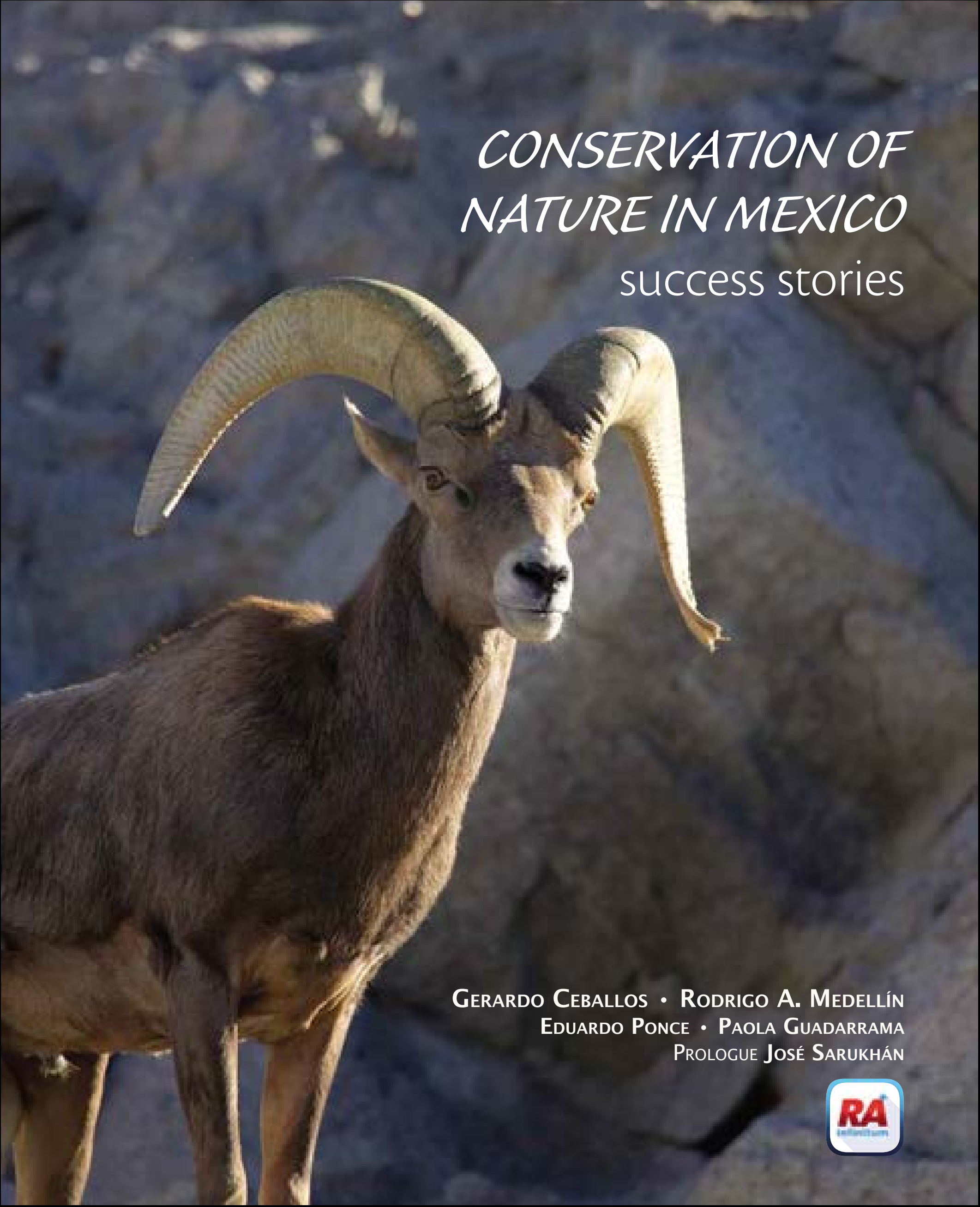
CONSERVATION OF NATURE IN MEXICO

success stories



GERARDO CEBALLOS • RODRIGO A. MEDELLÍN
EDUARDO PONCE • PAOLA GUADARRAMA
PROLOGUE JOSÉ SARUKHÁN

Protection and conservation of the environment

The Carlos Slim Foundation supports a variety of biodiversity conservation and sustainable development strategies in Mexico. To this end, strategic alliances have been created with the World Wildlife Fund (WWF), the Secretariat of Environment and Natural Resources (Semarnat), The Mario Molina Center, The National Autonomous University of Mexico (UNAM), the National Commission for the Knowledge and Use of Biodiversity (Conabio) and the National Commission of Natural Protected Areas (Conanp), among others.

The work that has been carried out with WWF in six regions of the country - where 18 priority sites are located-stands out:

- The Great Mayan Reef
- Chihuahuan Desert
- Gulf of California
- Monarch Biosphere Reserve
- Oaxaca
- Chiapas

Based on policies compatible with the sustainable development of each region, the Carlos Slim Foundation joined since 2005 the efforts to support the National Jaguar Conservation Strategy and reduce the impact of human activities on its populations. Ten national and one international symposia have been carried out to date. Issues on jaguar conservation, solutions and actions are discussed and analyzed in these symposia. Between 2009 and 2011 the first National Jaguar Census was carried out in 15 regions of the country, and a population of 4,000 adults was estimated, being the Yucatan Peninsula the region with the largest population of this feline. Currently, the second Census is being carried out to assess the state of conservation of the populations. 57 biological corridors to maintain connectivity among jaguar populations have been identified, the main ones being: Yum Balam-Sian Ka'an-Calakmul Corridor, Sinaloa-Nayarit Corridor and Chamela-Cuixmala-Sierra Manantlán-Cabo Corrientes Corridor.

Wildlife Conservation Management Units (UMA, for its acronym in Spanish) have also been established in several regions to contribute to the reproduction, rescue, protection, environmental education and research of wildlife.

The Carlos Slim Foundation and TELMEX reaffirm their commitment to protecting the natural surroundings and the environment.

FUNDACIÓN
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Cover: Bighorn Sheep. © Phillip Colla / Oceanlight.com
Back cover: La Conchuda Waterfall, La Venta's river Canyon, El Ocote, Chiapas. © Jorge Silva Rivera

CONSERVATION OF NATURE IN MEXICO

success stories

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Conservation is a state
of harmony between men
and land

ALDO LEOPOLD

CONSERVATION OF NATURE IN MEXICO

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FOREWORD

Biological diversity is one of the greatest wonders of Earth. Millions of wild species live in every corner, including the most inhospitable places like the frozen poles and the depths of the ocean. Unique treasures in this infinite universe because, to our knowledge, life is unique to our planet.

In addition to its beauty, biological diversity is critical for maintaining human well-being. The quality and quantity of food, fibers, medicines, fertile soils, fresh water, the air in the atmosphere and the productive seas, among many other benefits known as environmental services, depend on a rational use and sustainable management of natural resources. However, the planet's ability to maintain environmental services and human well-being has been reduced and could suffer negative and irreversible changes.

Mexico, in this regard and given its amazing biodiversity, has an enormous responsibility to ensure the future of wild plants, animals and microorganisms for the benefit of the future generations. It is important to spread the knowledge about the great efforts of conservation and successful management of species and ecosystems in a world overwhelmed by the enormous challenge of facing the global environmental crisis. Institutions like the Commission for the Knowledge and Use of Biodiversity (CONABIO), the Secretariat of the Environment and Natural Resources, the Mexican Secretariat of the Navy and the Mexican Secretariat of National Defense are key elements for the conservation of nature in Mexico and their initiatives have worldwide impacts. For example, the gray whales that are born in Baja California spend the summer in the Arctic, and have resumed their migration to the Korean coast —phenomenon that stopped more than 50 years ago— and is now a reality thanks to the success achieved in Mexico.

Over the last decades, the Carlos Slim Foundation, concerned about the environment, has developed and implemented protection and conservation plans and programs, as well as educational and social development programs, to help stop and reverse the process of environmental deterioration that threatens Mexico's vast biodiversity. The Foundation is actively involved in the search for a better future for all, working in partnership with the World Wildlife Fund (WWF) in six regions of the country such as The Great Mesoamerican Reef, Chihuahuan Desert, Gulf of California, Monarch Butterfly Biosphere Reserve, Oaxaca and Chiapas and with 104 specific programs for the conservation of priority species like the jaguar and the great white shark.

Similarly, Wildlife Conservation Management Units (UMA, for its acronym in Spanish) have been established in several regions to contribute to reproduction, rescue, protection, environmental education and research.

Héctor Slim Seade
Chief Executive Officer
Telmex

PROLOGUE

We are living in a time in which the information reaching society through the media is strongly marked by catastrophic and discouraging news (sadly, many of them true), in relation to what most people expect to know about their social, economic and natural environments even when the information is perceived as reliable and not distorted by the media or personal interests. The society justifies this as "good news don't sell", twisting the reality of our country.

In fact, there are a lot of positive news in Mexico. Governmental as well as non-governmental organizations, local people, men and women are constantly working and are an example of serious and committed social responsibility.

Contributing to show the positive face to Mexico's situation is the aim of this book. This and another book published by CONABIO in 2010 (*Patrimonio natural de Mexico, Cien casos de éxito*) coordinated by former Secretary of Semarnat Julia Carabias, aim at showing the work that is being done in conservation and in the recovery of species that have disappeared locally or whose populations are vulnerable. In the last book, the stories were told by the people working in those regions; many of them members of organizations, rural communities, non-governmental organizations, the academia and the federal government. In other words, a great variety of actors committed to the study, conservation and sustainable management of our natural heritage.

In this book, Gerardo Ceballos and Rodrigo Medellín tell their stories in an accurate and beautiful manner. Their life-long work, financed mostly by the Carlos Slim Foundation, is a story of the great biological diversity and wonderful landscapes of our country. The Foundation has always been interested in communicating the scientific knowledge to reach the public in general.

Many of the stories are recent because researchers started to create knowledge about Mexico's wildlife and ecosystems only in the middle of the last century. Enrique Beltrán, Faustino Miranda, Maximino Martínez, Efraín Hernández X., Cándido Bolívar, Federico Bonet, Gonzalo Halffter, Arturo Gómez Pompa, among others, built the framework for the scientific community dedicated to the "science of biodiversity" and influenced the federal government to allow academics participation in the decision-making processes. Their studies about the biodiversity and ecosystems of Mexico started opening the dense jungle of ignorance and indifference of the country.

Unfortunately, this has not prevented bad decisions by the government, like the Forest Clearance National Program, which affected the integrity of Mexico's nature, did not benefit society, and destroyed development options based on the natural ecosystems. However, the influence of the actors cited above has allowed the county to have an effective institutional infrastructure and a clear legal framework. Mexico is an international example on research and conservation of the natural capital. The stories told here are a testimony of the latter.

The success stories are divided into five areas: 1) The Pacific and Gulf of California, 2) the arid deserts with emphasis in northern Mexico, 3) the temperate forests located in the neovolcanic belt, 4) the tropical perennial and deciduous rainforests, which include iconic species like the jaguar and the bats, species for which Ceballos and Medellín have contributed mostly to their knowledge, and 5) marine and wetland systems, marine turtles as a particularly notable case, crocodiles and the Whale Shark Biosphere Reserve.

It would be inappropriate and would not serve the purpose of this prologue to describe each of the thirty cases this beautiful book contains. However, I will describe a few cases, letting the readers submerge themselves in the stories offered by the authors. The stories in this book are accessible and attractive for the general public and many of the cases illustrate the hard work of researchers who study the biodiversity of the country.

The first case is about the Revillagigedo Archipelago, World Heritage Site since this year (2017) and aptly named "the Mexican Galapagos", offering fundamental and new information about past processes and current biodiversity that can be of interest to people not familiar with the Archipelago.

Another case is about Cabo Pulmo, the northernmost reef of the Pacific Ocean and an example of conservation. Cabo Pulmo's success is due to the joint efforts of the academia and the local people that have shown the importance of this ecosystem and have always protected their integrity against malicious touristic development that benefit only a few. The local community, mostly fishermen, changed their traditional activities of extraction and now benefit from a vibrant and sustainable tourism and controlled fishing.

A special case is that of the bighorn sheep, whose recovery in Tiburón Island allowed the maintenance of its populations and the management of the species, creating an income for the local people of the island. This success was possible thanks to the participation of many organizations like the Institute of Ecology of UNAM, the non-governmental organization "Unidos para la Conservación", the Seri indigenous group and government and international (US) institutions.

