Final Evaluation Report

Your Details	
Full Name	Katia Lizeth Treviño Cuéllar
Project Title	Using the evolutionary history of conifers to stablish conservation priorities
Application ID	38049-2
Date of this Report	31st October 2023

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
Identifying the PD distribution of the gymnosperm community along the Sierra Madre Oriental.		☑		We were able to use three chloroplast sequences per species to build a local community phylogeny and model species distribution from which phylogenetic diversity indices were obtained and its potential distribution was successfully mapped across the landscape. Future work needs to be done to take the potential distributions to real species distribution and update maps with the current species distribution taking into consideration recent fires, land use change, lodging and urban establishments.
Identification of ED species (Evolutionary Distinct) which might not have been assessed before or are not globally recognized as endangered.			☑	Based on the built phylogeny the evolutionary distinctiveness of each species was determined and most distinct species were identified.
Exploring the possible discrepancies between globally endangered (EDGE) and locally endangered (EDLE) we would highlight the importance of local risk assessments to protect regional genotypes that might prove useful in future conservation actions			☑	Using the IUCN global conservation status as well as the local Mexican NOM-059 protected list of species we obtained EDGE and EDLE indices for all species. Differences were observed and important information gaps were identified. However, for a proper updated ranking of species priorities, IUCN red list status needs to be updated for endemic species, and a homologous assessment is required to assess the risk of local populations of species that might have wider distribution ranges for proper comparisons to be made

			and to understand the risk at regional level conifers from NE Mexico have.
Evaluate the representation of areas of high diversity within the already stablished Natural Protected Areas.			Phylogenetic diversity distribution was compared with the distribution of species richness and analysed against the natural protected areas that are currently stablished. Priority regions with no protection were identified.

2. Describe the three most important outcomes of your project.

a). Construction of potential distribution maps for the analysis of potential gymnosperm phylogenetic diversity across the Sierra Madre Oriental landscape

We sampled approximately 100 individuals, 2-4 individuals per species for all 31 different conifer taxa from NE Mexico. Species with wide distribution ranges were sampled across their distributional range. All samples were extracted, and DNA is currently stored in the DNA collection from the Molecular Ecology Laboratory at the Faculty of Biological Sciences from the Universidad Autónoma de Nuevo León (Figure 1). Additional arboreous species from high elevation ecosystems were sampled and DNA extracted with the aim of including a wider range of taxa in the future to our analyses.
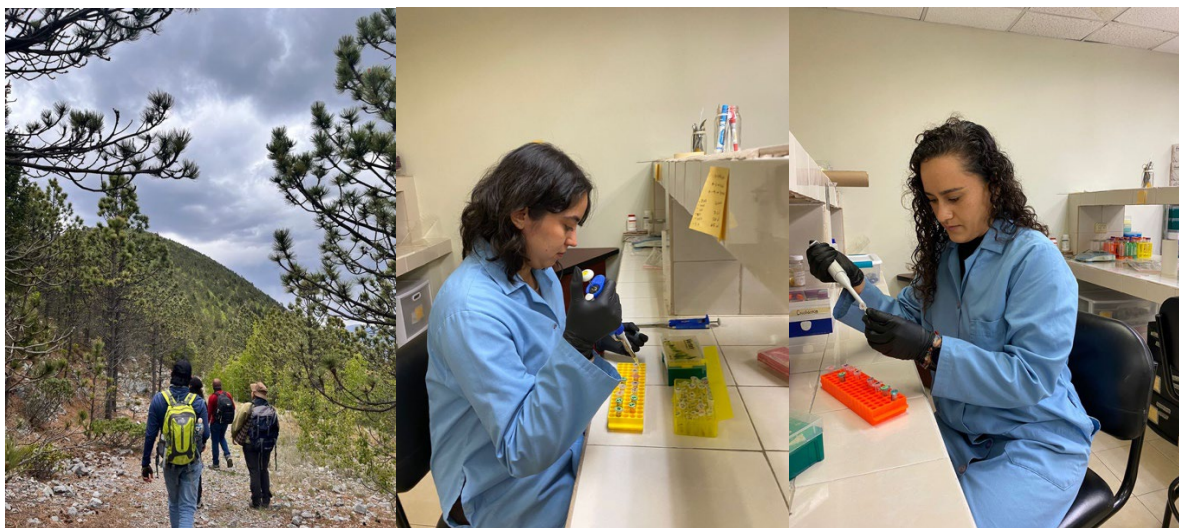
Figure 1. Fieldwork and Lab work. In the lab photos, MRes students María Susana Sánchez Chávez (left) and Mayté Méndez Lozano (right.)

