Chapter 10
Successful Experiences in Promoting Scientific Research in Mexican Conservation Biology

Arturo Gómez Barrero, Arturo Gómez-Pompa, and Andrea Gómez Lissarrague

Abstract This chapter describes two private projects that promote and support scientific research in conservation biology in Mexico. The first project describes 10 years of experiences of a program known as "Por Amor al Planeta," funded by Volkswagen Mexico, which recognizes the efforts of Mexican scientific researchers in the field of biological conservation in Mexico, specifically in natural protected areas. The second project is based on the Ecological Reserve "El Edén" (located north of Quintana Roo, México). It explains more than 20 years of experiences of a private reserve dedicated to supporting and promoting scientific research in biodiversity conservation and management.

Keywords Biodiversity · Conservation · Awards · Eden · Reserve · Research

10.1 Introduction

One central problem of biodiversity conservation in Mexico today is that although it seems that we all agree on its importance and the urgency to protect it, there are very few places that have been studied in depth. Scientific research in conservation biology is scarce and is badly needed. As Watson and Venter wrote in their recently publication, "Conservation biology is the study of attempts to protect and preserve biodiversity. It focuses on both the biological and social factors that affect the success of conservation efforts and on determining ecosystems and species whose

A. Gómez Barrero (✉)
ARGO Environmental Consulting Firm, Puebla, Mexico
e-mail: agomezbarrero@argoconsultores.com

A. Gómez-Pompa
Botany and Plant Sciences Department, University of California (UC), Riverside, Irving, TX, USA
e-mail: floramex@ucr.edu

A. Gómez Lissarrague
El Edén Ecological Reserve, Issaquah, WA, USA

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conservation is a high priority" (Watson and Venter 2017). We need to know what are the best approaches for conservation to confront the major well-known threats that menace our planet's biodiversity: climate change, tropical deforestation, habitat loss, biological extinctions, and pollution.

Scientific research is not a priority action in the calls for conservation of nature. The principal global initiative to confront this problem has been to create more areas protected from human activity as insurance for the future. According to the National Commission of Protected Areas of Mexico (CONANP 2017), protected areas are portions of land or water in the country representing various ecosystems, where the original environment has not been essentially altered and which produce environmental benefits increasingly recognized and valued. However, the information in which to base the size, number of areas, and location needed to protect high diversity sites is scarce. Most of the new protected areas are selected by educated guesses of local experts rather than in hard data generated by research. An incomplete list of the best-known fauna (mostly vertebrates) and flora (mainly flowering plants) usually is used as the "scientific" validation for the establishment of the reserve. As Bernard Williams once said, "A natural park is not nature, but a park; a wilderness that is preserved is a definite, delimited, wilderness. The paradox is that we must use our power to preserve a sense of what is not in our power" (Williams 1995).

The explanation for why this has not been done in developing countries is that there are not enough scientists available to do the needed in-depth studies in protected spaces. Conservation organizations and funding agencies have given high priority to short-term studies that have low cost, which unfortunately do not provide the needed information. Long-term scientific studies to address the badly needed problems of biodiversity conservation and management seem to have been postponed permanently.

In contrast with this fact, we have the permanent discussion that the reason why we want to conserve biodiversity is because of the potential value it has for humankind. Here we have a painful paradox. We are protecting a biodiversity that we do not know and we are not planning to study, using the reason of its usefulness. How can anyone know if something is useful or not if we do not know we have it?

10.1.1 Problem Description

The enormous transformation to which our planet has been subjected has brought the dramatic loss of biological resources. The current challenge is to assess this problem in various parts of the world and find ways to stop and reverse it. This can only be done with scientific information produced throughout the world.

Scientific research in Mexico on biological conservation does not have the priority it should have. The country invests a good amount of resources in the creation of protected areas but very little on scientific research to explore the best approaches for the protection of rare species and ecosystems.

The two approaches we describe in this chapter are addressing the importance to promote scientific research in conservation biology and biodiversity conservation.

The Volkswagen Award, "Por Amor al Planeta" (For the Love of the Planet), was created to recognize a distinguished group of Mexican scientists for their outstanding scientific contributions to biological conservation in Mexico, as well as give support for research projects in natural protected areas (NPAs). "El Edén" Ecological Reserve (EEER) is a private NPA dedicated to doing and promoting scientific research in a dry tropical forest region and wetland site in the Mayan region of Mexico.

10.2 Por Amor al Planeta: Project of Volkswagen Mexico

The natural legacy in Mexico is a privilege that must be recognized as an important element for the sustainable future of societies. Thus, the work of protecting this natural capital concerns not only a few sectors of society.

Volkswagen Mexico (VWM) encourages the vision shared by different sectors of Mexican society about the urgent protection and study of nature. VWM believes that the responsibility with biodiversity is a principle and to participate in the search of solutions to the environmental crisis is a priority. Therefore, action was taken to contribute to the conservation, restoration, and recovery of nature, through the establishment of the "Por Amor al Planeta" program.

The program consisted of two awards: Award for Scientific Research in Biological Conservation and Support for a Research Project in an NPA, which will be described in detail. The first edition of the program was in 2006 and the last one in 2015, 10 years promoting scientific research in Mexico.

One essential part of the program was the selection of the jury, which was composed mainly of people who have a recognized and proven trajectory nationally and internationally in different aspects of nature conservation. In the first edition of the program, the jury was consisted by; a representative of the federal government (Ernesto Enkerlin Hoeflich, PhD, member of the National Commission of Protected Natural Areas, CONANP), a representative of the Organized Civil Society (OCS) (Ing. Guillermo Barroso Montull, president of a Mexican environmental conservation group, PRONATURA AC), four researchers with proven trajectory both nationally and internationally (Rodolfo Dirzo, PhD; Exequiel Ezcurra, PhD; Otto Solbrig, PhD; and Ernesto Rodríguez Luna, PhD), and, finally, three members of VWM (Francisco Bada Sanz, Thomas Karig, and Raúl Rodríguez).

In the second edition, Otto Solbrig, PhD, left the jury because the jury meetings scheduled for the second edition were not compatible with his agenda. The other jury members invited Gonzalo Halffter Salas, PhD, (winner of the first edition of the program) to participate as a member of the jury for the second edition. For the third edition, Gonzalo Halffter Salas, PhD, left the jury for health reasons, and again by consensus of the other members of the jury, it was decided to invite again the winner of the second edition, so Gerardo Ceballos González, PhD, joined the jury. For the next jury meeting (fourth edition), the winner of the third edition was also included, so Rodrigo Medellín Legorreta, PhD, joined the jury, giving a total of ten members. All members of the jury (Fig. 10.1) confirmed their participation year after year until the last edition (2015) of the VWM program.

Fig. 10.1 Members of the jury of ¨Por Amor al Planeta¨ program and staff of VWM. (Photograph by ARGO Environmental Consulting Firm)

It should be noted that, since the beginning and throughout the 10 years of the program, the figures of president of the jury and representative of the OCS remained permanently occupied by Mr. Thomas Karig (vice president of corporate relations of VWM) and Mr. Guillermo Barroso Montull.

10.2.1 Award for Scientific Research in Biological Conservation

The award was intended to recognize researchers or research groups with a distinguished career within the area of biological conservation in Mexico, whose contributions influenced the establishment of current or potential policies for the conservation of nature. The award promoted the formation of new generations of researchers and the dissemination of their work toward society.

Trajectory, scientific relevance, social impact, replicability, and commitment to the training of new scientists were the main aspects that the jury members evaluated to make their final decision.

More specifically the following criteria were taken into consideration to choose the winner of each of the ten editions of the program.

- That the project's active researchers or groups of researchers were using an NPA as a fundamental site for the development of their work and studies.
- That the researchers had a distinguished career and proven experience in scientific research for at least 10 years.
- That, through the award, the scientist's full trajectory was recognized in order to stimulate long-term productivity as well as creativity in their work.
- That the work done by the researcher showed a transcendental biological, social, and economic impact.
- That the project contained originality, creativity, scope, and degree of innovation of scientific and technological development programs and their impact on the generation of knowledge about biodiversity in Mexico.
- That the results of their work can be applied in similar circumstances in the protection, management, and restoration, as well as the sustainable management of the natural resources of different regions of the country.
- That the information derived from their research allowed the definition of better biological governmental conservation policies.
- That the researcher or research group was forming new generations of researchers on conservation biology.
- That the applicant had carried out important actions to inform the general public on the findings and importance of the research done.

10.2.1.1 Winners

First Edition (2006): Gonzalo Halffter Salas, PhD.

