COASTAL RANCHES CONSERVANCY – DATA COLLECTION PHASE

GAVIOTA WILDLIFE CORRIDOR PROJECT REPORT

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INTRODUCTION

In the present day, anthropogenic influence on rural and wild ecosystems is often detrimental and inescapable. Modern society relies upon extensive infrastructure that heavily impacts the natural world. In order to attempt to balance the harm that human development causes, there is a need to be especially cognizant of ways to minimize negative impacts. The Gaviota Creek Watershed Restoration Project conducted by the Coastal Ranches Conservancy in Santa Barbara County, California is attempting to do just that. By restoring the Gaviota Creek Watershed, the Coastal Ranches Conservancy will be able to minimize anthropogenic impact and bring health back into the ecosystem at this important site. Though the study area is only focused on one specific watershed, the project site is part of the Los Padres National Forest and Santa Ynez Mountains and its restoration will allow for a wider improvement of ecosystem health throughout the region. Further, Highway 101 runs through the study area making this restoration project directly impacted by a major interstate. This highway acts as an extreme barrier for wildlife movement as animals are either confined to one side of the forest or risk losing their lives in crossing unless they are able to make use of the series of culverts that are installed underneath the highway. Therefore, in order for wildlife populations to flourish to their full potential and true ecosystem health to be obtained, connectivity in the area must be a major focus.

The following summary is a first step in pin-pointing where connectivity is failing and will serve to inform decisions as to where wildlife is being most affected by the highway and therefore where the need for redirecting wildlife to nearby “safer” crossings is most important. In order to achieve this goal, data has been compiled from citizen science, government, and museum or research agency sources which shows the amount and diversity of wildlife (both dead and alive) recorded in the study area after 1950. The largest contributor to the dataset was the Global Biodiversity Information Facility (GBIF), a database that combines several sources (e.g. citizen science, museum collections, and scientific organizations) to give a large amount of information about specific study areas. GBIF had 714 instances in the Gaviota-Hwy 101 corridor. The second largest contributor was the California Roadkill Observation System (CROS) managed by the Road Ecology Center at the University of California, Davis. This database combines agency and volunteer collected roadkill observations, and contributed 77 data points to our study, half of which were provided by the California Highway Patrol and the other half by citizen science reports. iDigBio, a database that digitally archives preserved museum specimens as well as reports citizen science observations contributed 37 points to this data set. Other sources included the citizen science database, iNaturalist as well as the Santa Barbara Museum of Natural History.

METHODS

The study area was determined prior to data collection. The stretch of highway 101 that was of primary interest for this study runs a total distance of approximately 6 miles, from the Nojoqui Summit near Old Coast Highway to Calle Mariposa at Gaviota, In order to make sure that wildlife in the area were comprehensively represented, a balance had to be struck between making the study area too wide around Highway 101, thereby including data on wildlife that was not likely to be impacted by the highway, versus making the study area too narrow which could result in the possibility of excluding important data. Through trial and error, it was determined that a 500-foot buffer on both sides of a line representing the highway offered the most effective study area (See Figure 1).

The search for data began after the study reach was determined. For the GBIF database, the data was gathered by searching occurrences by location. A square with the coordinates -120.25259, 34.46858 for the upper left-hand corner and -120.163737, 34.472963 for the lower right-hand corner was drawn. All data found was then downloaded and uploaded to ArcGIS. All points with coordinates outside of our study area were excluded, leaving only points that were relevant to the 500-foot buffer highway corridor. The same coordinates and exclusion system were used for iNaturalist, iDigBio, and the CROS data. GBIF, iNaturalist, and iDigBio all allow for public download straight from the website, which is how we obtained data from those sources. The data from CROS was obtained by contacting the database administrator, Fraser Shilling, and requesting a GIS shapefile.

After all relevant data was collected and compiled, the instances were sorted to ensure data quality. Highway 101 has been established since 1926, but the installation of Gaviota State Park in 1953 brought more infrastructure to this segment of the road and resulted in the land-use factors that exist today. With this in mind, the compiled dataset excludes all points recorded before 1950 as they are likely not relevant to the current conditions of the study area. Furthermore, all duplicate records and data with erroneous dates or other unverifiable information were also excluded.

