

# Aquatic Sampling at Canada de los Osos Reserve in 2013-2019

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**Cumulative 2013, 2016, 2017, 2018, and 2019 results. 2019 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 metamorphosing California newts (N, *Taricha torosa*), Sierran treefrogs (TF, *Pseudacris 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. 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. Therefore, in 2016 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 remaining ponds on the reserve and two streams were sampled. In 2018, turtle sampling in seasonal streams and two ponds associated with the Old Corral Pond watershed was expanded because of evidence of turtle movement in 2017. Reduced sampling of reserve ponds was conducted and directed primarily to ponds that had tiger salamanders and red-legged frogs in previous years.

**In 2019, turtle sampling continued (11 April – 12 May and 15 June – 29 July), but was further expanded in Coon Hunters Gulch in Henry Coe State Park, and also expanded to Hagerman Creek. The six ponds that have had tiger salamanders were resampled, as were five other ponds that have had red-legged frogs in the past. One new pond on the Willson Ranch was also sampled.**

## 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 2017 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.

In 2018, sardine-baited hoop traps were installed at Old Corral Pond and in the pond outlet stream (Turtle Creek") downstream to the Willson Ranch from 28 March through 28 April to trap western pond turtles and track their seasonal movements between the pond and the stream and within the stream. On 1 April through 28 April hoop traps were also installed farther downstream, just downstream of the Henry Coe State Park/Willson Ranch Boundary, and also in the tributary from Spring Valley, which joins the stream from Old Corral Pond on the Willson Ranch just upstream of Henry Coe Park. From 7 July through 22 July traps were installed in Old Corral Pond, in (North) Spring Valley Pond #2, and also on the private pond on the Willson Ranch just upstream of the combined boundaries of the ranch, the reserve, and Henry Coe State Park. As in previous years, captured turtles were measured, sexed, females checked for eggs, and marked with coded shell notches and with PIT tags.

The six ponds with previous tiger salamander occurrences (Old Corral, Rocci's, East Big Spring, West Big Spring, Old Willson Road, and Four Corners ponds) were searched for egg masses on 10 March and sampled for amphibians by dip and seine between 28 March and 22 July. On 24 April, Rock Corral,

Elephant Ridge Road, Cattail, and Hagerman ponds were sampled by dip net, and a baited hoop trap was installed for 6 days in Cattail Pond to check for fish. Hagerman Falls Pond was sampled on 30 August.

**In 2019, beginning on 12 April ( through 12 May) sardine-baited hoop traps were installed at Old Corral Pond, in the pond outlet stream downstream to the Willson Ranch, farther downstream (as Coon Hunter's Gulch) into Henry Coe State Park, and at the stream crossing of Canada de los Osos near the entrance road. Later sampling (15 June – 29 July) was conducted at the previous sites and at North Spring Valley Pond and in Hagerman Creek.**

**Beginning 18 April sampling with dip nets or seines was conducted for amphibians 1-4 times at all of the ponds that have had California tiger salamanders or red-legged frogs in the past. In late July a new pond on the Willson Ranch was sampled by dip net.**

## RESULTS AND DISCUSSION

### *Key Results*

**In 2016, California tiger salamanders were captured in six ponds (Old Corral, Rocci's, East Big Spring, West Big Spring, Old Willson Road, and Four Corners ponds). In 2017, they were captured in five ponds (Old Corral, Rocci's, West Big Spring, Old Willson Road, and Four Corners ponds), but were less abundant than previously in all of the ponds except Old Willson Road Pond). In 2018, they were captured in only two ponds (Rocci's and Old Willson Road Pond), but were less abundant than previously in both ponds; none were collected early in Four Corners Pond, which was not resampled a second time prior to drying. In 2019, tiger salamanders were present in all six ponds, but were scarce in Rocci's Pond and Four Corners Pond; in East Big Spring Pond they somewhat common in late April, but only one, with a stub tail, was present in late June.**

**The absence of predatory tiger salamanders in East Big Spring Pond in 2017 and 2018, and in Old Corral Pond in 2018, was associated with successful California red-legged frog reproduction in those years. In 2019, red-legged frog tadpoles were again common in East Big Spring Pond, despite the presence of some tiger salamander larvae. In most prior years when tiger salamanders were abundant, adult red-legged frogs were present and presumably reproduced, but no successful reproduction occurred. However, in 2013 both species successfully reproduced in Old Corral Pond. In 2019, red-legged frog tadpoles were found in East Big Spring Pond, Mallard Pond, Cattail Pond, Wood Duck Pond, and El Toro 1 and 2 Ponds, where they have collected previously. Red-legged frogs and bullfrogs were both present in 2019 in a newly sampled pond on the Willson Ranch, which was dry in 2018.**

**The expanded trapping results for western pond turtles (93 different turtles captured 255 times) documented extensive spring movements of (almost exclusively) male turtles among the sampled seasonal streams and the Old Corral and Spring Valley #2 ponds and also the perennial pond on the adjacent Willson Ranch. The Willson Ranch pond contained abundant bullfrogs and also black crappie**

*(Pomoxis nigromaculatus)*. Although that pond contained both mature male and female turtles in 2018 and 2019, no younger turtles were seen or captured. Juvenile turtles and one migratory female were found in and near the seasonal streams downstream of the Willson Ranch Pond in both years, where several females may move to lay eggs. In Coon Hunter's Gulch, downstream in Henry Coe State Park, turtles were captured up and downstream of a 55 foot high multi-stepped waterfall. Marked turtles moved up and downstream around the waterfall, including one turtle that moved both directions around the "barrier." Pond turtles were also captured in the perennial bedrock section of Hagerman Creek (a tributary to Cedar Creek) at the east boundary of the reserve.

#### 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 (**see 2018 results**), 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.

In 2018, 67 different turtles were captured in Old Corral Pond, including 13 not previously captured there (Figure 4). Twelve of the new turtles were young, including 10 hatchlings from 2017 nesting. The other new turtle at the pond was a male, previously caught in the stream downstream of the pond. Since 54 of the turtles had been captured before, they were well acquainted with the traps as a source of food, and some individual turtles were caught up to 8 times. The contents of several traps were processed before the others were checked, and in two cases, a turtle from the earlier processing was recaptured in another trap within 10-15 minutes of its release! Fifty-five of the 67 turtles were caught during the much briefer (2 week) July sample period as the pond level dried down; the greatly increased catch rate may have been due to prior experience in 2018 and/or to a last feeding effort prior to pond drying.

Seven of the males captured in the pond had previously been captured in the stream downstream of the pond, including one male caught in the pond in 2018 and then in the stream downstream of the pond, then in Henry Coe State Park farther downstream, and then in the lower portion of the tributary from Spring Valley, and finally back in Old Corral Pond again. Three other males caught in the stream downstream of the pond in 2018 had previously been caught in the pond. An additional male caught in 2017 in Spring Valley Pond #2 was caught in the stream downstream of Old Corral Pond in 2018. The movement of males apparently occurs primarily in April and May, during the breeding season, with males making extensive movements to locate receptive females. This is similar to observations on nearby Coyote Creek, with a burst of male movement during breeding season (Belli 2015). No females caught in any year in Old Corral Pond have been caught elsewhere, and none of the females in the stream immediately downstream of the pond have been caught in the pond. Females appeared to be relatively sedentary, also similar to observations on Coyote Creek (Belli 2015), where female movements were short and usually associated with moving close to suitable nesting areas. In coastal Waddell Creek, where nesting habitat was scarce, females made longer movements within the watershed to nest (Davis 1998, Crump 2000, Abel 2010, Smith et al. 2003).

**In 2019, 41 mature turtles were captured in Corral Pond (compared to 44 in 2018), and only 1 new male and 1 small juvenile were captured (Figure 4). The biggest change in 2019 was the capture of only 6 small juveniles compared to 23 in 2018. Reproductive success in 2017 (with emergence in 2018) was substantial, but was not reflected in captures or observations of those juveniles in 2019. Predation or overwintering mortality of the newest young turtles (such as by possible flooding of**

overwintering turtles near the 2018 shoreline within the 2019 impoundment zone) was apparently substantial. The slightly fewer mature male turtles in the pond was due to extensive movements of turtles throughout the locations, including captures of “Corral Pond Turtles” in the stream and at Willson Pond. Only a single turtle was seen on 20 August when the pond was less than 0.3 m deep; the rest had already moved upland.

The abundance of captured turtles in 2016 (n=41), 2017 (n=56), 2018 (n=67), and 2019 (n=45) including abundant small, young turtles (n=11-21) prior to 2019, indicates that the Old Corral Pond 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 (see the three sections below).

***“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 2017, 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 in 2017 and 2018. Two sub-adult bullfrogs (BF) were captured and removed **in 2017**; 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 2017 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.

