Aquatic Sampling at Canada de los Osos Reserve in 2013-2017

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Cumulative 2013, 2016, 2017 results. 2017 results and modified text are in bold.

INTRODUCTION

In 2013, western pond turtles (*Actinemys* (=*Emys) marmorata*) were trapped, larger individuals shell notched, and four turtles radio-tracked to upland habitats after pond drying at Old Corral Pond in the Canada de los Osos Ecological Reserve. Seining the drying pond was used to sample for small pond turtles and larval and metamorphing California newts (N, *Taricha torosa*), Sierran treefrogs (TF, *Pseudarcris sierra (=Hyla regilla*)) and California red-legged frogs (RLF, *Rana draytonii*). Seining also documented an abundant population of larval and transforming California tiger salamanders (CTS, *Ambystoma californiense*).

Continuation of the 2012-2015 drought resulted in very early drying of the Old Corral Pond in 2014 and 2015, and no sampling was conducted. The early drying raised some concern that the population of turtles and amphibians might have been impacted by the drying or by the extended period of potential upland predation. In May – August 2016, the pond was resampled. In addition, other seeps, spring boxes, and ponds were sampled, including seven ponds that were excavated and deepened in 2015 in attempts to prolong water retention (see maps, Figures 1-3). **In 2017, most previously sampled ponds were resampled in April – August, and several additional ponds and two streams were sampled.**

The Reserve provides aquatic habitat in permanent ponds and in seasonal ponds that can dry early or last into late summer (Table 1). Seasonal streams are also present, as are developed spring boxes and tanks and drinkers artificially supplied with water; all provide potential habitat for amphibians.

METHODS

Old Corral Pond was trapped with sardine-baited hoop traps for turtles on 20-24 May, 16-20 June and 22-23 August 2016. Some turtles were also caught with seine and dip net on 22 and 23 August 2016**. In 2017, Old Corral Pond was sampled for turtles by 4-6 hoop traps from 25 April – 21 May and from 7 - 19 August. In response to observations of turtles in the stream downstream of, and supported by seepage from, the Old Corral Pond, hoop traps were used to sample from 29 April – 21 May at up to 4 sites downstream to the Willson Ranch Boundary. Two hoop traps were also installed in Spring Valley Pond #2 (the northern and larger of the two ponds) from 14 May – 21 May to check for turtles**

and fish; angling was also used to unsuccessfully sample for fish. A single hoop trap was used to sample for turtles (10 May – 14 May) on the outlet stream from Spring Valley near its confluence with the outlet stream from Corral Pond (near the boundary with the Willson Ranch and with Henry Coe State Park). Hoop traps were also used from 9 - 19 August in Turkey Pond, 11 - 19 August in Tooth Pond, and 14 – 19 August in Deer Spring Lake to sample for turtles and fish. All three ponds were also dip netted for amphibians and invertebrates. Captured turtles were measured for carapace length, sexed if mature, and PIT tagged in the peritoneal cavity anterior to the right hind leg. Turtles larger than 70 mm were shell notched.

On 20, 22, 24 May, 16, 20, 23 June, and 22, 23, 28 August 2016, seines and dip nets were used to sample a variety of ponds, seeps, and spring boxes for amphibians (and for fish in one pond). **On 2, 20, 27 April, 15, 18, 21 May, 25, 30 June, and 7 August 2017 wide mouthed dip nets and seines were used to sample ponds for amphibians. Larvae were identified and enumerated. Shorelines were searched for metamorphs and older frogs. General sizes of larvae were noted. On 25 June and 17 August angling was used in Deer Spring Lake and on 30 June in Gulnac Lake to unsuccessfully sample for fish.**

On 5 July Rocci's Pond, Old Corral Pond, and Old Willson Road Pond were re-sampled by seines and dip nets with Bryan Mori to capture California tiger salamander larvae for genetic sampling. Larvae had already transformed and left West Big Springs Pond. Clips from tails were taken from 6 larvae at Rocci's Pond, 17 larvae at Old Corral Pond, and 20 larvae at Old Willson Road Pond. The genetic samples were provided to Dr. Brad Schafer at UCLA for analysis.

Headlamps were used to search for eyeshine to sample for frogs in Old Corral, Turkey, and Tooth ponds on 11 August 2017.

RESULTS AND DISCUSSION

Old Corral Pond **(37° 03' 14.0" N, 121° 23' 03.4" W)** ***Western Pond Turtles***

Sixty-three different turtles were captured between the 2013 and 2016 sampling. At least fourteen of the turtles were caught in both years (smaller turtles from 2013 were not marked), accounting for about one-half of the mature males (9 of 20) and females (5 of 10) caught in 2016. **In 2017, 43 different turtles were captured in April and May, including 10 new males and 5 new immature turtles; no new females were captured. In August trapping was again resumed when the pond was less than 1.2 m deep and when most turtles were apparently still in the pond. Forty-six different turtles were captured (79 total captures) in 12 days, more than the number captured during 27 days in April and May; three new turtles were captured in August and 5 males and 5 females were captured, which had been caught in 2013 and/or 2016, but not in April/May 2017. All 12 females caught in 2017 were caught or re-caught in August, compared to 7 in April and May. Catch rate per trap-day and also the capture of females was about double in August, apparently during binge feeding prior to pond drying.**

Sixty-two of the turtles now carry PIT tags, including four turtles too small for shell notching. Seventy-two are shell notched.

Size distribution of turtles captured in 2013, 2016, and 2017 was similar, although the total number of individual turtles captured in 2016 (n=41) **and 2017 (n=56)** was greater than in 2013 (n=33; Figure 4). This probably reflected the greater trapping effort in 2016 (12 versus 5 days**), and especially in 2017 (27 days in April and May and 12 days in August). The sex ratio of mature turtles was different among years (12M: 9 F in 2013, 20M: 10F in 2016, and 32 M: 12 F in 2017; Figure 4), due to a substantial increase in captured males in 2016 and 2017.**

A majority of turtles marked in 2013 were apparently not recaptured in 2016 or 2017. Some may have been small enough in 2013 that their notches were not recognized in 2016-2017 (thus the PIT tagging in subsequent years); however, 5 mature males, 1 mature female, and an immature turtle > 100 mm were never recaptured in 2016 or 2017. Two mature males and 1 mature female first captured in 2016 were not recaptured in 2017. In addition, the first-time capture of about half of the mature turtles in 2016 may indicate that some turtles could have low capture or recapture probability ("trap shy"). Alternatively, the capture of new turtles in 2016 and 2017, and the lack of recaptures of some turtles, may also reflect substantial movement of turtles to and from the pond, including through the seasonal stream supported by seepage from the pond. Half of the new males in 2017 had an atypical reddish-brown carapace, not noticed at Old Corral Pond before, but observed previously in a different study in a pond near Coyote Creek which had reddish brown mud. The pond on the Willson Ranch just north of the entrance from the Reserve probably has turtles, and they likely move in the stream and to Old Corral Pond. That pond is also the likely source of the bullfrogs (*Lithobates catesbeiana*) that were captured this year in the stream downstream of Old Corral Pond and the single adult male bullfrog observed (and removed) in August in Old Corral Pond. In addition, downstream of the confluence of the two tributaries from Old Corral and Spring Valley ponds, the stream is named Coon Hunter's Gulch, a tributary to Hunting Hollow, within Henry Coe State Park. Hunting Hollow discharges to Coyote Creek just downstream of the park on Santa Clara Open Space land. Those streams are mostly dry in summer, but are passable to turtles and have some residual pools in summer that can support turtles.

Many of the turtles have been recaptured multiple times in the baited traps and are "trap-happy;" the sardine baits are in partially opened cans and accessible for feeding. Trap recapture rates or mark/recapture ratios cannot be used to estimate mortality losses or to make population estimates, because of the variable trap vulnerability of individual turtles.

The abundance of captured turtles in 2016 (n=41) and 2017 (n=56), including abundant small, young turtles (n=11-12) indicates that the turtle population has been doing well, despite annual drying of the pond, and especially early drying in 2013-2015. The population appears robust and secure, especially with its connections to seasonal streams and at least one pond downstream.

***"Turtle Creek"—the seasonal stream downstream of Old Corral Pond* (trapped from 37° 03' 22.6" N, 121° 23' 22.5" W downstream to the Willson Ranch Boundary [37° 03' 30.1"N, 121° 23' 37.3"])**

TF BF RLF Turtles

Thirteen western pond turtles were captured by hand or hoop trap from 29 April-21 May, when the deepest pools were < 0.5 m. This included 6 juvenile turtles, 4 mature males, and 3 mature females

(Figure 4). Trapping occurred during the mating season, when males regularly extensively move to seek mating opportunities, and males were usually caught and re-caught in traps that held females. One of the males caught in the stream had previously (2016) been caught in Old Corral Pond. Another turtle, captured twice in the stream, was captured in August in Old Corral Pond. The juvenile, female, and some male turtles had patterned coloration associated with stream-dwelling, rather than the drab coloration of turtles from Old Corral Pond. They also showed slower growth than most turtles in Old Corral Pond, and were probably resident in the stream.

Adult and sub-adult red-legged frogs were somewhat common in the stream. Two sub-adult bullfrogs (BF) were captured and removed; they presumably moved upstream from the pond on the Willson Ranch, just north of the reserve. An adult bullfrog calling and observed in Old Corral Pond in August apparently also moved upstream through the stream to the pond. Treefrogs and their tadpoles were also present in the stream, which was dry by August.

