

Final Project Evaluation Report

Your Details	
Full Name	Kristen Marie Lear
Project Title	Bats, agaves, and people: Filling critical knowledge gaps and building local capacity to conserve the endangered Mexican long-nosed bat and its foraging habitat
Application ID	24874-2
Grant Amount	£4990
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Date of this Report	May 9, 2019

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
<p>Research Objective 1: Determine agave and landscape characteristics that provide high quality food resources for bats</p>				<p>We monitored bat foraging on flowering agaves on 32 nights and conducted agave surveys around each focal agave (Figures 1 and 2). From preliminary analysis, bats appear to prefer agaves that are growing in clusters rather than spread out across the landscape. This information is being used by Bat Conservation International in their new Agaves for Bats restoration initiative.</p> <p>I will publish final results in a peer-reviewed journal article (target journal: Journal of Wildlife Management) and my PhD dissertation (to be finished by May 2020).</p>
<p>Research Objective 2: Determine the optimal spatial arrangement of flowering agaves on the landscape to maximize bats' energy efficiency</p>				<p>Analysis is ongoing for this objective, but preliminary results indicate bats prefer clustered agaves.</p>
<p>Research Objective 3: Identify the agave restoration practices that are most likely to be adopted by local communities and the most effective incentives to encourage their adoption</p>				<p>I conducted 27 interviews with agave harvesters (Figure 3), and from these interviews distilled which restoration practices and incentives are best for each community. I have shared this information with Bat Conservation International to aid in their ongoing Agaves for Bats Initiative.</p> <p>I presented these results at the North American Society for Bat Research meeting in Puerto Vallarta, Mexico and at the Integrative Conservation Conference in Athens, Georgia.</p>
<p>Research Objective 4: Understand the long-</p>				<p>Through the community interviews, I learned important information</p>

<p>term impacts of agave restoration programs on agave populations and community livelihoods</p>			<p>about the effects of agave harvest and management on agave populations. Effects vary by specific practice, location, and agave species. This information is helping guide our current restoration activities.</p>
<p>Other Research: Survey abandoned mines for bats</p>			<p>With the help of local landowners, we surveyed four abandoned mines and two caves near two known roosts of Mexican long-nosed bats (Rosillo Cave in Coahuila and Infierno Cave in Nuevo Leon) (Figures 4 and 5). We discovered a related nectar-feeding bat species, the threatened Mexican long-tongued bat (<i>Choeronycteris mexicana</i>), roosting in two of the caves. The mines may be candidates for PIT (Passive Integrated Transponder) monitoring, which would contribute to our bi-national effort to understand the bats' migration. The cave that contained <i>C. mexicana</i> is often visited by locals and there was much evidence of vandalism (graffiti, trash, etc.). We will work with the local communities to begin protecting these caves for bat roosting.</p>
<p>Community Engagement: Host a symposium for government environmental agencies and other stakeholders</p>			<p>We hosted a symposium on pollinating bats and their conservation for protected area managers, environmental NGOs, communities, and other interested parties on July 18, 2018 (Figures 6, 7, and 8). 45 people attended from 19 organisations. This symposium was a key part of our efforts to begin agave restoration work in the area. (See more details below)</p>
<p>Community Engagement: Develop and implement educational programming about bats</p>			<p>We created educational materials about bats and hosted a bat workshop for the Bridgestone Monterrey summer camp, which consisted of approximately 20 girls ages 12 to 13. We gave a presentation about pollinating bats</p>

			<p>and then led a fun, interactive "pollination game" with the girls. (Figure 9)</p> <p>We planned and led the first-ever "BatFest" in Monterrey on November 2, 2018 at the Parque Ecologico Chipinque, which was attended by over 300 people, including many kids. This event introduced members of the public to bats and their ecological and economic importance. We led bat kid's activities and crafts, gave research presentations, and took attendees on "bat walks" to demonstrate the use of specialized research equipment. We plan to host this event again next year.</p> <p>I presented my research in Spanish at a meeting of the Sociedad de Cactaceas y Suculentas (Society of Cactuses and Succulents) in Monterrey. (Figure 10)</p> <p>I helped develop an outreach brochure about bat-friendly agave farming for agave farmers in a neighbouring state (Aguascalientes). These brochures are being used by the Department of Sustainability, Environment, and Water. (Figure 11)</p>
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2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

Our main difficulty in the field was finding agaves that were flowering to monitor. The timing of flowering can vary year to year based on precipitation and other factors, and this year the blooming was later than in previous years. However, we used some of the "down" time to search for new bat roosting sites, and successfully surveyed four mines and two new caves (some of which had bats) (Figures 4 and 5).