In 2018, 17 turtles were captured in the stream between Old Corral Pond and the southern Willson Ranch boundary (two-thirds of a mile; Figure 5). These included 8 males previously or subsequently caught in Old Corral Pond, 1 male previously caught in Spring Valley Pond #2, and four turtles that ended up in the Willson Ranch Pond. Four other turtles had been previously captured in the stream, including 3 females with distinctive shell patterns and slower growth, which are apparently resident in the seasonal stream.

Again in 2018, red-legged frogs were present in the stream, as were 3 bullfrogs that were apparently moving upstream from the pond on the Willson Ranch; a male also made it upstream to Old Corral Pond. Treefrog tadpoles and adults were again present in 2018, but the stream dried by late June. No evidence of red-legged frog reproduction was observed, apparently because the stream regularly dries too early for successful reproduction.

**In 2019, 18 turtles were captured in the stream between Corral Pond and the Henry Coe Park boundary (Figure 5). These included 4 resident females from previous years and transitory turtles moving up and downstream between Corral Pond, Henry Coe, and the Willson Pond.**

**Several red-legged frogs were seen along the stream, but no tadpoles were observed in the pools. Four adult or subadult bullfrogs were found along the stream, and one male apparently moved upstream through the stream and was present in Corral Pond in May.**

**Coon Hunter's Gulch (Henry Coe State Park, 37° 03'35.8" N, 121° 24' 12.5 W)      BF      TF**  
**RLF      Turtles**

This seasonal stream is below the confluences of the stream from Old Corral Pond and the stream from Spring Valley, and is also downstream of the smaller, much more seasonal stream from the Willson Ranch Pond.

The successful trap 2018 was in a pool immediately downstream of the boundary fence (between the Willson Ranch and Henry Coe State Park), but a trap farther downstream caught no turtles in 2018. Seventeen different turtles were captured, including 9 juveniles (Figure 5). Four of the five males had previously been captured in the stream closer to Old Corral Pond, and two of those had also been caught in Old Corral Pond. Three females were captured, one of which was later captured in the Willson Ranch Pond. Unlike in Old Corral Pond, the captured turtles were only captured once, apparently reflecting the transitory nature of their presence at the trap in 2018. Bullfrogs, treefrogs, and red-legged frogs (but no RLF tadpoles) were also observed in the sample pool.

**In 2019, with much higher stream flow than in 2018, turtle activity downstream of the Henry Coe Boundary pool was much more extensive, and a trap was moved downstream of a 55 foot high multi-stepped falls. 11 males, 4 females, and 6 younger turtles (Figure 5) were caught between the boundary fence and the falls, including 1 trapped 3 days after it was first captured in a trap downstream of the falls. Two from above the falls were trapped below the falls, where 6 males, one female, and 6 younger turtles were trapped, including one of which later returned upstream above the falls. The falls and the steep slope around the falls are definitely not a significant impediment to turtle movement. Both red-legged frogs and bullfrogs were present above and below the falls.**

**Willson Ranch Pond (37° 03' 42.8" N, 121° 23' 54.0" W) BF      Td      Turtles      Black Crappie**

**Bullfrogs were abundant in this usually perennial pond near the reserve boundary (it has gone dry in severe drought). Also present were western toads (*Anaxyrus boreas*) and their metamorphs, and black crappie, a small but predatory fish.**

In 2018, thirteen mature turtles were captured in the pond, including 7 females. One of the females had previously been captured in the stream in Henry Coe State Park, 300 m downstream of the pond. Three of the males had been previously captured in the stream, including one that had been previously caught in Old Corral Pond. Another male had previously been caught in Old Corral Pond. The lack of young turtles in the pond was most likely due to the abundant bullfrogs and to the predatory fish. The movement of one female to and from the nearby stream at the Henry Coe trap site, and the abundance

of juvenile turtles there, may indicate that at least some females leave the vicinity of the pond to reproduce.

**In 2019, eighteen mature turtles were captured in in the pond, with the 13 males including 4 previously marked turtles from Corral Pond or its outlet stream and 2 unmarked turtles (Figure 5). Three of the females from last year were caught elsewhere, one in the stream heading towards Corral Pond, and two gravid females that went downstream and were recaptured in the pond without eggs. One new female was captured. As in 2018, it appears that some of the females move elsewhere for egg laying. With the abundant crappie and bullfrogs and their tadpoles in the pond, invertebrates as turtle food are very scarce.**

**Willson Ranch Pond #2 (37° 04' 08.5" N, 121° 23' 57" W) BF RLF N TF**

**This pond on the Willson Ranch seemed close enough to Coon Hunter's Gulch to potentially be used by western pond turtles (based upon the amount of movement we have detected elsewhere). It also is located between the only six ponds on the Reserve that have tiger salamanders and the eight ponds in Henry Coe State Park in the Hunting Hollow area with tiger salamanders (Joseph Belli data). The pond was dry in 2018, but had a maximum depth of 0.8 m on 29 July 2019. No pond turtles were seen, and no tiger salamander larvae were captured by dip-netting, although it is possible that they had already metamorphosed and left the pond. Several adult red-legged frogs and bullfrogs were seen. Bullfrog tadpoles (6-7 cm TL) were about three times as abundant as red-legged frog tadpoles (9-12.5 cm TL). The red-legged frog tadpoles had hind legs, and some metamorphs were present. Larval newts were very abundant, and some adults were present.**

**Spring Valley Creek (from Spring Valley Pond (#2) downstream to 37° 03' 34.8" N, 121° 24' 10.8" W)**

The outflow from Spring Valley is a relatively steep, rocky, seasonal stream that joins with the outflow from Old Corral Pond near the junction of the reserve, the Willson Ranch, and Henry Coe State Park. The lone turtle captured in 2017 in Spring Valley Pond #2 (north) apparently descended through the stream and ascended the stream from Old Corral Pond in 2018. Another turtle from Corral Pond in 2018, descended its outlet stream, entered Henry Coe, briefly ascended the outflow from Spring Valley (where it was trapped), and then returned to Corral Pond. No turtles were trapped in 2018 at a trap mid-way up the stream. Near the confluence of the two streams a dead emerged nestling turtle was also discovered in 2018.

**The trap near the mouth of this stream caught no turtles in 2019, despite the higher and more persistent stream flow than in 2018; there was some flow near the mouth of the stream on 20 July, and flow farther upstream into at least September.**



**South (#1) Spring Valley Pond (37° 02' 59.6 N, 121° 24' 5.8" 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 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.

In September 2018, tree frog metamorphs were present, and bullfrogs and young of year bullfrog tadpoles were abundant.

**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. That turtle left the pond in 2018 and was recaptured twice in Turtle Creek, downstream of Old Corral Pond. Limited hoop trap sampling in May 2017 near the confluence of the two seasonal tributaries did not catch any turtles, but one male turtle in 2018 ascended the short distance to the downstream trap, before retreating and returning up the Turtle Creek to Old Corral Pond. Trapping in the pond from 7-22 July 2018 failed to capture 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 did not undertake the extensive movements that males did, and would be very unlikely to colonize.

**In 2019, the pond was much deeper than in 2018. Trapping caught trapping caught no turtles.**

**Establishing a turtle population by transplanting gravid females or juvenile turtles to the pond would not be successful. Bullfrog predation on small turtles would prevent establishment of a reproductive population.**

**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 2017-2019.

**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 red 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 very 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.

**Canada de los Osos stream from east of Turkey Pond downstream to the reserve Boundary**

Turtles have been observed moving in this seasonal stream before, and a single turtle trap was installed on 12 April 2019 downstream of the entrance road, as stream flow was rapidly declining. A single mature male turtle was captured, probably retreating downstream from his exploration of the stream. Bullfrogs, treefrogs, and their tadpoles, and western toad tadpoles are usually present before it dries. Movements upstream through this early drying stream to Turkey Pond are fruitless, as the abundant largemouth bass and bullfrogs preclude a turtle population.

**Old Corral Pond Amphibians/snakes    CTS (except 2018)    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 metamorphs 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 may have occurred in 2016. On 5 July 2017 California tiger salamander larvae were apparently less common than previous years and 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 2017. 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.

In 2018, the shoreline was searched for amphibian egg masses on 10 March, prior to most rain and when the pond level was low. Only treefrog eggs were observed. No eggs were observed on 28 March, but treefrog tadpoles were common, and adult red-legged frogs were observed. On 20 June, 33 red-legged frog tadpoles (5-7 cm) were captured by dip-netting, newt larvae were common (80+), and tree frog tadpoles were abundant (650+); the red-legged frog tadpoles were in the deepest portions of the pond. By 14 July some of the 35 red-legged frog tadpoles captured had their hind legs, and by 22 July red-legged frog tadpoles were apparently scarce. Red-legged frog tadpoles were still present in the nearly dry pond in on 6 August, but metamorphs were not observed along the shoreline in July or August; the pond was dry on 9 August. A single bullfrog was present in late July and August. No tiger salamander larvae were captured in 2018.