RESULTS

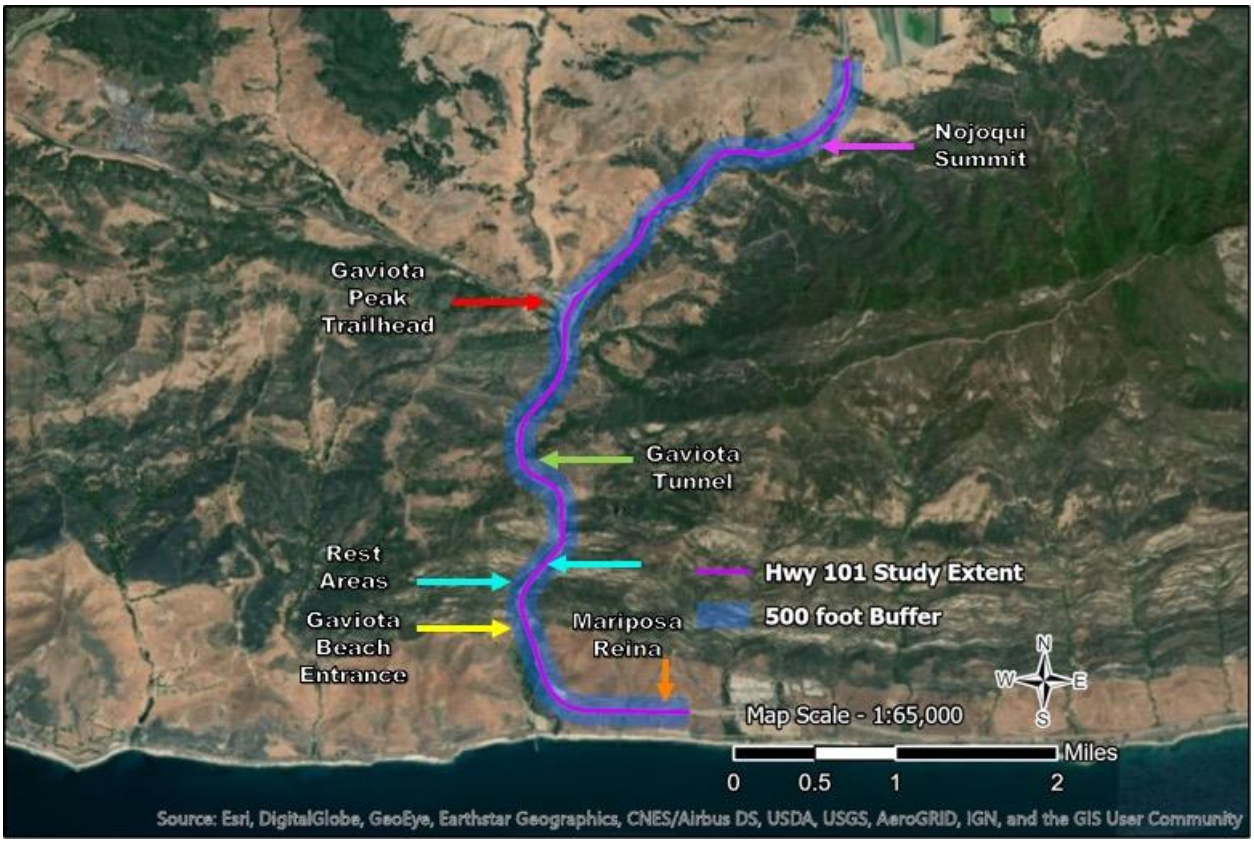

***Figure 1*:** Study area map, highway 101 (pink line) and 500-foot buffer (blue margin) within the broader Santa Ynez mountains and Gaviota Coast landscape. The map includes the broader landscape to demonstrate the ridgelines and surrounding topography that likely influence wildlife movement across the highway corridor. Points of significant vehicle entry and exit from the highway are labeled and indicated with arrows.

The locations indicated on the above map, the Nojoqui Summit, Gaviota Peak Trailhead (which is an offshoot from the Highway 1 and 101 interchange in Las Cruces), Gaviota Tunnel, Rest Areas, the Gaviota Beach Park Entrance, and Mariposa Reina are all prominent features along this section of the highway. These features are places where drivers are commonly entering and exiting the highway, and the tunnel marks where there is a shift in the topography of the highway. When compared with *Figure 2*, which shows the wildlife data categorized by Class, the locations of observations of the class Mammalia were highly correlated to these features. This can be compared with *Figure 4,* which shows that the majority of records of dead animals were in similar locations.