A Bayesian phylogeny (phylogenetic tree can be found in project updates) was constructed with three different genes, missing genetic information from databases was sequenced from the locally sourced DNA previously extracted. The DNA collection of these Mexican conifers is very important to ensure that further analyses can be performed. Based on the modelling of species distribution performed by MRes student María Susana Sánchez, phylogenetic diversity analyses were

performed at a landscape level which allowed us to get the first insight into the potential distribution of phylogenetic diversity across the Sierra Madre Oriental Mountain Range, as well as the comparison of species richness and phylogenetic diversity (Figure 2).
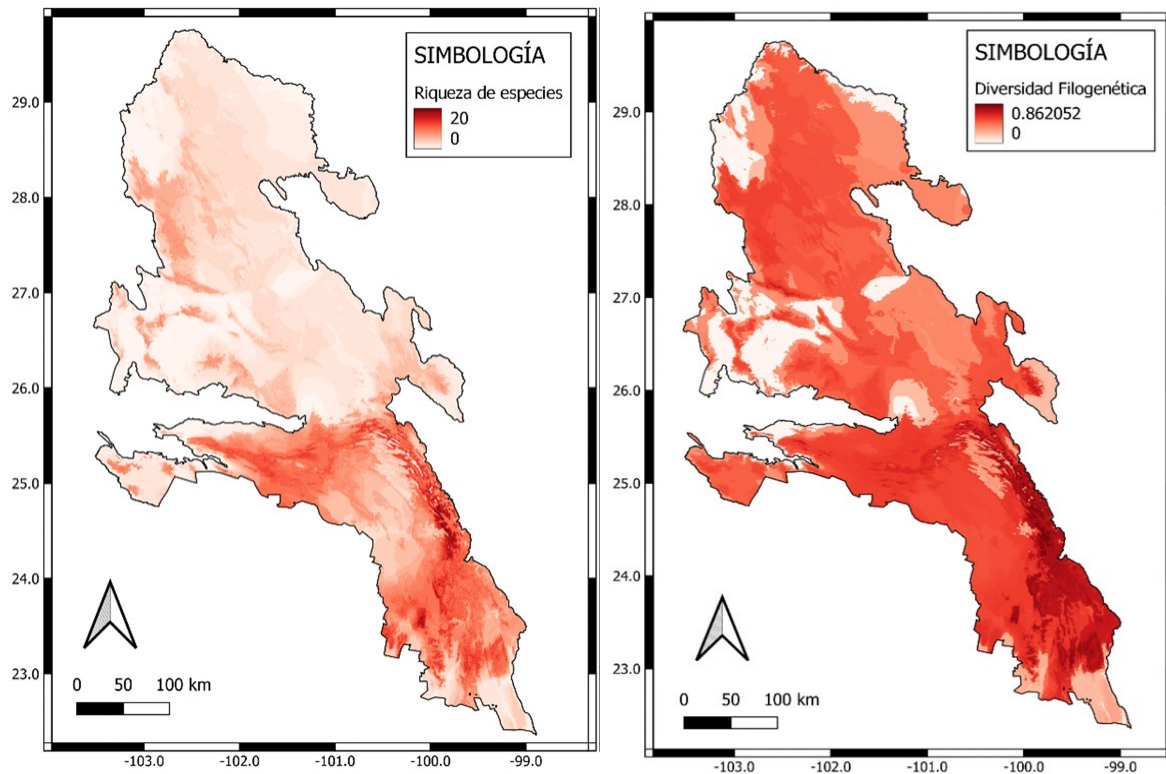
Figure 2. Conifer species richness and phylogenetic distributions across the Sierra Madre Oriental.