**On 18 April 2019, unhatched newt eggs were common, and treefrog tadpoles were abundant. No red-legged frogs or egg masses were seen while walking the shoreline. No red-legged frogs were seen when checking turtle traps through 26 June, although a bullfrog was calling on 3 May. Six seine hauls out to 1 m deep on 26 June caught five tiger salamander larvae (6-8 cm and 11-12 cm TL); the largest was spotted, but still with full gills. Larval newts and treefrog tadpoles were abundant. On 29 July, eight tiger salamander larvae were captured (half 6.5-8.5 cm and half 11-13 cm TL), with no transition traits. Newt larvae were abundant, and more than 20 adults were present. No treefrog tadpoles were captured. On 20 August, the pond was mostly less than 0.3 m deep, and two larval tiger salamanders (7.5-9 cm TL) were captured. On 31 August, 6 tiger salamander larvae (9-13 cm TL) were captured with the pond less than 0.15 m deep. None were transforming, but a fully metamorphed tiger salamander emerged from the pond and headed upland. Larval newts were abundant, with many partially metamorphed. Adult newts were still present. No red-legged frog tadpoles were seen or captured on any sampling day.**

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

**CTS (less abundant 2018) TF N**

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.

In 2018, newt eggs and some treefrog eggs and tadpoles were present on 10 March. On 14 April and 19 April a relatively few (14 April: 5; 5.5-6.5 cm. 19 April: 8; 5.5 -8.5 cm) tiger salamander larvae were captured by dip-netting. On 20 June intensive dip-netting collected no newt larvae or treefrog tadpoles, although some treefrog metamorphs were present. Only backswimmers were common in the pond. Only 5 tiger salamander larvae (12-12.5 cm) in various stages of metamorphosis were collected. The pond still had water (10 x 5 m) on 22 July, but dried by mid-August.

**On 13 May 2019, 32 tiger salamander larvae (mostly 4-7.5 cm TL, but four at 8-10 cm TL) were captured along the shore to the outer margin of the rushes. Treefrog tadpoles and small metamorphs were uncommon. No newt larvae were captured, but ostracods were abundant.**

**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 or 2018.

**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 or 2018.

**West Big Spring Pond (37° 02' 48.2" N, 121° 23' 43.6" W) CTS (2016, 2017, 2019) 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.

On 10 March 2018, treefrog eggs and frogs were common in this small, muddy pond. On 5 April treefrog tadpoles were common in dip-net samples, and there were some adult newts and newt eggs. On 16 June the pond was down to 1.2 m deep and was intensively dip-netted. No tiger salamander larvae were captured, but newt larvae and treefrog tadpoles were common. The pond was nearly dry on 22 July and dry in early August.

**On 18 April 2019, small newt larvae and treefrog tadpoles were common. Fifteen tiger salamander larvae were captured, half about 3 cm TL and half 5-6 cm. Ostracods were present. On 22 June only two tiger salamander larva (5, 7 cm TL) was captured during intensive dip netting. CTS have metamorphed and left by the end of June, even in wet years. Newt larvae were abundant, and treefrog tadpoles were still common. On 29 July the pond was reduced to a shallow 2 x 3 m puddle with pig wallowing, but a small (0.3 x 1 m) puddle was still present on 31 August.**

**East Big Spring Pond (37° 02' 47.7" N, 121° 22' 58.2" W) CTS (2016, 2019) 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 lasted until winter rains.

On 10 March 2018, treefrog egg masses were common, especially on burr weed. No frogs were seen. On 28 March treefrog eggs were again common, and some tadpoles were present. Two red-legged frog metamorphs/yearlings and 1 adult were seen. On 5 April, red-legged frog tadpoles were fairly common, and one adult and 5+ yearlings seen. Treefrog tadpoles were common, but no newt larvae were captured. Several small (<15 mm total length) newt larvae were captured on 14 April, red-legged frog tadpoles were common, and yearling and adult red-legged frogs present. On 28 April a recently metamorphed red-legged frog (with tail remnant) from 2017 was present; therefore, some tadpoles apparently over-wintered. On 16 June the pond was still to 0.8 m deep, and red-legged frog tadpoles (9-11 cm) were common, with about one-third with hind legs. Tree frog tadpoles were not much more abundant than those of red-legged frogs, and newt larvae were scarce. By 23 September the pond had shrunk to about 5 by 6.5 m and less than 0.5 m feet deep. About 25-30 red-legged frog metamorphs and one adult female were observed.

As in 2017, no tiger salamander larvae were captured in 2018, despite their abundance in 2016.

**On 29 April 2019, 18 tiger salamander larvae were captured, with most 3.5-4 cm TL, two 5.5-6 cm, and two 7-7.5 cm. On 22 June (with denser aquatic plants) only 2 tiger salamander larvae were captured (5, 7 cm TL, one with a stub tail). No CTS were captured on 29 July, or on 20 or 31 August. This substantially differed from 2016, when large CTS were still common in October, but aquatic plants were sparse in the recently deepened pond in 2016.**

**Red-legged frog tadpoles were common (>100) during 29 April and 22 June (5.5-7.5 cm TL) sampling. On 29 July, 30 RLF tadpoles were captured (5.5-8 cm TL). On 20 August (five: 6-8.5 cm TL) and 31 August (four: 7.5-9) red-legged frog tadpoles were apparently scarce, although dense aquatic plant, coontail (*Ceratophyllum demersum*), occupied most of the remaining pond volume (0.7 m deep) and interfered with sampling. No RLF metamorphs were seen on 20 August, but a single metamorph was seen on 31 August. Metamorphs were common in mid-September. Treefrog tadpoles were common early, but apparently not present on 29 July. Newt larvae were common on all dates, with some transforming in late August.**

**The pond was deepened in 2015, but loses depth quickly in early summer; the pond still should last all year, except in extreme droughts. The pond is fenced, but by August pigs were able to get over the lowered deer openings and were doing some rooting.**

**Four Corners Pond (37° 02' 49.2"N, 121° 22' 46.3"W) CTS (few 2016-2017, 2019 more common)  
RLF(2016-17, 2019) 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.

On 28 March 2018, treefrog eggs were abundant around the shore of the mostly full pond. Several metamorph-sized treefrogs, and an aquatic garter snake were present. On 14 April, treefrog tadpoles were uncommon in the still deep pond, and no newts or their larvae or tiger salamander larvae were collected by seine or dip-net. No frogs were seen. The pond was rechecked on 20 June, but had already been dry for some time. Although deepened in 2015, the pond rapidly loses water to seepage after the rainy season, providing poor habitat for most amphibians.

**On 22 April 2019, the leaky pond was already down more than a meter and was almost 1 m deep. Seven tiger salamander larvae (4-6 cm TL) were captured. Yearling red-legged frogs (four measured: 55-65 mm SVL) were fairly common, although the pond dried early in 2018, so they were not from the pond in 2018. They presumably had come over the ridge from East Big Springs Pond, where metamorphs were abundant in fall 2018. Treefrog tadpoles of various sizes and newt larvae (1.5-2.5 cm TL) were very abundant. Some ostracods were present.**

**Rocci's Pond (37° 03' 02.8"N, 121° 23' 40.7"W) CTS (scarce 2019) 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.

On 11 April 2018, seventeen small (20-32 mm total length) tiger salamander larvae were captured by seine and dip-net. Newt larvae were apparently uncommon and even smaller (<10 mm). Treefrog tadpoles were common, but also mostly small. On 20 June the pond was still 0.6 m deep, and newt larvae were 3-4 cm long, but not abundant. Tiger salamander larvae were scarce (4 captured with intensive dip-netting), and three (11.5-12 cm) were near metamorphosis (partial gills and spotting on tail). The fourth was only 4 cm long. Treefrog tadpoles were still common, and few metamorphs were present. Back swimmers were few, but giant water bugs and ostracods were relatively common. The pond was dry by August.

**On 13 May 2019, only 3 small (2.5-3 cm TL) tiger salamander larvae were captured with intensive dip-netting. On 26 June the pond had dense pondweed except where shaded, and only 5 tiger salamander larvae (4-6 cm TL) were captured with substantial dip-netting. On 1 August the pond was still 0.6 m deep, with pondweed on about half of the surface. No tiger salamander larvae were captured. No red-legged frogs were seen or their tadpoles captured during any of the sampling efforts. Treefrog tadpoles were abundant in May and June (with metamorphs present), but scarce on 1 August. Newt larvae were common in May (when 3 adults were also present), abundant in June, and very abundant on 1 August. Small ostracods were abundant in May, but scarce by 1 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 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 2017.