One last case worth mentioning in this short text I was asked to write is the vision and tenacity of the people, the integrated work of the different government levels and the solid and permanent involvement of non-governmental organizations, local and international, in the temperate forests of the Sierra Gorda, central northeastern Mexico. Martha Ruiz Corzo has been a guide, an inspiration and a leader of the Sierra Gorda Biosphere Reserve, known by those who know and admire her as "Paty Ruizcorzo".

This reserve covers a great extension of land with a variety of ecosystems containing a great diversity of plant and animal species, and also a great diversity of indigenous cultures that persist today and that have played a fundamental role in the management and conservation of nature. The work of "Paty" ranges from convincing the communities to conserve and use their resources rationally, finding ways to compensate them to have a better future at least complementing their salaries. She has been the main promoter of the project, connecting successfully with bureaucracy and international institutions always interested in her projects. Walking among the vast territories of the Sierra Gorda is not only a pleasure for the soul but also a remainder of what people in the country can accomplish.

There is a lot to be grateful for. The knowledge of our nature, its protection and sustainable use is in benefit of the communities that live in or depend on these ecosystems, terrestrial or marine. This book, edited by TELMEX and the Carlos Slim Foundation as part of a long history of conservation, proves it..

José Sarukhán

UNAM

CONABIO

Gerardo Ceballos and Rodrigo A. Medellín

CONSERVATION SUCCESS STORIES

Environmental deterioration is one of the most pressing challenges humanity faces right now. Edward O. Wilson, two time Pulitzer Prize winner and one of the most revered contemporary naturalists and conservationists, aptly describes this tragedy-in-the-making: "*The worst thing that will probably happen—in fact is already well underway—is not energy depletion, economic collapse, conventional war, or the expansion of totalitarian governments. As terrible as these catastrophes would be for us, they can be repaired in a few generations. The one process now going on that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us*".

However dim the current state of affairs and future prospects seem, there are reasons to believe that humankind will rise to the occasion, prevent the further deterioration of our environment and even restore some of the degraded habitats and better protect the plants and animals with which we share planet Earth. There is hope. Millions of people and innumerable institutions throughout the world are devoted to the conservation of nature, participating from small-scale efforts to worldwide initiatives. The focus of these actions run the gamut of needs: energy conservation and alternative sources; habitat and species protection; conservation of natural protected areas; management and sustainable use of flora and fauna; pollution abatement; waste reduction; climate change, and many

Sea lion on an islet of Baja California. (CCK)

others. An encouraging note is the willingness of people from very different backgrounds and cultures to unite against environmental threats and work toward equitable solutions to the challenges. While the complexity of environmental challenges is daunting, there are many successful examples which demonstrate that, given the knowledge, motivation, opportunity, and resources, humans can live in a healthier environment and that the scars of human-inflicted wounds can disappear into history.

There are an increasing number of institutions in Mexico that support the management and conservation of biological diversity, from the frontline of the government to the non-governmental organizations such as the National Commission of Natural Protected Areas (CONANP) from Secretariat of Environment and Natural Resources (SEMARNAT), the National Commission for the Knowledge and Use of Biodiversity (CONABIO), the National Council of Science and Technology, the Carlos Slim Foundation, the World Wildlife Fund Mexico (WWF), the Mexican Fund for the Conservation of Nature (FMCN), Naturalia, Pronatura, Natura Mexicana, Island Conservation, the National Alliance for Jaguar Conservation, and many non-governmental organizations working at a regional level. Besides, universities like the National Autonomous University of Mexico (UNAM), state universities and regional research centers such as the Northwestern Center for Biological Research, play a fundamental roll on these issues.

Seven years ago, the National Commission for the Knowledge and Use of Biodiversity (CONABIO) and Natura Mexicana published a book with hundred success cases in Mexico's conservation, which was an inspiring milestone and set a precedent. This new book is a recapitulation and celebration of some of the many conservation success stories of Mexico's biodiversity. The stories range from a local to a national scale and show that the loss of species and natural environments can be avoided and that the species and ecosystems that they are part of can recover with strong and long-term actions. The core of conservation are the natural protected areas, the endangered species and their sustainable use. An important part of Mexico's conservation is the alliance between non-governmental organizations such as the Carlos Slim Foundation and the World Wildlife Fund.

FUNDACIÓN Carlos Slim | WWF

The Carlos Slim Foundation is one of the most relevant actors of nature conservation in Mexico. It has been dedicated to the conservation of both the natural and social environments for decades, developing solid conservation, education and social development programs to stop and revert the damage that threatens the vast and unique biological diversity of the country.

In an unprecedented event in 2008, the Carlos Slim Foundation and the World Wildlife Fund (WWF) gathered together a group of distinguished conservationists, non-governmental organizations, scientists, communities, and the federal government to establish an alliance aimed to promote the conservation of Mexico's natural heritage and the sustainable development. The Alliance is committed to support local and national conservation initiatives that counteract the environmental degradation and, simultaneously, promote a better quality of life for the communities.

The Carlos Slim Foundation-WWF Alliance supports conservation actions of species and ecosystems with 104 specific programs in six high-biodiversity sites: Gulf of California, Chihuahuan Desert, Oaxaca, Chiapas, Mesoamerican Reef, and the Monarch Biosphere Reserve. It also works on the conservation of wide-ranging species such as the jaguar and actions to mitigate the effects of climate change.

Gulf of California

The Gulf of California, better known as the "aquarium of the world", harbors a great diversity of marine species including whales, sharks, and sea turtles. It is also highly prized by the commercial and recreational fishing industries because of its high productivity. The Alliance supports the protection and recovery of threatened marine species such as the Gulf of California harbor porpoise, the gray whale and some threatened iconic terrestrial mammals such as the Mexican pronghorn which formerly lived in parts of the peninsula. These efforts have allowed the identification of important corridors for the humpback whale like the Cabo Pulmo —Cabo San Lucas corridor and the Bahía Banderas— Los Cabos corridor. In addition, the Alliance supports the eradication of exotic species and the restoration of 16 islands of enormous biological importance such as Guadalupe and Espíritu Santo Islands, thus allowing the recovery of native species of birds, mammals and reptiles. Besides, it works with government institutions such as CONANP and the Federal Office for the Protection of the Environment (PROFEPA), non-governmental organization and local communities to improve the surveillance in twelve protected areas and fish refuges. The Alliance also supports environmental education programs in local schools from La Paz, Baja California Sur, and promotes sustainable fishing practices in local communities.

Chihuahuan Desert

In addition to its beauty and relative isolation, the Chihuahuan Desert is unique because of the high rate of endemism and species diversity, being home of more than 30% of the world's cacti species. However, the desert grasslands, critical habitat for bison, prairie dogs, the aplomado falcon and other threatened species, are one of the most threatened ecosystems

due to unsustainable land use practices. Given the ecological, economic, and social importance of the grasslands, sustainable livestock production practices have been developed in more than 62,000 hectares of the Janos Biosphere Reserve and the central valleys of Chihuahua. Working through local institutions, the project targets water management issues and restoration of the forest and riparian environments in the Conchos-Bravo Rivers basin. Finally, the involvement of local students, teachers and landowners in scientific studies, communication activities and sustainable food production have been promoted in Cuatrociénegas, considered one of the most exceptional places in the world. Today, Cuatrociénegas is one of the best-known places in term of biodiversity since it has a complete species inventory from microorganisms to vertebrates.

Oaxaca

The Carlos Slim Foundation - WWF Alliance programs in Oaxaca, the most biologically and culturally diverse state in Mexico, focus on species protection, sustainable forest use, and conservation and protection of water sources. Protection of sea turtles like the olive ridley or the leatherback turtle through the consolidation of more than six turtle camps and fishing practices that avoid incidental captures have been a priority. In addition, the Alliance supports the monitoring of climatic factors on key nesting beaches for these species, identifying adaptation strategies in the face of climate change. A pilot project of sustainable forestry use, which benefits both the business community and the locals, has been initiated on more than 19,000 hectares of La Mixteca and Zoque forest. The Alliance is also working on a comprehensive water management plan for the Copalita-Zimatán-Huatulco river basin and the Valles Centrales region to safeguard the integrity of rivers and wetlands.

Chiapas

Chiapas is one of the most biologically diverse states in Mexico. The Carlos Slim Foundation - WWF Alliance programs focus on preserving the health of the forests, specially the rainforests of El Triunfo Biosphere Reserve and the Lacandon Region through increased surveillance against illegal logging and other destructive forestry practices. Four natural protected areas, including Montes Azules, Lacantún, Chan-Kin, and El Triunfo, which encompass almost 500,000 hectares, have improved protection plans. Ionic and threatened species such as the resplendent quetzal, the spider monkey, and the tapir are being monitored and protected.

ABOVE *American Bison in the Janos Biosphere Reserve, Chihuahua.*
BELOW *Dry forest in Huatulco's coast, Oaxaca.* (*above, JP; below, CCK*)

Additionally, the Alliance together with the local communities, has helped the restoration of more than 30,000 hectares and it is actively working with the communities in the management of sustainable forest products. A land use management plan has been promoted for the Lacandon Region which considers different economic activities such as the production of chilies and handcrafts, aquaponics and the creation of ecotourism centers. This plan, with the involvement of more than eleven peasant communities (known as *ejidos*) has allowed the maintenance of forest cover on the south part of the region.

Mesoamerican Reef

The Mesoamerican Reef, the second largest reef system in the world, is located off the east coast of Mexico and its neighbors to the south; Guatemala, Belize, and Honduras. This economically important area supports vibrant tourism and fishing industries. Alliance supported projects enhance monitoring and surveillance in natural protected areas and promote sustainable communal tourism such as responsible whale shark watching. Additionally and due to the surface water scarcity, water protection and efficient use instruments have been encouraged. The conservation and sustainable use of fish resources has been a focus area for the Alliance, in particular the sustainable exploitation of the lobster. The generation of scientific information by the local fishing communities on aggregation sites for species like the dusky grouper has allowed the design and implementation of strategies for its protection.

Monarch Butterfly Biosphere Reserve

The Monarch Butterfly Biosphere Reserve, which is the winter refuge for the monarch butterfly, is critical for the migration and survival of the species. As a member of the Fund for the Conservation of the Monarch Butterfly (Fondo Monarca), and in close collaboration with CONANP, the National Forestry Commission (CONAFOR) and the FMCN, the Alliance has participated in the monitoring of the colonies and changes in forest cover in the reserve core and surrounding areas. The communal surveillance has been improved and incentives for the protection of the forests have been generated, thus reducing illegal logging significantly. Besides, sustainable business for the communities have been promoted and reforestation actions have been carried out. Environmental education activities with 6,000 people including children, teenagers and adults have been implemented, working in the production of organic food and fertilizer and proper solid waste management plans, among others.

ABOVE *Cozumel Reef, Quintana Roo.* BELOW *Monarch butterflies, Michoacan. (CCK)*

ABOVE *Jaguar in Calakmul Biosphere Reserve, Campeche.*
BELOW *Jaguar in La Goleta Private Reserve, State of Mexico.*
(above, SGI/DN; below, RL)

Jaguar Conservation

The jaguar conservation project was nationally implemented in 2005. This initiative generates information about the species such as habitat use and primary prey species to develop public policies that support their protection. Since 2005 there have been eleven annual symposia named "The Mexican Jaguar in the 21st Century". A key product is the National Strategy for Jaguar Conservation, developed by members of the National Alliance for Jaguar Conservation and CONANP. This national strategy provides the framework for the conservation of the jaguar. Essential to the strategy is the establishment of biological corridors, natural protected areas, monitoring of the jaguar and its prey, and policies to address the jaguar-cattle conflict.

Climate Change

Climate change respects no borders and its effects will be felt at all spatial scales, from international to the local. Some communities have already begun to adapt to the likely new climate scenario. At the state level, vulnerability assessments for Oaxaca and Sinaloa have been supported as part of the State Programs of Action Against Climate Change (or PEACC, for its acronym in Spanish). Nationally, research has been initiated to identify priority areas for the connectivity of regions that will be critical for the movement of flora and fauna as the species adapt to evolving climatic conditions.

Natural Protected Areas

One of the core elements of nature conservation in Mexico is the natural protected areas, areas of exceptional biological value and diversity. Currently, there are 182 protected areas decreed by the federal government, covering more than 90 million hectares, or almost 18% of the country's maritime and terrestrial territory.

