

# LOS *Planes* ***Watershed***

*Conservation begins with knowledge*

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**How to cite this document:** Gutiérrez, D. & Hernández, J. 2026. *Los Planes Watershed: conservation begins with knowledge*. La Paz, Baja California Sur, Mexico: Pronatura Noroeste and San Diego Natural History Museum. [62 pp.]

Project overall coordination: Sula Vanderplank and Lori Hargrove.

Writing and content editing: Diana Laura G. López, José Fernando Hernández Valencia, Sula Vanderplank, Gerardo Marrón.
Reviewed by: Lori Hargrove, Adam G. Clause, Jorge H. Valdez Villavicencio, Natalia Worman, Angela Tamayo Vázquez.
Creative direction: Diana Laura G. López.
Editorial design: Amanda González Moreno.
Cover photography: Alfredo Martínez.

Photography: Diana Laura G. López, Alfredo Martínez, Gerardo Marrón, Sula Vanderplank, Emmanuel Javier Vázquez, Jon Rebman, Alan Harper, Jorge H. Valdez Villavicencio, José Luis León de la Luz, Angela Tamayo Vázquez, Jonathan Villarreal Fletes, Nohel Alfredo Martínez, Ulises Martínez Hernández, Steven Mlodinow, Andy Wilson, Miguelcashat, Abraham Sánchez Romero, Mario Fernando Arvizu Valenzuela.

Illustration: Luis Felipe Estrada Gaviria.

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First edition, 2026.
La Paz, Baja California Sur, Mexico.

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# WELCOME MESSAGE

You are holding the result of more than five years of shared work among researchers, students, teachers, and above all, the people who work in and care for the Los Planes Watershed every day.

This report does not aim to lecture, but to share what we learned together: which plants, animals, and processes sustain this watershed, how nature has responded to years of restoration, and what challenges we still face. You will find data, stories, and recommendations meant both for those who know this territory by heart and for those who are just beginning to discover it.

None of this would have been possible without the kindness of those who provided access to the field or shared their time with so many people passionate about discussing biodiversity. To the communities of the Los Planes Watershed: thank you for sharing your knowledge, for allowing us to study it in depth, and for trusting that this work would be worthwhile. This report is, first and foremost, a way to give back that knowledge and to say thank you.

We hope this reading sparks curiosity, answers some questions, and raises new ones. And above all, that it reinforces something we already knew before starting this project: that the future of this watershed depends on those of us who live in it, visit it, and choose to care for it.

Thank you for joining us on this journey.





# EXECUTIVE SUMMARY

Over the past 15 years, on a private property within the Los Planes Watershed, intensive restoration work began with the goal of increasing groundwater recharge, surface flows, ecosystem services, and the watershed's biodiversity. Starting in 2021, an inter-institutional team launched a multi-year study to quantify, with scientific evidence, the real benefits of these water and soil management practices. Fieldwork took place between 2022 and 2025, while environmental education and community outreach activities spanned four years until 2026.

To do this, three comparison areas were selected within the same watershed: one with active grazing and no restoration work; one with approximately five years of restoration work on soil, water infiltration, and grazing exclusion; and one with fifteen years of that same type of management (a timeframe still current as of this report's publication date). This work included significant changes to water flow, the filling of gullies, the construction of gabions, the recovery of eroded landscapes, and extensive growth of new vegetation.

Under the coordination of Pronatura Noroeste and the San Diego Natural History Museum (The Nat), and with the collaboration of researchers from institutions in Mexico and the United States, this project brought together specialists in botany, invertebrate zoology, herpetology, ornithology, mammalogy, hydrology, social studies, and environmental education to document the watershed's biodiversity and evaluate the effect of ecological restoration on it.

This report presents, in an accessible way, the overall results of this research: what was found within each biological group, what we learned by comparing the three study areas, what threats the watershed faces, and what actions can strengthen its conservation. Its purpose is to give this knowledge back to those who live in, work in, and care for the Los Planes Watershed, and to offer evidence that can guide future management and conservation decisions in the region and beyond.

# PARTICIPANTS

*Who Made This Research Possible*

This report is the result of the joint work of a large and diverse team: researchers from scientific institutions in Mexico and the United States, students, teachers, naturalist guides, watershed landowners and residents, and civil and government organizations. More than 100 people and 46 collaborating organizations participated, at different times and in different roles, in research, restoration, and environmental education in the Los Planes Watershed over the past four years.

*Research Teams by Study Area*

## BIRDS

Lori Hargrove, Philip Unitt, Gerardo Marrón, Angela Tamayo Vázquez, Jorge Cristerna Fernández, Selene Asiul Barba Bedolla.



## MAMMALS

Scott Tremor, Jonathan Villarreal Fletes, Gerardo Marrón, Mónica Marvan Barradas, Ana Montiel, Winifred F. Frick, Jerrica Jamison, Nayelli Rivera Villanueva, Drew Stokes, Angela Tamayo Vázquez.

## SOCIAL STUDIES AND ANTHROPOLOGY

Shane J. Macfarlan, Sula Vanderplank, Michelle E. Thompson, Gerardo Marrón, Diana Laura G. López.

## INVERTEBRATE ZOOLOGY

Shahan Derkarabetian, Natalia Rodríguez Reveló, Pam Horsley, Eva Horna Lowell, Rachel Allingham, Mónica Marvan Barradas, Gerardo Marrón, Iván López Ramírez, María Luisa Jiménez Jiménez, David Chame, Carlos Palacios, Jair Rojas, Krista Pelayo, Bertha Patricia Macías Vaca, Michael Wall.

## ENVIRONMENTAL EDUCATION

Lizz González Moreno, Diana Laura G. López, José Fernando Hernández Valencia, Paula Sternberg Rodríguez, Natalia Worman, Fernando Garza Larracilla, Eleonor Gómez Rebolledo, Paola Estrada Gastelum, Emilio García Galindo, Cyara Kamila Arce Palacios.







## BOTANY AND FLORA

Sula Vanderplank, Jon Rebman, Alfonso Medel Narváez, Gerardo Marrón, Exequiel Ezcurra, Abraham Sánchez Romero, Mariana Delgado, Glenn Ehrenberg, Enrique Flores García, Benjamin T. Wilder, Betsy Arnold, Luisa Marrón, Blanca R. López, Pedro Peña Garcillán, Daniela Varela, Tamara Arce, Sophie Winitsky, Karla Daniela Núñez García, Tania Bravo, Melissa Díaz, Sandra Jiménez, Karina Lee Cerda, Lluvia Flores, Lorene Archdekin, Rachel Sadowski, Augusto Olmos, Rebecca Lampl, Karen Branks, Diana Laura G. López.



## HYDROLOGY AND SOILS

Laura M. Norman, Jason R. Sorenson, Alma L. Anides Morales, Florent Gomis, Florance Cassassuce, Carlos Lim, Anne McEnany.



## HERPETOLOGY

Bradford D. Hollingsworth, Adam G. Clause, Anny Peralta García, Jorge H. Valdez Villavicencio, Marco E. Solis Sotelo, Diego Maldonado de la Torre, Angela Tamayo Vázquez, David Francisco Pérez Cañas, Fernanda Jacqueline Manrriquez Gómez, Alexia Guadalupe Mejía Licona, Daniel Hernández Paredes, Gerardo Marrón, Diana Laura G. López, Leilany Heraldez Gaxiola, César Gael Cortes Hernández, Fany Reyes Bolaños, José Abelino Cota Castro, Patricia Galina Tessaro, David Chávez Lara, Gustavo Arnaud Franco, Michelle E. Thompson, Jessica M. Barba, Sahamara Ruiz Ornelas, Cypress Hansen, Chance A. Stevens, Ana Gatica Colima, José Manuel Sánchez, Rafael A. Lara Reséndiz, Emmanuel Javier Vázquez.



# COMMUNITY PARTICIPANTS

Among those who participated directly from the communities:

## NATURALIST GUIDES

Sebastián del Valle, Pablo Palafox Pérez Rocha, Said Estrada Nateras y Ana Lucía Acuña Sánchez (Rancho Cacachilas), y María Rodríguez-Salinas (Salinas Adventures).



## EDITORS OF THE "¡VÁMONOS PAJAREANDO!" COMPENDIUM

Maximiliano Quintero Vidales, Ángel Antonio Márquez Díaz, Alexandra Gómez Rosales, Osmar Palacios, Tomoko Palacios, Marina Quiñonez Gluyas, Lautaro Tlacaélel Jiménez Calderón, Mónica Paola Gaona Ramírez, Susana Belén Martínez Ruiz y Federico González Garza Medellín.

## CLUBS

The Explorer Clubs in El Ancón and El Triunfo (Kumutú STEAM) and the Californios Verdes Ecology Club (EPI México).