To avoid some of the difficulties I had last year with the availability of NGO members to help me in the field, this year I hired several local undergraduate students from the Universidad Autonoma de Nuevo Leon to serve as field assistants. This also allowed me to train them in field work methods, and some of them have even gone on to pursue independent bat research projects or Master's research.

3. Briefly describe the three most important outcomes of your project.

1) Firstly, the information (social and ecological) gathered from this project is directly impacting ongoing conservation efforts for the endangered Mexican long-nosed bat. One of the most tangible outcomes of this project is the revised Species Status Assessment (SSA) for the endangered Mexican long-nosed bat that project collaborators and I completed at the end of 2018. This document for the U.S. Fish and Wildlife Service will allow the agency to complete an updated federal Species Recovery Plan and target federal research and conservation efforts where they are most needed. The information is also directly guiding Bat Conservation International's new Agaves for Bats initiative and their range-wide conservation plan.

2) Second, with funding from the Rufford Foundation, we hosted the first ever pollinating bat symposium for protected area managers, environmental NGOs, students, communities, and other local stakeholders in northeast Mexico on July 18, 2018 (Figures 6, 7, and 8). 45 people attended from 19 organisations. The full-day symposium consisted of presentations from myself and project collaborators (Dr. Emma Gomez-Ruiz, Dr. Jose Juan Flores Maldonado, undergraduate and master's students conducting bat research with Dr. Gomez-Ruiz, Dr. Thomas Lacher from Texas A&M University (USA), and Dr. Jon Flanders from Bat Conservation International) followed by a discussion session. During the discussion, we collected information about current bat conservation efforts in the region from each attendee, and garnered significant interest in conducting collaborative research and conservation efforts for pollinating bats in the future. It is important to note that the Rufford Foundation was the sole funder of this symposium, so without that support the symposium would not have been possible.

3) We also reached wide audiences through our environmental education programs. Through the BatFest in November 2018, we reached over 300 people (kids and adults) and educated them about the importance of bats. Through our Bridgestone summer camp event, we reached about 20 middle school girls and engaged them in fun, informational activities about bats (Figure 9).

4) Finally, through my field work, I trained eight Mexican undergraduate students from the local university on biological field work and data analysis. I am continuing to work with them to analyse the data collected and publish the results together (six undergraduates from the University of Georgia are also helping with this).

4. Briefly describe the involvement of local communities and how they have benefitted from the project.

During our field work, we always met with the community leader and our local contacts. We stayed in the ejido building and paid the community for use of these buildings. We also ate with local families and provided payment for meals and supplies. In this way our project supported the local economies. We also hired several young men from the communities to be our guides when searching for and exploring old mines and caves for roosting bats. This not only provided money to them, but also gave us an opportunity to discuss bat conservation with them. We

have maintained contact with these community members and leaders and are working with Bat Conservation International to provide agave restoration programmes that will pay the communities to plant agaves for bats.

Local residents of Monterrey, Nuevo Leon benefitted from our educational programmes (the BatFest in November and the Bridgestone summer camp presentation and activities with kids in the summer).

I also helped create a brochure (Figure 11) about pollinating bats and bat-friendly agave management for the state government of Aguascalientes, a state in central Mexico. My contact at the Department of Sustainability, Environment, and Water is giving this brochure to local agave farmers in the state to encourage them to adopt bat-friendly practices. We are encouraging the adoption of these practices so that the farmers can benefit from nectar-feeding bats through their pollination services.

5. Are there any plans to continue this work?

I will be continuing this work by analysing all the data collected this past summer. I will publish all the results in several peer-reviewed journals (both natural and social science journals) and in my PhD dissertation (by May 2020).

Importantly, project members and I are hosting a collaborative meeting in Monterrey this month (May 2019) with partners from Bat Conservation International (BCI) and local protected area managers and other local NGOs. At this meeting we will create an action plan for implementing agave restoration programs in northeast Mexico. BCI began their Agaves for Bat initiative last year in the southwest US (Arizona in particular) and will be spreading to New Mexico and Texas this year. Beginning in 2020 they want to do restoration programs in northeast Mexico where we are working. My project team members and I are working with them to select communities and restoration sites. Our upcoming meeting will detail our plan of attack for this work so we can solicit project funding from various agencies.

