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WILCOX RANCH

Solano Land Trust

2008-2011 ECOLOGICAL MONITORING REPORT

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J-140

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1.0 INTRODUCTION

This report summarizes the methods and results of the 4-year vernal pool monitoring conducted between 2008 and 2011, as well as recommendations for future monitoring and assessments for Wilcox Ranch ('site') in Solano County, CA (**Figure 1**). Monitoring surveys were conducted on East Wilcox Ranch, a 1,497-acre Preserve Area comprised of high quality vernal pool and grassland habitat that is owned and managed by the Solano Land Trust (SLT). Vernal pools on site range from large playa pools to small vernal pools and swales (**Figure 2**). The site provides documented habitat for multiple special-status species including vernal pool fairy shrimp (*Branchinecta lynchi*), Conservancy fairy shrimp (*B. conservatio*), vernal pool tadpole shrimp (*Lepidurus packardi*), California tiger salamander (*Ambystoma californiense*) (CTS) and the delta green ground beetle (*Elaphrus viridis*), as documented by Larry Serpa (Serpa 2002). The site also provides habitat for midvalley fairy shrimp (*B. mesovallensis*), a non-listed large branchiopod.

Two to three rounds of surveys were conducted annually by Vollmar Natural Lands Consulting (VNLC), assessing water quality, aquatic invertebrate abundance and richness, amphibian abundance and richness, and general pool characteristics. Surveys were conducted or assisted by VNLC biologists under federal recovery permit # TE-035336, with Ms. Cassie Pinnell serving as VNLC project manager. Additional survey assistance was provided by VNLC biologists including Mr. John Vollmar, Ms. Wendy Renz, Ms. Roxy Hulme and Mr. Jake Schweitzer, as well as Mr. Ben Wallace of Solano Land Trust, Mr. Christopher Searcy of UC Davis and Mr. Adam Clause of UC Davis. These surveys were authorized by USFWS (tracking numbers include: 81420-2009-TA-0279, 81420-2010-TA-0189, 81420-2011-TA-0147). Individual year monitoring results were presented in reports to SLT (2008, 2009 and 2010) and in 90-day reports to USFWS (2008-2011). Statistical analysis of the data was conducted by Ms. Renz and Mr. Eric Smith of VNLC. This report was prepared by Ms. Pinnell with assistance from Ms. Renz and Mr. Smith.

Figure 1. Vicinity Map of Wilcox Ranch, Solano County, CA. Image Taken from GoogleMaps, 2008.

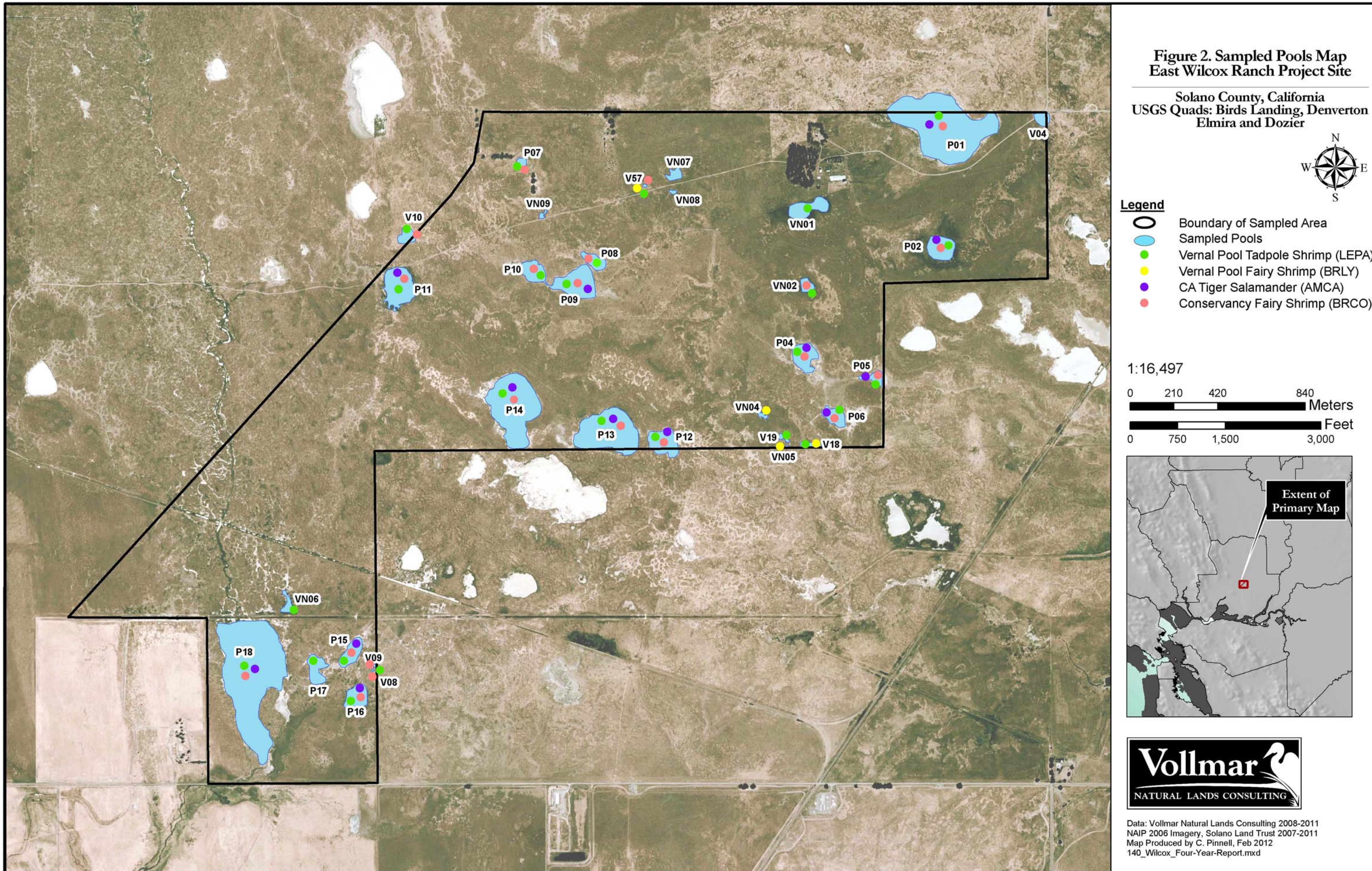


Figure 2. Sampled Pools Map
East Wilcox Ranch Project Site
Solano County, California
USGS Quads: Birds Landing, Denverton
Elmira and Dozier
N
W
E
S
Legend
Boundary of Sampled Area
Sampled Pools
Vernal Pool Tadpole Shrimp (LEPA)
Vernal Pool Fairy Shrimp (BRLY)
CA Tiger Salamander (AMCA)
Conservancy Fairy Shrimp (BRCO)
1:16,497
0 210 420 840 Meters
0 750 1,500 3,000 Feet
Extent of Primary Map
Vollmar
NATURAL LANDS CONSULTING
Data: Vollmar Natural Lands Consulting 2008-2011
NAIP 2006 Imagery, Solano Land Trust 2007-2011
Map Produced by C. Pinnell, Feb 2012
140_Wilcox_Four-Year-Report.mxd
P01
V04
P07
VN07
V57
VN08
VN09
VN01
V10
P02
P08
P10
P09
P11
VN02
P04
P05
P14
VN04
P06
P13
P12
V19
V18
VN05
VN06
P15
P18
V09
P17
V08
P16

2.0 METHODS

Table 1 presents survey dates and types of surveys conducted by VNLC on Wilcox Ranch from 2008-2011:

Table 1. Types of Surveys and Dates Conducted by VNLC 2008-2011

<table>
<tr><th>Types of Surveys</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th></tr>
<tr><td>Aquatic Invertebrates/
Large Branchiopods/
Water Quality
‘Round 1’</td><td>2/11/2008</td><td>2/17/2009</td><td>1/25/2010
2/5/2010</td><td rowspan="2">2/10/2011
2/14/2011
2/17/2011</td></tr>
<tr><td>Aquatic Invertebrates/
Large Branchiopods/
Water Quality
‘Round 2’</td><td>2/27/2008
3/1/2008</td><td>3/3/2009
3/12/2009</td><td>3/5/2010</td></tr>
<tr><td>Amphibians/
Large Branchiopods/
Water Quality
‘Round 3’</td><td>4/9/2008
4/17/2008</td><td>4/20/2009</td><td>4/21/2010</td><td>4/22/2011
5/2/2011</td></tr>
</table>

2.1 Water Quality

Water quality sampling was conducted in a total of 37 pools and adjacent swale complexes, including 29 pools sampled across all four years and 8 pools that were added as potential habitat after the first sampling year. Visits corresponded to early, mid and late season inundation periods within the sampled pools (**Table 1**). Water quality sampling was conducted concurrently with the aquatic invertebrate and amphibian sampling.

Water quality monitoring included turbidity (NTU), temperature (^{0}C), pH, salinity (ppt), and dissolved oxygen (mg/l). Pool depth was also recorded. All data except turbidity and pool depth were collected using a YSI 556 multi-parameter handheld electronic meter. Data were collected by placing the instrument probe below the water surface (minimum two inches) within an undisturbed area of the sampled pool. Turbidity was measured by filling a vial from an undisturbed portion of the water column and placing it inside a Hach 2100 portable turbidimeter. A minimum of one set of water quality data was collected from the center of each pool during each survey. Pool depth was sampled by using a pole with marked increments of one inch. To achieve the most accurate results by minimizing pool disturbance, water quality data were collected before pools were surveyed for invertebrates, amphibians or pool depth. The data collected for each sampled pool were recorded onto standardized data sheets, then entered into spreadsheets for analysis.

2.2 Aquatic Invertebrates

Aquatic invertebrate sampling was conducted concurrently with the water quality sampling (see **Table 1**). Aquatic invertebrate monitoring data for the project includes presence/absence, species richness (number of different species in sample volume), species abundance (total number of individuals observed), and ratio of generalist to more specialized vernal pool species (vernal pool indicators: VPI).

Survey dates were selected to optimize detection of target species. Monitoring surveys are ideally conducted once the pools have held water long enough for branchiopods to mature. Additionally, survey dates were selected based on regional detections of target species. Sampling was conducted using a technique that provides semi-quantitative data on aquatic invertebrate and amphibian richness and abundance. Sampling was conducted using a 650-µm mesh size dip-net. At each sampled pool, a total of five 10-meter cross-sweeps (resembling a moving 'figure 8') were made with the dip-net. The five sweeps were made in a transect of the pool, with the first at the edge and the fifth at the center. This cross-sweep sampling technique is used to stir up the bottom of the pool, which increases the chance of capturing vernal pool tadpole shrimp and other bottom-dwelling invertebrates, as well as those existing in the upper water column.

After the completion of each sample sweep, the contents of the net were examined for large branchiopods and amphibians. Additionally, all macroscopic aquatic invertebrates were identified to the lowest justifiable taxon during the first sweep and recorded on standardized data sheets. The numbers of individuals observed within each taxonomic group were recorded in abundance classes (**Table 2**). If large branchiopods were not detected during the initial semi-quantitative sampling technique, additional sweeps were made with the net. If other taxonomic groups of aquatic invertebrates were detected during the additional sweeps, an 'X' notes their presence. After the taxonomic identification and enumeration were completed, the contents of the net were placed back into the pool from which they were collected.

Table 2. Abundance Classes Assigned for Aquatic Invertebrate and Large Branchiopod Surveys, VNLC 2008-2011

Class	Rating	Value Used in Database
Rare	≤2	1
Not Common	3-10	3
Common	11-49	11
Very Common	50-100	50
Abundant	>100	101
Super Abundant	>1000	1001
Present	X	NA; counted for # taxa
Carapace (LEPA)	CA	NA; counted for # taxa

2.3 California Tiger Salamander

Surveys for larval California tiger salamander (CTS) were conducted during only one round annually in April, and were not protocol-level. The surveys were intended only to determine presence and estimate relative abundance, and not to determine absence. Pools were sampled using a seine. Seine surveys were conducted by two biologists using a 10'x 4' seine with ¼-inch mesh. The biologists seined throughout all of the pools with standing water. Quantitative sampling was conducted by seining 3 sweeps of 15 meters each per pool. If CTS was not detected in these initial sweeps, then additional sweeps for presence were conducted in the pools. The amount of time spent seining each pool for presence varied per pool size. Smaller pools could be thoroughly sampled in as little as 5 minutes, whereas larger pools required as much as 25 minutes. Data on all amphibian, aquatic invertebrate, and fish species captured or observed were recorded on standardized data sheets. Other pond habitat data were also recorded including current and maximum potential ponding depth and pond habitat type. Surveys for adult CTS were not conducted.

2.4 Data Analysis

All aquatic invertebrate and amphibian abundance counts and water quality measurements were entered into an Excel spreadsheet directly from the field datasheets that were used during the four years (2008-2011) of data collection at Wilcox Ranch. The aquatic invertebrate sampling protocol included five dip net sweeps collected along a transect from the edge of the pool to the center, but the associated aquatic invertebrates were recorded from only the first dip net sweep. The amphibian sampling protocol involved several seine sweeps (usually three). Therefore, any comparisons targeting associated aquatic invertebrates or water quality were compared against 'sweep 1' for large branchiopods and 'seine 1' for CTS to maintain consistency. The total (sum abundance) of all dip net sweeps and all seine sweeps was also calculated and entered into the database for species of interest, including all large branchiopods and CTS, to be able to compare a method that used only a first sweep versus a method that used multiple sweeps. Most abundance data was recorded using classes (except CTS which used direct counts), which were then converted to numeric values for the data analysis (**Table 2**).

Water quality measurements were recorded with the following units: salinity in parts per thousand (ppt); temperature in degrees Celsius; dissolved oxygen in milligram per liter (mg/L) and in percent dissolved oxygen (%DO); conductivity in milliSiemens per centimeter (mS/cm); pH in pH units; and turbidity in nephelometric turbidity units (NTU). When multiple water quality readings were recorded, only the first one was entered into the database. When water quality data was missing, appropriate formulas where applied (if possible) to calculate the missing values from other values that had been recorded during the field visit (e.g. salinity values were missing from data sheets for all 2011 visits due to equipment failure and from pool V16 on 2/11/2008 and were thus calculated from specific conductivity values).

Seven parameters were calculated from the aquatic sampling data to examine richness and abundance: 1) number of invertebrate taxa; 2) number of special-stauts large branchiopod taxa; 3) number of vernal pool indicator taxa where eight taxa were designated as "vernal pool indicators," including vernal pool tadpole shrimp, Conservancy fairy shrimp, vernal pool fairy shrimp, and *Branchinecta* species for unidentified juveniles, calanoid copepods, cyclopod copepods, Cladocera, and Microturbellaria; 4) percentage of vernal pool indicator taxa (calculated as number of vernal pool indicator taxa divided by number of invertebrate taxa); 5) invertebrate abundance; 6) vernal pool indicator invertebrate abundance; and 7) percentage vernal pool indicator invertebrate abundance. Descriptive statistics were calculated for all fields in the database, including for these seven calculated parameters, using JMP-IN (Sall 2001), including: average (mean) with standard error; range (minimum and maximum reported); and standard deviation. Statistics for vernal pool fairy shrimp were not calculated, as so few occurrences were observed on the site an adequate sample size was not available.

Using a standard box and whiskers plot to examine all parameters, outliers were identified and excluded when appropriate (e.g., outliers in pH were identified as those measurements with pH< 5.8 and pH >10, which excluded all measurements taken in 2010 when the water quality meter pH probe was malfunctioning). Distributions that did not fit the Normal distribution were transformed when possible to achieve normality (e.g. the salinity distribution was transformed to a normal curve using the log base 10 transformation).

The abundance of the three main species of interest (vernal pool tadpole shrimp, Conservancy fairy shrimp and CTS) was examined over the four years of the study using both the first sweep and the total sweep amounts. Vernal pool fairy shrimp were observed so rarely (most years had no observations) that this species was not considered in the data analysis. The mean number of invertebrate taxa and the mean number of vernal pool indicator taxa for vernal pools versus playa pools over the four years of the study were examined using bar graphs that also showed the standard error (SE) in the mean. Similarly, the mean invertebrate abundance and the vernal pool indicator invertebrate abundance for vernal pools versus playa pools over the four years of the study were examined with bar graphs showing SE. Correlations between abundance of the species of interest and explanatory variables such as water quality measurements were examined by conducting Spearman's rank correlation, with the correlation coefficient rho being used to examine the strength and direction of correlation, and the p value being used to check significance of the relationship ($\alpha = .05$).

Repeated-measures statistics were conducted for all aquatic invertebrate and amphibian abundance counts and water quality measurements (to prevent pseudoreplication) for all pools over all four years to determine if there were any statistically significant differences in the parameters between years, or between survey rounds. All distributions for each of the parameters were previously checked for normality assumptions and transformed to meet normality assumptions, as described above. Normally-distributed parameters were analyzed with a repeated-measures ANOVA in JMP 9. Distributions that did not fit the normal curve, and could not be transformed, were tested either by Friedman's test, or, in the case of data sets where no more than two years could be matched, by the Wilcoxon rank-sum non-parametric test. ANOVAs were conducted on the transformed data sets. Differences in the parameters were considered significant when p-values were 0.05 or less, or highly significant when p-values were 0.001 or less. All p-values reported are from ANOVA, except for the invertebrate abundances where the Friedman or Wilcoxon test was run, therefore the Friedman or Wilcoxon p-value are reported for these. Bonferroni corrections (on either p-value or alpha level) were not performed as there is still considerable debate regarding their efficacy and such corrections can cause a substantial loss in precision of the findings.