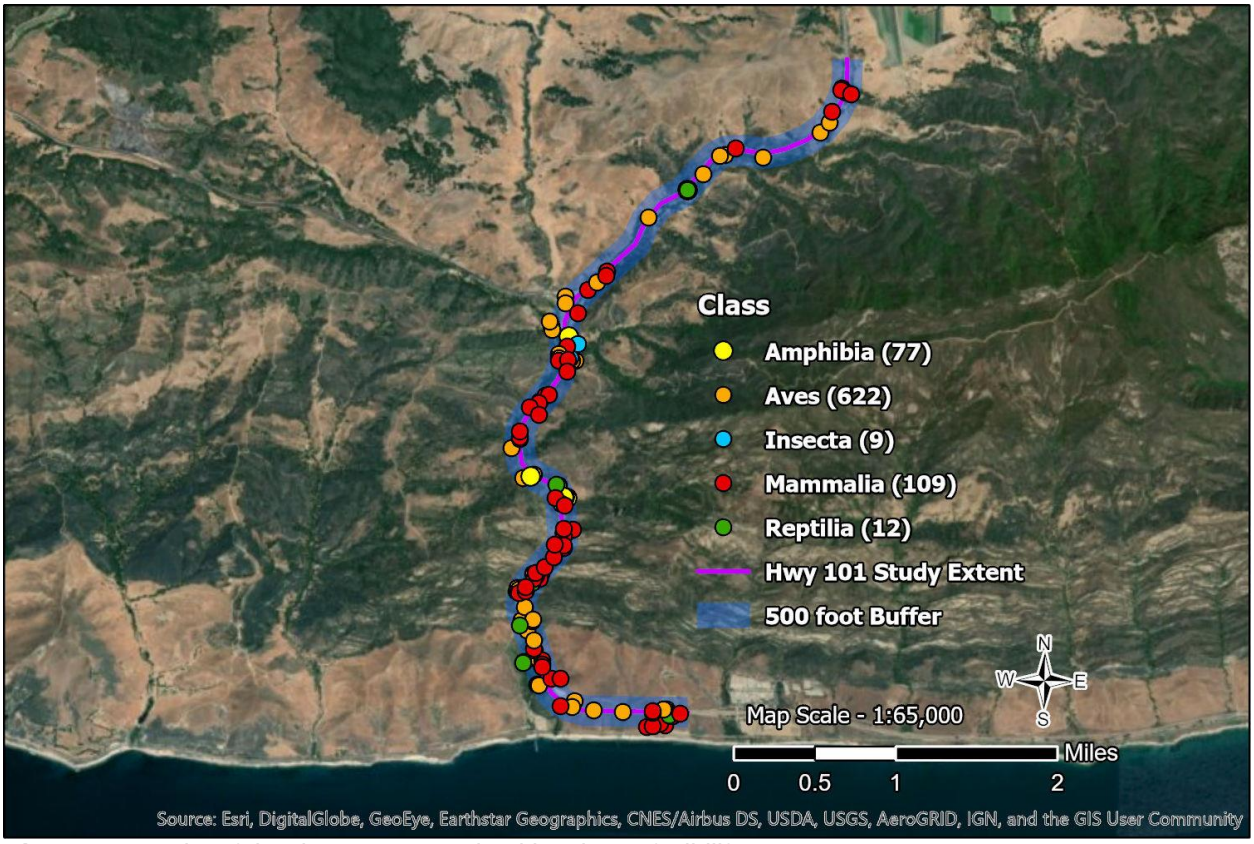

Figure 2*:* Results of the dataset categorized by class of wildlife.

The most visibly numerous data points seen in *Figure 2* are from mammal observations (red-colored points), however, as indicated in the map legend, there are more records of Aves species in the dataset than Mammalia. Many of the Aves observations are in close proximity to each other and/or had the same coordinates and it is not possible to visually display all of the data points on a map at the scale presented in *Figure 2*. Therefore, it can be concluded that more than one Aves observation are represented by each orange colored point on the map, while each red point likely represents only a single or small number of mammal observations. When compared with *Table 2,* it can be seen that the majority of Aves observations are from GBIF and originally sourced from the Cornell Lab of Ornithology's eBird database. eBird is a citizen science platform that allows individuals to easily record sightings of live birds. The birds documented by eBird are likely away from the highway and less applicable to the issue of connectivity. To demonstrate only the Aves specimens that were directly impacted by the highway, *Figure 3* represents the more pertinent data by excluding eBird data. Data from Naturgucker (another citizen scientist GBIF source), as well as iNaturalist are also excluded in *Figure 3* as these data points are also sightings of living species that, due to the intrinsic nature of citizen science apps, may not even be roadside observations. The exclusion of iNaturalist and Naturgucker removes three mammal and two reptile observations as well as 14 Aves instances. All of the remaining bird specimens documented in the other databases are roadkill observations, meaning that these animals had been found hit on the highway and are therefore more drastically impacted by the infrastructure.

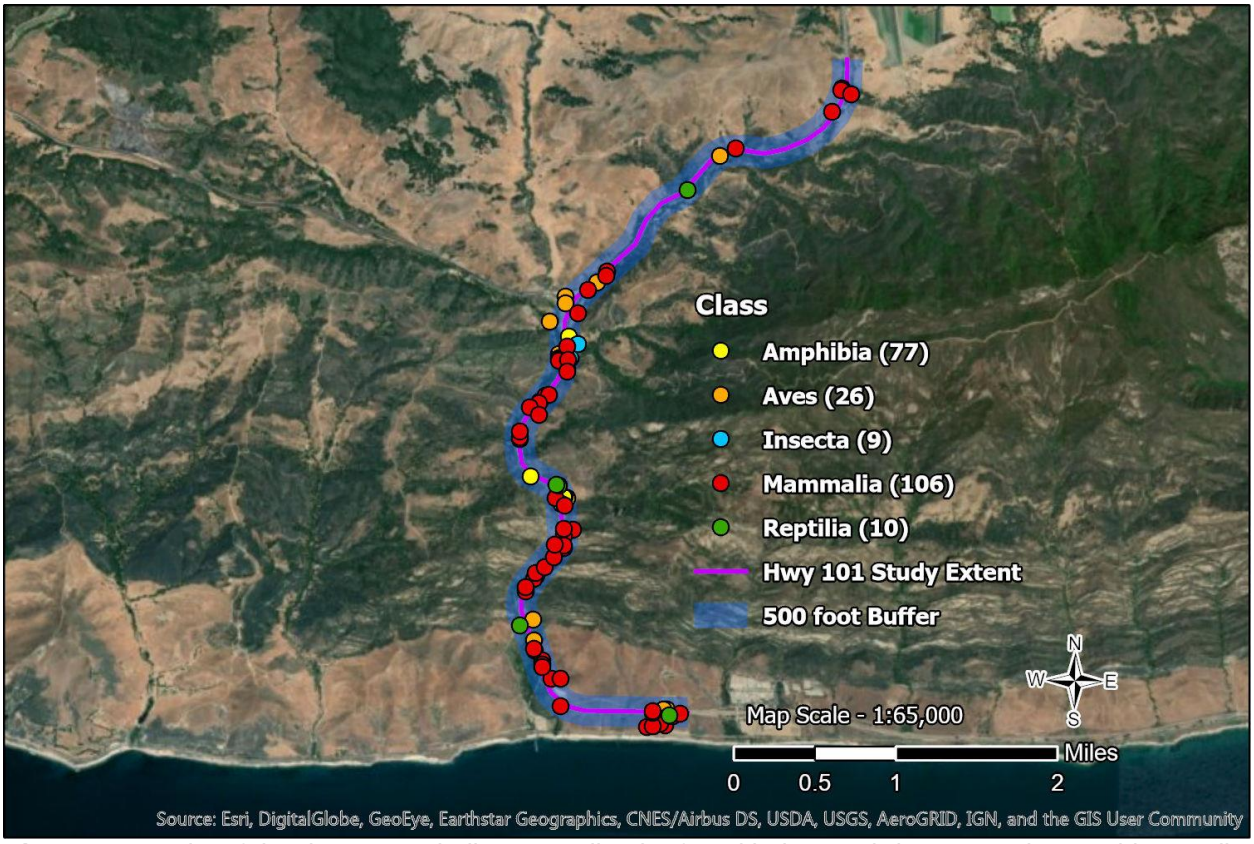

Figure 3: Results of the dataset excluding Cornell Lab of Ornithology eBird, Naturgucker, and iNaturalist data.