6. How do you plan to share the results of your work with others?

I have already shared this work at two national conferences (the North American Society for Bat Research meeting in Puerto Vallarta, Mexico in October 2018, and the Integrative Conservation Conference in Athens, Georgia in September 2018). I also presented at my university's annual Symposium on Integrative Conservation in January 2019. I will be presenting the results of this work at the UK's Bat Conservation Trust annual meeting in September 2019.

As mentioned previously, I shared this project with the public in Mexico through several presentations (including at our symposium and to the Succulent Society in Monterrey). Our work was also featured in a blog post at Bat Conservation International (see Figure 12, <http://www.batcon.org/resources/media-education/news-room/the-echo/1185-boots-on-the-ground.>)

I will be producing three manuscripts for publication in peer-reviewed scientific journals. My target journals are the Journal of Wildlife Management, Conservation

Biology, and Ecology and Society. I will also complete my dissertation from the results of this project in May 2020.

I have also actively shared project updates, photos, and experiences from the field on my social media accounts, including Instagram (batsforlife_kristen), Twitter (BatsForLife), and Facebook.

Finally, I am sharing the results of this project with Bat Conservation International, since the results will be critical as they begin their agave restoration work in northeast Mexico. My in-country collaborators and I are also sharing results with protected area managers and communities near the two important roosting caves of the bats (Infierno Cave and Rosillo Cave).

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

The Rufford grant was used for field work from April through July, 2018. This coincides with the timeline provided in the grant application.

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion. Exchange rate used: 1 GBP = 26.07 pesos

Item	Budgeted Amount	Actual Amount	Difference	Comments
Field assistance for data collection	910	1834	+910	I took an additional assistant into the field on many trips to give her field work experience, which increased the money spent on this budget item.
Food for field work	420	1030	+610	We spent a total of £1460 on food during field work, which was £610 more than budgeted. I ended up taking an additional student on many of the trips to provide field training to her. I had £430 from another grant, so I spent £1030 from the Rufford grant to cover this cost.
Gas for field work	910	427	-483	Gas was cheaper than expected, so we spent £483 less than budgeted.
Vehicle rental for field	1640	1690	+50	The cost ended up being about

work				£3 more per day than estimated in the budget, and given the limited availability of 4x4 trucks we had to rent the truck for the entire time I was in Mexico (early April through the end of August, 3.5 months). This increased our cost for this budget item. I had £2720 for this expense from other funding sources, so I used £1690 from the Rufford grant.
Symposium expenses	1000	240	-760	The cost of the symposium was less than expected, in part because we were able to get a meeting room at the local university free of charge.
Consumables	110	110		With this money I bought items like infrared lamp batteries, fuses for the IR lamps, propane for a camp stove, and other miscellaneous field work expenses.
TOTAL	4990	5331	+341	This overage was covered by other small grants.

9. Looking ahead, what do you feel are the important next steps?

Completing data analysis and publishing my results in peer-reviewed scientific journals, as well as sharing my results with local stakeholders, are the most important immediate next steps. Looking longer term, Bat Conservation International is planning to begin the northeast Mexico phase of their Agaves for Bats initiative in 2020, so I will be providing technical assistance and data for them to help with this initiative. Project team members are currently working to do more agave surveys in the area and are talking with local community members about participating in these agave programs.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

The Rufford Foundation logo as well as a link to the Rufford website appears on my professional website (<https://kristenlear.wixsite.com/batconservation/>). The logo also appeared on my three presentations at the conferences I presented at last year, as well as on outreach presentations that I have given in Athens, GA. The logo will appear on all future presentations related to this project, and the Rufford Foundation will be acknowledged in all peer-reviewed journal articles and my PhD dissertation.

I also tagged the Rufford Foundation on social media (e.g. my Twitter posts related to the project). I have also shared my application with graduate students in my department and have encouraged colleagues, as well as several students who have reached out to me via my website, to apply for a Rufford grant.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Ana Gabriela Castañeda Aguilera (Biologist) was one of my field assistants for the bat and agave monitoring, and also my translator for community interviews. She also served as my translator in 2017.