## CITIZEN SCIENCE

Pablo Hernández Almaraz, Sergio Alejandro Pérez Valencia, Ricardo Magaña, Frida Sánchez, Dánae Fenton, Mauricio Tellez Mendoza, Javier Eduardo Alcalá Santoyo, Ney Barajas, Sergio Alcalá, Aranza Mendoza Sánchez, Vicente Covarrubias, Osiel Alejandro Flores Rosas, Sonia Rodríguez Elizondo, Graciela González Franco López, Paola Sandoval Flores.








## ARTISTS

Diana Laura G. López (photography and design), Alfredo Martínez (photography and video), Ulises Martínez Hernández (Frente al Color; design of the Cacachilas spider image, the Caminos del Agua Festival, and the La Paz City Nature Challenge), Luis Felipe Estrada Gaviria (Poco Café Mucho Arte; naturalist illustration), Mario Fernando Arvizu Valenzuela (photography and design, La Paz City Nature Challenge), Eliseo Geraldo González (macro photography), and Magdalena López García (Deserticola; artistic outreach).

## STUDENTS

César Gael Cortes Hernández, Sol Andrea Rodríguez Herrera, Leilany Heraldez Gaxiola, Clarisa Hurtado Chaurand, Daniela Sánchez Matías, Alexia Guadalupe Mejia Licona y Daniel Hernández Paredes.



## VOLUNTEERS

Chance A. Stevens (herpetology, La Ventana) and Jennifer M. Alba Horta (monitoring and education, UABCS).

## STUDENTS AND EDUCATIONAL INSTITUTIONS

Telebachillerato Comunitario No. 21, El Sargento
Escuela Secundaria Alejandro Meza León, San Antonio
Escuela Primaria Mariano Matamoros, Agua Amarga
CECyT 09, Los Planes
Escuela Primaria Rural José Vasconcelos, Ligüí, Loreto.
Escuela Primaria Estado de Hidalgo, San Javier, Loreto.
Escuela Secundaria Técnica No. 8, Ventura Moyron Ojeda, Los Planes



Xantus's hummingbird (*Basilinna xantusii*)

# GOALS OF THE EXPEDITION

*An Expedition to Understand the Value of Water for Biodiversity*

Over the past fifteen years, major efforts have been dedicated to restoring a 40-hectare property located in the Los Planes Watershed, in Baja California Sur. The property had previously been affected by overgrazing and had been partially cleared using heavy machinery. One of the most important measures was fencing the property to prevent unauthorized grazing, along with restoring hydrological processes and soil retention through check dams and gabion walls. Today, this property is clearly distinguishable from neighboring land, which continues to experience considerable grazing without specific herd management and suffers the consequences of erosion and runoff; this contrast can even be seen in satellite imagery.

The question guiding this expedition was: beyond the lush green landscape that the area has become, *what value does this restored land have to biodiversity?*

Sustainable ranching is a widely used term, but poorly understood in practice. For the ranching community, it remains a challenge to demonstrate the benefits of healthy livestock management beyond increased biomass and plant cover. This project sought to go beyond the usual ecosystem health indicators, evaluating ecosystem services and hydrological behavior as evidence of the ecological value of restoration. A specific goal was to identify potential indicator species that could be used regionally to evaluate cattle and goat management, as well as the importance of a healthy ranch. To address this challenge, a team of regional specialists, advisors, and scientists came together to undertake a comprehensive project evaluating the conservation and restoration value of the Los Planes Watershed, one that would leave lessons useful for sustainability in the Cape region and beyond.

The Los Planes Watershed Research Project brings together the efforts of Pronatura Noroeste and the San Diego Natural History Museum, in collaboration with scientists from across northwestern Mexico, to measure the ecosystem's response and resilience based on the results of hydrological restoration that has been carried out for more than fifteen years in the region. Through collaborative research with specialists in botany, insects, reptiles, birds, and mammals, this report presents the results of this research, celebrating the rich natural and cultural history of Baja California Sur.

WHAT VALUE DOES THIS RESTORED LAND HAVE TO BIODIVERSITY?



# EXPLORING THE WATERSHED

*Geographic and Socio-environmental Context*

The Los Planes Watershed is located in the municipality of La Paz, Baja California Sur, in the southeastern part of the state, south of the city of La Paz. It drains toward the Gulf of California and features an environmental transition ranging from arid scrubland and low deciduous jungle in the lower and middle zones to oak and pine-oak forest in the Sierra de la Laguna at higher elevations (González-Abraham et al., 2010).

This topographic diversity directly shapes the climate. San Juan de Los Planes and most of the watershed have a predominantly hot, arid climate (BWh, per the Köppen classification), with average annual temperatures between 18°C and 29°C and summer maximums that often exceed 35°C. Average annual rainfall is around 300 mm and is concentrated mainly between July and September, linked to the influence of hurricanes and tropical storms (Nomad Season, n.d.). This seasonality shapes runoff and infiltration processes in the watershed.

Water dynamics depend largely on the Los Planes aquifer (key 0323), which is unconfined to semi-confined and can reach up to 300 m in thickness in some areas. Streams are mostly ephemeral, carrying the flows generated during the rainy season toward the Gulf of California. In recent decades, groundwater extraction has exceeded natural recharge, leading to overexploitation of the aquifer (National Water Commission [CONAGUA], 2024).

The communities of San Juan de Los Planes, San Antonio, El Sargento, and La Ventana lie within the watershed, along with other smaller rural communities (National Institute of Statistics and Geography [INEGI], 2020). Their low population density and ways of life maintain a close relationship with the land and the sea, although the local economy and land use have changed over time.

THE COMMUNITIES OF SAN JUAN DE LOS PLANES, SAN ANTONIO, EL SARGENTO, AND LA VENTANA LIE WITHIN THE WATERSHED, ALONG WITH OTHER SMALLER RURAL COMMUNITIES

Since colonial times, the area was part of settlement routes. Mining activity in the San Antonio and El Triunfo district dates back to the mid-18th century. However, it was during the 19th century, and especially during the Porfirian era, that it gained greater importance due to gold and silver extraction, driven by the arrival of foreign capital. The mining boom of the late 19th and early 20th centuries transformed the regional economy and left behind infrastructure, cultural traditions, and mining waste that remain in the landscape today (González Cruz & Rivas Hernández, 2018).



Today, the territory combines large areas of natural vegetation with developed zones, mainly in the valleys and alluvial fans, where extensive ranching and rainfed and irrigated agriculture take place. Fishing complements the economy along the coast, while ecotourism and other services related to the sustainable use of natural resources have gained a presence, especially in coastal communities (INEGI, 2020). The upper areas associated with the Sierra de la Laguna retain greater ecological integrity.

These processes are reflected in a Southern Baja Californian identity shaped by practices linked to ranching, farming, the sea, and mining memory, present in patron saint festivals, oral histories, and local knowledge of natural resources. Added to this is a growing number of foreign residents, particularly along the coast, which has fostered an exchange of languages, customs, and ways of life, enriching the watershed's cultural diversity.

The ecological relevance of this environment is also linked to the influence of the Sierra La Laguna Biosphere Reserve, decreed in 1994 (Official Gazette of the Federation, 1994). Studies conducted in the region have documented its high biodiversity and driven research on hydrology, water quality, and ecological restoration.



California Scrub-Jay
(*Aphelocoma californica*)



# STUDY ZONE

*The Starting Point*

The research focused on a private property within the Los Planes Watershed, in a representative stretch of tropical deciduous forest in southern Baja California Sur where several Natural Infrastructure in Dryland Streams (NIDS) structures have been installed. These structures, built with local materials such as rock and sediment, help reduce erosion by slowing rainwater runoff, promoting water infiltration, and retaining fertile soil. Their goal is to restore ecological processes that help maintain the ecosystem's natural balance.

To compare the effect of ecological restoration on biodiversity, the different research teams worked across three zones, or plots, under different management conditions:

NON-RESTORED ZONE: an open site with notable signs of erosion, no natural infrastructure, and active, continuous grazing year-round.

RECENTLY RESTORED ZONE: an area with approximately five years of restoration, where natural infrastructure work has been carried out and from which grazing is excluded.

LONG-TERM RESTORED ZONE: an area with fifteen years of restoration, with the same type of natural infrastructure work, and with grazing exclusion sustained over a longer period.

These three plot conditions: active grazing, recent restoration, and long-term restoration, serve as a reference throughout the report. This comparison makes it possible to distinguish which changes in biodiversity are associated with the length of time a site has been restored, beyond the particularities of each biological group.





# HOW DO WE CONDUCT OUR RESEARCH?

*The Methods Behind Each Result*



The project began in 2021. Fieldwork was carried out between 2022 and 2025, while environmental education and community outreach activities took place over four years. The methods used were varied and complementary, making it possible to document the biodiversity of the Los Planes Watershed by studying different biological groups and comparing the effects of ecological restoration across three landscape conditions.

The ornithology team monitored birds through observation surveys, photographs, and recordings of their calls at the different study sites, complemented by point counts (575 in total, over three years and two seasons per year) to estimate the abundance and density of each species. This information made it possible to compare the richness, abundance, and composition of bird communities between restored and unmanaged areas.

