %	Tot: 5 Mass: 5	SCIRPIS		SILTED
4	x 3 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: 25 Mass: 22	SCIRPIS		SILTED
5	x 7 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: / Mass:	~~SCIRP~~ JAUMEA		STRANDED
6	x 5 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: / Mass:	JAUMEA		STRANDED
7	x 10 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: 12 Mass: 10	CATTAILS		
8	x 5 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: / Mass:	JAUMEA		STRANDED
9	x 5 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: / Mass:	JAUMEA		STRANDED
10	x 12 x	Sphere / 1/2 sph. / Cube	% / % / %	Tot: 6 Mass: 4	CATTAIL		

POSSIBLY HATCH

Red-legged Frog Egg Mass Data

Mass ID	Mass Dimensions (cm)	Egg Dia. (mm)	Dominant Veg.	Water depth (cm)	Attachment	Stage	Comments
11	x 10 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: / Mass: /	CATTAIL		STRANDED
12	x 13 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 6 Mass: 6	"		
13	x 15 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 10 Mass: 10	"		
14	x 7 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: / Mass: /	JUNCUS?		STRANDED
15	x 7 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: Mass: /	"		STRANDED
16	x 12 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 10 Mass: 10	CATTAIL	⊙	
17	x 10 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 15 Mass: 15	CATTAIL		
18	x 10 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 30 Mass: 25	CATTAIL		
19	x 10 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 30 Mass: 30	CATTAIL	⊙	
20	x 10 x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: 30 Mass: 28	CATTAIL		HATCHING 50 TADPOLES 50% of CLUSTER[illegible]
	x x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: Mass:			
	x x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: Mass:			
	x x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: Mass:			
	x x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: Mass:			
	x x	Sphere 1/2 sph. Cube	___% ______ ___% ______ %	Tot: Mass:			

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 52

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.* Plaintiffs, v. CITY AND COUNTY OF SAN FRANCISCO, *et al.*, Defendants.	Case No.: 3:11-CV-00958 SI **DECLARATION OF PETER BAYE, PH.D.**

I, Dr. Peter Baye, declare as follows:

1. I am submitting this declaration in support of plaintiffs' reply brief for its motion for preliminary injunction.

2. My qualifications to provide expert comments on conceptual restoration alternatives for coastal wetlands are based on over 30 years of professional experience in coastal wetland and terrestrial ecology, with emphasis on planning, management, and restoration of degraded coastal wetlands. Following my Ph.D. research in coastal ecology, I spent over twenty years as a professional technical planner and advisor on California coastal wetland restoration and management, with emphasis on recovery of rare and endangered species. I have worked for the U.S. Fish and Wildlife Service to prepare endangered species recovery plans for coastal species and their ecosystems, including estuaries and coastal lagoons, as well as biological opinions prepared for interagency consultations (Section 7 Endangered Species Act). I also worked as senior regulatory staff for the U.S. Army Corps of Engineers San Francisco District. I was a contributing author (3 chapters) to the multi-agency San Francisco Bay Area Wetland Ecosystem Goals Project – Species and Communities Profiles (2000), and the Goals Project (1999) conservation recommendations and background sections I am currently an independent consultant in coastal ecology, specializing in wetland management and restoration plans that benefit recovery of endangered plant, fish and wildlife species, for clients including county

governments, and federal and state resource agencies and non-profit land trusts and conservation organizations. Most of my recent work involves adapting management and restoration design of coastal wetlands to long-term sea level rise and climate change, which is essential to recovering the ecosystems on which endangered species depend – the principal goal of the Endangered Species Act. I was lead ecologist co-author of two California State Parks lagoon management/restoration plans supporting California red-legged frogs in the central coast region (Laguna Creek and Pilarcitos Creek lagoons), and I have provided consulting services and peer review for on coastal lagoon enhancement and restoration projects in State Parks and National Parks jurisdiction in this region (Rodeo Lagoon, Crissy Field (Presidio) Lagoon, Big Lagoon, Scott Creek Lagoon, Waddell Creek Lagoon). I was lead ecologist a co-author of a 2011 technical report on Laguna Salada wetland restoration alternatives (PWA 2011; available at http://wildequity.org/versions/3921), and I was an invited speaker to the Sharp Park advisory working group convened by San Francisco Recreation and Parks Department in November 2010, where I presented an introduction to California coastal lagoon wetlands, with an emphasis on Laguna Salada and similar lagoons.

