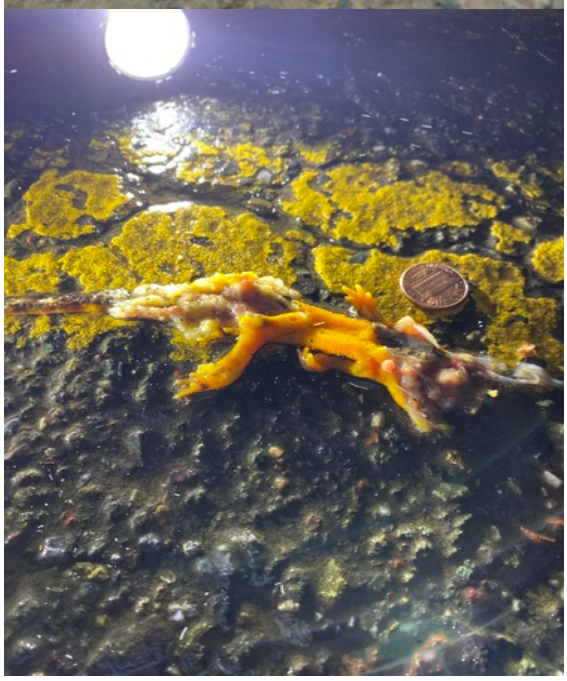
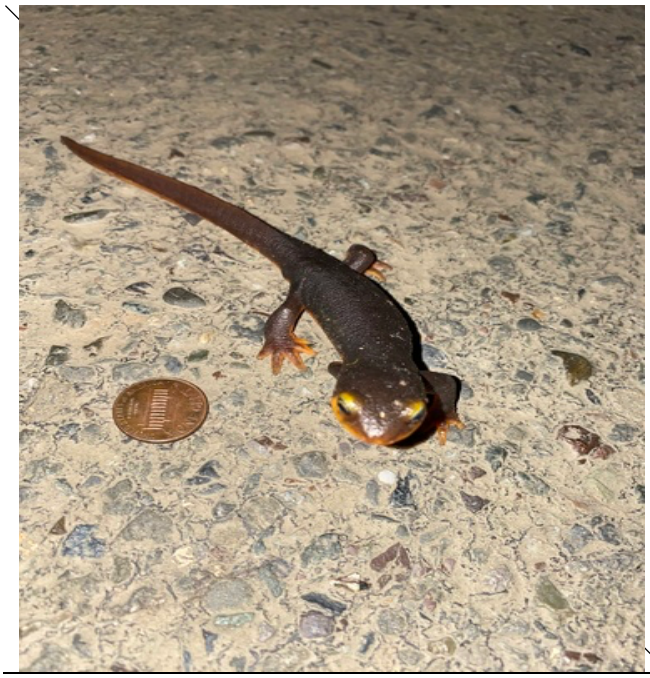
Chileno Valley Newt Brigade

Year One Data Analysis December 2019-February 2020

By: Triana Anderson





Introduction:

Chileno Valley Newt Brigade was founded by Sally Gale, a land owner, community organizer, and concerned citizen in northern Marin County. In the winter of 2018/2019 she observed what seemed like abnormally high levels of newt mortality along a segment of road near her ranch bordering Laguna Lake and set out to find out more about this problem, and to do something about it. She learned that newts (a subspecies of the salamander family) are semi-aquatic and newt populations migrate every year from their woodland habitats to local bodies of water to reproduce[i]. This migration makes them vulnerable to habitat fragmentation created by all our roadways. The newt migration typically occurs between December and February and at which time the newts travel to their body of water, mate, and return to their upland environment[ii]. At this time there may also be juvenile newts, newts that were hatched from eggs laid the previous winter, journeying to the upland habitat for the first time[iii].

The purpose of the Chileno Valley Newt Brigade was first and foremost to protect newts, to help them on their journey to spawn in Laguna lake and return to their woodland habitat. Volunteers were recruited who were interested in spending evenings and nights along this approximately mile long stretch of Chileno Valley Road to carry newts across the road. The opportunity to collect data while observing the newt migration was not overlooked and to this end, volunteers were trained to use iNaturalist, a citizen science app that allows users to take georeferenced pictures and upload them to an online database of species observations, where they can be identified and vetted by crowed sourced species identifiers (expert scientist as well as other citizens). In its first year, the Chileno Valley Newt Brigades goals for this data were to see if it would be possible to answer the following questions with this data:

- Are there specific locations the newts are gravitating to in order to cross the road?
- On what scale are the newts dying as they cross Chileno Valley Road?
- When are the newts migrating to the lake and when are they leaving the water to return to their upland habitat?
- Are there climactic indicators that determine when the newts begin their migration or return journey?

Methods:

<u>iNaturalist</u>

iNaturalist is a citizen science project and online social network of naturalists, citizen scientists, and biologists built on the concept of mapping and sharing observations of biodiversity across the globe[iv]. The fact that this data collection method can be carried out by anyone with a smart phone, makes it both very powerful and also limiting. To collect data for the Chileno Valley Newt Brigade Project a project page was created in iNaturalist and several project specific fields were created so that when Newt Brigade volunteers added data to this group they would also be asked to input, the direction the newt was traveling, if the newt was alive, dead, or injured and the number of dead newts in the photo they had taken. In order to train volunteers to use the iNaturalist app and to lean about newt ecology, there were two meetings held at Chileno Valley Ranch. At these meetings volunteers learned about the California Newt's life cycle, how to identify a California Newt from other species of newts, how to download the iNaturalist app, create an account and how to upload pictures to the app and to the Chileno Valley Newt Brigade project. Volunteers were trained in safety procedures related to being on the road late at night, and asked to take pictures of the newts using a penny for scale, and oriented so that they were

facing the lake when they took the picture The additional fields on iNaturalist allowed volunteers to collect more data than the normal species data that would be collected by iNaturalist.

Weather Station

In addition to collecting data from iNaturalist the project also used data collected from a personal local weather station operated by a neighbor to Chileno Valley Ranch. Weather Underground is a commercial weather service providing real-time weather information over the Internet. Weather Underground provides weather reports for most major cities across the world on its Web site, as well as local weather reports for newspapers and third-party sites[v]. This neighbor, a member of the Chileno Valley Newt Brigade, allowed the group access to the weather data collected by their weather station, to have local data to compare to newt migrations and to try and determine if there are changes in the weather that trigger newt movement.

Data Curation

As mention above there are limitations to using citizen-based science to collect data. One of these limitations is inconsistency in data quality. Even with well trained volunteers, it can be hard to make sure all participants are properly recoding their data. For this reason, data management is especially important when using iNaturalist. A large amount of work went into going through the observations that were exported from the Chileno Valley Newt Brigade project to verify data that was submitted and to fill in fields that were left incomplete, therefore an explanation of how the data was curated is important to explain the data you will see in the accompanying spreadsheet. For full disclosure, I am not a trained naturalist, and I was recruited to this project for my experience with data analysis and with cartography.

All observations entered in the Chileno Valley Newt Brigade Project from December 1st 2019 to February 29th 2020 were exported into an excel worksheet. Any observations that did not include a photo were deleted as there was no way to verify the observation. For observations that did not include a species, direction of travel, alive, dead or injured, number of dead individuals, or juvenile, designation, their photos were open and were categorized accordingly. In many observations the species was identified as "Pacific Newts" which is a genus but not a species categorization. In these cases, as well as in cases where the species was not identified, the default observation was to identify it as a California Newts, unless it was obviously not. Similarly, most dead newt observations were tagged as California Newts, even though it was not possible to determine the species from a picture of the remains of the animal. A separate column was created in the spreadsheet for these species' identifications (column P). The following column (column Q) contains the species (or genus) identifications as they were exported from iNaturalist. Observations lacking a dead, alive or injured identification were easily categorized using the photos from iNaturalist. The number of dead newts was also usually easily identifiable using photos, though there were limited cases where it is possible that the newt remains photographed could have been the remains of multiple newts. However, unless it was clearly obvious multiple individuals were flattened the default for this field was 1, when dead individuals were observed. In cases where the newt's direction of travel was left blank, the direction of travel was recorded as unknown. Volunteers were directed to always take photos oriented so that they were facing the lake, specifically so that it would be possible to double check this data field. However, certainty that all volunteers had followed this protocol was not high and so direction of travel was recorded as unknown when it was not recorded at the time of

observation. The final field, whether the observed newts were juveniles or not was added partway through the project and many of these observations were categorized using the photos. The default categorization for this field was no, not juvenile. In cases where it was not clear if the newt was a juvenile, such as squashed remains or a below average size but not clearly a juvenile, the newts were categorized as adults.