**The ponds were not sampled in 2019, but the upper pond still had about 3 x 5 m of water on 1 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.

**On 1 August 2019, this perennial pond was at least 1.8 m deep, but was 1.5 m below the spillway. Adult red-legged frogs were present, and 9 tadpoles (8-10 cm TL), with hind legs were captured. Newt larvae were abundant, and treefrog tadpoles were still moderately common. A wood duck was also 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 Tooth Lake and Turkey Pond, so larger predatory fish are apparently not 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.

On 24 April 2018, this early-drying pond was sampled by dip-net. Treefrog tadpoles were abundant, and newt larvae to 2.5 cm long were present.

**In 2019, a small puddle was still present on 15 July, but the pond was dry on 20 July.**

**Rock Corral Pond (37° 01' 41.98"N, 121° 20' 20.61"W)      RLF (2016)      TF      N (2017 and 2019)**

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 even in dry years.

On 24 April 2018, the pond was mostly shallow, with the deepest portion <0.6 m deep. Treefrog tadpoles were common, but no adult treefrogs or other amphibians were seen or captured. Two aquatic garter snakes were present.

**On 18 April 2019, treefrog tadpoles of various sizes were abundant in the pond, but only a single newt larva was captured. One aquatic garter snake was seen. The pond is always shallow (< 0.6 m), but persists throughout wet years. The pond itself is fenced against pigs, but the grassland outside the fence was severely rooted by pigs.**

**Cattail (Tule) Pond--Hagerman Canyon Road (37° 02' 27.3" N, 121° 20' 20.6" W) RLF      TF      N  
BF 2019**

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.

On 24 April 2018, treefrog tadpoles, newt larvae, and red-legged frog tadpoles 2.5-5 cm long were common during dip-netting of Cattail Pond. A hoop-trap, baited with sardines, was installed and fished for 6 days, without catching catfish that were once observed at the pond.

**On 13 May 2019, a single adult bullfrog was present, and it was seen by Bob Clement on several other dates. The bullfrog was not seen on 24 July, when red-legged frog tadpoles were common.**

**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 metamorphosed, 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.

**On 13 May 2019, several red-legged frog adults were present, and red-legged frog tadpoles (20+ to 6-7 cm TL) were fairly common in the deepest portion of the pond. Newt larvae were abundant and (>12) adult newts were present. Treefrog tadpoles and near-metamorphs were abundant. Ostracods were present. The pond was still muddy, so algal food for tadpoles was scarce.**

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.).

On 24 April 2018 the pond was already shallow (<0.5 m). Treefrog tadpoles were uncommon. An adult newt was present, but no newt larvae were collected or observed.

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.

**On 24 July 2019, adult red-legged frogs were seen at El Toro 2, but not at El Toro 1. Red-legged frog tadpoles were present in both ponds; they were observed at the fence line in the clear water in El Toro 2. Nine tadpoles (6.5-9 cm TL) were captured in El Toro 1. No bullfrogs were observed, or**

bullfrog tadpoles captured, so the loss of bullfrogs from the two ponds during the 2013-2015 drought still is apparently in effect. Newt larvae (5-6 cm TL) were abundant, and some treefrog tadpoles were present in El Toro 1.

**Hagerman Creek (37° 02' 56.4"N, 121° 20' 17.9" W)**      RLF (2017)      TF      Turtles  
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 by electrofisher 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.

**Trapping from 20-24 July 2019 captured 2 males and 1 female turtles (length 128-143 mm) and 5 immature turtles (80-114 mm) in the perennial bedrock channel at the reserve boundary (Figure 4). None were caught in remnant pools downstream of the bedrock reach. California roach, prickly sculpin, and green sunfish were again present in the warm, barely flowing (0.01 cfs) bedrock pools (too warm to support trout). No red-legged frogs or their tadpoles were seen, but tree frogs and some treefrog tadpoles were present.**

**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.

On 30 August 2018, the pond was mostly less than 0.6 m deep. Newt larvae were scarce and near to metamorphosis. Back swimmers were abundant and some ostracods were present, but no tree frogs or red-legged frogs or their larvae were observed or captured. The dry watershed may retard colonization by red-legged frogs.

**On 3 July 2019, the pond was an estimated 2-3 m deep, and 1 m below the spillway. No red-legged frogs or bullfrogs were seen, and no tadpoles were captured. Treefrog tadpoles (and some metamorphs) and newt larvae were abundant. Diving beetles, damselflies, back swimmers, and ostracods were relatively common. The deepened pond seems suitable for red-legged frogs, but a potential source population may be too far away and separated by dry habitats.**

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.

The seepage-supported outlet stream was checked on 30 August 2018, but had long been dry. No red-legged frogs were observed in the dry channel or along the shoreline of the lake.

**Six days of trapping in July 2019 caught no pond turtles. Dip netting at the lake shoreline caught bullfrog tadpoles, one newt larva, but no treefrog tadpoles on 15 July 2019. No frogs were seen in the pools immediately downstream of the dam (where red-legged frogs have been seen in the past), and no red-legged frog tadpoles were captured. Treefrog tadpoles and newt larvae were captured in the largest pool, which was also a pig wallow.**

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 7).

### 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 in 2016. West Big Springs Pond can now last longer into summer, and had abundant tiger salamanders that metamorphosed late in 2016 and some tiger salamanders that metamorphosed by late June in 2017 and 2019.

East Big Springs and Hagerman Fall ponds should retain water all year except during extreme drought, based upon results in 2016-2019. East Big Springs had abundant tiger salamander larvae in 2016, but lacked them in 2017 and 2018. They were apparently common in late April 2019, but scarce or absent by late June (or due to difficult capture in dense aquatic plants). 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. Successful red-legged frog reproduction occurred in East Big Spring Pond in 2017, when tiger salamanders were absent; some tadpoles apparently overwintered and metamorphosed in spring 2018., Tiger salamanders were again absent in 2018, and red-legged reproduction was much more successful, with 25-30 metamorphs seen on 23 September and numerous tadpoles also still present. Red-legged tadpoles were common in 2019, despite the presence of some tiger salamander larvae. The rooted, submerged plant Coontail has progressively increased in the pond since its deepening in 2015, which may be affecting pond ecology; algae for tadpoles is now scarcer, and predator-prey dynamics might have changed in the presence of dense escape cover.

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 and April 2018 and 2019. Seepage usually does prevent it from fully drying. Four Corners and Hagerman ponds are in drainages where coarser soils may not hold water without an effort to seal the pond bottom. In 2018 Hagerman Pond was nearly full on 10 March, but was apparently dry by late May. Four Corners Pond did have a very few tiger salamander larvae in May of 2016 and 2017 and they were more abundant in 2019. The very abundant newts in Four Corners Pond, which is bordered by oak woodland, may prey on tiger salamander and red-legged frog eggs.

### Tiger Salamanders

California tiger salamander larvae were present in 6 ponds in 2016 and 2019 (Old Willson Road, West Big Springs, East Big Springs, Four Corners, Rocci's, and Old Corral ponds). They were absent in East Big Springs Pond in 2017, and larvae were scarce in Four Corners Pond and apparently relatively

uncommon in Rocci's Pond in both years. In 2018, tiger salamanders were captured only in Old Willson Road Pond, where they were much less abundant than in 2016 and 2017, and in Rocci's Pond. In 2019, they were present in all six ponds, but very scarce in Rocci's Pond.

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 (Hunting Hollow Area) that could have supported them prior to pond construction (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. Their absence from both ponds in 2018, and from Old Corral Pond in 2018, and relative scarcity in Old Willson Road Pond in 2018, may be a delayed effect of the 2012-2015 drought and/or the delayed rains in 2018. 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 or 2018. The abundant juveniles produced in 2016 apparently matured and rejuvenated the reproduction in 2019.

The small, seasonal West Big Springs Pond, had tiger salamanders in both 2016 and 2017. However, it suffered severe wallowing damage from feral pigs in August 2017 and July 2018. The small 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 2017; they are larger ponds and fencing them would take more effort, but might be considered.

Many tiger salamander larvae (such as in East Big Springs Pond in 2016 and Old Willson Road and Old Corral ponds in 2016, 2017 and 2019) 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 to the east. 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.

### Red-legged Frogs

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 both 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; yearling frogs 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 2017. The absence of tiger salamander larvae in 2017 and 2018 in East Big Springs Pond and in 2018 Old Corral Pond was associated with successful red-legged frog reproduction.

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.

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 were present in both ponds in 2017 and 2019.

