Monitoring of the Threatened

Delta Green Ground Beetle at the

East Wilcox Ranch (Solano County, CA)

in 2007

Submitted By:
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INTRODUCTION

The Solano Land Trust has implemented a four-year program to monitor special-status species associated with the vernal pool and Valley Grassland habitats that occur at its East Wilcox Ranch. This ranch covers 1,342 acres and is located east of Travis Air Force Base within a region of the county that is referred to as the Jepson Prairie.

This report describes the findings of the first year of monitoring for the Delta Green Ground Beetle, a federally-listed threatened species that is known to occur in the Jepson Prairie region. Prior surveys at East Wilcox Ranch have found the beetle at seven of 18 playa pools that occur there. The 2007 surveys for the DGGB at East Wilcox Ranch performed the following tasks:

a) assessed habitat suitability for the beetle at the 18 playas at East Wilcox Ranch;
b) identified which of the 18 playa pools East Wilcox Ranch supported the beetle;
c) surveyed for the beetle at 6 playa pools at the Jepson Prairie Preserve;
d) prepared a data dictionary for use with a Trimble GeoXH GPS unit to gather data on habitat features and beetle occurrences; and
e) developed a survey design for subsequent monitoring the beetle.

The remainder of this report provides background information on the beetle, describes the survey methods and findings. Based on the 2007 survey results, this report also offers recommendations for future monitoring surveys at the East Wilcox Ranch.

BACKGROUND INFORMATION

The Delta Green Ground Beetle is known scientifically as *Elaphrus viridis* (Coleoptera: Carabidae) and was recognized as a threatened species by the US Fish & Wildlife Service (USFWS) in 1980. It is a terrestrial beetle, commonly referred to by the acronym "DGGB", and is known only from a several square mile area that includes the Jepson Prairie and vicinity in Solano County. A portion of the Jepson Prairie region, centered around Olcott Lake, has been recognized as critical habitat for the DGGB by the USFWS. As second, smaller area of critical habitat is at the Elsie Gridley Preserve. Vernal pools and playas are widely scattered throughout the Valley Grassland habitat that characterizes this region.

Since the DGGB's recognition as a threatened species, little information on its distribution, natural history, identification of immature stages, and understanding of determinants of good habitat quality has accrued. Although substantial portions of the Jepson Prairie region are protected, the lack of basic natural history information on the DGGB hampers habitat management and conservation efforts to benefit the beetle. Most historical and recent surveys for the beetle have generally been focused at or near Olcott Lake, which is located within the Jepson Prairie Preserve. Specific life history information on the DGGB is not available. Habitat management efforts to date have primarily focused on maintaining the native grasses and forbs that characterize the Valley Grassland plant community and controlling invasive plants. Cattle and sheep grazing, as well as controlled burns, have been used to manage the vegetation in the grasslands. However, the hooves of grazers may modify the muddy shorelines where the DGGB lives and may render these areas unsuitable for habitation by the DGGB.

The ground beetle genus *Elaphrus* consists of about 35 species worldwide, distributed exclusively throughout temperate regions of the Northern Hemisphere. Several taxa are associated with mud and wetland habitats and particular soil types (Goulet 1983). For this reason the genus is commonly called the Marsh Ground Beetles. Of those species whose ecologies have been studied, the preferred microhabitats are muddy bare ground or sparsely vegetated areas with little accumulation of duff. Related species are known to occur in mud flats, along shores, in bogs, and in marsh habitats. Some species prefer habitats that are shaded while others occur in more exposed, sunlit habitats. All 14 known species in the subgenus *Elaphrus*, of which *E. viridis* is a member, live in open sunlit habitats usually at the margins of water bodies. Goulet (1983) also discusses taxonomy and evolutionary relationships of the species in the genus *Elaphrus*.

The Jepson Prairie and East Wilcox Ranch are characterized by vernal pool and valley grassland habitats. Two types of vernal pools occur there, including larger playa pools, sometimes also known as vernal lakes that typically occur on Pescadero clay soils, and smaller vernal pools. The playas are usually deeper and retain water longer than the smaller, shallower vernal pools. Also, they often have well-defined shorelines that are bare or sparsely vegetated as the high water recedes during the winter and spring activity period of DGGB adults and larvae.

East Wilcox Ranch was historically used for sheep grazing. More recently cattle have grazed at the ranch. Thus the grasslands include a mix of native indigenous grasses and forbs as well as invasives and annuals typical of pasture lands in this part of California.