To study mammals, an Anabat detector was set up in each of the three study areas to record bat calls. Camera traps were also installed to document larger mammals without disturbing their behavior. To study small mammals, 189 Sherman traps were used to temporarily capture rodents across the three study areas. The animals were identified, measured, and marked on the ear before being released, allowing researchers to identify individuals if they were captured again. This information made it possible to compare species richness, abundance, community composition, and demographic structure across areas with different management histories.

The herpetology team assessed the reptiles and amphibians (lizards, snakes, toads, and frogs) using a series of standardized pitfall traps and box traps in arrays with drift fences. Three trap arrays were installed across each of the three study plots. During each field visit, the team also did visual surveys to record incidental observations, complemented by verified observations from the iNaturalist platform. All captured individuals were identified, measured, and, when found in traps, marked. The information gathered made it possible to compare species abundance and community composition among the different study areas, and to assess changes observed over time.

For the invertebrate study, Malaise traps, Blue Vane traps, and pollinator collection containers were used, along with hand collection using UV light and sifting of zalate leaf litter. These techniques made it possible to record insects, spiders, and other arthropods associated with different soil microhabitats, as well as to assess the diversity of species present. In addition, the La Palma bronzed brown tarantula (*Aphonopelma prosoicum*) was monitored through monthly night surveys along a roughly 5-km circuit crossing both restored zones with grazing exclusion (equivalent to one hectare sampled per survey), recording each individual observed within one meter on either side of the circuit and its sex.

The botanists carried out a floristic inventory through systematic surveys across most of the watershed's accessible areas, recording each observed species on the iNaturalist platform. In addition, they assessed the composition, structure, and conservation status of the vegetation using monitoring plots and transects, applying methods such as nearest-neighbor studies, density estimates, quadrats, sinuous floristic transects, cover classes, individual counts, photo plots and health assessments of cacti and succulent trees. These analyses made it possible to compare vegetation conditions and document the changes associated with ecological restoration. In addition, an interdisciplinary botany and geology team characterized areas of heavy clay soils with historical geothermal activity associated with the San Juan de Los Planes fault (Coyan et al., 2013), through fieldwork making it possible to document a distinctive microhabitat ("fault meadows") and its associated flora.

As part of the study on drought impacts, the health status of cacti and succulent trees was assessed in the Los Planes Watershed and in other localities in southern Baja California Sur. Each individual was classified as healthy, damaged, or dead. Repeat photography was also used to assess the change in their condition over time. This information made it possible to analyze how these plants respond to prolonged drought periods and to generate indicators of vegetation vulnerability and resilience to environmental stress.

To understand the relationship between local communities and watershed conservation, the social studies team investigated how ranchers participate in conserving land, water, and biodiversity, as well as the main obstacles they face in getting involved in conservation initiatives. Information was gathered through semi-structured interviews with 31 people from the region, ages 23 to 94 (average age 61). During the interviews, participants shared the conservation practices they currently implement, the strategies they are aware of, the main limitations to putting them into practice, and their perceptions and values regarding conservation



Coral vine (*Antigonon leptopus*)

of the territory. These results made it possible to better understand the social dimension of watershed management and to identify opportunities to strengthen collaboration between the community and conservation projects.

The economic, historical, cultural, and ecological importance of pitayas in Baja California Sur was also investigated. Their economic value was assessed through community surveys conducted at pitaya sales points in different communities. To learn about the history of the relationship between people and these plants, Jesuit accounts and other historical manuscripts were consulted. Likewise, the ecological communities that benefit from their flowers and fruit were studied through detailed observations of the various animals that visit the plants. This approach made it possible to understand the importance of pitayas not only as a food and economic resource, but also as part of the region's biocultural heritage and ecological relationships.

Together, these methods provided a comprehensive view of the conservation status of the Los Planes Watershed. The combination of field monitoring, ecological analysis, interviews, and citizen science tools made it possible to understand how species, habitats, and people respond to management conditions and restoration actions.







# WHAT DID WE FIND?

*A First Look at the Findings, Group by Group*

The following is a summary of the main results obtained by each team. Some of these data come from analyses that are still in progress; this is noted in each case, so the results may change slightly as the teams complete their data processing. The complete technical information, including statistical methods and detailed tables, is available in the Project Library (see "Resources for Further Learning").



Ocote (*Nahuatlea arborescens*)

# PLANTS

## *An unprecedented floristic inventory, and new species for science*

The botany team completed the first floristic inventory of El Ancón, recording 274 plant species. Of this total, 27% are endemic to Baja California Sur. If we also consider species whose distribution is restricted to the peninsula and those considered quasi-endemic, nearly 35% of the recorded flora is limited to this region. As part of this work, a photographic field guide was produced featuring all the species found at the site.

In the monitoring plots, bare soil cover fell from approximately 90% to 65% during the first five years of restoration, and plots under long-term recovery maintain around 35% plant cover, compared with 12% in unrestored areas. The strongest signal, however, came from plant height, with few plants reaching more than 50 cm high as a result of overgrazing in the plots with no restoration, and significant increases in height for shrubs and trees in the plot restored since 2011; for example, 62% of plants were 1-2 m tall. An illustrative case is that of the ocote (*Nahuatlea arborescens*), a large long-lived tree found only in the Cape region: in plots with fifteen years of restoration and livestock exclusion, its height shot up to over three meters, as compared to an average of 18 cm in unrestored areas, and the density more than doubled with just five years of restoration and grazing exclusion.

One surprising finding was that the restored areas had a slight decrease in overall plant diversity, i.e., there were slightly fewer different plants in the areas that had been restored. This was the opposite of our initial expectation that improved growing conditions would increase diversity. A more detailed analysis revealed that the drop was only true for herbaceous plants, mostly due to a loss of non-native and invasive species in the restored areas. As the soil quality returns and the canopy closes there is more competition for resources. Restoration reduces invasive and non-native plants and promotes the abundance of native species.

The team's drought study, published in Global Change Biology (Wilder et al., 2025), documented a severe drought between 2020 and 2022 and an increase of approximately 2°C in maximum summer temperatures over three decades. Assessments of the condition of cacti and succulent trees—classified as healthy, damaged, or dead—showed that sweet pitaya and sour pitaya were among the species most affected by drought. Cardón cacti, elephant trees, and old man cactus were also affected to varying degrees depending on the location, raising concerns about a possible tipping point for these key species (Macfarlan et al., 2024). Repeat photographs show the remarkable recovery of many of these plants following the rains of 2024.

Another notable finding from this period was the discovery of "fault meadows," a microhabitat with clay soils formed through hydrothermal alteration along the San Juan de Los Planes fault. These meadows are home to plants with extremely restricted distributions, including two species that appear to be new to science and, so far, are known only from this site: *Marina cacachilensis*, which is currently undergoing formal description, and an undescribed Heliotropium species (Vanderplank et al., 2026).

FIRST FLORISTIC INVENTORY OF EL ANCÓN, RECORDING 274 PLANT SPECIES.









A NEW TYPE OF EXTRAFLORAL NECTARY WAS DISCOVERED ON SOUR PITAYA, ATTRACTING PROTECTIVE ANTS AND WASPS.









A HARVESTMAN (ARACHNID) WAS DISCOVERED THAT COULD BE A SPECIES NEW TO SCIENCE, EXCLUSIVE TO THE CAPE REGION.

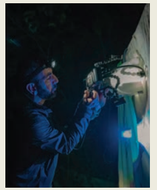
# INVERTEBRATES

## *The least-known group, with more surprises still to uncover*

No previous studies of this kind existed on invertebrate biodiversity in the Los Planes Watershed, so this work represents a first baseline for the group. Combining Malaise traps, Blue Vane traps, pollinator containers, sifting of zalate (*Ficus* spp.) leaf litter, and hand collection with ultraviolet light, the team has so far identified 5,152 specimens to at least the order or morphospecies level, with a considerable number still pending processing. On the iNaturalist platform, around 134 photographed species have been documented in the El Ancón area.

Among the most notable findings is a harvestman (arachnid) that appears to be undescribed by science and exclusive to the Cape Region, as well as the record of *Opilioacarida*, a mite group specialized in high-quality microhabitats not previously known from the Los Planes Watershed. Two thesis projects are analyzing, on one hand, the succession of saproxylic insects (which feed on decaying wood) in small-leafed elephant tree (*Bursera microphylla*), where beetles dominate morphospecies richness; and on the other, the arachnid community in zalate leaf litter (around 550 specimens processed), where pseudoscorpions showed greater richness in areas that had been restored for a longer period of time. The European honeybee (*Apis mellifera*) was also observed, which may compete with native bees for food and nesting sites.

A special case: La Palma bronzed brown tarantula (*Aphonopelma prosoicum*). Aside from its original species description, no study had previously focused on it. Through monthly nighttime surveys along a route of just over 5 km that runs through both restored areas with grazing exclusion, a maximum density of 4.5 individuals per hectare was recorded. The species emerges from its burrows between August and November; since it lives in underground burrows, soil compaction caused by livestock could directly affect its survival, so it could serve as an indicator of soil compaction and could benefit from rotational grazing schemes.