Table 1 extrapolates on *Figure 3* by listing the species found in each class. The common name of each data point is listed as well as the Latin name, and the number of observations where the animal was found dead, living (as in the case of some CROS data where there was a collision that the animal survived), or if the survival status was unknown or not reported are provided in the corresponding columns D, L and U. This provides information on which and how many animals are most impacted by the highway. The Dead, Living or Unknown status of each individual is also mapped in *Figure 5* and can be compared with *Figure 7* for more information about the type of specimen or observation made.

***Table 1*:** Numerical results of the dataset by class and species of wildlife, excluding iNaturalist, Naturgucker, and eBird data from the GBIF database. Column "D" contains the number of individuals for each species found dead, column "L" contains the number of individuals that survived or were not affected and reported as Living, and column "U" contains the number of individuals for which the survival status was unknown or not reported. The grand total of specimens is in the column labelled "TOTAL".

COMMON NAME	LATIN NAME	D	L	U	TOTAL
AMBHIBIA					**77**
Aboreal salamander	*Aneides lugubris*	35	0	0	35
Black-bellied slender salamander	*Batrachoseps nigriventris*	1	0	0	1
California red-legged frog	*Rana draytonii*	39	0	0	39
Pacific tree frog	*Pseudacris regilla*	2	0	0	2
AVES					**26**
Acorn woodpecker	*Melanerpes formicivorus*	1	0	0	1
Allen's hummingbird	*Selasphorus sasin*	3	0	0	3
American kestrel	*Falco sparverius*	1	0	0	1
American robin	*Turdus migratorius*	2	0	0	2
Barn owl	*Tyto alba*	3	0	0	3
Black phoebe	*Sayornis nigricans*	2	0	0	2
Black-throated loon	*Gavia arctica*	2	0	0	2
Great-horned owl	*Bubo virginianus*	6	0	0	6
Long-billed curlew	*Numenius americanus*	1	0	0	1
Nuttall's woodpecker	*Picoides nuttallii*	1	0	0	1
Red-tailed hawk	*Buteo jamaicensis*	2	0	0	2
Red-winged blackbird	*Agelauis phoeniceus*	2	0	0	2
INSECTA					**9**
Unknown		2	0	0	2
Braconoid wasp	*Apanteles*	1	0	0	1
Brimstone butterfly	*Danepteryx adiuncta*	1	0	0	1
Diving beetle	*Neoclypeodytes pictodes*	1	0	0	1
Mason bee	*Osmia lignaria*	1	0	0	1
Sand bug	*Emblethis vicarious*	1	0	0	1
Western yellow jacket	*Vespula pensylvanica*	1	0	0	1
Woollyleaf ceanothus moth	*Tischeria ceanothi*	1	0	0	1

COMMON NAME	LATIN NAME	D	L	U	TOTAL
MAMMALIA					**106**
American badger	*Taxidea taxus*	1	0	0	1
Black bear	*Ursus americanus*	2	1	0	3
Bobcat	*Lynx rufus*	3	0	0	3
California ground squirrel	*Otospermophilus beecheyi*	2	0	0	2
California vole	*Microtus californicus*	21	0	0	21
Coyote	*Canis latrans*	3	0	0	3
Gray fox	*Urocyon cinereoargenteus*	10	0	0	10
Mountain lion	*Puma concolor*	2	3	0	5
Mule deer	*Odocoileus hemionus*	8	22	0	30
Pallid bat	*Antrozous pallidus*	1	0	0	1
Racoon	*Procyon lotor*	5	0	0	5
Red fox	*Vulpes vulpes*	1	0	0	1
Striped skunk	*Mephitis mephitis*	3	0	0	3
Unknown		0	0	12	12
Virginia opossum	*Didelphis virginiana*	2	0	0	2
Western gray squirrel	*Sciurus griseus*	3	0	0	3
Wild Boar	*Sus scrofa*	0	1	0	1
REPTILIA					**10**
California kingsnake	*Lampropeltis california*	1	0	0	1
Common kingsnake	*Lampropeltis getula*	1	0	0	1
Prairie rattlesnake	*Crotalus viridis*	1	0	0	1
Sierra garter snake	*Thamnophis couchii*	2	0	0	2
Southern alligator lizard	*Elgaria multicarinata*	1	0	0	1
Southwestern pond turtle	*Actinemys pallida*	1	0	0	1
Western fence lizard	*Sceloporus occidentalis*	2	0	0	2
Western pond turtle	*Actinemys marmota*	1	0	0	1
Grand Total					**829**

Figure 4 is a map of the excluded data (iNaturalist, eBird, and Naturgurker) grouped by Class. These points are all citizen science sightings and ensures that all data are represented. However, the data in *Figure 4* is less relevant to connectivity and the animals are likely less impacted by the highway.