Primary habitat for the DGGB is the immediate shoreline of playa pools that support the appropriate mix of bare or sparsely vegetated ground, low-growing vegetation on flat to gently sloping ground, and the preferred prey items (primarily springtails, i.e., Collembola). Prominent plants among the low-growing vegetation include primarily prostrate pincushionplant (*Navarretia prostrata)*, and secondarily alkali heath (*Frankenia grandifolia (Frankenia salina in Calflora)*, bristled downingia (*Downingia bicornuta)*, toad rush (*Juncus bufonius)*, and several bunchgrasses). In the primary habitat, activities by DGGB adults such as hunting, basking (thermoregulating behavior), and mating have been observed, as well as DGGB larvae. The adult beetle can also be observed less frequently at bare spots along trails or barrens between the smaller vernal pools and playas. At these bare spots basking behavior of the adults visiting these locations has usually been noted.

Both the larvae and adult life stages of the DGGB are predaceous, primarily on springtails, which live in the moist shoreline zone of the playa pools, usually within about one meter of the water. Other types of small, probably soft-bodied insects may also be occasional prey items. Larval and adult life stages of the DGGB have good visual acuity, thus the sparsely vegetated immediate shoreline is ideal habitat for their hunting habits.

The winter activity period for DGGB adults and larvae is unusual for members of the genus *Elaphrus*. Both life stages live underground in the cracks and crevices of the clay soils that form as the playas dry out. This is probably a strategy to avoid the hot, dry months of the

year. There appears to be but one generation per year. Adults may live as long as one year and possibly even longer.

STUDY METHODS

Field surveys were performed to assess habitat suitability at the 18 playa pools on East Wilcox Ranch and to perform presence-absence surveys for the beetle both at East Wilcox Ranch and six playa pools at the Jepson Prairie Preserve. The remainder of this section describes the study methods employed for both the habitat assessment and presence-absence surveys.

Habitat Assessment Survey.
Prior to conducting field surveys, several data layers for all of Solano County were gathered and loaded into a geographic information system (GIS) using ArcGIS v9.1 (ESRI). These GIS layers included:
   a) color aerial photography provided by Solano County;
   b) a map of all soil types that occur in Solano County from the Soil Conservation Service based on mapping by Bates (1977); and
   c) historical and recent records for the DGGB from the California Natural Diversity Data Base (2007), the BUGGY Data Base (Entomological Consulting Services, Ltd. 2007), the entomological literature, and various technical reports on Wilcox Ranch (copies provided by Ben Wallace of the Solano Land Trust).

The aerial photo and soils layer were clipped to include just the Wilcox Ranch and immediately surrounding lands. This information was used to identify all soil types that occur at East Wilcox Ranch, but in particular, all locations characterized by Pescadero clays.

A GPS data dictionary was prepared to record habitat features of each of the 18 playa pools and information about each DGGB observation (Table 1). The entire perimeters of the 18 playa playas were walked and measured during the habitat assessment survey. Features such as soil type(s), ponding, vegetation cover, land use, type of grazing animals, and presence of the preferred springtail prey item were examined to evaluate the suitability of every playa pool to support DGGB. For every playa portions of the shoreline characterized by bare to sparsely-vegetated ground were mapped using a Trimble GeoXH GPS unit with submeter real time precision. Post-processing of the collected GPS data included differential correction to improve the positional fixes. This information was used to subjectively rate each playa pool as low, medium, or high quality habitat for the DGGB.

Presence-Absence Surveys.
Presence-absence surveys for the DGGB were conducted at the 18 playas at Eastern Wilcox Ranch (Figure 1) and at 6 playas at the Jepson Prairie Preserve (Figure 2). Survey techniques included diurnal visual surveys and nocturnal black lighting on one warm evening. Since prior survey attempts by Dr. Fred Andrews, Kavanaugh, and Arnold to capture DGGB using pitfall traps failed to capture any DGGB life stages, pitfall traps were not used during my surveys even though such traps are often an effective technique for capturing other types of ground beetles. The keen visual acuity of DGGB adults may explain why the pitfall traps are ineffective.

In February, March, and April, surveys were conducted on 12 dates. For the diurnal visual surveys, the "squat and stare" technique was used. An observer watches approximately a 1 square meter area of bare to sparsely-vegetation ground at the shoreline of a playa pool for a 3-minute duration. This process is repeated at numerous locations around the perimeter of each playa. I did this at approximately 100 ft. intervals around the perimeter of each playa, with the intervals estimated by pacing.

One nocturnal survey at East Wilcox Ranch was performed on March 11 using black lights at playas where DGGB were observed during 2007 and headlamps to survey additional shoreline and inter-pool areas. Thirteen black lights were set out on this warm night. Temperatures on most other nights during the adult activity period of the DGGB were too cool for insect activity so only the one night survey was performed.