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 aided by periodic drying that reduced bullfrog numbers. At Kelly Lake red-legged frogs were present in the pools immediately downstream of the dam in 2016 and 2017, 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 Reserve ponds and also in the Willson Ranch Pond. Largemouth bass and bluegills are present in Tooth Lake and Turkey Pond (Figure 6); 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 in catching any fish. Invertebrates are modestly common, so a large population of predatory game fish is unlikely. Mosquitofish are present in the lake.

The Willson Ranch Pond presently has black crappie, although it has completely dried in some past droughts.

### 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 and 4 adults (that were also removed) in both 2017-2019 in the seasonal stream downstream of Old Corral Pond, single mature male bullfrog (observed and later removed) in Old Corral Pond in August 2017 and another in 2018 and 2019. 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, where they are common. 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. In 2019 a single bullfrog was at Cattail Pond for at least part of the spring and summer. That pond is also far from any likely source of bullfrogs.

### 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. They were also found at the Willson Ranch Pond in 2018 and 2019. 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 in 2017, and expanded in 2018, with discovery of male and female turtles in the seasonal outlet stream from the pond, and with

the documentation of extensive movement of (male) turtles among Corral Pond, Spring Valley Pond, the Willson Ranch Pond and the seasonal streams that connect them in 2018 and 2019. Turtles were also documented moving up and downstream around a 55 foot tall multi-step falls in Coon Hunter's Gulch in Henry Coe State Park. However, the near lack of movement by female turtles makes establishment of reproductive populations more problematic.

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.

Occasional sightings have been made of pond turtles in Tooth and Turkey ponds and in the very seasonal stream (Canada de los Osos) near and upstream of the reserve headquarters. They can access these 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 would 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 could then act somewhat like the situation at Old Corral Pond and the stream and ponds downstream.

Transplants to establish other turtle populations in the reserve would only result in turtles isolated to a single pond, without the substantial metapopulation network of ponds and seasonal streams documented for Old Corral Pond, Willson Ranch Pond and the seasonal streams associated with them.

## **ACKNOWLEDGMENTS**

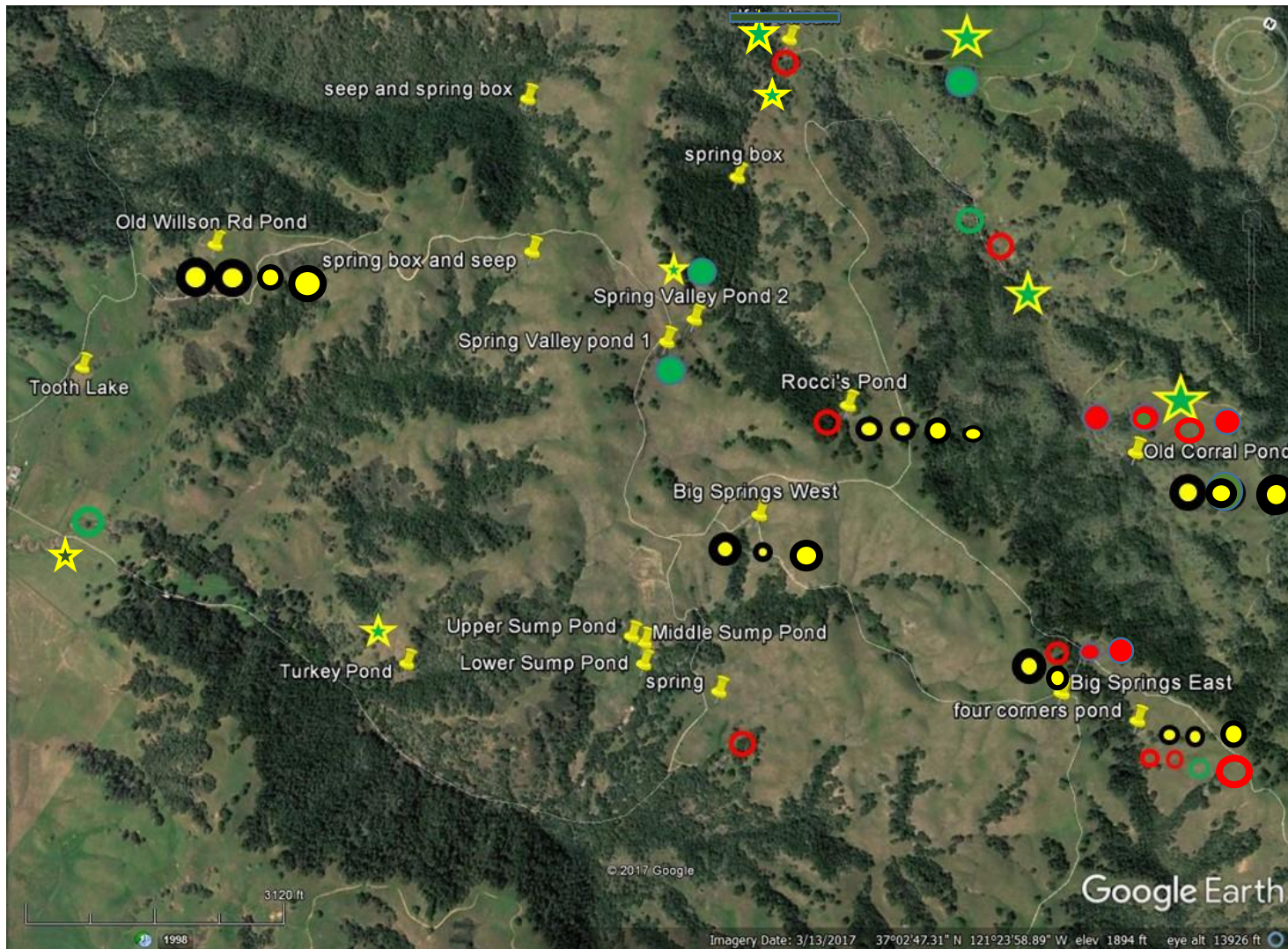
Sampling in Canada de los Osos Reserve was conducted under a Letter of Permission from the California Department of Fish and Wildlife. Margaret Wolford gave permission to sample the ponds on the Willson Ranch, and a permit the California Department of Parks and Recreation allowed sampling of Coon Hunter's Gulch in Henry Coe State Park; the expanded turtle sampling greatly improved our understanding of western pond turtle movements and ecology. Indispensable sampling assistance in 2019 came from Joseph Belli, Bob Clement, Henry Coletto, and Terris Kasteen.

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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.**

<b>Permanent Ponds</b>	<b>← Late Seasonal</b>	<b>Early Seasonal</b>
<ul style="list-style-type: none"> <li>&gt;O Deer Spring Cattail (tule)</li> <li>&gt;O Kelly</li> <li>&gt;O Gulnac Spring Valley 1 and 2</li> <li>&gt;O Tooth</li> <li>&gt;O Turkey Wood Duck</li> </ul>	<ul style="list-style-type: none"> <li>← ++ East Big Spring El Toro 1 (El Toro 2)</li> <li>← ++ Hagerman Falls Mallard Old Corral Rocci's Old Willson Road</li> </ul>	<ul style="list-style-type: none"> <li>++ Bushy Road Elephant Head Road</li> <li>++ Four Corners</li> <li>++ Hagerman</li> <li>++ Rock Corral Slump 1,2,3</li> <li>← ++ West Big Spring</li> </ul>
<p>Canada de los Osos</p> <p>Old Corral Outlet Stream</p>		
		
	<b>Spring Boxes</b>	
		<b>Drinkers</b>



**Figure 1. Western portion of the Reserve and adjacent ranch with sampling results 2016-2019. 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.**