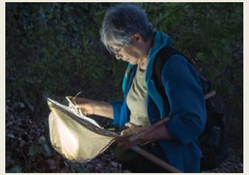
















Baja California Nightsnake (*Hypsiglena slevini*)

## AMPHIBIANS AND REPTILES

### *A diverse community, with many surprises*

Using standardized pitfall traps and box traps, incidental observations, and verified iNaturalist observations, the herpetology team accumulated over 1,900 observations and documented 29 species of reptiles and amphibians, roughly half of them endemic to Baja California Sur. Only one introduced species was recorded: the common house gecko (*Hemidactylus frenatus*) (see "Threats to the Watershed"). Whether or not this non-native species has a negative impact on native organisms in the Los Planes Watershed remains a scientific mystery (Valdez-Villavicencio et al., 2024).

It was found that the Cape whiptail (*Aspidoscelis maximus*), a species endemic to the Cape region, was more common in the restored area with grazing exclusion, suggesting a favorable response to restoration (see "Special Species" and "Health Indicators"). However, no other reptile or amphibian showed this pattern, pointing to the surprising complexity of this community's response to restoration.

Breeding populations of three amphibian species were confirmed: the red-spotted toad (*Anaxyrus punctatus*), the Couch's spadefoot toad (*Scaphiopus couchii*), and the Pacific chorus frog (*Pseudacris regilla*). These three species indicate the availability of sufficient surface water for the survival of eggs and tadpoles. The results suggest that restoration activities could be contributing to the survival of these water-dependent species in the Los Planes Watershed (see "Health Indicators").



Cape whiptail (*Aspidoscelis maximus*)

Among the most notable findings are two records of the Cape striped racer (*Masticophis aurigulus*), one of the three rarest snake species across the entire Baja California peninsula (excluding the islands). The largest specimens ever recorded of Hunsaker's spiny lizard (*Sceloporus hunsakeri*) were also documented, as were the largest females ever recorded of the Cabo San Lucas leaf-toed gecko (*Phyllodactylus unctus*). All three species are endemic to the Cape region, making this additional information particularly relevant (see "Special species"). In addition, the team documented cannibalism in the orange-throated whiptail (*Aspidoscelis hyperythrus*), a behavior never before observed in this species. These notable observations have already been published (Clause et al., 2026, Marrón et al., 2025, Manrriquez-Gómez et al., 2026, and Ruiz-Ornelas et al., 2026). For several Mexican co-authors, these publications are the first of their careers, underscoring how this project helped members of our team build new skills and scientific capacity.

THREE MEXICAN HERPETOLOGISTS PUBLISHED THEIR FIRST-EVER SCIENTIFIC ARTICLES BASED ON RESULTS FROM THIS PROJECT.













Cape spiny-tailed iguana (*Ctenosaura hemilopha*)

Gray thrasher
(*Toxostoma cinereum*)

# BIRDS

## *Eighty-five species, and a clear response to restoration*

The tropical deciduous forest of the Los Planes Watershed and its endemic species had been understudied before this project. Over three years of monitoring (six visits, two per year), the ornithology team documented 85 bird species through 575 point counts distributed across the three site types: unrestored (with active grazing), recently restored (approximately five years), and long-term restored (approximately fifteen years).

Of 39 species with enough detections for analysis, 16 of them (41%) showed significantly higher density in the restored area than in the grazed or recently restored areas, including two peninsular endemic species: Xantus's hummingbird (*Basilinna xantusii*) and the Gray thrasher (*Toxostoma cinereum*), along with others such as the California quail (*Callipepla californica achrustera*), the Gray vireo (*Vireo vicinior*), and the Varied bunting (*Passerina versicolor*). In contrast, only 5 species (13%) showed the opposite pattern, preferring the habitat outside the restoration areas. The year 2024 was particularly dry (24 mm of recorded rainfall compared with an annual average of around 314 mm), which likely dampened the increases expected for the study's final year.


Varied bunting
(*Passerina versicolor*)



ELEPHANT TREES ARE A KEY FOOD SOURCE FOR LOCAL WILDLIFE; THE GRAY VIREO HELPS DISPERSE ITS SEEDS.









Eva's mouse (*Peromyscus eva*)

# MAMMALS

## *Rodents as silent witnesses to soil recovery*

This study provides one of the first experimental assessments, for the southern Baja California peninsula, of how grazing affects native rodent communities in tropical deciduous forest, an important knowledge gap in a region where grazing has shaped the landscape for nearly 500 years. Using Sherman traps distributed across three study areas, an actively grazed control, a site with approximately five years of restoration, and another with approximately fifteen years of restoration, the team has accumulated, over three years and five sampling seasons, a total of 745 captures corresponding to 481 distinct individuals. The Spiny pocket mouse (*Chaetodipus spinatus*) was the most abundant species (447 captures), followed by Eva's mouse (*Peromyscus eva*, 247 captures), Bryant's woodrat (*Neotoma bryanti*, 36 captures), and the Desert pocket mouse (*Chaetodipus ammophilus*, 15 captures).

The abundance of Eva's mouse (*Peromyscus eva*) was strongly associated with food availability after rainfall, and it was considerably more abundant during January monitoring. Both Eva's mouse and Bryant's woodrat (*Neotoma bryanti*), two generalist, wide-ranging species, were detected from the study's earliest stages in the plots with the longest restoration, but not in the recently restored plots or in the actively grazed control. The coexistence of old and new burrows in the restored plots suggests that these populations have not only returned but are actively reproducing.

In total, 4,200 calls from 14 bat species were identified. Overall, the long-term restoration area recorded approximately twice as many calls as the short-term restoration area, which in turn recorded approximately twice as many calls as the untreated area. Among the species most frequently encountered in the long-term restoration area were the California myotis (*Myotis californicus*), the Canyon bat (*Parastrellus hesperus*), the Western yellow bat (*Lasiurus xanthinus*), and the Western long-eared bat (*Myotis evotis*).

Camera trap data were limited, but include records of Gray fox (*Urocyon cinereoargenteus*) across all three treatments, White-tailed antelope squirrel (*Ammospermophilus leucurus*) and Coyote (*Canis latrans*) in the non-restored, actively grazed zone, and a Raccoon (*Procyon lotor*) detected in July 2024 within the fifteen-year restoration plot. The team proposes the Coyote (*Canis latrans*) as a possible indicator species for water, soil, and habitat health, though it notes that a dedicated population study is needed to assess its current status and abundance.










The Spiny pocket mouse (*Chaetodipus spinatus*)







# SOCIAL STUDIES

*The voice of those who live and work the land*

**Ranching knowledge.** Through semi-structured interviews with 31 people from the region (ages 23 to 94, average age 61), the social studies team documented how ranchers participate in conserving land, water, and biodiversity. Every person interviewed agreed that conservation practices improve their lives, their community, and the ecosystem. Twenty-eight of the 31 people reported having started at least one conservation strategy, for a total of 74 distinct strategies spread across categories such as water management, biodiversity, and livestock management. The most frequently cited barrier to taking further conservation action was a lack of resources, such as time, funding, or technical knowledge, mentioned in 34% of recorded responses. To learn about conservation topics, most people turn to government sources, such as the National Commission for Protected Natural Areas (CONANP).

**The value of pitayas.** This component investigated the economic, historical, and ecological importance of pitayas through surveys at sales points, a review of Jesuit accounts and other historical manuscripts, and detailed observations of the wildlife that visits their flowers and fruit. According to these historical sources, the pitaya was once the most important plant for the region's peoples, a value that persists today in clothing, art, and culinary traditions, although on working ranches it is recognized mainly as a source of forage. As a keystone species, the pitaya attracts a wide variety of birds, bats and other small mammals, lizards, and many insects (bees, wasps, true bugs, beetles, and ants, among others) as well as arachnids. Cactus health assessments confirm that sweet pitaya and sour pitaya are among the species most affected by drought (see "Plants"), directly linking this species' ecological wellbeing to its cultural and economic value for the watershed's communities.







# ENVIRONMENTAL EDUCATION

*From the classroom to the field: four years building a relationship*

The Los Planes Watershed is far more than a place where plants, invertebrates, reptiles, birds, mammals, or water resources are studied: it is a territory where communities and nature have built a close relationship over generations. For this reason, the environmental education component was guided for four years by a central question: how can we strengthen a lasting relationship between communities and their territory so that conservation continues beyond the project's own lifespan? Among other things, this meant building bridges between scientific knowledge and the knowledge communities have accumulated over generations, and ensuring that girls and young people spent time alongside women scientists doing fieldwork, showing that science can also be built from, and for, their own communities.

The environmental education component was organized around the same groups the rest of the project studied: plants, invertebrates, reptiles, birds, mammals, and water, but took the sessions out into the field: to the very stream, hill, or trail that families in the region have known since childhood. Researchers shared how science is done and which key or endemic species inhabit the watershed, while the communities shared their own knowledge about how they name these species or where they had seen them throughout their lives.