Halffter Salas is a biologist of the National School of Biological Sciences of the National Polytechnic Institute. He has been the founder and director general of the Institute of Ecology, A.C. He was the director of the Museum of Natural History of Mexico City.

He has published more than 240 scientific articles and 55 books or book chapters INECOL (2017). His diverse contributions to the areas of animal behavior, biogeography, biodiversity, and the conservation of natural resources make him one of the most important Mexican scientists. He is considered as one of the pioneers in the establishment of new concepts that influenced the notion of sustainability and the development of biodiversity conservation policies, and he contributed to the creation of several biosphere reserves of Mexico.

Three of his most important and recent publications in conservation biology are:

1. Escobar, F., G. Halffter and L. Arellano. 2007. From forest to pasture: An evaluation of the influence of environment and biogeography on the structure of dung beetle (Scarabaeinae) assemblage along three altitudinal gradients in the Neotropical Region. *Ecography* 30: 193–208.

2. Halffter, G. 2005. Towards a culture of biodiversity conservation. *Acta Zoológica Mexicana (n.s.)* 21 (2): 133–153.
3. Padilla, D.N. & G. Halffter. 2006. Biogeography of the areas and Canthonini (Coleoptera: Scarabaeinae) of dry tropical forests in Mesoamerica and Colombia. *Acta Zoológica Mexicana (n.s.).* 23 (1): 73–108.

Second Edition (2007): Gerardo Ceballos González, PhD.

Professor Ceballos González is a highly distinguished and globally recognized ecologist and conservation biologist. He is a world leader in the evaluation and design of conservation strategies for both endangered species and threatened ecosystems. He has earned this distinction because of his significant contributions to science and conservation efforts, including but not limited to his (1) pioneering and extraordinarily diverse ecological and conservation research, (2) exceptional efforts to use ecological knowledge to address crucial societal issues, (3) building of bridges between ecology and conservation in order to humanely implement viable options to attain paths to ecological sustainability, and (4) untiring efforts to increase the ecological literacy of the general public. Notable among his many conservation achievements is his success in proposing and facilitating the establishment of more than 20 protected areas that cover almost 2% (4 million hectares) of the Mexican land mass. These reserves protect thousands of plant and animal species, including an estimated 20% of all endangered vertebrate species.

His research and advocacy was instrumental in the 1994 adoption of the Mexican Law for Endangered Species Protection, which now protects more than 4000 endangered species; this is one of his most long-lasting contributions. He is the author of 48 books and more than 500 scientific and outreach articles of conservation biology, ecology, ecological applications, and biological conservation. A lot of his artiles are published in scientific journals such as Science, PNAS and PLoS One.

Three of his most important and recent publications in conservation biology are:

1. Ceballos, G., P. R. Ehrlich and R. Dirzo. 2017. Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proceedings of the National Academy of Sciences*, *114*(30), E6089–E6096.
2. Ceballos, G., A. Barnosky, A. García, R.M. Pringle, T.M. Palmer and P.R. Ehrlich. 2015. Accelerated Modern Human Induced Species Losses: Entering the Sixth Mass Extinction. *Science Advances.* 1:e1400253.
3. Ceballos, G., P.R. Ehrlich and A.H. Ehrlich. 2014. *Annihilation of Nature: Human Extermination of Birds and Mammals.* John Hopkins Press, Baltimore.

Third Edition (2008): Rodrigo A. Medellín Legorreta, PhD.

Medellín Legorreta (Fig. 10.2) is a senior professor of ecology at the Institute of Ecology, University of Mexico. He has dedicated his life to the study of the ecology and conservation of mammals in Mexico and elsewhere for over 30 years. Working from rainforests to deserts to montane forests, he uses community ecology, plant-animal interactions, population biology, and molecular ecology to solve conservation problems.

Fig. 10.2 Dr. Medellín working with bats FWS U.S. Fish and Wildlife Service (2015). (Photo by Marina Rivero)

He has over 190 publications including over 90 papers in peer-reviewed journals and over 50 books and book chapters on bat ecology and conservation, jaguar conservation and recovery, mammal diversity analyses, and conservation of large mammals. Medellín Legorreta was the head of the Wildlife Department of the Mexican federal government in 1995–1996, the founder and director of the Program for the Conservation of Bats of Mexico, and the founding director of the Latin American Network for Bat Conservation RELCOM. Rodrigo is the co-chair of the Bat Specialists Group of IUCN. He co-coordinated Mexico's first National Jaguar Census, CENJAGUAR.

He has taught conservation biology and community ecology for over 30 years. He is an adjunct professor at Columbia University in New York, Andalucia International University, the University of Arizona, and others. His work studying and protecting mammals has influenced policy and spanned all continents and many countries. Since 2016 he is a member of the Board of Reviewing Editors of Science Magazine. Medellín Legorreta has received various recognitions and awards, including the first-ever Whitley Gold Award from Princess Anne of England again in 2012, the first individual ever to receive two Whitley Awards. In 2014 BBC Natural World produced the multi-awarded film The Bat Man of Mexico (narrated by David Attenborough) covering Rodrigo's work on bats.

Three of his most important and recent publications in conservation biology are:

1. De la Torre, J. A., J. F. Gonzalez Maya, H. Zarza, G. Ceballos and R. A. Medellin. 2017. The jaguar's spots are darker than they appear: assessing the global conservation status of the jaguar *Panthera onca*. *Oryx* 51: DOI: https://doi.org/10.1017/S0030605316001046

2. Frick, W.F., E.F. Baerwald, J.F. Pollock, R.M.R. Barclay, J.A. Szymanski, T.J.Weller, A.L. Russell, S.C. Loeb, R.A. Medellin and L.P. McGuire. 2017. Fatalities at wind turbines may threaten population viability of a migratory bat. *Biological Conservation* 209: 172–177.
3. Wiederholt, R., L. López-Hoffman, C. Svancara, G. McCracken, W. Thogmartin, J. Diffendorfer, K. Bagstad, P. Cryan, A. Russell, D. Semmens and R.A. Medellin. 2015. Optimizing conservation strategies for Mexican free-tailed bats: a population viability and ecosystem services approach. *Biodiversity and Conservation* 24(1): 63–82.

Fourth Edition (2009): Valeria Souza Saldivar, PhD.

Souza Saldivar earned a BS in Biology, MS in Genetics, and PhD in Ecology from the National Autonomous University of Mexico (UNAM). She completed two postdoctoral positions with Richard Lenski on the long-term *E. coli* evolution experiment.

The last years of her investigations have been dedicated to defending and to preserving the Valley of Four Ciénegas in the state of Coahuila, demonstrating and spreading to national and international level the biological, economic, and cultural value of the region. The contributions in the study of conservation and ecology in this area are not only original, innovative, and numerous but also of scientific relevance. Furthermore, she has linked its research with concrete actions for conservation. For the area, she has suggested different strategies for the sustainable management of wetlands. Thanks to her scientific work and dissemination of information, the World Wildlife Foundation (WWF) has declared Four Ciénegas a priority conservation site.

She is currently a senior researcher in the Department of Evolutionary Ecology of the Institute of Ecology of the UNAM. She has published more than 49 research articles in international refereed journals and 12 in national and dissemination journals. She has written seven chapters in books, a coedited book, and ten articles in national magazines.

Three of her most important and recent publications in conservation biology are:

1. Souza V., L. Espinosa-Asuar, A.E. Escalante, L. E. Eguiarte, J. Farmer, L. Forney, L. Lloret, J.M. Rodríguez-Martínez, X. Soberón, R. Dirzo and J. J. Elser. 2006. An endangered oasis of aquatic microbial biodiversity in the Chihuahuan desert. *PNAS* 103(17): 6565–6570.
2. Rusch D.B., A.L. Halpern, G. Sutton, K.B. Heidelberg, S. Williamson et al. 2007. The Sorcerer II Global Ocean Sampling Expedition: Northwest Atlantic through Eastern Tropical Pacific. *PLOS Biology* 5(3): e77. https://doi.org/10.1371/journal.pbio.0050077
3. Hernández A., H.S. Espinosa-Pérez and V. Souza. 2017. Trophic analysis of the fish community in the Ciénega Churince, Cuatro Ciénegas, Coahuila. *PeerJ* 5:e3637.

Fifth Edition (2010): María Enriqueta Velarde González, PhD.

Velarde González is a senior full-time researcher at Instituto de Ciencias Marinas y Pesquerías, Universidad Veracruzana. She has focused her work on seabird ecology, mainly breeding and feeding ecology, as well as conservation and management of insular ecosystems. She has also carry out research about the distribution of seabirds at sea and in the islands of the Gulf of California. One application of her research has been the use of data from her studies of seabird feeding and breeding ecology for the prediction of commercial fisheries.