3. I have studied the remnant dunes and wetlands of Laguna Salada through field observations and detailed investigation of the scientific literature since the early 1990s, with emphasis on coastal geomorphology and vegetation. I have visited Laguna Salada with regular frequency since members of my family moved to Pacifica in the late 1990s. My interest in Laguna Salada stems from a broader long-term scientific interest in geographic variability in ecology of Central Coast and North Coast lagoons and estuaries within California. I conducted intensive investigations of Laguna Salada as part of a planning effort to develop revised ecologically sustainable long-term restoration alternatives adapted to sea level rise and climate change, as lead ecologist for a professional consulting team assembled by ESA-PWA (Philip Williams & Associates), the firm that prepared the original (1992) restoration plans for Laguna Salada.

4. I have directly examined herbarium records, historical aerial photographs, and 19th century U.S. Coast Survey maps (with topography and vegetation type symbols) of Laguna

Salada and most other coastal lagoons of the San Mateo, Santa Cruz, and Marin coast that are comparable with Laguna Salada, as part of my professional work on multiple coastal lagoon wetland management projects. There are multiple, convergent lines of evidence that confirm that the salinity regime influencing the aquatic and wetland vegetation of Laguna Salada in the years prior to golf course construction was inconsistent with a "saline" or "brackish to saline" lagoon, particularly at the landward (eastern) end of the lagoon wetland salinity gradient. Therefore, it is my professional opinion that Laguna Salada was neither a saline tidal lagoon nor a salt marsh prior to construction of Sharp Park Golf Course or in its natural condition.

5. The strongest and most direct evidence of the pre-golf salinity regime and vegetation at the landward end of Laguna Salada prior to golf construction is a ground-level historical photograph taken during the agricultural land use phase, dated approximately in 1928. Attached as Exhibit A. This photograph appears in the 2011 PWA report appendix on historical ecology of Laguna Salada (PWA 2011, Appendix A, Figure A-1), and is also publicly featured as part of a natural interpretive display sign erected on Mori Point by the National Parks Service. The photograph shows clearly identifiable prevalence of marsh plant species that are physiologically intolerant of marine salinity to brackish salinity (polyhaline conditions) – specifically, California tule, cattails, and bulrushes – <u>the same relatively salt-intolerant species that are dominant today along Laguna Salada.</u> The open water appears to be covered by floating mats of sago pondweed, a fresh-brackish submerged vascular plant typically associated with salinity regimes supporting tule-cattail-bulrush marsh. California red-legged frogs use sago pondweed stands as breeding habitat at Laguna Creek Lagoon in Santa Cruz. The tule-cattail-bulrush marsh assemblage in the pre-golf photo essentially the same as the typical vegetation bordering most California red-legged frog breeding habitat sites in other coastal lagoons in the region. Other freshwater marsh species intolerant of even moderately brackish salinity at Laguna Salada appear in early 20^{th} century herbarium collections. (PWA 2011 Appendix A, Table A-1).

6. There is no evidence of any salt marsh plant species in the circa 1928 photograph of pre-golf Laguna Salada at the landward lagoon shore location. The lack of salt marsh vegetation is particularly significant because other aerial and ground photographs of Laguna Salada from the

1920s and earlier show that artificial breach canals were cut through the beach, apparently to drain the lagoon at low tide, so that the lagoon would act as a sump for agricultural drainage of flood-prone lowland croplands of the adjacent valley. Artificial breaching of the barrier beach during the growing season would allow seawater to enter the lagoon before wave action sealed the artificial, unstable breach with sand. Even with artificial breaching to increase growing-season seawater influxes to the lagoon, the landward edge of the lagoon is dominated with cattail, tule, and bulrush marsh vegetation that indicates prevalent fresh-brackish (oligohaline) rather than saline (polyhaline to euhaline) conditions in the landward fringing marshes of the lagoon in the long-term.