The reserves, which are managed by the CONANP created in 1994, include national parks, biosphere reserves, flora and fauna protection areas, and sanctuaries. The creation of protected areas is the result of the vision and effort of academic groups, environmentalists and other non-governmental organizations, public officials, landowners and business partners which represent all sectors of society. The oldest were established more than 100 year ago and additional new ones are being planned.

The federal government in Mexico manages 45 Biosphere Reserves (777,615 km^2), 66 National Parks (1,113 km^2), five National Monuments (163 km^2), eight Natural Resources Protection Areas (45,033 km^2), 40 Wildlife Protection Areas (69,969 km^2), and 18 Sanctuaries

(1,502 km^2). There are also dozens of areas managed by local governments and 384 voluntarily designated areas for communal and private conservation, with a total area of almost 413,000 hectares managed for sustainable practices.

Protected areas are located throughout the country and they vary widely in size and attributes. The largest ones, which cover millions of hectares, are Sian Ka'an, El Vizcaíno, and the Mexican Caribbean Biosphere Reserves, and the smallest ones, consisting of only tens or hundreds of hectares, tend to be the Sanctuaries. Regardless of their size, they all protect endemic species, exceptionally diverse ecosystems, and biological processes that sustain numerous environmental services, all of them integrated in unique landscapes and natural phenomena.

Protected natural areas in the arid Sonoran Desert and the Chihuahuan Desert include the Reserves of El Vizcaíno, El Pinacate, Gran Desierto de Altar, Janos, Cuatrociénegas, and many islands in the Gulf of California.

Pine, fir, and oak temperate forests, and the cloud forests of the Sierra Madre Oriental, Sierra Madre Occidental, the Transvolcanic Belt, and the Sierra Madre del Sur are protected in reserves such as the Monarch Butterfly Biosphere Reserve in the State of Mexico and Michoacán, as well as in national parks such as San Pedro Mártir in Baja California, Izta-Popo in Puebla and the State of Mexico, and Pico de Orizaba in Veracruz.

The tropical rainforests and wetlands of the coastal plains, from Sinaloa to Chiapas on the Pacific and from Tamaulipas to the Yucatan Peninsula on the Gulf of Mexico are protected by Marismas Nacionales (Nayarit), Chamela-Cuixmala (Jalisco), El Triunfo and Montes Azules or Lacandona (Chiapas), and Calakmul (Campeche) Biosphere Reserves. Mexico's marine reserve areas protect coral reefs in the shallower waters and hydrothermal vents in the depths of the ocean.

The National Commission for the Knowledge and Use of Biodiversity

The CONABIO, directed by the renowned ecologist José Sarukhán and created in 1992 has granted Mexico recognition worldwide. It was not only a new concept at the time but represented the government's recognition of the importance of biodiversity. The structure of the Commission, which includes the Secretariat of Energy, Environment, Agriculture, Health, Public Education, Finance, Foreign Relations and others, is evidence of its importance in the country's development. Thanks to the CONABIO, Mexico is one of the few countries with complete biodiversity inventories for some regions. It also serves as scientific authority for the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) and works in close collaboration with the Convention of Biological Diversity (CBD) and other Conventions on the environment.

Endangered Species

The story of the disappearance of the ivory-billed woodpecker is similar to many other mammal, bird and fish species that have gone extinct in Mexico in the last century. The destruction of natural environments, overexploitation, illegal hunting, pollution, transmission of diseases by domestic animals, and the introduction of exotic species are the main causes for extinction. Animals like the passenger pigeon, the sea otter, the Mexican grizzly bear and the San Quintin kangaroo rat are now only historical references in scientific literature.

The Potosí pupfish, a small fish endemic to a spring in Cerro El Potosí, Nuevo León, was recently added to the growing list of extinct animals. The overexploitation of nearby aquifers caused the spring to dry and thereby doomed the fate of the pupfish. Some pupfish specimens were kept in aquariums and private collections for more than three decades, but all eventually died without successfully breeding. The death of the last member of the species in 2014 is a reminder that extinction is forever and our failure to protect the environment will doom many other species.

There are many recent examples of the extinction of plant and animal species unique to Mexico, but in the past thirty years there has also been an unprecedented level of effort to prevent species loss. Programs that address the causes of population decline, reintroduced species or facilitated the increase in numbers have been successful for some sea turtles, the American flamingo and the bighorn sheep. Recovery programs for other species like the scarlet macaw, Mexican wolves and the California condor are in process; the data suggests that the programs are successful and a more complete assessment in a few decades will indicate if these and other species will once again be a permanent member of the ecosystem. There is still much to be learned about species protection and effective recovery efforts, but if recent examples of success are any indication and the interest continues, it is possible that current and future generations will be able to enjoy the benefits of the rich biological heritage of Mexico.

Rural Communities and Land Owners

The system of land ownership is an important component in any conservation effort. The protection of natural areas depends substantially on private owners and rural communi-

ties organized under common land use or part-ownership regimes. Unfortunately, the country's agrarian reform did not include a system of territorial reserves that could serve as the starting point for natural protected areas. Less than three percent of the Mexican landscape is federal government property, the majority of the land inside natural protected areas is owned by communal land members, part-owners and, to lesser extent, private owners. Incentives to protect the natural resources and ecosystems, such as payment for environmental services, are necessary to maintain a productive working relationship with the multiple actors involved. It is also important to consolidate the role of stakeholders as key actors in conservation and the safeguarding of the nation's natural heritage.

The Future

There is an overwhelming international consensus among scientists that the environmental crisis, including species extinction and the disappearance of the natural environments, is one of the greatest challenges in human history. The increasing rate of species extinction should be a wake-up call for decisive actions to address the sources of environmental problems. The window of opportunity to act is narrow, perhaps as little as two or three decades. Despite this ominous state of affairs, there are glowing examples of species at the brink of extinction that have recovered, environmental scars healed and ecosystem services and structure restored. Conservation is about protecting our environment, our planet Earth, our home. Success stories are a reminder that the fate of the environment, and ultimately ours, rests on us. These examples of success prove that, with the commitment of the many different sectors of society, environmental deterioration can be stopped and reversed and that future generations of humankind will be richer for the actions we take today.

Las Nubes, Selva Lacandona, Chiapas. (JS)

Peninsula and Gulf of California

Islands of the Gulf of California

The Gulf of California or Sea of Cortez, located between the Baja California Peninsula and the states of Sonora and Sinaloa, is one of the most productive seas in the world. It has a length of 1,400 kilometers, and the 900 islands and islets that populate the Gulf comprise a total area of about 420,809 hectares. These islands which function as "natural laboratories" are among the best protected areas in the country. Evolutionary processes, such as the origination of new species, extinction and new habitat colonization, fundamental to the understanding of biological diversity, are ongoing and evident in many of these islands. The Grandes Islas region, in the upper part of the Gulf, is dominated by large or unique islands such as Ángel de la Guarda, Tiburón, San Esteban, San Lorenzo, Rasa, and San Pedro Mártir. Because of its biological diversity and natural beauty the region is a priority area for the Carlos Slim Foundation - WWF Alliance conservation efforts.

The origin of the Gulf of California is closely related to the San Andrés Fault, a major geologic feature that extends through California and into the Gulf of California for about 1,600 kilometers. The Baja California Peninsula started separating from the continent about 130 million years ago, and significant tectonic activity created the Gulf about 25 million years ago. After a series of collapses and tectonic uplifts, the Gulf developed into its modern form only 4.5 million years ago. It is estimated that in a couple million years the Peninsula will completely detach from the continent because of the fault induced tectonic activity and the constant movement northward of the underlying plates. When this occurs, the historical "mistake" of the 17th century European depiction of the Peninsula as an island will become a geographic fact.

Weather in the Gulf is influenced primarily by the arid conditions of Sonora and Baja California and the mountains throughout the Peninsula, some of which exceed 3,000 meters blocking the eastward movement of the wind and humidity coming from the Pacific Ocean. The high productivity of the turquoise waters of the Gulf, which contrast with the bleaker arid landscape, is the product of tidal currents and upwellings. The currents are vertically mixed when they collide with the islands, passing through the narrow channels between them. The upwelling occurs when the superficial water is replaced by colder and nutrient rich water from the depths of the ocean. Construction of the Hoover Dam in 1935 and the Glen Canyon Dam in 1962 in the United States significantly altered the amount and timing of the waterflow of water from the Colorado River which historically entered the upper Gulf, thereby eliminating this source of nutrients.

The biological diversity of the islands in the Gulf of California is primarily the result of the abundance of marine organisms that feed the birds and marine mammals and the isolation from the rest of the continent. The impressive list includes 36 terrestrial mammal species, 300 bird species, 115 reptiles, and 5 amphibians. Unique mammal species include the endemic black jackrabbit of Espíritu Santo Island and the previously extirpated bighorn sheep of Tiburón Island.

The islands are an important nesting and breeding site for marine birds, both migratory and resident. Ninety percent of the Heermann's gull and 95% of the elegant tern breed on Rasa Island, and the largest populations of the blue-footed booby and brown booby in Mexico are found on San Pedro Mártir Island.

Reptiles are the most diverse terrestrial vertebrate taxon on the islands, hosting 115 species. Most species are lizards and iguanas, but there are also snakes and turtles. Almost half of the species are endemic and some are restricted to only one island, such as the Monserrat Island diamondback rattlesnake, and others are exclusive to several islands, like some iguana and chuckwalla species. Unfortunately, 25 species are currently endangered.

High diversity of plant species is a characteristic of arid environments. The islands host 655 plant species, of which 28 are endemic. The cacti and succulents are the dominant vegetation type. Tiburón and Espíritu Santo islands have the largest number of species, 298 and 235, respectively. Other vegetation types include mangroves in the wetlands and plants adapted to coastal dunes.

The depth of the water in the Gulf of California varies significantly, from the shallow northern end to depths exceeding 3,000 meters in the southern reaches where it meets the Pacific Ocean. More than 30 marine mammal species live in the Gulf, including cetaceans such as the humpback, sperm, killer, and rarely, the blue whale, as well as short-beaked common dolphins and pinnipeds like the numerous sea lions. The endemic and critically endangered vaquita, or Gulf of California harbor porpoise, also lives in the northern region of the Gulf. Unfortunately, it is incidentally caught in the nets used to catch the highly prized and valuable totoaba, another endemic fish that is also in danger of extinction. The Gulf is also an important feeding area for sea turtles, including the green, olive ridley and the loggerhead.

The introduction of invasive exotic species, such as goats, dogs, cats, rats, and mice, has been the primary cause for extinctions. Goats are voracious herbivores that not only eat native plants but damage seedlings and facilitate soil erosion,

Rasa Island, with less than one square kilometer, protects 95% of the global population of royal tern. Up to 200,000 terns have been counted in years of sardine abundance, their main food source. (JR)

PAGE 46 *There are about 900 islands and islets off the coast of the Baja California Peninsula, all protected under the category of Flora and Fauna Protection Area.* (CCK)

PAGE 48 *The spectacular biological diversity of the Baja California Peninsula is related to the heterogeneity of the physical environment where the sea, mountains and desert blend together.* (JD/NPL)

The islands of the Gulf of California are home to 115 species of reptiles. Many of them, such as the desert iguana, were isolated from their continental congener, which allowed them to follow a different evolutionary path. (CCK)

PAGE 55 *The venomous Santa Catalina Island rattlesnake, although a rightful rattlesnake, lacks a rattle. There are no predators on the island to warn of their presence.* (CCK)

destroying the habitat of many species. Cats and rodents, hard to eradicate due to their small size and feral nature, eat the eggs and hatchlings of sea birds which tend to nest on or near the ground, and they are hard to eradicate due to their small size and feral nature. Alonso Aguirre Muñoz, director of Island Conservation (GECI), has coordinated a very successful program for the eradication of invasive species such as cats and rats. In collaboration with the National Autonomous University of Mexico (UNAM), the Northwestern Center for Biological Research (CIBNOR), several government agencies, and the local people, GECI works on this fundamental conservation program to reestablish the unique communities of flora and fauna.

All the islands in the Gulf of California were decreed as a Migratory Bird and Wildlife Refuge and Reserve Zone in 1978 because of their biological importance. In 2000, they were decreed as Flora and Fauna Protection Areas and added to UNESCO's Worldwide Network of Biosphere Reserves. In 2005, UNESCO declared the islands and protected areas of the Gulf of California a World Heritage site.