With Enriqueta Velarde, conservation of the islands of the Gulf of California rose to a new level, with her work published in 1988 titled "Islands of the Gulf of California," formed and led a research group on the Gulf Islands. This publication was a real breakthrough in the conservation of the islands and the entire Gulf. The validity of this study is so great that, almost 20 years later, it formed one of the central elements in the designation of the Gulf of California Islands as a World Heritage Site.

Three of her most important and recent publications in conservation biology are:

1. Bourillón, L., A. Cantú, F. Eccardi, E. Lira, J. Ramírez, E. Velarde and A. Zavala. 1988. *Islas del Golfo de California*. Coedited by la Secretarıa de Gobernación/ UNAM, First Edition, Distrito Federal, México. 292 pp.
2. Velarde, E., E. Ezcurra, M.A. Cisneros-Mata and M.F. Lavín. 2004. Seabird ecology, El Niño anomalies, and prediction of sardine fisheries in the Gulf of California. *Ecological Applications* 14: 607–615.
3. Christian, C., D. Ainley, M. Bailey, P. Dayton, J. Hocevar, M. LeVine, J. Nikoloyuk, C. Nouvian, E. Velarde, R. Werner and J. Jacquet. 2013. A review of formal objections to Marine Stewardship Council fisheries certifications. *Biological Conservation* 161: 10–17.

Sixth Edition (2011): Mario González Espinosa, PhD, and Víctor Sánchez-Cordero Dávila, PhD.

In this edition, there was a tie between Mario González Espinosa and Víctor Sánchez-Cordero Dávila.

González Espinosa is an agronomical engineer with a PhD in population biology from the University of Pennsylvania (USA). He is a senior research staff member of El Colegio de la Frontera Sur (ECOSUR), where he has held several academic positions in graduate programs for almost 25 years.

For more than 30 years, his work has focused on understanding the interactions of Mayan rural communities, land-use change, and the provision of ecosystem services in their territories to support their sustainable development in mountain areas of Chiapas and Tabasco. He has dedicated a lot of his time to helping build academic capacities in southern Mexico including graduate education programs, an institutional herbarium, and a productive research group through the training of more than 40 master's and PhD students.

He has over 120 publications including papers and book chapters, and he has been the lead editor of several books. He is a founding member of the "Fundación Internacional para la Restauración de Ecosistemas" operated from Madrid. Besides

the "Por Amor al Planeta" Award, in 2013 he received the "Medalla al Mérito Botánico," the highest distinction awarded by the Botanical Society of Mexico.

Three of his most important and recent publications in conservation biology are:

1. Ramírez-Marcial, N., M. González-Espinosa and G. Williams-Linera. 2001. Anthropogenic disturbance and tree diversity in Montane Rain Forests in Chiapas, Mexico. *Forest Ecology and Management* 154: 311–326.
2. González-Espinosa, M., J.M. Rey-Benayas, N. Ramírez-Marcial, M. A. Huston, and D. Golicher. 2004. Tree diversity in the northern Neotropics: regional patterns in highly diverse Chiapas, Mexico. *Ecography* 27: 741–756.
3. Toledo-Aceves, T., J. A. Meave, M. González-Espinosa and N. Ramírez-Marcial. 2011. Tropical montane cloud forests: current threats and opportunities for their conservation and sustainable management in Mexico. *Journal of Environmental Management* 92: 974–981.

Sánchez-Cordero Dávila studied a Sciences bachelor's degree in the Faculty of Sciences of the UNAM and the master's and PhD in the University of Michigan (School of Natural Resources) in the United States. He is a full-time researcher at the Institute of Biology.

His area of expertise includes the modeling of species distribution in aspects of biogeography and conservation of mammals predominantly in Mexico. His research group has made theoretical contributions on the evolution of ecological niches of species, proposing that these ecological niches are conserved throughout evolutionary times, which helps to explain vicarious speciation processes. These theoretical-methodological approaches have also been applied to identify priority areas for biodiversity conservation at different geographic scales and to demonstrate that Mexico's protected areas are effective instruments for the conservation of biodiversity. In addition, these theoretical approaches have been used to identify geographical areas at risk of emerging infectious diseases of public health importance, such as leishmaniosis and Chagas disease, by modeling the distribution of their reservoirs and potential vectors, respectively.

He has published 83 refereed scientific articles including publications in science, nature, Proceedings of the National Academy of Science, and PLoS ONE, 4 books in national editions, 35 book chapters in national and international editions, and 2 articles in extenso.

Three of his most important and recent publications in conservation biology are:

1. Peterson, A., J. Soberón and V. Sánchez-Cordero. 1999. Conservatism of ecological niches in evolutionary time. *Science* 285: 1265–1267.
2. Peterson, A., V. Sánchez-Cordero, C. Beard, and J. Ramsey. 2002. Ecologic niche modeling and potential reservoirs for Chagas disease, Mexico. *Emerging infectious diseases* 8: 662–667.
3. Herrera M., L. G., J. J. Flores-Martínez and V. Sánchez-Cordero. 2017. Geographical distribution and conservation status of an endemic insular mammal: The Vulnerable fish-eating bat *Myotis vivesi*. *Oryx*. 1–6.

Seventh Edition (2012): Eric Mellink Bijtel, PhD.

He was raised in Mexico's Sonoran Desert and with a background in animal husbandry (B.S., Universidad Autónoma Chapingo, 1979) and arid lands resource sciences and wildlife ecology (PhD, University of Arizona, 1986).

Mellink Bijtel has devoted his carrier to the study of wildlife conservation issues in the Gulf of California, also called Sea of Cortez, a large inlet of the eastern Pacific Ocean along the northwestern coast of Mexico. He has focused on sea and coastal birds, as well as on mammals (especially rodents), but generating information also on reptiles and amphibians.

Mellink Bijtel focuses on understanding the historical processes leading to the current condition of species, communities, or landscapes. Many of his approximately 200 publications have provided information of high value for the management and biological conservation of Mexican fauna, especially of the Gulf of California and Pacific Islands. Mellink Bijtel is also active in the forming of future managers and scientists through both teaching graduate courses and directing M.Sc. thesis and PhD dissertations.

Three of his most important and recent publications in conservation biology are:

1. Mellink E. and M.E. Riojas-López. 2017. The demise of a tropical coastal lagoon as breeding habitat for ground-nesting waterbirds: Unintended, but anticipated consequences of development. *Coastal Management* 45: 253–269.
2. Mellink E., M.E. Riojas-López and M. Cárdenas-García. 2017. Biodiversity conservation in an anthropized landscape: Trees, not patch size drive bird community composition in a low-input agroecosystem. *PLoS ONE* 12(7): e0179438.
3. Mellink, E., M.E. Riojas-López and J. Luévano-Esparza. 2009. Organochlorine content and shell thickness in brown booby (*Sula leucogaster*) eggs in the Gulf of California and the southern Pacific coast of Mexico. *Environmental Pollution* 157: 2184–2188.

Eighth Edition (2013): Enrique J. Jardel Peláez, PhD.

Jardel Peláez is a professor of forest ecology and management at the University of Guadalajara, an institution he joined in 1986 as researcher and field manager at the recently created "Las Joyas" Research Station (LJRS) in the Sierra de Manantlán. This mountain range, located in western Mexico, has functioned for more than 30 years as a site for long-term ecological research and for education and training in biological conservation and natural resource management. It was the initial stage for the establishment of the Sierra de Manantlán Biosphere Reserve (SMBR).

Jardel Peláez participated in the creation and initial management of the SMBR, where he has worked for the last 30 years in projects that integrate scientific research on forest ecology with community-based forest management and wildlands conservation.

His research has contributed in different areas of ecology and has also been very useful in the development of best silvicultural practices, land-use planning, habitat and biodiversity conservation, forest ecosystems management, and fire management.

Applying the experience gained in the SMBR, Jardel Peláez has done consulting and training work in projects about protected area planning, forest management certification, fire ecology, and management in other parts of Mexico, El Salvador, and Cuba. He has also actively participated in national or regional initiatives related to nature conservation, communal forestry, and long-term ecological research.