South (#1) Spring Valley Pond **(37° 02' 59.6 N, 121° 24' 05.8 "W)** **BF** **TF** **N** **Td**

The southern of the two Spring Valley Ponds is deep in spring, but loses depth rapidly over the summer and can go dry. It was sampled by seine and dip net on 20 May 2016. Newt larvae, treefrog tadpoles, and western toad (*Anaxyrus boreas*) tadpoles were common. **In April and May 2017 bullfrogs were observed to be very abundant in the pond, but no sampling for other amphibians was conducted.**

North (#2) Spring Valley Pond **(37° 03' 03.29"N, 121V 24' 04.29"W)** **BF** **TF** **Turtle**

The northern Spring Valley Pond has a relatively stable water level and is fully bordered by dense cattails. It was inefficiently dip-netted because of depth and cattails on 20 May 2016. Only bullfrog tadpoles were captured**.**

On 28 August 2016 and 16 May 2017 it was sampled by angling, without success. No fish were caught in hoop traps from 14-21 May 2017. Invertebrates were reasonably common in dip-net samples, so no predatory fish are likely present. Numerous bullfrogs and bullfrog tadpoles were caught in the hoop traps, and a single mature male western pond turtle was captured. Treefrog tadpoles were relatively uncommon in the pond, probably because of the abundant bullfrogs and bullfrog tadpoles.

The single male turtle captured in 2017 probably reached the pond through the seasonal, rather steep outlet stream that joins "Turtle Creek" at the Willson Ranch. Limited hoop trap sampling in May near the confluence of the two seasonal tributaries did not catch any turtles. It is unlikely that a reproducing population of turtles would naturally establish in the pond, because of the difficulty of moving upstream to the pond and the unlikelihood of resident turtles in the steep, shaded, seasonal stream. In addition, although an occasional male might move through the stream, especially during mating season, female turtles do not undertake the extensive movements that males do.

If a turtle population was established by transplanting gravid females or juvenile turtles to the pond, bullfrog predation on small turtles could be an issue.

Spring Box **(Approx. 37° 03' 16" N, 121° 24' 06"W) Td N**

This spring box is uphill along the road leading to the Willson Ranch. It was dip netted on 23 June 2016, and contained western toad tadpoles and newt larvae**. This spring box was not sampled in 2017.**

Tooth Lake **(37° 02' 24.7" N, 121° 25' 15.9" W) BF TF Turtle? Bass + Bluegills + crayfish**

Hoop trapping for turtles and fish was conducted in Tooth Pond in 2013 without capturing either turtles or fish. However, largemouth bass (*Micropterus salmoides*) and bluegills (*Lepomis macrochirus*) are present in the pond, which receives angling effort. In 2017, hoop traps were used to sample from 11 – 19 August 2017. One largemouth bass 37 cm long and 59 bluegills 12.5 – 24 cm long were captured (Figure 5). A partial fish kill in a previous summer reduced bluegill abundance, but resulted in much better growth and size of the remaining bluegills (Bob Clement, pers. com.).

A turtle (Bob Clement, pers. com.), bullfrogs and treefrogs have been observed in past years, and dip netting on 11 August 2017 caught young-of-year bullfrog tadpoles and very recent treefrog tadpoles within dense cover, especially of smartweed; they were nearly absent in less dense habitat accessible to bass and bluegills. Also captured in escape cover were swamp crayfish (*Procambarus clarki)*. A night eye shine survey on 11 August 2017 found scarce bullfrog metamorphs and about 6-10 adult bullfrogs. Intermediate-sized (sub adult) bullfrogs were not observed.

Both bass and bullfrogs can prey on young turtles, so the pond may lack or have very few turtles and may not have successful reproduction. Pond turtles can access Tooth Lake and Turkey Pond from perennial portions of Canada de los Osos, downstream (west) of the reserve, which is a tributary to Coyote Creek. Within the reserve the stream is seasonal, and dries early in summer.

Turkey Pond **(37° 02' 14.0" N, 121° 24' 15.3" W) BF TF Turtle Bass + Bluegills + Mosquitofish**

Hoop trapping for turtles and fish in Turkey pond in 2013 failed to capture any turtles, although western pond turtles have been occasionally seen at the Tooth and Turkey ponds or in the usually dry stream bed near and downstream of Turkey Pond (Henry Colleto and Bob Clement, pers. comm). **Bluegills were very abundant and some largemouth bass were captured in the hoop traps in 2013; mosquitofish (*Gambusia affinis*) were also present. Treefrog tadpoles (and invertebrates) were very scarce in dip net samples in 2013 and May 2017. Turkey Pond was hoop-trapped for fish and turtles from 7 - 19 August 2017. A largemouth bass 43.5 cm long (fork length) was caught, as well as bluegills 14-20.5 cm long (n=61; Figure 5). The bluegills were much bigger than in 2013, when 109 bluegills ranged from 10-17.5 cm (Figure 5). The apparent reduction in abundance, but substantial increase in size, of the bluegills may reflect water quality-related fish kills during the severe 2014 and 2015 drought years, and subsequent increase in growth among the remaining bluegills.**

A single mature male pond turtle was captured in August 2017, but a significant turtle population is unlikely in the presence of the largemouth bass and bullfrogs, because of potential predation on young turtles. As at Tooth Lake, bullfrogs were far less abundant than at ponds without bass. A night

eye shine survey found about 12 large adult bullfrogs and about 20 bullfrog metamorphs; intermediate-sized bullfrogs were not observed. Dip netting on 7 August 2017 found almost no insects except giant water bugs, in the presence of abundant bass and bluegills.

Old Corral Pond Amphibians/snakes **CTS RLF TF N BF red-sided garter snake**

When sampled by seine and dip net on 20 May 2016, the pond was three-quarters full and over 4 m deep. Treefrog tadpoles were abundant and newt larvae were present. No red-legged frog tadpoles or California tiger salamander larvae were captured and were probably in deeper water.

On 22 August 2016 the deepest part of the remnant pond was about 0.4 m deep. Seining for amphibian larvae and metamorphs captured relatively uncommon larval newts and some metamorphs, and some treefrog tadpoles. Treefrog metamorphs were also along vegetated portions of the shoreline. No red-legged frog tadpoles or metamorphs were captured or seen. Most abundant were California tiger salamander larvae. None of the captured tiger salamanders had fully resorbed gills or the fully developed spotting pattern of full metamorphs or adults. On 28 August the pond was less than 0.25 m deep and catch per seine haul was less than about one-fourth that of a week earlier, despite a reduction in pond volume by about three-fourths. Again, none of the captured salamander larvae showed full metamorph characteristics. However, the substantial reduction in salamander abundance appeared to indicate that many salamanders were triggered by the declining water level to transform and emigrate upland during the week. The pond was fully dry within 4 days. The pond supports a large California tiger salamander population, in the absence of cattle grazing and the abundant ground squirrel (*Otospermophilus beecheyi*) burrows associated with cattle grazing.

Water level on 22 August 2016 was somewhat lower than on 7-12 July 2013, a more severe drought year, when California red-legged frog tadpoles and metamorphs were abundant. It may be that red-legged frogs had metamorphed earlier than seining took place in 2016. However, no metmorphs were found along the vegetated portion of the shoreline. Earlier in summer adult red-legged frogs were seen along the shoreline (Bob Clement, pers. comm.)

Despite the substantial depth of the Old Corral Pond when full, it presently does not hold water well, and drains down relatively quickly in summer. This assures the seasonal nature of the pond and that bullfrogs or fish would not be able to successfully establish. Leakage also supports a well-developed vegetated channel in the seasonal drainage downstream of the pond.

In 2017, when the pond was nearly full on 20 April, dip-netting in the shallows produced abundant treefrog tadpoles. Newt eggs were present, but had hatched. On 27 April, 4 adult red-legged frogs were seen on the dam face at the water line, and 2 red-legged frogs were seen in the stream downstream of the dam. Several yearling red-legged frogs were seen while checking traps in May, so although no red-legged frog tadpoles were captured in 2016, successful reproduction did occur in 2016. On 5 July 2017 California tiger salamander larvae were captured by seining in water to 1 m deep, but the deepest portions (1.2 – 1.6 m) of the pond could not be sampled; Newt and treefrog larvae were also captured, but no red-legged frog tadpoles were captured. On 7 August the pond was clear and less than 1.1 m deep; filamentous algae coated the bottom and occurred as floating mats on 25+% of the surface. Few tiger salamanders and newts were still present, and no larval red-legged

frogs or treefrogs were captured in seine or dip net; one possible red-legged frog metamorph was seen. However, a nighttime eye shine survey on 11 August observed no metamorph red-legged frogs, only one adult red-legged frog, and no treefrogs. An adult male bullfrog was seen and heard calling (and was removed later in August). On 17 August some tiny treefrog metamorphs were present in the spike rushes above the water line. The pond dried in early September.

A large California red-sided garter snake (*Thamnophis sirtalis infernalis*) was seen and photographed in May. This has been the only location where red-sided garter snakes have been sighted, although Santa Cruz aquatic garter snakes (*Thamnophis atratus atratus*) are regularly seen at most of the ponds on the Reserve.

Old Willson Road Pond **(north of Tooth Lake; 37° 02' 44.3" N, 121° 25' 05.9" W)**

CTS TF(2017) N (2017)

This grassland pond was sampled by seine and dip net on 16 June 2016. On that date it contained numerous (n=63) tiger salamander larvae and recent metamorphs. No newt larvae or frog tadpoles were captured, but may have been consumed by the very abundant tiger salamanders.

On 2 April 2017, limited seining of the dam face at this pond captured 9 variable-sized tiger salamander larvae (2.5 -3.8 cm total length). A few larger treefrog tadpoles with hind legs were also captured. On 26 June the deepest part of the pond was 0.7 m, and limited dip net sampling captured 7 tiger salamander larvae (9-10.5 cm). A few treefrog tadpoles and newts were also captured. On 5 July, 21 tiger salamander larvae (7-11 cm) were captured by dip net; none were transforming, and genetic samples (tail clips) were taken from 20 of the salamanders. Treefrog tadpoles and newt larvae were uncommon in the presence of the abundant tiger salamander larvae. The pond was dry by mid-August.