Field assistants (including students): **Jonathan Esqueda, Lynnette Flores, Greta Guzman, Ceci Guzman, Daniel Hernandez, Sandra Hernandez, Melisa Martinez, Rosalinda Morales, Katia Trevino**

Dr. Jose Juan Flores Maldonado (Executive Director of Especies, Sociedad y Habitat, A.C.) my local partner organization. Dr. Maldonado served as a mentor and collaborator during field work coordination. He also was one of the leaders of our BatFest in Monterrey and a co-organizer for the symposium.

Dr. Emma Gomez-Ruiz (Professor, Universidad Autonoma de Nuevo Leon) served as a project mentor, providing guidance on field work planning. She also spearheaded our Bridgestone summer camp educational program, and was one of the leaders for our BatFest in Monterrey as well as a co-organizer for the symposium.

Cuauhtemoc Ibarra Sanchez (Biologist, Especies, Sociedad y Habitat, A.C.) helped with planning field work and conducting the bat and agave monitoring. He also was one of the leaders of our BatFest in Monterrey and a co-organizer for the symposium.

Jaileen Rivera-Rodriguez was a Master's student (Texas A&M University) who I mentored during the collection of her field data. She also helped with data collection for my project.

Drs. Jeffrey Hepinstall-Cymerman, Elizabeth King, Clint Moore, Laura German, and Meredith Welch-Devine are my PhD committee members from the University of Georgia. They have assisted with the field design and development of statistical analyses for the bat and agave monitoring, as well as the creation of the community interviews. All are currently assisting me with the preparation of journal manuscripts for publication.

12. Any other comments?

The two Rufford Foundation grants that I have received have been critical to my PhD dissertation research. Without them, I would not have been able to complete my field work, so I am grateful to the foundation for your support!

I am excited to continue my work with the conservation of these bats by working together with local communities. Implementing the work has been a slow process

since we want to make sure we understand how best to do programmes (like agave restoration programs) in ways that are both appropriate for the bats and that fit within the local cultures. Partnering with large organizations like Bat Conservation International has also been vital to our success, although this also brings some challenges (like the slow timescale of getting the work done). But there is a lot of momentum right now for programs in the region, and our upcoming meeting in Monterrey will help solidify our plans to move forward and get agaves in the ground to help feed and protect the bats!



Figure 1: Collecting nectar from agave flowers. © Kristen Lear



Figure 2: Taking GPS coordinates of a flowering agave. © Kristen Lear



Figure 3: Interviewing an agave harvester about management practices and their effects on agave populations. © Tom Prebyl



Figure 4: Kristen Lear and field assistants Jonathan Esqueda, Daniel Hernandez, and Gretta Guzman outside an abandoned mine. © Kristen Lear



Figure 5: Exploring abandoned mines and surveying for bats in Coahuila, Mexico. © Kristen Lear



Figure 6: Participants of our symposium on the conservation of pollinating bats in northeast Mexico

(Photo from <http://www.fcb.uanl.mx/nw/es/media-bio/fotogalerias/1542-fotogaleria-del-coloquio-murcielagos-polinizadores-del-noreste-de-mexico>)



Figure 7: Project team member Dr. Jose Juan Flores Maldonado (right) discussing conservation efforts for pollinating bats with a symposium attendee. © Kristen Lear



Figure 8: Kristen Lear presenting about her Rufford project at the symposium "Conservation of Pollinating Bats in Northeast Mexico". © Jon Flanders/ Bat Conservation International)



Figure 9: Project team members Dr. Emma Gomez Ruiz and Kristen Lear leading an interactive "pollination game" with middle school students at a Bridgestone summer camp in Monterrey, Mexico. © Daniel Hernandez



Figure 10: Kristen Lear presenting about this Rufford-funded project in Spanish at a meeting of the Sociedad de Cactaceas y Suculentas (Society of Cactuses and Succulents) in Monterrey. © Daniel Hernandez

Los cultivos de maguey pueden ayudar a los murciélagos

Una medida muy sencilla y útil es dejar que al menos 5% de los magueyes de una plantación florezca. El quiote se debe dejar en pie hasta que la inflorescencia se convierta en frutos con semillas. Así, los murciélagos de la región podrán alimentarse de su néctar y polen. Los agaves que se deje florecer, podrán estar en una misma línea o en grupos.