Weather data from Weather Underground for this three-month period was copied into an excel workbook. There was a gap in the weather data recorded from January 30th 2020 to February 5th 2020. The weather and newt data were used to create the graphs and charts seen bellow. The newt data was also exported to ArcGIS. The maps seen below were created with access to the State Coastal Conservancy's ArcGIS and show the geographic distribution of the observations collected by Newt Brigade volunteers.

There was also data collected manually by site organizers, this data has been superficially compared and is largely consistent with counts from iNaturalist, however this data is not analyzed or compared in this report.

Data:

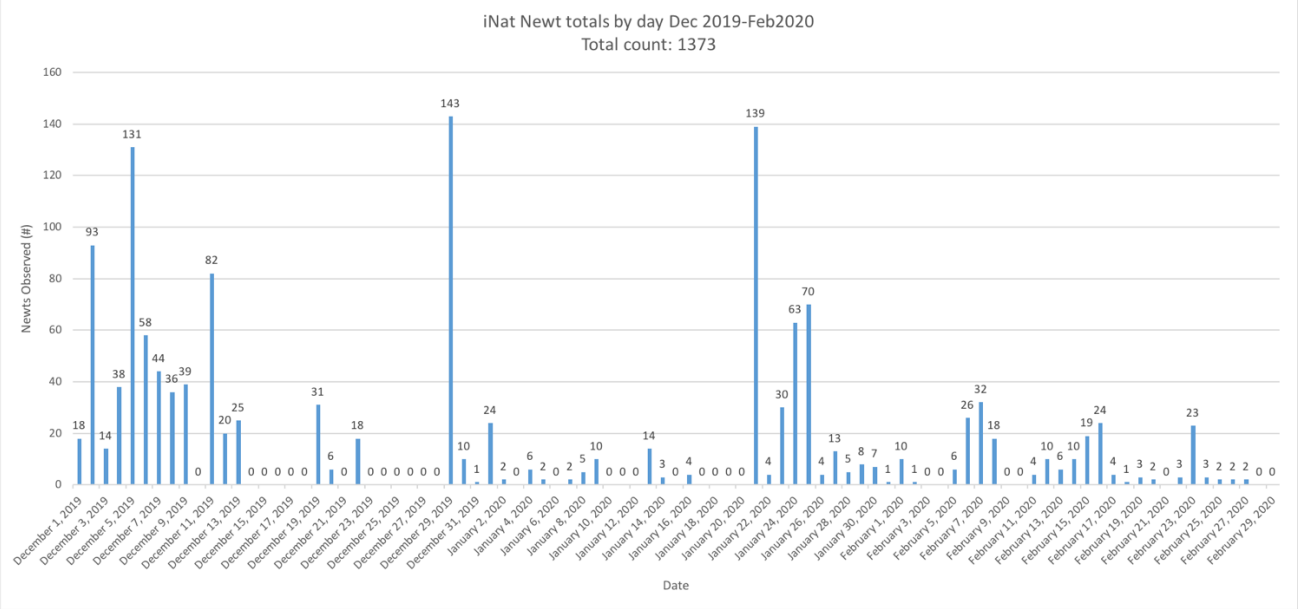


Figure 1 Number of Newts Observed by Day from Dec 2019-Feb 2020. Total newts observed: 1,434

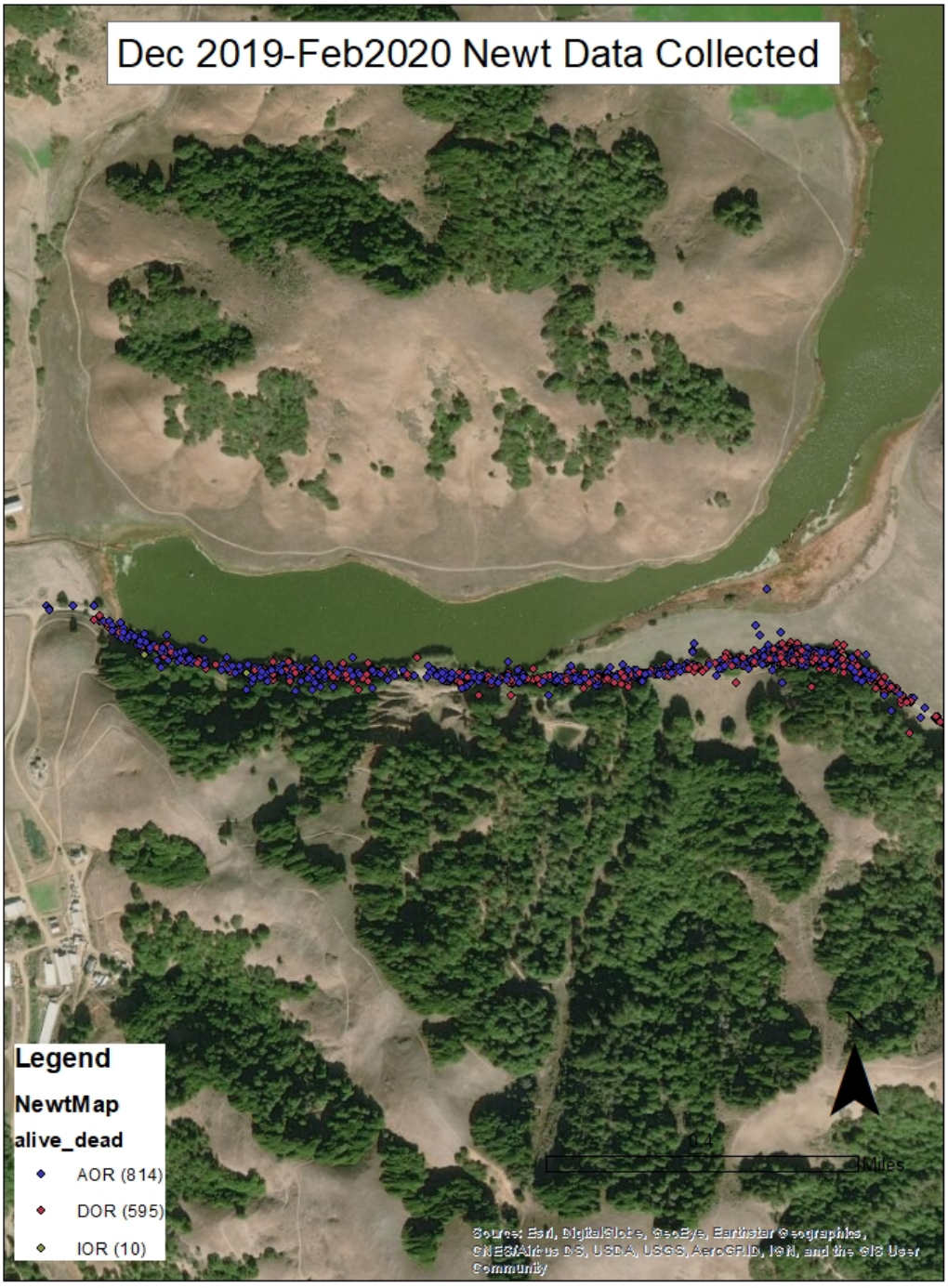


Figure 2 Map of all locations newt data was collected over the three month period, showing if the newts were observed alive, dead, or injured. AOR=alive on the road DOR=dead on the road IOR = injured on the road