Three of his most important and recent publications in conservation biology are:

1. Jardel, E.J., A.L. Santiago-Pérez, C. Cortés M. y F. Castillo-Navarro. 2004b. Sucesión y dinámica de rodales. En: R. Cuevas-Guzmán y E.J. Jardel (Editores). *Flora y Vegetación de la Estación Científica Las Joyas*. Universidad de Guadalajara. Guadalajara, Jal. Pp. 179–203.
2. Jardel-Peláez, E.J., R. Cuevas, A.L. Santiago y J.M. Rodríguez. 2014a. Ecología y manejo de los bosques mesófilos de montaña. En: Gual-Díaz, M. y A. Rendón-Correa (Comps.) El bosque mesófilo de montaña de México. Diversidad, ecología y manejo. CONABIO. México D.F. Pp. 141–187.
3. Jardel-Peláez, E.J. 2015. Criterios para la conservación de la biodiversidad en los programas de manejo forestal. *Programa de las Naciones Unidas para el Desarrollo-Comisión Nacional Forestal*. Zapopan, Jalisco, México. 126 Pp.

Ninth Edition (2014): Alfonso Aguirre Muñoz, PhD.

Aguirre Muñoz is an oceanographer and holds an interdisciplinary PhD in social sciences with focus on regional studies. He has a 40 years' professional trajectory that covers environmental conservation, fisheries and aquaculture, academy, and banking and finances for development. For the last 15 years, he has been the executive director of the Ecology and Conservation Group of the Islands (GECI), a science-based nonprofit organization devoted to the restoration and conservation of the Mexican islands (Fig. 10.3), always using and developing the best science methods and working in collaboration with local communities, government agencies, international organizations, and academic institutions.

During this period, GECI became a world leader in the complex field of island restoration and conservation. Before that, he founded and directed "Agromarinos," a successful family business committed to oyster aquaculture and artisanal seaweed fisheries. His varied publications and applied research subjects include teamwork on coastal management and aquaculture, island restoration, and critical reflections in the field of conservation. In addition to "Por Amor al Planeta," Aguirre Muñoz also received the MIDORI Prize for Biodiversity 2016, a Distinguished Citizen Award 2015 honored by the Society of the Ancient California and the municipality of Ensenada, the Pacific Seabird Group Special Achievement Award 2017, and several scholarships.

Three of his most important and recent publications in conservation biology are:

1. Aguirre-Muñoz, A. 2017. Gobernanza ambiental y responsabilidad social para la restauración ecológica en América Latina y el Caribe. In: Zuleta, G.A., A.E. Rovere y F.P.O. Mollard (Eds.), *SIACRE-2015: Aportes y Conclusiones. Tomando decisiones para revertir la degradación ambiental*. Vázquez Mazzini Editores, Buenos Aires, Argentina. Pp. 65–73.

Fig. 10.3 Biodiversity conservation of the Mexican Islands. (Photographs by Alfonso Aguirre)

2. Aguirre-Muñoz, A. et al. 2011. Island restoration in Mexico: ecological outcomes after a decade of eradications of invasive mammals. In: Veitch, C R; Clout, M N and Towns, D R (eds.) 2011. *Island invasives: Eradication and management*. IUCN, (International Union for Conservation of Nature), Gland, Switzerland. Island Invasives International Conference. Auckland, New Zealand. Proceedings.
3. Aguirre-Muñoz, A. et al. 2011. Eradications of invasive species on islands in Mexico: the roles of history and a non-profit organization. In: Veitch, C R; Clout, M N and Towns, D R (eds.) 2011. Island invasives: Eradication and management. IUCN, (International Union for Conservation of Nature), Gland, Switzerland. Island Invasives International Conference. Auckland, New Zealand. Proceedings.

Tenth Edition (2015): Ricardo Rodríguez Estrella, PhD.

Rodríguez Estrella has been an ecologist working with wildlife and their interactions in different ecosystems (e.g., desert areas, temperate forests, islands, and oases) during the last 35 years.

Rodríguez Estrella has contributed to the conservation of biodiversity determining the relevance of critical habitats as oases and desert ecosystems in Northwestern Mexico for the conservation of endemic and predator species. Several species he

has studied are now included in the Mexican endangered species act. His work has been useful for the establishment of four national protected areas. He has promoted the belief that oases in the Baja California Peninsula should be included as an officially natural protected area due to their biogeographic history, number of endemics of all biological groups, and their fragility and vulnerability. Furthermore, he has promoted the idea that conservation of oases and their biodiversity be encompassed within the local human populations development. At the present, he has conducted a program of control and eradication of exotic invasive species from these biological systems. In the last years, he has been the head of the scientific group working with the ecology and monitoring of the threatened golden eagle in Mexico.

He has written more than 150 scientific research and educational papers. He has worked in the dissemination of science and environmental education to show to the public the relevance of biodiversity for human development and the need of their conservation.

Three of his most important and recent publications in conservation biology are:

1. Rodríguez-Estrella, R., J.A. Donázar and F. Hiraldo. 1998. Raptors as Indicators of Environmental Change in the Scrub Habitat of Baja California Sur, Mexico. *Conservation Biology*, 12: 921–925.
2. Tella, J. L., J. Figuerola, J.J. Negro, G. Blanco, R. Rodríguez-Estrella, M.G. Forero, M.C. Blázquez, A.J. Green and F. Hiraldo. 2004. Ecological, morphological and phylogenetic correlates of interspecific variation in plasma carotenoid concentration in birds. *Journal of Evolutionary Biology*, 17: 156–164.
3. Holroyd, G. L., R. Rodriguez-Estrella, and S. R. Sheffield. 2001. Conservation of the burrowing owl in western North America: issues, challenges, and recommendations. *Journal of Raptor Research* 35: 399–407.

10.2.2 Support for a Research Project in a Protected Natural Area

This other ward seeks to stimulate scientific and technological research in the country's NPA, from the federal level to the state, municipal, community, and private levels. It distinguished the biological and ecological importance of the area as well as the technical, economic, and scientific viability of the project. The support consists of funding the project with $ 50,000 USD annually for up to 3 years.

The following criteria were taken in consideration to choose the winner of each of the ten editions of the program.

- That the project proposed new techniques for conservation, management, and use of biodiversity.
- That the academic and practical activities proposed in the projects showed biological and ecological importance.

- That the project was represented by a Mexican researcher or by an academic institution that collaborates in an NPA based in Mexico.
- That the projects promoted the training of new researchers and technicians on conservation issues.
- That the project showed the richness of flora and fauna of the NPA, giving priority to conservation projects of endangered species.

10.2.2.1 Winners

First Edition (2006): "Conservation evaluation of Cactaceae species in danger of extinction in the reserve of the biosphere Tehuacán-Cuicatlán." Oswaldo Téllez Valdés

Proposal entitled, "Conservation evaluation of Cactaceae species in danger of extinction in the Biosphere Reserve Tehuacán-Cuicatlán."

During the 3 years that VWM supported this project, the group of researchers and its leader Oswaldo Tellez Valdés PhD could provide information related to endemic species of Mexican Cactaceae as well as the identification of the conservation status of the same and the role that the Reserve (Tehuacán-Cuicatlán) was playing in their protection.

The family Cactaceae is in the major group of angiosperms (flowering plants) and is integrated by 52 genera and 850 species, of which 35% of the genera and 84% of the species are endemic of Mexico. These plants have been used as a source of food, construction material, fuel, and ornamental plants.

The geographic analysis carried out showed the extent of the area where the Cactaceae are located within the Reserve and how this distribution is related to temperature and precipitation patterns. On the other hand, the ecological analysis evaluated parameters such as habitat conditions, reproductive efficiency of the Cactaceae, and estimations of the number of individuals in different areas of the Reserve (Fig. 10.4).

Fourth Edition (2009): "Extending the conservation of the dry forest in the Balsas River Basin: proposal for a protected natural area in the Mixteca Baja Poblana." David Valenzuela

Proposal entitled, "Extending the conservation of the dry forest in the Balsas River Basin: proposal for a protected natural area in the Mixteca Baja Poblana."

This project studied an area of the Mixteca Baja Poblana, southwest of Puebla, where there are important remnants of dry forests, an area that has suffered damages, with high biodiversity rates, but at the same time fragile and one of the least protected ecosystems in the country. Through the results presented, they sustain that this area should be considered an NPA. This region stands out for its biodiversity and its contribution to the recharge of aquifers.

In short, the results showed that 290 plants were found of 77 families and 209 genera: four threatened and one endangered. Endemic species of bats (*Eumops* sp.