The combined efforts of many different actors have significantly enhanced the protection of the ecological integrity of these islands. The programs focus on the protection of ecosystems, sustainable use of resources, monitoring of biodiversity, and the establishment and implementation of conservation centered regulations and guiding principles. The efforts also include environmental education, a vital component for the community and tourists alike to understand the need and value of conservation and become active participants in the responsible use and protection of the natural resources. The Gulf of California, the "aquarium of the world" as Jacques Yves Cousteau aptly named it, including its diverse, wonderful, and alluring islands, now have a promising future because of the work of many partners united in their protection.

Gerardo Ceballos and Paola Guadarrama

Cabo Pulmo

Diving or snorkeling in a coral reef is one of the most stimulating experiences that a human being can have. Already one meter below the surface, hundreds of fish from dozens of species can be seen, as well as sea turtles, crabs, snails and, of course, coral structures and sponges, among many other things. Looking at it closely, a reef's microcosm is no less spectacular: fish smaller than a thumb garnished with neon lights, micro starfish, veined snails the size of a coffee bean, or a miniature hermit crabs fighting for a tiny shell to use as a house.

Coral reefs are one of the richest and most diverse ecosystems in the world; and most of them can be found in crystal-clear tropical waters. Cabo Pulmo's location is privileged: right in the southeastern end of the Baja California Peninsula, at the Sea of Cortez's entrance, about 100 km south of La Paz Bay. This means it is one of the most northern reefs in the eastern Pacific, located exactly at the Tropic of Cancer's latitude (23°N), the limit between tropical and subtropical waters. It is about 150,000 years old, and is the oldest reef in the Pacific. Nowadays, more than 800 species inhabit it.

Because of its visual appealing, and for being one of the most productive areas for fishing, it has called the attention of fisheries, conservationists, developers, and various visitors for decades. After many years of overfishing —mainly of shark and mollusks that produce mother of pearl— and excessive visitors, it was decreed, in 1995, a National Park with more than 7,000 hectares. A few years later, some attempts of building massive resorts were made by ambitious companies, without any sustainable interest. Shark fishing collapsed and, even if the populations are recovering, it is not yet time to resume this activity.

The decree and publicity promoted Cabo Pulmo's popularity and the Park has been visited regularly. This can be considered as a positive aspect: many

Management plans for natural protected areas like Cabo Pulmo regulate the extraction of fish such as the bigeye trevally to maintain their populations, ensuring the sustainable exploitation of resources and the well-being of the coastal communities. (CCK)

The Pacific islands, mostly of volcanic origin, are very productive environments. The plankton and krill, which form the basis of the food chain, are eaten by a variety of fish and mollusks that support other species inside and outside the ocean. (CCK)

PAGE 58 *Besides the ecological importance of the biodiversity of the Sea of Cortez, its waters are an important source of income for the residents, such as the adventure tourism, which congregates visitors from around the globe, seeking to submerge themselves in this amazing scenery.* (CV)

were made aware about the importance of this beautiful place and its conservation. Sadly, the coral suffered the consequences of so many visitors. In spite of the education campaigns made by the fishermen, part of the superficial section of the reef is dead because of too many people walking on it.

The insistence on having a chaotic, and destructive, development in Cabo Pulmo was particularly strong during the 1980s. Facing this issue, professors and researchers from the Autonomous University of Baja California Sur visited the area. They studied the species and the behavior of the ecosystem; and started to discuss the importance of the reef with the inhabitants. Even then, many companies continued insisting. It was then when Judith Castro Lucero, daughter, granddaughter and great-granddaughter of Cabo Pulmo fishermen —along with all her community— committed to the conservation of this amazing area. They prompted the creation of the organization Amigos para la Conservación de Cabo Pulmo. This civil association has achieved important goals by getting both the conservational and fishing communities of Mexico together. They have also made an ally of legendary Dr. Sylvia Earle, an American oceanographer better known as "Her Royal Deepness", or simply "Her Deepness", because of her constant fight to protect the seas of the planet.

The amazing success of conservation in Cabo Pulmo, with its social participation and its low scale tourism has surpassed the Mexican borders. Nowadays, there are other parks where communities have been involved in conservation and sustainable economic development. One example is Guanahacabibes National Park in Cuba. The case of Cabo Pulmo provides several lessons that should be considered. 1) The recognition of the ecological importance of a reef that provides many benefits for the local community, our country and the oceans that surround us. 2) The participation of academics from Baja California, who discussed with the community the value of this reef by using accurate information along with effective and accessible awareness-raising mechanisms. 3) The fishermen community's commitment that was able to defeat the perverse economic interests. The Cabo Pulmo fishermen and their organization have given us a clear lesson: it is possible, when using collaboration —cross-sectional, international, and inter institutional— and a respectful and honest treatment, to use one's power and make a difference. 4) The importance of commitment and responsibility of the Mexican government and its environmental sector to

promote and assure the conservation of ecosystems, starting with well-founded proposals, well-aimed actions and structured conservation programs.

The great writer John Steinbeck describes this fascinating and spectacular reef with great detail in The Log from the Sea of Cortez*, explaining that "[t]he complexity of the life pattern on Pulmo Reef was even greater at Cape San Lucas. Clinging to the coral, growing on it, burrowing into it, was a teeming fauna. Every piece of the soft material broken off skittered and pulsed with life —little crabs and worms and snails. One small piece of coral might conceal thirty or forty species, and the colors on the reef were electric."*

It is important to celebrate the conservation success in Cabo Pulmo, learn from it, acknowledge it, and replicate it. It is also important to visit it with responsibility, as well as enjoying and encouraging its conservation as much as possible. Many more coral reefs are waiting for us Mexicans to get involved and fight decidedly for them.

Rodrigo A. Medellín

The frogfish and the coral hawkfish are examples of the diversity of species that live in the waters of the Sea of Cortez. This wealth is due to the different environments that coexist there, from shallow rocky reefs and sandy seafloors to deep continental slopes and hydrothermal vents. (above, OA; below, CCK)

Revillagigedo Islands

In the Pacific Ocean, 600 kilometers off the coast of Colima, four mountains rise that from space look like tiny lost spots in the blue immensity. These insignificant points constitute the largest distinct units of Mexico's most important archipelago. The remote Revillagigedo archipelago has a high and unique biodiversity and it extends Mexico's Exclusive Economic Zone by 303 kilometers. Named in 1793 in honor of the viceroy in New Spain and 2nd Count of Revillagigedo, Juan Vicente Güemes Pacheco de Padilla, this archipelago is part of Mexico's insular territory that includes more than 2,500 islands, cays, and atolls.

Three islands (Socorro, San Benedicto, and Clarion), and an islet (Roca Partida) form the archipelago. The islands are the summits of gigantic submarine volcanoes formed from the separation of the Pacific and Cocos plates. The islands closest to the continent, Socorro, with its dormant volcano Evermann and San Benedicto, with its active volcano Bárcena that erupted twice in the middle of the 20th century, were discovered in the 1500s. The western-most island, Clarion, and the islet Roca Partida, the oldest of the four terrestrial units, are more than 1,000 km from the coast and were discovered in the 1700s.

This extraordinary and fragile ecosystem is located at the convergence of two marine biogeographic regions, the Northeast Pacific and the Eastern Pacific. Cold, south flowing ocean currents from California mix with warm, north flowing currents from Ecuador, create an area of high productivity and diversity that is important for the fishing industry. About 30% of all the terrestrial and marine species of the archipelago are endemic, meaning they cannot be found in any other site in the world. Twenty six percent of the 202 catalogued plant species on the islands are endemic, and of the 92 bird species on the islands, including the magnificent frigatebird, tropicbird, seagulls, warblers and plovers, 10 are endemic. The most extreme example of endemism are those animals associated

Revillagigedo islands are a breeding, nesting, feeding, and resting site for many seabirds such as the red-footed booby. (CCK)

PAGE 66 *In 2016, the Revillagigedo Archipelago joined the reserves recognized by UNESCO as a World Heritage Site because of the unparalleled natural wealth its islands and waters hold.* (CCK)

with only one island, such as is the burrowing owl, red-tailed hawk, raven, and the booby limited to Clarion Island. Socorro Island hosts the only reproduction and nesting site of the Townsend's shearwater, the Socorro parakeet, and the Socorro mockingbird, all three of which are in danger of extinction. Unfortunately, the Socorro elf owl and the rock wren have gone extinct. The islands also have many endemic reptiles such as the Clarion Island tree lizard, the Socorro Island tree lizard, some geckos and snakes.

The waters around the archipelago support a very diverse community of marine organisms, both transient and resident, such as: humpback whales; killer whales; dolphins; 22 species of corals; 214algae species; and 251 fish species, including 20 shark species. Many iconic species use these waters including the whale shark, giant manta ray, the endemic Clarion angelfish, and four sea turtle species: leatherback, the olive ridley, hawksbill and the black sea turtle, a subspecies of the green sea turtle which nests on Clarion Island.

The introduction of exotic species, beginning more than two centuries ago, was a major assault on the integrity of the ecological health, and the effects are still being expressed today. Sailors and explorers began visiting the archipelago sometime after the 1790s when the Count of Revillagigedo ordered the occupation of the islands. Almost a century later, in 1869, the Mexican government authorized the introduction of 100 sheep and 25 cows on Socorro Island to establish a small community. When humans abandoned the island, the sheep expanded significantly, destroying the vegetation and habitat of many endemic animals, causing severe erosion, spreading exotic plant species, and changing the predominant vegetation cover to thorn scrubland. Domestic cats that arrived with the military detachments 1972 and 1978 turned feral and are responsible for the extinction in the wild of the Socorro dove and severe population reduction of other bird species. Rodents, scorpions and 47 plant species, including cotton, were introduced on Socorro Island, and the domestic pig was introduced on Clarion Island where it destroyed bird and sea turtle nests. While the pig was exterminated in 2002, the European rabbit, introduced during the 1980s, adapted well and currently has an abundant population.

Despite this destruction, the history of the Socorro dove is a hopeful one. This bird was still abundant on the island when Dr. Bernardo Villa-Ramirez, one of Mexico's first trained biologist, visited in 1958. More than two decades later,

The humpback whale finds an ideal site for giving birth in the waters of the Mexican Pacific. Some archipelagos, like Revillagigedo, are so productive all year round, that these giants don't migrate back north when summer arrives. (EH)

PAGE 70 *Like many other insular birds, the Socorro mockingbird suffered from an intense predation pressure from rats and cats. This mockingbird occupies only 10 square kilometers in Socorro Island, where their population is estimated at 500 individuals. (CCK)*

several expeditions failed to locate a specimen and it was reported extinct. Fortunately, during the first half of the 20th century, several individuals had been taken to private collections in the United States and Europe. The famous ornithologist, Luis Baptista, once curator of the bird and mammal collection at the California Academy of Sciences, set out to recover the species with the dream of someday bringing it back to the island. Earlier eradication programs of exotic animal species were successful by the time he visited Mexico to begin this ambitious project in 1995 and much of the native vegetation had recovered. This rehabilitated landscape is now ready for the Socorro dove and the network of captive breeding facilities prepare for the eventual release of the birds. Currently, several specimens are at the Africam Safari Zoo in Mexico and facilities on the island are under construction, evidence of the efforts to bring back this unique and symbolic bird from the brink of extinction.

Another example of island recovery is the rapid reappearance of flora and fauna of San Benedicto Island following their loss from the 1948 and 1952 eruptions of the Bárcena volcano. Since 1994, 12 species have been recorded, 10 of which are endemic.

The wealth of the natural history of these islands and marine environment has been known for more than 150 years. Benito Juárez, national hero and president of Mexico, enacted a decree in 1861 to explore the archipelago, and two years later published the first Mexican scientific study. Since then, innumerable studies on the flora and fauna have been conducted. These early studies provided baseline data and other information for the establishment of a 636,685 hectare (maritime and terrestrial) Biosphere Reserve in 1994. In 2004, this archipelago was declared a RAMSAR site by The Convention of Wetlands of International Importance, and in 2016 UNESCO decreed it a World Heritage site.

The success in bringing back the rich assortment of flora and fauna to this group of small islands in the Pacific is a symbol of what is possible. It demonstrates that despite significant odds against stopping and reversing environmental degradation resulting from generations of human activities, the landscape and the native biota can regain their former presence and the mockingbirds and shearwaters and myriad other fauna and flora can join the Socorro dove in returning home.

Gerardo Ceballos and Paola Guadarrama

Elephant Seals and the Guadalupe Fur Seal

Few places on Earth had such abundant diversity of marine mammals like Guadalupe Island. This island, a remote place lost in the vast Pacific Ocean 250 kilometers off the coast of Baja California, was home to huge colonies of sea otters, fur seals, sea lions, and elephant seals. In the 19th Century the colonies attracted hunters from far away countries like Russia. The hunt was quick and indiscriminate; a single Russian ship killed 10,000 otters in the year 1810. The otters were valued for their skin, highly prized in Europe. The trade value for otter skins reached 100,000 dollars annually and a few years later, the otters had disappeared from the Island.