3.0 RESULTS

The following results are based on four years of monitoring data that was collected 2-3 times annually. Due to the naturally high levels of seasonal and annual variation for vernal pool species and water quality, even significant results should be considered representative of a small 'snapshot' in time.

3.1 Seasonal and Annual Variation

We tested for significant differences for each parameter both year-to-year and between sampling rounds, in order to detect seasonal and annual variation. For normally-distributed data, we used a repeated-measures ANOVA in JMP. For non-normal data (i.e. abundance data) we instead performed Friedman's test in PAST (PAleontologic STatistics 2.04). For some pools, particularly short-lived vernal pools, there was insufficient data to test more than two years or sampling rounds with Friedman's test, and so we instead compared the two most complete years or rounds with Wilcoxon's test, in PAST. The results of these tests are provided in **Table 3**.

Table 3. Annual and Seasonal Variation Analysis, 2008-2011, compiled by VNLC.

Parameter	Year by Pool Type		Effective Survey Rounds by Pool Type (nested)		Effective Survey Rounds by Year			
	Playa Pools	Vernal Pools	Playa Pools	Vernal Pools	2008	2009	2010	2011
Salinity (ppt)	*	*	**	*	**	**	**	**
Temp C (water)	**	*	**	**	**	**	-	**
DO (mg/L)	*	*	-	-	**	**	-	-
SpC (mS/cm)	-	-	**	*	**	**	**	**
pH (units) (2010 left out)	-	-	-	-	**	**	N/A	-
Turbidity (NTU)	-	-	*	*	**	**	**	-
Corrected Max Depth (in)	*	*	*	**	**	**	-	-
LEPA+	*	-	-	-	*	*	-	-
Total LEPA+	**	-	**	-	*	-	-	-
BRCO+	*	-	**	-	*	-	*	*
Total BRCO+	*	-	**	-	*	*	**	-
CYCA	-	-	*	-	*	*	*	*
BRSP+	-	-	-	-	-	-	-	-
Ostracoda	*	-	-	-	-	*	-	-
Calanoida+	**	*	**	-	-	*	-	**
Cyclopoda+	*	-	*	-	-	*	**	*
Cladocera+	-	*	**	-	-	*	-	-
Dytiscidae	-	-	-	-	-	-	-	-
Hydrophillidae	-	-	-	-	-	-	-	-
Notonectidae	*	-	*	-	-	-	-	*
Corixidae	*	-	**	-	-	*	*	*
Culicidae	-	-	-	-	-	-	-	-
Chironomidae	-	-	-	-	-	-	-	-
Lymnaeidae	*	-	**	-	-	-	*	*
Microturbellaria+	-	-	-	-	-	-	-	-

Parameter	Year by Pool Type		Effective Survey Rounds by Pool Type (nested)		Effective Survey Rounds by Year			
	Playa Pools	Vernal Pools	Playa Pools	Vernal Pools	2008	2009	2010	2011
CTS	**	-	**	-	-	*	*	-
Total CTS	**	-	**	-	-	*	**	**
PSRE	*	-	*	-	-	-	-	*
# Invert. Taxa	**	**	**	-	*	*	-	N/A
# Listed Large Branch. Taxa	-	-	-	-	*	-	N/A	-
# VPI Taxa	**	*	*	**	*	-	-	N/A
% VPI Taxa (#VPI/#Invert)	*	-	**	*	-	**	*	N/A
Invert. Abundance	-	*	*	-	-	*	-	*
VPI Invert. Abundance	-	-	*	-	-	*	-	*
% VPI Invert. Abundance	-	-	**	*	-	-	-	*

** = 0.001
* = 0.05

These results show significant variation between sampling years and sampling rounds, particularly in the water quality parameters and in the number of taxa observed. Abundances of the target species all show significant seasonal and annual variation. Statistical power was generally lower in vernal pools than in playa pools, due to the ephemeral nature of vernal pools giving fewer opportunities for re-sampling.

3.1.1 Conservancy Fairy Shrimp Peak Levels

Round 2 (generally late February or early March) detected significantly higher numbers of Conservancy fairy shrimp than surveys conducted in January-early February or April, based on Wilcoxon rank-sum, non-parametric analysis ($p<0.05$). These results support our observations at comparable sites in the region that this species is generally best detected in February or March, and is often greatly reduced by April. Abundance classes assigned per sweep ranged from 0-11 (Rare, Not Common or Common). Cumulative abundance (5 sweep total) ranged from 0-175.

3.1.2 Vernal Pool Tadpole Shrimp Peak Levels

This species persisted in high numbers during Round 2 and Round 3, indicating that it tends to persist later in the year than Conservancy fairy shrimp. However, to maximize efficiency, sampling for this species should occur with the Conservancy fairy shrimp sampling (late February or early March), rather than with CTS. Abundance classes assigned per sweep ranged from 0-11 (Rare, Not Common or Common). Cumulative abundance (5 sweep total) ranged from 0-39.

3.1.3 CTS Peak Levels

Surveys for CTS larvae were incidental to Branchiopod monitoring during Rounds 1 or 2. Detection levels were not sufficiently high to compare abundance levels across years. Abundance per seine sweep during Round 3 (April) ranged from 0-41 (no abundance classes assigned as total CTS larvae was counted during each survey). Survey protocol for CTS larvae recommends surveys between early March and late May. Due to our field observations in the region, we support these recommendations and suggest that April is generally an ideal time to sample for CTS larvae on the site.

3.1.4 Vernal Pool Fairy Shrimp Peak Levels

This species was only detected once during all four years. In 2009, vernal pool fairy shrimp was observed in mid March in Pool V19, as well as in very low numbers in two small swale pools, V18 and VN05. Surveys were conducted in mid-March of 2007 by Mr. Russ Huddleston and vernal pool fairy shrimp were observed in the same pool (labeled as V15 by Mr. Huddleston). Additionally, he observed a very low number of vernal pool fairy shrimp in Pool V57. Too little data exists for this species to statistically determine peak detection timing. However, based on past surveys and results from nearby occurrences, late February or early March should detect this species (though it is also likely that they may be present earlier in the season).

Table 4. Minimum, Maximum and Mean (+/-SE) of Special-Status Species for Target Survey Rounds (2008-2011) at Wilcox Ranch, Solano County, CA. Data collected and compiled by Vollmar Natural Lands Consulting 2008-2011.

		2008			2009			2010			2011			ALL 4 YEARS		
		Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max
CTS	All Pools	NA	NA	NA	5.00±2.15	0	36	10.05±2.61	0	41	3.35±1.04	0	17	4.90±1.01	0	41
	All Playa	NA	NA	NA	5.63±2.38	0	36	11.06±2.96	0	41	3.38±1.14	0	17	5.27±1.14	0	41
	All Vernal	NA	NA	NA	0	0	0	4.33±3.84	0	12	3.25±2.93	0	12	2.60±1.57	0	12
LEPA	All Pools	13.24±2.47	0	36	1.11±0.29	0	4	2.55±0.76	0	13	4.90±0.97	0	23	5.21±0.77	0	36
	All Playa	16.00±2.42	0	36	1.18±0.35	0	4	3.06±0.91	0	13	6.88±1.39	0	23	6.63±1.00	0	36
	All Vernal	6.60±5.40	0	28	1.00±0.53	0	3	0.5±0.29	0	1	2.30±0.94	0	11	2.48±1.02	0	28
BRCO	All Pools	24.41±10.33	0	175	7.11±3.14	0	55	9.45±6.36	0	129	9.60±2.80	0	55	12.00±2.84	0	175
	All Playa	33.58±13.91	0	175	10.91±4.85	0	55	11.44±7.92	0	129	14.76±4.38	0	55	17.09±4.14	0	175
	All Vernal	2.40±1.75	0	9	1.14±1.68	0	4	1.50±1.50	0	6	2.85±1.85	0	23	2.17±0.90	0	23

Target Survey Rounds

CTS = Round 3 (Late April - Early May)

LEPA = Round 2 (Mid - Late February)

BRCO = Round 2 (Mid - Late February)

N/A = No surveys conducted

3.2 Distribution and Abundance

3.2.1 Special-status Species

The abundance of all special-status species varied significantly during the four years of monitoring (**Table 3**). The annual minimum, maximum and mean target species abundance levels for all pools (sum total of 5 sweeps or 3 seines) during peak detection are presented above in **Table 4**. The 2008 large branchiopod site wide ('all pools') abundance levels were significantly higher than the 2009-2011 monitoring years. 2009 was also the only year that vernal pool fairy shrimp was observed during the surveys. 2008 also had the highest and most consistent precipitation of the four sample years (**Table 8**). Larval CTS levels were highest in 2010, however, 2008 sampling did not occur for this species. Playa pools supported higher abundances of each species than the vernal pools, with the biggest variation between pool types occurring for Conservancy fairy shrimp. **Table 5** presents annual special-status species presence by pool.

Table 5. Special-Status Species Presence by Year

Pool	BRCO					LEPA					BRLY					AMCA		
Year	07	08	09	10	11	07	08	09	10	11	07	08	09	10	11	09	10	11
P01	X	X	X	X		X	X	X	X								X	
P02	X					X	X	X	X								X	
P04	X	X	X	X		X	X	X	X							X	X	
P05	X	X	X	X		X	X	X	X								X	
P06	X	X	X	X		X	X	X	X							X	X	
P07		X	X	X		X	X	X	X									
P08	X	X		X		X	X	X	X									
P09	X	X	X	X		X	X	X	X							X		
P10	X	X					X	X	X									
P11	X	X	X	X		X	X	X	X							X	X	
P12	X	X	X	X		X	X	X	X							X	X	
P13	X	X	X	X		X	X	X	X							X	X	
P14	X	X	X			X	X	X	X							X	X	
P15	X	X	X	X		X	X	X	X								X	
P16		X	X	X			X	X	X							X	X	
P17							X		X									
P18	X	X	X			X	X	X	X							X	X	
V04																		
V08			X															
V09			X			X			X									
V10	X	X	X	X		X	X	X	X									
V18(15)						X	X		X		X		X					
V19								X	X									
V57		X				X	X	X	X		X							
VN01								X										
VN02			X					X										
VN04*													X					
VN05*													X					
VN06									X								X	
VN07																		
VN08																		
VN09																		

*=Swale of V19

3.2.2 Associated Aquatic Invertebrates

Table 6 presents the mean (and SE) aquatic invertebrate data collected during the first sweep from all pools during monitoring years 2008-2011. The table also presents the results for vernal pools versus playa pools, as well as overall site mean average ('All'). Playa pools consistently had higher numbers of taxa (richness) as well as abundance than vernal pools. Overall, the site consistently has a higher richness and abundance of vernal pool indicator species than of generalist invertebrate species.

Table 6. Aquatic Invertebrate Mean and SE Values by Year (2008-2011), Pool Type (Playa and Vernal) and Overall (All). Data collected and compiled by VNLC, 2008-2011.

Parameter[1]	2008	2009	2010	2011	Vernal	Playa	All
# Invert taxa	4.4 ±0.3	3.4 ± 0.3	4.8 ± 0.3	6.3 ± 0.4	4.0 ±0.3	5.1 ± 0.2	4.8 ± 0.2
# Listed branch taxa	0.9 ± 0.1	0.7 ± 0.1	0.8 ± 0.1	0.9 ± 0.1	0.5 ± 0.1	0.9 ± 0.1	0.8 ± 0.1
# VPI taxa	2.7 ± 0.2	1.6 ± 0.1	2.1 ± 0.2	2.7 ± 0.2	1.9 ± 0.2	2.4 ± 0.1	2.3 ± 0.1
% VPI taxa	61%±3%	56%±5%	45%±3%	48%±4%	50%±3%	52%±2%	52%±2%
Invert abundance	64.7±12.0	47.2±9.3	39.6±4.6	94.8±11.6	45.7±9.6	69.2±5.6	61.1± 5.0
VPI invert abundance	51.3±9.4	39.4±8.9	28.3±3.9	75.4±10.2	33.7±7.1	55.7±5.3	48.1±4.3
% VPI invert abundance	76%±3%	74%±5%	65%±4%	72%±5%	66%±4%	74%±3%	71%±2%

1. # Invert taxa = Mean number of aquatic invertebrate taxa observed in sweep 1
   # Listed branch taxa = Mean number of listed large branchiopod species observed in sweep 1
   #VPI taxa = Mean number of vernal pool indicator taxa observed in sweep 1
   %VPI taxa = Percentage of vernal pool indicator taxa observed in sweep 1 (#VPI taxa/#Invert taxa)
   Invert abundance = Mean number of invertebrates observed in sweep 1
   VPI invert abundance = Mean number of vernal pool indicator invertebrates observed in sweep 1
   % VPI invert abundance = Percentage of vernal pool indicator taxa observed in sweep 1 (VPI invert abundance/Invert abundance)

3.3 Habitat Characteristics for Species of Interest

Water quality data was collected twice at each pool (edge and center). Multiple weak correlations were observed between water quality and large branchiopods. However, none of the correlations generated a rho value high enough to indicate a notable linear relationship between any of the water quality and large branchiopod abundance data. Many of the water quality parameters fluctuate greatly (even within the course of one day) and any study designed to assess the relationship between water quality and large branchiopods would require more frequent sampling or a continual data logger. Due to the very small sample size (2-3 rounds per year) and the wide variability in the data, the following results are provided only to inform future research questions and are not intended to be used to inform management actions.

3.3.1 Vernal Pool Tadpole Shrimp

A correlation was observed between vernal pool tadpole shrimp abundance and turbidity. However, a linear relationship was not detected during the regression analysis. Researchers at CSU Sacramento (Kneitel Lab) are currently assessing the relationship between this species and turbidity and the possibility that this species may increase pool turbidity through bioturbation activities (J. Kneitel, pers comm.). Additionally, temperature and abundance were nearly correlated. Researchers have indicated that temperature may play an important role in large branchiopod development (Helm 1998).

3.3.2 Conservancy Fairy Shrimp
Correlations were detected between Conservancy fairy shrimp abundance and turbidity and maximum current pool depth. General field observations made by VNLC researchers at sites throughout this species range corroborate these general correlations, though a more comprehensive study is necessary to confirm this relationship.

3.3.3 California Tiger Salamander
Correlations were observed between CTS abundance and maximum current pool depth. This agrees with VNLC observations that CTS require deep, long-lived pools for breeding. A relationship may exist between other parameters and CTS larvae abundance, but our sampling schedule for CTS is targeted only at late-season detection, and is therefore too infrequent to reliably capture these relationships.

3.3.4 Vernal Pool Fairy Shrimp
No statistics were run on vernal pool fairy shrimp, as this species was only observed in very few pools between 2008 and 2011, and was observed in very low abundance levels. However, general observations suggest that this species is more associated with smaller, vernal pools than with the large playa pools on site. This species is not generally observed in the same pools as Conservancy fairy shrimp (VNLC general regional field observations), however co-occurrence is known from nearby preserves (ex. Montezuma Wetlands Preserve in Solano County).

3.4 Water Quality Results

Table 7 presents the range of water quality results recorded for the seven water quality parameters recorded during the four years of monitoring at Wilcox Ranch.

Table 7. Water Quality Range Results from All Pools, 2008-2011, Wilcox Ranch, Solano County. Data collected and compiled by Vollmar Natural Lands Consulting.

Parameter	Site Range	Playa Pool Range	Vernal Pool Range
Salinity (ppt)	0 - 0.67	0.02 - 0.67	0.01 - 0.32
Water Temperature (C)	7 - 34	7 - 34	7 - 29
DO (mg/L)	0.08 - 16.12	0.24 - 15.14	0.08 - 16.12
Specific Conductivity (mS/cm)	0.01 - 0.99	0.03 - 0.99	0.01 - 0.45
pH (units)	6.26 - 9.46	6.64 - 9.46	6.26 - 8.08
Turbidity[1] (NTU)	4.5 - 1000+	8 - 1000+	4.5 - 1000+
Current Maximum Depth (in)	1 - 26	1 - 26	1 - 17

1. Turbidimeter only measures up to 1000 NTU

3.5 Meteorological Data

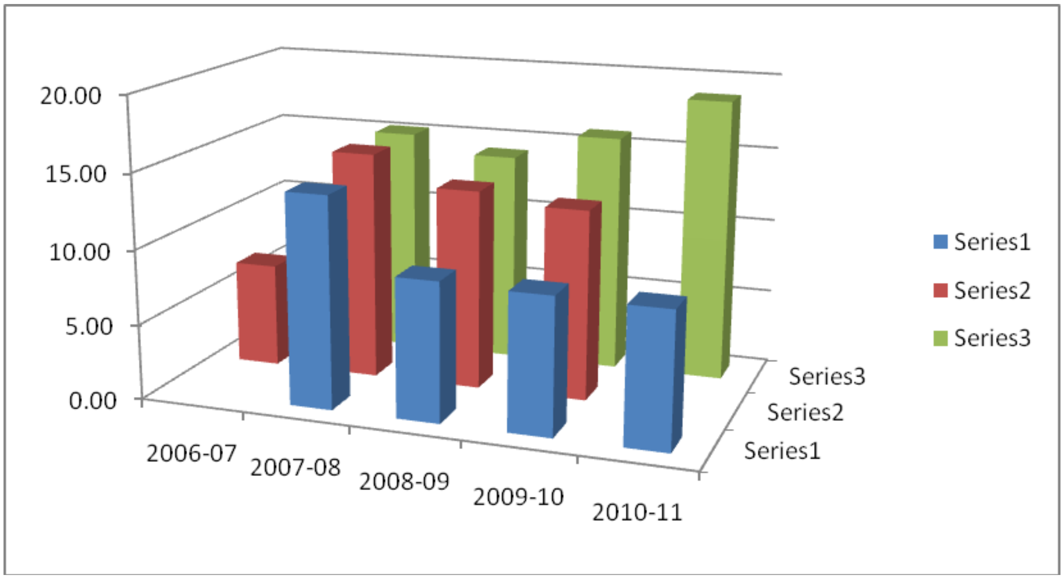
Ponding levels and water quality are directly influenced by precipitation and evaporation patterns throughout the ponding season. Cumulative precipitation data for each monitoring round is provided below in **Table 8** and **Figure 3**. Overall, Round 1 precipitation levels were highest in 2008 with approximately 14 inches, with the following three years each at approximately 9 inches. The 2008 monitoring season had the smallest range of precipitation with only 1 inch difference between Round 1 and Round 3. The precipitation variation between rounds was greater in the following years (5, 6 and 10 inches, respectively).