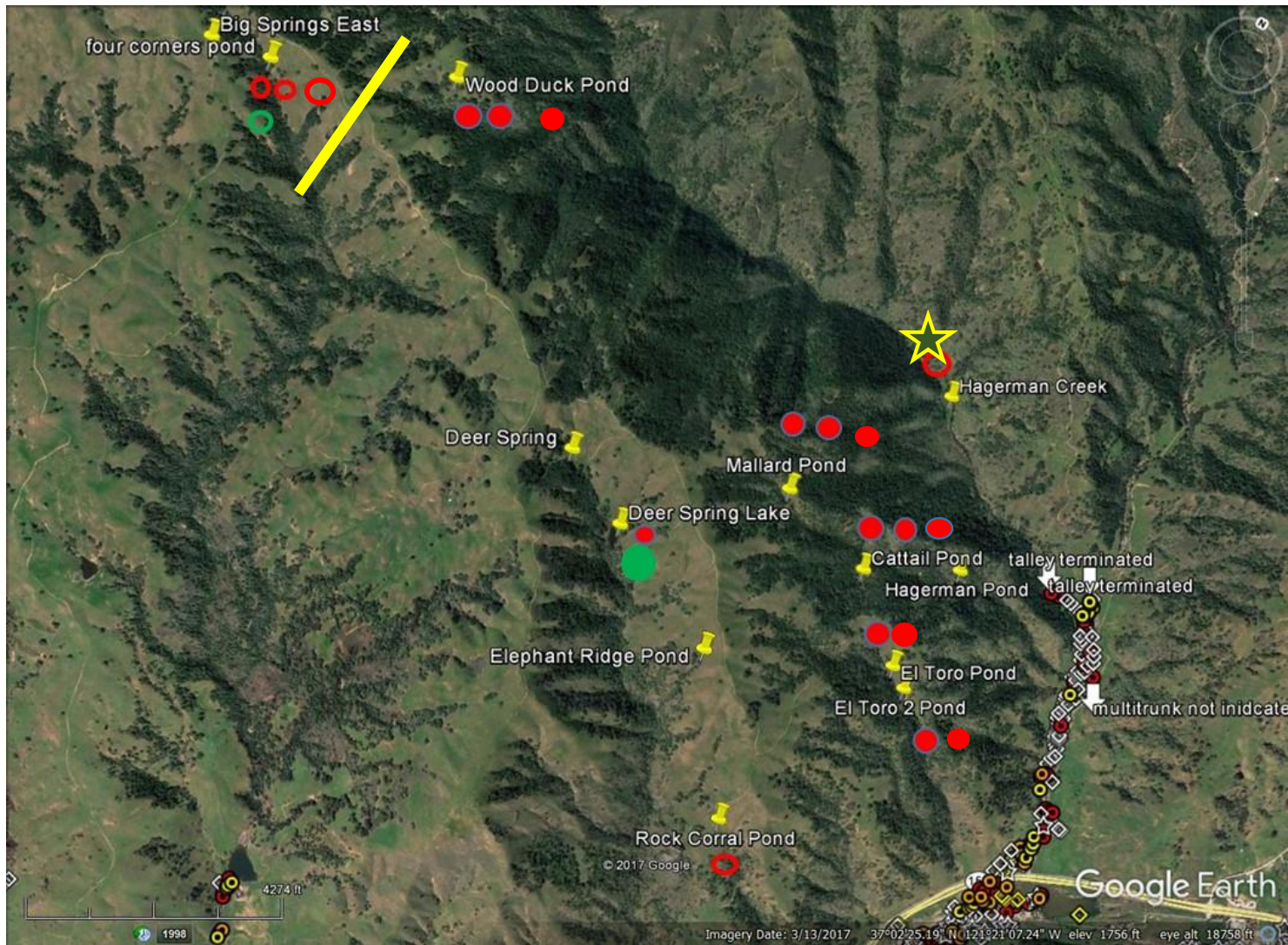
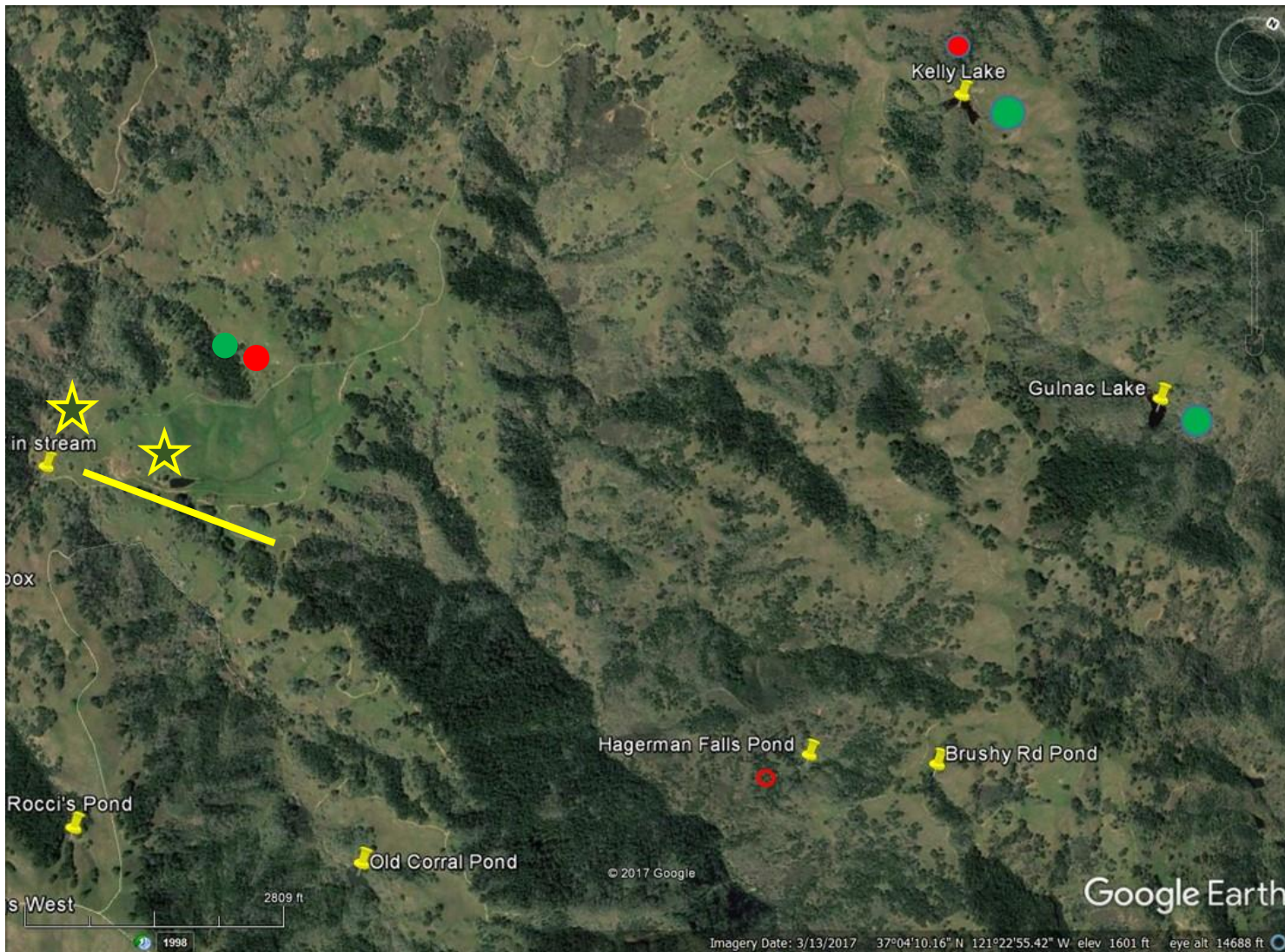


Figure 2. Eastern portion of the reserve (with the same symbols). Tiger salamanders were absent, and bullfrogs were restricted to one isolated, permanent pond. Red-legged frogs, including reproducing populations, were more widespread. Western Pond turtles were only in Hagerman Creek. Rock Corral, Wood Duck, Cattail, El Toro and El Toro 2, and Mallard ponds, and Hagerman Creek were surveyed in 2019.



**Figure 3. Northern (Willson Ranch) portion of the reserve. Ponds are scarce, and the two large reserve lakes are dominated by bullfrogs. Red-legged frogs have been found in the pools downstream of the dam at Kelly Lake. No red-legged frogs were captured or seen at Hagerman Falls Pond in 2018 or 2019 or Kelly Lake in 2019. The two ponds north of the yellow bar are on the Willson Ranch.**



Figure 4. Western Pond Turtle sizes and sexes (U=unknown; M=male; f=female) in 2013, 2016, 2017, 2018, and 2019 at Old Corral Pond and Hagerman Creek in 2019 in Canada de los Osos Reserve. Turtles caught in previous years are in **BOLD italics**. \* indicates moved to pond from stream