Sampling Design for Future Monitoring.
One of the goals of this study was to develop a sampling design for DGGB that could be used in future monitoring years at East Wilcox Ranch to estimate population numbers or density. Originally I laid a grid, measuring 100 x 100 meters over the aerial photograph of the ranch and planned to use the intersections of the grid lines as sampling points to search for the DGGB. Habitat conditions at each sampling point would be characterized by vegetation type, soil type, wetland type, and other features. Based on the correlations of DGGB observations with habitat features, I could then develop meaningful habitat strata at East Wilcox Ranch to refine this initial sampling design for future DGGB monitoring. However, because of the size of East Wilcox Ranch, several thousand sampling points would need to be visited and DGGB numbers in 2007 were too low to conclusively demonstrate absence of the beetle if it was not observed. Also, sampling of several thousand points in the field would require several weeks of effort, which was deemed impractical given the limited budget. Thus, this type of sampling was not conducted in 2007. An alternative sampling approach is discussed in the next section of this report.

RESULTS AND DISCUSSION

Habitat Assessment.
Figure 1 illustrates the 11 soil types and their respective distributions at East Wilcox Ranch as determined by Bates (1977). Pescadero clays characterize the majority of the 18 playa pools. A few of the playa pools are characterized by more than one soil type (Table 2).

In addition to the soils, Table 2 lists the findings of other habitat features that were evaluated for the 18 playas during my habitat assessment. East Wilcox Ranch supports a total of 129.5 acres of playa pools. These playas range in size from 0.75 to 29.27 acres, with shoreline perimeters ranging from 803 to 6,108 feet.

Due to the lower than normal seasonal rainfall, ponded water levels were very low during my surveys. One of the playas had only muddy soils (#8) or puddles during my visits in the winter of 2006-2007. Clearly playas that exhibited continuously ponded water provide better habitat for the DGGB and its springtail prey compared to those playas that exhibited intermittent

ponding or no ponding. However, in a wetter year even the drier playas may provide suitable habitat for the DGGB.

Shoreline features of every playa were examined and measured and the results of shoreline evaluations for DGGB suitability are illustrated in Figure 3. Some shoreline areas exhibited gentle slopes or flat areas ("Sloped" in Table 2) while other portions were steep. During surveys at off-site locations, DGGB adults have primarily been observed in flatter to gently sloped shoreline areas, especially where bare to sparsely-vegetated soils ("Bare" in Table 2) are prevalent. At East Wilcox Ranch an estimated 20.5% of all shorelines were characterized by bare, flat or slightly sloped ground conditions (Table 2). Nearly one-half (49.1%) of all playa shorelines were characterized by flat or slight slopes with grassy vegetation. Steep, barren slopes characterized 22.1% of the shorelines, while 8.2% of the shorelines were steep and vegetated ("grassy" in Table 2).

Playas characterized by Pescadero clays, with flat to gently-sloped shorelines, extensive areas of bare to sparsely-vegetated soil, and favored springtail prey items provide the best habitat for the DGGB. Playas exhibiting this suite of features were rated as "high" potential habitat for the DGGB. Three of the plays were considered of high habitat quality. Nine of the playas exhibited medium quality habitat for the DGGB, while the remaining 6 playas exhibited low quality habitat. Due to the lower than normal seasonal rainfall experienced during the 2006- 2007 winter, some of these medium or low quality playas that might provide better habitat for the DGGB during a normal rainy season. Regardless, these findings underscore the need to manage these lands to improve habitat quality to benefit the DGGB as 15 of the 18 playas were rated as low or medium quality habitat. In particular, control of invasive weeds and grasses that currently grow along the shorelines of the playa pools would improve habitat quality for the DGGB.

Presence-Absence Surveys.
Ten DGGB adults were observed at nine playas on East Wilcox Ranch in the spring of 2007 (Table 2) between February 15 and April 13. Two adults were observed at playa #14, while single adults were observed at playas #1, #4, #5, #6, #8, #9, #11, and #13 (Figure 3). Table 3 provides information on weather conditions for each DGGB observation and the number of "squat and stare" survey stations at each playa pool on every survey date.

Six playas at the Jepson Prairie Preserve were also monitored for the DGGB in 2007 and adult beetles were observed at three playas. Olcott Lake, playa #54 in Figure 2, was treated as two playas, #54E and #54Wbecause it is bisected by Cook Lane. Six adult DGGBs were observed at the three playas, one each at playas #50 and #51, and 4 adults at playa #54W. Additional information about these survey findings are presented in Arnold and Kavanaugh (2007).

In 2007 the first DGGB adult was observed at playa #50 (Figure 2), located about 1 mile south of Olcott Lake on February 15th, while the last adult was observed on April 13th (Arnold and Kavanaugh 2007). Thus the adult activity period was about 58 days in duration in 2007. In past years DGGB have been observed as late as May 19th (Arnold and Kavanaugh 2007). The lower than normal rainfall during the winter of 2006- 2007 may have resulted in a shorter adult

activity period as most of the playas in the greater Jepson Prairie region were dry or just muddy by mid-April and several pools did not even pond any significant water during the rainy season.