Table 8. Total precipitation (inches) prior to each round of monitoring (CIMIS Station #121, Dixon CA). Table prepared by Solano Land Trust, 2012.

Year	Round 1	Round 2	Round 3
2006-07	N/A	6.95	N/A
2007-08	14.08	15.22	15.23
2008-09	9.25	13.31	14.10
2009-10	9.07	12.64	15.89
2010-11	8.97	N/A	18.81

Precipitation data obtained from CIMIS Station #121, Dixon CA, measured from October 1 to the day prior to monitoring round.

Figure 3. Precipitation Levels (inches) per Survey Round (Series) During Monitoring Years at Wilcox Ranch, Solano County, CA. Figure prepared by Solano Land Trust, 2012.



The temperature and evapotranspiration levels presented below in **Table 9** represent air temperature and evaporation rates, which are factors in ponding levels and duration. Overall, average temperatures were consistently lower in January and increased throughout the monitoring season. The warmest year was 2009, which exhibited both the highest average air temperatures as well as the highest maximum air temperatures for each month.

Table 9. Monthly Temperatures (Minimum, Maximum and Average) and Evapotranspiration Rates During Monitoring Years at Wilcox Ranch, Solano County, CA.

Month Year	Avg Max Air Temp (F)	Avg Min Air Temp (F)	Avg Air Temp (F)	Ref. ETo (in)
Jan-07	57.1	28.1	41.9	2.3
Feb-07	58.0	37.6	47.6	1.7
Mar-07	69.4	39.4	53.5	3.8
Apr-07	71.9	42.9	57.2	5.1
Jan-08	49.6	32.8	40.6	1.0
Feb-08	58.0	34.0	45.8	2.2
Mar-08	65.4	37.5	51.2	4.3
Apr-08	71.1	38.2	55.3	7.8
Jan-09	62.4	36.0	48.3	1.8
Feb-09	62.6	41.8	52.0	1.7
Mar-09	70.2	44.0	57.0	4.4
Apr-09	77.1	46.3	61.7	5.9
Jan-10	54.0	40.2	47.2	0.7
Feb-10	57.2	38.8	48.0	1.3
Mar-10	62.6	36.9	49.8	3.6
Apr-10	64.0	38.8	51.5	4.0
Jan-11	48.7	28.5	36.2	1.0
Feb-11	58.7	34.2	46.3	2.4
Mar-11	61.1	41.8	51.6	2.6
Apr-11	68.2	41.4	55.3	5.1

Additional precipitation and temperature data is available in Appendix D.

4.0 DISCUSSION AND FUTURE MONITORING RECOMMENDATIONS

The following recommendations for a revised monitoring protocol are intended to improve efficiency of monitoring for SLT while maintaining the quality of data. Additionally, these recommendations are compiled with the understanding that a high level of variation occurs annually and seasonally within and between pools (**Table 3**).

4.1 Sample Size

A total of 37 pools have been sampled at the site between 2008 and 2011. Many of these pools support few to no large branchiopods, and therefore serve as poor indicators of overall site habitat quality for the target listed species. Therefore, we propose that a subset of pools that support strong populations of special-status species be selected as the regular indicator of overall site health. Under this design, the remaining pools will be sampled on a less frequent basis, as discussed in **Section 4.2** below. The proposed subset is comprised of 12 pools that are distributed across the project site in a pattern designed to reflect changes to any portion of the site. These pools were not selected randomly and were instead selected to provide information about the condition of the pools that support the majority of the special-status species on the site. **Table 10** lists the pools (and target species present) recommended for the target subset.

Table 10. Pools Recommended for Target Monitoring at Wilcox Ranch, Solano County, CA.

Pool ID	BRCO present	LEPA present	CTS present	BRLY present
P01	X	X	X	
P04	X	X	X	
P05	X	X	X	
P06	X	X	X	
P07	X	X	X	
P12	X	X	X	
P13	X	X	X	
P14	X	X	X	
P16	X	X	X	
P17	X	X	X	
V10	X	X		
V18		X		X

4.2 Monitoring Frequency and Timing

We recommend monitoring the subset (12 pools) every other year and monitoring the full suite of pools (approximately 37) every 6 years (**Table 11**). Due to the high variability of inter-annual population levels (**Table 3**), we suggest that annual monitoring is excessive and unnecessary for a preserved site with very low levels of environmental degradation or changes in management.

Table 11. Proposed Pool Monitoring Schedule for Wilcox Ranch, Solano County, CA.

Pools Surveyed	Frequency	Corresponding Years
Subset (12)	Every 2 years	2013, 2015, 2017, 2019, 2021, 2023, 2025, etc.
Total (37)	Every 6 years	2013, 2019, 2025, etc.

As per survey timing, large branchiopod and larval California tiger salamander populations are dependent on pool ponding patterns and precipitation and weather patterns. Survey dates should be selected to maximize the potential to identify the species in the field. In general, vernal pool tadpole shrimp and Conservancy fairy shrimp tend to occur later in the season (as adults) than some of the early species including vernal pool fairy shrimp. Larval CTS tend to occur later in the season than most large branchiopods. Therefore, we are recommending two rounds of surveys per survey year, once in late February/early March for large branchiopods and once in mid April/early May for CA tiger salamanders. These recommendations are based on an analysis of abundance data from 4 years of sampling on the project site (**Section 3.1**), as well as observations from other sites in the region.

4.3 Methods

4.3.1 Special-status Species

We recommend collecting large branchiopod and CTS data in a manner than can be compared to past data from this site, but also in a way that can be compared to data collected at other sites in the region. The statistical data analysis included in this report used only the first sweep data of the five sweeps. For large branchiopods we are recommending a hybridization of VNLC methods and methods proposed by Carol Witham and USFWS in 'Listed Vernal Pool Crustaceans Routine Monitoring Protocol for Preserved Areas'. These guidelines have not yet been adopted universally, but will likely be the methods used by other preserve managers in the region in the near future. For CTS, we recommend a continuation of the methods employed in the last three years, which were suggested by UC Davis researcher Mr. Searcy who has been conducting CTS research at the nearby Jepson Prairie Preserve. **Table 12** outlines the proposed methods.

4.3.2 Associated Species

Associated aquatic invertebrate taxa can be identified to the most appropriate taxonomic level and recorded during large branchiopod surveys. The abundance and diversity of the associated aquatic invertebrate communities may be useful in assessing or recognizing environmental shifts or patterns that may affect large branchiopods. However, these species are not the target species and the identification process could significantly increase the amount of time required to complete the surveys. Therefore, we recommend that aquatic invertebrates be recorded at a minimum for one sweep per pool during every 6^{th} year of surveying. If the surveyor is familiar with aquatic invertebrate species, then more frequent monitoring could be undertaken. A photo appendix of the most common aquatic invertebrates observed at Wilcox Ranch is included as **Appendix C**. These species are also included in the standardized datasheet used for Wilcox Ranch monitoring (**Appendix B**).

Table 12. Large Branchiopod and CTS Sampling Methods Specifications

Unit	VNLC (2008-2011)	VNLC 4-year Data Analysis	Witham et al	Recommendation
	Sampling (Large Branchiopods)			
Volume per pool	2040 L (72ft^3)	408 L (14.4ft^3)	565L-1695L (20ft^3 – 60ft^3)	816 L (28.8ft^3)
Sweep length	10m	10m	None	10m
Number of sweeps	5 (408L each)	1 (first sweep)	5-15 (113L each)	2
Net area	408cm^2	408cm^2	None	408cm^2
Mesh size	650 microns	650 microns	None	approx. 650 microns
Sweep location	Edge to center	Edge	Microhabitats	Edge and center
	Abundance classes assigned per species (Large Branchiopods)			
Record intervals	Per sweep	Per sweep	Average across all sweeps	Per sweep
Abundance Classes	Rare (≤2)	Rare (≤2)	Low (<1 per sweep)	Record individual numbers between 1 and 25 to compare to both methods. Use abundance class 'Common' for 26-49
	Not Common (3-10)	Not Common (3-10)	Med (1-5 per sweep)	
	Common (11-49)	Common (11-49)	High (6-25 per sweep)	
	Very Common (50-100)	Very Common (50-100)	Very High (>25 per sweep)	Very Common (50-100)
	Abundant (>100)	Abundant (>100)		Abundant (>100)
	Super Abundant (>1000)	Super Abundant (>1000)		Super Abundant (>1000)

Unit	VNLC (2008-2011)	Recommendation
Sampling (CTS)		
Sweep length	15m	15m
Number of sweeps	3	3
Seine size	10' x 4'	10' x 4'
Mesh size	¼-inch	¼-inch
Sweep location	Variable	Edge to center
Additional (if no CTS is detected)	5-25 minutes, pending size	5-25 minutes, pending size

4.3.3 Water Quality

Current depth, temperature and turbidity are more commonly considered a potentially important factor in large branchiopod and CTS abundance or presence than other water quality parameters (author's personal observation). These parameters are also easy to record and do not require an expensive water quality instrument. Therefore, we recommend that these three parameters be recorded per pool during every survey. Depth should be recorded at the deepest portion of the pool by using either a yard stick or the handle of the invertebrate sampling net (a four foot stretch of pvc pipe labeled in 1 inch increments with a permanent marker). Temperature should be recorded with a thermometer at the edge and near the center by dropping the thermometer to the bottom of the pool (flag thermometer with brightly colored flagging to retrieve when finished). Turbidity can be recorded using visual estimates that correlate with visibility of the water column as follows: 1) completely clear view to bottom (tap water); 2) some murky coloring apparent in water column, but still able to identify vegetation on pool bottom; 3) moderate murky coloring, only able to identify vegetation in upper water column; 4) completely murky, no visibility in water column (chocolate milk). All surveyors should be calibrated against each other before conducting visual estimates.

4.3.4 Habitat Quality

Additional notes can easily be made during all survey rounds and can inform any changes to site conditions and habitat quality. Observations should be recorded on trash, algal levels, and predators (fish), as well as any other notes important to site manager.

5.0 BASELINE AND THRESHOLD LEVELS

A population 'baseline level' is defined in this report as a population abundance estimate that can be compared against future data to assess the directional trend, if any, of the target population. Baseline levels are presented for each of the three target special-status species and are compiled from four years of data (2008-2011). Due to the relatively short window of data available, these 4-year baseline levels are intended to be preliminary and should be re-calculated after 10 years of monitoring has been completed to provide a more comprehensive estimate of site populations.

After the completion of 10 years of monitoring, the baseline levels will be re-calculated utilizing the 10-year window of monitoring data, to determine the population 'threshold levels'. These threshold levels will be set as indicator levels to determine whether management or research actions should be instigated to address potential population declines. The development and use of these threshold levels will be described in greater detail below in **Section 6**.

The postponement of the development of threshold levels is based on the high annual variability of population levels for all target species observed on this site (**Table 3**). The premature development of threshold levels, utilizing only a small 'snapshot' of this annual variability, would likely result in the implementation of unnecessary research or management activities that may work against the natural variability of these species' population levels. Therefore, the following 'baseline levels' are intended only to provide the site manager an idea of general directional trending over the next 6 years (until the 10 year results have been compiled), and are not intended to trigger management or research actions.

However, the postponement of developing threshold levels is based on the assumption that the management activities and site conditions of Wilcox Ranch will not change significantly before the 10 years of baseline data has been collected. If significant changes occur on site, the future population data will not be useful as baseline data as it may reflect a response to site alterations and will not represent natural variability.

5.1. Four-Year Baseline Level Development

The following baselines were developed to provide abundance estimates that are comparable to future monitoring results. Therefore, the data used to calculate these levels was selected as a subset of the 2008-2011 data from the target rounds and pool subset described in the future monitoring recommendations outlined in **Section 4**. **Table 10** describes the subset data used to compile these baseline levels. For a list of exact survey dates associated with the selected target survey rounds, see **Table 1** (**Section 2.0**).

Table 13. Data Selected to Compile Baseline Levels for Target Species

Species	Target Survey Round	Pool Subset
Conservancy Fairy Shrimp	Round 2	P01, P04, P05, P06, P07, P12, P13, P14, P16, P17, V10
Vernal Pool Tadpole Shrimp	Round 2	
CA Tiger Salamander	Round 3	
Vernal Pool Fairy Shrimp	Round 2	V18

The selected data was used to calculate the sum total of all five sweeps per pool. This total was then calculated with other pool totals to create a mean (and SE) abundance per year and across all four years.

5.2 Four Year Baseline Levels of Target Species

The following levels represent the mean and SE of species abundance (5 sweep total) of the subset pools, across the four monitoring years. **Table 14** also presents the mean and SE for each of the monitoring years.

5.2.1 Conservancy Fairy Shrimp

The four-year baseline levels for Conservancy fairy shrimp are 18.36 $\pm$ 4.92 per subset pool. This mean is higher than the mean levels for three of the monitoring years, due to the relatively high levels of 2008. However, only one of the years (2010) had levels below the SE of the four-year mean (13.44).

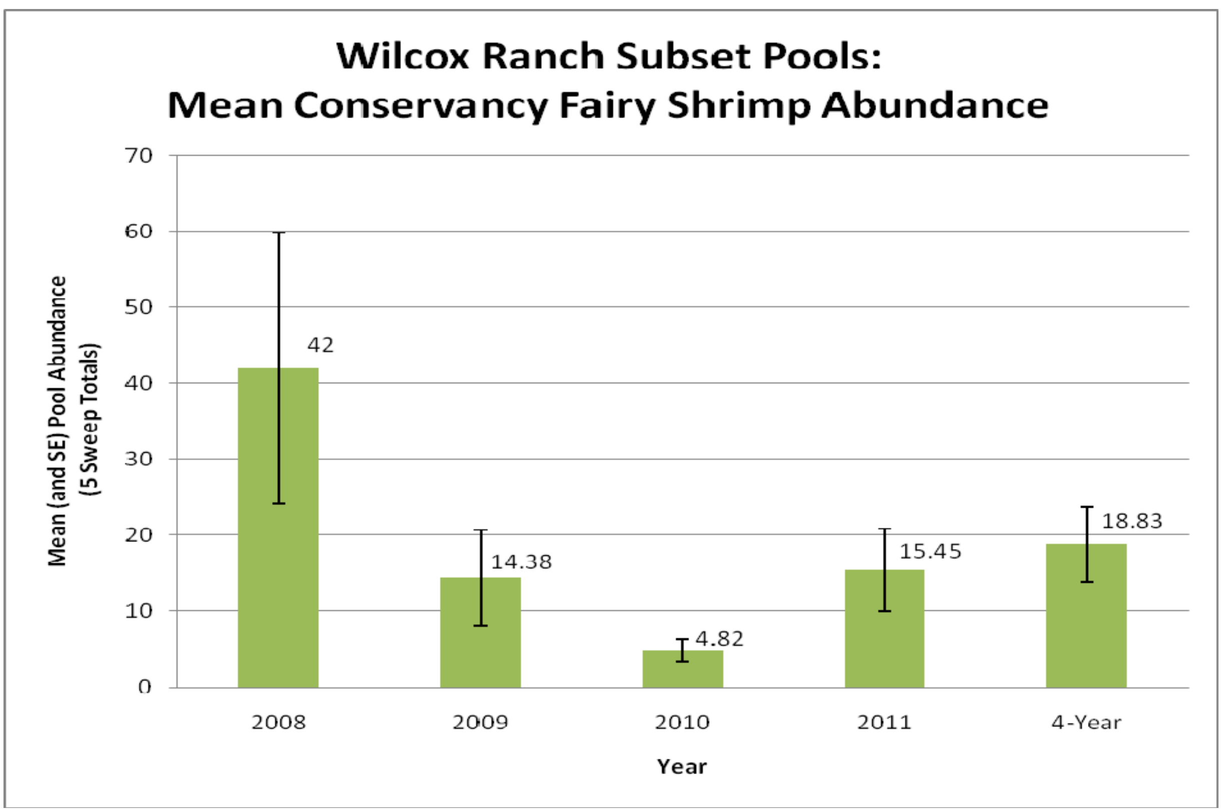


Table 14. Four-Year Baseline Abundance Levels (5 sweep or 3 seine total) of Target Species, Wilcox Ranch, Solano County. Data collected and compiled by Vollmar Natural Lands Consulting, 2008-2011.