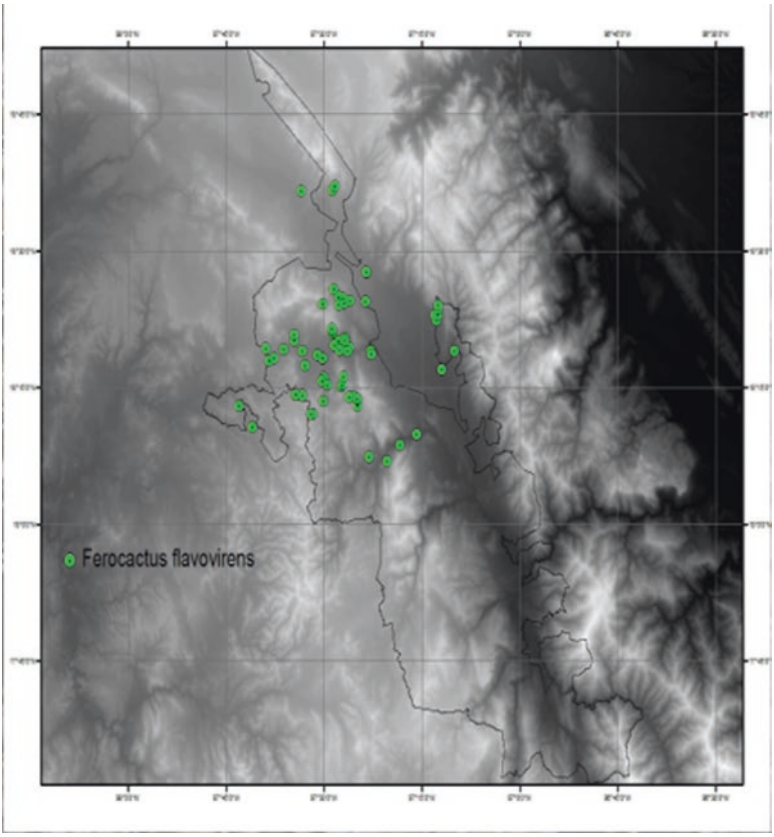

Fig. 10.4 The *green dots* show the distribution in the Tehuacán-Cuicatlán Reserve of *Ferocactus flavovirens*, an endemic species from the Tehuacán-Cuicatlán Reserve. (Image by O. Téllez V)

and *Musonycteris harrisoni*) (Fig. 10.5) were found, the latest in danger of extinction. The identification of 20 species of beetles and 145 morphospecies of 26 families of 5 orders of insects (Coleoptera, Hemiptera, Neuroptera, Hymenoptera, and Orthoptera) was made. Nearly 35 species of ants, 23 genera and 6 families were found, contributing with 24 more species of ants reported in the state of Puebla. Finally, they found five species of two families of mice (Heteromyidae and Muridae).

With all the information gathered by the group of researchers and its leader David Valenzuela Galván, PhD, it was possible to verify the high biological value that dry forest of the Mixteca Baja Poblana represents, so their purpose of making this area an NPA was valid.

Seventh Edition (2012): "La Malinche Science Station: Integrative Research for Conservation and Environmental Education." Margarita Martínez Gómez

Proposal entitled, "La Malinche Science Station: Integrative Research for Conservation and Environmental Education".

Fig. 10.5 *Musonycteris harrisoni*, endemic species that occurs in the dry forest of the Mixteca Baja Poblana. (Photograph by D. Valenzuela)

The main purpose of the project was to contribute knowledge in the maintenance of the ecosystems of the National Park La Malinche (NPLM) on which only partial information exists on that time. With the support of VWM, they could create La Malinche Scientific Station (LMSS), a facility that favor the conditions for the coordination and development of different investigations. The ecosystems that host the NPLM are characteristic of the high mountains of the Transverse Neovolcanic Axis, site of great biological wealth due to the confluence of two large biogeographic regions and to the geological history of the area.

Margarita Martinez Gómez, PhD, is the leader of a research group that performs an integrative study of the natural resources and biodiversity at NPLM. Some of the results they have found through their investigations showed the identification of 3268 species of bacteria. Of these species *Halomonas nitrophilus*, *Halomonas desiderata*, and *Chthoniobacter flavus* are the most abundant in these ecosystems. The NPLM area shields 19 species of reptiles, which represent 2.19% of the total species in Mexico and 8.7% of the reptiles of the central mountains. Furthermore, there are nine species of amphibians, which correspond to 2.39% of the total Mexican species and 6.8% of the species the central mountains. The monitoring provided a new record of reptiles (*Sceloporus spinosus*) and one of amphibians (*Hyla plicata*). Seven species of bats were recorded, of which *Myotis thysanodes* had not previously been observed in the NPLM.

The implementation of artificial ponds has given back to the fauna of the NPLM a little of the water resource of which it was deprived for several decades. So far, 1 species of amphibian, 30 birds, and 7 mammals are benefiting from the water provided by the ponds to perform their vital activities, such as reproduction and hydration. In addition, the incorporation of nest boxes has significantly favored the reproduction of an increasing number of bird species using secondary cavities.

All the information they have collected through their investigations has been of great support, allowing the detection of critical populations that require special attention. Currently, the LMSS is still being used and new research studies are in process to continue supporting the conservation of NPLM.

10.2.3 Reflections

Biological diversity is a subject of interest to the world. Besides representing the variety of ecosystems, living beings, and their genetic variations, for societies it is established as a source of sustenance, energy, recreation, and food, among other goods and services. Up to now, according to a study published by *PLoS Biology*, about 8.7 million species (give or take 1.3 million) is the new estimated total number of species on Earth (Mora et al. 2011). Their results also suggest that 86% of the species on earth still need to be discovered, an outcome that allows to account for the scientific work that remains to be done.

On the other hand, considering that the current population of the Earth, according to the 2017 revision of the United Nations, is 7.3 billion and is expected to reach 9.8 billion by 2050, the pressure exerted on natural resources will be even greater (UN 2017). As a society, we depend on biodiversity to survive and satisfy our basic needs, and it plays an important role in the economy of the countries, as well as providing environmental services that balance the functioning of the planet. Therefore, it becomes important to promote initiatives that help us to know more about our biodiversity, its importance, and meaning. We need to fill in the gaps as quickly as possible since this will allow establishing lines of research on effective biodiversity conservation.

The award for Scientific Research in Biological Conservation has become the most important recognition in Latin America dedicated to biological conservation, has promoted the career of researchers who obtained such precious recognition, and has become an inspiration for all new researchers from our country.

Some testimonies of the winners of the "Por Amor al Planeta" Award are mentioned below.

> This type of awards sends a very clear signal to new researchers and students about the importance of research in biological conservation in Natural Protected Areas, not only for being valued in the academic environment, but also, and especially, by important actors of the society like VWM. (Eric Mellink Bijtel)

> For us, for our Research Center on Biodiversity and Conservation and for the Autonomous University of the State of Morelos, this recognition has been very positive, since it confirms that our work is doing well and because it highlights our commitment and impact on the conservation of biodiversity and with society in general. An award like the one we have received; no doubt encourages that the scientific research done in the country in biological conservation increases in quality and quantity. (David Valenzuela)

10.3 El Edén Ecological Reserve

El Edén Ecological Reserve A. C. (EEER) is a nongovernmental, nonprofit organization based in Cancun, Quintana Roo, founded by Dr. Arturo Gómez-Pompa and a group of recognized conservationists in the early 1990s. It is the first private ecological reserve dedicated to scientific research on conservation, management, and restoration of biodiversity in Mexico (Gómez-Pompa et al. 2010a). This pioneering initiative has helped discover the possibilities and difficulties of doing and promoting research and conservation projects in private protected spaces.

The EEER is in the Mexican State of Quintana Roo, in the northern portion of the Yucatan Peninsula (Fig. 10.6). It is 30 miles to the NW of the City of Cancun and 15 miles to the north of the town of Leona Vicario, in the region known as "Yalahau" (where the water is born, in Maya).

The project began with the acquisition of approximately 900 hectares (ha). Today EEER has under its protection three additional neighboring properties, with an area of about 3000 ha.