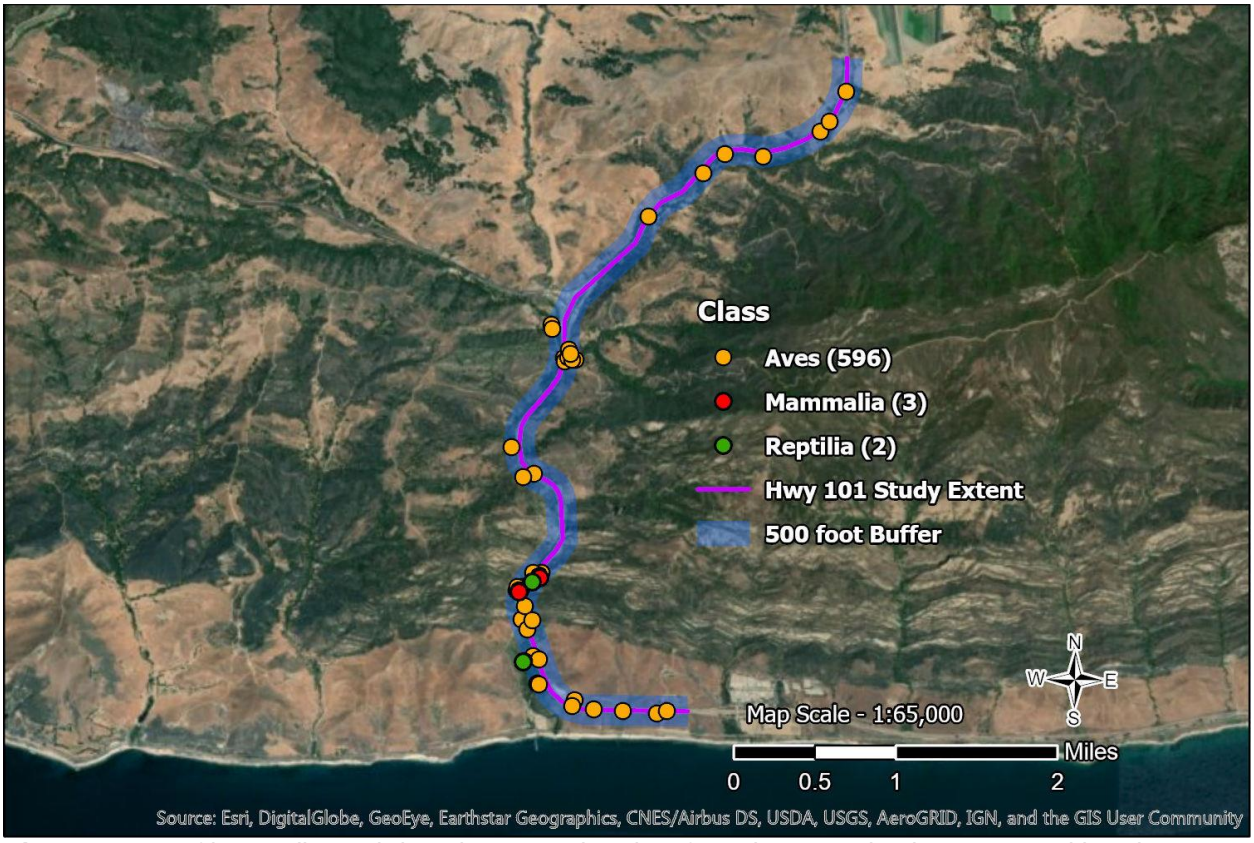

Figure 4*:* Map of iNaturalist, eBird, and Naturgucker data from the GBIF database grouped by Class.

The locations of observations recorded as dead, living, or unknown are mapped in *Figure 5.* This includes iNaturalist, eBird, and Naturgucker data points from the GBIF database. Refer back to *Figure 1* for comparison with prominent highway features.