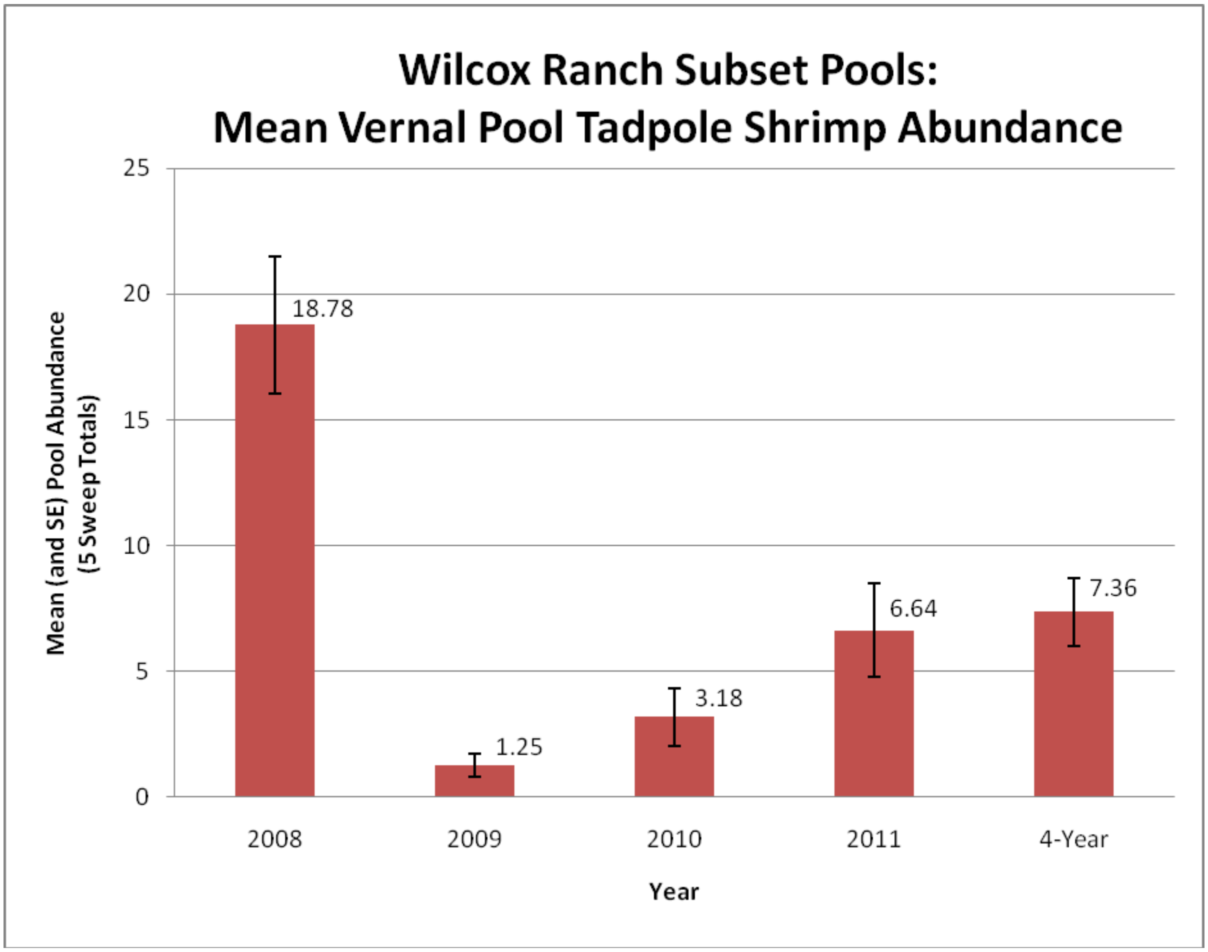
		2008			2009			2010			2011			ALL 4 YEARS		
		Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max
CTS	All Pools	NA	NA	NA	5.00±2.15	0	36	10.05±2.61	0	41	3.35±1.04	0	17	4.90±1.01	0	41
	All Playa	NA	NA	NA	5.63±2.38	0	36	11.06±2.96	0	41	3.38±1.14	0	17	5.27±1.14	0	41
	All Vernal	NA	NA	NA	0	0	0	4.33±3.84	0	12	3.25±2.93	0	12	2.60±1.57	0	12
	Subset Pools	NA	NA	NA	7.60±3.69	0	36	11.91±3.21	0	30	3.00±1.00	0	10	5.78±1.42	0	36
LEPA	All Pools	13.24±2.47	0	36	1.11±0.29	0	4	2.55±0.76	0	13	4.90±0.97	0	23	5.21±0.77	0	36
	All Playa	16.00±2.42	0	36	1.18±0.35	0	4	3.06±0.91	0	13	6.88±1.39	0	23	6.63±1.00	0	36
	All Vernal	6.60±5.40	0	28	1.00±0.53	0	3	0.5±0.29	0	1	2.30±0.94	0	11	2.48±1.02	0	28
	Subset Pools	18.78±2.73	12	36	1.25±0.45	0	4	3.18±1.13	0	13	6.64±1.86	0	23	7.36±1.36	0	36
BRCO	All Pools	24.41±10.33	0	175	7.11±3.14	0	55	9.45±6.36	0	129	9.60±2.80	0	55	12.00±2.84	0	175
	All Playa	33.58±13.91	0	175	10.91±4.85	0	55	11.44±7.92	0	129	14.76±4.38	0	55	17.09±4.14	0	175
	All Vernal	2.40±1.75	0	9	1.14±1.68	0	4	1.50±1.50	0	6	2.85±1.85	0	23	2.17±0.90	0	23
	Subset Pools	42.00±17.83	0	175	14.38±6.29	0	55	4.82±1.51	0	13	15.45±5.43	0	55	18.36±4.92	0	175

Subset of Pools: P01, P04, P05, P06, P07, P12, P13, P14, P16, P17, V10

Target Survey Rounds
CTS = Round 3 (Late April - Early May)
LEPA = Round 2 (Mid - Late February)
BRCO = Round 2 (Mid - Late February)

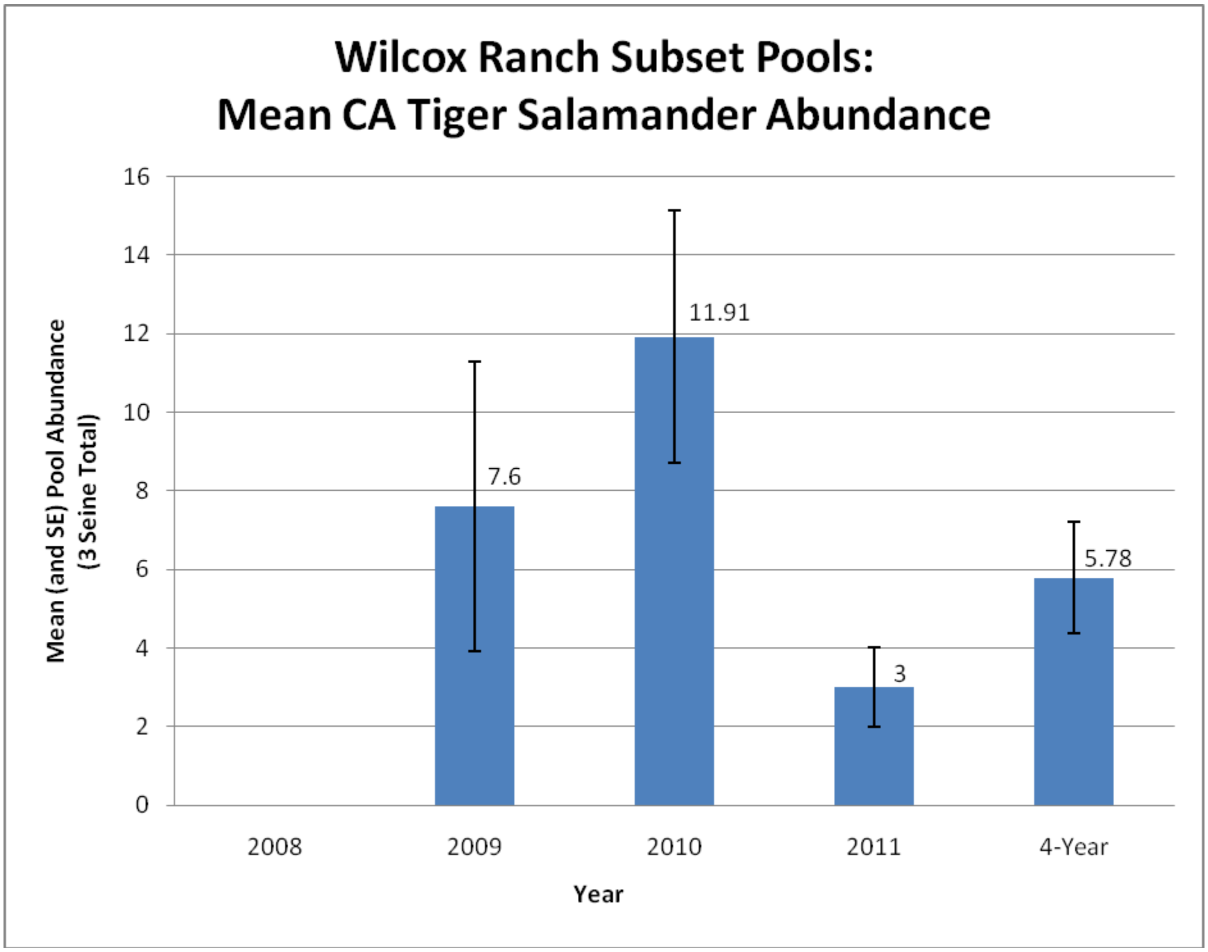
5.2.2 Vernal Pool Tadpole Shrimp

The 4-year subset pool mean for vernal pool tadpole shrimp is 7.36 ± 1.36. This level is also higher than all years excepting 2008 due to the relatively high values in 2008.



5.2.3 California Tiger Salamander

The 4-year baseline abundance level for CTS is 5.78 ± 1.42. This value is lower than both 2009 and 2010, due to the low levels observed in 2010.



5.2.4 Vernal Pool Fairy Shrimp

Due to the very low levels detected during our surveys, we are not recommending the development of a baseline level for vernal pool fairy shrimp. Instead, presence in occupied pools should be recorded and tracked. *Branchinecta lynchi* detections at Wilcox Ranch East are summarized below.

Table 15. First round survey results for all pools with *B. lynchi* detections at Wilcox Ranch East.

YEAR	SURVEY DATE	PRE-SURVEY PRECIP.(")		Pool # Hudd: V15, Pinn: V18			Pool # V57			Pool # VN05			LEAD SURVEYOR
		60 Dy	Oct>	# BRLY	Pool Depth	Pool Area	# BRLY	Pool Depth	Pool Area	# BRLY	Pool Depth	Pool Area	
2002	02/15	6.49	13.88	NS	NS	NS	NS	NS	NS	NS	NS	NS	Serpa
2007	03/12	3.56	6.95	**50**	**10 cm**	**40m^2**	**3**	**8 cm**	**375m^2**	NS	NS	NS	Huddleston
2008	03/01	9.90	14.08	?	?	?	0	10cm	*	NS	NS	NS	Pinnell
2009	02/17	4.92	9.25	NS	NS	NS	0	36 cm	*	NS	NS	NS	Pinnell
	03/03	7.90	13.31	**1**	**20 cm**	*	NS	NS	NS	NS	NS	NS	Pinnell
	03/12	7.87	13.33	NS	NS	NS	NS	NS	NS	**1**	**15 cm**	*	Renz/Voll
2010	02/05	8.98	9.07	0	31 cm	*	0	38 cm	*	NS	NS	*	Pinnell
2011	02/10	5.62	8.97	**1**	**25 cm**	*	0	41 cm	*	NS	NS	NS	Pinnell

Key:

*	No data reported from the survey.
?	Survey location not indicated in 2008 report. No *B. lynchi* found that year, but unclear whether this pool was surveyed.
[Blank]	No survey reported from that pool during.

Notes:

Precipitation data obtained from CIMIS Station #121, Dixon CA, measured from October 1 to the day prior to monitoring round.
Pool #V15 as designated by Huddleston (2007) was labeled as Pool #V18 in 2009-2011 Vollmar reports.
Location of Pool#V18 is unclear in 2008 Vollmar report 2008 survey location map is not included.

5.3 Ten Year Threshold Level Development

After the 10-year monitoring window has been completed, the results from all 10 years will be re-calculated to develop threshold levels. These threshold levels will be used to compare future monitoring results and determine whether additional management or research actions are necessary to assess and address future population level declines.

The development of the 10-year threshold levels should be completed as follows:

1. Enter all data into the excel spreadsheet in specified format (available from VNLC)
2. Convert abundance classes into numeric values (**Table 2**)
3. Calculate mean and standard error (SE) of 5 sweeps for each year per species per pool (across all 10 years)

The resulting values for each pool should represent the 10-year mean and SE of each pool per target species. The lower bounds of the SE of this mean should be the established threshold level of that species in the target pool (mean value minus the standard error). These threshold levels will be used to assess when future management or research actions should be implemented to address declining population levels of each target species. This process is described below in **Section 6.**

6.0 USING THRESHOLD LEVELS TO INFORM FUTURE MANAGEMENT

The subset pools on site will be surveyed every other year following the 10-year baseline development period (Years 12, 14, 16, etc.). All pools on site will be surveyed every six years (Years 12, 18, 24, etc.), as described in **Table 11**.

Future survey results should be compared against the site 10-year baseline levels by calculating the subset mean and SE of the target species abundance. If the future monitoring levels are significantly lower than the baseline, a series of steps should be followed before initiating research or management actions. These steps are described below.

1. Check methods and data for errors.
   a. If errors are found then correct and recalculate final results.
2. Assess whether survey timing was appropriate.
   a. Check with other surveyors in the region (e.g. VNLC, Carol Witham, etc.) or agencies to determine whether surveys were conducted in the window of regional species presence.
3. Assess regional patterns.
   a. Discuss abundance levels at other sites with regional surveyors or agencies to determine if low abundance levels are consistent with other sites throughout the region (indicating a regional response and not a site specific response).
   b. Compare annual precipitation and ponding data to previous monitoring years; extremely low ponding (resulting from precipitation and weather patterns) could negatively impact levels of target species.

If none of the above steps address the low abundance observed on site, thereby alerting SLT that low levels on site are not caused by regional conditions (weather, precipitation, etc), SLT should make note of conditions and re-sample the site in the following year (thereby re-setting the every other year pattern). If low abundance levels persist, SLT should consult with the appropriate regulatory agencies and/or consultants to discuss the need for research studies or additional management activities.

7.0 POTENTIAL FUTURE ANALYSES

The monitoring methods we are recommending for years 5-10 will establish a strong baseline understanding of natural site conditions and variability on Wilcox Ranch, assuming no major changes in management or other major human-caused modifications to the site. This monitoring plan will help SLT recognize any need for research studies. It will also expand on the data available for review, allowing for higher-power statistical analysis. A few possible avenues for future research include:

- Effect of water quality parameters on special-status species abundance
    - Special interest for parameters that could be influenced by global warming and could present physiological stress (salinity, temperature and dissolved oxygen)
        - Water data should be gathered by continual data-loggers throughout the season

- Effect of pool depth or ponding duration on special-status species abundance or presence

- Effect of rainfall, temperature, and evapotranspiration rates on pool communities

- Correlation between special-status species abundance and presence and aquatic invertebrate community composition

8.0 REFERENCES

California Irrigation Management Information System (CIMIS). 2011. Department of Water Resources, Office of Water Use Efficiency. Precipitation Data from 2007-2011, Station #121, Dixon CA. Available at http://wwwcimis.water.ca.gov/cimis/data.jsp.

Helm, Brent P. 1998. *Biogeography of Eight Large Branchiopods Endemic to California*. *In* Witham, C.W., E.T. Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff (Editors). *Ecology, Conservation and Management of Vernal Pool Ecosystems- Proceedings from a 1996 Conference.* California Native Plant Society, Sacramento, CA.

Huddleston, Russel. 2007. *Wilcox Ranch Vernal Pool Crustacean Monitoring Report.* Report prepared for Solano Land Trust.

Kneitel, Jamie and Russell Croel. 2010. Researchers at CSU Sacramento studying the relationship between vernal pool tadpole shrimp and turbidity. Personal communication with Cassie Pinnell discussing unpublished results on December 8, 2010. CSU Sacramento, CA.

Serpa, Larry. 2002. *Wilcox Property Species, Solano County California.* Dataset provided by Ben Wallace, Solano Land Trust.

Vollmar Consulting, 2008-2010. Wilcox Ranch Ecological Monitoring Reports (Years 2008-2010). Prepared for Solano Land Trust.

Appendix A. Representative Site Photographs, East Wilcox Ranch. Taken April 21, 2010 by VNLC.

Pool P04, water level slightly below ordinary high water mark.

Edge of Pool P14, water levels ordinary high water mark.

Appendix A. Representative Site Photographs, East Wilcox Ranch. Taken April 21, 2010 by VNLC.

Pool P15 in distance, bordered by early bloom vegetation including goldfields and Sonoma sunshine

Pool P18, upper edge of pool with early bloom vegetation

Appendix A. Representative Site Photographs, East Wilcox Ranch. Taken April 21, 2010 by VNLC.

Pool VN06, added to survey pools in 2010. VN06 pools behind a large berm and includes more perennial hydrophytic vegetation than vernal pools on site

Pool V10, beginning to dry down and exhibiting early bloom vegetation along edge

Appendix A. Representative Site Photographs, East Wilcox Ranch. Taken April 21, 2010 by VNLC.