Its original objective was to evaluate the possible contribution of a relatively small NPA to the knowledge and conservation of biodiversity of the Yucatan Peninsula, in contrast with the large size of biosphere reserves. According to United Nations Educational, Scientific and Cultural Organization (2017), biosphere reserves are special places for testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. The area of the reserve (Fig. 10.7) was chosen because it has very important characteristics. The most notable was the scarcity of biological, ecological, archeological, anthropological, and environmental

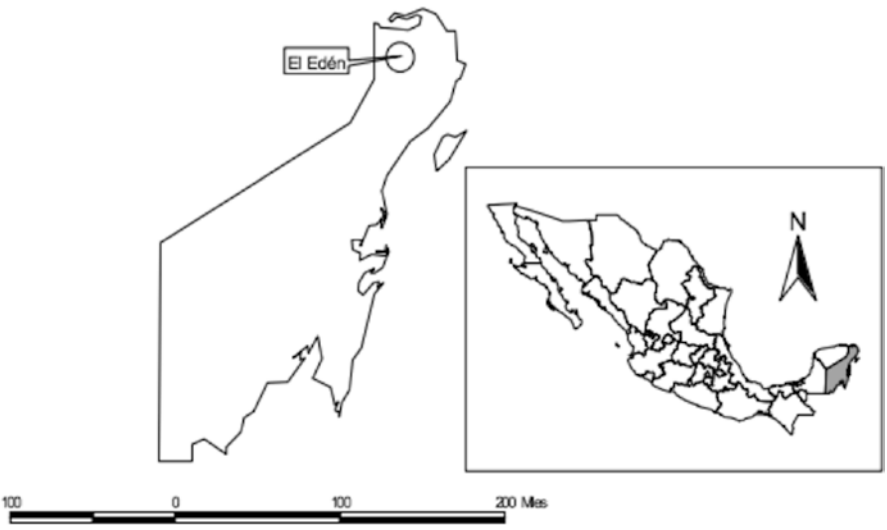

Fig. 10.6 The Mexican State of Quintana Roo is shown in *black* in southern Mexico (inset), and the circle shows the location of El Edén Ecological Reserve. The bar scale applies to Quintana Roo. (Image from Gómez-Pompa et al. 2003)

Fig. 10.7 Photograph that shows the area of the EEER. (Photograph by Emmanuel Solis)

studies in an unpopulated region. It was the last great unexplored area of natural savannah in the northeastern portion of the Yucatan Peninsula. The area was inhabited and uninhabited several epochs over periods of time. Little was known about the presence and activities of ancient Maya in the area.

A variety of habitats are present, tropical savannahs, secondary forests, seasonally inundated forests, wetlands, and several small lagoons. The known flora is made up of 404 species (Schultz 2005) and represents approximately 18% of all species of known plants (2300) in the Yucatan Peninsula. The known mammals are made up of 9 orders and 23 families. In the reserve lives one of the members of the Felidae family with the highest risk of extinction, the jaguar (*Panthera onca* – Fig. 10.8), along with four other felids, which are also threatened. A group of conservationists in the EEER headed by Marco Lazcano are currently working on the conservation of the jaguar, assuring their well-being, reproduction, and a protected permanent habitat. Several other biological inventories have been initiated and published: birds, bats, rodents, fishes, amphibians, butterflies, fungi, slime molds, diatoms, and others.

The climate at the EEER region is characterized by an extended winter/spring drought, with the wet period beginning in June or July and a dry season from November to June. The Yalahau bioregion, where the reserve is located, is subject to hurricanes and is periodically inundated, creating macrohabitats and microhabitats for numerous species of aquatic and semiaquatic organisms. The inundated savannah (Fig. 10.9) is an interesting vegetation type for studying wetlands (Novelo and Tavera 2003). Fires are also relatively common, and their intensity and frequency are apparently related to the quantity of fallen timber left after hurricanes and to fires started during each dry season usually by farmers for land-clearing purposes.

Fig. 10.8 *Panthera onca* in EEER. (Photograph by Marco Lazcano)

Fig. 10.9 The EEER inundated. (Photograph by Cristina MacSwiney)

The reserve's scientific research is widely recognized nationally and internationally and its prestige as a leading conservation organization is appreciated by the national conservation community. The scientific information generated on the biological, ecological, and chemical diversity of the EEER is unique in the country and a model to be followed by other NPA. In its short existence, it has become one of the best known NPAs from the biological and archeological perspective of Mexico. Its ecological restoration works are also widely known and appreciated.

EEER is perhaps one of the very few protected areas where long-term experimental biology and field ecology research in the management and conservation of biodiversity is encouraged. A significant benefit to the use of experimental biology in conservation and environmental management is its ability to isolate the effects of stressors or cause by performing experiments under controlled conditions, which allows scientists to separate the effects of a variable from other possible effects (Seebacher and Franklin 2012). Experimental ecology and conservation science can strive to develop solutions that are relevant to the problem and realistic to the end users. Research funding must be directed toward practical solutions that can be acceptable to stakeholders (Cooke et al. 2017; FWS 2015).

Research done at the EEER has proven that highly disturbed sites have great scientific value. The discovery of managed wetlands (Fig. 10.10) by the ancient Maya has been considered one of the most important scientific findings of the last decades. "Understanding the past and present dynamics of wetlands . . . holds a key to understanding the evolution of Maya civilization" (Jacob 1995).

The *Lowland Maya Area: Three Millennia at the Human-Wildland Interface*, book published in 2003 by the editors A. Gómez-Pompa, M. F. Allen, S. Fedick, and J. Jiménez-Osornio, is one of the most important publications of EEER done in collaboration with the University of California, Riverside (UCR).

Wetlands are one of the most biologically active ecosystems; therefore, they are ecosystems with very high net primary productivity (Novelo and Tavera 2003). Understanding the management of wetland resources over time in a distinctive environment provides a unique opportunity. The El Edén wetland consists of a large, shallow depression measuring approximately 5.5 km north-south by 0.8 km east-west (Fedick and Morrison 2004).

The presence of wetlands in the EEER makes the zone attractive for studying algae (diatom flora). Eberto Novelo, Rosaluz Tavera, and Claudia Ibarra headed a big study published in 2007, in which they focused on karstic wetlands to identify the diatom flora present at El Edén. Out of the 156 taxa identified in the Reserve, nine were recognized as new species and three new combinations were proposed (Novelo et al. 2007 p. 4).

"Los Hongos de El Edén": An introduction to the tropical mycobiota of Mexico is another significant publication of the EEER. This book written by Gastón Guzmán in 2003 provides a lot of valuable information of the tropical fungi of Mexico. His investigation showed that EEER hosts one third of the myxomycetes diversity known for the entire country (Guzmán 2003).

One important successful project facilitated and promoted by the EEER to stimulate scientific education was created by Dr. Dan Bisaccio. He used the protocols developed by the Smithsonian Institution, Program of Man and the Biosphere

Fig. 10.10 Cenote at the EEER area. (Photograph by Emmanuel Solis)

(SIMAB), to educate more than 700 high school students from Mexico, the United States, Asia, and Europe in learning methods for biodiversity research and monitoring and allowed students to learn about ecology and biodiversity by doing research projects in the field (Fig. 10.11).

Throughout 20 years, the EEER has been an important promotor of regional conservation: actively participating in the prevention, detection, and combat of wild fires; inspection and surveillance to avoid land invasion; the fight against hunting; and the extraction of illegal forest resources.

EEER has proven its resistance to one of the costliest and destructive hurricanes (Wilma) in the history of the region. The Reserve experienced 36 h of a category 4 hurricane and its passage through the area left floods and damaged 70% of its rustic infrastructure. Studies of its ecological impact and recovery from Wilma have been made possible by the information gathered before and after the hurricane by a team of scientists working at EEER.

The most substantial proof of success of the EEER as the first private ecological reserve dedicated to scientific research on conservation in Mexico are the studies that have been published in different lines of investigations, as well as all the students that have been able to take advantage of its facilities and resources to learn and create valuable knowledge. “La Sabana Research Station” was built to accommodate scientists and occasional visitors. As a result, there have been 30 bachelor’s, master’s, and doctoral theses, 49 scientific publications, 13 science communication articles, more than 30 scientific reports, and 4 books with topics of archeology, agroecology, biodiversity, chemical diversity, and ecology based on the Reserve. Several new species have been discovered.

Fig. 10.11 Students of Dr. Dan Bisaccio in a field expedition at EEER. (Photograph by Dan Bisaccio)

- Endophytic fungus: *Edenia gomezpompae* (Macías-Rubalcava et al. 2008)
- Diatom: *Aulacoseira periphytica* sp., *Caloneis subanicola* sp., *Capartogramma paradisiaca* sp., *Cymbopleura cachii* sp., *Encyonema densistriata* sp., *Fragilaria dzonoticola* sp., *Nitzschia yalahau*, *Pinnularia mayarum*, *Stauroneis amphibia* sp. (Novelo et al. 2007)

Each project and publications attracts new scientists and students, creating collaborative projects in different subjects. Below we present a table (Table 10.1) with some of the selected publications of the EEER, classified by research area. A complete list can be consulted in the web page of the Reserve.[1]

Specific examples of important studies on the priority research areas or lines of investigation at the EEER are mentioned below. It is important to remark that these lines were initially chosen by the Advisory Board of the Reserve followed by a group of scientists that were invited to participate in research projects of the EEER. This initial group of scientists began the first studies and acquired an initial funding by small grants from UCR.