With these maps we were able to identify an underestimation of diversity at the northern distributions of the Sierra Madre Oriental which despite being less species rich areas hold important levels of phylogenetic diversity.

b). Identifying conservation priorities through Evolutionary Distinctiveness indices

Based on the Bayesian community phylogeny we were able to stablish an evolutionary distinctiveness ranking from the conifer species that inhabit the Sierra Madre Oriental (Table 1).

Table 1. Evolutionary distinctiveness indices for conifer species within the Sierra Madre Oriental

Species	Evolutionary Distinctiveness (ED)	EDGE	EDLE
Taxus globosa	0.129510856	0.5861933	0.1287161
Taxodium mucronatum	0.059828062	0.0587998	0.0587998
Abies vejarii	0.041671493	0.0477581	0.1101413
Juniperus coahuilensis	0.036925302	0.036953	0.036953
Pinus teocote	0.036708138	0.0367436	0.0367436
Cupressus arizonica	0.036641532	0.0366793	0.0366793
Juniperus angosturana	0.034115038	0.1028607	0.0342392
Juniperus zanonii	0.032827124	0.0328271	0.0392313
Juniperus pinchotii	0.032721822	0.032891	0.032891
Juniperus flaccida	0.032013248	0.0322047	0.0322047
Juniperus deppeana	0.031800114	0.0319981	0.0319981
Pseudotsuga menziesii	0.030695025	0.0309265	0.0371648
Juniperus saltillensis	0.030337281	0.4942948	0.0305794
Pinus arizonica var. stormiae	0.028812303	0.0977198	0.0290982
Pinus pinceana	0.020326606	0.0208159	0.4845314
Picea mexicana	0.020003424	0.4842146	0.4842146
Pinus greggii	0.019629177	0.0887537	0.0201322
Picea martinezii	0.019610796	0.4838296	0.4838296
Pinus pseudostrobus	0.018272079	0.0188003	0.0188003
Pinus strobiformis	0.01773116	0.0182689	0.0182689
Pinus remota	0.016207391	0.0167706	0.0230089
Pinus nelsonii	0.015048484	0.479345	0.479345
Pinus cembroides	0.015035426	0.0156167	0.0156167
Pinus cembroides var. bicolor	0.013285045	0.0138907	0.020129
Pinus patula	0.013035714	0.0136446	0.0136446
Pinus arizonica	0.012550704	0.0131657	0.0131657
Pinus hartwegii	0.012363643	0.012981	0.012981
Pinus culminicola	0.011355133	0.4756998	0.4756998
Pinus montezumae	0.011339344	0.0119687	0.0119687

We are planning to help update IUCN risk assessments and work on a framework based on the IUCN guidelines to assess local risk for widely distributed species. Once this is completed EDGE conifer species for NE Mexico will be properly identified and mapped to identify EDGE species rich areas and conservation units.

c). Informing the effectiveness of current National Protected Areas and identifying priority areas that lack protection as well as general information gaps.