Vernal swales occur throughout the Wilcox site

Typical vernal pool vegetation including popcorn flower (*Plagiobothrys stipitatus* var. *micranthus*), Fremont's goldfields (*Lasthenia fremontii*) and Sonoma sunshine (*Blennosperma bakeri*), generally found along pool edges and swales in mid-spring

Appendix B

Standardized Invertebrate, Amphibian And Water Quality Datasheet

Site: Date: Surveyors: Weather: Pg __ of __

					Large Branchiopods[3]						Copepods			Beetles		Hemip		Diptera				Amph[4]		
Pool No.	Sweep	Temp C	Turbidity (NTU)	Max Depth (in)	*LEPA*	*BRLY*	*BRCO*	*BRME*	*CYCA*	Ostracods	Calanoida	Cyclopoda	Cladocera	Dytiscidae	Hydrophilidae	Notonectidae	Corixidae	Culicidae	Chironomidae	Lymnaeidae	Microturbellaria	PSRE	CTS	Notes

LEPA = L. packardi	CYCA = Cyzicus californicus	Record individual numbers between 1 and 25
BRLY = B. lynchi	CTS = Ambystoma californiense	C: Common (26-49)
BRCO = B. conservatio	PSRE = Pseudacris regilla	VC: Very Common (50-100)
BRME = B. mesovallensis		A: Abundant (>100)

Appendix C. Photographs of Common Aquatic Invertebrates (sources for photographs are listed below each photo- none of these photos were taken by VNLC).

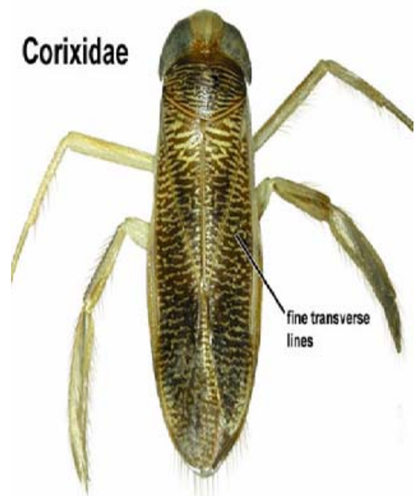
Copepods (www.vernalpool.org)

Cladocera (en.wikipedia.org)

Ostracoda (cfb.unh.edu)

Appendix C. Photographs of Common Aquatic Invertebrates (sources for photographs are listed below each photo- none of these photos were taken by VNLC).

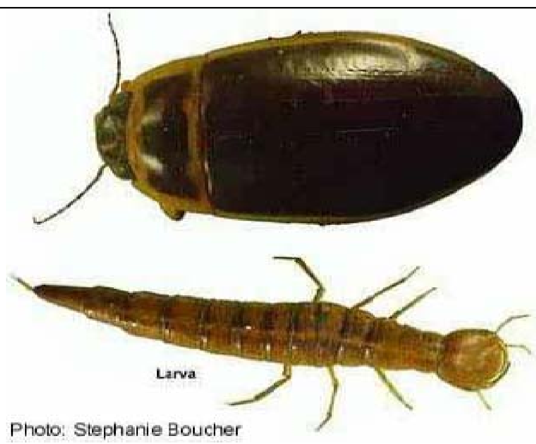
Notonectidae (www.tolweb.com)



Corixidae (flashcardmachine.com)

Odonata-dragonfly larvae (aquatax.ca)

Odonata- damselfly (mybackyard.info)



Dytiscidae (Stephanie Boucher)

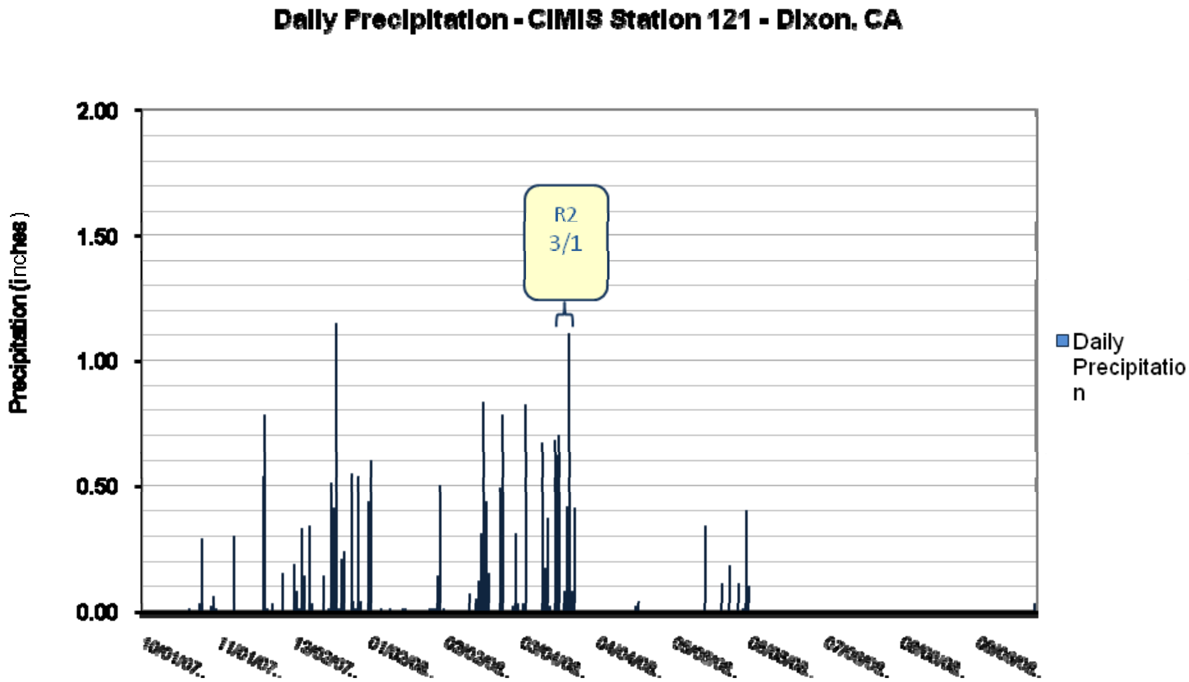
Hydrophilidae (watermonitoring.uwex.edu)

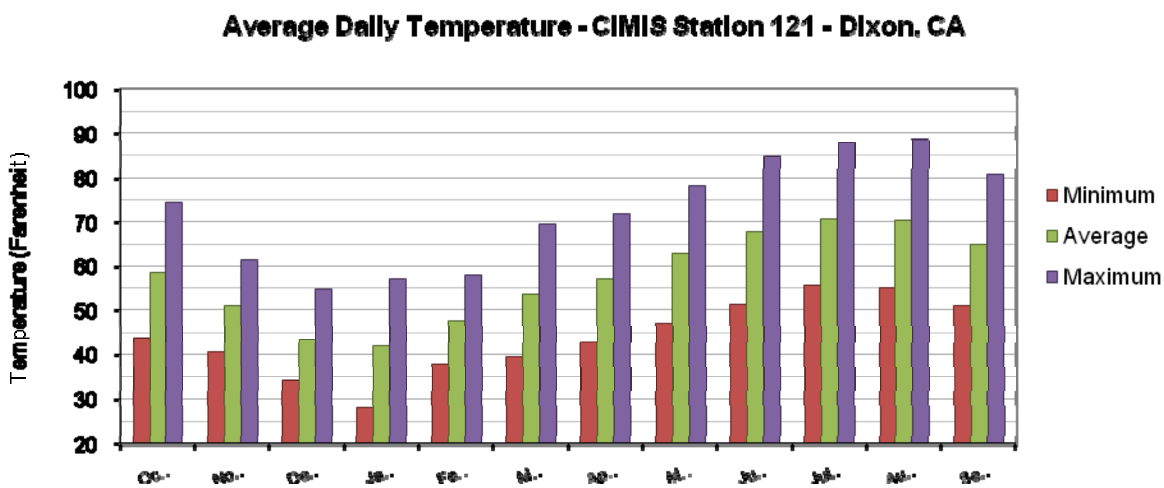
Appendix C. Photographs of Common Aquatic Invertebrates (sources for photographs are listed below each photo- none of these photos were taken by VNLC).

	
Culicidae (bugpeople.org)	Chironomidae (cfb.unh.edu)
	
Microturbellaria	Hydracarina (micrographia.com)
	
Cyzicus- clam shrimp (sacsplash.org)	*Lynceus*- lentil clam shrimp(bugguide.net)

Appendix D. Meteorological Data

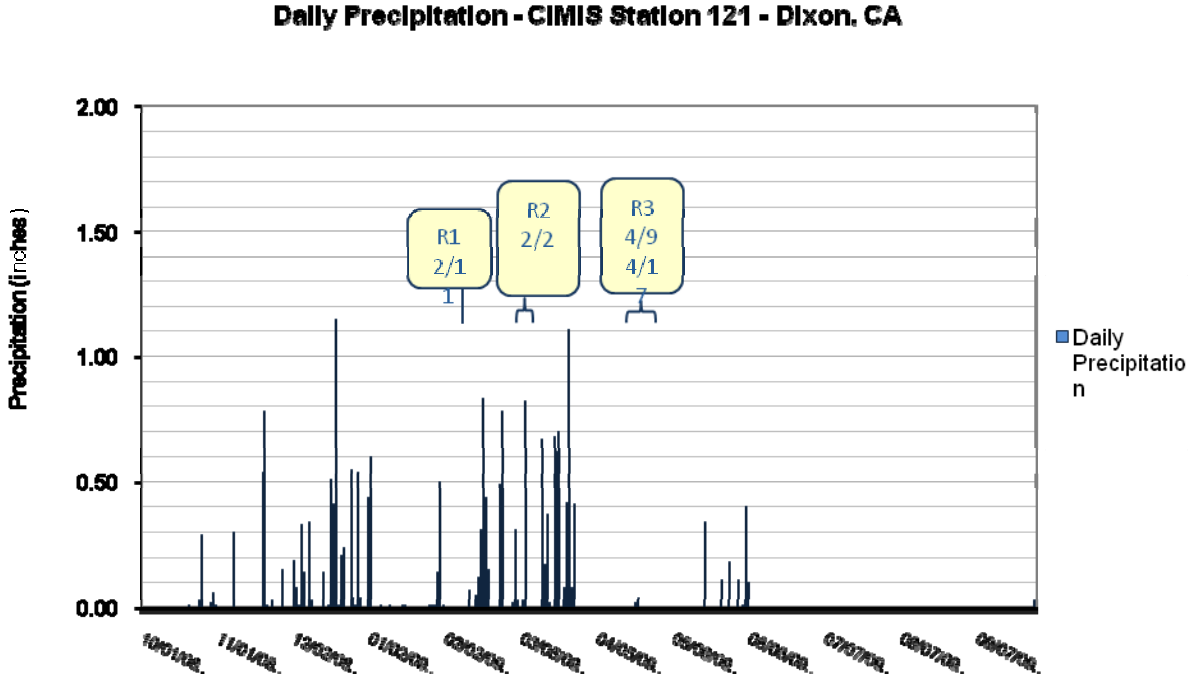
Precipitation & Temperature - October 2006 - September 2007

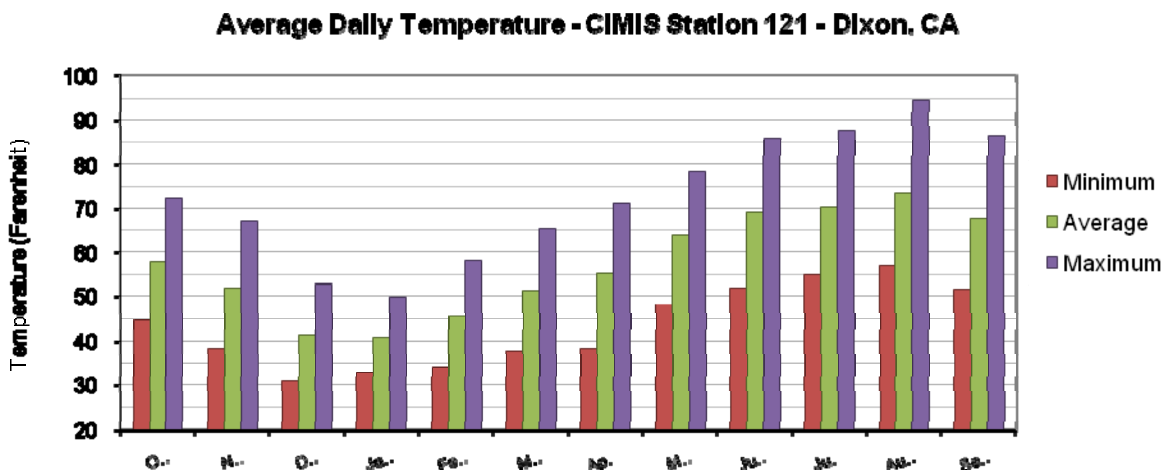




Appendix D. Meteorological Data

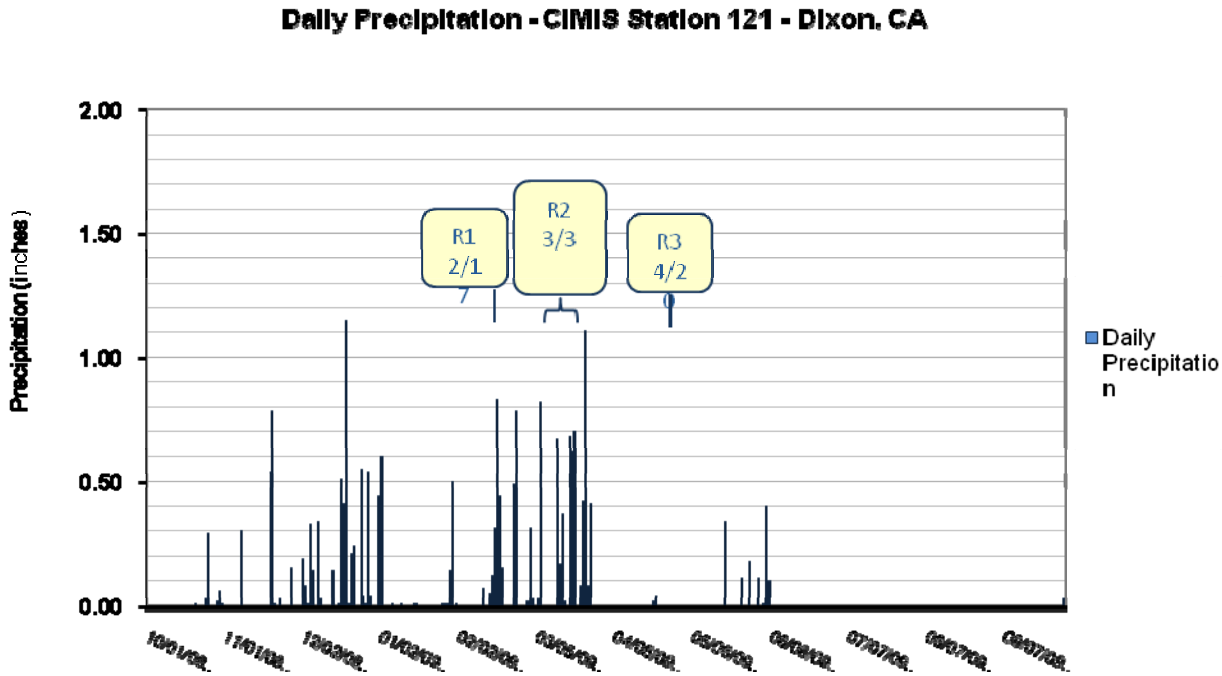
Precipitation & Temperature - October 2007 - September 2008

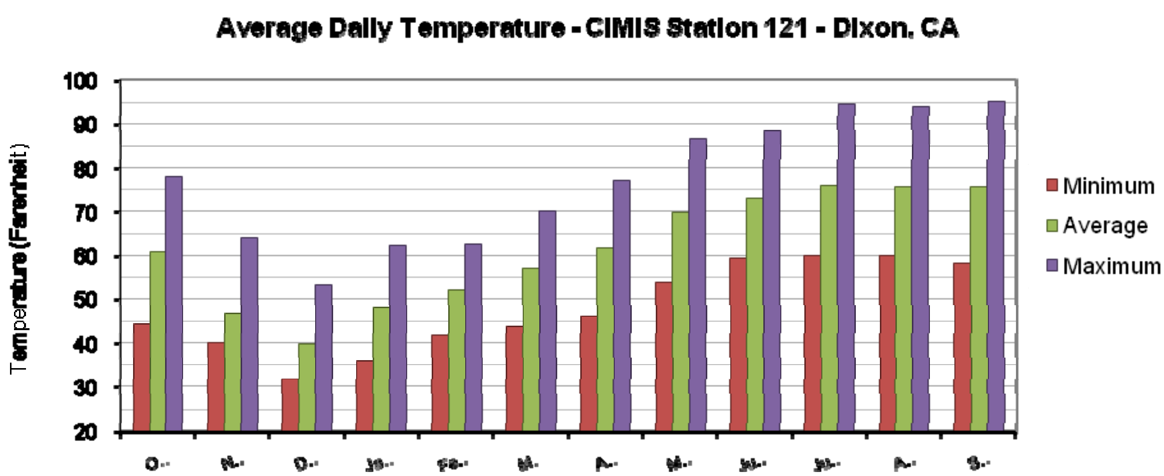




Appendix D. Meteorological Data

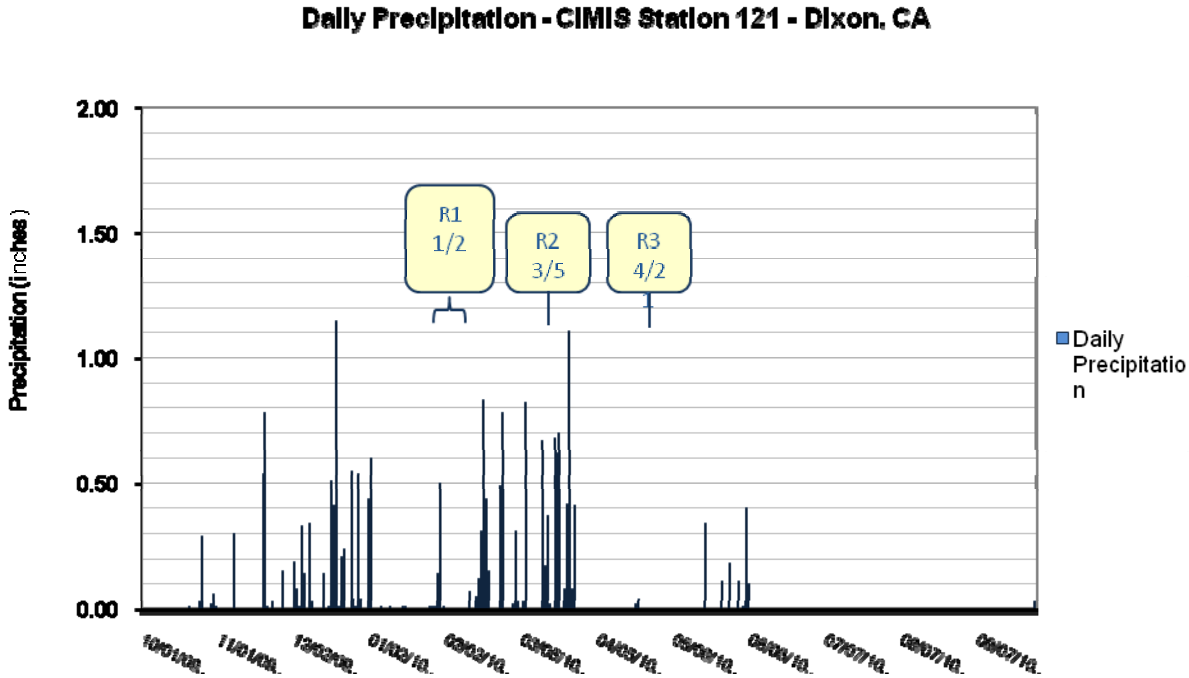
Precipitation & Temperature - October 2008 - September 2009