Seep and Spring Box on Spur Road off Old Wilson Road **(approx. 37° 03' 15" N, 121° 24' 39" W) TF N**

This tiny seep and spring box was sampled by dip net on 16 June 2016. Treefrog tadpoles and newt larvae were present in the spring box. **The seep and spring box were not checked in 2017.**

Seep and Spring Box in grassland gully to south of Old Wilson Road **(37° 03' 00.6" N, 121° 24' 27.0" W)**

The spring box was dense with aquatic vegetation and partially filled with sediment (which was cleaned out) on 16 June 2016. No amphibians were captured during dip-netting. **The seep and spring box was not checked in 2017.**

West Big Spring Pond **(37° 02' 48.2" N, 121° 23' 43.6" W) CTS TF N**

This small pond was deepened in 2015, but is less than 9 m in diameter and sustained by winter rains only. It will be seasonal in all years, but is now capable of lasting into August of most years. The pond

was seined and dip-netted for amphibians on 20 May and 16 June 2016, but was dry by early August. On 20 May 2016, 27 tiger salamander larvae were captured by limited seining. Also captured were newt larvae. On 16 June 2016, tiger salamander larvae were captured, including several without gills and/or with faint metamorph spotting. The pond was very shallow, and no newts or treefrog tadpoles were captured, but treefrog metamorphs were present along the shoreline.

On 2 April 2017, the turbid pond was deep enough so only shoreline areas could be sampled by seine and dip net. Only treefrog tadpoles were captured. On 15 May, the maximum depth was 0.8 m, and 8 large (8.5 – 13.5 cm TL) California tiger salamanders were captured by intensive dip netting; abundance was apparently substantially less than in 2016. Treefrog tadpoles were more common, as were newt larvae to 3 cm long, than in 2016 when tiger salamander larvae were abundant. Genetic sampling was planned for tiger salamanders at the pond, but on 26 June only a single transformed tiger salamander was captured by intensive dip netting. Newt larvae were common, but few treefrog tadpoles remained. On 7 August the pond had shrunk to 6 feet diameter and less than 0.2 m deep, but was clear. Feral pig wallowing had muddied the pond by 17 August. The pond was dry by late August.

East Big Spring Pond **(37° 02' 47.7" N, 121° 22' 58.2" W) CTS(2016) TF RLF N**

This small pond is associated with a spring, but is in open grassland. The pond was deepened in 2015 and was fenced against pig use. It is now likely that the pond will retain water through fall of average or wet years. The pond was seined and dip-netted for amphibians on 20 May, 16 June, and 22 August 2016. On 20 May 2016, 68 tiger salamander larvae to 15 cm long were captured during limited seining. Treefrog tadpoles (n=30) and newt larvae (n=6) were also captured. A single yearling-sized red-legged frog was captured. On 16 June 2016, 50 tiger salamander larvae were captured, but the largest were smaller (12.5 cm) than in May. None of the larvae showed color changes or gill reduction associated with early metamorphosis. Treefrog tadpoles and newt larvae were still present. On 22 August 2016, tiger salamander larvae were still present, but much less abundant; none of the remaining larvae showed change of color or reduction in external gills. With the deepened pond, and the presence of the spring, this pond should hold water year round in many years. Conspicuously absent on all dates, were red-legged frog tadpoles, despite the presence of an adult/sub-adult. However, with the improved habitat conditions, a reproducing red-legged frog population is possible.

On 20 April 2017, the pond was sampled by seine and dip net, but the deepest portion (>1.2 m) could not be sampled. Treefrog tadpoles were common. No tiger salamander larvae or red-legged frog tadpoles were captured, but one adult/sub-adult red-legged frog was seen. On 18 May, an adult female red-legged frog and 12 red-legged frog tadpoles (4.5-5+ cm TL) were captured by intensive dip-netting. All parts of the pond were accessible to sampling, with the deepest part of the pond 1.1 m; the red-legged frog tadpoles were in the deepest habitats. Treefrog tadpoles were abundant (350), and newt larvae were common (70), but no tiger salamander larvae were captured despite their abundance in 2016. The newts and treefrogs were much more abundant than in 2016, when tiger salamander larvae were abundant. On 26 June, 14 red-legged frog tadpoles were captured, but were still only about 5 cm long. Newt larvae were common, but treefrog tadpoles were scarce, with most apparently already transformed; metamorphs were present along the shoreline. No tiger salamander larvae were captured. On 7 August maximum depth of the pond was 0.9 m, and two large adult red-

legged frogs were present, and one (110 mm SV female) was captured. Six red-legged frog tadpoles were captured during limited dip net sampling. One was only 5 cm long, but the others were 8-9 cm and had their rear legs. Newt larvae were still common, but treefrog tadpoles were scarce. On 31 August two red-legged frog metamorphs were observed. As predicted in 2016, the pond should last until winter rains.

Four Corners Pond **(37° 02' 49.2"N, 121° 22' 46.3"W) CTS RLF BF(2016) TF N**

This pond was deepened in 2015, and is deep when full, but does not hold water well. It was already quite shallow (0.4 m) when it was sampled by seine and dip nets on 22 May 2016. The pond is in a well-defined, oak-shaded drainage; the coarser substrate in the drainage may result in the observed rapid pond draw-down. Only 3 tiger salamander larvae were captured by seining, but early water level draw down might have triggered metamorphosis. Treefrog tadpoles and newt larvae were common, but red-legged frog larvae were apparently absent. Two bullfrogs were present, as was a yearling red-legged frog.

On 20 April 2017, the pond was intensively sampled by seine and dip net, but the deepest areas (> 1.2 m) could not be sampled. However, as in 2016, the pond was already substantially below the spillway, despite evidence that the pond had spilled during the wet winter. Treefrog tadpoles were abundant, as were newt larvae and hatching newt egg masses. One two-year old red-legged frog was captured, but no red-legged frog tadpoles were captured. On 18 May, the maximum depth was 0.8 m, and newt larvae (4-5.5 cm) were abundant and treefrog tadpoles were common. A single tiger salamander larva was captured, as was an adult female red-legged frog. The pond is bordered by oak woodland, and newt abundance was higher than at most other ponds. The scarcity of tiger salamander larvae in both 2016 and 2017, and possibly the lack of red-legged frog reproduction, may be due to egg predation by the very abundant newts. Hagerman Falls Pond is also surrounded by oak woodland and had very abundant newt larvae. Four Corners Pond was dry by July.

Rocci's Pond **(37° 03' 02.8"N, 121° 23' 40.7"W) CTS RLF(2016) TF N**

This pond is partially surrounded by oak woodland, except to the east. It was sampled by seine and dip net on 24 May 2016, when two-thirds of the pond surface was deeper than 1 m. Tiger salamander larvae were present, but only 6 were captured. They may have been more common in deeper water. Treefrog tadpoles and newt larvae were common. No red-legged frog tadpoles were captured, but may have been in deeper water. One adult red-legged frog was captured.

On 27 April 2017, seining and dip-netting captured abundant treefrog tadpoles, and larval newts. The deepest part of the pond could not be sampled (> 1 m), but 8 tiger salamander were captured with substantial seining and dip netting effort. They varied widely in size (5 – 10 cm total length), suggesting different reproduction times or early cannibalism. The pond was resampled on 5 July, and again tiger salamander larvae were scarce (n=7) and varied substantially in size (7-12 cm total length); genetic samples (tail clips) were taken from 6 of the salamanders. Newt larvae were abundant, and treefrog tadpoles were common. No red-legged frog tadpoles or adults were captured or seen on

either 2017 sampling day. The lack of red-legged frog reproduction and scarcity of tiger salamanders may be due to egg predation by abundant adult newts. The pond was dry by mid-August.

Upper Slump Pond **(37° 02' 29.8" N, 121° 23' 49.9 W),** ***Middle Slump Pond*** **(37° 02' 30.1" N, 121° 23' 48.0" W), and** ***Lower Slump Pond*** **(37° 02' 27.8" N, 121° 23' 46.6" W) TF N**

These closely adjacent ponds are in open grassland at the bottom of a major landslide. They were sampled by dip net on 2 April 2017, when the maximum depth of the ponds was about 0.6 m. Treefrog tadpoles were abundant in all three ponds. Newt larvae were only captured in in Upper Slump Pond, the largest of the three ponds; they were common in that pond. Large Dytisidae (predaceous diving beetle) larvae were common in all three ponds, but scarce ostracods were present only in the middle pond. Red-legged frogs have been observed at the ponds in the past, but none were seen, and no red-legged frog tadpoles were captured. The ponds were dry and plowed by pigs by August.

Wood Duck Pond **(37° 02' 50.9" N, 121° 22' 09.0W) RLF TF N**

This perennial pond within oak woodland was sampled by seine and dip net on 20 June 2016. Red-legged frog tadpoles were common, but some dead tadpoles were observed. Three adult red-legged frogs were seen. Newt larvae and treefrog tadpoles were common.

On 20 April 2017, five adult red-legged frogs were seen, and one red-legged frog tadpole was caught on the vegetated, deep and steep face of the dam. Treefrog tadpoles and newt larvae were present.

Deer Spring Lake **(37 02' 14.6" N, 121 21' 06.9" W) BF RLF Mosquitofish**

On 23 August 2016, 26 June 2017, and 17 August 2017 angling was attempted without capturing any fish. The thick border of emergent vegetation almost prevents angling, but even when an opening was cut through tules to make casting possible on 17 August 2017 no fish were caught. The lake was sampled by a baited hoop trap for turtles and fish on 14 – 19 August, but neither turtles nor fish were captured. The Lake was reported to have contained crappie (*Pomoxis* sp.) and largemouth bass. Adult bullfrogs are common at the pond, either due to a lack of largemouth bass and/or to the dense tule and cattail border. On 26 June 2017, intensive sampling with dip nets captured yearling bullfrog tadpoles and mosquitofish (*Gambusia affinis*). A single red-legged frog tadpole was captured.