[1] www.reservaeleden.mx

Table 10.1 List of selected publications that have been done in El Edén in the priority areas of research of the EEER

Research area	Publications
New taxa	Macías-Rubalcava ML, Hernández-Bautista BE et al. (2008). Naphthoquinone spiroketal with allelochemical activity from the newly discovered endophytic fungus *Edenia gomezpompae*. Phytochemistry 69(5): 1185–1196
Restoration ecology	Allen, M. F, Gómez-Pompa, A et al. (2005). Effects of mycorrhizae and nontarget organisms on restoration of a seasonal tropical forest in Quintana Roo, Mexico: factors limiting tree establishment. Restoration ecology, 13: 325–333
Wetland ecology	Becerra-Absalón I, Tavera R (2003). Cambios de la comunidad algal (Perifiton) relacionados con el ciclo hidrológico en un tintal anegable en Quintana Roo. Estudios Mexicanos 19(2): 263–275
	Calderón-Medina ET (2006). La comunidad fitoplanctónica de un humedal tropical en la Reserva Ecológica el Edén, Quintana Roo, Mexico. Biología (UNAM Facultad de Ciencias). México D.F., Universidad Nacional Autónoma de México. Tesis de Licenciatura: 95 p
	Ibarra C, Novelo E et al. (2009). Diversity and structure of periphyton and metaphyton diatom communities in a tropical wetland in Mexico. Revista Mexicana de Biodiversidad, 80(3), 763–769
	Novelo E, Tavera R (1999). Algas y humedales de Quintana Roo. Ciencias. Facultad de Ciencias, UNAM. 55–56:44–45
	Novelo E, Tavera R (2003). The role of periphyton in the regulation and supply of the nutrients in a wetland at El Edén, Quintana Roo. In: Gómez-Pompa A, Allen MF et al. (eds) The lowland Maya area: three millenia at the human-wildland interface. Food Product Press, U.S.A, pp. 217–239
	Vargas Ramos R, Novelo E (2003). Nitrogen fixation by cyanoprokaryotes in the Eden Ecological Reserve in Quintana Roo, Mexico. Estudios Mexicanos 19(2): 277–285
Chemical ecology	Anaya AL, Mata R et al. (2003). Allelochemical potential of *Callicarpa acuminata*. Journal of Chemical Ecology 29(12): 2761–2776
	Flores-Carmona MDC, Cruz-Ortega R et al. (2008) Allelopathic potential of some tropical trees of Ecological Reserve El Edén, Quintana Roo, Mexico. Allelopathy Journal 21(1): 57–72
	Macías-Rubalcaba ML, Hernández-Bautista BE et al. (2010). Allelochemical effects of volatile compounds and organic extracts from *Muscodor yucatanensis*, a tropical endophytic fungus from *Bursera simaruba*. Journal of Chemical Ecology 36: 1122–1131
	Pech GG, Brito WF et al. (2002). Constituents of *Acacia cedilloi* and *Acacia gaumeri*. Revised structure and complete NMR assignments of Resinone. Z. Naturforsch. 57c: 773–776
	Romero-Romero T, Anaya AL et al. (2002). Screening for effects of phytochemical variability on cytoplasmic protein synthesis pattern of crop plant. Journal of Chemical Ecology 28(3): 617–629
	Sauceda Garcia A (2006). Busqueda de compuestos bioactivos en hongos antagonicos endofitos de plantas con potencial aleloquimico de la Reserva Ecologica El Edén, Quintana Roo. Ciencias Biológicas (UNAM Instituto de Ecología). Mexico D.F, Universidad Nacional Autónoma de México. Tesis de Maestría: 75 p
	Vargas Ramos, R. (2009). On the fate of old stored carbon after large- infrequent disturbances in plants. Plant Signaling and Behavior 4(7): 617–619

(continued)

Table 10.1 (continued)

Research area	Publications
Biodiversity	Andrade-Torres A. (1997). Riqueza abundancia y diversidad de myxomicetes sobre hojarasca, troncos caídos y cortezas de árboles tropicales vivos. Facultad de Biología, Universidad Veracruzana. Tesis de Licenciatura
	Cózatl-Manzano R, Naranjo-Garcia E (2007). First records of freshwater molluscs from the Ecological Reserve El Edén, Quintana Roo, Mexico. Revista Mexicana de Biodiversidad 78(2): 303–310
	Gómez Espinosa MC (1999). Taxonomía y biogeografía de los moluscos terrestres de la Reserva Ecológica El Edén. Quintana Roo. Biología (UNAM Facultad de Ciencias). México D.F, Universidad Nacional Autónoma de México. Tesis de Licenciatura: 69 p
	Heaton HJ, Gómez-Pompa A et al. (1999). Extreme ecological and phenotypic differences in the tropical tree chicozapote (*Manilkara zapota* (L.) P. Royen) are not matched by genetic divergence: a random amplified polymorphic DNA (RAPD) analysis. Molecular Ecology 8(4): 627–632
	Hernández RAM (1999). Estudio de la diversidad de la vegetación secundaria en la Reserva Ecológica El Edén, Quintana Roo. Escuela de Biología. Benemérita Universidad Autónoma de Puebla. México. Tesis de Licenciatura: 79 p
	Ibarra C, Tavera R et al. (2009) Diversity and structure of periphyton and metaphyton diatom communities in a tropical wetland in Mexico. Revista Mexicana de Biodiversidad 80: 763–769
	León-Cortés JL, Jones RW et al. (2003). A preliminary assessment of the butterfly fauna of El Edén Ecological Reserve: species richness and habitat preferences. In: Gómez-Pompa A, Allen M.F, et al. (ed) The lowland Maya area: three millenia at the human-wildland interface. Food Product Press, U.S.A, pp. 261–276
	MacSwiney GMC. (2000). Estructura de la comunidad de quirópteros de la Reserva Ecológica El Edén, Quintana Roo, México. Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Yucatán. Tesis de Licenciatura: 58 p
	Schultz GP (2005). Vascular flora of the El Edén Ecological Reserve, Quintana Roo, Mexico. Journal of the Torrey Botanical Society 132(2): 311–322
Animal ecology	González-Marín RM, Gallina S et al. (2008). Densidad y distribución de ungulados silvestres en la Reserva Ecológica El Edén, Quintana Roo, México. Acta Zoológica Mexicana (n.s.) 24(1): 73–93
	MacSwiney GMC, Bolívar-Cimé B et al. (2009). Insectivorous bat activity at cenotes in the Yucatan Peninsula, Mexico. Acta Chiropterologica 11(1): 139–147
	MacSwiney GMC (2007). Ecology and conservation of bat assemblages associated with water-filled sinkholes (cenotes) in the Yucatan Peninsula, Mexico. Animal Ecology. University of Aberdeen, UK. Tesis de Doctorado: 152p
	MacSwiney GMC, Clarke FM et al. (2008). What you see is not what you get: the role of ultrasonic detectors at maximising inventory completeness in Neotropical bat assemblages. *Journal of Applied Ecology* 45(5): 1364–1371
	MacSwiney GMC, Vilchis P et al. (2007). The importance of cenotes in conserving bat assemblages in the Yucatan, Mexico. *Biological Conservation* 136(4): 499–509
	Torres-Romero EJ (2009). Densidad, abundancia, uso de habitat y patrones de actividad del ocelote (*Leopardus pardalis*) en la zona noreste del estado de Quintana Roo: estudio usando cámaras trampas. El Colegio de la Frontera Sur. Tesis de Maestría
	Panti-May JA, MacSwiney GMC et al. (2015). Reproduction and postnatal development in the Yucatan vesper mouse. Mammalia 79(2): 169–176