Based on the distribution of Natural Protected Areas (NPAs) in the Sierra Madre Oriental, we identified a good representation of phylogenetic diversity within them. However, a deeper understanding of the management and conservation programmes that are taken place in the different NPA is important to understand if conifers are being properly protected by these. We identified a significant area with high phylogenetic diversity at the southeast of the SMO that lacked NPA (Figure 3). This area of the SMO has been previously highlighted as a vulnerable area in our last grant results due to severe arid conditions and intense forest fires in the last decade. Further research and conservation actions are required to ensure a better understanding of the populations that inhabit here as well as their genetic resources and connectivity with populations further up north where protection is in place.
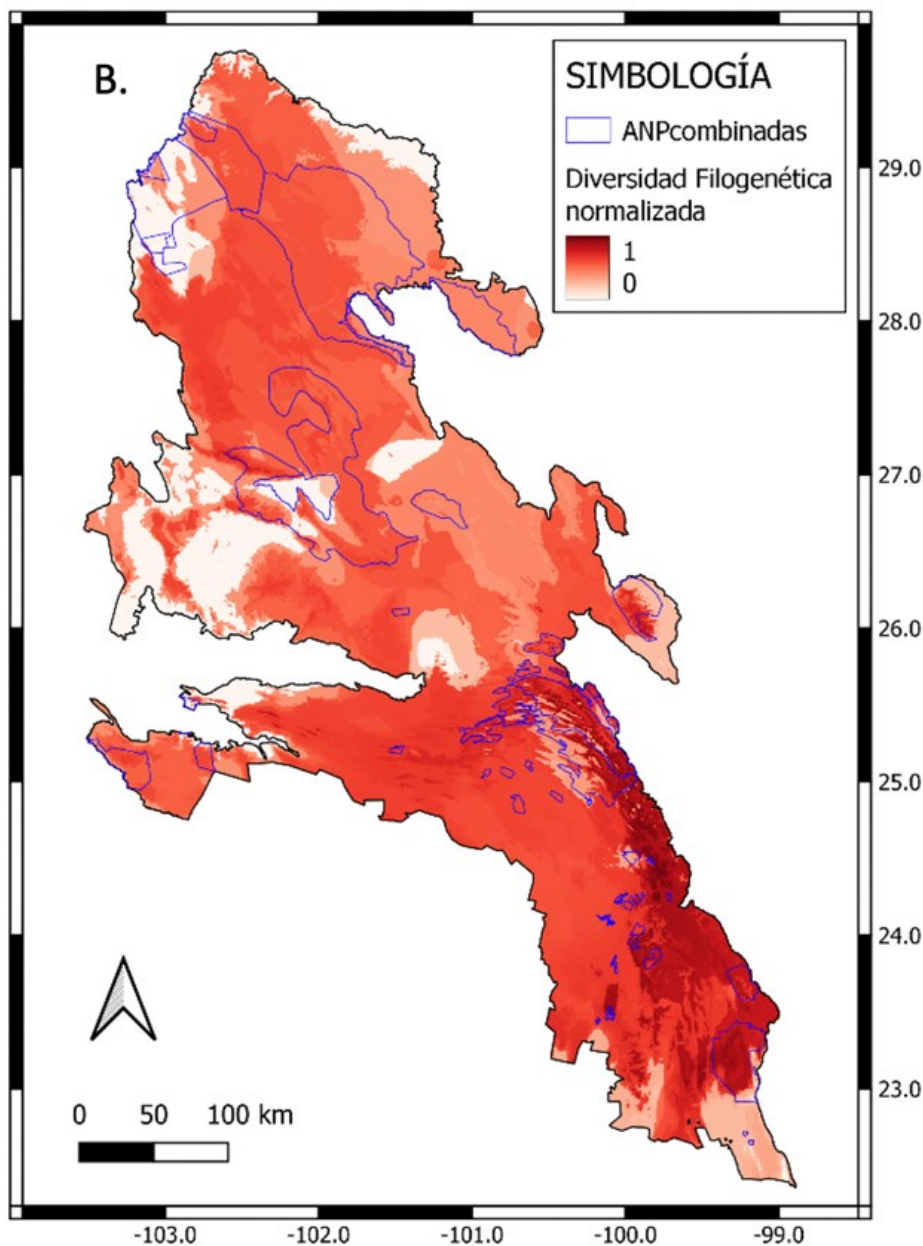
Figure 3. Conifer Phylogenetic Diversity distribution in the Sierra Madre Oriental against current Natural Protected Areas.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

- Due to the lack of distribution maps for the conifer species in NE Mexico, potential distribution models of species were conducted to identify potential distribution for all species. However, upon the evaluation of potential distribution zones, it became clear that for most taxa the downloaded occurrences were heavily biased to easy access areas as well as popular hiking destinations. For endemic and restricted distribution species, potential distribution models overestimated establishment, mainly due to changes in the landscape, land use change, and very specific abiotic conditions necessary for the species establishment that the model didn't take into consideration. Future actions will include to work along local communities and management authorities to take these potential distributions and conduct additional fieldwork to build current and updated distribution maps.