Invertebrates appeared to be relatively abundant compared to in Tooth Lake and Turkey Pond, so larger predatory fish may not be present

Pond West of Elephant Ridge Road **(37° 02' 04.6" N, 121° 20' 40.7" W) TF N**

This pond is located in a gully within grassland. Upslope in the gully is a (winter) seep, but the pond dries early. It was sampled by seine and dip net on 20 June 2016, and treefrog tadpoles and newt larvae were present.

This pond was sampled by seine and dip net on 20 April 2017. Treefrog tadpoles and newt larvae were common and aquatic garter snakes were present. The pond was dry by mid-June.

Rock Corral Pond **(37° 01' 41.98"N, 121° 20' 20.61"W) RLF (2016) TF N (2017)**

This small pond was deepened in 2015 and fenced against pigs. It was very shallow (<20 cm) on 20 June 2016, when it was sampled with seine and dip net. Treefrog tadpoles were common, and two sub-adult or adult red-legged frogs were seen in the largely dry cattails on one side of the pond.

Despite the very wet winter, and pond deepening in 2015, the pond was shallow (< 0.3 m) on 20 April and 21 May 2017. Treefrog tadpoles were common, and some newt larvae were also caught by dip-netting. An aquatic garter snake was seen, but no red-legged frogs were seen in the pond or in the dense cattail border. Although shallow, seepage maintains the pond until late summer.

Cattail (Tule) Pond--Hagerman Canyon Road **(37° 02' 27.3" N, 121° 20' 20.6" W) RLF TF N**

This deep, perennial pond is located on a drainage within oak woodland and immediately adjacent to the road. It was not sampled in 2016, but contained newt larvae, treefrogs and tadpoles, and red-legged frogs and tadpoles in 2013.

On 21 May 2017, the steep-sided, cattail-bordered pond was seined, and red-legged frog tadpoles were captured. Treefrog tadpoles and newt larvae were scarce in the samples.

Mallard Pond **(37° 02' 27.36"N, 121° 20' 41.70"W) RLF TF N**

This pond is moderately large, but dries in late summer. It was over 1.1 m deep when sampled by seine on 20 June 2016. Four adult red-legged frogs were seen, and 5 large red-legged frog tadpoles captured; some may have already metamorphed, but no metamorphs were seen. Treefrog tadpoles and newt larvae were also present.

On 21 May 2017, the pond was quite deep (1.3+ m), with a vegetated or steep-sided shoreline. Five red-legged frog adults were seen or captured by seine. Fifteen large red-legged frog tadpoles (5.5-6.5 cm long) were captured. Treefrog tadpoles were common, and some newt larvae were also captured. The pond retained water until near the end of August.

Hagerman Pond **(37° 02' 35.1" N, 121° 20' 12.4" W) TF**

This pond is located on a drainage within oak woodland, and was deepened in 2015. However, it does not hold water well, and was very shallow (<10-15 cm), but clear, when sampled by dip net on 20 June 2016. Only tree frog tadpoles were present.

Road access was blocked until mid-June, and this very shallow pond was not sampled in 2017; however, treefrog tadpoles were observed in late June (Bob Clement, pers. com.).

El Toro Pond **(37° 02' 16.5" N, 121° 20' 05.4" W)** ***and El Toro 2 Pond*** **(37° 02' 14.2" N, 121° 20' 01.4" W)**
RLF TF N

Earlier reports of the two El Toro ponds (on the eastern boundary of the reserve, adjacent to or on the El Toro Ranch) indicated that bullfrogs were abundant and also that fish were present in El Toro 2, with is mostly on the El Toro Ranch. However, on 26 June 2017 no bullfrogs or bullfrog tadpoles were present in El Toro Pond on the reserve. Red-legged frog adults and sub-adults were seen at El Toro Pond, and red-legged frog tadpoles were captured in dip nets. Newt larvae were abundant, and treefrog tadpoles were common, as were aquatic garter snakes. Also present were abundant black fingernail clams; other known occurrences on the reserve are in Hagerman Falls Pond and Tooth Lake.

El Toro Pond 2 was almost completely outside the reserve on the adjacent El Toro Ranch. Red-legged frog tadpoles were observed to be common in the clear, shallow (shaded) water at the boundary, and treefrog tadpoles and newt larvae were also seen. No fish were seen, and the presence of abundant amphibian tadpoles in open water indicates no predatory fish were present. Apparently, both El Toro Ponds fully dried during the 2013-2015 drought, eliminating bullfrogs from the two ponds and fish from El Toro 2 Pond. The Google Earth photo from late September 2009, the third of three drought years, shows El Toro Pond with little water left, but El Toro 2 with substantial remaining water; the extremes of the 2013-2015 drought years were necessary to eliminate the bullfrogs and fish.

Hagerman Creek **(37 02' 56.4"N, 121 20' 17.9" W)** **RLF TF roach sculpin sunfish**

Intermittent Hagerman Creek was sampled in July 2013 and walked from near Hagerman Falls down to the reserve gate. Adult and sub-adult red-legged frogs were observed and California roach (*Lavinia symmetricus*) captured. On 14 August 2017 the stream was sampled near the gate, and California roach were common, and prickly sculpin (*Cottus asper*) and nonnative green sunfish (*Lepomis cyanellus*) were also captured in isolated bedrock pools. Two large (female) adult red-legged frogs were seen, as well as some treefrogs.

Hagerman Falls Pond **(37° 03' 50.0" N, 121° 22' 14.7" W)** **TF N RLF?(2017) BF?(2017)**

This pond west of and downhill from Hagerman Falls Road was deepened in 2015, and may now last through the summer of average and wet years. It was over 1.6 m deep when sampled by seine and dip net on 23 June 2016. Only treefrog tadpoles and abundant newt larvae were captured, but the pond could be able to support red-legged frogs.

On 30 June 2017, the pond was deep and steep-sided, and rushes prevented seining. The accessible portions of the pond were dip netted, and newt larvae were common. Relatively few treefrog tadpoles were captured. Two frogs were briefly seen as they jumped from shore, and one surfaced.

One was likely a red-legged frog and one may have been a bullfrog (it squeaked when it jumped). On 7 August the pond had shrunk, but maximum depth was still more than 1.2 m. A single medium-sized frog jumped from the shore. Newt larvae were very abundant (similar to 4 Corners Pond, which is also surrounded by oak woodland), but treefrog tadpoles were now scarce. Garter snakes and fingernail clams were present. The clam has elsewhere been found in El Toro Pond and Tooth Lake.

Brushy Road Pond **(37° 03' 56.7" N, 121° 21' 59.4" W) TF N**

This pond east of and downhill from Brushy Road was deepened in 2015. It was almost 0.8 m deep when sampled by seine on 23 June 2016. Treefrog tadpoles and newt larvae were captured.

On 30 June 2017, the pond was shallower (0.3 m) than in 2016. Treefrog tadpoles and metamorphs and newt larvae were common. Several aquatic garter snakes were present. The pond was dry before August.

Kelly Lake **(37° 05' 05.25"N, 121° 22' 43.83"W) BF RLF TF Td Golden Shiners**

This large reservoir in the NE portion of the reserve was sampled by dip-net and seine on 23 June 2016. The pond was unsuccessfully sampled by angling in 2013 and 2016. Bullfrog tadpoles and treefrog tadpoles were captured. Western toad metamorphs were seen along the shoreline. In perennial pools downstream of the dam adult red-legged frogs were seen. Golden shiners (*Notemigonus crysoleucas*), a relatively small and not strongly predatory nonnative minnow, were also captured by seining**.**

Apparently, Kelly Lake and Gulnac Lake received periodic stocking of rescued juvenile steelhead/rainbow trout (*Oncorhynchus mykiss*) decades ago. Golden shiners were probably introduced as a forage fish for rescued steelhead; the steelhead are unable to reproduce in the pond, and disappeared after period stocking of rescued steelhead was discontinued. This permanent lake was not sampled in 2017.

Gulnac Lake **(37° 04' 45.8" N, 121° 21' 57.6" W) BF TF N stickleback**

This large, permanent, tule-bordered reservoir was sampled by seine and dip net on 30 June 2017. No fish were caught by angling. Bullfrog adults and tadpoles were abundant. Treefrog tadpoles and newt larvae were common. Aquatic insects were relatively common, so large predatory fish are apparently absent. Threespine stickleback (*Gasterosteus aculeatus*) were common. Threespine stickleback frequently occur with juvenile steelhead, and were probably transferred to the pond with steelhead.

CONCLUSIONS/MANAGEMENT IMPLICATIONS

The distribution and abundance of amphibians and reptiles in the ponds are affected by habitat conditions, but also by strong competitive and predatory interactions among the species (Figure 6).

Effects of Deepening Ponds

Four of the seven ponds that were deepened in 2015 (East Big Springs, West Big Springs, Hagerman Falls, and Brushy Road ponds) had substantially improved habitat conditions in 2016, but Brushy Road Pond was actually shallower in 2017 than 2016. West Big Springs Pond can now last longer into summer, and had abundant tiger salamanders that metamorphed in 2016 and some tiger salamanders that metamorphed by late June in 2017. East Big Springs and Hagerman Fall ponds should retain water all year during average to wet years, based upon results in 2016 and 2017. East Big Springs had abundant tiger salamander larvae in 2016, but surprisingly, lacked them in 2017. Both ponds might potentially support reproducing red-legged frog, but egg predation by newts, especially in Hagerman Falls Pond, and tadpole predation by tiger salamanders in East Big Springs Pond, may limit red-legged frogs. Limited successful red-legged frog reproduction occurred in East Big Spring Pond in 2017, when tiger salamanders were absent.