DGGB numbers were too limited in their occurrence and abundance at East Wilcox Ranch to achieve sample sizes necessary to estimate population numbers using any statistically-based methods. In a year of normal rainfall, presumably DGGB numbers will be greater than observed in 2007.

Sampling Design for Future DGGB Monitoring.

During the squat and stare survey technique an observer searches an approximately 1 square meter area of ground for DGGB. However, a larger or smaller area may actually be surveyed at a particular location or by different observers, thus the plot size is not truly standardized in a manner that can be used for subsequent statistical analysis. Also, since the DGGB has keen eyesight, laying a frame to define a sampling plot on the ground is likely to cause the DGGB to flee or hide which would reduce its chances for detection. Thus, statistical sampling techniques that use a standardized plot size to estimate population numbers or density are not likely to provide reliable results when monitoring the DGGB.

For these reasons and also the low number of observations of the DGGB both at East Wilcox Ranch and throughout the greater Jepson Prairie region in 2007, I believe a plotless sampling technique, such as a nearest neighbor method (Clark and Evans 1954) is more appropriate to obtain population or density estimates of the DGGB. This technique has generally been used with plants, especially trees, but has also been applied to a few insects. Since the DGGB adults are mobile, I suggest that the shoreline of playas selected for monitoring be sampled on the same day if enough permitted observers are available. Otherwise, it may be necessary to sample different playas on different days, but these sampling dates should be within a few consecutive days with similar weather conditions so seasonal differences in DGGB abundance don't influence estimates of abundance. Statisticians generally recommend a minimum sample size of 30 observations to obtain reliable estimates of population parameters and for detection of differences in results between years, pools, etc.

As DGGB adults are observed using the squat and stare technique at various locations around the perimeter of each playa, the position is recorded with a mapping grade GPS unit or the position is temporarily marked with a pin flag. The distance of each observed DGGB to its nearest neighbor is measured. The nearest neighbor may be at the same playa or a nearby playa. The sum of the distances for all observed DGGBs is divided by the number of observed beetles, which gives an average distance between any two nearest beetles.

Additionally, the density of DGGBs can be determined by dividing the number observed in the study area by the size of the study area. At East Wilcox Ranch, the study area would be a belt, perhaps as wide as 10 m, around the shoreline perimeter of each playa pool. For some playas, the belt distance may be smaller depending upon habitat conditions associated with a particular playa. Krebs (1999) provides worked examples of the nearest neighbor method.

This monitoring method provides not only a density estimate, but also information about the spatial occurrence and pattern of DGGB adults. As management of the habitat at East

Wilcox Ranch with grazing or other techniques is implemented, comparison of the beetle densities and spatial information should be useful for evaluating if the habitat management techniques are benefiting the DGGB population in future years.

ACKNOWLEDGEMENTS

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Clark, P.J. and F.C. Evans. 1954. Distance to nearest neighbor as a measure of spatial relationships in populations. Ecology 35:445-453.

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Table 1. Data Dictionary for DGGB Habitat and Beetle Observations.

"DGGB", Dictionary, "Richard Arnold"

"ShoreLine", line, "", 3, seconds, 1, Code
  "Area ID", text, 30, normal, normal, Label1
  "NatureOfShoreline", menu, normal, normal
    "Grassy"
    "Gravelly"
    "Concrete"
    "Weedy"
    "Bare"
    "Other"

  "FeatureOfShoreline", menu, normal, normal
    "Steep"
    "Sloped"
    "Other"
  "Comment", text, 40, normal, normal

  "WaterStatus", menu, normal, normal
    "Standing-Deep"
    "Standing-Shallow"
    "Running"
    "Dry"
    "Other"

  "LandUse", menu, normal, normal, Label2
    "Pasture-Grazing"
    "Grassland-Idle"
    "Cropland"
    "Open-Bare"
    "Other"

  "WetlandType", menu, normal, normal
    "Playa Pool"
    "Vernal Pool"
    "Swale"
    "Creek/Stream"
    "Foot Trail"
    "Other"

  "PreyItems", menu, normal, normal
    "Springtail - gray"
    "Springtail - black"
    "Midge - larvae"
    "Other"
    "None"

```
  "DGGB Observations", menu, normal, normal
    "Feeding"
    "Basking"
    "Crawling"
    "Other"

"DGGB Observation", point, "", 1, seconds, 10, Code
  "Behavior", menu, normal, normal
    "Feeding"
    "Basking"
    "Crawling"
    "Other"
  "Comment", text, 40, normal, normal

"PreyItems", point, "", 1, seconds, 10, Code
  "Item", menu, normal, normal
    "Springtail - gray"
    "Springtail - black"
    "Midge - larvae"
    "Other"
    "None"
  "Comment", text, 40, normal, normal

"FeaturePoint", point, "", 1, seconds, 10, Code
  "Comment", text, 40, normal, normal

"FeatureLine", line, "", 5, seconds, 1, Code
  "Comment", text, 40, normal, normal

"FeatureArea", area, "", 5, seconds, 1, Code
  "Comment", text, 40, normal, normal

"Road", line, "", 5, seconds, 1, Code
  "Comment", text, 40, normal, normal

"Fence", line, "", 5, seconds, 1, Code
  "Comment", text, 40, normal, normal

"Pole", point, "", 1, seconds, 10, Code
  "Comment", text, 40, normal, normal
```