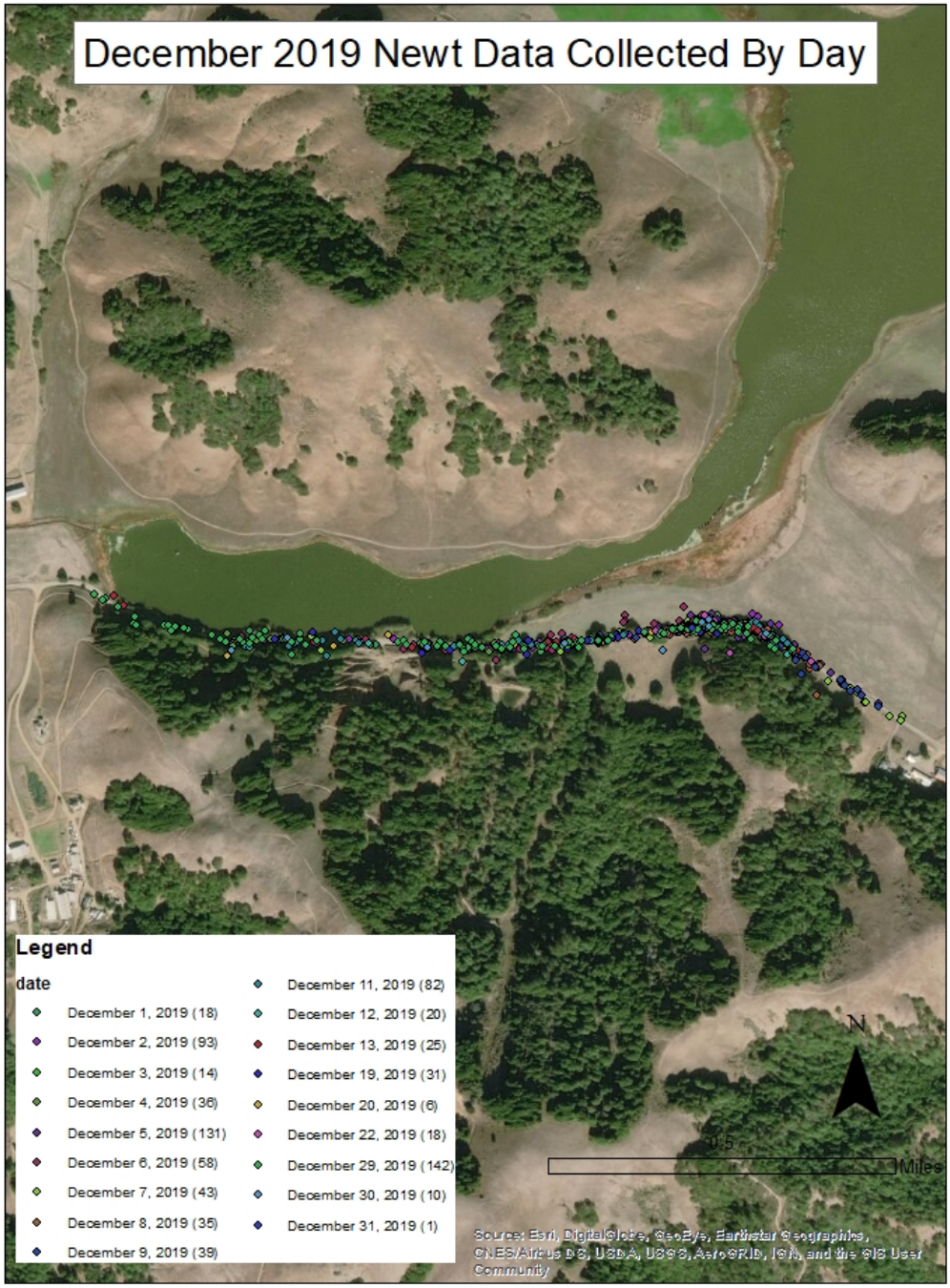


Figure 3 Map of all locations newt data was collected in December 2019. Total December Count = 807 newts

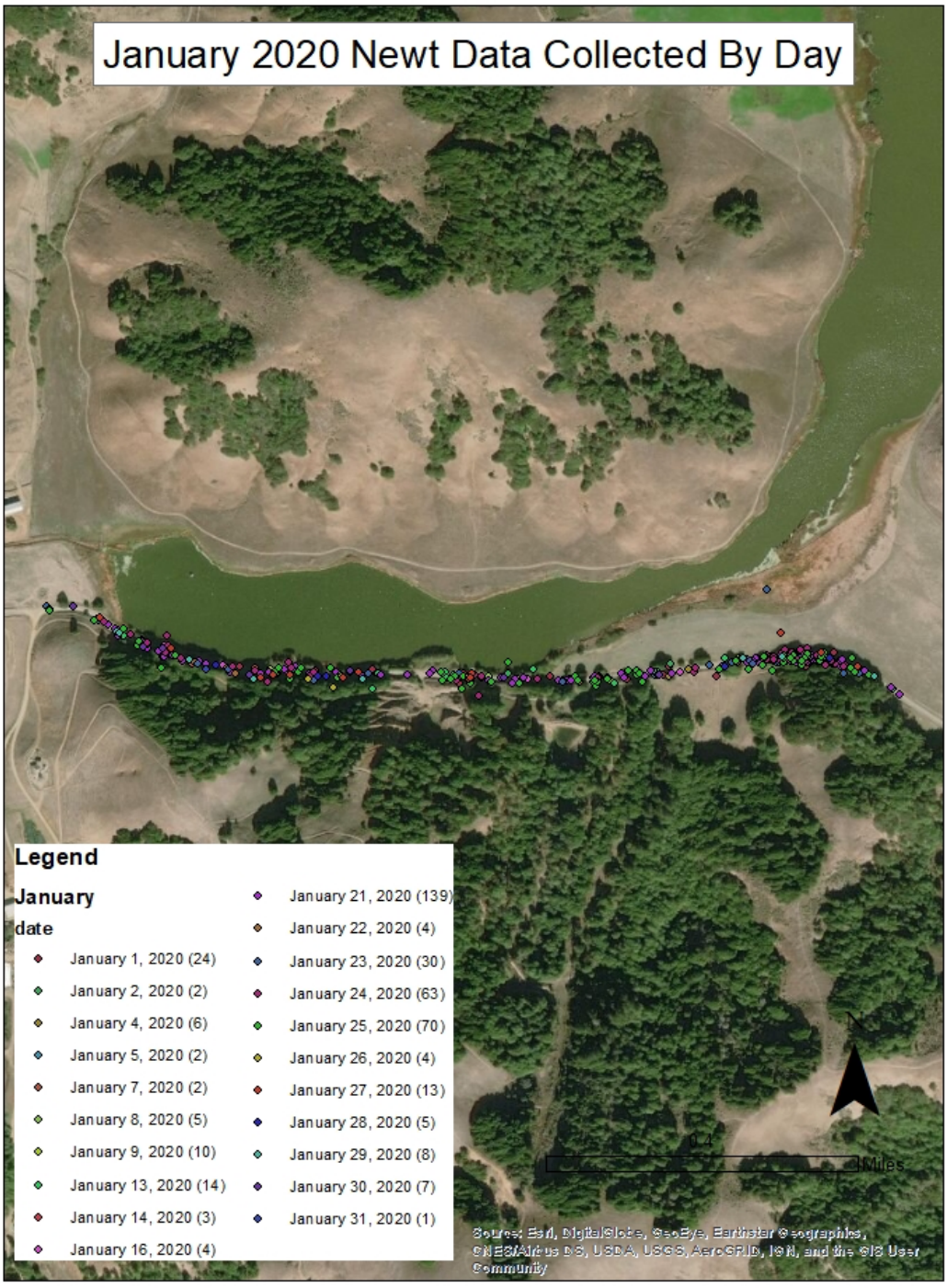


Figure 4 Map of all locations newt data was collected in January 2020. Total January Count = 416 newts