Kissing bug (*Dipetalogaster maxima*)

One of the most evident changes occurred in perceptions toward species that traditionally inspire fear or rejection, such as rattlesnakes and the kissing bug, the latter carrying a real risk of transmitting Chagas disease. Among adults, the shift in reaction was notably quick, often within a single session, learning to keep their distance and stay calm around rattlesnakes and to recognize and prevent kissing-bug bites. Among children, the process was more gradual and remains to be documented in more detail. The same pattern, from reactive fear to informed respect, extended to lizards and other previously overlooked insects.





















Knowledge did not flow only from science to the community: with plants and birds it worked the other way, as children and adults frequently showed detailed knowledge that often exceeded what session facilitators expected. Mammals, harder to observe, were studied mainly through tracks and camera traps, which made it possible to recognize many of the species communities have always lived alongside. Citizen science, through tools like iNaturalist and the Christmas Bird Count, turned communities from mere audiences of biodiversity into generators of data now used by various scientific institutions.

Overall program reach increased between 2023 and mid-2026, although annual attendances fluctuated: from 14 events and 125 attendees in 2023, to 24 events and 593 attendees in 2024, 21 events and 360 attendees in 2025, and 21 events reaching 738 people through June 2026. This growth was supported by an increasingly broad network of schools, families, and institutions, and by events organized jointly with other organizations, such as Biodiversity Month 2024 and 2026, or the 2026 City Nature Challenge in La Paz, in which a network of 24 collaborators helped secure third place nationally for number of observations and species recorded (see “Participants”). The work took place in eleven communities across the watershed and surrounding areas, and in several of them the relationship with the project continues today through iNaturalist, where neighbors keep logging observations independently.

## ART ALSO HELPS SHARE SCIENCE: LOCAL ARTISTS JOINED THE PROJECT TO CONNECT SCIENTIFIC KNOWLEDGE WITH THE TERRITORY AND ITS COMMUNITIES.



# WHAT DID WE LEARN?

*What the data, taken together, are telling us*

The comparison between the three study areas shows that sites with lower grazing pressure, soil-retention and water-capture structures, and a longer period of restoration consistently show several indicators of improved ecological conditions: greater plant cover, more diverse microhabitats, less erosion, and a greater presence of sensitive species. These patterns are consistent with a positive effect of restoration on biodiversity, though it is worth remembering that this is a comparison between sites, so other landscape characteristics could also be influencing these differences.

The findings from the various research teams show that the Los Planes Watershed holds greater biodiversity than had previously been documented. In several groups, species remain to be discovered or their distribution is only beginning to be documented, underscoring the importance of continuing scientific monitoring and biological exploration in the region.

The results also show that, at sites with soil-restoration work, it is not only plants that show better conditions: invertebrates, birds, mammals, and the ecological processes that sustain ecosystem function show similar patterns. This suggests that restoration's benefits extend beyond vegetation. However, the project also showed that some species require special attention to ensure their conservation.

One such case is Bryant's woodrat (*Neotoma bryanti*), a species whose presence was greater at better-conserved sites and which could serve as an important indicator of ecosystem recovery. The subspecies present in the region, *Neotoma bryanti bryanti*, is not currently listed under any risk category of NOM-059-SEMARNAT-2010 (the Mexican Official Standard governing at-risk native species). Based on the information generated by this project, it is recommended that the species be evaluated for inclusion in Mexico's Special Protection (Pr) category, in order to promote preventive conservation action.



The research also made clear that restoration actions must be planned with the biodiversity already present at a site in mind. For example, many of the most sensitive invertebrate species live exclusively in microhabitats associated with canyons, under rocks, and in areas with particular moisture and shelter conditions. Because these sites overlap with areas where soil-retention and water-capture structures, such as gabions, are built, it is advisable to assess the biodiversity present beforehand, analyze how these structures could affect canyon connectivity, and adjust their placement when necessary to minimize impacts on these organisms.



The study of the La Palma bronzed brown tarantula (*Aphonopelma prosoicum*) offers a similar lesson from underground: as a burrow-dwelling species, it is reasonable to think that soil compaction associated with the continuous passage of livestock could affect its survival, although this relationship has not yet been directly confirmed. This hypothesis is consistent with a message repeated across several study groups: reducing livestock pressure on a given area, for example, through rotational grazing, appears to benefit both vegetation and the fauna that depend on less compacted soil.

The botany team's drought study adds an additional layer of urgency to these findings. Sweet pitaya and sour pitaya are among the cacti most affected by the extreme heat periods documented between 2020 and 2022, raising concern about a possible tipping point in their populations. Since pitayas are a keystone species both for wildlife and for the region's cultural identity (see "Social Studies" and "Value to the Community"), their vulnerability to drought is, at the same time, an ecological and a community issue.

LA PALMA BRONZED BROWN TARANTULA CAN REACH UP TO 4.5 INDIVIDUALS PER HECTARE IN THE BEST-CONSERVED AREAS.

Finally, the discovery of the so-called "fault meadows", clay-soil microhabitats associated with geothermal activity along the San Juan de Los Planes fault, home to at least two plant species apparently new to science,

suggests that the watershed's geology also shapes its biodiversity in ways we are only beginning to understand. This kind of finding underscores that, even after several years of study, the Los Planes Watershed continues to reveal new and relevant information for its conservation.

One of this project's most important lessons, however, did not come from the lab or from field monitoring, but from the relationship between science and communities. The change was not the community's alone. Communicating science to non-specialist audiences is a well-known challenge in science outreach, and several researchers took seriously the task of learning, with the pedagogical support of Pronatura Noroeste's education team, how to translate their technical knowledge into activities that people still remember months later. The relationship between science and community changed in both directions. Conserving the Los Planes Watershed, in short, depends both on what science can contribute and on what communities already know.



Coast Horned Lizard
(*Phrynosoma coronatum*)

THE RELATIONSHIP BETWEEN SCIENCE AND COMMUNITY CHANGED IN BOTH DIRECTIONS





# HEALTH INDICATORS

## *Species and Signals That Reveal the Watershed's Condition*

A watershed's health does not depend solely on the number of species it hosts, but also on the quality of its habitats and the ecological processes that sustain biodiversity, conserve soil, and support water infiltration. This research identified various biological and ecological indicators that make it possible to assess the conservation status of the Los Planes Watershed and the ecosystem's response to restoration actions.

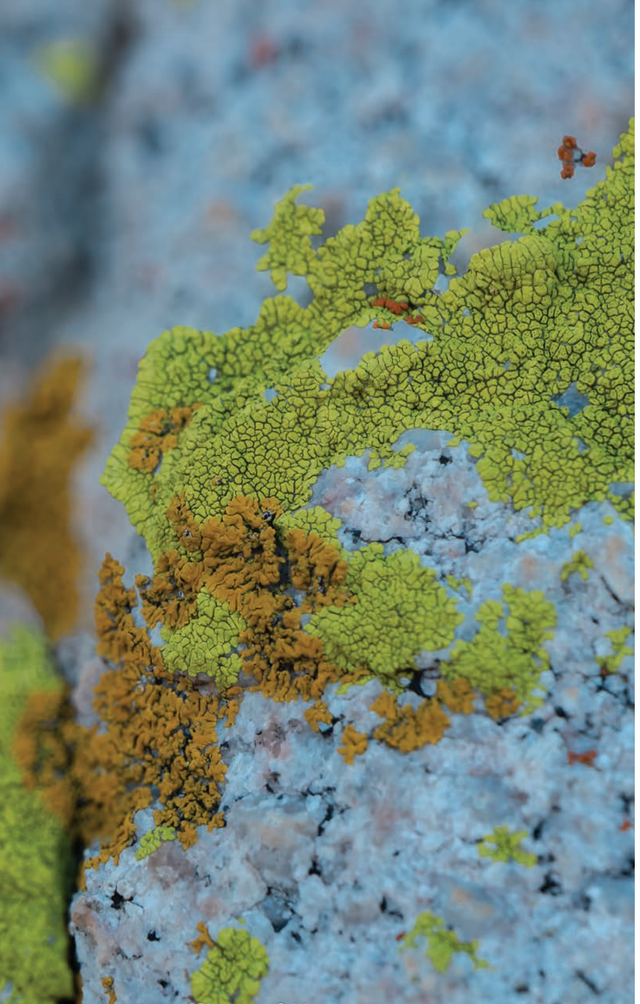
### *Biological soil crusts: soil beginning to recover*

One of the clearest indicators of recovery was the presence of biological soil crusts in areas with the longest time without grazing. Although not vascular plants, these communities of lichens, mosses, algae, and other microorganisms play a fundamental role in stabilizing soil, reducing erosion, and supporting the establishment of native seedlings. Their presence indicates that the soil is beginning to recover ecological processes essential for natural regeneration.

### *Stable soils and vegetation regeneration*

Soil stability is another key indicator. In areas without restoration, greater erosion and gully formation were observed, which hinders the establishment of new plants due to constant soil loss. In contrast, restored areas showed better conditions for vegetation regeneration.