7. The folk-name “Laguna Salada” indicates only that the aqueous salinity of the lagoon was sufficiently brackish (for potable or agricultural irrigation water, readily detectable by taste above 2 parts per thousand salt concentration) to be distinguished from predominantly freshwater lagoons with no appreciable salinity (less than 2 ppt). Botanists and geographers in the 19th century, like authors of place-names, did not make the distinction between “brackish” (a term that was brought into widespread scientific descriptive use in the 20th century) and “saline”. Other early historical place-names suggest that salinity-descriptive nomenclature like “Freshwater Bay” used by early navigators of Suisun Bay (actually estuarine: brackish in summer, nearly fresh in winter, contrasting with saline San Francisco Bay) reflected seasonal (like “Arroyo Seco”, dry creek) rather than permanent salinity or hydrological regimes, as well as contrasts with nearby waterbodies. Thus, a naïve literal interpretation of “Laguna Salada” as “Saline Lake” is inconsistent with early maps, early 20th century photos prior to golf construction. (PWA 2011 Appendix F, p. 208-211).

8. Equally naïve and unsupported by historical and scientific evidence is the popular belief (repeated uncritically by some environmental professionals) that golf course construction “created” the fresh-brackish lagoon wetlands at Laguna Salada. There is no evidence from aerial photos that golf construction contributed additional marine overwash flood protection structures to Laguna Salada’s natural barrier beach, and certainly not beyond any minor changes that may have been inherited from the agricultural land use era.

9. Fresh-brackish vegetation is typical of the landward edges of central California coastal lagoons where freshwater stream deltas slightly above high tide elevations intergrade with lagoon fringing wetlands. This is exactly the structure represented in the mid-19th century U.S. Coast Survey map of Laguna Salada: the marsh map symbol is restricted to the southwest corner of the lagoon where three small channels, oriented like marsh distributary channels of the freshwater Sanchez Creek, intersect the marsh. Exhibit B, p. 1 (PWA 2011, Figure A-11). The three distributary channels are shown as artificially channelized seasonal arroyos (freshwater seasonal creek) in the 1897 U.S. Geological Survey map of Laguna Salada. The 19th and 20th century US Coast Survey and subsequent U.S. Geological Survey maps all represent Laguna Salada as a <u>closed lagoon with no open tidal inlet to sustain high salinity.</u> Exhibit B, p. 2. This is consistent with other coastal lagoons with full exposure to Pacific swell and exhibit mostly ephemeral outlets for freshwater overflowing from the lagoon side of the barrier beach – not tidal inlets. Analysis of wave power and lagoon discharge (potential tidal prism or water volume) relationships (PWA 2011) confirms that tidal inlets would be inherently unstable and prone to closure Laguna Salada.

10. Salt marshes and saline coastal lagoons in northern and central California are associated with the seaward ends of lagoons with at least seasonally stable tidal inlets. All other coastal stream mouth lagoons south and north of Laguna Salada in Marin to Santa Cruz counties exhibit fresh-brackish marsh or freshwater-dependent riparian woodland at their landward ends, in both modern and historical conditions. Many of these lagoons also support persistent populations of California red-legged frogs in the fresh-brackish landward portions of lagoon wetland gradients, even where past impoundments (dams) to increase freshwater resources have not been constructed, or have been degraded.

11. It is also my professional opinion that artificially low lagoon water surface elevations and shallow lagoon depths maintained by pumping water from Horse Stable Pond promote the spread of tule and cattail marsh and increase lagoon vulnerability to excessive seawater flooding and salinity intrusion. Tules (*Schoenoplectus californicus*) and cattails (*Typha latifolia*, *T. angustifolia*) dominate the lowest, most deeply submerged marsh at Laguna Salada. Both are