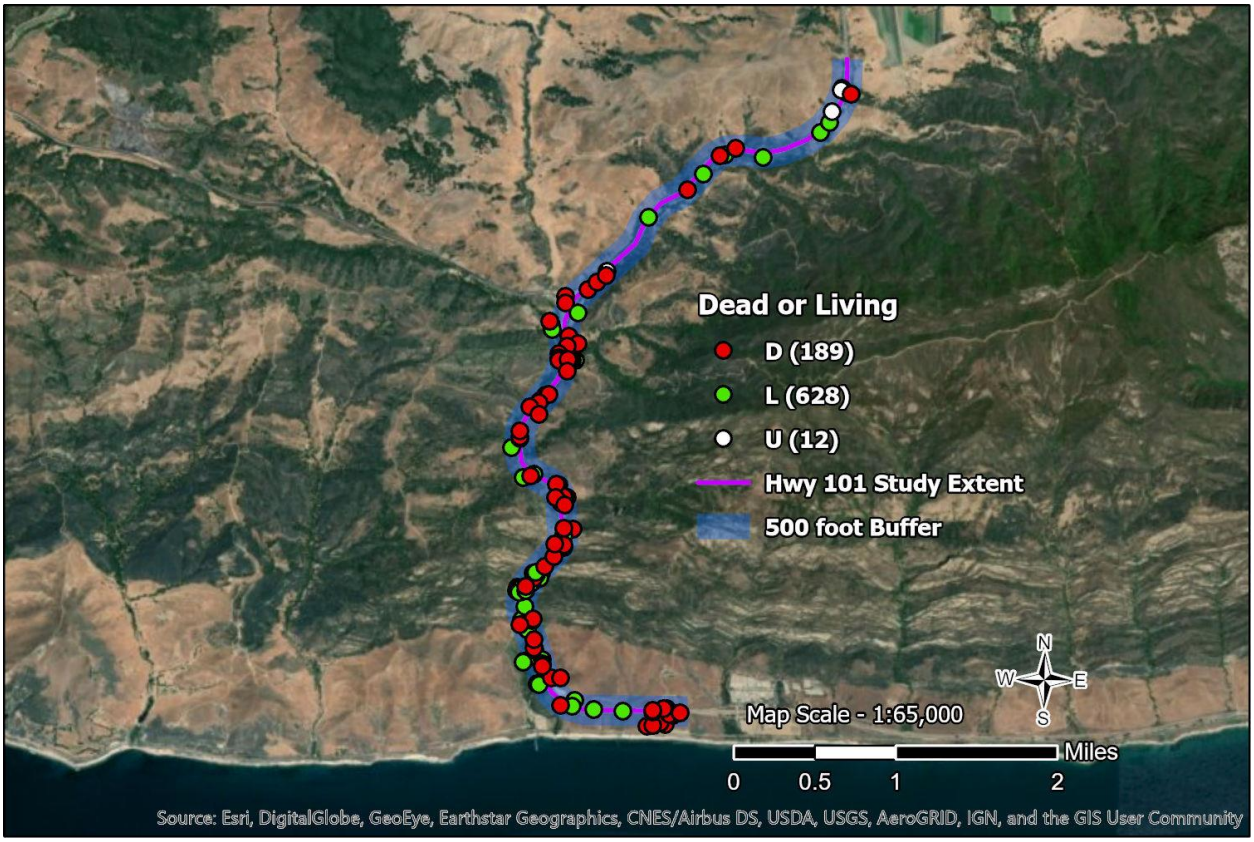

Figure 5*:* Wildlife observation data categorized by observed status: dead (D), living (L), or unknown (U).

The database from which each observation was gathered is listed in *Figure 6.* Though GBIF was the largest contributor, 582 of those instances were Cornell Lab of Ornithology eBird records. CROS, the second largest contributor, contained the majority of roadkill specimen data points. Therefore, the location of the CROS data points are the most important to note as they show places in which collisions with wildlife occurred or dead animals were found on the highway.

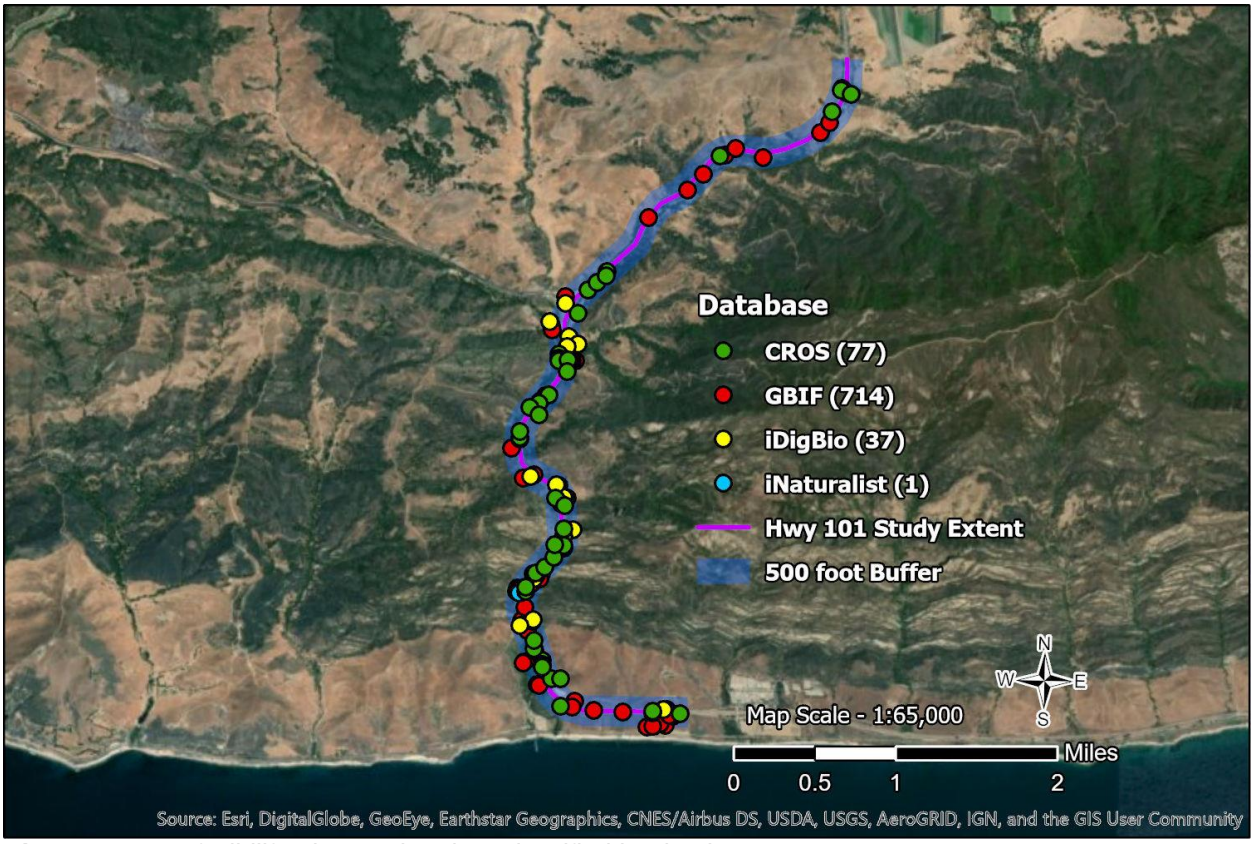

Figure 6*:* Map of wildlife observation data classified by database source.