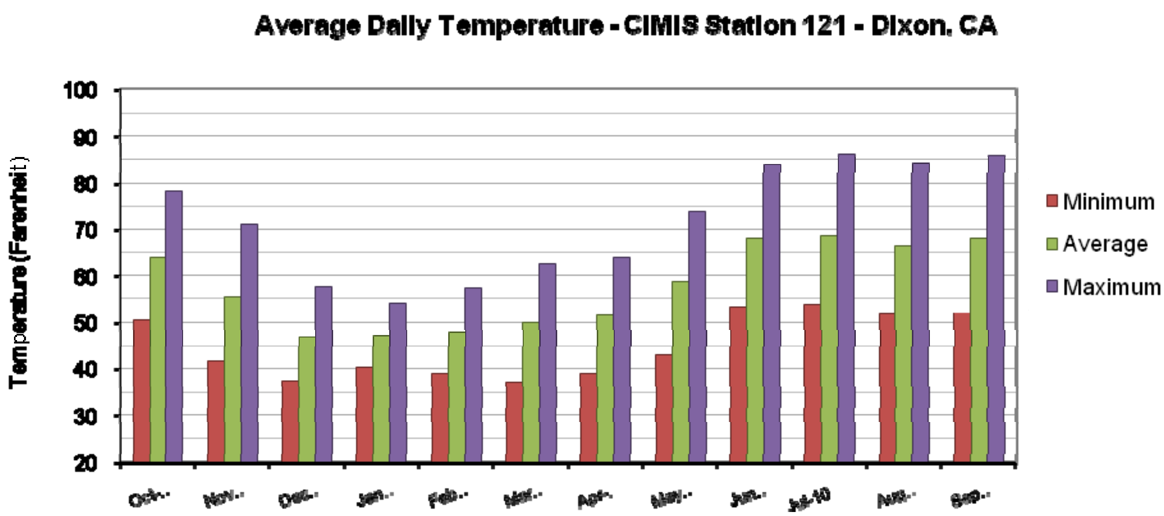




Appendix D. Meteorological Data

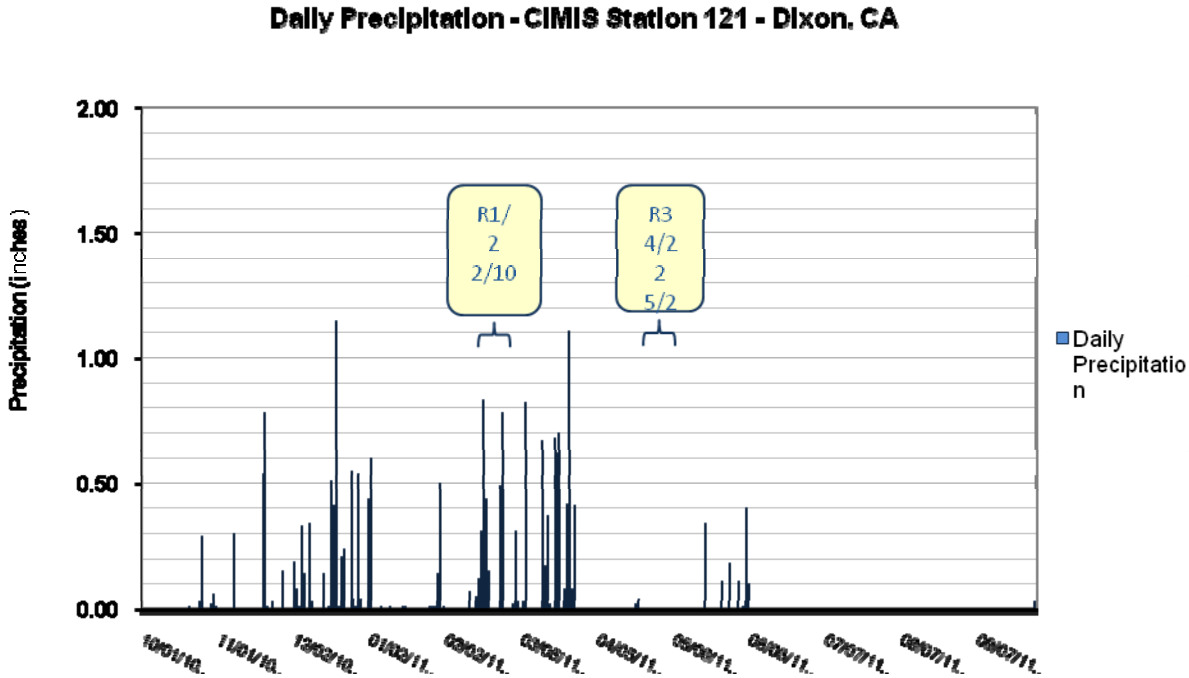
Precipitation & Temperature - October 2009 - September 2010

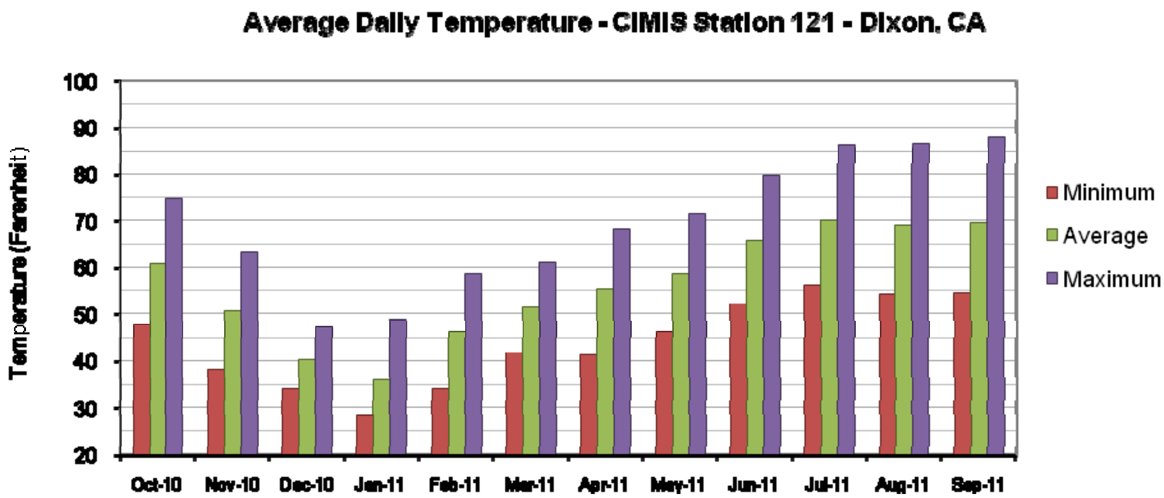




Appendix D. Meteorological Data

Precipitation & Temperature - October 2010 - September 2011





Appendix E

Selected Statistical Analysis

Wilcox 4-Year Data Review

Meeting with Ben Wallace
Sept 26, 2011 (updated Feb 2012, E. Smith)

Agenda:

- Update on Database
- Update on Terms for Data Analysis
- Descriptive Statistics for Species of Interest
- Significant Trends in the Data

Terms Used in Analysis

Effective Survey Rounds

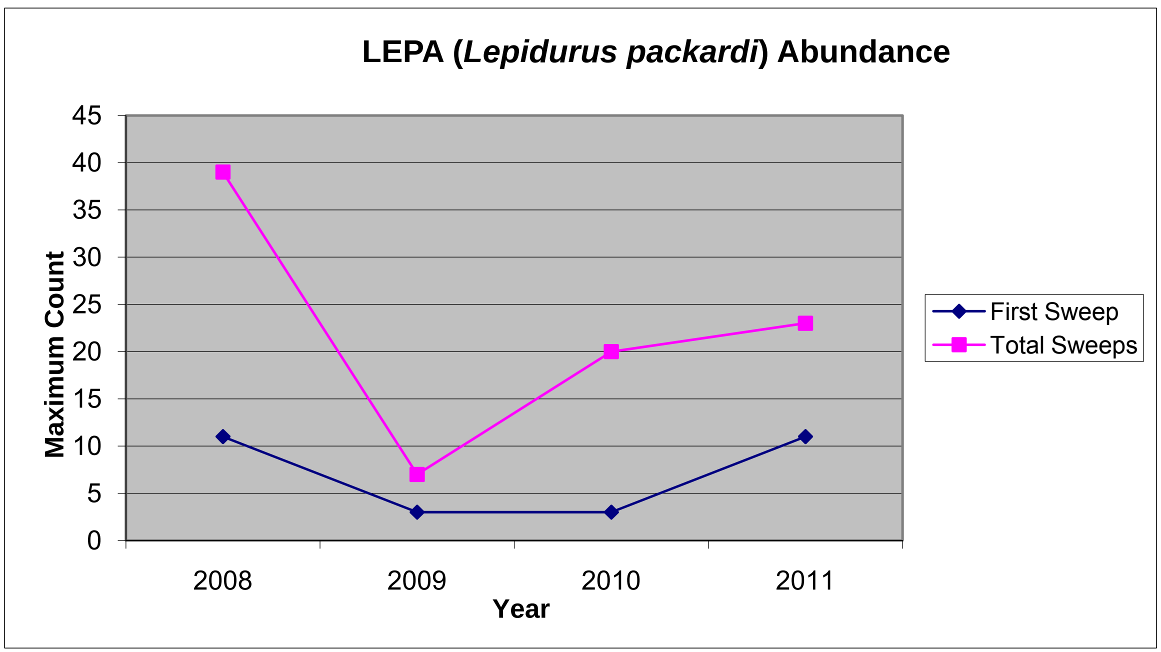
	2008	2009	2010	2011
Round 1	2/11/2008	2/17/2009	1/25/2010 2/5/2010	none
Round 2	2/27/2008 3/1/2008	3/3/2009 3/12/2009	3/5/2010	2/10/2011 2/14/2011 2/17/2011
Round 3	4/9/2008 4/17/2008	4/20/2009	4/21/2010	4/22/2011 5/2/2011

Abundance Classes

Class	Rating	Value Used
Rare	≤2	1
Not Common	3-10	3
Common	11-50	11
Very Common	50-100	50
Abundant	>100	101
Super Abundant	>1000	1001
Present	X	NA; counted for # taxa
Carapace (LEPA)	CA	NA; counted for taxa

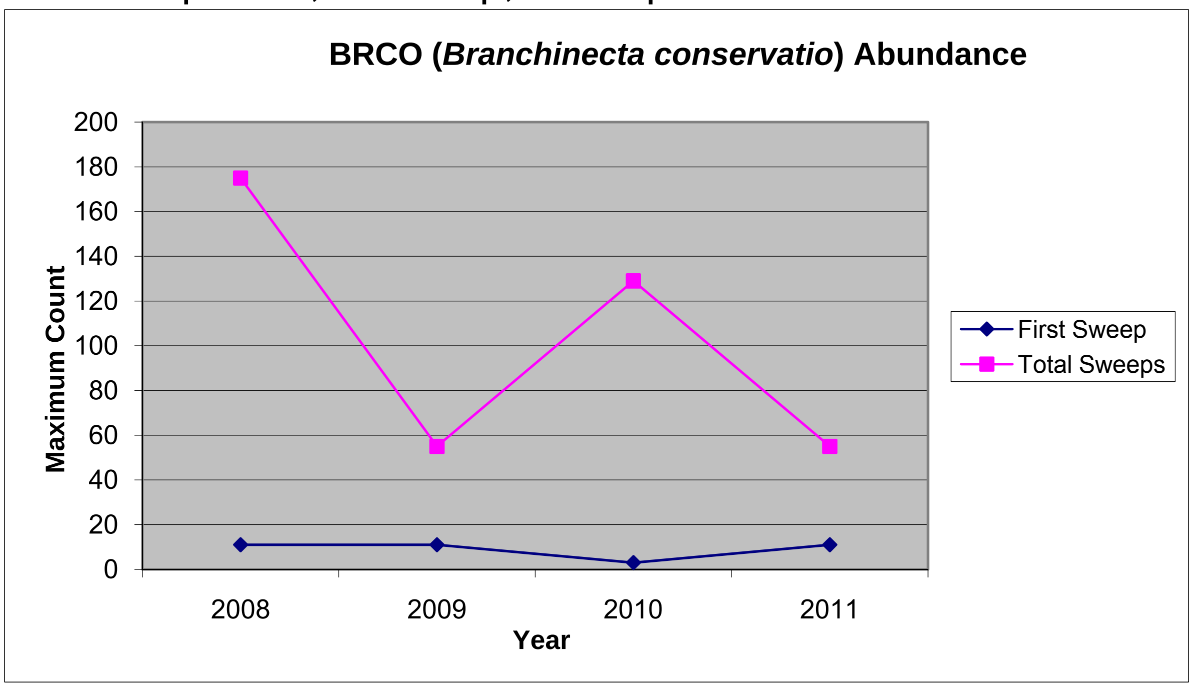
Descriptive Statistics for Species of Interest

- LEPA/Total LEPA:
  - Range is 0-11 (0-39 with 5 sweeps)
  - Highest numbers in 2008 and 2011
  - Higher in playa pools than vernal pools (by both methods)
  - Positively correlated with depth, turbidity, salinity/conductivity→ Expected, like deep, turbid pools



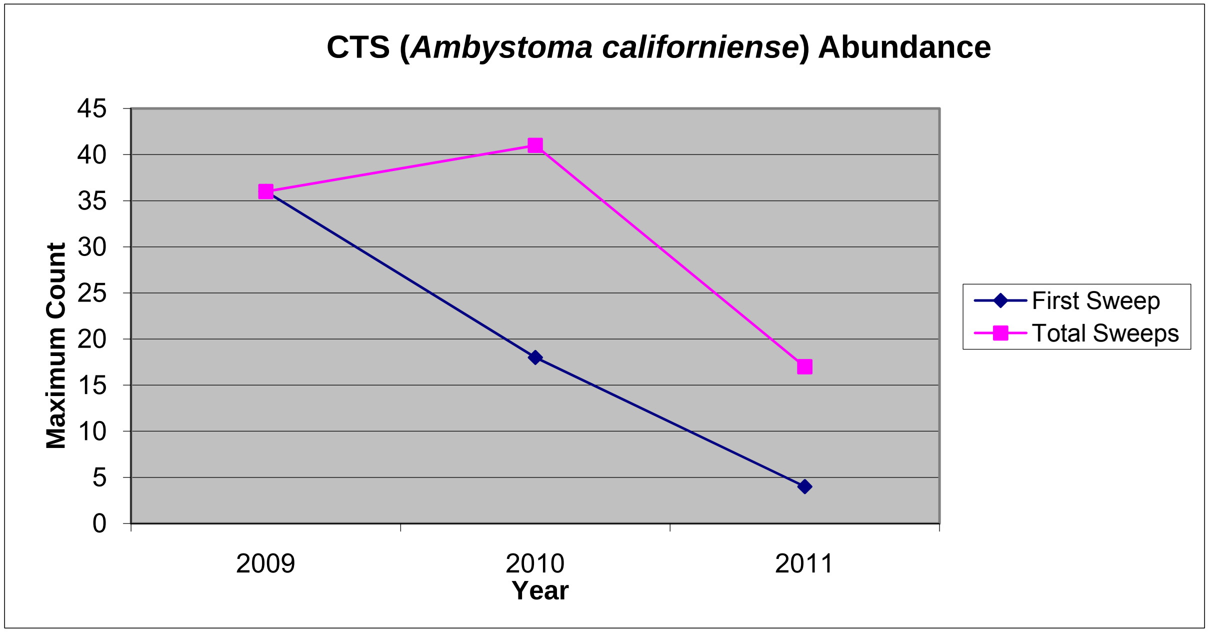
Descriptive Statistics of Interest

- BRCO/Total BRCO:
  - Range is 0-11 (0-175 with 5 sweeps)
  - Highest numbers in 2008 and 2010
  - Higher in playa pools than vernal pools (by total sweeps method)
  - Positively correlated with depth, turbidity, conductivity/salinity→ Expected, like deep, turbid pools



Descriptive Statistics of Interest

- CTS:
  - Range 0-36 (0-41 with 3 seines)
  - Highest numbers in 2009 & 2010 (0 in 2008)
  - Higher in playa pools than vernal pools (by both methods)
  - Positively correlated with depth → Expected, like deep, long-lasting pools



TRENDS with statistical significance, but maybe not biological importance

NOTE: * p < .05; ** p< .001

- Salinity (ppt): Range 0-0.67; Playa: 0.02-0.67; Vernal: 0.01-0.32
  - *Mean salinity decreased from 2008 to 2011 for vernal pools→ increased rain in 2011
  - Mean salinity increased from Rd 1 to Rd3: in playa pools**, in vernal pools*, all 4 years** → expected, salts get concentrated as pools evaporate

- Water temperature (C): Range: 7-34; Playa: 7-34; Vernal: 7-29
  - Mean water temp decreased from 2008 to 2011: in playa pools** and in vernal pools* → expected, colder wetter springs
  - Mean water temp increased from Rd1 to Rd3: in playa pools** and in vernal pools **, for 2008**, 2009** & 2011** (increased in 2010, but not sign) → expected, pools warm over season

TRENDS with statistical significance, but maybe not biological importance

NOTE: * p < .05; ** p< .001

- DO (mg/L): Range 0.08-16.12; Playa: 0.24-15.14; Vernal: 0.08-16.12
  - *Mean DO lower in vernal pools in 2008 than in other years→ Why?
  - **Mean DO lower in Rd1 in 2008 → Why?
  - **Mean DO lower in Rd 3 in 2009 → Why?
- SpC (mS/cm): Range 0.01-0.99; Playa 0.03-0.99; Vernal 0.01`-0.45
  - Mean SpC same for all 4 years in vernal pools and playa pools
  - Mean SpC increased in Rd3 in playa pools**, in vernal pools*, for all four years**→ expected, evaporation leads to ion concentration
- pH (units): Range 6.26-9.46; Playa 6.64-9.46; Vernal 6.26-8.08
  - Mean pH increased from Rd1 to Rd3 in 2008** and 2009** → respiration/algae?