The cold and productive waters of the California current that runs south from Alaska is primarily responsible for the impressive marine diversity. The microorganisms that proliferate in these waters are the starting point of the marine food chain which supports the web of invertebrates and fish, which, in turn, sustain the mammal populations of the Northern elephant seal, California sea lion, and Guadalupe fur seal, and, formerly, the sea otter. Their abundance attracts a large concentration of great white sharks which feed on these mammals, especially fur seals.

Once the sea otter population was extirpated, hunters exploited the Northern elephant seals, primarily for their oil and the Guadalupe fur seals for their valuable skin. A male Northern elephant seal can weigh up to 3,700 kilograms and measure more than three meters in length; females are smaller. One specimen could yield hundreds of liters of oil that was used for lamps, machine lubricants, or in the production of soap and candles. The Guadalupe fur seal is a smaller species; males, which are larger than females, may weigh up to 120 kilograms and measure two meters long. Their underfur was used to make hats and

The country's most representative kelp forests can be found in the Mexican Pacific, specifically off the coast of Baja California. The productivity of this ecosystem and the number of species it contains are comparable with those of tropical rainforests. (CCK)

jackets. Estimates of the population size of the Northern elephant seals at the beginning of the 19th century was 200,000 individuals and for the Guadalupe fur seal, about 100,000. They bred in Isla Guadalupe and other islands of the region, from the Revillagigedo Archipelago in the south off Colima's coast to the north in the Farallon Islands off the coast of San Francisco, California. They congregated to breed in large concentrations on the rocky beaches of the islands at the end of autumn and during winter, after several months at sea.

The peak period of exploitation of these animals, primarily by Russian, Japanese, and American ships, occurred between 1840 and 1860. By the middle of the 19th century, the indiscriminate hunting had reduced their populations considerably. In 1870, the rocky beaches of Guadalupe Island, once home to tens of thousands of animals, were covered in bones and fur pieces, the shocking spoils of the slaughter that had pushed the Northern elephant seals and Guadalupe fur seals to the brink of extinction. These species were considered extinct except for some small groups that survived off the coasts of Guadalupe Island and the Baja California Peninsula. Commenting on this large-scale slaughter of marine mammals, the American naturalist Laurence M. Huey described the tragedy of the Northern elephant seal in 1930, "few, if any, living species today have been so deeply scored, so driven to the very brink of extermination." As incredible as it seems, the remaining populations were also hunted, and by the end of the century, fewer than 100 specimens of this species survived in Mexican waters.

The history of the Guadalupe fur seal is similar. The thousands of individuals that existed at the beginning of the 19th century was, by the 1850s, just a memory. In one of the paradoxes that fill scientific annals, the Guadalupe fur seal was not identified as a distinct species until 1897, after it was nearly extirpated from Guadalupe Island. George A. Bartholomew, a pioneer researcher of this fur seal, wrote about the tragedy of these animals; "the small surviving remnant of the once teeming population of fur seals of coastal California and Baja California is a pathetic testimony of man's rapacity and indifference to the status of mammals other than himself." By 1928, the species was considered extinct despite the decree by president Álvaro Obregón in 1922 to provide protection to the island as National Park. Fortunately, the fur seal was "rediscovered" in 1954,

Although humans almost caused the extinction of the Guadalupe fur seal, today the species is recovering successfully. In five decades, the population grew from only 14 individuals to more than 7 000, that live mainly on Guadalupe Island. (CCK)

PAGE 76 *The islands represent living laboratories where the factors that determine colonization and extinction rates can be studied. This helps us understand how biodiversity originates, maintains and disappears.* (CCK)

At the beginning of the 20th century the elephant seal population was down to the last dozen individuals in Guadalupe Island. Thanks to protective public policies, the population has recovered and now exceeds the 100 000 individuals. (FEV)

PAGE 81 *The Guadalupe fur seal has recovered thanks to legal protection and the conservation of the two islets where it lives. Nowadays this species can be spotted on the rocky beaches of Guadalupe Island.* (CCK)

when seven individuals were seen in a cave of the Island's coast. The decree saved the elephant seal and other marine mammals from extinction, except for the sea otter that once inhabited those waters. But, luckily, the sea otter survived in Monterey Bay, California.

Año Nuevo, a beach located on the California coast about 70 kilometers south of San Francisco, is one of the few places where the elephant seal inhabits continental beaches. It is a sanctuary, a unique place, a refuge for this species that was nearly brought to extinction. This colony is a sign of optimism. These huge mammals have returned to breed on these coasts, a sight that had not been seen in more than a century and a half. The breeze is fresh and the water of the ocean cold. On the beach, huge males weighing up to three tons rested on the sand with their female group and this year's calves which weight about 100 kilograms. Some animals threw sand onto their backs to refresh and cover from the sun. The females were getting ready to return to the sea where they spend most of the year.

These mammals have returned to this Californian beach almost one hundred years after the decree. The Northern elephant seal population now exceeds 150,000 individuals and the Guadalupe fur seal about 20,000. This remarkable recovery is credited, in large part, to the actions of a visionary Mexican President whose signature prevented these wonderful animals not to be remembered in stories and museum collections but to enjoy them in their natural surroundings.

Gerardo Ceballos

Elephant seals congregate in Coronados, San Martín, Guadalupe, San Benito, Cedros and Natividad Islands during the breeding season, where they feed on a variety of fish, jellyfish and squid. (EH)

Gray Whale

The gray whale is the most protected cetacean in Mexico. It belongs to the group of baleen whales, or Mysticeti, and carries out one of the most amazing migrations in the animal kingdom. Nowadays, there are two populations in the North Pacific: one in the west and one in the east. The northwestern, or Korean, population has only 120 individuals, which is why the International Union for Conservation of Nature (IUCN) considers it as Critically Endangered. The northeastern population, which lives from Alaska to Baja California, has recovered in a magnificent story of conservation and currently has more than 20,000 individuals.

The Californian population migrates from 8 to 11,000 km, following the coastline from the Bering Strait —where it feeds on invertebrates from the depths of the ocean like crustaceans and mollusks— to the Baja California Peninsula's coasts and the Sea of Cortez, where they reproduce from December to April. Pregnant females are the first to undertake migration, and are the ones who lead the group; they are followed by females in reproductive stage, adult males, and young females and, at the end, young males. When they arrive to Mexican waters, pregnant females congregate in lagoons and shallow bays where, after a 13 months gestating period, they give birth to calves that can measure up to 5 meters. Whales continue reproduction and lactation until the middle of February, when migration to the North begins once again.

In Mexican waters, systematic whaling to obtain oil, meat, and bones that were highly priced started after the invention of explosive harpoons in 1840. They were mainly hunted in reproduction lagoons like Bahía Magdalena, Ojo de Liebre, and San Ignacio, but also in waters near islands like San Martín, San Benito, Cedros, and Natividad. Famous hunter Charles M. Scammon, one of the first

It is estimated that the North American gray whale population exceeds 20 000 individuals, representing the largest and most monitored population of this species on the planet. (CCK)

explorers of Baja California's coastal lagoons, hunted more than 200 gray whales in Laguna Ojo de Liebre, main breeding area of the species, during the winter of 1858. It has been calculated that in three decades more than 5,000 specimens were hunted, which is why, 30 years later, by 1875, migrating populations were on the verge of extinction.

Almost a century later, in 1946, the International Whaling Commission (IWC) was established. Its purpose was to orderly develop the whaling industry. Hunting limits were established by species and area; regions were assigned as sanctuaries; protection of calves and females was implemented; and hunting methods were restricted. But the diminishing whale numbers were evident, and a strong worldwide movement against whaling started. By 1982, the IWC established a moratorium on commercial hunting, which is still in effect. This moratorium does not include aboriginal or native communities' subsistence whaling, which needs few animals. In spite of these efforts, some countries refuse to end their activities: Japan, Norway, and Island still hunt different cetacean species —especially common minke whales, cachalots, and Fin whales— to what they claim to be scientific research. In 2014, the International Court of Justice declared Japan whaler activities as illegal.

In Mexico, the action that probably saved the gray whale from extinction was the decree of President Álvaro Obregón, who in 1922 prohibited marine mammals' hunting in Mexico. Gray whale conservation consolidated when, five decades later, Ojo de Liebre and San Ignacio in Baja California were declared Refugios de Ballenas y Ballenatos (Whales and Calves Refuges) in 1972 and 1979, and El Vizcaíno Biosphere Reserve was established in 1988. Since then, the federal government, the communities, and the academia have made population and genetic studies, and strategies have been developed to enhance the presence of this species as a tourist attraction.

Ecotourism has been very successful: between 1996 and 2007, more than 160,000 visitors were recorder in both refuges, which were declared World Heritage by UNESCO in 1993. In the year 2000, guidelines and specifications for activities in whale watching zones were established, and it was decreed that no marine mammal specimen could be subject to extractive use, either commercial or for subsistence. Shortly after, in 2002, it was established that seas on which the nation

LEFT *The lagoons where gray whale calves are born also receive many species of birds like ducks, egrets and seagulls. The preservation of these complex and fragile marine ecosystems has been a tremendous success.* (CCK)

BELOW *Despite having been on the verge of extinction, almost all whale and marine mammal species in Mexico have recovered thanks to protective policies implemented 100 years ago.* (CS/B)

exercises its sovereignty are part of an Refuge Area to Protect the Great Whale Species of the Mysticeti and Odontoceti Suborders.

There are still prevailing problems like pollution and ship traffic that are dangerous for the species. However, due to strict conservation measures, both in Mexico and the rest of the world, gray whale populations recovered in numbers that are considered to have existed before commercial whaling. Every winter, gray whales arrive in greater numbers to breed in the Baja California coastal lagoons, in a show like those of the 19th century. In the calm waters of those lagoons, calves and whales enjoy the same freedom their ancestors did centuries ago, far from the bustle and dangers of the outside world.

PAOLA GUADARRAMA AND GERARDO CEBALLOS

PAGE 87 *During winter, the shallow waters of the Baja California coastal lagoons, rich in nutrients and predator-free, are a special place for gray whales. Many of the gray whales that swim throughout the Pacific are born here, in San Ignacio and Guerrero Negro lagoons.* (*above, JSR; below MSN/SP*)

The Guadalupe Island Biosphere Reserve is recognized as one of the four sites in the world where it is possible to see the great white shark from a boat or inside a submerged cage. (RF)

Great White Shark

Guadalupe fur seals, calmly swimming in the cold waters around Isla Guadalupe, invite to tranquility and relax. Suddenly, the sea surface is broken by a white foam explosion: a powerful hydrodynamic shape sinks its numerous and sawed teeth in a young fur seal that pointlessly tries to scape. This scene is repeated hundreds of times a year in the Mexican Northern Pacific. Even if many sea animals are covered by a mysterious veil and generate an admiration that is closer to fear, the one that probably causes it more is the great white shark. It is the most powerful predator fish in the world, and its intelligence is usually presented —in books, movies and sensational media— as mistakenly evil. Because of its strength and size, the white shark has become a great attraction in alternative tourism.

Isla Guadalupe represents, by itself, a great conservational success that should be divulged and shouted from the rooftops. The island's vegetation suffered, for almost three centuries, great damage due to domestic goats that were introduced by whalers, sailors, and fishermen during the 17th and 18th centuries. These animals reduced the original vegetation to a few stalks of grasses and left the soil naked in most of the area, severely degrading the ecosystem. After some failed efforts to eradicate goats to allow the vegetation and endemic species to recover —for the island's flora evolved through millions of years without the presence of herbivoouse mammals— GECI (Island Conservation) was able, in 2007, to completely eradicate goats. It was a long, expensive, and exhausting process for all involved; but it represented a great step for biodiversity conservation in the island, Mexico, and the whole world. It is still necessary to eradicate cats, which bring grave danger to bird sea colonies.