A particularly important finding was the scarcity of shrubs and young trees reaching heights above the knee in areas open to grazing and without restoration. In addition, several native species showed intense, preferential browsing by livestock, among them: mauto (*Lysiloma divaricatum*), ocote (*Nahuatlea arborescens*), pimentilla (*Adelia brandegeei*), *Aeschynomene vigil*, rama prieta (*Indigofera fruticosa*), celosa (*Mimosa tricephala* var. *xanti*), palo colorado (*Colubrina viridis*), malvarosa (*Melochia tomentosa*), lemilla (*Carlowrightia arizonica*), and rama blanca (*Holographis virgata*). The absence of adult individuals of these species could compromise the ecosystem's future recovery.



## *Microhabitats that sustain biodiversity*

The presence of highly specialized organisms also helps assess ecosystem quality. Some invertebrate groups, such as Opilioacarida, were found only in very specific, well-conserved microhabitats associated with rocks, crevices, and particular moisture conditions. Leaf litter from *Ficus* trees likewise acts as a refuge for small invertebrates during the warmer months. Their presence indicates that these small refuges maintain ecological processes that rarely persist in degraded environments, and so they must be explicitly considered in any management work or activity planned near canyons and rocky outcrops.

## *Streams with available water*

Dense vegetation along streams is itself an indicator of the watershed's hydrological health: riparian vegetation may support infiltration and soil moisture, depending on site conditions. The red-spotted toad (*Anaxyrus punctatus*), Couch's spadefoot toad (*Scaphiopus couchii*), and Pacific chorus frog (*Pseudacris regilla*) depend directly on this seasonal water availability, because successful reproduction requires the accumulation of sufficient surface water after rains. The presence of these three species confirms that, at least intermittently, there is enough water to sustain their reproductive cycles.



## *Fauna indicating a functioning ecosystem*

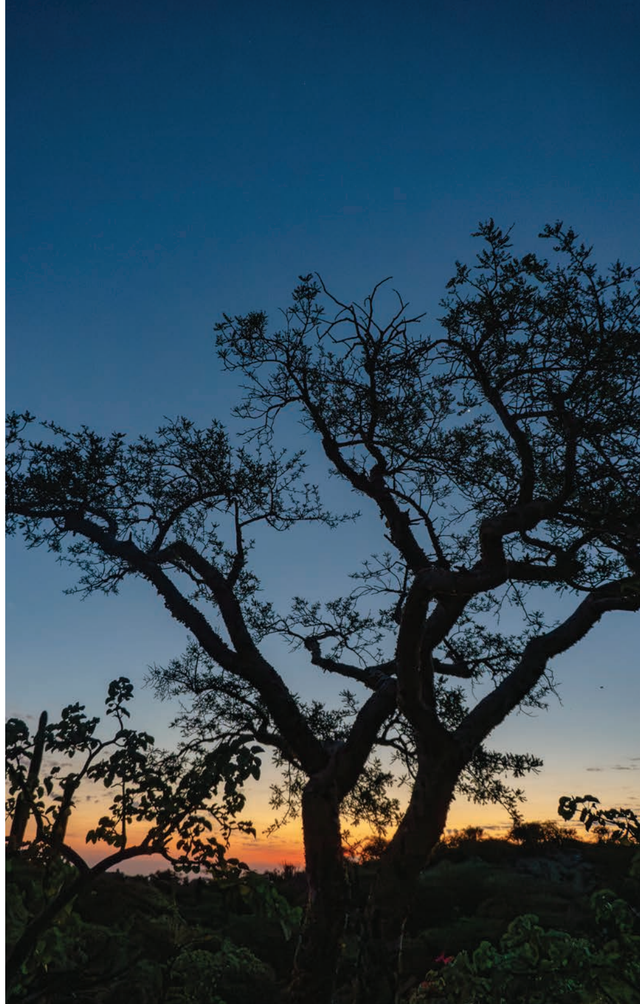
Some vertebrate species also reflect the watershed's overall condition. Birds rarely observed, such as the Varied bunting (*Passerina versicolor*), are associated with dense, moist vegetation zones, so their presence could reflect the progress of restoration work. The Gray vireo is associated with drier areas and has a close relationship with small-leafed elephant tree (*Bursera microphylla*), a keystone species. The Gray vireo winters in elephant-tree habitats, mainly in Baja California Sur and Sonora, where it relies heavily on their fruit for winter feeding and can act as a key seed disperser (Bates, 1992). It is a short-distance migratory bird that nests in chaparral and pinyon-pine habitats in Baja California and the southwestern United States. The Baja California peninsula population could represent a significant share of its global population (Hargrove et al., 2023).



Eva's mouse (*Peromyscus eva*) was associated with sites with greater plant cover and better conservation conditions. Consistently, the abundance of small mammals as a whole was higher at the site with the longest history of restoration and exclusion of grazing than at the site with the most recent restoration, and lower in the area with active grazing, reinforcing the relationship between duration of restoration and recovery of wildlife.

Among reptiles, the Cape whiptail (*Aspidoscelis maximus*) was more abundant at sites with long-term restoration and grazing exclusion than in grazed areas, suggesting a positive response to habitat recovery. However, we found that this species was unique in this response among the reptile species sampled, showcasing interesting complexity in how the lizard and snake community may or may not be affected by certain restoration actions.

No single indicator can describe the watershed's condition on its own. However, the combination of more stable soils, the presence of biological soil crusts, vegetation regeneration, conservation of specialized microhabitats, and the return of sensitive species suggests that restored areas may be recovering essential ecological processes. These indicators show that restoration benefits not only individual species, but strengthens the ecosystem's overall functioning and increases its capacity to sustain biodiversity and the environmental services the community depends on.



# SPECIAL SPECIES

*Neighbors Worth Getting to Know*

The Los Planes Watershed is home to species that, because they are found exclusively on the Baja California Peninsula, because of their fragility, or because they clearly reflect ecosystem health, deserve special attention in management and conservation decisions. This section brings together, as a quick guide, some of the most representative species documented so far by the different research teams.

**Risk categories under NOM-059-SEMARNAT-2010:**

**(P)** *Endangered*

**(A)** *Threatened*

**(Pr)** *Subject to Special Protection*

**(!)** *Not listed under NOM-059-SEMARNAT-2010*

# ENDEMIC TO BAJA CALIFORNIA SUR



**Prickly pear (Pr)**
*(Opuntia bravoana)*
Uncommon; seedlings vulnerable to livestock passage.

**Ocote (!)** *(Nahuatlea arborescens)*
Highly sensitive to livestock browsing; its recovery benefits other scrubland species.





**La Palma bronzed brown tarantula (!)**
*(Aphonopelma prosoicum)*
Indicator of soil compaction.



**Cape striped racer (A)**
*(Masticophis aurigulus)*
New records of the geographic distribution of this species were documented.



**Cape whiptail (Pr)**
*(Aspidoscelis maximus)*
Indicator of habitat recovery.

**Hunsaker's spiny lizard (Pr)**
*(Sceloporus hunsakeri)*
During this project, we found the largest-ever male and female of this species. (A recent technical assessment recommends reclassifying it as Threatened)





**San Lucan alligator lizard (Pr)**
*(Elgaria paucicarinata)*
The first specimens of this species were found after decades without any records in the watershed.



**Cabo San Lucas leaf-toed gecko (Pr)** *(Phyllodactylus unctus)*
Nocturnal gecko, the largest-ever females recorded of this species, were documented.

# ENDEMIC TO BAJA CALIFORNIA SUR



**Biznaga (A)**
*(Ferocactus townsendianus* var. *townsendianus)*
Seedlings vulnerable to livestock passage.



**Palo amarillo (!)**
*(Esenbeckia flava)*
An uncommon tree, native to the region.



**Cape spiny-tailed iguana (Pr)**
*(Ctenosaura hemilopha)*
The largest lizard recorded in the watershed.

# PENINSULAR ENDEMIC



**Lomboy colorado (!)**
*(Jatropha vernicosa)*
A species of cultural significance due to its medicinal use.



**Eva's mouse (!)**
*(Peromyscus eva)*
Indicator of ecosystem productivity after rainfall.

# NATIVE



**Bryant's woodrat (!)**
*(Neotoma bryanti bryanti)*
An endemic subspecies of the Baja California Peninsula, it builds burrows ("trojes") that serve as microhabitats for other species.



**Varied bunting (!)**
*(Passerina versicolor)*
Its presence is linked to the conservation of riparian vegetation, a key habitat for numerous resident and migratory bird species.





**Old man cactus (Pr)**
*(Lophocereus schottii)*
It is endemic to the Sonoran Desert vegetation of northwestern Mexico.



**Desert ironwood (Pr)**
*(Olneya tesota)*
Its wood has cultural uses in Mexico, but globally it is threatened.



**Gray vireo (!)**
*(Vireo vicinior)*
Indicator of conserved native scrubland; disperses elephant tree seeds.



**Red-diamond rattlesnake (Pr)**
*(Crotalus ruber)*
Its presence is linked to the conservation of riparian vegetation, a key habitat for numerous resident and migratory bird species.