Beneficios

Los productos obtenidos bajo este esquema podrán ser más atractivos para los mercados que buscan productos amigables con el ambiente. Además, las semillas obtenidas se podrán utilizar para producir nuevas plantas de agave que ayudarán a incrementar la variabilidad genética dentro de la plantación, contribuyendo a tener cultivos más saludables.

Literatura consultada

Trejo-Salazar, R. E., Eguarte, L. E., Suro-Piñera, D. y R. A. Medellín. 2016. Save our bats, save our tequila: Industry and science join forces to help bats and agaves. *Natural Areas Journal*. 36: 523-530.

Agradecimientos: Kristen Lear.

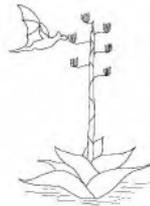
Concepto e ilustración: Héctor Ávila Villegas.

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PRÁCTICAS SUSTENTABLES EN EL CULTIVO DE AGAVE



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El agave

El agave o maguey es una planta originaria de México. Con más de 150 especies (69% endémicas), estas plantas dominan los paisajes de más de la mitad del territorio nacional. En nuestro país, el agave se aprovecha para obtener alimentos, fibras y bebidas alcohólicas como pulque, tequila, mezcal, raicilla y bacanora.

El cultivo de agave

Tradicionalmente, los cultivos de agave se establecen y se renuevan a partir de los retoños (hijuelos) de las plantas adultas. Para obtener la mayoría de los productos, el escapo o quiote se corta antes de que la planta florezca, pues es el momento en que tiene mayor concentración de azúcares en su interior. Este manejo, tiene ciertas repercusiones. En los cultivos, impide que haya mayor variabilidad genética en las plantas, haciéndolas más susceptibles a parásitos, enfermedades y condiciones climáticas adversas.

En los ecosistemas, reduce las fuentes de néctar y polen para muchos animales silvestres como los murciélagos magueyeros, que se alimentan principalmente de estas plantas. A su vez, la falta de estos murciélagos pone en riesgo a las poblaciones silvestres y cultivadas de agaves, ya que sin ellos estas plantas no se pueden reproducir sexualmente a través de la polinización.

Murciélagos magueyeros, aliados del cultivo de agave

Los principales polinizadores de los agaves son: el murciélago trompudo (*Choeronycteris mexicana*), el murciélago magueyero mayor (*Leptonycteris nivalis*) y el murciélago magueyero menor (*L. yerbabuena*).

Estas especies evolucionaron junto con los agaves a fin de otorgarse beneficios mutuos: la planta ofrece alimento (néctar y polen) a cambio de la polinización (los murciélagos ayudan a que plantas separadas por grandes distancias se puedan reproducir sexualmente, con el beneficio de incrementar su diversidad genética).

Desafortunadamente, los murciélagos magueyeros están desapareciendo por amenazas como la pérdida del hábitat, la muerte por personas y la falta de fuentes de néctar y polen. Por ello, es necesario recuperar sus poblaciones y su importante papel en los ecosistemas y en los cultivos de agave.

Cultivo de agave y apicultura

Los agaves maduran entre los 5 a 20 años de edad, según la especie. En los cultivos de agave se puede desarrollar la apicultura durante este tiempo, dejando y promoviendo que crezcan flores silvestres que den néctar y polen a las abejas, como acetilla, árnica, árnica morada, cabezona, cinco llagas, diente de león, galitillo de monte, girasol morado, ojo de gallo, entre otras.