Size	2013	2016	2017	2018	2019	Hagerman Cr
45 – 49 mm	U					
50 – 54	U	U		UUU		
55 – 59	U		U	UUUUUU	U	
60 – 64						
65 – 69	U	UU		U		
70 – 74	U					
75 – 79	UUU	UU	<b>U</b>			
80 – 84	U	U	UU			
85 – 89		U	<b>U</b>	<b>U</b>		UU
90 – 94	UU	UUUU	<b>UU</b>	U		
95 – 99			UU	<b>UUU</b>		U
100-104	U M			<b>UU</b>	<b>M</b>	
105-109			<b>M</b> U	<b>UU</b>	<b>UUU</b>	
110-114			UU	U <b>U</b>	<b>U</b>	UU
115-119	MM	<b>M</b>		<b>MMM</b>	<b>U M</b>	
120-124	MMM	<b>M</b> MM	<b>M</b> MMM	<b>UU</b>	<b>F</b>	
125-129		M F	<u><b>M</b></u> M <b>M</b> *(stream)	<b>MMMMM M</b> *	<b>F M</b> * <b>M</b> * <b>MMM</b>	F M
130-134	M	<b>MM</b>	<b>MMM</b> MM	<b>M M</b> *	<b>MM</b>	
135-139		<b>M</b> F	<u><b>MMM</b></u> M <b>F</b>	<b>MMM</b> *	<b>M</b> * <b>M</b>	
140-144	M F	<b>M</b> MMM <b>F</b>	<b>MMM</b> <b>F</b>	<b>MMMM</b> <b>FF</b>	<b>M</b> <b>F</b>	M
145-149	M F	M F	<b>MMM</b> <b>MM</b> M <b>F</b> <b>FF</b>	<b>MMMMMM</b> <b>FFF</b>	<b>MMMM</b> M <b>FF</b>	
150-154	FFFFF	<b>M</b> M <b>F</b>	<u><b>M</b></u> <b>MM</b> <b>F</b>	<b>MMM</b> <b>F</b>	<b>MMMM</b> * <b>F</b>	
155-159	M FF	<b>M</b> M <b>FFF</b> <b>FF</b>	M <b>F</b>	<b>MM</b> <b>FFF</b>	<b>M</b> * <b>M</b> * <b>FFF</b>	
160-164	MM	M F	<u><b>FF</b></u> <b>FF</b>	M* <b>FFFF</b>	<b>M</b> <b>FFFF</b>	
165–169		<b>M</b>	<b>M</b> M <b>F</b>	<b>M</b>	<b>F</b>	
170-174					<b>M</b>	
<b>Totals</b>	<b>12U, 12M, 9F</b>	<b>11U, 20M, 10F</b>	<b>12U, 32M, 12F</b>	<b>23U, 31M, 13F</b>	<b>6U, 25M, 14 F</b>	<b>4U,2M,1F</b>

Figure 5. Western Pond Turtle sizes and sexes (U=unknown; M=male; f=female) in 2013, 2016, 2017, and 2018 at Old Corral Pond in Canada de los Osos Reserve. Turtles caught in previous years are in ***BOLD italics***. Turtles previously or subsequently caught in pond indicated with\*; previously caught in stream with \*\*.

Size	'17 Str	'18 Stream	2019 Stream	COE'18	Coe '19	2019<Falls	Willson'18	Willson'19
50 – 54				U				
55 – 59			U	U				
60 – 64	U				U	U		
65 – 69	U			UU	UU	UU		
70 – 74				U		U		
75 – 79	U							
80 – 89			<b><i>U</i></b>					
85 – 89				U	<b><i>U</i></b>			
90 – 94								
95 – 99	U			U	<b><i>U</i></b>	U		
100-104	U			U				
105-109						U		
110-114	U	<b><i>U</i></b>	<b><i>F</i></b>	U	<b><i>U</i></b>			
115-119	M					MM		
120-124		U			<b><i>M</i></b>			
125-129	MM	<b><i>F M***M***M*</i></b>	<b><i>MM*M**F</i></b>	<b><i>F M***M**</i></b>	<b><i>M*M*M*M M</i></b>	<b><i>M* M F</i></b>		
130-134		<b><i>M*</i></b>	M		<b><i>F M*</i></b>	<b><i>M***</i></b>	F	F
135-139	FFF	<b><i>M* F**F**F**</i></b>	<b><i>M M* F</i></b>	<b><i>F M**</i></b>	<b><i>F F M</i></b>	M	<b><i>F M M**</i></b>	<b><i>M***M**M</i></b>
140-144			<b><i>M</i></b>	F	<b><i>F*</i></b>		<b><i>M Fc**</i></b>	<b><i>F* M***M*MM</i></b>
145-149			<b><i>M M** F*</i></b>					<b><i>F</i></b>
150-154	<b><i>M*</i></b>		<b><i>M**M**</i></b>			FF		
155-159		<b><i>M*M*</i></b>	<b><i>M**</i></b>			<b><i>M***</i></b>		<b><i>M**</i></b>
160-164		<b><i>M*M*</i></b>		M	<b><i>M*** M</i></b>		F	<b><i>M***M** M F</i></b>
165–169		<b><i>M*</i></b>		<b><i>M***</i></b>			<b><i>M*M**</i></b>	<b><i>M* M</i></b>
170-174		<b><i>M*</i></b>					F	<b><i>F</i></b>
<b>Totals</b>	<b>6U,4M,3F</b>	<b>3U,11M,3F</b>	<b>2U, 12M, 4F</b>	<b>9U, 5M, 3F</b>	<b>6U,11M,4F</b>	<b>6U,6M,1F</b>	<b>6M, 7F</b>	<b>13M, 5F</b>

Figure 6. 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	XXXXXXXXXX XXXXXXXXXX		
12	XXXXXX XXXXXXX		XX
13	XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX		X
14	XXXXXXXXXXXX XXXXX	XX XXXXX	XX XX
15 (6 in)	XXXXXXXXXXXXXXXXXX XXXXXXXXXXXX	XXX XXX	XXX X
16	XXXX XX	X XXXX	XX X
17	X	X XXX	XXX X
18		XXXX XXXXXXX	XXX
19		XXXXXXXXXX XXXXXXXXXXXX	XXXXX XXX
20 (8 in)		XXXXX XXXX	XXX XXXX
21			XX XX
22			XXXXX XXXX
23			XXXXX XXXX
24			X

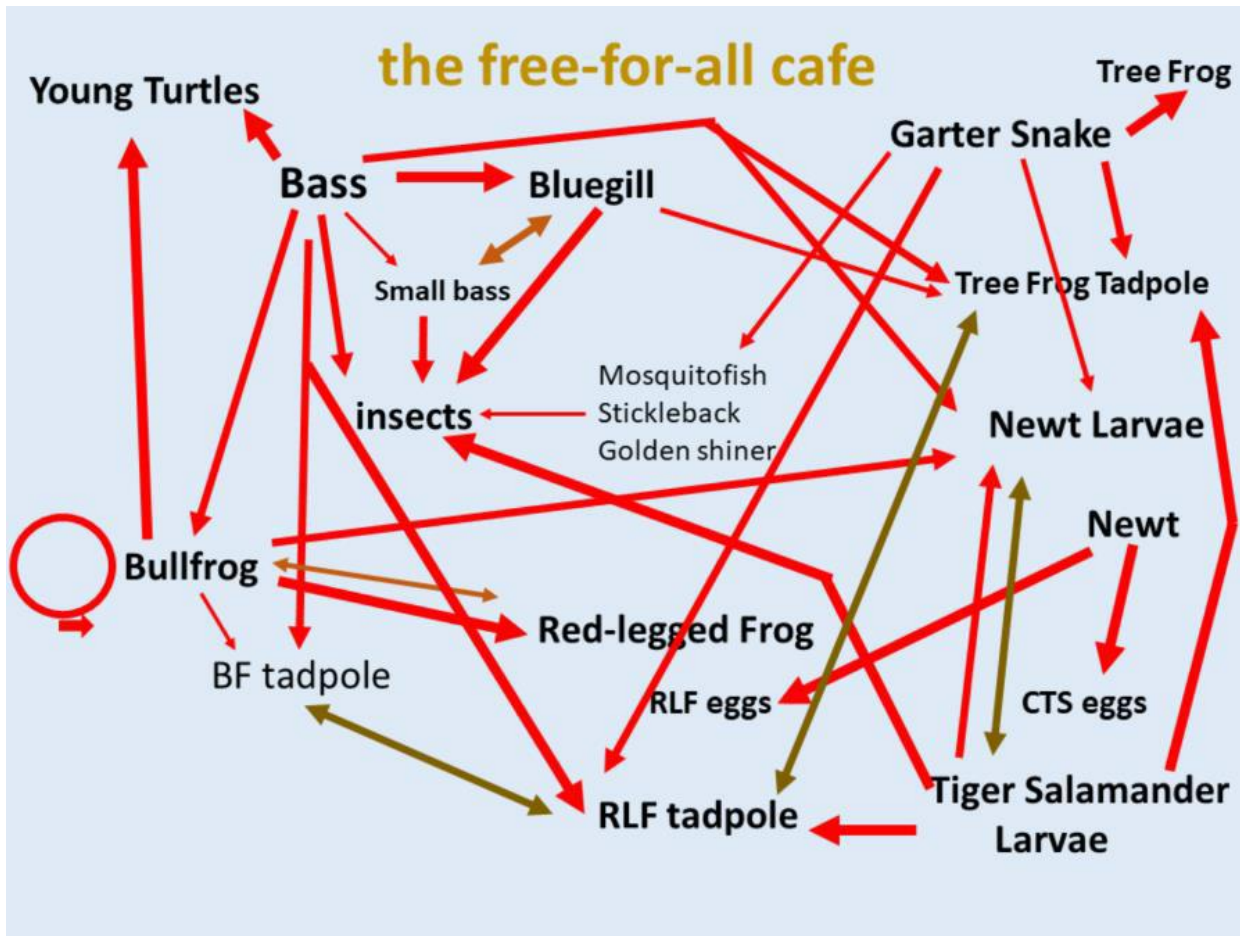


Figure 7. The complex competition (brown arrows) and predation (red arrows) interactions among the potential pond animals affect distribution and abundance at Canada de los Osos Reserve. Nonnative largemouth bass and bluegills (in two ponds) strongly affect other species, as do nonnative bullfrogs in seven of the 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. 2019 Photos**