- Taxonomic discrepancies between closely related species were identified at the beginning of the project. For this, three different genes were sequenced from locally sampled specimens. Despite the use of multiple genes, pinyon and juniper pine relationships are still in need of more support to agree on a more accurate phylogeny. The assembly of chloroplast genomes for species that lack this genetic information could aid in the identification of species level barcodes and the construction of a fully resolved phylogeny. The identification of species barcodes in developing countries is urgently needed. First world countries are currently working on the development of barcodes of local species; however, the use of accessible technologies is necessary for developing countries to catch up with these conservation efforts, especially when most of global biodiversity is found in low-income countries. Being that these species, especially endemic ones are very possibly the result of a speciation event from a single common ancestor, the identification of conservation units beyond species level would be a useful decision-making tool. For this, population structure analyses for closely related species where taxonomic units are not completely clear will provide new insights into the genetic structure and diversity where conservation units can be stablished and properly managed without disturbing potential evolutionary events in the future.

- To identify species of high conservation priority the EDGE methodology was used, species were scored based on their evolutionary distinctiveness and IUCN red list risk status. Most of species were last assessed between 2010 and 2013, but since then the Sierra Madre Oriental landscape has changed significantly due to forest fires, human establishments, land use change, lodging, and climate changed induced shrinkage of species distributions. We realised that although for endemic species IUCN assessments more accurately depict local probability of extinction, for widely distributed species, like *Pinus cembroides*, the current threats of local populations are not taken in consideration when assigning a level of risk. The Mexican NOM-059 list of protected species was used to assess the local state of Mexican conifer

populations more accurately, however, the criteria between both is not the same making this comparison not quite homologous. To tackle this, we propose the use of a local risk assessment framework that follows the same criteria as the IUCN to identify local conservation units at risk rather that species as a whole taxonomic unit, since unique populations might host important genetic resources as well as provide important ecosystem services for local ecosystems where their extinction even if local would represent the loss of important biodiversity.

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

This project was partially possible due to the help of local stakeholders and rural landowners who allowed us to access sampling regions that have been closed to general public after the severe fire seasons that the SMO has experienced these past years. We worked closely with NGOs that are involved in the restauration of temperate forests in the Sierra Madre Oriental. It is important to highlight that 70% of the Mexican territory is private property, owned mostly by local and rural communities, therefore any work conducted is not only upon the benefit of the preservation of biodiversity but for the overall maintenance of our ecosystems that are the main source of income of these rural communities. A prime example of this is pinyon pine nut sales, where recent changes in seed production periodicity probably induced by climate change have impacted the economy of rural communities greatly. Likewise exotic species and fires affect rural communities' homes and homogenise the landscape where less biodiversity translates in less resources for them to sell and use. The wellbeing of rural communities in Mexico relies greatly on healthy and sustainable ecosystems, being this on of the main reasons why an integral assessment of our biodiversity is required.

5. Are there any plans to continue this work?

Yes, we are currently stablishing relationships with IUCN conifer coordinators to help in the updating of risk assessments for NE Mexican conifers. This will update our EDGE species results to reflect a more accurate priority status based on current risk. We have also had conversations with the London Zoological Society EDGE of Existence programme about the work we have been conducting and plan to work close with them to take this global approach to a regional level to better understand biodiversity patterns at a local scale and how evolutionary history can be used as an efficient tool to set conservation priorities in low income countries.

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

We are working on two different case studies that will be publish as part of a state-wide study on the state of Nuevo León, México. This biodiversity synthesis is aimed for local and federal stakeholders, government authorities and policy makers as a reference for management and conservation plans. Invitation letters from both case studies (first case study related to 1st Rufford Small Grant and second case study to 2nd Rufford Small grant) can be found as attachments to this report, Rufford

Foundation will be included in the Acknowledgments sections of both case studies as the main funding body.