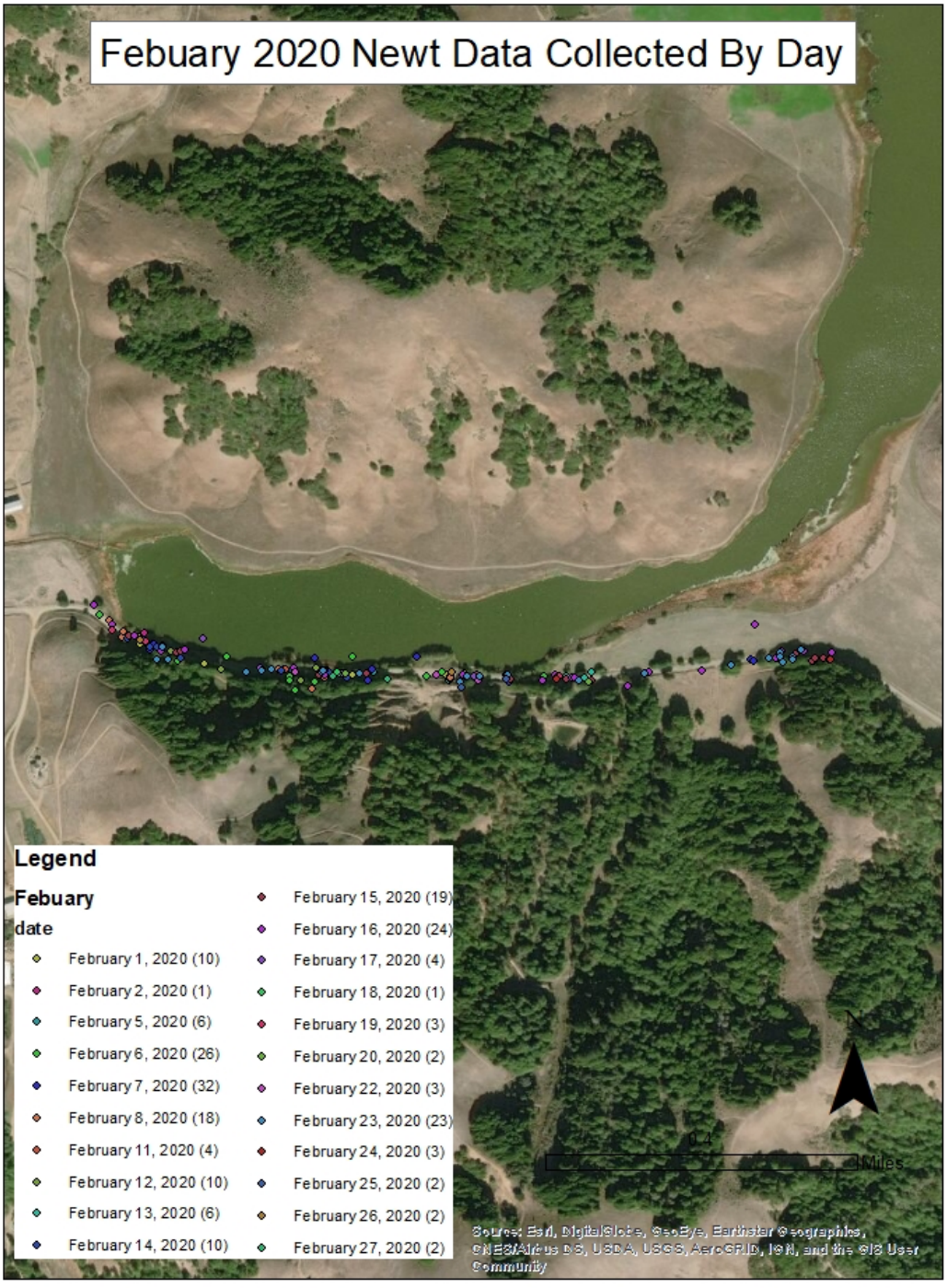


Figure 5 Map of all locations newt data was collected in February 2020. Total February Count = 211 newts

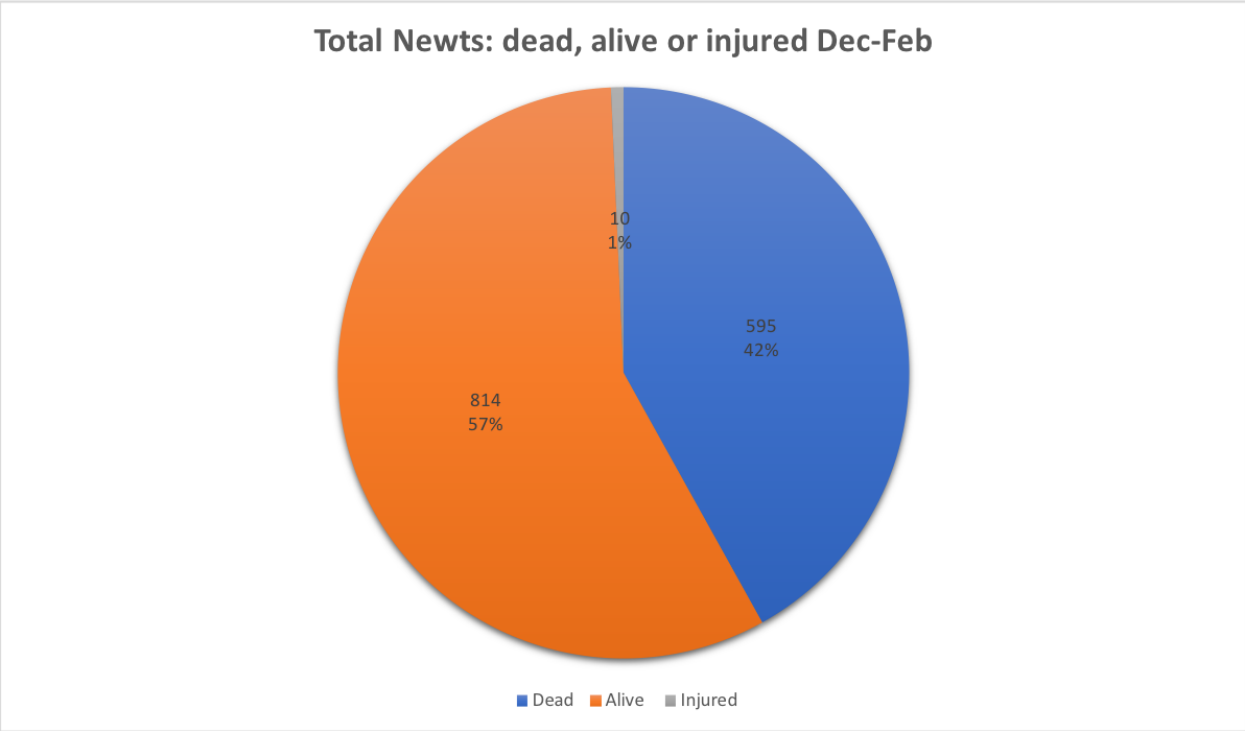


Figure 6 Dead, Alive, and Injured Newts Over 3 Months

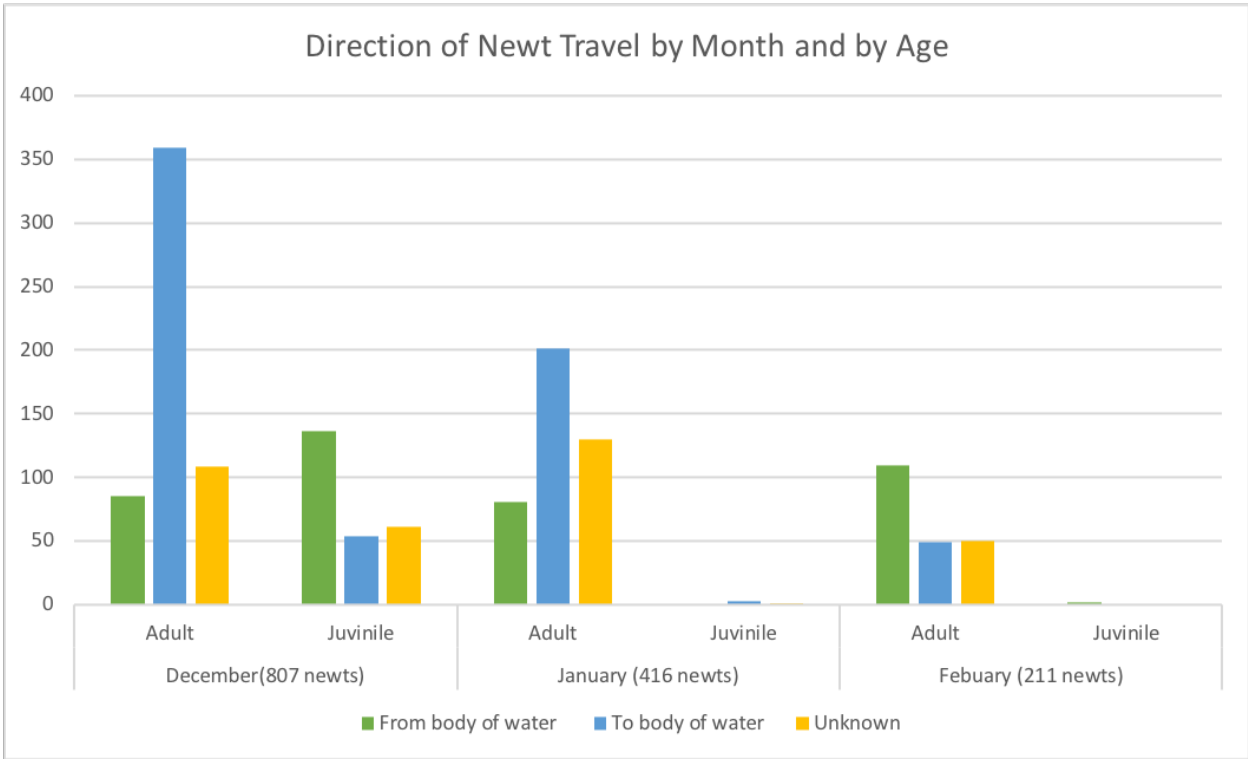


Figure 7 Direction of Newt Travel by Month and Age

Weather Data:

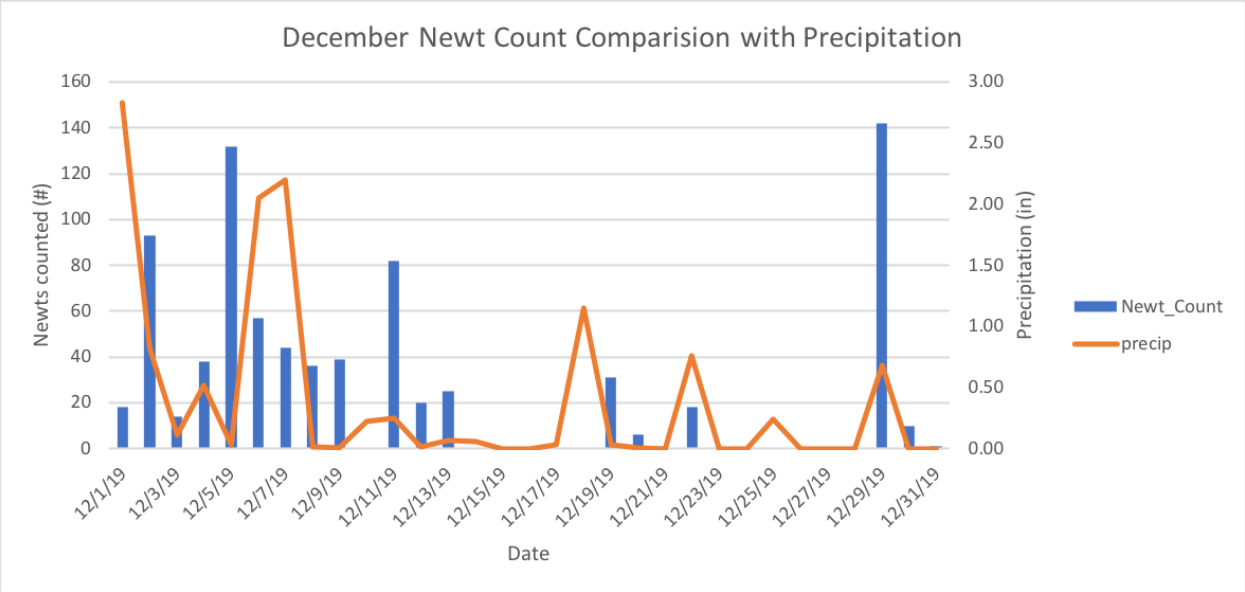


Figure 8 December 2019 Precipitation Data

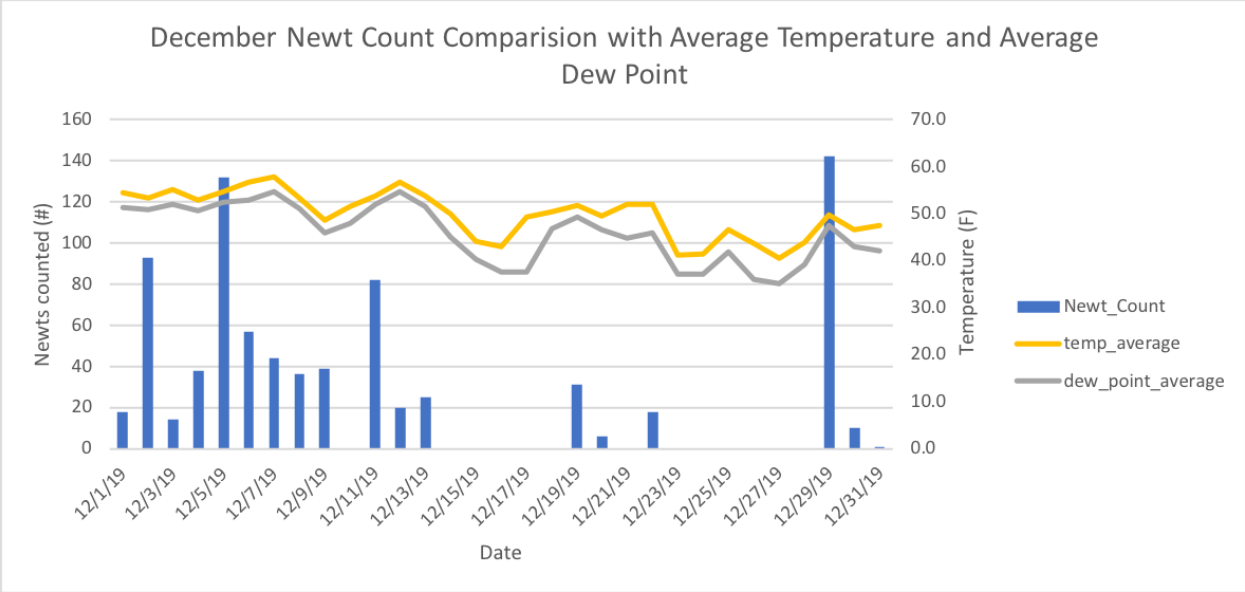


Figure 9 December 2019 Average Temperature and Average Dew Point Data

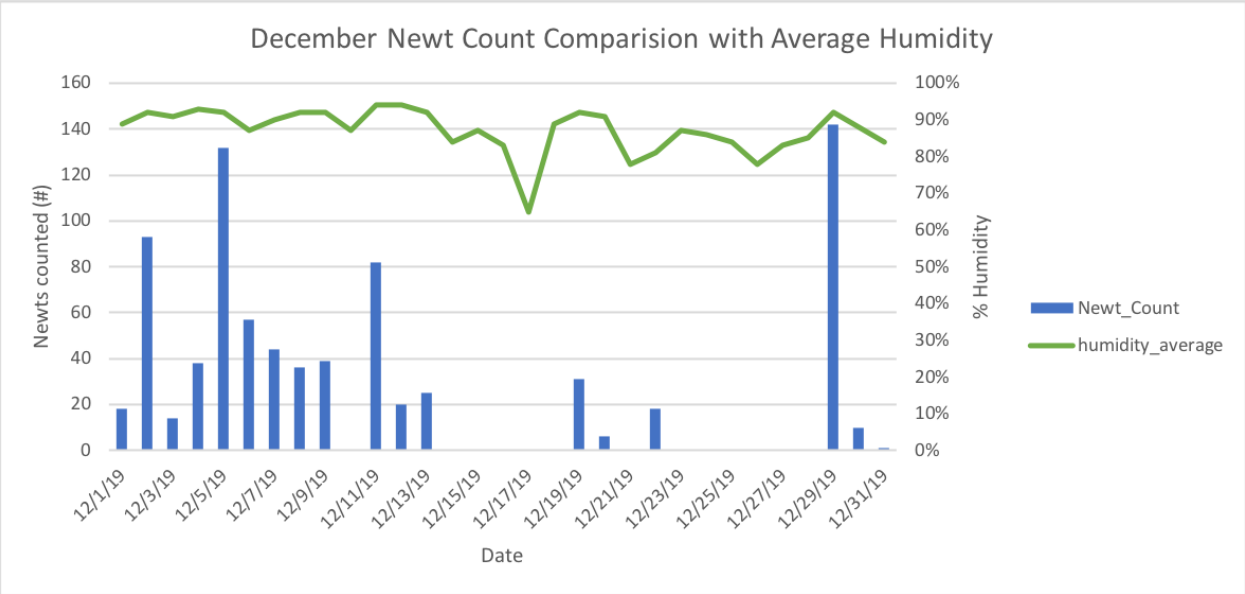


Figure 10 December 2019 Average Humidity Data

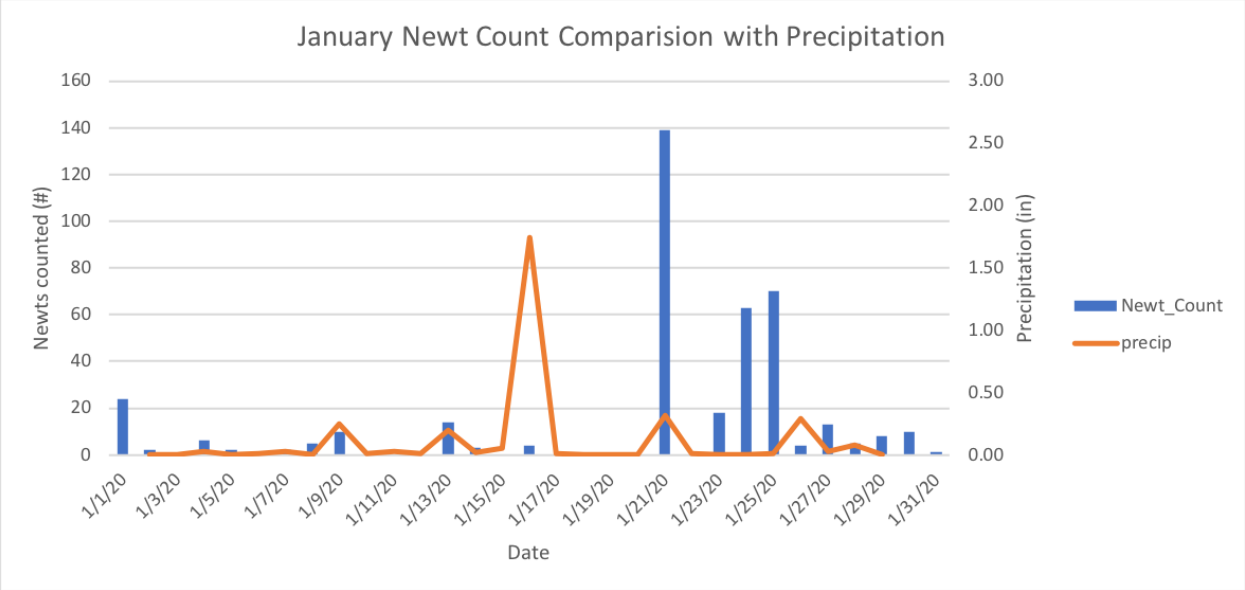


Figure 11 January 2020 Precipitation Data

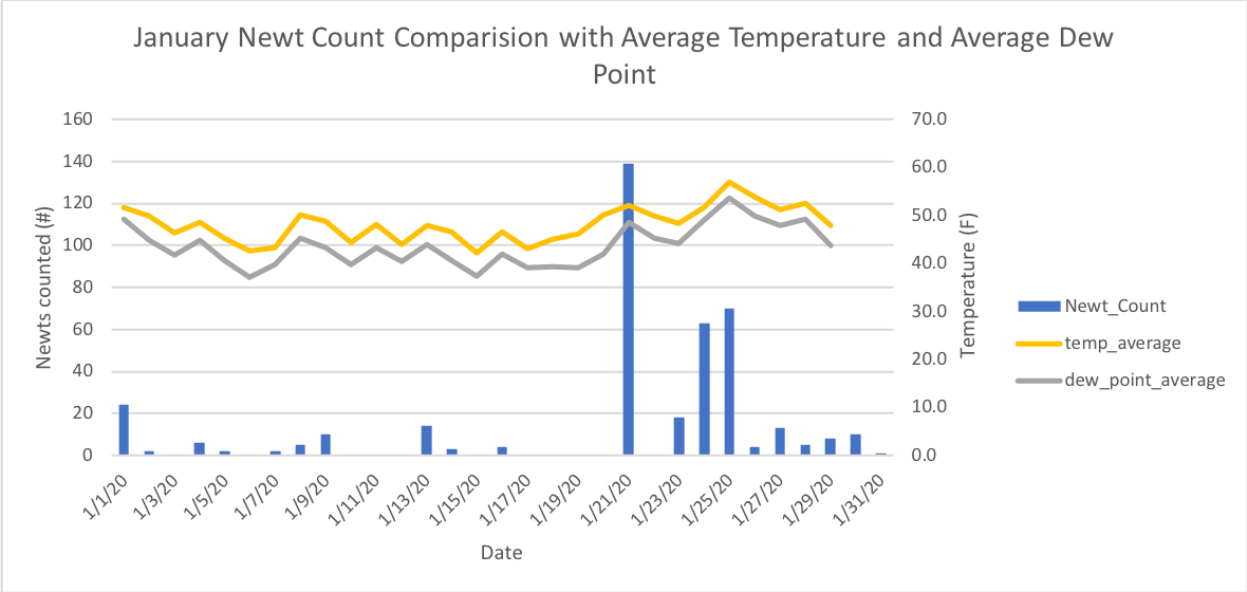


Figure 12 January 2020 Average Temperature and Average Dew Point

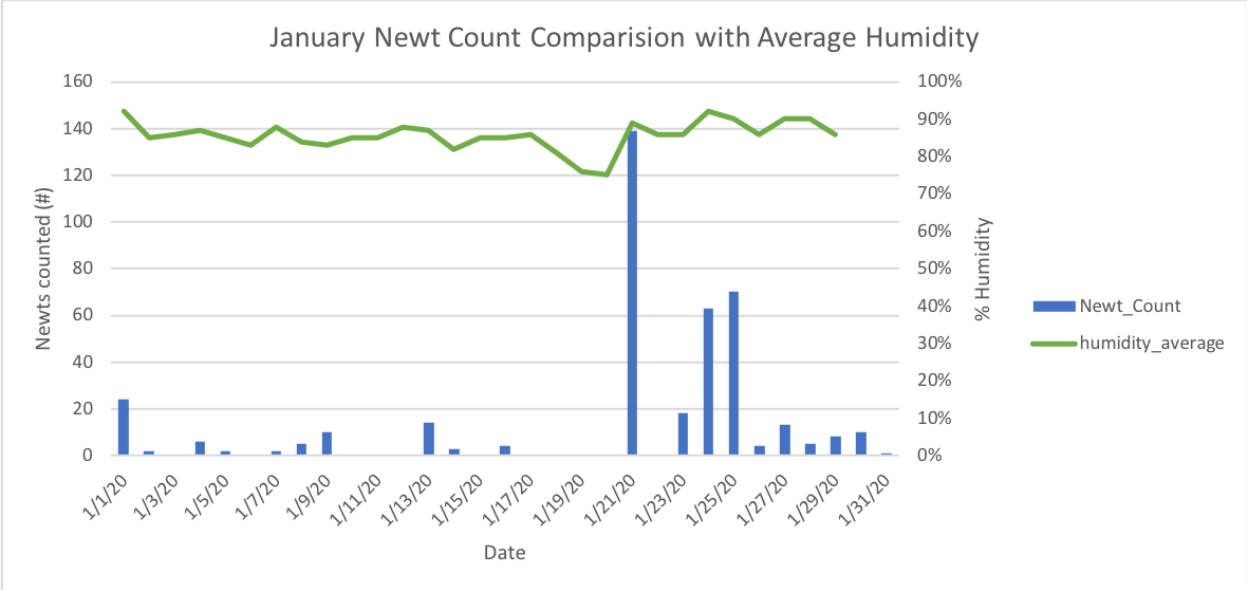


Figure 13 January 2020 Average Humidity Data

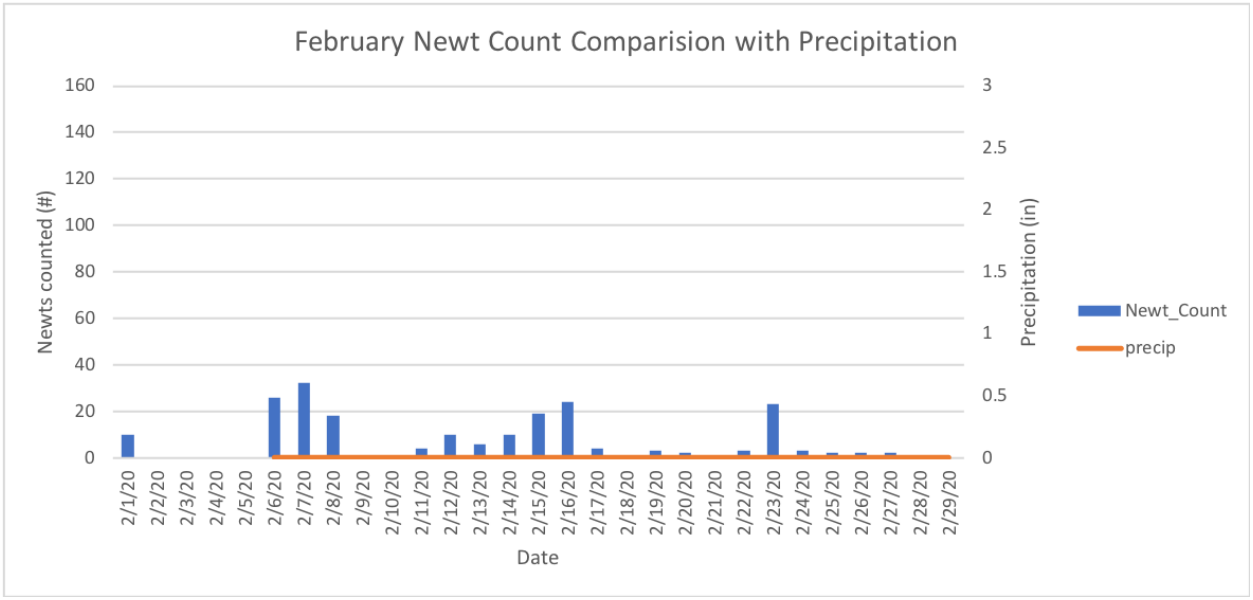


Figure 14 February 2020 Precipitation Data

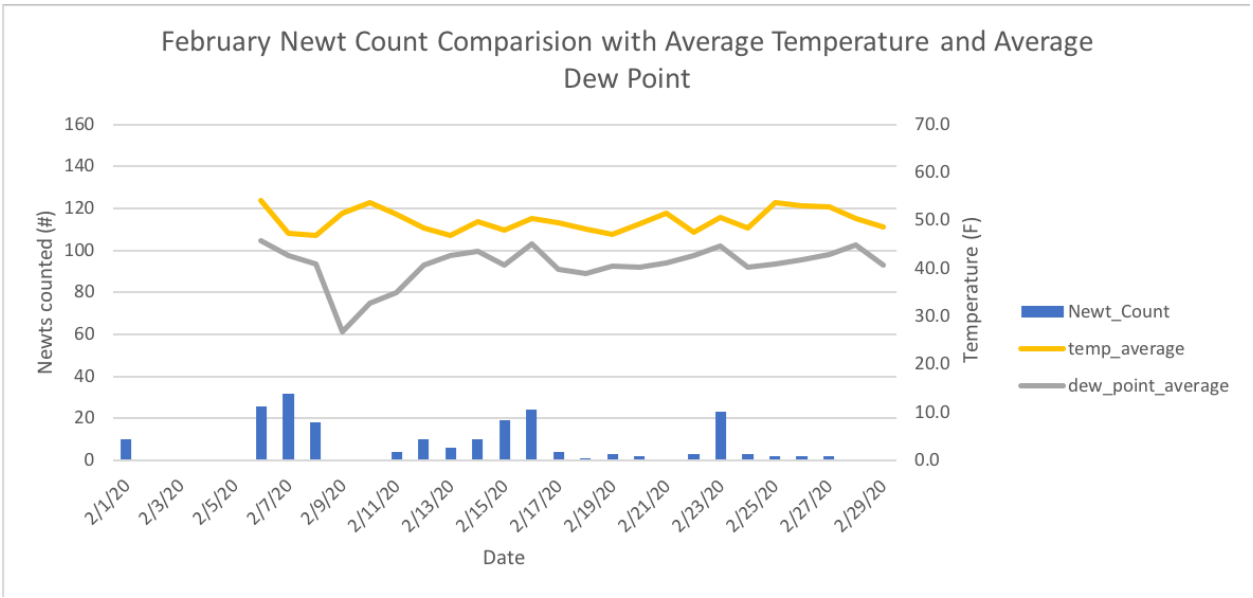


Figure 15 February 2020 Average Temperature and Average Dew Point Data

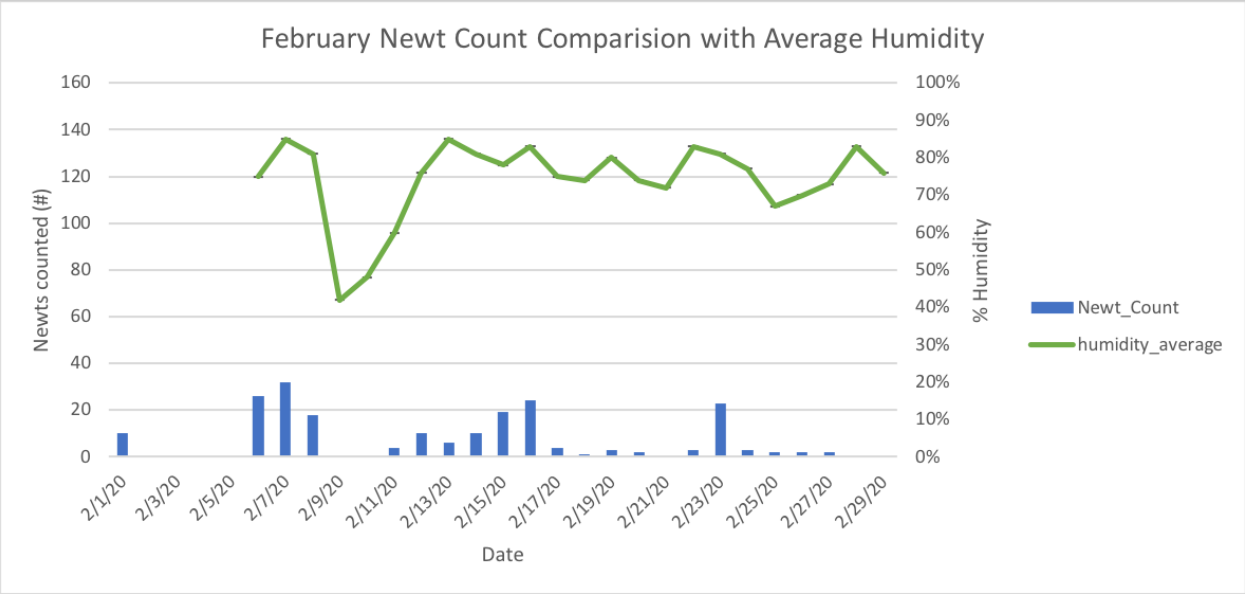


Figure 16 February 2020 Average Humidity Data

Analysis:

Figures 2-5 show maps of the geographic distribution of where the newt observations were collected. The first map, Figure 2, shows the data points collected over all three months, the following maps, Figures 3-5, show the data points by month in order to get a clearer view of all the data points. The first thing to note when looking at this data is that these points represent where the newts were seen by humans, and are not necessarily entirely representative of the locations of all the areas' newts. These data points can be influenced by where the humans happened to be when at whatever given time they were out on the road, by where it was safest for them to be on the side of the road, or by conditions that made it easier or harder for human observers to spot the newts near the road, such as lighting, or vegetation. The accuracy of these points is also subject to some instrumental uncertainty, which is quantified and recorded by iNaturalist as "positional accuracy", and