Archeology	Fedick SL (1998). Ancient use of wetlands in Northern Quintana Roo, Mexico. In: K. Bernick (ed) Hidden dimensions: the cultural significance of wetland archaeology. University of British Columbia Press, Vancouver, BC, pp. 107–129
	Fedick SL, Morrison BA (2004). Ancient use and manipulation of landscape in the Yalahau region of the northern Maya lowlands. Agriculture and Human Values 21: 207–219
	Fedick SL, Morrison BA et al. (2000). Wetland manipulation in the Yalahau Region of the Northern Maya Lowlands. Journal of Field Archaeology. 27(2): 131–152
	Gómez-Pompa A, Allen MF, Fedick SL, Jiménez-Osornio JJ (eds) (2003). The lowland Maya area: three millenia at the human-wildland interface. Food Product Press, U.S.A
	Mathews JP (1998). The ties that bind: the Ancient Maya interaction spheres of the Late Preclassic and Early Classic Periods in the Northern Yucatán Peninsula. Anthropology, University of California, Riverside. University Microfilms, Ann Arbor
	Morrison B (2000). Ancient Maya settlement of the Yalahau region: an example from the El Edén wetland. Anthropology. University of California, Riverside. Tesis de Doctorado: 210p
Agroecology and plant ecophysiology	Flores-Delgadillo L, Fedick SL et al. (2011). A sustainable system of a traditional precision agriculture in a Maya homegarden: soil quality aspects. Soil and Tillage Research 113(2): 112–120
	Goode LK, Allen MF (2009). Seed germination conditions and implications for establishment of an epiphyte, *Aechmea bracteata* (Bromeliaceae). Plant Ecology 204: 179–188 Goode LK, Allen MF (2008). The impacts of hurricane Wilma on the epiphytes of El Edén Ecological Reserve, Quintana Roo, Mexico. Journal of the Torrey Botanical Society 135(3): 377–387
	Hasselquist NJ, Santiago LS et al. (2010). Belowground nitrogen dynamics in relation to hurricane damage along a tropical dry forest chronosequence. Biogeochemistry 98: 89–100
	Hasselquist NJ, Allen MF et al. (2010). Water relations of evergreen and drought-deciduous trees along a seasonally dry tropical forest chronosequence. Oecologia 164: 881–890
	Ramírez-Trejo MR, Pérez-García B et al. (2010). Effect of fire on the germination of spores of *Pteridium caudatum*, an invasive fern. Journal of Tropical Ecology 26: 457–465
	Vargas Ramos R, Allen MF et al. (2008). Biomass and carbon accumulation in a fire chronosequence of a seasonally dry tropical forest. Global Change Biology 14(1): 109–124
	Vargas Ramos R, Trumbore SE et al. (2009). Effects of vegetation thinning on above- and belowground carbon in a seasonally dry tropical Forest in Mexico. Biotropica 41(3): 302–311
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- Biodiversity
  This priority area of research began its activities since the Reserve's creation. The long-term objective was to have an inventory of all the species of the EEER. As an example of this, we can mention the work of Gillian P. Schultz who produced the first large-scale qualification and quantification of the vegetation of the Reserve and initiated the inventory of the flora. Another example is the inventory of freshwater mollusks of El Edén. Eleven species of freshwater mollusks were found (Cózatl-Manzano and Naranjo-Garcia 2007).
- Wetland Ecology
  Studies of wetland ecology were created in the EEER by a group of scientists from UNAM, headed by Norberto Novelo PhD, and his students. They initiated the inventories of algae. They began their research by investigating the structure and diversity of diatoms in communities of metaphyton and periphyton from the wetlands of El Edén (Ibarra et al. 2009).
- Archeology
  Another priority line of investigation is the historical ecology of the region. This line of research was headed by archeologist Scott L. Fedick of UCR. The studies provide information of how the Maya could transform what might seem to be a wetland wasteland into a managed productive landscape (Fig. 10.12). Their investigations suggest the hypothesis based on archeological evidence that the ancient Maya manipulated and managed the wetland mud rich in nutrients from the algae (periphyton) to be used probably as a fertilizer (Fedick and Morrison 2004).
- Chemical Ecology
  This priority line of investigation was headed by Dr. Ana Luisa Anaya from UNAM. This research focuses on the allelochemical potential of the flora of the EEER (Anaya et al. 2003). One example was the chemical investigation of the mycelium of *Edenia gomezpompae*, a newly discovered endophytic fungus isolated from the leaves of *Callicarpa acuminata* collected from El Edén (Macías-Rubalcava et al. 2008).
- Agroecology and Plant Ecophysiology
  As an example of this priority, it is worth mentioning an investigation that was developed at EEER by a group of scientists from UCR headed by Michael Allen, Edith Allen, and their students. During this investigation, the first attempts were made to quantify biomass above and below ground and carbon stocks to calculate the seasonal recovery of dry forests after the fire (Vargas Ramas et al. 2008).
- Restoration Ecology
  This priority research area was headed by a team of scientists from UCR: Michael Allen and Edith Allen. They analyzed the effects of mycorrhizal fungal community composition on the restoration of tropical dry seasonal forest trees (Allen et al. 2005).
- Animal Ecology
  The EEER has this priority as an important line of research. The newest example is the study on rodent communities with arboreal habits that has been carried out at the Reserve. The Yucatán vesper mouse *Otonyctomys hatti* is one of the endemic species of the Yucatan Peninsula that exhibits low population density with strict arboreal habits, depending on the conservation of the mature tropical forests of the region (Zaragoza-Quintana et al. in prep.).

Fig. 10.12 Constructed features within the seasonally inundated wetland consist of alignments of limestone boulders and slabs apparently intended to function as dikes and check dams to control water and sediments. (Photograph by Scott L. Fedick)

10.3.1 Reflections

Protected areas have been a main instrument of ecosystem conservation and have contributed to stopping ecosystem degradation and to maintaining essential ecological processes (Pujadas and Castillo 2007). The EEER is a different type of protected area that promotes research in private lands (Gómez-Pompa 1998).

For their outstanding actions, the EEER in 2005 received the Nature Conservation Award by the Ministry of Environment and Natural Resources of Mexico (SEMARNAT) and the National Commission of Natural Protected Areas (CONANP).

The long-term existence of this private conservation experiment will be strongly linked to the support and protection it receives from federal, state, and municipal authorities. Its survival depends on the support given by conservation organizations to stimulate the creation of many more private reserves dedicated to research in different fields. Its success also depends of available funding from donations of friends and philanthropists interested in the conservation of the biotic heritage of Mexico.

The EEER has received important support from the following institutions: UCR, UNAM, Yucatan Autonomous University (UADY), University of Veracruz (UV), and Souhegan High School.

10.4 Final Remarks

Most lands in protected areas in Mexico are not state owned. There is a mosaic of tenancy that includes private lands owned by individuals or nongovernmental organizations (NGOs) and communal properties managed by indigenous or peasants' communities (Pujadas and Castillo 2007). Most lands in the National System of Protected Areas belong to "ejidos" or indigenous groups living within or adjacent to protected areas.

EEER model could be used to bring scientific research and to give the necessary support to this type of dual conservation in collaboration with research and educational institutions, government, and other private reserves.

Biological and ecological conservation should not be only by decree; the participation of smallholders, private groups, and individuals who can help in this national effort should be sought and encouraged. The need to involve people in the conservation process implies more than solely informing people about the "rightful" implementation of nature conservation. Rather, it entails abandoning the top-down and hegemonic attitude where nature is perceived as a scientific question only, not directly intelligible to humans, and which needs to be conveyed through science (Skandrani 2016).

All kinds of incentives should be given for the creation of private protected areas of all kinds, especially those proposed by indigenous groups. We recommended to carry out an in-depth study on the endemic biota of Mexico. These resources are unique to the country and therefore we have a great responsibility for their care. We need to create conscience to the public on the importance of research and the need for conservation and educational projects in local rural communities with participation of local schools and children. An example of this approach is the book "Atlas de la Flora de Veracruz" (Castro-Cortés et al. 2010) and the project of "Plants of my Community"[2] produced by the UV with collaboration from EEER.

The set of NPAs of Mexico does not protect the biological and ecological diversity of the country. It is necessary to encourage the creation of new NPAs by providing evidence through experimental biology and conservation science that supports the need of protecting those critical areas. Although an expanding human footprint and rapidly changing environment have led to increasingly complex and difficult conservation questions, experimental biology can produce the evidence needed to address many of the key questions so that solutions can be found across a range of relevant scales (Cooke et al. 2014). The best-managed formally protected areas are those under the care of research centers and/or higher education. Such an arrangement should be promoted with all priority areas.

[2] www.reservaeleden.org/plantasloc/

Knowledge of the flora, fauna, and microorganisms of Mexico is still very scarce. It is essential to promote the study of this national biotic wealth. It is recommended to initiate an urgent program to carry out a comprehensive assessment of the biological diversity we have in the country's protected areas. We cannot make a good planning of the additional needs of biological conservation if we do not know what is already protected. The two approaches we described in this chapter showed us the importance of promoting scientific research in conservation biology as well as providing us valuable information of the biodiversity and ecology of Mexico.

We should stimulate the creation of projects such as the Volkswagen Award in order to promote the formation of new Mexican scientists in conservation biology and recognize the current contributions made by scientists. As we mentioned before, establishment of private reserves initiatives should be reinforced. The government and research institutions must support and offer incentives to the creation of private reserves such as EEER. That way, we could generate scientific research to explore the best approaches for the protection of rare and endangered species and ecosystems.

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