As mentioned previously, in viewing *Figure 5,* it should be remembered that the majority of the GBIF data is avian species from eBird. Furthermore, noting that the majority of mammal observations came from CROS is helpful in determining that the class Mammalia is being impacted most directly by the highway in road collisions. This is elaborated upon in *Figure 6,* where the data is displayed by the type of observation. The label "Trfc Collision-" in *Figure 6* refers to traffic collisions with an animal which either did not result in an injury to the driver of the car "-No Inj", or it was unknown if an injury occurred "Unkn Inj". The majority of these collisions were with Mule deer. The Phrases "Animal Hazard" and "Live or Dead Animal" indicate an animal on the highway. Due to the fact that all eBird, iNaturalist, and Naturgucker data is of live sightings, these points have also been excluded in *Figure 6*. However, these data are included in *Table 2,* where the types of observations for each database source are listed.

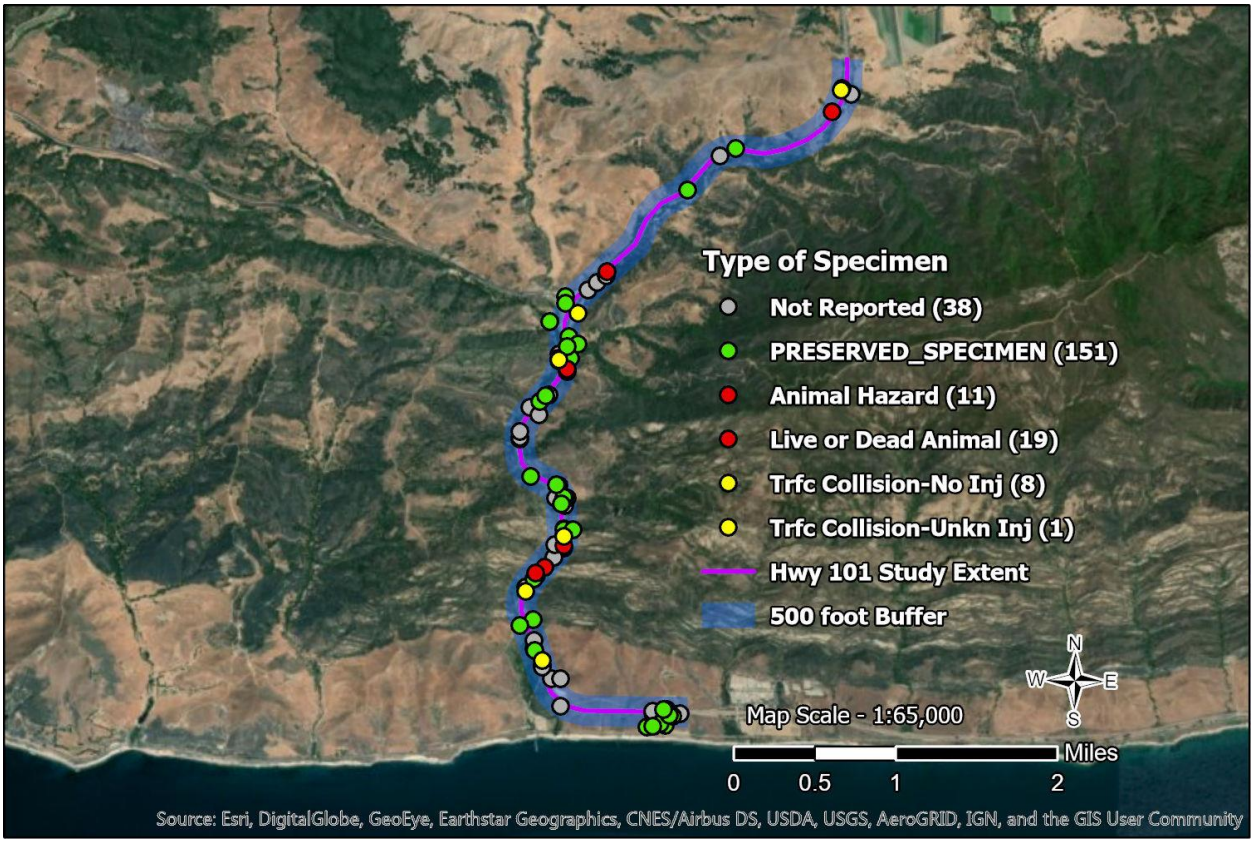

Figure 7*:* Map of wildlife records classified by type of specimen or observation, excluding eBird, iNaturalist, and Naturgucker records from the GBIF database.

Table 2: Type of wildlife observation by database.

Database & Observation Type	Count of Type of Specimen
CROS	**77**
Not Reported	38
Animal Hazard	11
Live or Dead Animal	19
Traffic Collision-No Injury	8
Traffic Collision-Unknown Injury	1
GBIF	**714**
Observation	**600**
Cornell Lab of Ornithology - eBird	582
iNaturalist	13
Naturgucker	5
Preserved Specimen	**114**
California Academy of Sciences	33
Natural History Museum of Los Angeles	39
Berkeley Museum of Vertebrate Zoology	21
Santa Barbara Natural History Museum	19
University of Michigan Museum of Zoology	1
Western Foundation of Vertebrate Zoology	1
iDigBio	**37**
Preserved Specimen	37
iNaturalist	**1**
Sighting	1
Grand Total	**829**

DISCUSSION AND CONCLUSION

There are three locations that have high densities of roadkill along the Highway 101 Gaviota corridor. The CROS data was most indicative of this fact. Mammals are disproportionately impacted by the highway and Mule deer are hit with the most frequency. Preserved specimens are also indicative of roadkill areas and generally coincide with the dead observations in *Figure 4*. The three most impactful locales are indicated by the yellow circles in *Figure 8* and can be described by the lower-most part of the study area (near Mariposa Reina), near the Rest Areas and the tunnel, and at the intersection point where Highway 1 merges with Highway 101 (near Gaviota Peak Trailhead). Therefore, this study suggests that these three areas should be considered priorities for assessing culvert use and connectivity restoration.