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

Although we understand that uncertainties at a global level need to be embraced to stablish conservation priorities fast in a scenario where global warming is driving significant change in populations survival and distributions, at a regional scale we believe these uncertainties can and must be resolved. A global understanding of the world's biodiversity is just as crucial for global actions as local biodiversity information is necessary for local policy change, and since conservation and management plans are usually more effective when tackled at a regional level, our goal is to inform as much as we can on the status of NE Mexican conifers, being a group that has historically been understudied and is highly vulnerable under the future climate scenario. Closer work with rural communities to understand their perspectives and needs will be important to best set future actions to help in the self-preservation of temperate forests in NE Mexico.

8. 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?

Yes, PG seminars were presented as one poster and one presentation, the Rufford Foundation logo was used in both of these. The Rufford Foundation will be included in Acknowledgments of two case studies for an important Biodiversity synthesis for the Nuevo León state that is part of a national initiative of the National Commission of Biodiversity (CONABIO).

9. Provide a full list of all the members of your team and their role in the project.

PhD student Katia Lizeth Treviño Cuéllar (PI)
Project development and organization. Fieldwork for sample acquisition and taxonomic identification. Sample processing, DNA sequence and phylogenetic analyses. Results analyses and interpretation. Stablishing relationships with stakeholders and local authorities through Dr Susana Favela as well as the establishment of links with the EDGE of existence program and IUCN conifer experts.

Dr Susana Favela Lara (conifer expert)
Member of several conservation committees from federal and private institutions, Dr Favela was key in establishing contact with local communities and federal authorities. She is an expert in taxonomy and systematics of conifers from NE Mexico and her input during the fieldwork was very important to accurately identify closely related species as well as the interpretation of the community phylogeny. She is the chief of the Molecular Ecology Lab where DNA is being stored.

MRes student María Susana Sánchez Chávez
Construction of potential distribution models. Sample processing, DNA sequence and phylogenetic analyses.

Dr Luis Alexander Peña Peniche
GIS training and input to build potential distributions maps as well as the Sierra Madre Oriental grid for this project.

Dr María Concepción Jordán Hernández
Phylogenetic training to conduct phylogenetic analyses.

10. Any other comments?

Fieldwork for this project benefited the MRes thesis project of Mayté Méndez Lozano, whose thesis topic is part of our broader aim to explore biodiversity indices for NE Mexican flora. Her project involves the analyses of the functional and phylogenetic diversity of arboreous plant species in one of the Sierra Madre Oriental's alpine ecosystems, the Sierra de la Marta. Mayte's thesis is being supervised by Dr Susana Favela Lara and externally advised by PhD student Katia Lizeth Treviño Cuéllar.

Katia Lizeth Treviño Cuéllar: As the PI of this grant, I want to state that I started a NERC funded Doctoral Training Partnership in September 2022 based in the University of Edinburgh. My PhD was initially aimed to conduct work on molecular analyses of Antarctic Seals; however, my PhD project has recently changed, and I will now pursue the continuation on this Rufford project working with NE Mexican conifers with the help of the Royal Botanic Gardens of Edinburgh and the advice of the EDGE programme from the London Zoological Society as my PhD thesis.

ATTACHMENTS

Invitation letters for Case Studies

San Nicolás de los Garza, N.L., a 28 de agosto de 2023

Asunto: Invitación para participar como autor de estudio de caso en el libro:

Síntesis Diagnóstica de la Biodiversidad de Nuevo León

Estimado/a M. en C. Katia Lizeth Treviño Cuéllar,

Espero que este mensaje le encuentre bien, nos dirigimos a usted en calidad de Coordinadores Estatales para la elaboración de la Síntesis Diagnóstica de la Biodiversidad de Nuevo León (SDBNL), nombramiento otorgado mediante el oficio SMA 799/2023 por el Maestro Félix Guadalupe Arratia Cruz, Secretario de Medio Ambiente de Nuevo León.

El objetivo principal de este proyecto es desarrollar un diagnóstico sobre la biodiversidad de Nuevo León, siguiendo el modelo establecido por la Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) para los estados.