Wilcox Ranch - 2007 DGGB Study
Pool sizes and characteristics

Pool Number	Pool Potential	DGGB Observations	Collembola Prey Items	Size (acres)	Perimeter (feet)	Bare Shoreline* (feet)	Percent of Shoreline that is:								Current Land Use	Grazing Animal(s)	Water Condition in Pool	Soil Types in Pools Soil Name(s)	(acres)
							Sloped and				Steep and								
							Bare	Grassy	Gravelly	Wetland Veg	Bare	Grassy	Gravelly	Wetland Veg					
1	Low	1	Yes	24.90	5,643	1,867	32.5%	67.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	24.90
2	Low	0	Yes	7.86	2,778	-	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	7.86
3	Low	0	Yes	1.30	867	-	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Solano Pescadero complex	1.30
4	Medium	1	Yes	6.07	2,671	1,412	23.2%	32.4%	0.0%	0.0%	28.9%	15.5%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	5.64
																		Solano Pescadero complex	0.43
5	High	1	Yes	1.53	1,370	1,239	49.5%	10.1%	0.0%	0.0%	40.5%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	0.74
																		Solano loam	0.79
6	Medium	1	Yes	3.01	3,304	1,666	30.4%	41.3%	0.0%	0.0%	19.4%	8.9%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	3.01
7	Low	0	Yes	0.75	1,048	-	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay loam	0.75
8	Low	1	No	0.94	803	411	52.0%	26.1%	0.0%	0.0%	0.0%	21.9%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Muddy	Pescadero clay	0.76
																		Pescadero clay loam	0.18
9	Medium	1	Yes	5.92	2,202	1,665	9.2%	0.0%	0.0%	0.0%	66.1%	24.6%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	4.90
																		Pescadero clay loam	1.02
10	Medium	0	Yes	3.19	1,853	89	0.0%	80.2%	0.0%	0.0%	4.7%	15.1%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	2.79
																		Pescadero clay loam	0.39
11	Medium	1	Yes	6.07	2,314	803	34.9%	39.7%	0.0%	0.0%	0.0%	25.4%	0.0%	0.0%	Pasture - Grazing	Cattle & Sheep	Shallow	Pescadero clay	6.07
12	High	0	Yes	2.95	1,426	1,451	26.0%	0.0%	0.0%	0.0%	74.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Sheep	Shallow	Pescadero clay	2.07
																		Solano loam	0.88
13	Medium	1	Yes	13.33	3,855	2,778	7.8%	28.2%	0.0%	0.0%	64.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle	Shallow	Pescadero clay	9.08
																		Pescadero clay loam	4.25
14	High	2	Yes	15.07	3,684	2,830	4.8%	8.6%	0.0%	0.0%	71.6%	15.1%	0.0%	0.0%	Pasture - Grazing	Cattle	Shallow	Pescadero clay	15.07
15	Medium	0	Yes	2.92	2,435	283	11.4%	88.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle	Shallow	Pescadero clay	2.92
16	Medium	0	Yes	2.61	1,262	607	24.3%	51.1%	0.0%	0.0%	24.6%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle	Shallow	Pescadero clay	2.61
17	Medium	0	Yes	1.84	1,364	920	65.8%	34.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle	Shallow	Pescadero clay	1.84
18	Low	0	Yes	29.27	6,108	1,325	21.7%	78.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Pasture - Grazing	Cattle	Shallow	Pescadero clay	29.27
Totals		10		129.53	44,988	19,346	20.5%	49.1%	0.0%	0.0%	22.1%	8.2%	0.0%	0.0%					129.53