A secondary conclusion from this study is regarding the ecology of this system. Table 1 demonstrates the most common species documented in the area, which indicates the populations that are present and interacting with the highway. Though the iNaturalist, eBird, and Natgucker data was not considered when concluding where connectivity was most reduced, these sources also contribute to signifying the population ecology of the system. This is especially true with regard to eBird as the birds likely will not directly benefit from a wildlife corridor (since they are primarily flying), but their presence paints a bigger picture of the wider biology of the system. A further consideration on this point is that birds are also most visible and easily seen as most

species are diurnal and may generally be less concealed from the highway. However, the combination of all datasets overall shows that the area is biodiverse and wildlife species from all classes should be considered in restoration and conservation efforts.

Through collection and compilation of this data, it can be seen that the most highly impacted class of wildlife are mammals. Aves are widely present in the area while reptiles, amphibians, and insects are less commonly recorded. There are three locations in which mammals are regularly being killed along the corridor, while other classes of animals are commonly observed throughout the study area. Sources used were GBIF, iDigBio, CROS, and iNaturalist. CROS data was provided courtesy of the Road Ecology Center at UC Davis. This study is funded by the Coastal Ranches Conservancy and is in partnership with the Cheadle Center for Biodiversity and Ecological Restoration.

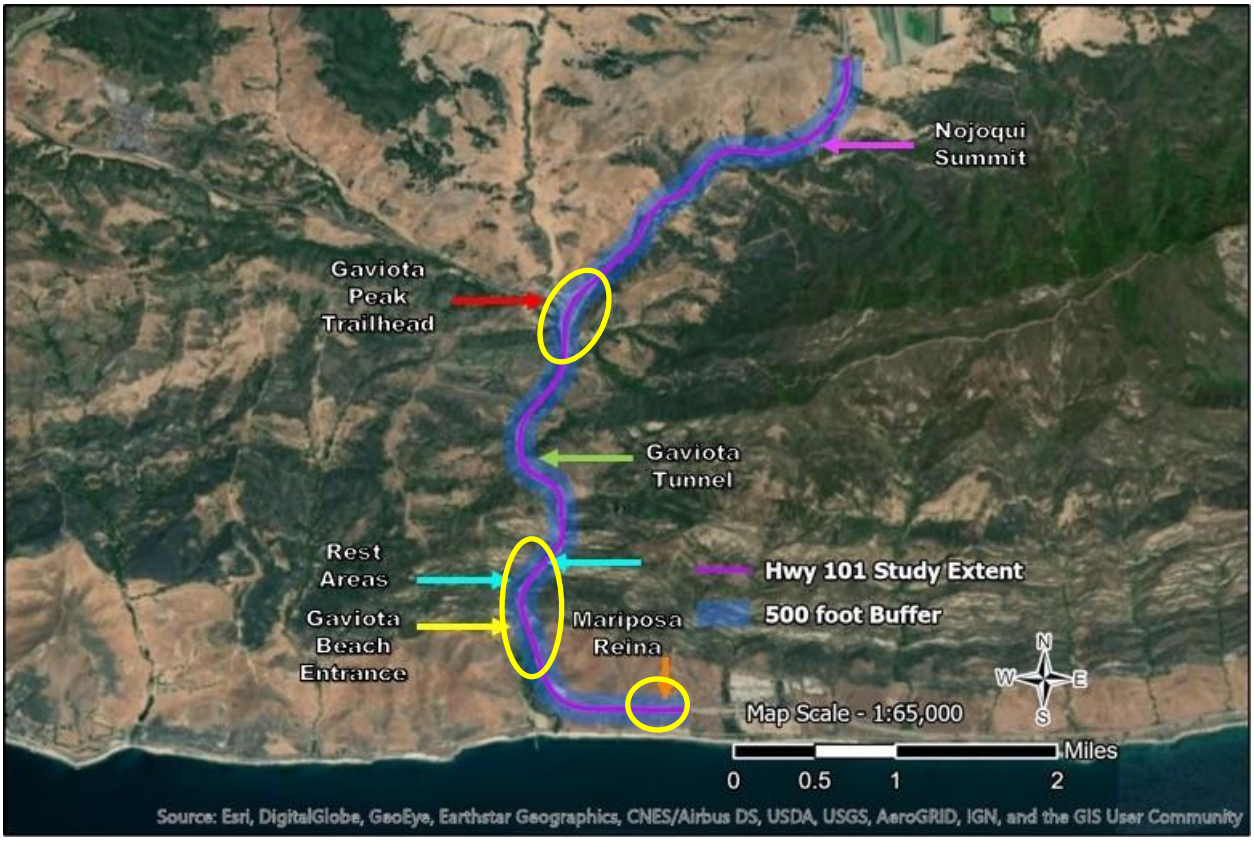

Figure 8*:* Study area with points of significant vehicle entry and exit from the highway labeled and indicated with arrows. Yellow circles indicate areas of highest roadkill density.