Rock Corral Pond was deepened in 2015 and fenced against pigs, but the pond is near a ridge top and was shallow in June 2016 and 2017. Four Corners and Hagerman ponds are in drainages where coarser soils may not hold water without an effort to seal the pond bottom. Four Corners Pond did have a very few tiger salamander larvae in May of 2016 and 2017; the very abundant newts in Four Corners Pond, which is bordered by oak woodland, may prey on tiger salamander eggs.

Tiger Salamanders

California tiger salamander larvae were present in 6 ponds in 2016 and/or 2017 (Old Willson Road, West Big Springs, East Big Springs, Four Corners, Rocci's, and Old Corral ponds), although larvae were scarce in Four Corners Pond and apparently relatively uncommon in Rocci's Pond in both years. All ponds with tiger salamanders are in the southwest portion of the preserve (Figures 1 and 2). Similar pond habitats exist elsewhere in the reserve, but the other areas probably lacked suitable habitat, as seeps or seasonal streams, for tiger salamanders before artificial pond construction. With no nearby populations, tiger salamanders were (are) unable to access and use the apparently suitable ponds. In Henry Coe State Park, just to the north, ponds with tiger salamanders are similarly restricted to the wetter areas in the western portion of the park (Joseph Belli, unpublished).

The scarcity of tiger salamander larvae in West Big Springs Pond, and their absence in East Big Springs Pond in 2017, despite being abundant in both ponds in 2016, was a surprise. Perhaps relatively few adults lived through the 2013-2015 drought years, and didn't survive after reproducing in 2016 or have enough energy reserve to repeat spawning in 2017. The abundant juveniles produced in 2016 should rejuvenate the reproduction in future years.

The small, seasonal West Big Springs Pond, has had tiger salamanders in both 2016 and 2017. However, it suffered severe wallowing damage from feral pigs in August. The pond could be relatively easily fenced against pig use, as has previously been done at East Big Springs and Rock Corral ponds. There was similar damage to the larger Old Willson Road and Rocci's ponds in early August; fencing them would take more effort, but should be considered.

Many tiger salamander larvae (such as in East Big Springs Pond in 2016 and Old Willson Road and Old Corral ponds in both 2016 and 2017) appear to delay metamorphosis until very late in summer, if water is still available, and then can apparently very quickly metamorph as conditions deteriorate.

The present isolation of tiger salamanders to the western portion of the reserve appears to indicate that there should not be hybridization/introgression with the introduced tiger salamanders present in the Pacheco Creek drainage. However, genetic samples were taken in 2017 at Old Willson, Rocci's and Old Corral ponds to confirm the genetic integrity of the tiger salamanders on the reserve.

<u>Red-legged Frogs</u>

California red-legged frogs are more widespread than tiger salamanders (Figures 1-3). However, they were only observed or collected as sub adults or adults at Old Corral, East Big Springs, Four Corners, Rocci's, and Rock Corral ponds in 2016. In 2013 red-legged frog tadoles and metamorphs were abundant at Old Corral Pond. In 2016, I only collected red-legged frog tadpoles at Mallard and Wood Duck ponds. Predation by abundant tiger salamander larvae in several smaller ponds may have eliminated scarce red-legged frog tadpoles, but the timing of sampling at Old Corral Pond in 2016 may come after red-legged frog tadpoles had metamorphed and metamorphs dispersed; yearlings were observed at the pond in 2017, so some successful reproduction apparently occurred. In 2017, a single possible metamorph was seen in August, but a subsequent nighttime eye shine survey found no metamorphs and only one possible adult. However, adults were frequently seen at the pond in April and May.

The severe and prolonged drought, especially in 2013-2015, may have reduced red-legged frog abundance sufficiently to temporarily suppress reproduction at the small and early-drying ponds. Populations may recover, and also expand to improved ponds, with a series of wetter years. However, egg predation by newts, and predation on tadpoles by tiger salamander larvae, may suppress red-legged frogs in some ponds, especially if the number of reproducing adults is small. In 2017, some red-legged frog reproduction occurred at the deepened East Big Spring Pond (which lacked tiger salamanders in 2017), but did not occur at the much deeper Hagerman Falls Pond (which has abundant newts); only a possible red-legged frog adult was observed at Hagerman Falls Pond in June and August.

The paired El Toro ponds, on the east boundary, used to be dominated by bullfrogs, and game fish were in the pond across the boundary on the El Toro Ranch. Following the severe 2013-2015 drought, both ponds apparently dried, and now bullfrogs are apparently gone and red-legged frogs are present in both ponds.

The capture of a single red-legged frog tadpole in Deer Spring Pond, which has abundant bullfrogs, indicates that some resident red-legged frogs, or those in adjacent small wetlands, appear to use the

pond for reproduction. At a study pond in Henry Coe State Park, with a dense cattail border, red-legged frogs were able to persist in relatively small numbers, despite common bullfrogs (Smith, unpublished). In that case coexistence was added by periodic drying that reduced bullfrog numbers. At Kelly Lake red-legged frogs are present in the pools immediately downstream of the dam, even though bullfrogs are abundant in the lake itself. Red-legged frogs might occur in Canada de Los Osos ponds that have bullfrogs, but significant numbers are unlikely, especially if predatory fish are also present.

Fish

Fish are present in five ponds. Largemouth bass and bluegills are present in Tooth Lake and Turkey Pond; mosquitofish are also present in Turkey Pond. Predation by Largemouth bass and the smaller bluegill severely depressed invertebrate abundance and can eliminate or severely depress treefrogs, newts, and red-legged frogs. They even suppress bullfrog abundance in Tooth Lake and Turkey Pond. Both bass and the bullfrogs in the two ponds can prey on juvenile pond turtles. Tooth and Turkey ponds provide accessible angling opportunities, but are a relative desert for native aquatic life. Turkey Pond has an outlet pipe and valve, and could easily be drained to remove fish and reduce bullfrogs; periodic seasonal draining could further suppress bullfrogs. Slow annual draining would also sustain stream flow in the creek into mid-summer. Pond turtles and red-legged frogs could then successfully occupy the rejuvenated pond.

Gulnac and Kelly lakes have fish, but apparently no highly predatory fish, as invertebrates and treefrog tadpoles are common. Both ponds have abundant nonnative bullfrogs. Gulnac Lake contains abundant threespine stickleback, a small native California fish that is scarce in the presence of predatory fish. They were probably introduced to the lake with period plantings of rescued juvenile steelhead prior to the 1970's. Kelly Lake contains golden shiners, a small, nonnative minnow, which were probably introduced as a forage fish for transplanted trout. Neither lake has a spawning stream to support trout, so the trout populations died out when periodic planting ended.

Deer Spring Lake is ringed by dense tules and cattails and nearly impossible to fish from shore. It is supposed to have had sport fish (largemouth bass and crappie; Henry Colleto, pers. com.), but angling attempts in 2016 and 2017 and trapping in 2017 were unsuccessful. Invertebrates are modestly common, so a large population of predatory game fish is unlikely. Mosquitofish are present in the lake.

Bullfrogs

Bullfrog tadpoles, which usually take a year to metamorph, appear to restrict bullfrogs to six of the permanent ponds at Canada de los Osos: Deer Spring Lake, Kelly Lake, Gulnac Lake, Tooth Lake, Turkey Pond, and the Spring Valley Pond complex. All have at least some tule or cattail border, but Spring Valley Pond #2 (cattail) and Deer Spring Lake (tule with some cattail) are completely ringed by a dense border. Bullfrogs are much less abundant at Turkey Pond and Tooth Lake, which also contain large, predatory largemouth bass.

Outside of those permanent ponds, bullfrogs have been seen or captured only as two individuals (that were removed) in Four Corners Pond in 2016, two sub-adults (that were also removed) in ("Turtle Creek") the seasonal stream downstream of Old Corral Pond in 2017, and a single mature male bullfrog (observed and later removed) in Old Corral Pond in August 2017. Therefore, bullfrogs haven't, and hopefully won't, spread to other ponds. The bullfrogs in the stream and in Old Corral Pond probably moved upstream from the permanent pond on the Willson Ranch just north of the reserve boundary. No nearby likely source can account for the bullfrogs in Four Corners Pond, although there are reservoirs far down in the drainage south of the reserve boundary.

Western Toads

Toad tadpoles or metamorphs have been found only at Kelly Lake, the (potentially seasonal) southern Spring Valley Pond, and a spring box north of Spring Valley in 2016. Those locations were not sampled in 2017, and no toads were found elsewhere. Why they are not associated with more of the ponds is not known, but tadpoles can develop quickly and can probably use small springs, spring boxes, and drinkers for reproduction.

Western Pond Turtles

The answer to "why does only Old Corral Pond have turtles?" was answered this year with discovery of turtles in the seasonal outlet stream from the pond, with the movement of a turtle from the pond to the stream and a turtle from the stream to the pond, and the apparent movement of new male turtles to pond from downstream sources. The stream ("Turtle Creek") appears to harbor both resident turtles (based upon coloration and growth rate) and is a pathway for turtles to and from Old Corral Pond and the stream and also likely the permanent Willson Ranch Pond near the southern boundary of the ranch. Overland movement to other potential ponds would be much more difficult and is unlikely. The seasonal nature of Old Corral Pond also means that largemouth bass and bullfrogs are not present, allowing successful reproduction and a robust turtle population. The leaking of the pond not only makes the pond seasonal, but supports the spring and early summer stream flow in the stream downstream of the pond.