capable of spreading by creeping below-ground stems (rhizomes) in mud where water depths are three feet or less, with slower spread in relatively deeper water up to limits of tolerance. The limits of tolerance for submergence of tules may be closer to 4 feet. It is my professional opinion that increasing lagoon water depths to 4 feet or greater during most of the winter and spring months at Laguna Salada would most likely exceed their limits of submergence tolerance, and cause cessation of spread and thinning or dieback of marsh vegetation. Raising lagoon levels by one to two feet, at least through the winter and spring each year for multiple consecutive years would likely "drown" most of the marsh that has slowly and progressively invaded the lagoon bed after decades of artificially low managed water levels. This would likely convert most of the marsh-invaded lagoon bed back to shallow open water. Increased gradual fluctuation of lagoon levels over multiple years (not rapid brief fluctuations due to pump operation to stabilize levels around fixed average elevations) would also help narrow the elevation range of tules and cattails, and restrict the upper limit of tule and cattail spread during drier years. This would promote growth of seasonal marsh with lower-growing rush, spikerush, and sedge vegetation along the upper marsh areas. It is therefore my professional opinion that the assertion that the existing water-level management by pumps at Laguna Salada inhibits the expansion of tules and cattails is scientifically unsupported, and I believe it is flatly incorrect. The converse is true: the pumping regime at Laguna Salada, which is designed to stabilize water levels below a maximum elevation above +7.5 ft NAVD, is likely the primary cause of progressive long-term tule-cattail spread across the artificially and permanently shallow lagoon.

12. It is my professional opinion that golf course mowing of freshwater marsh and lagoon pumping during peak flooding periods create the vegetation structure and hydrology conditions that are unsuitable breeding habitat. At Sharp Park, particularly in the Northeastern portion of Sharp Park closest to Laguna Salada, the City of San Francisco regularly mows marsh vegetation down to a low turf height. This mowing, combined with the abrupt dewatering of Laguna Salada following heavy rainfall and lagoon flooding, are the primary reasons that California red-legged frog egg masses laid in this area become stranded. If mowing were ceased as requested by the

Plaintiffs, the seasonally flooded marsh edges attractive to red-legged frog breeding could be allowed to remain shallowly flooded during winter months.

13. The fact that the golf encroaches into the marsh by mowing the marsh vegetation is consistently neglected by all technical reports prepared by the City of San Francisco and its consultants that I have reviewed, all of which describe the "flooding of fairways" as though the flooding were entirely unnatural flooding of uplands, rather than the normal seasonal re-occupation of the lagoon's wetland margins.

Pursuant to 28 U.S.C. § 1746, I hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on this 4th day of November, 2011. /s/ Peter Baye

Peter Baye

I, Brent Plater, hereby attest that Peter Baye's concurrence in the e-filing of this document has been obtained.

Executed on: November 4, 2011

Brent Plater

EXHIBIT A

EXHBIT A
Declaration of Dr. Peter Baye
1928 Photograph of Laguna Salada
Before Golf Course Construction
Showing salt-intolerant plant species.

EXHIBIT B

EXHIBIT B, P.1
Declaration of Dr. Peter Baye
Mid-19th Century U.S. Coast Survey Map of Laguna Salada