LEFT *The legal protection of the white shark, the seas where it lives and the non-extractive use that the observation of this species represents, have stopped the extermination of this and other species of sharks.* (MU/SP)

ABOVE *White sharks suplement their usual diet of fish, turtles and other marine creatures with calves of sea lions and elephant seals, that between July and December gather on the coasts to reproduce, representing an important source of fat and protein.* (CCK)

While this was happening, the island started to gain renown in Mexican and international media because of the discovery of an important great white shark population. This population visits Mexican waters during the same season in which thousands of elephant seals, sea lions, Guadalupe fur seals, and other marine mammals use the island to reproduce. Nowadays, the white shark population of Isla Guadalupe is one of the most popular in the world due to its high density, water clarity, and good ecotourism practices. There are only four places in the world where a visitor can, from a secure cage, observe great white sharks in the wild: the north of Australia, the southern coast of South Africa, the Farallon Islands, in the San Francisco coastline, and Isla Guadalupe in Mexico. But it is only in the Mexican Pacific waters where these impressive giant fish can be observed in exceptionally crystal clear waters, with a visibility of more than 25 meters. These conditions, obviously, allow for the shark to be observed in its entire splendor, approaching the cage with elegance and might, to the point of even touching the bars. The experience is truly unique and leaves an unforgettable mark in one's memory.

Mexican sharks have received protection from Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Mexico and other countries promoted the inclusion of the great white shark, the basking shark, the whale shark, three species of hammerhead shark, and some others on Appendix II of that Convention. This means that international trade of individuals, parts, products, and sub products is prohibited without a CITES certificate from both country of origin and country of destination. Nationally, this implies that Mexico includes these animals in its list of threatened species (NOM-059).

Mexico's battle in CITES to protect these sharks has been huge. Some sectors in Mexico opposed the inclusion of sharks in these lists, arguing that they practiced sustainable fishing, which is obviously not possible due to the scarcity of the species in Mexico and to the voraciousness of fishing practices. But discussion, scientific evidence, and common sense won the battle for the great white shark. Mexico's participation in the CITES Conference of the Parties debates was crucial to achieve the inclusion of this species in Appendix II.

Given the remote location of Isla Guadalupe —right in the Pacific Ocean, 240 km to the southeast of the central Baja California coastline— the logistical and conservation operations are not easy. The Mexican Secretariat of the Navy has played an important role to secure the success of the protection program, both in land and surrounding waters that are part of the Isla Guadalupe Biosphere Reserve, which is composed of the 24,300 ha of the island, and more than 452,000 maritime hectares. The island possesses more than 200 plant species, 35 of which are endemic to the island. After the destruction of their habitat by the goats and the introduction of cats, some birds, like the Guadalupe storm petrel, became extinct, but others are recolonizing and contributing to the restoration of this complex insular ecosystem.

It is worth mentioning that, during the last decade, tourist development and fishing activities started growing in a disordered and accelerated way. Very soon, Mexican authorities, along with service providers and NGOs, started to regulate the activity with good practice manuals and protection programs. Nowadays, for example, it is not allowed to attract the sharks with bait, and the visitor's cages have been redesigned to avoid risks and accidents.

The great white shark, emblematic animal and predator par excellence of the seas all around the globe, has today one of its biggest concentrations in Mexican waters, where it is protected by authorities, academics, fishing communities, service providers and NGOs. The orchestration of so many actors has only been possible due to the good will and common interest of all involved. Even if there are misunderstandings, some setbacks, and some aspects to be polished, the observation program has both feet steadily on the ground (or on the water, we might say) and moves forward onto the future with all the indicators of success. Today, Mexico can be proud of having one of the best observation systems of the great white shark, something that few countries can brag about.

Rodrigo A. Medellín

Shark watching is a very important source of economic income for the communities settled around marine environments, promoting a culture of conservation and sustainable development. (CCK)

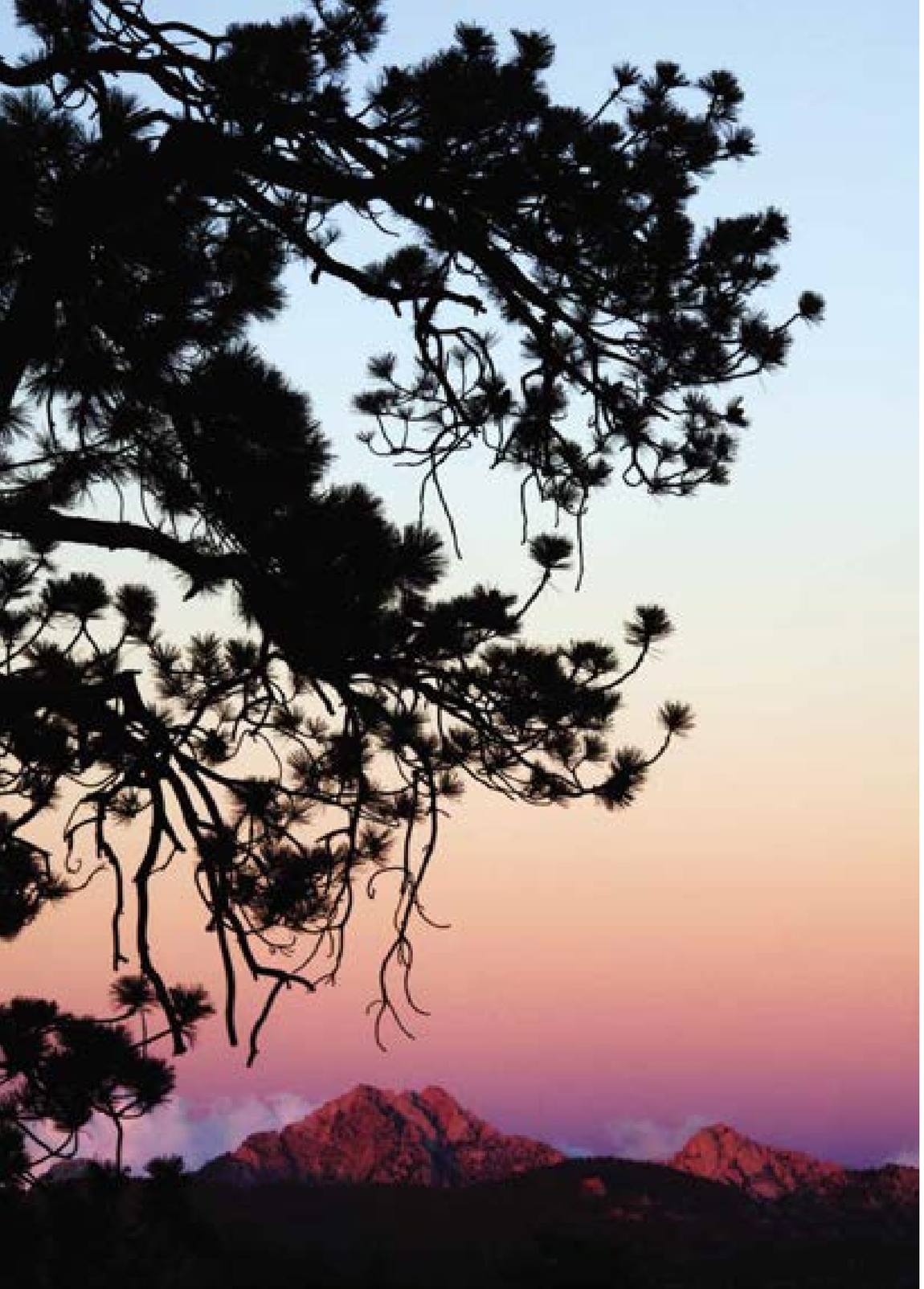
RIGHT *The islands of Baja California make up a diverse island complex. There are islets of a few square kilometers that stand above the sea only by 30 meters like Isla Partida and there are islands of amazing proportions like Guadalupe with 23 000 hectares and elevations of 1 200 meters.* (CCK)

California Condor

The megafauna of North America 20,000 years ago, before the arrival of the first humans, was amazingly diverse. Species like the mammoth —a huge beast weighing as much as 10 tons— and birds with a wing span of 6 meters roamed the landscape, and large herds of giant Ice Age bison, camels, and antelope, followed by their predators such as lions, saber-tooth tigers, wolves, and cave bears lived in the wide valleys of northern Mexico. Part of the food and energy cycle, a plethora of scavenger birds such as giant condors, eagles, and vultures that took advantage of the abundant food supply, eating the remains of dead animals. But 10,000 years ago, the Pleistocene age ended, marking the end of the megafauna in Mexico and the rest of North America. Almost 85% of the terrestrial vertebrates weighing more than 100 kilos became extinct, and the surviving species gradually regrouped to form the communities we know today.

The California condor was one of the giants that survived. At the zenith of its success as a dominant scavenger, the species ranged over a very large territory, from northern United States to the Baja California Peninsula, and from the Pacific coast to the Colorado Canyon, more than one thousand kilometers inland. In the last few centuries, its distribution was confined to the mountainous areas of southern California and to the San Pedro Mártir Sierra in the northern part of the Baja California Peninsula. The decline in population and shrinkage of range is attributed to the disappearance of animals which were its food source, initially the result of natural events and later by human activities such as hunting, and habitat modification that affected the animals upon which the condor scavenged. More recently, in the 19th and 20th centuries, lead poisoning from the ammunition used by hunters and the unintentional poisoning used in predator control such coyotes, was a major threat to the survival of the species.

Through a successful international collaboration, the California condor has recovered thanks to an intensive breeding program in captivity and reintroduction in protected areas. (CCK)



At the beginning of the 20th century, condors had disappeared from most areas they had once occupied and only a few pockets of them remained in the wild.

A small condor population had survived in the rough mountains of Sierra San Pedro Mártir until 1932. San Pedro Mártir, located in the north of the Baja California Peninsula, is now a National Park that at that time still sheltered twenty individuals of the species. The condor, as a carrion-eating species, fed on bighorn sheep and deer carcasses but could also ate any kind of mammal and bird carcass. On occasions, they would fly to the far coasts of the Gulf of Mexico and the Pacific Ocean where they fed on fish and marine mammals. Their huge size made them vulnerable and their population started to decline. They disappeared from the horizon and from the country due to the ranchers' attack. Some of the local ranchers saw them as a threat to their cattle, being livestock production the main economic activity of the region. They exterminated the condors with poison and shotguns. Sometime in 1932 the last condor disappeared from the majestic mountain range of San Pedro Mártir.

In 1987 there were only 27 individual specimens in the wild in southern California. In the preceding three decades, the population had diminished drastically; the survival of the species was in doubt. In an effort to ward off this fate, the California Department of Fish and Game captured all the wild condors and took them to zoos in San Diego and Los Angeles to start a captive breeding and recovery program.

Use of innovative breeding and rearing techniques was successful, and within five years later, the number of surviving condors almost doubled to 52 and the first pair was released in southern California. Bird monitoring showed that human infrastructure such as cables, roads, and croplands had a devastating effect, so they were recaptured and re-released in a more remote area. By 1995, there were 96 condors in captivity, 6 in the wild, and a breeding center in Idaho. Two years later, in 1997, there were 107 individuals in captivity, 17 in the wild, and one other state, Arizona, was participating in the recovery program. The program expanded to the Baja California Peninsula, and in 1998, the Secretariat of Environment and Natural Resources (SEMARNAT) coordinated the release of 6 individuals in the San Pedro Mártir Sierra, marking the beginning of a successful program. This was a new era in the recovery of endangered species in Mexico. The condor, which had been absent from mountains and valleys in the San Pe-

dro Mártir Sierra for decades, had finally returned. Eight years after SEMARNAT began their reintroduction program, which included a monitoring component, the condor population had increased to 43 individuals, three of them born in the wild. Later, the Chapultepec Zoo in Mexico City began a captive breeding program and, in 2015, the first condor was born there.

The California condor has returned home after decades of struggle for survival. The road to the recovery of this emblematic species was long and had many challenges and setbacks. However, the passion to preserve this and other magnificent species and the willingness to employ creative solutions to vexing and complex problems involving nature and human enterprises, coalesced into a successful program that saved this species from extinction. It is an example of what can be done to protect our biodiversity, the lifeline to sustainability and a more complete living world.