**Photo 1. West Big Spring Pond on 18 April 2019. This small pond was deepened in 2015 and lasts into July or August. It had abundant tiger salamander larvae in 2016, fewer in 2017, none in 2018, and they were common again in 2019. The small pond could be fenced to keep out pigs, which do damage by wallowing.**



**Photo 2. Small tiger salamander larvae in West Big Springs Pond on 18 April 2019. Only two were captured during resampling on 22 June. They apparently metamorphosed and left the pond by late June in 2016, 2017, and 2019.**



**Photo 3. Four Corners Pond on 22 April 2019. The pond was deepened in 2015, but leaks and dries early. It deepest was 1 m during sampling, but had already dropped 1.5+ m from full pool in March. A very few tiger salamanders were present in 2016 and 2017, but they were more common in 2019; it dried early in 2018. Yearling red-legged frogs were common in 2019, apparently from East Big Spring Pond, just over the hill. Very abundant newts may limit tiger salamander and red-legged frog reproduction by egg predation.**



**Photo 4. Tiger salamander larvae from Four Corners Pond on 22 April 2019.**



**Photo 5. Tiger salamander larvae from East Big Springs Pond on 29 April 2019. They were abundant in the pond in 2016, but absent in 2017 and 2018. In 2019 they were common in April, but were scarce (or difficult to catch) later.**



**Photo 6. East Big Springs Pond on 20 August. The pond was deepened in 2015, but drains quickly in early summer before stabilizing. Red-legged frog adults are usually present, but tadpoles were not present in 2016, when tiger salamanders were abundant. Tiger salamanders were absent in 2017 and 2018 and red-legged frog tadpoles were common. The tadpoles were also common in 2019, despite the presence of apparently few tiger salamanders. The pond is fenced against pigs, but by July some were entering over the low “deer” gates.**



**Photo 7. Abundant red-legged frog tadpoles grew relatively slowly in East Big Springs Pond in the presence of dense coontail plants in 2019. Most only had their hind legs on 31 August 2019, when the first metamorph was seen and captured. However, metamorphs were common by mid to late September.**



**Photo 7. Old Willson Road Pond on 13 May 2019. The pond is in open grassland, and is dominated by tiger salamanders, which were abundant in 2016, 2017, and 2019, but much less abundant in 2018. They apparently quickly reduce treefrog tadpoles and newt larvae in the pond.**



**Photo 8. Abundant tiger salamander larvae of a wide range of sizes on 13 May 2019. Cannibalism tends to eliminate the smaller individuals.**





**Photo 9. Rocci's Pond on 13 May 2019, when intensive sampling captured only 3 small (25 – 30 mm TL) tiger salamander larvae. They were unusually scarce in 2019, but were less common than elsewhere in 2016-2018. Abundant newts as egg predators may be responsible for the scarcity of tiger salamanders and for the lack of red-legged frog tadpoles in 2016-2019.**



**Photo 10. On 26 June 2019 tiger salamander captures were still few (5), and they were small (4-6 cm) compared to their potential prey, including newts and tree frog tadpoles. None were caught on 1 August, and the pond was dry by late August.**



**Photo 11. Rocci's Pond on 1 August 2019, when when the pond was still up to 2 feet deep, but no tiger salamander larvae or treefrog tadpoles were captured.**



Photo 12. Rock Corral Pond on 18 April 2019. The pond was deepened and fenced in 2015, but is shallow. It does persist through most summers and supports treefrogs, some newts, and occasional transient red-legged frogs. The fence keeps the pigs out, but rooting is extensive outside the fence.



Photo 13. Old Corral Pond on 20 July 2019, when it had lost two-thirds of its depth to leakage. The leakage keeps the outlet stream running into mid-summer, supporting resident turtles and turtle movements up and downstream from Corral Pond, Willson Pond, and Coon Hunter's Gulch in Henry Coe State Park.



Photo 14. Corral Pond tiger salamander larvae of widely varying sizes (6-12 cm) on 26 June 2019. Tiger salamanders were common in 2016, 2017, and 2019, but absent in 2018; red-legged frog tadpoles were then common.



Photo 15. On 31 August 2019 Corral Pond was nearly dry (less than ½ ft deep) and subject to pig wallowing. However, tiger salamander larvae that had not metamorphosed were still present in the pond. Some of the abundant newt larvae had partially transformed.

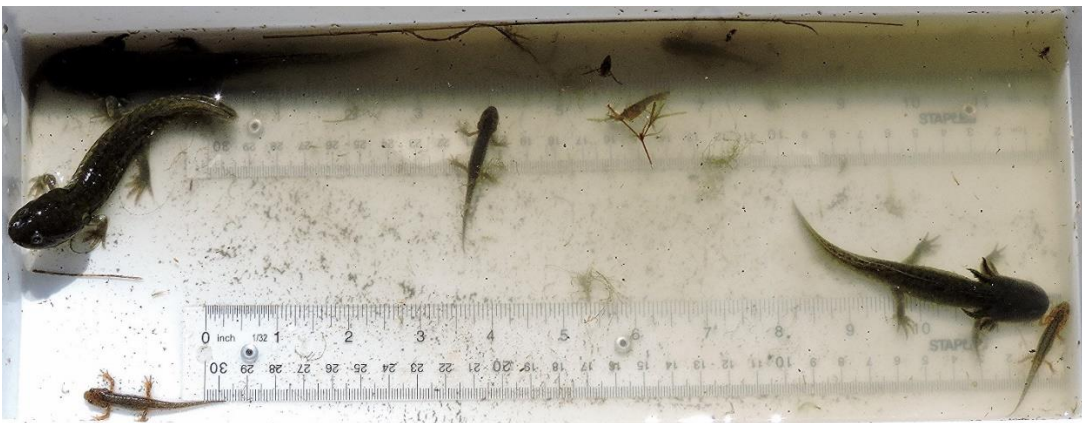


Photo 16. Tiger salamander and newt larvae from Corral Pond on 31 August 2019.



Photo 17. While sampling Corral Pond on 31 August 2019, a fully metamorphosed tiger salamander exited the pond and marched upland.



**Photo 18. Mallad Pond on 13 May 2019. Red-legged frog tadpoles were relatively common in the deeper portions of the pond, and some adult frogs were seen. Newt larvae were abundant, and some adult newts were present. Treefrogs were abundant and there were frog metamorphs along the shore.**



**Photo 19. Wood Duck Pond on 1 August 2019, when the pond was 7-9 ft deep, and red-legged frogs and tadpoles with hind legs were common. A wood duck was also present.**



**Photo 20. El Toro Pond on 20 July 2019. The pond and the nearby El Toro 2 Pond (on the immediately adjacent ranch) lost their bullfrogs (and fish in El Toro 2) during the 2013-2015 drought, and only red-legged frogs and tadpoles were present in both ponds in 2017 and 2019.**



**Photo 21. Red-legged frog tadpoles from El Toro Pond on 20 July 2019.**



**Photo 22. Red-legged frog tadpole and near-metamorph from Willson Pond #2 on 29 July 2019.**



**Photo 23. Willson Pond #2 on 29 July 2019. The pond was dry in summer 2018, but was 0.8 m deep when sampled. Bullfrogs and red-legged frogs were present, and bullfrog tadpoles outnumbered red-legged frogs about 3 to 1. The pond's ecology and location, between tiger salamander ponds in the Reserve and in Henry Coe State Park, suggests that it might support tiger salamanders. They could have already transformed and moved upland by late July.**



**Photo 24. Perennial bedrock section of Hagerman Creek on 15 July, where western pond turtles were trapped in 2019. Red-legged frogs were present in 2017, and California roach, prickly sculpin, and green sunfish were present in 2017 and 2019. The reach is too warm for trout.**



**Photo 25. Location of the falls on Coon Hunter's Gulch in Henry Coe State Park. The 55 foot high multi-step falls is in the canyon on the right, and turtles apparently bypass the falls up and downstream on the steep slope to the left.**



**Photo 26. The lower two steps of the 4-step falls on Coon Hunter's Gulch.**