A single male turtle was captured in Spring Valley Pond #2 (the north pond) this year. It apparently accessed the pond by another seasonal tributary that joins the outlet stream from Old Corral Pond near the southern boundary of the Willson Ranch. When the two tributaries join they become Coon Hunter's Gulch, a tributary to Hunting Hollow in Henry Coe State Park. The stream downstream of Spring Valley is steep, and heavily shaded, providing a difficult pathway to the pond and unsuitable habitat to support a stream population of turtles. Female turtles move less, and are unlikely to move upstream to Spring Valley; a reproducing population in Spring Valley is very unlikely.

Occasional sightings have been made of pond turtles in Tooth and Turkey ponds and in the very seasonal stream near and upstream of the reserve headquarters. They can access the locations from the perennial portions of the stream west of the reserve, which is a tributary to Coyote Creek. However, the abundant predatory bullfrogs and largemouth bass in the two ponds may prevent successful reproduction in the two ponds.

If Turkey Pond was drained to remove the fish and reduce the bullfrogs, a turtle population could be established (by transplants) that might migrate between the pond and perennial portions of the stream downstream of the reserve; it might act somewhat like the situation at Old Corral Pond and the stream and ponds downstream.

Otherwise, the best possibility to establish another substantial turtle population on the reserve would be at Mallard Pond in the eastern portion of the reserve. The seasonal pond is relatively large, and lasts into mid-summer, as Old Corral Pond does. As a seasonal pond, it lacks bullfrogs and fish, and is partially surrounded by suitable grassland for turtle nesting and oak woodland as upland estivation/hibernation habitat. Establishment could be by introducing young turtles and gravid females, which are more likely to stay in the new habitat than older turtles and males. Introduced turtles could be radio-tracked to determine their movements.

Other possible locations for new turtle populations include Kelly Lake, Gulnac Lake, and Deer Spring Lake. All three are isolated permanent lakes, but have abundant bullfrogs. Apparently, all three lack largemouth bass, but should receive additional monitoring before any turtle transfer is attempted.

ACKNOWLEDGMENTS

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Table 1. The ponds on the Canada de los Osos Reserve include: 7 permanent ponds and 1 permanent pond/adjacent seasonal pond complex, five of which have fish (>O); 7 late seasonal ponds, which can last until August, 2 of which were deepened in 2015 (++) and are now likely to be permanent in most years; and 9 early seasonal ponds that dry in early summer — 5 of those were deepened in 2015 (++), and one of those can now last into August. The stream (Canada de los Osos) near the Reserve headquarters dries early, but is perennial downstream (west) of the reserve. The stream downstream of, and supported by seepage from, Old Corral Pond lasts into mid-summer. Spring boxes/tanks throughout the Reserve and artificial drinkers near the Reserve headquarters also supply water for wildlife and breeding habitat for amphibians.

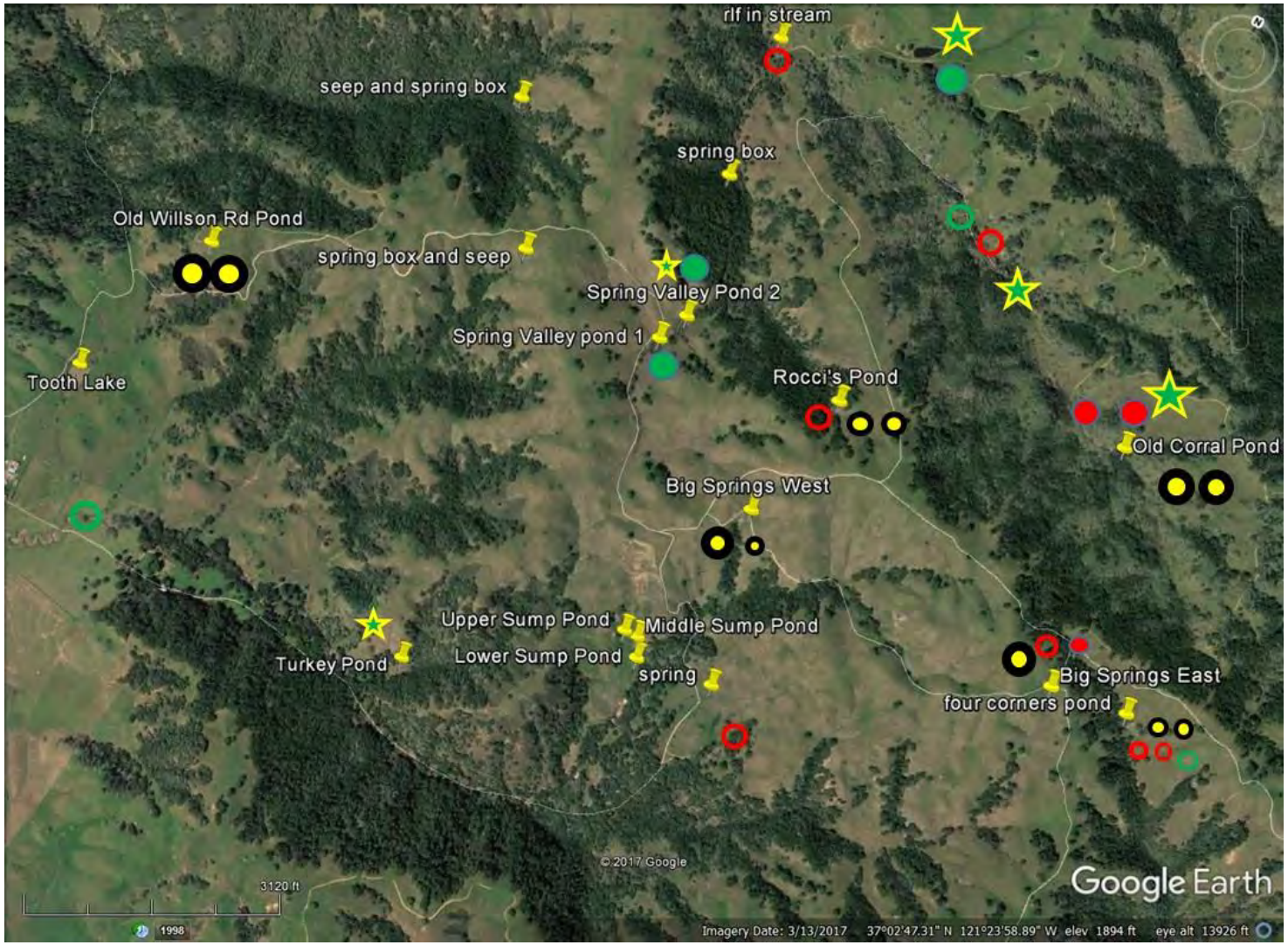

Figure 1. Western portion of the Reserve and adjacent ranch. Stars indicate sites with pond turtles; black and yellow bullseyes indicate sites with tiger salamanders; red dots indicate reproducing red-legged frogs; red circles indicate sub-adult/adult red-legged frogs without apparent reproduction; green dots indicate reproducing bullfrogs; green circles indicate sub-adult/adult bullfrogs only; small symbols indicate scarcity. Predatory bass and bluegills are only in Tooth Lake and Turkey ponds. Newts and treefrogs are not mapped, because they were found at almost all sites.

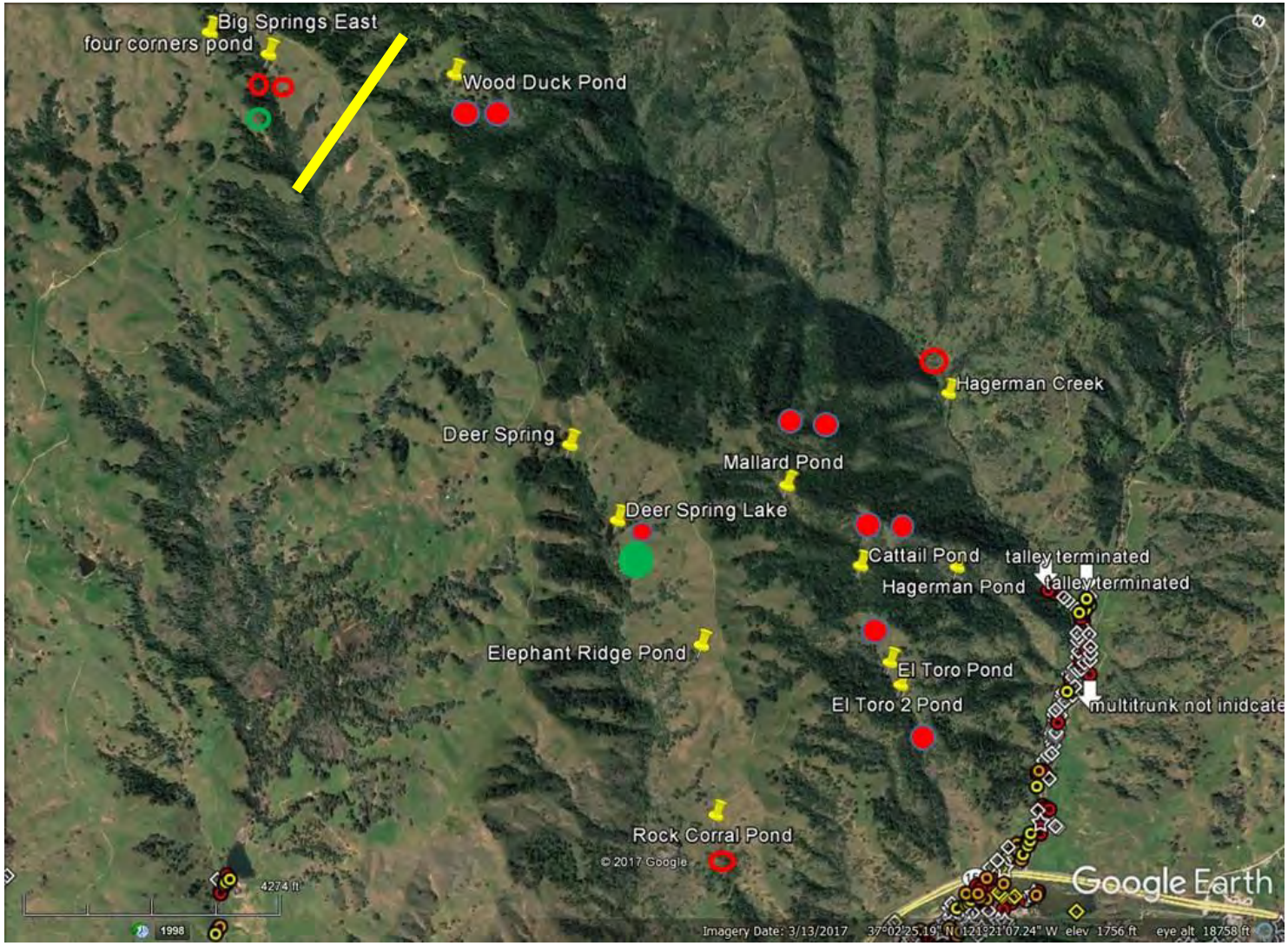

Figure 2. Eastern portion of the reserve (with the same symbols). Pond turtles and tiger salamanders are absent, and bullfrogs are restricted to one isolated, permanent pond. Red-legged frogs, including reproducing populations, are more widespread.