Eduardo Ponce and Gerardo Ceballos

The successful birth of condor chicks in the wild has been a huge challenge because there was little knowledge about the species behavior and requirements. However, after years of efforts, 43 condors where successfully released in the wild and three chicks have been born and are living in the wild. (CCK)

PAGE 100 *The released condors are being constantly monitored to understand their requirements and improve future plans for the recovery of the species.* (CCK)

PAGE 102 *A condor's population requires a huge area because each condor can fly in a range of 50 kilometers per day in search for food. The Sierra de San Pedro Mártir National Park, protected for 70 years, provides these vast areas for this and many other species.* (CCK)

The desert landscapes of the Baja California Peninsula offer a unique scenario for nature lovers since these arid lands are home to one of the fastest terrestrial animals of the planet. (CCK)

Pronghorn antelope

Every afternoon wanes with beautiful sunsets in the Baja California desert, and all animals seen to contemplate the brilliant colors that come from a hallucinated dream. The pronghorn appear, almost ghostly, in the middle of the plain: one after the other within our range of vision. Being able to admire these great runners crossing the desert is a reality because of many people who have not given up in their effort to stop the threats that brought this species close to extinction a couple of decades ago. Up to the 18th century, the pronghorn inhabited a great extension of the Mexican plains and deserts. They lived from the north of the Valley of Mexico up to Sonora, Chihuahua, and Coahuila, and in most of Baja California. Later on, the pronghorn population in Mexico declined severely: by the 1980s, there were less than 1,000 animals in the whole territory in Baja California there were less than 70 animals. We can contrast this number with the pronghorn that in those years (and up to this day) inhabited the state of Wyoming: close to 500,000. There are more pronghorn than people in Wyoming!

The pronghorn is the fastest animal in America. It is an ungulate (group of mammals with hooves) that inhabits the plains and pastures of North America, where it moves around long distances looking for the grasses on which it feeds. The pronghorn is very susceptible to extinction: the persistence of the species requires large populations. If this does not happen, predators —mainly coyotes— kill the fawns that tend to be born synchronically, during the same month. The coyote populations in Mexico are favored by the presence of people, because they feed of the garbage that we produce. Ocean waste, such as whales and other dead animals, provide them with a lot of food, too. Poaching and fragmentation of its habitat because of highways and villages, along with the presence of barbed wire that delimits properties all around the country,

have brought problems to the pronghorn in almost every region where it used to be found.

All these factors took the pronghorn very close to extinction in Baja California. In the 1990s, the much needed initiative and support finally arrived. Many organizations —Northwestern Center for Biological Research (CIBNOR), Natural Spaces and Sustainable Development (ENDESU A.C.) and the National Commission of Natural Protected Areas, with private support initiative— started a conservation campaign based on pronghorn's reproduction in semi-captivity and the releasing of the animals in controlled areas. By the 2000s, the recovery of the peninsular pronghorn had begun, even if the project developed slowly. A group of conservationists, led by Felipe Ramírez of ENDESU, had eradicated the coyote population from a large confinement, which allowed the pronghorn to start multiplying. Their number started growing and it was possible to start thinking about new areas to reintroduce them. While this was happening, the possibility of Mexicans visiting a camp was made possible. In this camp, people could appreciate the conservation efforts and admire this fascinating animal. The visits included guides and explanations that helped visitors learn more about this amazing species and the ecosystems it inhabits.

Pronghorn, like any animal adapted to North American deserts and plains, are severely affected by droughts and climate cycles. Females usually give birth to two fawns in northern latitudes and less inhospitable ecosystems than the Baja California desert, where they usually have only one, even if occasionally they do have two. The way in which female pronghorn protect their fawns from a marauding predator is by leaving them lying down with their head and neck right next to the ground. Their main defense is going unnoticed by staying perfectly still among the vegetation. But coyotes are very cunning and make use of the gaps left by the pronghorn' strategy. After leaving their fawn, or fawns, among the vegetation, the doe goes with the herd in order to feed. Every four or six hours, it detaches from the herd to visit and feed its fawns. This strategy works very well when the coyotes are not observing the females. Once the coyotes detect a doe that detaches from the group, they never take their eyes off her and observe carefully the exact place in which its fawns are. As soon as the female goes back to the group, the coyote creeps slowly and quietly to the unguarded fawns that end up in its jaws. This period lasts some months and, if the young

Pronghorn are known to inhabit grasslands but the populations of Baja California and Sonora are adapted to the arid conditions prevailing in the deserts like El Vizcaíno, El Pinacate and the Great Desert of Altar. (CCK)

PAGE 110 *Territorial fights between males for a territory are common in pronghorn, as in other American and African ungulate species.* (CCK)

PAGE 113 *Pronghorn conservation strategies include captive breeding, translocation of individuals and reintroduction, as well as exclusion areas for cattle and predators such as the coyote.* (*above,* CCK; *below,* JSR)

are few (for example, as a result of a small number of females in the population), the effect of predation can be catastrophic.

The labor of recovering a population is long and there is not a recipe for the automatic growth in the number of individuals of a certain species. It is important to always take into account aspects such as the population growth rate, the causes of mortality, the females' fecundity rate, the threats that took the species to the brink of the abyss and, most of all, it has to be evaluated whether if these threats have been suppressed or not. Next to these fundamental variables, there are additional contingencies and particularities of the area in which the recovery program is being done: unexpected climate events, diseases, parasite outbreaks, increase in predation or other mortality causes. This is why the deep knowledge of a species, its ecology and surroundings —combined with a good dose of intelligence, common sense and insistence— are fundamental to accomplish recovery. Nowadays, in Baja California Sur alone, we have more than 800 pronghorn and the populations have spread to Baja California, where they live mainly in the Área de Protección de Flora y Fauna Valle de los Cirios (Valley of the Cirios Flora and Fauna Protection Area). In Mexico, there are more than 2,000 individuals. The sun shines ones again for the fastest animal in the continent.

Rodrigo A. Medellín

Arid Lands

Janos, Prairie Dogs, and the American Bison

Between 1892 and 1894 the governments of the United States and Mexico created an International Boundary Commission to relocate the border area between the two countries. The border region, especially the northwestern region of Mexico's Chihuahua state and southern New Mexico state in the United States, is a vast territory covered with grasslands and scrubland, relatively isolated and little developed. The international commission's task was long and dangerous. The huge cement blocks that mark the international boundary had to be installed all throughout the borderline between both countries, in inhospitable arid regions where water was scarce and apaches very plentiful. To ensure the Commission's success they brought along a small army. One member of the American team, the officer and surgeon Edgar Alexander Mearns had a great interest in nature and described and collected the plants and animals he encountered, starting the description of one of the most beautiful landscapes of northwest Mexico.

The Sierra de San Luis mountain range, located on this vast treeless region, was once a place where rivers flowed, feeding the grasslands and satisfying the thirst of many plants and animals. Between the great diversity you could find trees like ash, sycamore, and fir and animals like bison, deer, peccaries, pronghorn, wolves, bears, eagles, hawks, and owls, but the most amazing were the immense colonies of prairie dogs that covered for more than 50,000 hectares, spreading over 100 kilometers into what is now Janos, Casas Grandes and Ascencion Municipalities in Chihuahua state.

After the extermination of the Apache nation in the 18th century, the land was subdivided among the new Mexican inhabitants who raised cattle. The low human population put relatively little pressure on the environment and the

The constant conservation efforts have gradually influenced the conscience of the residents of the Janos' grasslands, who recognize and have genuinely appropriated the biological value of their land. (EP)

LEFT *Since its reintroduction in 2009, the number of wild bison has tripled in Mexico and thousands of people have admired the beauty and magnificence of these giants of the prairies.* (CCK)

ABOVE *During summer mornings it is possible to observe the behavior and the coexistence of the prairie dog families, named after the unique calls they use to communicate with their conspecifics.* (CCK)

PAGE 114 *Mexico has one of the largest and most diverse deserts in North America, the Chihuahuan Desert. Despite the limited amount of rain it receives, it holds a great variety of plants and animals that are adapted to live in this arid environment that covers almost a quarter of the country.* (SGI/DN)

abundant wildlife and cattle co-inhabited the landscape of plains and mountains. Studies in the region since the 1980's slowly revealed the extraordinary biological diversity, and the key species in this ecosystem: the complex colonies of prairie dog, the largest in the world, and the last herds of American bison. During the early part of the 20th century, agricultural and livestock production were the main economic activities and the land was owned by ranchers, communal ownership or Mennonites, a German ethnic and religious group that relocated from Canada in the 1970's. The absence of electricity helped minimize the impact of these activities in the area.

However, the introduction of electricity by the end of the 1990's brought drastic changes to the environment. Well drilling facilitated the expansion of fields for intensive agricultural production, and the result was a precipitous decrease in the prairie dog colonies; there were only 15,000 hectares of active colonies by the year 2000, and the last bison and pronghorn were vanishing. Recognizing the serious threat to this unique ecosystem, initiatives were initiated and with the support of communal land owners, locals, agricultural and livestock producers, academics and officials from the National Autonomous University of Mexico (UNAM), the Janos Biosphere Reserve was established on December 8th 2009, covering more than 523,000 hectares. Shortly after its establishment, 23 American bison were released into the reserve as part of their reintroduction into the landscape of this part of Mexico. In addition to the prairie dogs and American bison, the reserve has many iconic mammals including the Mexican pronghorn, coyote, grey fox, and badger which live in the pastures and plains and bear, cougar, turkey, peccaries, and deer which live in the pine and oak temperate forests of the highlands.

More than 13,000 people live in the reserve and are involved primarily with livestock and agriculture. Their way of life depends on the conservation of nature which provides the ecological services they need. Many communal land members, ranchers and agrarian workers, and other residents of the region understand the relationship between human well-being, conservation of the resources and the protection of the environment. They have witnessed the advent of electricity and paved roads in their communities, but have also seen increasing environmental deterioration as a result. While some former residents left the region, many who have stayed strongly support the creation of the reserve, convinced that this mechanism will help ensure the well-being of their families while pre-

RIGHT *Between 2013 and 2017 the network of prairie dog colonies recovered by more than 3 000 hectares. It is estimated that to date there are more than 30 000 prairie dogs living inside the Janos Biosphere Reserve.* (KS)

BELOW *The recovery of the grasslands is vital to start a new era of management and conservation that allows the healthy coexistence between humans and nature.* (RSC)

PAGE 122 *Conservation of the grasslands inhabited by prairie dogs has allowed the recovery of other species like the kit fox.* (RL)

serving the flora and fauna that have always been with them.

The support of the Carlos Slim Foundation - WWF Alliance and other institutions has been a fundamental factor in the conservation projects in the Janos Reserve and other regions of the Chihuahuan Desert. The expansion of the prairie dog colonies, the reintroduction of the pronghorn in the reserve, the development of new livestock practices compatible with conservation and the promotion of soil and grasslands recovery programs has been achieved in the last years with their support.

From the Mesa de las Guacamayas in the Sierra Madre, one of the wildest areas in Janos, the vast forests and pastures reveal that, despite the deterioration it has suffered in the last decade, Janos is still one of the best conserved regions in Mexico. With adequate conservation and resource management programs, it is possible to maintain natural ecosystems and develop sustainable production activities that are essential for the population's well-being. Conservation and development must be parallel activities. Time will be the best witness of the benefits of this reserve. The reserve, created out of the desire and need to protect Mexico's heritage, is a magical legacy for future generations.

Gerardo Ceballos and Eduardo Ponce

Cuatrociénegas

The Chihuahuan Desert, which covers the entire Mexican altiplano, is a very peculiar desert, which although it may seem incredible, hides an astonishing diversity of fish in pools and wetlands that appear in the desert landscape. In the center of the state of Coahuila there is a place called Cuatrociénegas which is a true aquatic paradise: a system of springs that feed crystalline pools and streams in which life manifests itself in a thousand surprising ways.

Given that water is the limiting resource for productive activities in the region, the lakes and ponds of Cuatrociénegas began to suffer at the start of the 19th century the human siege for the development of one of the most important dairy basins in the country and to feed large-scale agricultural projects. Large expanses of desert were covered with alfalfa at the expense of draining the precious waters of Cuatrociénegas. These initiatives destroyed an important part of this unusual eden in the middle of the desert, as the water level began to fall and by the 1950s several lakes had dried up and others were in the process. Although there are several hundred pools in the region of Cuatrociénegas, a brief visit with Google Earth is enough to realize that this siege is a worrying reality. Here and there, on the foothills of the mountains, where the springs that feed the ponds flow, one can see the emerald green threats of irrigation circles with fossil water, the oldest on earth; water that in no way will be recharged before human beings disappear from the world. These pristine waters, between 200 and 250 million years old, and its unique biodiversity are a treasure preserved thanks to the exceptional conditions of Cuatrociénegas.

For anyone who knows and understands the geological and evolutionary history of Cuatrociénegas, it is evident that if this aquifer is still used uncontrollably it will be exhausted, and at that moment the entire region will no longer

The 400 or more pools and springs of the Cuatrociénegas Valley are an oasis of life in the desert. In their crystalline waters there are unique plants, animals and bacteria that have evolved isolated for millions of years. (IDG)

have the value that humans so much appreciate. But if we exhaust the water, not only agricultural and livestock production will be impossible, but one of the greatest treasures of the planet will have been lost: the notebook in which the history of life on Earth has been written.