can be seen in the spreadsheet in column O. This instrumental inaccuracy may account for some of the points displayed further from the road. Over the three month period the data points look fairly evenly distributed across the observation area, with a slightly higher density in the eastern segment of the observation area, where the road curves to the south, as well as a higher density in the western side of the observation area, about 0.3 miles from the road junction seen at the left of the map. The December map showed the highest clustering of data in the eastern portion of the collection area, the January map showed a fairly even distribution of observations along the collection area, and the February map showed a higher clustering of observations in western part of the map.

Over the three-month period there were 1,429 newt observations recorded by 29 different people. Of the newts recorded over this time 814 were reported as live newts, 595 were dead, and 10 were injured. These numbers are displayed in Figure 6 and show that 57% of newts were found alive, 42% were found dead and 1% were injured.

Figure 7 shows the direction of newt travel broken down by month and by the age of the newts. This data shows higher numbers of juveniles moving at the beginning of the migration period, that is in the month of December, and almost no juveniles in January and February. This

is consistent with what would be expected given known information about newt life cycles. However, given what is known about newt life cycles it would be expected that these newts were all moving from the lake to the upland habitat. About 60% of the newts were recorded heading away from the body of water, approximately 20% were observed heading to the water and about 20% had an unknown direction of travel. The majority of the juvenile newts were headed in the direction that they were expected to be going in, it is possible that the ones recorded as headed in the opposite direction were not, as it can be hard to determine newt direction when a volunteer happens upon a newt. It is also possible that newts could have been misidentified as juveniles, or that there is some other factor motivating their behavior. The December data also shows the majority of adult newts were headed to the body of water at that time, with some newts headed away from the body of water. The newts headed away from the body of water may have migrated early and already be returning from the lake, or may have had their direction misidentified. The number of adult newts headed to the lake decreased in magnitude and also percentage in January. There were fewer newt observations recorded in January, however the number of adult newts recorded leaving the body of water remained the same, meaning that a higher percentage of newts were seen leaving the body of water in January as compared to December, presumably meaning the news has completed their mating and egg laying and were returning to their upland habitat. This trend continued into February, with a jump in the number of newts reported moving away from the body of water and fewer newts reported moving towards the body of water. This data is consistent with what is known about the migration of the California newt, however especially when using citizen science data, it is important to consider what role bias can play in recording the data. When happening across an amphibian on the side of the road it can be hard to determine their direction of travel especially because they freeze when confronted with light. When recording the direction of travel, it is possible that volunteers were biased by what they knew about newt migrations when recording direction of travel.