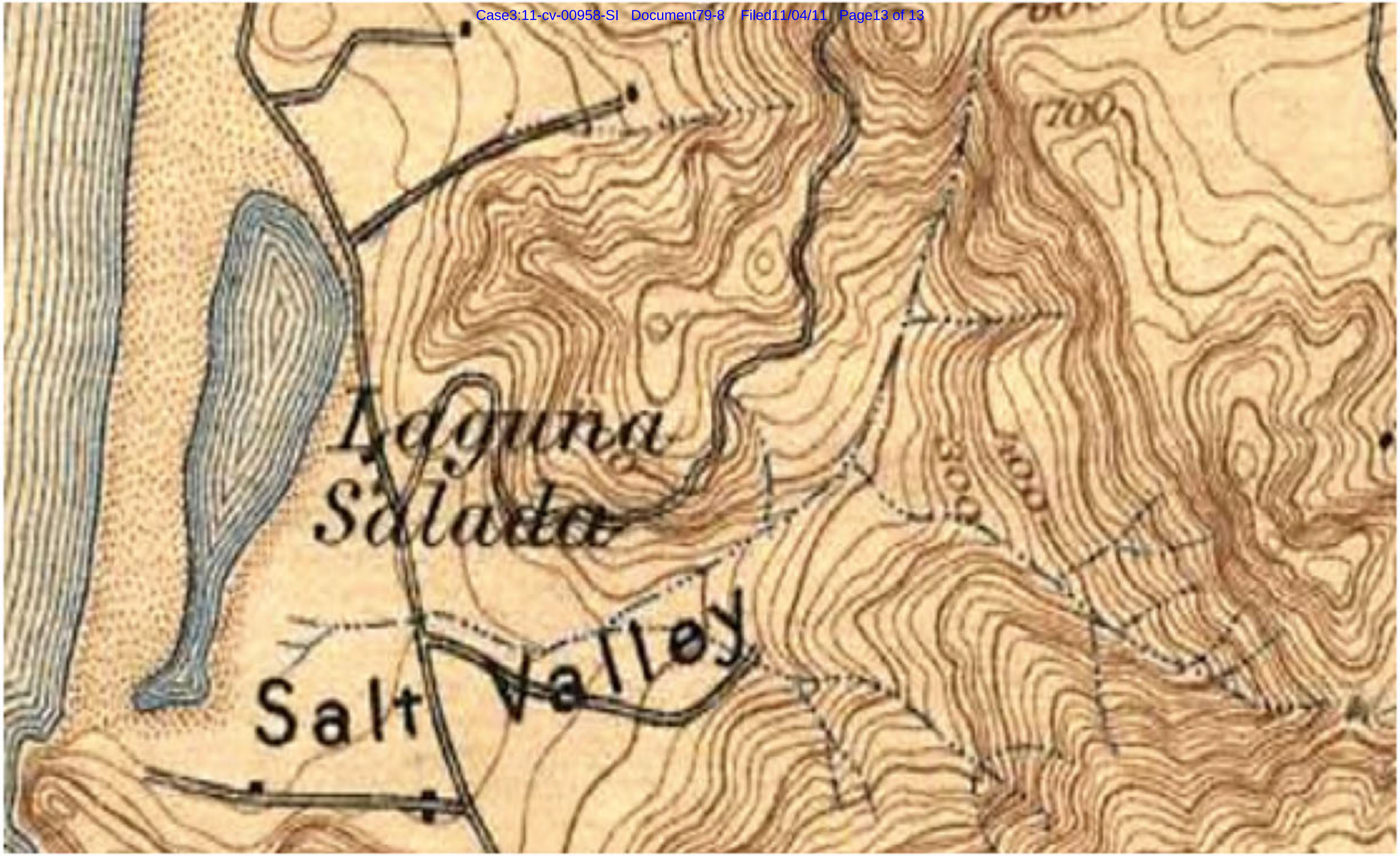


EXHIBIT B, P. 2
Declaration of Dr. Peter Baye
1897 U.S. Geological Survey Map of Laguna Salada

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 53

Attachment A: Sharp Park Compliance Plan Map

Wild Equity Institute v. City and County of San Francisco,
No. 3:11-CV-00958 SI (N.D. Cal.)

Plaintiffs' Motion for a Preliminary Injunction

Plaintiffs' Exhibit 51

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

WILD EQUITY INSTITUTE, a non-profit corporation, *et al.*

Plaintiffs,

v.

CITY AND COUNTY OF SAN FRANCISCO, *et al.*,

Defendants.

Case No.: 3:11-CV-00958 SI

MONITORING DECLARATION OF SAM MCNALLY

I, Sam McNally, declare as follows:

1. I am a resident of San Francisco, California, and a graduate student at San Francisco State University. My graduate work focuses on amphibians and amphibian declines, and I am very familiar with the California red-legged frog.

2. On September 19, 2011, from approximately 3:00pm until approximately 4:45pm, I monitored compliance plan activities at Sharp Park Golf Course. From approximately 3:13pm until 4:00pm, I observed lawn mowing activities on and near hole 9, 10, and 13. The lawn mowing occurred within 20 feet of aquatic features near these holes. Attached as Exhibit A is a photograph of the mowing activity I took at the time.

3. I also observed several golf carts driving on and off golf cart paths on this day.

Pursuant to 28 U.S.C. § 1746, I hereby declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on this __28th__ day of October, 2011.

Sam McNally
Sam McNally

EXHIBIT A
Declaration of Sam McNally
Sharp Park Golf Course, Hole 9
September 19, 2011, 3:19 p.m.