TRENDS with statistical significance, but maybe not biological importance, cont.

- Turbidity (NTU): Range 4.5-1000; Playa 8-1000; Vernal 4.5-1000 (can see difference in means for pool types)
  - *Mean Turb higher in 2011 in playa pools → more rain, wind may increase mixing and turbidity
  - Mean Turb significantly different in Rd1, Rd2 & Rd3 in playas* and in vernal pools* (much higher in Rd3) → based on rainfall, wind, livestock patterns
  - Mean Turb increased from Rd1 to Rd3 in 2008, 2009, 2010 → based on rainfall, wind, livestock patterns
- Max Depth (inches): Range 1-26; Playas 1-26; Vernal 1-17
  - Mean max depth generally higher in 2011 than 2008 in playa* and vernal* pools → expected, more rain in 2011
  - **Mean max depth increased in Rd2 then decreased in Rd3 in playa pools → expected, get deeper in Rd2 then start to decrease
  - *Mean max depth decreased from Rd1 to Rd3 in vernal pools → expected, vernal pools reach max earlier in season
  - Mean max depth decreased from Rd1 to Rd3 in 2008*; mean max depth increased to Rd2 and then decreaesd in Rd3 in 2009* → pattern got mixed between vernal pools and playa pools or different filling pattern in different years?

TRENDS with statistical significance, but maybe not biological importance, cont.

- LEPA/Total LEPA
  - **Mean abundance higher in 2008 and 2011 than in 2009 and 2010 (see graph) in playa pools→ better years for LEPA, cyclical population?
  - **Mean abundance increased in Rd3 in 2009 (also in 2010 & 2011 but not stat significant)→ expected, <u>Rd 3 is generally best detection time</u>
  - *Mean abundance increased in Rd2 in 2008→ very dry year with short ponding duration, best detection time occurred earlier than usual
- BRCO/Total BRCO
  - **Mean abundance decreased in Rd3 in playa pools→ expected, by Rd3 they're usually gone
  - **Mean abundance decreased in Rd3 in 2008 (increased in Rd2), in 2009 (increased in Rd2), in 2010 (increased in Rd2), and in 2011 (no Rd2)→ expected, <u>Rd2 is generally best detection time</u> (and Rd3 is too late)

TRENDS with statistical significance, but maybe not biological importance, cont.

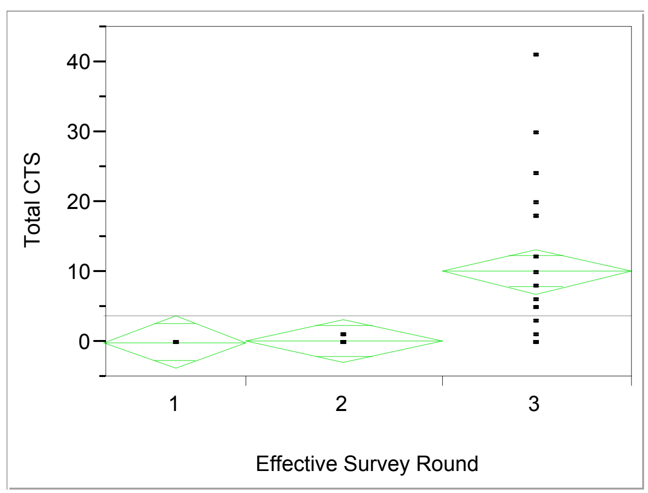
- LEPA/Total LEPA
  - **Mean abundance higher in 2008 and 2011 than in 2009 and 2010 (see graph) in playa pools→ better years for LEPA, cyclical population?
  - **Mean abundance increased in Rd3 in 2009 (also in 2010 & 2011 but not stat significant)→ expected, <u>Rd 3 is generally best detection time</u>
  - *Mean abundance increased in Rd2 in 2008→ very dry year with short ponding duration, best detection time occurred earlier than usual
- BRCO/Total BRCO
  - **Mean abundance decreased in Rd3 in playa pools→ expected, by Rd3 they're usually gone
  - **Mean abundance decreased in Rd3 in 2008 (increased in Rd2), in 2009 (increased in Rd2), in 2010 (increased in Rd2), and in 2011 (no Rd2)→ expected, <u>Rd2 is generally best detection time</u> (and Rd3 is too late)

TRENDS with statistical significance, but maybe not biological importance, cont.

- CTS/Total CTS (not done in 2008)
  - **Mean abundance higher in 2009 and 2010 in playa pools (*total CTS mean abundance highest in 2010 in playa pools) (see graph) → better years for CTS, cyclical population
  - **Mean abundance higher in Rd3 in playa and vernal pools, and in all years→ expected, <u>Rd3 is generally best detection time</u>

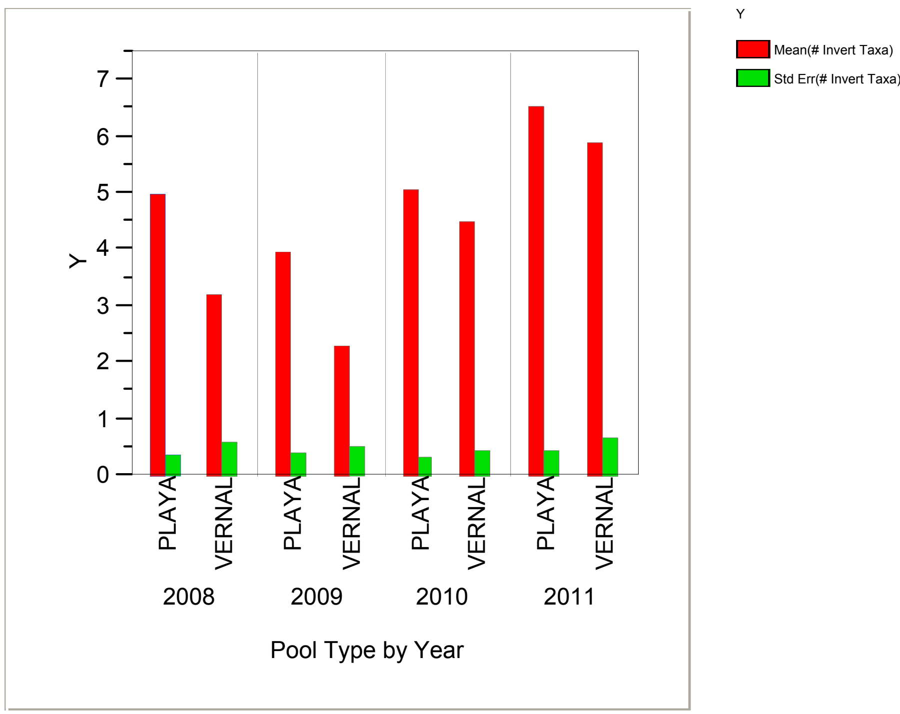
NOTE: Generally trends were stronger, more significant with 3 seines and 5 sweeps

Oneway Analysis of Total CTS By Effective Survey Round



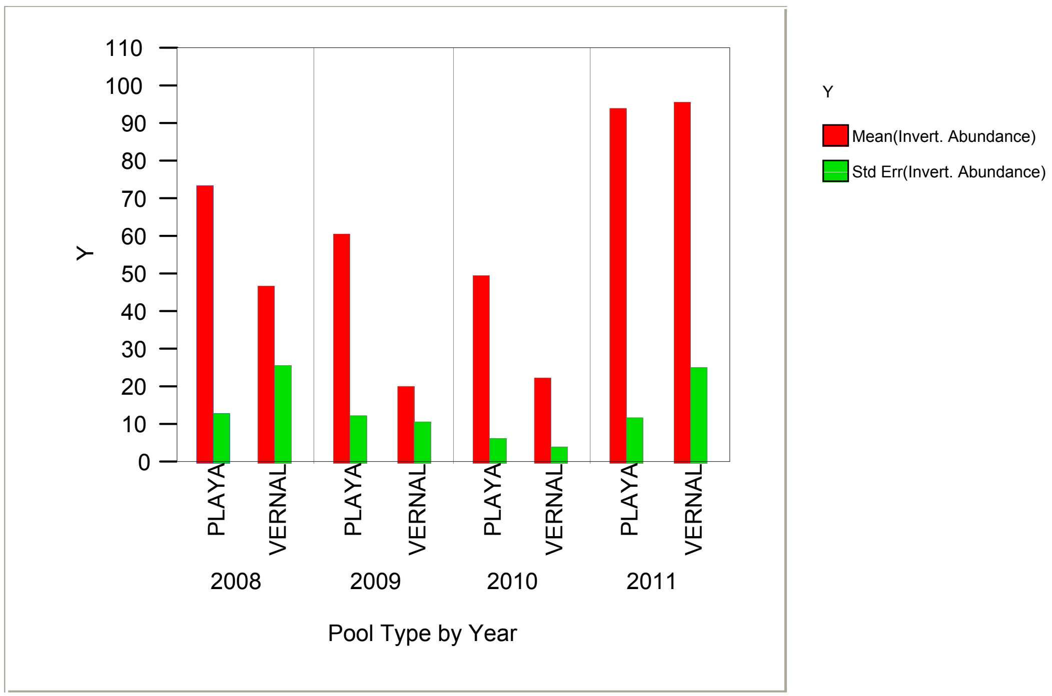
TRENDS with statistical significance, but maybe not biological importance, cont.

- # of Invertebrate Taxa and # of VPI Taxa
  - Mean # invertebrate taxa and mean # of VPI taxa were higher in playa pools than vernal pools overall * and in 2008 * and 2009* (only showing 1 graph)



TRENDS with statistical significance, but maybe not biological importance, cont.

- Invertebrate Abundance and VPI Invertebrate Abundance
  - Mean invert. abundance and mean VPI invert. abundance were higher in playa pools than vernal pools overall* and in 2009* and 2010* (only showing 1 graph)



Appendix F

2011 Water Quality Data

Appendix F. Wilcox Ranch East, 2011 Water Quality Data.
Data Collected and Compiled by Vollmar Natural Lands Consulting, February-May 2011.

Pool No.	Date	Salinity (ppt)	Temp (C)	SpC (mS/cm)	DO%	DO (mg/L)	pH (units)	Turbidity (NTU)	Max Depth (in.)
P01	2/17/11	0.06	7.18	0.14	100.20	11.92	7.57	1000.00	18.00
P01	4/22/11	0.12	18.80	0.28	83.20	*	7.87	1000.00	-
P01	4/22/11	0.11	18.59	0.27	87.90	*	7.87	1000.00	-
P02	2/17/11	0.02	7.47	0.06	99.00	11.83	7.34	82.90	21.00
P02	4/22/11	0.04	21.92	0.10	106.00	*	9.04	35.00	-
P02	4/22/11	0.04	20.09	0.11	116.10	*	9.26	12.00	-
P04	2/10/11	0.10	13.44	0.20	4.90	0.51	*	1000.00	11.00
P04	2/17/11	0.06	7.15	0.15	99.30	11.98	7.47	1000.00	11.00
P04	4/22/11	0.11	21.92	0.26	90.10	*	8.12	1000.00	8.00
P04	4/22/11	0.10	18.96	0.25	97.30	*	8.05	1000.00	8.00
P05	2/10/11	0.10	13.46	0.22	*	*	*	1000.00	12.00
P05	2/17/11	0.01	7.40	0.03	96.60	11.55	7.14	1000.00	12.00
P05	4/22/11	0.12	19.12	0.29	86.40	*	7.89	1000.00	8.00
P05	4/22/11	0.12	18.92	0.29	87.50	*	7.82	1000.00	8.00
P06	2/10/11	0.13	15.50	0.28	99.00	11.00	*	1000.00	8.00
P06	4/22/11	0.14	19.66	0.32	97.10	*	8.12	915.00	6.00
P06	4/22/11	0.14	19.67	0.32	94.90	*	8.06	953.00	6.00
P07	2/10/11	0.20	11.45	0.41	*	*	*	1000.00	9.00
P07	2/17/11	0.10	7.00	0.24	94.50	11.32	7.71	1000.00	9.00
P07	4/22/11	0.16	14.62	0.38	83.20	*	7.82	1000.00	8.00
P07	4/22/11	0.16	13.60	0.38	83.10	*	7.67	1000.00	8.00
P08	2/10/11	0.14	13.63	0.30	6.50	0.69	*	1000.00	8.00
P08	2/17/11	0.07	6.74	0.18	98.40	11.96	7.85	1000.00	8.00
P08	4/22/11	0.15	17.67	0.35	95.80	*	8.02	1000.00	6.00
P08	4/22/11	0.15	16.62	0.35	93.50	*	7.98	1000.00	6.00
P09	2/10/11	0.21	10.25	0.21	7.60	0.79	*	1000.00	12.00
P09	2/17/11	0.05	6.95	0.13	99.70	12.03	7.75	1000.00	12.00
P09	4/22/11	0.09	15.26	0.23	99.70	*	8.04	1000.00	10.00
P09	4/22/11	0.09	15.11	0.23	97.10	*	7.98	1000.00	10.00
P10	2/10/11	0.11	13.87	0.24	4.50	0.47	*	1000.00	7.00
P10	2/17/11	0.06	6.75	0.14	97.70	11.93	7.87	1000.00	7.00
P10	4/22/11	0.16	17.55	0.37	106.80	*	8.16	1000.00	6.00
P10	4/22/11	0.16	16.06	0.36	98.80	*	8.18	1000.00	6.00
P11	2/10/11	0.14	8.21	0.29	6.00	0.72	*	1000.00	17.00
P11	2/17/11	0.07	7.11	0.17	98.40	11.86	7.80	1000.00	17.00
P11	4/22/11	0.09	13.71	0.22	83.40	*	7.61	642.00	26.00
P11	4/22/11	0.09	13.61	0.22	81.50	*	7.65	612.00	26.00
P12	2/10/11	0.23	13.50	0.48	*	8.97	*	1000.00	9.00

Appendix F. Wilcox Ranch East, 2011 Water Quality Data.
Data Collected and Compiled by Vollmar Natural Lands Consulting, February-May 2011.