**Pacific chorus frog (P)**
*(Pseudacris regilla)*
An indicator species for seasonal or year-round water availability.



**Rosy boa (A)**
*(Lichanura trivirgata)*
The only boa from the peninsula; discreet and nocturnal.



**Oak tree(!)**
*(Quercus tuberculata)*
Only one specimen of this species was recorded in the 15-year restoration area.



**Couch's spadefoot toad (!)**
*(Scaphiopus couchii)*
It spends most of the year buried and emerges only during the rainy season to breed in temporary puddles.



**Red-spotted toad (!)**
*(Anaxyrus punctatus)*
One of the amphibian species best adapted to the Sonoran Desert, capable of surviving with very little water.



# THREATS TO THE WATERSHED

*The Risks the Watershed Faces, One by One*

The research made it possible to identify various threats affecting biodiversity and limiting ecosystem recovery in the Los Planes Watershed. Some result from human activities, while others correspond to invasive exotic species whose spread can profoundly alter ecosystem composition and function. These threats do not affect only plants and animals: in a broader sense, they also erode the everyday relationship communities have with the territory they depend on for water, soil, and daily sustenance. Knowing these threats is the first step toward reducing their impact and strengthening conservation actions.

Based on these identified threats, the research team proposes several actions that could help mitigate their effects and strengthen the watershed's recovery. These suggestions do not represent a single or definitive solution, but rather starting points that can be adapted to the conditions, capacities, and decisions of each community, ejido, or authority involved. Their effective implementation will depend on the combined efforts of residents, institutions, and civil society organizations, as well as on ongoing monitoring that allows strategies to be adjusted as their results become apparent over time.



## THREATS

| URBAN EXPANSION AND LAND-USE CHANGE | INTENSIVE GRAZING | INVASIVE EXOTIC PLANTS | INVASIVE POLLINATORS | INVASIVE BIRDS | DOMESTIC PETS | INVASIVE REPTILES | RESTORATION WORK WITHOUT ECOLOGICAL ASSESSMENT | CLIMATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| Impact on native flora and loss of species diversity. | Browsing of species such as ocote (*Nahuatlea arborescens*), mauto (*Lysiloma divaricatum*), pimentilla (*Adelia brandegeei*), palo colorado (*Colubrina viridis*), among others.  | 28 species recorded (around 10% of the flora). Notable examples include buffelgrass (*Cenchrus ciliaris*), *Cryptostegia grandiflora*, *Cynodon dactylon*, *Melinis repens*, *Tragus berteronianus*, *Nicotiana glauca*, *Aloe vera*, *Eragrostis ciliansis*, and *Mollugo verticillata*. | European honeybee (*Apis mellifera*).  | Brown-headed cowbird (*Molothrus ater*).  | Free-roaming dogs and cats. | Common house gecko, also known as Besucona (*Hemidactylus frenatus*).  | Construction of gabions in canyons. | Rising temperatures, longer drought periods, more intense and concentrated rainfall, and more frequent extreme weather events.  |
| The conversion of land for agriculture, tourism, and rural development further fragments native tropical dry forest habitats and isolates wildlife populations. | Reduces natural regeneration, compacts soil, and promotes erosion. Compaction can also affect burrow-dwelling fauna, such as the La Palma bronzed brown tarantula (*Aphonopelma prosoicum*; see "Special Species"). | Displaces native vegetation, alters habitat, and reduces biodiversity; *Cryptostegia grandiflora* can form deadly monocultures in moist canyons. | May compete with native bees for food and nesting sites, affecting pollination of local plants. | Parasitizes the nests of other birds, reducing their reproductive. | Prey on birds, reptiles, and small mammals, and disrupt wildlife behavior. | Can spread easily in buildings and other human-modified environments, and could potentially compete with native geckos. | Can affect microhabitats where highly specialized invertebrates live, such as Opilioacarida. | Reduces water availability, hinders vegetation regeneration, increases soil erosion, and favors the spread of invasive species. Can also alter the distribution, reproduction, and survival of endemic species such as the Belding's yellowthroat (*Geothlypis beldingi*). Sweet pitaya and sour pitaya are among the cacti most affected by the severe drought recorded between 2020 and 2022, raising concern about a possible tipping point in their populations. |
| It is important to stay informed about public consultations on projects that could threaten the region's biodiversity, participate in them whenever possible, and request timely and transparent information from the authorities regarding their potential impacts. At the same time, organizations and those who generate knowledge can provide this information to the authorities so that they have solid evidence on which to base their decisions. | Maintain exclusion areas, implement rotational grazing, and monitor vegetation recovery. | Early control and eradication, especially of buffelgrass, and ongoing monitoring to detect new outbreaks of high-risk species such as Cryptostegia grandiflora. | Support habitat for native pollinators and monitor the abundance of invasive species. | Monitor its spread and assess its impact on native bird populations. | Promote responsible pet ownership and prevent pets from entering natural areas. | Maintain ongoing monitoring in structures and disturbed areas near natural habitat. | Assess biodiversity beforehand and adjust the placement of structures to preserve habitat connectivity. | Strengthen native vegetation restoration, conserve streams and infiltration zones, control invasive species, reduce other pressures such as overgrazing, and maintain ecological monitoring to assess the ecosystem's response to climate change. |

## RECOMMENDED ACTIONS



# VALUE TO THE COMMUNITY

*Why This Watershed Matters, and What Is Gained by Caring for It*

The Los Planes Watershed is far more than a landscape: it is a natural heritage that sustains biodiversity, water availability, soil fertility, and the productive activities of those who live in the region.

That value depends, in large part, on building a genuine culture of conservation in the region. A culture of conservation is not built through rules or programs alone: it is built when caring for natural heritage becomes a shared habit, passed down between generations and reinforced in the watershed's everyday life. This happens when the people who inhabit a territory observe it closely, understand how it works, and find, in their own experience, reasons to care for it.

This culture also carries a value that goes beyond the educational: knowing the state of biodiversity, water, and soil is also a tool for decision-making. An informed community is better positioned to participate in decisions that affect its territory, from livestock management to the planning of new infrastructure or the establishment of protected areas, and to demand, with arguments and evidence, that those decisions take the watershed's care into account. Generating and sharing knowledge about biodiversity is not just a scientific exercise: it is also a way of strengthening communities' capacity to actively participate in public life and in the future of their territory.

The results of this project show that ecological restoration can generate visible benefits within a few years when grazing pressure is reduced and native vegetation is protected. These changes support the return of plant, invertebrate, bird, and mammal species, while also improving fundamental processes such as water infiltration and soil stability.

At the same time, the research confirms that the watershed is home to species unique to Baja California Sur and to biodiversity that is still far from being fully known. Conserving this landscape means protecting an irreplaceable biological heritage and strengthening communities' resilience in the face of the challenges of climate change and environmental degradation.

This value is not only ecological. Pitaya, for example, was for generations the most important plant for the region's peoples, present in their clothing, art, and cuisine; caring for it today is also a way of keeping that identity alive. And the recent discovery of species found nowhere else in the world, from new plants in the "fault meadows" to a tarantula no one had studied before, confirms that the Los Planes Watershed holds scientific value that reaches beyond its boundaries and that we are only beginning to document.

That value is also sustained by the communities themselves. Most of the ranchers interviewed during this project had already independently launched strategies for conserving water, soil, or biodiversity. This shows that caring for the watershed does not depend solely on science or institutions, but on knowledge and commitment that already exist in the territory, knowledge and commitment this project seeks to accompany and strengthen.

CARING FOR IT TODAY IS ALSO A WAY OF KEEPING THAT IDENTITY ALIVE

The most valuable part of this process cannot be summed up in the number of workshops held, the people who participated, or the species documented, although all of these mattered. Its true legacy lies in the changes that began to take shape in people and in the community: in those who now observe nature with greater curiosity and respect, in the girls, boys, and young people who discovered that science can also arise from their own territory, and in those who came to understand that community knowledge and scientific knowledge grow stronger when they engage with one another. The future of the Los Planes Watershed does not depend solely on researchers, organizations, or authorities: it depends on every person who lives, works, learns, and shares life in this territory.

This project will come to an end, but the knowledge built, the relationships strengthened, and the seeds sown will remain in the people and communities. In just a few years, the Los Planes Watershed has shown that restoration works and that nature can recover when given the chance. Caring for it is a shared responsibility: protecting the water, soil, biodiversity, and traditions that depend on it, while inspiring more residents to see themselves as stewards of the Los Planes Watershed for generations to come.

Rock fig (*Ficus petiolaris*)

# WHAT CAN WE DO?

*Concrete Actions for Landowners, Students, and Communities*

Conserving the Los Planes Watershed is a shared responsibility. The results of this research show that ecological restoration works, and that small actions, sustained over time, can generate major benefits for biodiversity, soil, and water. These are some actions that can strengthen the watershed's health and help ensure its benefits last for future generations.