Note: * - refers to the bare ground just beyond the perimeter of ponded water at the time of habitat characterization
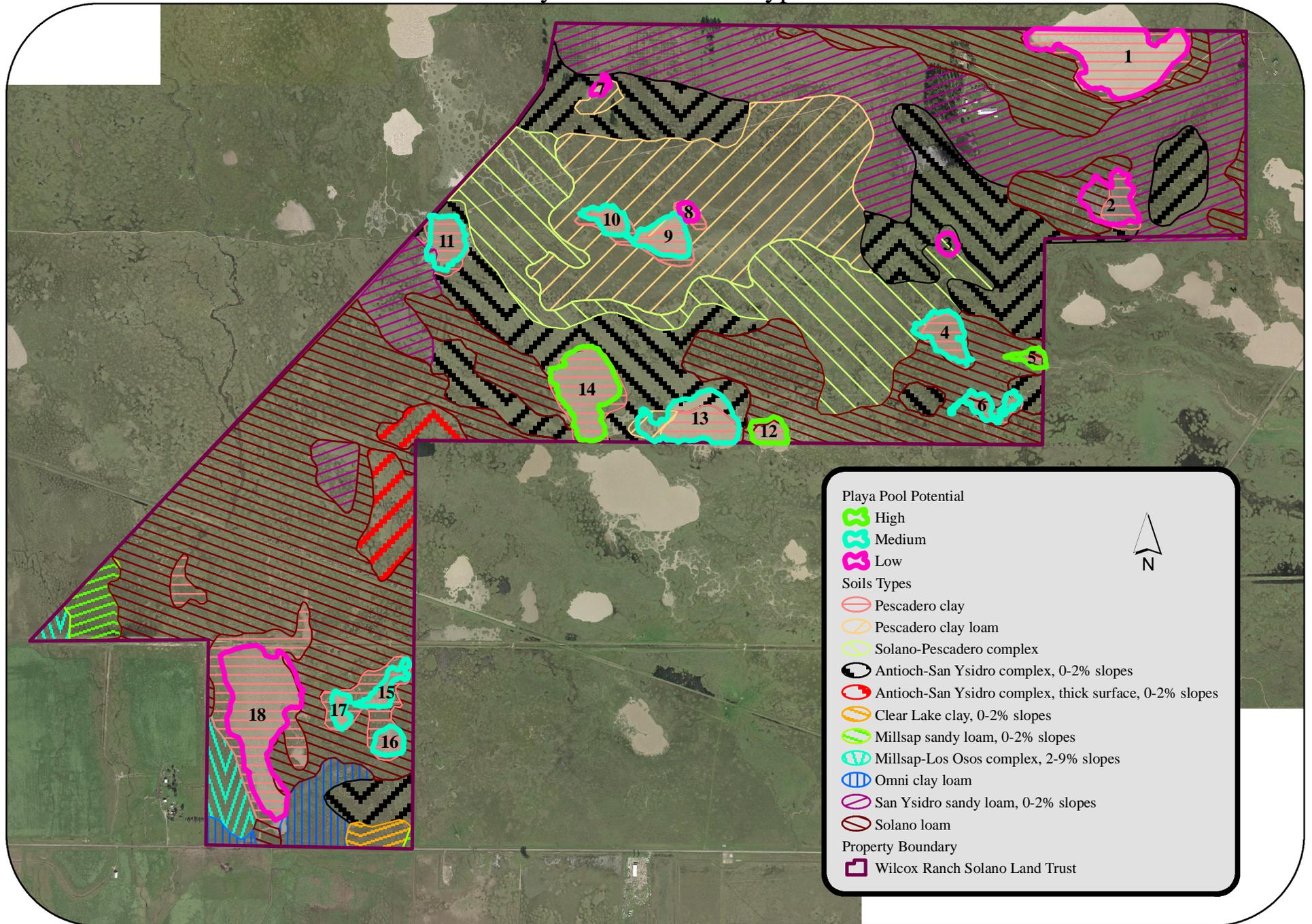
Table 3. DGGB Observations at Wilcox Ranch in 2007

Playa Pool ID #	Survey Date	Number of DGGB Observed	Number of Survey Stations	Air Temp °F	Wind Speed mph
1	Feb. 11	0	5	64	1
2	Feb. 11	0	5	65	1
3	Feb. 11	0	5	66	3
4	Feb. 11	0	5	66	3
5	Feb. 11	0	5	67	4
6	Feb. 11	0	5	68	4
7	Feb. 11	0	5	68	6
8	Feb. 11	0	5	67	4
9	Feb. 11	0	5	68	6
10	Feb. 11	0	5	66	5
11	Feb. 11	0	5	66	5
12	Feb. 11	0	5	65	7
13	Feb. 11	0	5	65	7
14	Feb. 11	0	5	64	8
15	Feb. 11	0	5	64	8
16	Feb. 11	0	5	64	8
17	Feb. 11	0	5	63	10
18	Feb. 11	0	5	63	11
1	Feb. 12	0	20	62	3
2	Feb. 12	0	10	63	2
15	Feb. 12	0	10	64	3
16	Feb. 12	0	10	64	3
17	Feb. 12	0	10	62	2
18	Feb. 12	0	20	62	2
1	Feb. 15	0	15	65	2
2	Feb. 15	0	10	65	2
3	Feb. 15	0	5	67	4
4	Feb. 15	0	15	68	5