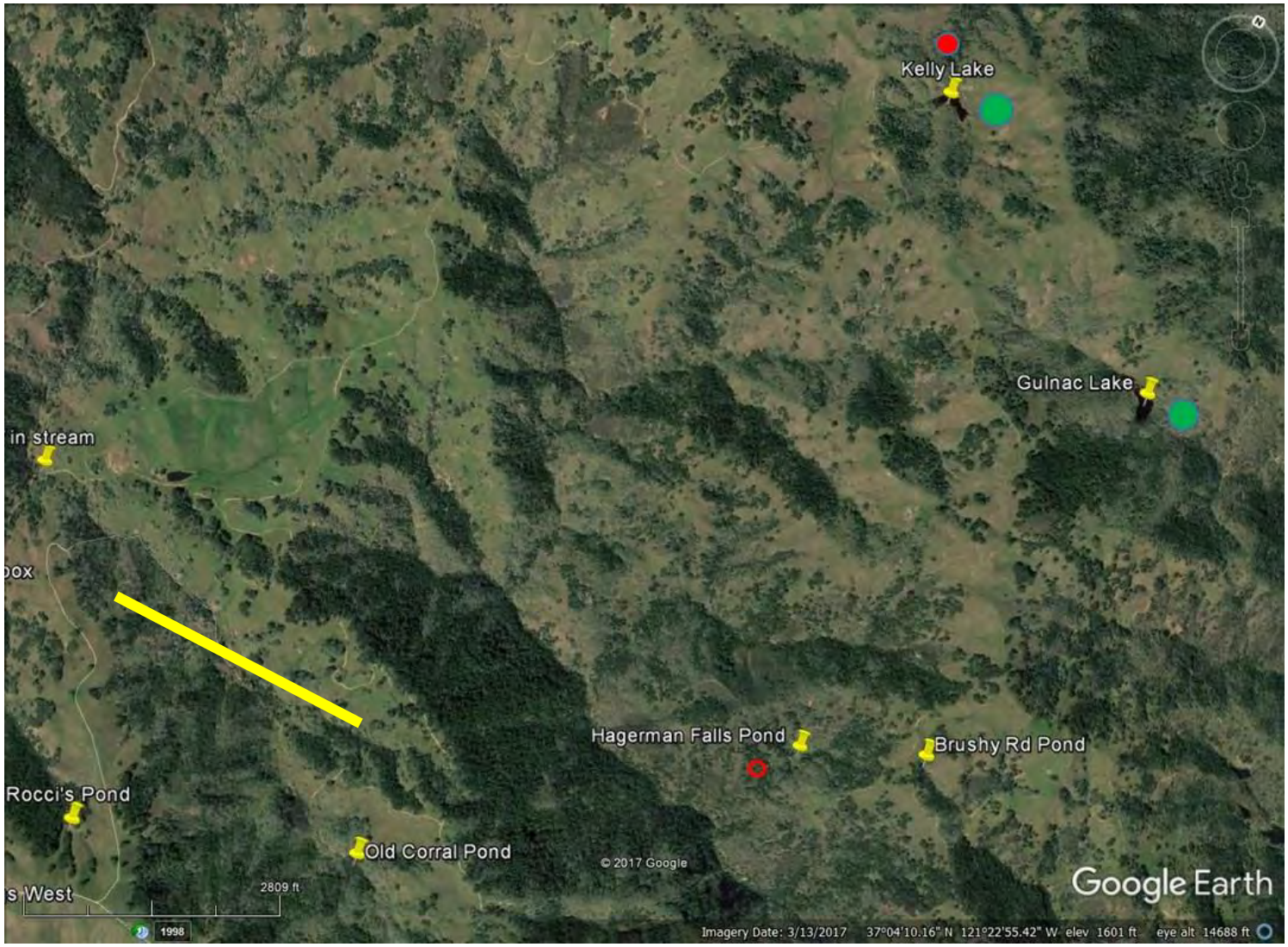

Figure 3. Northern (Willson Ranch) portion of the reserve. Ponds are scarce, and the two large lakes are dominated by bullfrogs. Red-legged frogs are in the pools downstream of the dam at Kelly Lake.

Figure 4. Western Pond Turtle sizes and sexes (U=unknown; M=male; f=female) in 2013, 2016 and 2017 at Old Corral Pond in Canada de los Osos Reserve. Turtles caught in previous years are in ***BOLD italics***.

Size	2013	2016	2017	2017 Stream
45 – 49 mm	U			
50 – 54	U	U		
55 – 59	U		U	
60 – 64				U
65 – 69	U	UU		U
70 – 74	U			
75 – 79	UUU	UU	***U***	U
80 – 84	U	U	UU	
85 – 89		U	***U***	
90 – 94	UU	UUUU	***UU***	
95 – 99			UU	U
100-104	U M			U
105-109			***M*** U	
110-114			UU	U
115-119	MM	***M***		M
120-124	MMM	***M*** MM	***M*** MMM	
125-129		M F	***M*** M ***M****(stream)*	MM
130-134	M	***MM***	***MMM*** MM	
135-139		***M*** F	***MMM*** M ***F***	FFF
140-144	M F	***M*** MMM ***F***	***MMM F***	
145-149	M F	M F	***MMM MM*** M F ***FF***	
150-154	FFFFF	***M*** M ***F***	***M MM F***	***M****
155-159	M FF	***M*** M ***FFF*** FF	M ***F***	***(*from pond)***
160-164	MM	M F	***FF FF***	
165–169		***M***	***M*** M ***F***	
Totals	**12U, 12M, 9F**	**11U, 20M, 10F**	**12U, 32M, 12F**	**6U, 4M, 3F**

Figure 5. Fork lengths (cm) of bluegills from Turkey Pond in July 2013 and August 2017 and Tooth Lake in August 2017.

Length (cm)	Turkey Pond 2013 (n = 109)	Turkey Pond 2017 (n=61)	Tooth Lake 2017 (n=59)
10 (4 in)	XXX		
11	XXXXXXXX		
	XXXXXXXX		
12	XXXXXX		
	XXXXXXX		XX
13	XXXXXXXXXXXXX		X
	XXXXXXXXXXXXXXXX		
14	XXXXXXXXXX	XX	XX
	XXXXX	XXXXX	XX
15 (6 in)	XXXXXXXXXXXXXX	XXX	XXX
	XXXXXXXXX	XXX	X
16	XXXX	X	XX
	XX	XXXX	X
17		X	XXX
	X	XXX	X
18		XXXX	
		XXXXXXX	XXX
19		XXXXXXXXX	XXXXX
		XXXXXXXXX	XXX
20 (8 in)		XXXXX	XXX
		XXXX	XXXX
21			XX
			XX
22			XXXXX
			XXXX
23			XXXXX
			XXXX
24			X