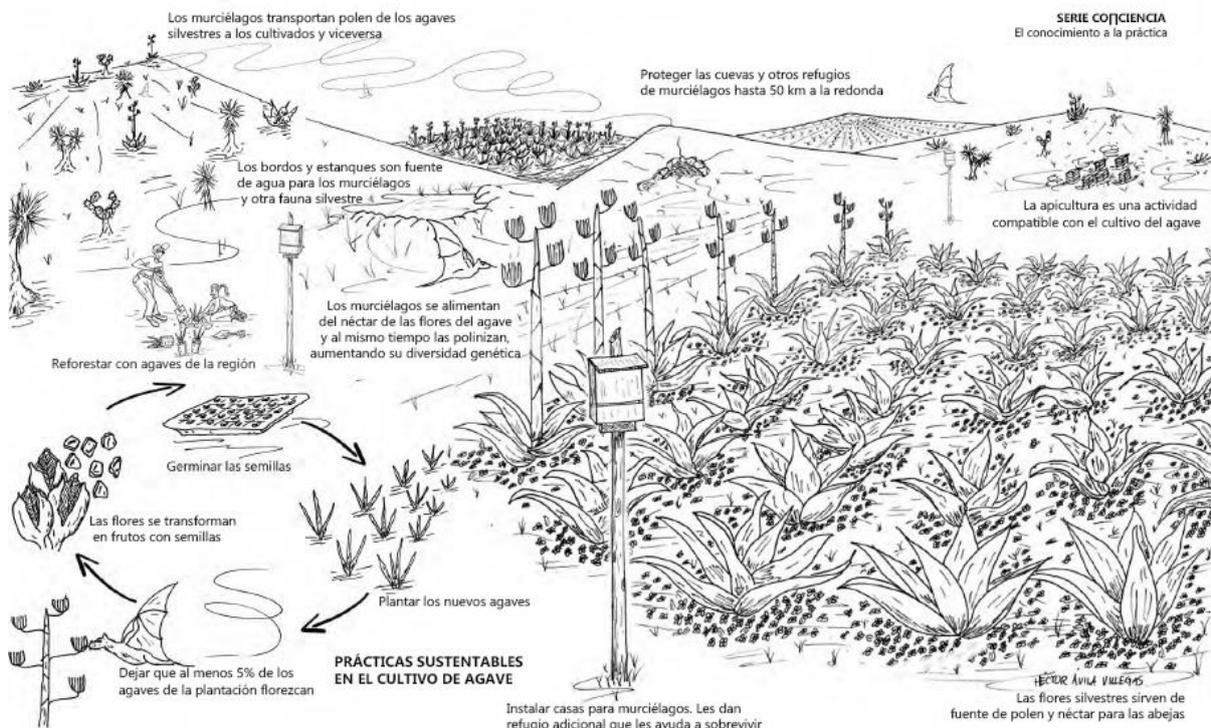


Figure 11: Bat-friendly agave farming brochure developed as an outreach tool for the Aguascalientes state government.

The Echo

Boots on the Ground

Published on September 14, 2018
Written by Merrill Read



If you're a bat biologist, chances are that the summer months mean it's time for field work - and lots of it! This past July, Jon Flanders, BCI's International Program Manager, went to visit several project partners to get a firsthand experience of their contributions to bat research and conservation.



Courtesy of Jon Flanders/BCI

Flanders first traveled down to the small town of Laguna, Mexico, to visit with Kristen Lear, a PhD student at the University of Georgia and BCI student scholar. Lear is currently working on how growing wild agave affects both bats and humans. Much of Lear's work involves conducting agave surveys in different habitats to estimate abundance, age structure, flowering times, damage by livestock, and human usage. Flanders was able to join Lear in her research by assisting in a night watch. This consisted of three teams tracking and filming bat visitation rates at flowering agave plants from 9:00 PM to 3:00 AM. The data collected at different sites is used to identify optimal foraging areas for pollinating bats.

About two hours away at El Infierno cave, Emma Gomez, an Assistant Professor at the Universidad Autónoma de Nuevo León and former BCI student scholarship recipient, was spending the summer monitoring Mexican long-nosed bat (*Leptonycteris nivalis*) populations. Gomez and her team collected invaluable data about the Mexican long-nosed bat populations. This included looking at genetic variability in bat DNA, and monitoring for heavy metal exposure in their diets. In addition, the team conducted acoustic monitoring, while also attaching PIT tags to the bats to track population movements between different roosting sites across the United States and Mexico.

Later, Gomez, along with Dr. José Maldonado, organized a colloquium to discuss the importance of pollinating bats, including *Leptonycteris nivalis*, and what can be done to protect them; Flanders was a featured speaker. This workshop drew a range

of participants: conservation groups, private landowners, and larger corporations. Flanders spoke of the importance in conserving habitats, using *Leptonycteris yerbabuenae* as an example - after decades of work by conservation organizations, academia, and larger land owners, the species is now no longer considered endangered in the United States and Mexico.

"The population was down to just few thousand individuals, and now is over 200,000 individuals. It's a great success story because it shows protecting bats from extinction is achievable and well worth the time and money we're investing in them," remarked Flanders.

Through the sharing of research, partnerships between organizations, and generous funding, the protection and conservation of bat species and their ecosystems can become a reality.



Courtesy of Jon Flanders/BCI



Figure 12: Blog post about our project by Bat Conservation International