Playa Pool ID #	Survey Date	Number of DGGB Observed	Number of Survey Stations	Air Temp °F	Wind Speed mph
5	Feb. 15	0	10	71	5
6	Feb. 15	0	10	72	5
1	Feb. 16	1	26	69	0
2	Feb. 16	0	20	80	0
3	Feb. 16	0	10	77	5
4	Feb. 16	0	20	74	8
5	Feb. 16	0	12	72	10
6	Feb. 16	0	15	72	8
8	March 4	1	4	67	4
9	March 4	0	15	67	4
10	March 4	0	10	67	5
11	March 4	1	10	65	5
12	March 4	0	5	64	4
13	March 4	1	15	65	6
14	March 4	1	15	66	4
15	March 4	0	10	67	4
16	March 4	0	5	67	4
17	March 4	0	5	69	4
18	March 4	1	11	70	4
1	March 5	0	20	71	3
2	March 5	0	15	72	3
3	March 5	0	5	71	3
4	March 5	0	15	69	4
5	March 5	1	10	69	3
6	March 5	1	15	70	3
7	March 11	0	5	72	2
8	March 11	0	5	72	2
9	March 11	1	10	74	2
10	March 11	0	10	75	3
11	March 11	0	10	73	4

Playa Pool ID #	Survey Date	Number of DGGB Observed	Number of Survey Stations	Air Temp °F	Wind Speed mph
12	March 11	0	5	73	4
13	March 11	0	15	74	3
14	March 11	0	15	74	3
12	March 14	0	5	66	1
13	March 14	0	15	68	0
14	March 14	1	15	70	1
15	March 14	0	10	71	1
16	March 14	0	10	72	3
17	March 14	0	10	74	1
18	March 14	0	20	75	1
1	March 18	0	20	68	1
2	March 18	0	5	69	0
3	March 18	0	5	68	1
4	March 18	0	15	69	2
5	March 18	0	5	71	2
6	March 18	0	10	72	3
7	March 18	0	5	73	2
8	March 18	0	5	73	2
9	March 18	0	10	74	3
10	March 18	0	10	75	3
11	March 18	0	10	74	3
12	March 23	0	10	71	3
13	March 23	0	15	72	3
14	March 23	0	15	70	2
15	March 23	0	10	72	2
16	March 23	0	10	73	3
17	March 23	0	5	73	3
18	March 23	0	20	74	4
1	March 30	0	15	68	3
2	March 30	0	10	66	2

Playa Pool ID #	Survey Date	Number of DGGB Observed	Number of Survey Stations	Air Temp °F	Wind Speed mph
3	March 30	0	2	66	3
4	March 30	0	10	67	1
5	March 30	0	5	68	0
6	March 30	0	5	68	0
7	March 30	0	5	69	1
8	March 30	0	5	69	1
9	March 30	0	10	70	1
10	March 30	0	10	71	0
11	March 30	0	10	72	0
12	April 11	0	5	60	4
13	April 11	0	10	60	4
14	April 11	0	10	61	5
15	April 11	0	10	61	5
16	April 11	0	5	62	6
17	April 11	0	5	62	5
18	April 11	0	15	64	5
1	April 13	0	15	60	0
2	April 13	0	5	60	0
3	April 13	0	2	62	1
4	April 13	0	5	62	1
5	April 13	0	5	63	1
6	April 13	0	5	63	1
7	April 13	0	2	63	1
8	April 13	0	2	65	1
9	April 13	0	5	65	0
10	April 13	0	5	65	0
11	April 13	0	5	67	0
12	April 13	0	5	68	1
13	April 13	0	5	69	2
14	April 13	0	5	69	2

Playa Pool ID #	Survey Date	Number of DGGB Observed	Number of Survey Stations	Air Temp ^oF	Wind Speed mph
15	April 13	0	5	70	2
16	April 13	0	5	70	2
17	April 13	0	5	70	1
18	April 13	0	10	71	2

Figure 1: Delta Green Ground Beetle Study at Wilcox Ranch Solano Land Trust
Playa Pools and Soil Types

Playa Pool Potential
- High
- Medium
- Low

Soils Types
- Pescadero clay
- Pescadero clay loam
- Solano-Pescadero complex
- Antioch-San Ysidro complex, 0-2% slopes
- Antioch-San Ysidro complex, thick surface, 0-2% slopes
- Clear Lake clay, 0-2% slopes
- Millsap sandy loam, 0-2% slopes
- Millsap-Los Osos complex, 2-9% slopes
- Omni clay loam
- San Ysidro sandy loam, 0-2% slopes
- Solano loam

Property Boundary
- Wilcox Ranch Solano Land Trust

N

0   1,250   2,500   5,000 Feet

September 19, 2007
Entomological Consulting Services, Ltd.