Pool No.	Date	Salinity (ppt)	Temp (C)	SpC (mS/cm)	DO%	DO (mg/L)	pH (units)	Turbidity (NTU)	Max Depth (in.)
P12	2/17/11	0.06	7.05	0.14	99.20	10.29	7.71	1000.00	9.00
P12	4/22/11	0.22	19.30	0.50	95.15	*	7.99	1000.00	9.00
P12	4/22/11	0.22	18.58	0.50	94.60	*	7.95	1000.00	9.00
P13	2/10/11	0.25	14.20	0.52	*	8.12	*	1000.00	10.00
P13	2/17/11	0.11	6.98	0.27	99.10	11.90	7.53	1000.00	10.00
P13	4/22/11	0.16	17.73	0.38	93.80	*	7.96	647.00	15.00
P13	4/22/11	0.16	16.73	0.38	94.90	*	7.89	662.00	15.00
P14	2/10/11	0.19	10.37	0.40	5.40	0.60	*	1000.00	10.00
P14	2/17/11	0.07	6.92	0.17	102.70	12.26	7.76	1000.00	10.00
P14	4/22/11	0.13	17.91	0.31	99.70	*	7.97	869.00	14.00
P14	4/22/11	0.13	16.20	0.31	95.10	*	7.88	865.00	14.00
P15	2/14/11	0.09	8.62	0.22	95.70	11.40	7.87	953.00	9.00
P15	5/2/11	0.59	15.59	1.24	33.30	*	7.66	1000.00	6.00
P15	5/2/11	0.60	22.12	1.26	103.50	*	8.13	1000.00	5.00
P16	2/17/11	0.06	-	0.16	97.70	9.89	7.69	295.00	15.00
P16	5/2/11	0.09	18.22	0.22	128.50	*	8.20	119.00	12.00
P16	5/2/11	0.09	13.79	0.23	86.90	*	8.51	105.00	12.00
P17	2/14/11	0.10	8.57	0.23	97.50	11.42	8.13	442.00	8.00
P17	5/2/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P18	2/14/11	0.13	8.99	0.32	93.60	11.45	7.86	683.00	10.00
P18	5/2/11	0.48	16.66	1.04	84.60	*	7.53	87.00	11.00
P18	5/2/11	0.48	15.22	1.02	91.40	*	8.40	81.00	11.00
V04	2/17/11	0.04	7.88	0.11	89.60	10.68	6.94	1000.00	13.00
V04	5/2/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V08	2/17/11	*	*	*	*	*	*	319.00	5.00
V08	5/2/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V09	2/10/11	0.08	9.92	0.17	6.40	0.73	*	84.00	13.00
V09	2/14/11	0.04	9.26	0.10	98.60	11.32	7.03	411.00	-
V09	5/2/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	2/10/11	0.14	10.18	0.29	*	*	*	1000.00	7.00
V10	2/17/11	0.06	6.74	0.16	98.20	11.97	7.76	1000.00	7.00
V10	4/22/11	0.19	13.01	0.45	94.60	*	7.89	1000.00	6.00
V10	4/22/11	0.19	13.06	0.44	96.00	*	7.90	1000.00	6.00
V18	2/10/11	0.12	17.05	0.26	*	5.00	*	486.00	10.00
V18	2/17/11	0.00	7.49	0.01	96.40	11.51	7.16	486.00	10.00
V19	2/10/11	0.12	11.61	0.25	5.60	0.62	*	366.00	12.00
V19	2/17/11	0.01	7.49	0.04	48.20	11.73	7.16	366.00	12.00
V57	2/10/11	0.08	13.00	0.18	5.10	0.53	*	39.00	16.00

Appendix F. Wilcox Ranch East, 2011 Water Quality Data.
Data Collected and Compiled by Vollmar Natural Lands Consulting, February-May 2011.

Pool No.	Date	Salinity (ppt)	Temp (C)	SpC (mS/cm)	DO%	DO (mg/L)	pH (units)	Turbidity (NTU)	Max Depth (in.)
V57	2/17/11	0.01	7.36	0.03	98.20	11.78	6.88	39.00	16.00
V57	4/22/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
VN01	2/10/11	0.03	18.97	0.06	3.70	0.35	*	73.00	11.00
VN01	2/17/11	0.01	7.35	0.04	98.40	11.77	7.11	73.00	11.00
VN01	4/22/11	0.03	19.07	0.08	112.60	*	7.59	-	13.00
VN01	4/22/11	0.03	19.43	0.08	95.80	*	7.75	-	13.00
VN02	2/10/11	0.14	14.59	0.29	*	*	*	447.00	10.00
VN02	2/17/11	0.01	7.41	0.03	97.10	11.63	7.06	447.00	8.00
VN06	2/14/11	0.07	8.11	0.17	97.40	11.50	7.94	491.00	17.00
VN06	5/2/11	0.32	15.73	0.71	77.80	*	8.08	563.00	10.00
VN06	5/2/11	0.32	15.08	0.71	72.09	*	7.63	795.00	10.00
VN07	2/10/11	0.08	11.53	0.16	5.40	0.59	*	31.00	6.00
VN07	2/17/11	0.04	7.34	0.10	76.20	9.14	7.23	31.00	6.00
VN07	4/22/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
VN08	2/10/11	0.03	15.87	0.06	4.00	0.39	*	4.50	4.00
VN08	2/17/11	0.04	7.24	0.11	90.00	10.64	6.95	45.00	5.00
VN08	4/22/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
VN09	2/17/11	0.04	7.30	0.10	96.60	11.60	7.20	411.00	11.00
VN09	4/22/11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- = Missing Data
N/A = Dry Pool
* = Equipment Malfunction

Appendix G

2011 Aquatic Invertebrate Data

Appendix G. Wilcox Ranch East, 2011 Total Aquatic Invertebrate Presence and Abundance*. Data Collected and Compiled by Vollmar Natural Lands Consulting, February-May 2011.

Pool No.	Date	LEPA	BRLY	LYBR	BRME	BRCO	CYCA	BRSP	Ostracods	Calanoida	Cyclopoda	Cladocera	Dytiscidae	Hydrophilidae	Notonectidae	Corixidae	Culicidae	Chironomidae	Lymnaeidae	Microturbellaria	PSRE	CTS	# Invert Taxa	#Listed Large Branchiopod Taxa	# VPI Taxa	% VPI Taxa	Invert. Abundance	VPI Invert. Abundance	% VPI Invert. Abundance
Round 1																													
P01	2/14/11	4	0	0	0	10	0	0	11	100	51	51	0	0	0	1	0	0	0	0	0	0	7	2	5	71.43	228	216	94.74
P02	2/14/11	3	0	0	0	0	0	0	1	100	11	100	1	0	0	1	0	1	1	1	0	0	10	1	5	50.00	220	215	97.73
P04	2/10/11	23	0	0	0	3	1	0	3	51	0	0	0	0	0	0	0	0	3	0	0	0	6	2	3	50.00	84	77	91.67
P05	2/10/11	11	0	0	0	2	2	0	3	51	0	1	0	0	0	0	0	0	0	0	0	0	6	2	4	66.67	70	65	92.86
P06	2/10/11	7	0	0	0	20	2	0	3	51	0	0	0	0	0	0	0	0	0	0	0	0	5	2	3	60.00	83	78	93.98
P07	2/10/11	6	0	0	0	13	0	0	3	51	0	3	0	0	0	0	0	0	0	0	0	0	5	2	4	80.00	76	73	96.05
P08	2/10/11	13	0	0	0	6	4	0	3	100	0	1	0	0	0	0	0	0	0	0	0	0	6	2	4	66.67	127	120	94.49
P09	2/10/11	5	0	0	0	29	2	0	1	100	0	11	0	0	0	1	0	0	0	0	0	0	7	2	4	57.14	149	145	97.32
P10	2/10/11	9	0	0	0	8	3	0	11	100	0	3	0	0	0	1	0	0	1	0	0	0	8	2	4	50.00	136	120	88.24
P11	2/10/11	13	0	0	0	47	0	0	1	100	0	1	0	0	0	0	0	0	0	0	0	0	5	2	4	80.00	162	161	99.38
P12	2/10/11	5	0	0	0	47	0	0	1	11	0	11	1	0	0	0	0	0	0	0	0	0	6	2	4	66.67	76	74	97.37
P13	2/10/11	1	0	0	0	8	0	0	1	100	0	1	0	0	0	1	0	0	0	0	0	0	6	2	4	66.67	112	110	98.21
P14	2/10/11	5	0	0	0	55	0	0	3	100	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3	75.00	163	160	98.16
P15	2/14/11	8	0	0	0	1	0	0	51	11	11	11	1	0	0	1	0	1	0	0	0	0	9	2	5	55.56	96	42	43.75
P16	2/14/11	1	0	0	0	5	0	0	100	100	51	100	1	0	0	3	0	0	0	1	0	0	9	2	6	66.67	362	258	71.27
P17	2/14/11	6	0	0	0	5	0	0	11	100	0	3	1	0	0	3	0	3	1	1	0	0	10	2	5	50.00	134	115	85.82
P18	2/14/11	5	0	0	0	0	0	0	11	11	51	11	1	1	0	3	0	0	0	0	1	0	8	1	4	50.00	94	78	82.98
V04	2/14/11	0	0	0	0	0	0	0	100	100	0	100	1	1	0	0	0	1	1	3	0	0	8	0	3	37.50	307	203	66.12
V08	2/14/11	0	0	0	0	0	0	0	3	3	3	1	1	0	0	0	1	1	0	0	0	0	7	0	3	42.86	13	7	53.85
V09	2/14/11	2	0	0	0	2	0	0	3	100	51	11	1	0	0	1	0	0	0	3	1	0	9	2	6	66.67	174	169	97.13
V10	2/10/11	7	0	0	0	10	5	0	3	100	0	1	0	0	0	0	0	0	1	0	0	0	7	2	4	57.14	127	118	92.91
V18	2/10/11	3	0	1	0	0	0	0	3	51	0	51	0	1	0	0	0	0	1	0	0	0	7	1	3	42.86	111	105	94.59
V19	2/10/11	4	0	0	0	0	0	0	1	3	3	100	1	0	0	1	0	1	1	1	0	0	10	1	5	50.00	116	111	95.69

Appendix G. Wilcox Ranch East, 2011 Total Aquatic Invertebrate Presence and Abundance*. Data Collected and Compiled by Vollmar Natural Lands Consulting, February-May 2011.

Pool No.	Date	LEPA	BRLY	LYBR	BRME	BRCO	CYCA	BRSP	Ostracods	Calanoida	Cyclopoda	Cladocera	Dytiscidae	Hydrophilidae	Notonectidae	Corixidae	Culicidae	Chironomidae	Lymnaeidae	Microturbellaria	PSRE	CTS	# Invert Taxa	#Listed Large Branchiopod Taxa	# VPI Taxa	% VPI Taxa	Invert. Abundance	VPI Invert. Abundance	% VPI Invert. Abundance
V57	2/10/11	1	0	0	0	0	0	0	51	100	0	51	0	0	0	1	0	0	1	11	1	0	7	1	4	57.14	216	163	75.46
VN01	2/10/11	0	0	1	0	0	0	0	1	11	0	0	0	0	0	1	0	0	1	0	0	0	5	0	1	20.00	15	11	73.33
VN02	2/10/11	11	0	0	0	2	2	0	3	11	0	1	0	1	0	1	1	0	1	0	1	0	10	2	4	40.00	34	25	73.53
VN06	2/14/11	5	0	0	0	23	0	0	51	100	100	100	1	1	0	1	0	1	1	3	0	0	12	2	6	50.00	387	331	85.53
VN07	2/10/11	0	0	0	0	0	0	0	3	3	0	11	0	0	0	0	0	0	0	11	0	0	4	0	3	75.00	28	25	89.29
VN08	2/10/11	0	0	0	0	0	0	0	11	11	11	11	0	0	0	0	0	0	0	3	0	0	5	0	4	80.00	47	36	76.60
Round 2																													
P01	4/22/11	8	0	0	0	0	15	0	1	3	0	3	0	0	1	1	0	0	3	0	0	7	8	1	3	37.50	35	14	40.00
P02	4/22/11	1	0	0	0	0	0	0	51	0	0	0	1	1	1	1	0	11	3	0	95	0	8	1	1	12.50	70	1	1.43
P04	4/22/11	5	0	0	0	0	47	0	3	1	0	1	1	0	1	1	0	0	3	0	0	2	9	1	3	33.33	63	7	11.11
P05	4/22/11	10	0	0	0	0	55	0	3	3	0	51	0	0	1	3	0	0	1	0	12	3	8	1	3	37.50	127	64	50.39
P06	4/22/11	8	0	0	0	0	31	0	1	3	0	51	0	0	1	1	0	1	1	0	0	1	9	1	3	33.33	98	62	63.27
P07	4/22/11	21	0	0	0	0	175	0	3	11	0	11	1	0	1	3	0	1	1	0	0	0	10	1	3	30.00	228	43	18.86
P08	4/22/11	13	0	0	0	0	47	0	3	3	0	3	0	0	1	11	0	1	1	1	2	2	10	1	4	40.00	84	20	23.81
P09	4/22/11	21	0	0	0	0	79	0	3	1	0	11	1	0	1	11	0	0	1	0	0	0	9	1	3	33.33	129	33	25.58
P10	4/22/11	6	0	0	0	0	18	0	3	3	0	3	0	0	0	3	0	1	1	0	1	0	8	1	3	37.50	38	12	31.58
P11	4/22/11	7	0	0	0	0	3	0	1	11	0	100	0	0	1	1	0	0	1	0	0	3	8	1	3	37.50	125	118	94.40
P12	4/22/11	6	0	0	0	0	9	0	3	51	0	100	0	0	0	0	0	0	1	0	0	2	6	1	3	50.00	170	157	92.35
P13	4/22/11	2	0	0	0	0	9	0	1	11	0	100	0	0	0	0	0	0	1	0	0	3	6	1	3	50.00	124	113	91.13
P14	4/22/11	7	0	0	0	0	7	0	1	100	0	3	0	0	1	0	0	0	0	0	0	10	6	1	3	50.00	119	110	92.44
P15	5/2/11	5	0	0	0	0	4	0	51	3	0	0	1	1	1	11	0	3	1	0	2	4	10	1	2	20.00	81	8	9.88
P16	5/2/11	2	0	0	0	0	0	0	0	0	0	51	1	1	3	11	0	0	51	0	0	2	7	1	2	28.57	120	53	44.17
P17	4/22/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00
P18	5/2/11	5	0	0	0	0	1	0	11	0	0	1	1	1	3	51	0	1	3	0	0	17	10	1	2	20.00	78	6	7.69

Appendix G. Wilcox Ranch East, 2011 Total Aquatic Invertebrate Presence and Abundance*. Data Collected and Compiled by Vollmar Natural Lands Consulting, February-May 2011.

Pool No.	Date	LEPA	BRLY	LYBR	BRME	BRCO	CYCA	BRSP	Ostracods	Calanoida	Cyclopoda	Cladocera	Dytiscidae	Hydrophilidae	Notonectidae	Corixidae	Culicidae	Chironomidae	Lymnaeidae	Microturbellaria	PSRE	CTS	# Invert Taxa	#Listed Large Branchiopod Taxa	# VPI Taxa	% VPI Taxa	Invert. Abundance	VPI Invert. Abundance	% VPI Invert. Abundance
V09	5/2/11	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	3	0	0	0.00	3	0	0.00
V10	4/22/11	15	0	0	0	0	39	0	11	100	0	0	0	0	1	3	0	1	1	0	1	0	8	1	2	25.00	171	115	67.25
V57	4/22/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00
VN01	4/22/11	0	0	0	0	0	0	0	0	0	0	0	1	3	0	3	3	1	11	0	0	1	6	0	0	0.00	22	0	0.00
VN06	5/2/11	5	0	0	0	0	5	0	1	0	0	3	1	1	1	3	0	0	1	0	4	12	9	1	2	22.22	21	8	38.10
VN07	4/22/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00
VN08	4/22/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00
VN09	4/22/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0.00

* = Abundance represents minimum observed individuals, recorded by abundance class
+ = Vernal Pool Indicator Species
LEPA= Lepidurus packardi
BRLY=Branchinecta lynchi
LYBR=Lynceus brachyurus
BRME=Branchinecta mesovallensis
BRCO=Branchinecta conservatio
CYCA=Cyzicus californicus
BRSP=Branchinecta sp. (immature)
PSRE=Pseudacris regilla
CTS= California Tiger Salamander -Ambystoma californiense

Appendix H

CNDDB Record of B. lynchi

Branchinecta lynchi

vernal pool fairy shrimp

Element Code: ICBRA03030

Status
Federal: Threatened
State: None

NDDB Element Ranks
Global: G3
State: S2S3

Other Lists
CDFG Status:

Habitat Associations

General: ENDEMIC TO THE GRASSLANDS OF THE CENTRAL VALLEY, CENTRAL COAST MTNS, AND SOUTH COAST MTNS, IN ASTATIC RAIN-FILLED POOLS.

Micro: INHABIT SMALL, CLEAR-WATER SANDSTONE-DEPRESSION POOLS AND GRASSED SWALE, EARTH SLUMP, OR BASALT-FLOW DEPRESSION POOLS.

Occurrence No. 218 **Map Index:** 34153 **EO Index:** 41717

Occ Rank: Fair
Origin: Natural/Native occurrence
Presence: Presumed Extant
Trend: Unknown

Dates Last Seen
Element: 1997-12-22
Site: 1997-12-22

Record Last Updated: 2002-07-18

Quad Summary: Dozier (3812137/498D)
County Summary: Solano

Lat/Long: 38.26970º / -121.84368º
UTM: Zone-10 N4236371 E601150
Mapping Precision: NON-SPECIFIC
Symbol Type: POLYGON
Area:

Township: 05N
Range: 01E
Section: 22 **Qtr:** XX
Meridian: M
Elevation: 25 ft

Location: 1.8 MILES SW OF DOZIER, 2.2 MILES WNW OF HIGHWAY 113 AT CALHOUN CUT, WEST OF JEPSON PRAIRIE.

Location Detail: LOCATED ALONG PG&E/PGT UNDERGROUND GAS PIPELINE RIGHT-OF-WAY. B. CONSERVATIO & L. PACKARDI PRESENT IN SOME CORRESPONDING POOLS.

Ecological: HABITAT CONSISTS OF RESTORED VERNAL POOLS IN CENTRAL VALLEY GRASSLAND; PLAYA POOLS CONTAINING WATER INTO JUNE, HIGH TURBIDITY; AND MODERATE-SIZED, SHALLOW VERNAL POOLS WITH LESS TURBIDITY.

Threat: POSSIBLE THREATS INCLUDE OVERGRAZING, CONVERSION TO CROPLAND, DEVELOPMENT.

General: 13 OUT OF 85 POOLS SAMPLED POOLS CONTAINED B. LYNCHI. TIGER SALAMANDER LARVA & HYLA REGILLA OBSERVED.

Owner/Manager: PVT

Sources

ARN98R0001 ARNOLD, RICHARD A. (ENTOMOLOGICAL CONSULTING SERVICES). PRT-797233 FOR VERNAL POOL CRUSTACEANS, PGT-PG&E PIPELINE EXPANSION PROJECT. 1998 VERNAL POOL CRUSTACEAN SURVEY REPORT. 1998-06-14.