Debido a su destacada trayectoria y conocimientos en su campo de trabajo, nos complace invitarlo/a cordialmente a formar parte de nuestro equipo como autor de un estudio de caso sobre **Adaptación genética local de *Pinus hartwegii* en gradientes altitudinales de ecosistemas de alta montaña de la Sierra Madre Oriental,** ubicado en la sección **Biodiversidad -Genes,** su valiosa participación ayudará a dar un enfoque especializado y riguroso a la construcción del diagnóstico.

Las actividades generales de los autores de estudios de caso serán:

- Comprometerse a cumplir con los tiempos acordados.
- Brindar información confiable y actualizada de acuerdo al estudio de caso.
- Enviar la información (textos, referencias, figuras, cuadros, listas de especies, mapas y otros insumos utilizados o generados) al coordinador de sección de acuerdo a las normas editoriales.
- Enviar y validar las listas de especies al coordinador de sección para retroalimentar a la CONABIO (cuando el estudio de caso lo requiera).
- Atender la información solicitada de la revisión técnica realizada por el coordinador de sección, por la analista Jessica Valero y por la CONABIO.

Se anexa una breve introducción de la SDBNL, así como las normas editoriales para brindar mayor claridad sobre el trabajo que implicará y con ello pueda evaluar e indicarnos su participación.

En caso de aceptar esta invitación, le informaremos de una futura reunión con los coordinadores y coautores de cada sección para explicar el contenido de la SDBNL, los términos de referencia, la regionalización a utilizar para el análisis, la forma y calendario de trabajo, así como para aclarar las dudas de los participantes.
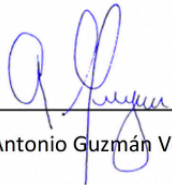
El tiempo estimado del proyecto es de un año a partir del 1 de septiembre, por esta razón agradeceremos que pueda confirmar su disposición para participar a más tardar el 31 de agosto para proceder con la coordinación logística necesaria.

La participación es voluntaria, no hay retribución económica, pero a todos los colaboradores se les hará mención en la obra resultante, la cual será uno de los insumos de trabajo para elaborar la Estrategia Estatal de Biodiversidad, por lo que su participación será de gran relevancia para el desarrollo sostenible y la preservación de la riqueza natural de nuestro estado.

Por favor, siéntase libre de contactarnos para cualquier aclaración o información adicional que pueda requerir. Esperamos contar con su valiosa participación en este importante proyecto.

Con nuestros mejores deseos,

Atentamente,

_____   _____
Dr. Antonio Guzmán Velasco   Dra. Susana Favela Lara

Coordinadores Estatales para la Síntesis Diagnóstica de la Biodiversidad de Nuevo León

Ubicación: Facultad de Ciencias Biológicas, Unidad B, UANL

Teléfonos: 81 1611 2282 y 81 1277 9903

Correos electrónicos: anguve@gmail.com, sfavela@gmail.com, sintesis.bio.nl@gmail.com

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Debido a su destacada trayectoria y conocimientos en su campo de trabajo, nos complace invitarlo/a cordialmente a formar parte de nuestro equipo como autor de un estudio de caso sobre **Diversidad filogenética de coníferas basado en el índice de distinción evolutiva,** ubicado en la sección **Biodiversidad -Especies**, su valiosa participación ayudará a dar un enfoque especializado y riguroso a la construcción del diagnóstico.

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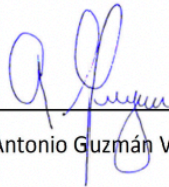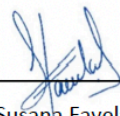
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Con nuestros mejores deseos,

Atentamente,

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Dr. Antonio Guzmán Velasco   Dra. Susana Favela Lara

Coordinadores Estatales para la Síntesis Diagnóstica de la Biodiversidad de Nuevo León

Ubicación: Facultad de Ciencias Biológicas, Unidad B, UANL

Teléfonos: 81 1611 2282 y 81 1277 9903

Correos electrónicos: anguve@gmail.com, sfavela@gmail.com, sintesis.bio.nl@gmail.com