Figure 2. - DGGB Jepson Study Area: Pools 50 - 54

County Road

Transmission Line

39

40

41

42

54

53

52

51

48

47

46

43

45

49

50

44

Railroad

0   1,250   2,500   5,000 Feet

January 23, 2007
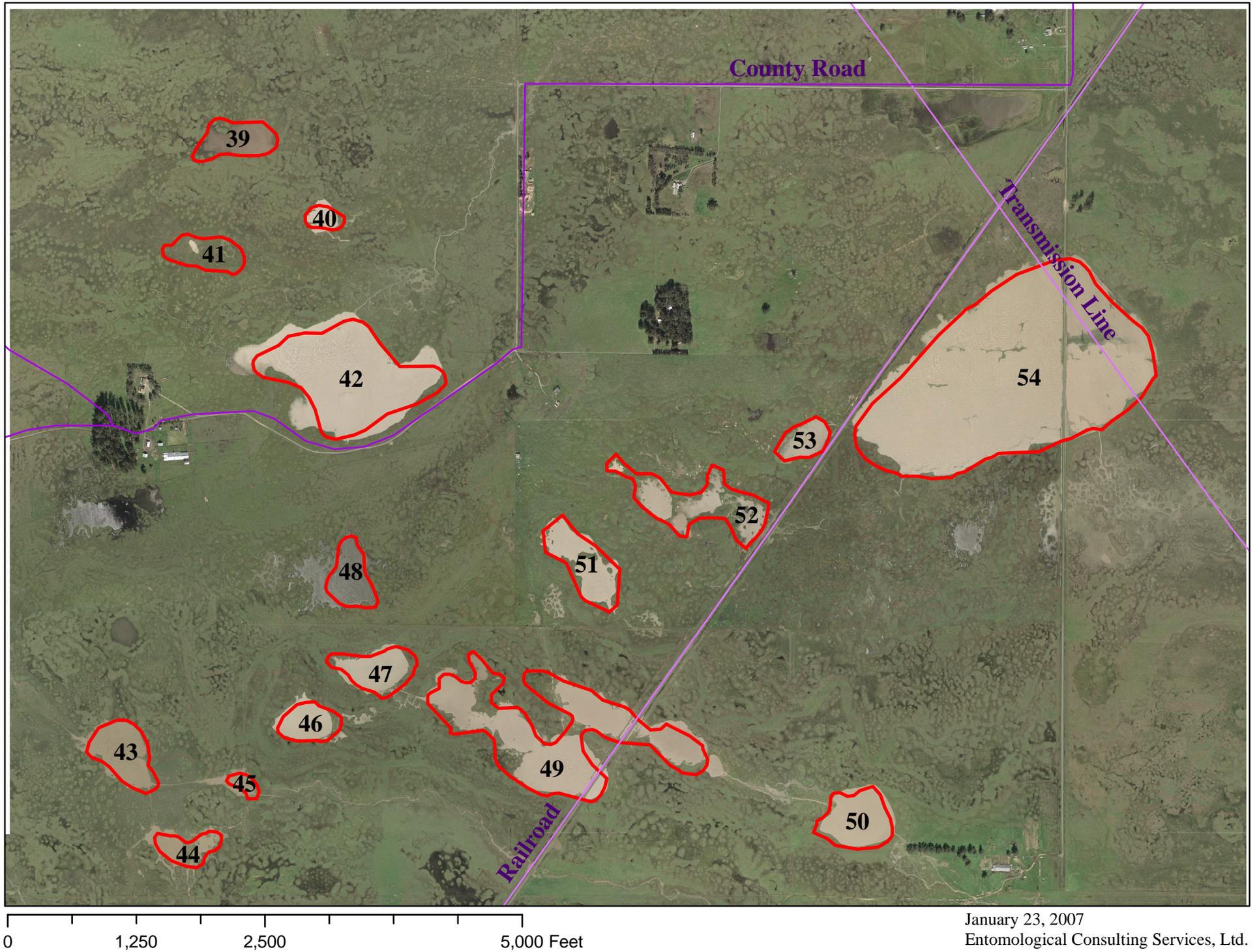Entomological Consulting Services, Ltd.

Figure 3: Delta Green Ground Beetle Study at Wilcox Ranch Solano Land Trust
Playa Pools, Habitat Types and 2007 DGGB Observations

Playa Pools
  Potential DGGB Habitat
Observations
  DGGB Observations
Shoreline Attributes
  Sloped, Bare
  Sloped, Grassy
  Steep, Bare
  Steep, Grassy
Property Boundary
  Wilcox Ranch Solano Land Trust

0   1,200   2,400   4,800 Feet

December 10, 2007
Entomological Consulting Services, Ltd.