Figures 8-16 show the weather data, displayed by month, compared with the number of newts recorded each night. At a superficial level, it can be observed that there was more rain December and there were almost twice as many newts recorded in December as January and almost 4 times as many newts in December as February (one of the driest Februaries ever recorded in California). Field observers noticed an even higher correlation between the amount of precipitation and the number of newts migrating than is displayed by this data. It is possible that additional analysis regarding the time of day when the precipitation occurred and the time when the newts were observed could yield additional information. As the newts prefer to migrate in the evening and at night, it might be more useful to compare the weather data in the hours leading up to the evening movement of the newts. The data did show a clear relationship between temperature and the number of newts observed. When the weather got cold, that is, temperatures approaching low 50s there were few to no newts observed in any of the three months. Additionally, the days when the largest number of newts were observed were days that were preceded by a dip in the temperature followed by an increase in temperature. It is unclear what role humidity plays in motivating newt migration. More analysis is needed with regard to the weather data and newt migration, and how these factors aggregate to influence newt migration. It is likely that this data will be more significant and easier to analyze with additional years of data.

Conclusions:

The data gathered in the first year of the Chileno Valley Newt Brigade is a useful starting point for future investigations into the newt populations in the region. These preliminary results have helped inform understanding of newt migration in the region; however this data is not all sourced from research grade data and the project was largely completed by non-expert naturalist volunteers. The newts were observed crossing the road thought the approximately one mile stretch of Chileno Valley Road bordering Laguna Lake, but there are two locations where higher densities of newts were observed, one at the eastern end of the monitoring area and one at the western end. These are the recommended locations for beginning an investigation about the effectiveness of an alternative means for amphibian road crossing, shown in Figure 17.

The winter of 2019-2020 shows a disturbingly high mortality rate for newts crossing the road with over 40% of the observed newts being killed by passing automobiles as they attempted to reach their breeding habitat or as they returned from it. This statistic shows the devastating effect of habitat fragmentation, and is indicative of a larger problem than just newt migration. Newts are an aquatic indicator species, meaning that the health of their population can indicate the heath of other aquatic species and more broadly the health of a watershed. If this newt population is in decline it could indicate degraded habitat of the entire lacustrine ecosystem and loss of biodiversity in the area.

The direction of travel data shows that juvenile newts are migrating from the lake in the earlier part of the migration season and were barely seen at all in the later part of the season. It is expected to see lower number of juvenile newts as the adult newts migrating to the lake represent many generations of newts, while the juvenile newts are presumed to be the previous year's spawn. Furthermore, juvenile newts are much smaller and harder to see than adult newts so it is expected that whatever sample of newt of newts is being observed would be statistically skewed towards adults. For this reason, it is especially heartening that the data shows quite a few juvenile newts. Further investigation is needed to determine what percentage of juveniles recorded in the newt migration is indicative of a healthy newt population.

The first-year data also shows a relationship between temperature and precipitation and the number of newts observed, however more data and analysis are needed to tie exact parameters to newt migration. Furthermore, it was unclear the extent to which, if any, humidity had on the newt migration, except for the extent to which humidity is tied to temperature and precipitation.

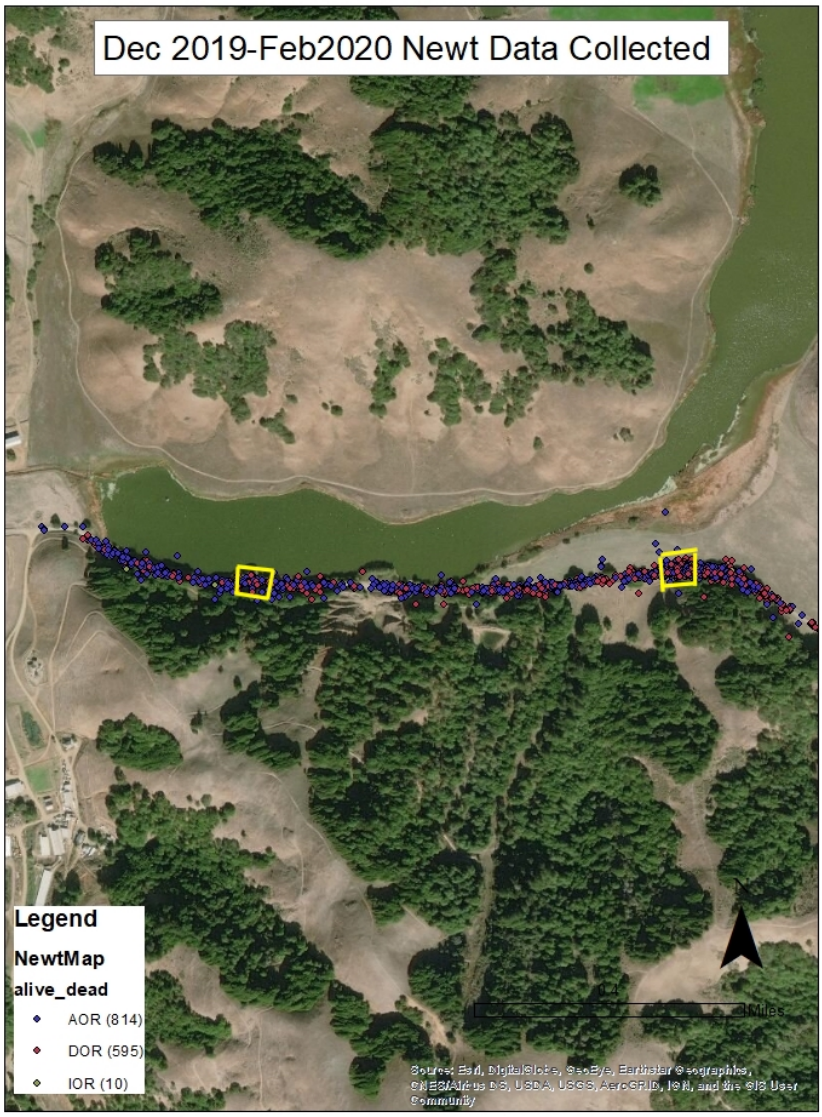


Figure 17 Highest Density Newt Observation Locations

For future data collection seasons:

This year the additional data fields on the Chileno Valley Newt Brigade Project on iNaturalist were not made "required fields", because, out of concern for different volunteer's technological abilities we wanted to make sure that users were able to add their observations even if they were not able to complete the additional data fields. I would say that overall volunteers did a good job filling in the fields but as the person who went through all the data to make sure all the fields were complete and to complete the ones that were not, I would recommend making the iNaturalist fields mandatory (I have already made this switch on the iNaturalist page, but it can

be switched back if consensus is that this will lead to a potential loss of data). This will make data analysis at the end of the season much easier and faster. Additionally, I would recommend that the field, "number of dead newts" be removed and instead volunteers be instructed to have each picture include only one individual. If interested in a better species count, I would make clear to volunteers the difference between the Genus: Pacific newts and the species: California newts (or other local newt species). I thought the penny was an excellent scale indicator and its use should be continued. While analyzing the data I found that the instructions for taking the picture in a certain orientation were not necessarily adhered to and was not that effective, furthermore while training volunteers I found that it was more confusing than helpful. Lastly, when it comes to newt direction in order to minimize bias it might be good not to inform volunteers which way the newts "should" be moving and rather encourage them to mark "unknown" if they are unable to determine direction of travel.
For any questions or if you would like access to the iNaturalist account as an administrator please email me at: triananderson@gmail.com

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[i] https://www.mnn.com/earth-matters/animals/blogs/what-difference-between-salamander-and-newt
[ii] http://www.californiaherps.com/salamanders/pages/t.t.torosa.html
[iii] https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=1428

[iv] https://www.inaturalist.org/home
[v] https://www.wunderground.com