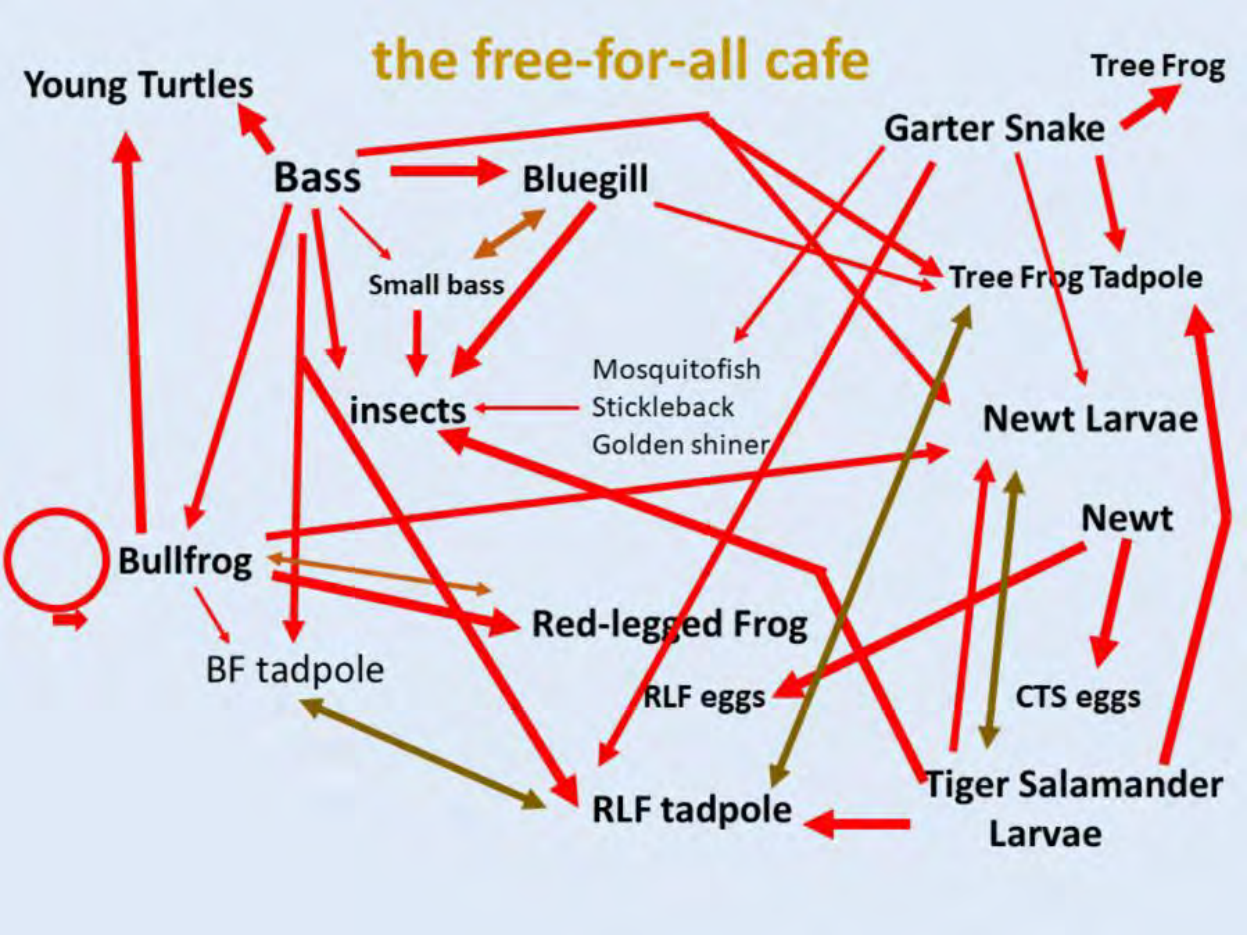

Figure 6. The complex competition (brown arrows) and predation (red arrows) interactions among the potential pond animals affect distribution and abundance at Canada de los Osos Reserve. Nonnative largemouth bass and bluegills (in two ponds) strongly affect other species, as do nonnative bullfrogs in seven of the of the nine permanent ponds. Tiger salamander larvae can substantially reduce other species in four of the seasonal ponds, but can possibly also be reduced (as can red-legged frogs) by newt predation on their eggs in two seasonal ponds.

APPENDIX A: Photos.

Photo 1. Old Corral Pond on 26 June 2017, when the pond was about half as deep (1.6+ m) as at its peak spring level.

Photo 2. Old Corral Pond on 19 August 2017, when the pond was less than 0.6 m deep. The stream downstream, partially sustained by seepage at the pond, had been dry for 3 weeks. The pond dried in early September.

Photos 3 and 4. Seasonal stream,"Turtle Creek," downstream of Old Corral Pond on 4 and 8 May 2017.

Photo 5. Confluence of the tributary from Old Corral Pond (left) and the steeper tributary from Spring Valley (right), just north of the Willson Ranch boundary. Immediately downstream, the stream enters Henry Coe State Park as seasonal Coon Hunter's Gulch, then joins Hunting Hollow and Coyote Creek.

Photo 6. Willson Ranch pond near the south ranch border with the reserve on 7 August. The permanent pond is a probable source and destination for pond turtles and bullfrogs to and/or from Old Corral Pond.

Photo 7. Tooth Lake on 26 June 2017. This is one of two ponds (along with Turkey Pond) on the reserve that are dominated by largemouth bass, bluegills, and bullfrogs.

Photo 8. Turkey Pond on 27 April 2017. This deep, permanent pond has largemouth bass, bluegills, and bullfrogs. One male pond turtle was captured in a baited hoop trap in August, and turtles have occasionally been encountered in the seasonal stream near the pond. However, turtles are unlikely to be successful in the presence of abundant predatory fish and bullfrogs.

Photos 9 and 10. Perennial portion of the stream, Canada de los Osos, upstream (left) and downstream (right) of Jameson Road, downstream of the Reserve, on 18 May 2017. The stream, which is a tributary to Coyote Creek, supports red-legged frogs and pond turtles and is a potential source of turtles to the seasonal portion of the stream on the reserve and possibly to Tooth Lake and Turkey Pond.

Photo 11. North Spring Valley Pond (#2) on 15 May 2017. The perennial pond is densely ringed by cattails and dominated by bullfrogs, but one male pond turtle was captured by baited hoop trap in May. It presumably reached the pond by the steep seasonal outflow stream that joins the tributary from Old Corral Pond near the southern border of the Willson Ranch.

Photo 12. South Spring Valley Pond (#1) on 13 May 2017. This pond is immediately adjacent to Spring Valley Pond #2, but dries in drought years and lacks a cattail border. It is dominated by bullfrogs, but was one of the few sites in 2016 with abundant western toad tadpoles.

Photo 13. Old Willson Road Pond on 26 June 2017. Spike rush was much more abundant than in 2016 in this pond dominated by tiger salamander larvae. Larval metamorphosis had apparently not started.

Photo 14**.** West Big Spring Pond on 15 May 2017. This small pond was deepened in fall 2015 and had abundant tiger salamander larvae in 2016, but relatively few in 2017. They had metamorphed, and most had exited the pond by 26 June 2017.

Photo 15. East Big Spring Pond on 18 May 2017. The pond was deepened and fenced against pigs in fall 2015 and receives seepage through most of summer (spring box to right in photo). It should last throughout most years. In 2016, tiger salamander larvae were abundant and present through at least October. None were present in 2017, and some red-legged frog tadpoles were present.

Photo 16. Four Corner Pond on 18 May 2017. The pond was deepened in fall 2015, but the pond still drains and dries early (it was dry by July in 2017). A few tiger salamander larvae were captured in 2016 and 2017, in the presence of very abundant newts.

Photo 17. Rocci's Pond on 27 April 2017. Tiger salamander larvae were relatively scarce, but quite variable in size, in April and July 2017, in the presence of abundant newts. The pond dried by mid-August.

Photo 18. Variable-sized tiger salamander larvae in Rocci's Pond on 27 April 2017 indicating multiple reproduction times and/or early cannibalism.

Photos 19, 20, and 21. Upper, Middle, and Lower Slump ponds on 2 April 2017. These natural ponds were formed by a large landslide, and were dry in 2017 by July and August. Only newt and treefrog larvae were present, although sub-adult and adult red-legged frogs have occasionally been seen.

Photo 22. Wood Duck Pond on 20 April 2017. This deep, perennial pond could only be inefficiently sampled, but one red-legged frog tadpole and newt and treefrog larvae were captured. Five adult red-legged frogs were seen.

Photo 23. Deer Spring Pond on 14 August 2017. This perennial pond is densely bordered by tules (and some cattails). Bullfrogs are abundant, but one red-legged frog tadpole was captured on 26 June. Angling and a baited hoop trap failed to capture fish, although largemouth bass and crappie were reported in the past.

Photo 24. Elephant Ridge Road Pond on 20 April 2017. A seasonal seep is uphill (below the trees), but this pond dries early. Treefrog tadpoles and newt larvae were present, but the pond dried by mid-June.

Photo 25. Rock Corral Pond on 21 May 2017. The pond was deepened and fenced against pigs in fall 2015, but is shallow by late spring. Seepage maintains some water and the cattails. Treefrog tadpoles and some newt larvae were present, and sub-adult/adult red-legged frogs were present in 2016.

Photo 26. El Toro (west) Pond on 26 June 2017. This pond formerly had abundant bullfrogs. However, bullfrogs were apparently eliminated in the 2013-2015 drought. Red-legged frog adults were seen, and red-legged frog and treefrog tadpoles and newt larvae were captured.

Photo 27. El Toro 2 (east) Pond on 26 June 2017. At and east of the boundary fence between the reserve and the El Toro Ranch. This pond formerly held bullfrogs and fish, which were apparently eliminated during the drought. Red-legged frogs and their tadpoles were observed in the clear shallow water at the fence, along with treefrog tadpoles and newt larvae.

Photo 28. Mallard Pond on 21 May 2017. This large pond lasts until August, and contains reproducing red-legged frogs. It is a suitable potential site to establish western pond turtles, because it lasts through much of summer and lacks fish and bullfrogs (similar to Old Corral Pond).

Photo 29. Hagerman Creek at the east boundary of the reserve on 14 August 2017. Adult red-legged frogs, treefrogs, California roach, prickly sculpin, and nonnative green sunfish were present in this intermittent stream.

Photo 30. Hagerman Falls Pond on 7 August. This pond was deepened in fall 2015. The pond overflowed in winter, and was inefficiently sampled on 30 June 2017, when it was over 1.6 m deep. It was still up to 1.2 m deep in August. Newt larvae were abundant and treefrog tadpoles common. Possible adult red-legged frogs were seen in both June and August.

Photo 31. Bushy Road Pond on 30 June 2017. This pond was deepened in fall 2015, but in June 2017 it held less water than in June 2016. It was dry by mid-July. Newt larvae, tree frog tadpoles, and aquatic garter snakes were present.

Photo 32. Gulnac Lake on 30 June 2017. This large, permanent reservoir is partially bordered by tules, and has abundant bullfrogs. Invertebrates, treefrog tadpoles, newt larvae, and threespine stickleback were common, which indicates a lack of predatory fish; angling was unsuccessful. This lake and nearby Kelly Lake previously received plants of rescued steelhead/rainbow trout, and the stickleback probably were inadvertently transferred to Gulnac Lake with them. Trout can't reproduce at either of the ponds and disappeared after transplants stopped.