## SUPPORT SUSTAINABLE LIVESTOCK MANAGEMENT

Grazing is an important activity for the region, but how it is managed directly affects ecosystem health. Reducing grazing pressure in the most sensitive areas and implementing rotational grazing systems allows vegetation to recover between periods of use, reduces erosion, and supports the natural regeneration of trees and shrubs.

It is also essential to maintain exclusion areas where vegetation can recover without the presence of livestock. These zones function as refuges for numerous species and help restore essential ecological processes.

## PROTECT SMALL BIODIVERSITY REFUGES

Biodiversity does not depend only on large trees or streams. Rocks, fallen logs, leaf litter, crevices, and biological soil crusts host an enormous diversity of organisms that perform essential ecosystem functions. Whenever possible, these microhabitats should be conserved and taken into account during restoration and land-management activities.

## PREVENT THE SPREAD OF INVASIVE SPECIES

Invasive exotic species are one of the greatest threats to local biodiversity. Detecting and controlling them early prevents them from spreading and displacing native vegetation and fauna. In particular, monitoring and controlling buffelgrass and other invasive species should remain a priority for the watershed's restoration.

## CONSERVE THE NATURAL LANDSCAPE

Avoiding new landscape transformations helps maintain connectivity between different habitats and allows species to move, feed, and reproduce naturally. Conserving existing ecosystems is generally more effective and less costly than restoring them once they have been degraded.

## PROTECT STREAMS AND RIPARIAN VEGETATION

Streams are the backbone connecting the watershed's water, soil, and biodiversity. Conserving the vegetation around them helps reduce erosion, improves water infiltration, maintains soil moisture, and provides food and shelter for a wide variety of species.

## KEEP LEARNING FROM THE ECOSYSTEM

Nature is constantly changing. It is therefore important to maintain scientific monitoring to understand how species and ecosystems respond to restoration actions and to the effects of climate change. The information gathered makes it possible to improve management strategies and make evidence-based decisions.



White-tailed antelope squirrel (*Ammospermophilus leucurus*)

## INVOLVE THE COMMUNITY

The participation of landowners, residents, students, teachers, organizations, and visitors has been key to this project. Continuing to strengthen this collaboration, through spaces for dialogue, joint training, and shared projects, helps expand knowledge about the watershed and ensures its care continues over time (see "Value to the Community"). Creating spaces where girls

*Conservation begins with knowledge*

and young people spend time alongside women scientists and researchers, moreover, opens the possibility that they might imagine a future of their own in conservation, research, or other careers related to caring for the environment. When communities bring together their existing knowledge with scientific research, they build the information and understanding to meaningfully participate in decisions about the future of their territory, rather than having those decisions made for them from the outside.

## LEARN TO LIVE ALONGSIDE BIODIVERSITY

Getting to know the species that share this territory has practical, immediate benefits. Knowing how to identify a kissing bug and respond correctly reduces the real risk of contracting Chagas disease. Knowing how to behave around a rattlesnake reduces accidents, both for people and for the snakes themselves, which help regulate rodent populations. Respect for all forms of life leads to communities that maintain ecological balance.



## CARE FOR AND REPLANT PITAYAS

Sweet pitaya and sour pitaya are keystone species for wildlife and, at the same time, a central part of the region's cultural identity. Avoiding unnecessary harvesting, supporting their natural regeneration, and considering replanting them on properties and in home gardens helps maintain food corridors for wildlife and preserve a tradition that has accompanied the watershed's communities for generations—especially given these species' vulnerability to drought.

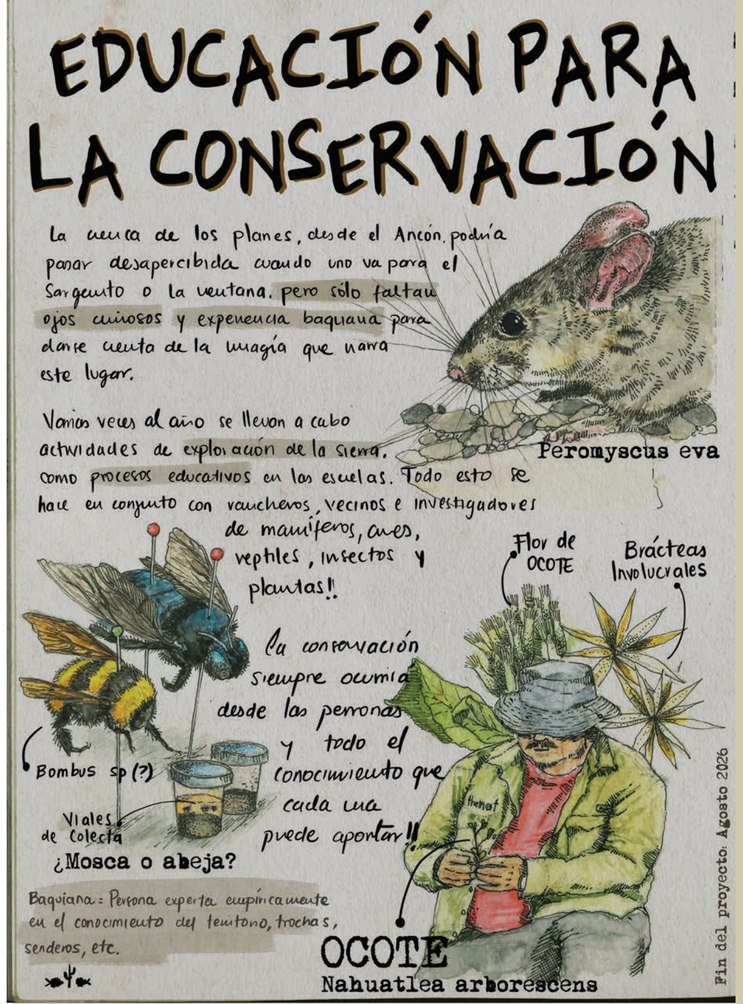
## SUPPORT THE CONSERVATION STRATEGIES COMMUNITIES HAVE ALREADY PUT IN PLACE

Many ranchers in the region have already launched their own conservation actions. The main barrier they face in doing more is not a lack of interest, but a lack of resources such as time, funding, or technical knowledge. Institutions, civil organizations, and government programs can strengthen these existing efforts by offering technical support, accessible funding, and spaces for knowledge exchange among ranchers, rather than starting from scratch.

## CONTRIBUTE THROUGH CITIZEN SCIENCE

Everyone can participate in understanding and conserving biodiversity. Recording plants, animals, and fungi through platforms like iNaturalist helps generate valuable information for research, detect population changes, identify invasive species, and document new records for the region. Every observation contributes to scientific knowledge and to protecting the Los Planes Watershed (see "Resources for Further Learning").






# RESOURCES FOR FURTHER LEARNING

*For Those Who Want to Keep Exploring the Los Planes Watershed*

This report is only a starting point. Those who want to dig deeper into the topics presented here, join the citizen science effort, or follow the project's work closely can do so through the following resources:

## SIGN UP FOR INATURALIST

Join the citizen science community documenting the biodiversity of the Los Planes Watershed and surrounding areas! Any observation of a plant, animal, or fungus can contribute valuable information for research and conservation.

## PROJECT LIBRARY

Browse the appendices, technical reports, field guides, and complete scientific articles produced by the different research teams for this and other studies in the watershed.

## EDUCATIONAL CURRICULUM

Explore the environmental education materials and activities developed for schools in the region.

## UPCOMING EXPEDITIONS

Learn about upcoming research projects through the San Diego Natural History Museum (The Nat) website.

Investigación en la Cuenca de los Planes

Visit www.cuencalosplanes.com for all the information about this project.

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# ACKNOWLEDGMENTS

This report exists thanks to the generosity of many people who chose to share their time and knowledge with a group of researchers who, in most cases, arrived as strangers. To the *ejidatarios* (holders of legally recognized land rights within Mexico's ejido system), landowners, and families of the Los Planes Watershed: thank you for letting us walk your trails, for sharing what years of life in this territory have taught you, and for trusting that science could add to that knowledge, not replace it.

To the schools, teachers, and parents, who opened their classrooms and trusted us to guide their young people and children, and to every member of the community who joined us in the various activities: thank you for your curiosity and for reminding us, again and again, why this work is worth doing.

To the researchers from the participating institutions, who dedicated years of effort, often through summer heat, cold winds, or long days in the field, to rigorously document what this watershed holds: thank you for your commitment to doing honest science and sharing it in an accessible way.

To the civil organizations, government institutions, and funders who made this project possible, especially Anne McEnany and Alumbra Innovations Foundation: thank you for backing long-term research, whose true value is felt over the years rather than in immediate results.

And to those who, without being formally part of any team, did their part simply because they love this place, guiding, naturalizing, illustrating or simply paying attention to the natural richness around them: this work is yours too.

The Los Planes Watershed welcomed us with generosity. We hope we have returned that trust with a report worthy of it, and that this is only the beginning of a relationship of shared care that continues long after this project concludes.


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