In 1958, Dr. Wendell L. Minckley visited Cuatrociénegas and immediately became aware of the unusual characteristics of these wetlands. He continued to visit and investigate Cuatrociénegas for several decades and described it thus: "No other place in North America offers greater opportunities for the study of aquatic and semi-aquatic systems in the deserts than the Cuatrociénegas basin. It is located in an area of extreme aridity, but the persistence of the thermal springs presents an almost unlimited spectrum of aquatic and mesic habitats ". Minckley wrote: "Each isolated spring, unless it is too hot or too saline, contains biotic elements that are very old remnants of previously abundant and widely distributed or very special endemic forms of life." But Minckley only managed to delineate the surface of what would later be revealed as a true treasure that encases the history of the entire life on the planet, from its origins.

In the 1990s, the United States National Aeronautics and Space Administration (NASA) approached Dr. Valeria Souza of the Institute of Ecology at UNAM to request her to initiate studies on the biological processes and the evolutionary history of Cuatrociénegas. What they found was completely unexpected: Cuatrociénegas is the most direct link we have to the origin of life on Earth, with the oldest living beings on the planet: alive and reproducing. We have learned more in Cuatrociénegas about the origin of life than anywhere else on Earth. There are bacteria as archaic as those that make up stromatolites, calcareous structures that are the result of bacterial growth for many millions of years. Cuatrociénegas stromatolites have been formed by colonies of bacteria whose lineage has been kept alive for 3,800 million years! Of course, these bacteria are so ancient that they do not live on oxygen, but rely on sulfur and other elements to breathe. In Cuatrociénegas there are bacteria of several thousands of species, and each represents a stage of the early evolution of life on Earth. Cuatrociénegas is, from the ecological, evolutionary and geological points of view, a primordial sea that possesses characteristics unique in the world.

The Churince pool has been studied by Dr. Souza and her group for over 20 years, and at that time it has become the most studied site in the world regarding

The combination of the pools and the desert is a visual spectacle that can be appreciated by future generations thanks to the passion of people interested in conserving the Mexican nature in the present. (DGT)

its microbiology and evolution. And with just reason, because here the conditions that gave rise to life as we know it today were created. The lessons we learn from Churince are the best tools to understand our past and value our future.

Once again, alliances with other institutions, the private sector, federal, state and local government agencies, were the way to consolidate the protection of this refuge. Building partnerships with communities through elementary and middle schools has been an essential element in cementing partnerships and extending and ensuring the positive impact of conservation. The Carlos Slim Foundation - WWF Alliance has been one of the key actors for the conservation of Cuatrocienegas and its wonderful biological diversity. The decree creating the Cuatrociénegas Area of Protection of Flora and Fauna was published in 1994 and protects more than 83 thousand hectares.

The road has not been easy. People used to use La Becerra canal as a water park. This channel was opened 80 years ago to transport water where agriculture needed it. The closure of this canal and the gates that drained the Churince well was achieved after arduous, long and exhausting negotiations, but the group of conservationists never gave up. These achievements ensure that Cuatrociénegas continues to mark the passage of time as it has for billions of years. The treasure that Cuatrociénegas represents today, fragile but real, rests in the hands of the people of Mexico for future generations. A lesson of commitment that all Mexicans should appreciate and emulate.

Rodrigo A. Medellín

To visit the vastest gypsum dunes of the planet is a unique and once-in-a-lifetime experience. The whiteness of their sands blends in with the mountains and the clouds of the skies of Coahuila. (RPR)

PAGE 130 *Cuatrociénegas pools preserve 17 species of fish, 10 of them exist only in these water bodies.* (IDG)

Mexican wolf

After many decades of a bloody war between ranchers and authorities on the one hand, and wolves and bears on the other, northern Mexico and the south of the United States of America were stripped of their most majestic predators. The war against the wolves gained momentum as the livestock activity made its way into the western United States and northern Mexico. Cattlemen soon found a formidable foe in wolf packs. These wolves, the Mexican wolves, were pleasantly surprised to have within their jaws an unexpected, large number of animals bigger than their natural prey, less agile, more juicy (since they moved much less than natural prey) and without the least possibility of escape, since their owners had placed them in confinements and corrals. Logically, they began preying every last calf, cow and even bull that could have made weak attempts to defend themselves.

The value of beef, a major component of our diet that has caused severe damage to biodiversity worldwide, has led the governments of Mexico and the United States to create units dedicated exclusively to eliminating these predators. In Mexico, the "Predator Control Campaign" was instituted and the product known as 1080, one of the most lethal synthetic and tasteless synthetic poisons in the world, was used to eliminate countless wolves, grizzly bears and black bears. In the United States the campaign covered the entire first half of the twentieth century. The result was that by the end of the 1950s, the Mexican wolf —the wolf subspecies that lives only in Mexico and the southwest of the United States— was considered endangered. Then something very curious happened. A trapper specializing in killing cattle predators, with thousands of wolves, bears and mountain lions under his name, Roy McBride, radically changed his stance and devoted all his effort to capturing the few Mexican wolves still surviving

In the mountains of Sonora a new era in Mexican wolf conservation began, marked by the release of the first wolves in the Sierra Madre Occidental. (MC/LSM)

The releases of wolves that have been conducted in Sonora and Chihuahua have originated the first population in Chihuahua after almost 50 years of absence. (JR)

PAGE 134 *Despite having been extirpated from the country 40 years ago, the future of the Mexican wolf is encouraging. Almost 10 years after their release, the first cubs have been born in the wild in the mountains of Chihuahua. (SGI/DN))*

in northern Mexico and that had not been crossed with domestic dogs, having been contracted by the government of the United States for that purpose. Working for several years in Durango and Chihuahua, McBride was able to capture about twenty wolves that were immediately placed in a captive breeding program, along with other wolves that previously remained captive. The initial number of animals was very small and this caused some genetic problems by inbreeding between related animals. But even so, the total number of Mexican wolves in captivity began to grow to nearly 400 animals, and it became clear that a studbook follow-up was needed to minimize the loss of genetic diversity caused by inbreeding.

By the 1990s plans to reintroduce Mexican wolves in Mexican territory began. The first attempts were met with strong opposition throughout northern Mexico by farmers and landowners, who, influenced by the so-called "little red riding hood syndrome", loathed the wolf even though it had disappeared from the region several generations before. Little by little and through an awareness campaign to promote the true role and character of the wolf, organizations such as Naturalia A.C. and Defenders of Wildlife, private and public zoos like Africam Safari and the Aragon zoo in Mexico City, and academic institutions such as the Institute of Ecology of Xalapa and the Universidad Autónoma Metropolitana, managed to open a crack in this stubborn opposition. The first attempts at reintroduction unfortunately did not have the desired success or permanence and the animals were either eliminated or simply disappeared without a trace. But the ongoing awareness campaigns, as well as the enduring commitment of academics and NGOs, together with the essential collaboration of landowners, producers and government, finally gave way to very pleasing news in recent years: today there are more than 30 Mexican wolves living in the wild In the north of Mexico, and some births of pups conceived in the wild have already been documented. At the same time, numbers in captivity continue to grow and in July 2017 an announcement was made of the birth in captivity of twelve wolfs in two litters: one of five pups in the Museum of the Desert in Coahuila, and another of seven pups in Los Coyotes zoo in Mexico City. In addition, in that same month of July the birth of four additional pups in the wild in the mountains of Chihuahua was announced.

All of these factors point, though tentatively, to the fact that the Mexican wolf's recovery in the wild will be a reality within a few decades. The wolf is a key

element of the temperate forests and mountains of North America and Eurasia that determines the health of the ecosystem and ensures that herbivore populations do not grow excessively. Conservation successes often advance slowly, but more importantly, they are stable and steady. In the case of large predators suffering from a negative public image, the process may be even slower. But the perseverance, creativity, intelligence and hard work of conservation professionals, based on alliances with the landowners, the different levels of government and other sectors, bring valuable results and crown these efforts with more success: The Mexican wolf is back in the mountains that belonged to him for millennia.

Rodrigo A. Medellín

The pine and oak forests in Chihuahua, Sonora and Durango preserve the last refugees where the wolf will one day return. (JR)

Bighorn Sheep

The bighorn sheep is the only species of the subfamily Caprinae, of the Bovidae family, that lives in naturally in the Mexican territory. It is a powerful ungulate whose horns have become an emblem of diverse groups, from state governments and motor vehicles, to football teams. It is an indicator of the admiration that many people feel for this inhabitant of the mountains of North America. In the wild, the elegance, strength and agility of sheep moving on almost vertical walls and canyons is astounding.

The bighorn sheep is one of the largest sheep in the world; Mexican adult males can weigh up to 80 kilograms and their horns weigh up to 12 kilograms. The hooves of these and other mountain sheep are soft and padded, which increases their grip on vertical rock surfaces. A single baby is born, usually, in the spring. The ewes are extraordinary mothers who care for and defend their offspring from the predators and the only predator that really exerts serious pressure on the sheep is the mountain lion. Perhaps because of the intermittent presence of the sheep in the mountains of the island or because they have never been able to cross the sea, there are no mountain lions on Tiburon Island. There are many coyotes and some golden eagles that occasionally take a lamb, but females tend to be alert, protecting them, so predation is not worrisome.

Originally this sheep lived in six states of Mexico: Nuevo León, Coahuila, Chihuahua, Sonora, Baja California and Baja California Sur. But in the 1960s the species disappeared from the first three states, extirpated by uncontrolled illegal hunting, the arrival of domestic goats and sheep and the introduction of an exotic species, the barbary sheep, which transmitted diseases to the bighorn populations. In 1975 the species was at such a risk that the Mexican government and the New Mexico Department of Fish and Game joined forces to capture

In 1944 president Manuel Ávila Camacho declared a permanent ban to protect the bighorn sheep. Since then and thanks to multiple efforts, the bighorn has returned from the gloom of extinction. (AB)

20 bighorn in the Pico Johnson area on the coast of the state of Sonora, and transfer them to Isla Tiburón, the largest in Mexico. Since at that time there were no bighorn on the island and there was no record of the presence of mountain lions, the population began to grow. But almost no attention was paid, until the Institute of Ecology of UNAM and the organization United for Conservation A.C. (Unidos para la Conservación) formed an alliance with the Comcaac indigenous community (known as the Seri) in the 1990s to discuss the sustainable use and conservation of the species on the island, opening a door for the sustainable development of the region.

The teams of UNAM and Unidos, supported by the Arizona Department of Game and Fish, conducted a helicopter census —which is the most accurate way to estimate the size of sheep populations— and recorded that in 1996, about 500 bighorn inhabited the island. With this data, two, and only two, hunting permits for old males were obtained. We contacted the Foundation for the North American Wild Sheep (FNAWS), which annually auctions a few hunting permits for this species. In this scheme the hunters offer very large figures —on the order of hundreds of thousands of dollars— for the possibility of hunting a single individual. A limited hunting program, with severe controls that ensure the conditions and limits of the operation, can become an unparalleled conservation tool. All the resources generated by the hunts enter directly into a trust created by and for the Comcaac community, and this is how conservation pays for itself.

Tiburon Island, with its 120,000 hectares, is the most pristine segment of the Sonoran Desert. There are no permanent human settlements and the desert develops completely naturally. As controversial as it may seem, the bighorn sheep management program has halted the environmental deterioration on the island, contributed valuable resources to the Comcaac community (more than three million dollars since the program began), and has highlighted the importance of protecting the sheep population. It is very difficult to think of a more effective tool to achieve all these goals.

Although our first impression in 1995 was that the transport of sheep to the island was an introduction of an exotic species, not native, in 2014 ancient remains of bighorn fecal pellets were found that, once dated, showed that there were sheep Inhabiting it 1,500 years ago. This means that the sheep disappeared from the island sometime between 1500 years before the present and

Between 2000 and 2009, more than 100 bighorn sheep were released in the state of Coahuila, thus establishing the first population after 30 years of absence. (SGI/DN)

PAGE 142 *The bighorn sheep is extraordinarily adapted to the rough sites and cliffs of the Sierra Maderas del Carmen in Coahuila.* (SGI/DN)

Dozens of breeding centers and farms have been created in Chihuahua, Coahuila and Baja California, inspired by the experience of Sonoran properties, where the bighorn sheep has recovered successfully. (SGI/DN)

today, and that the maneuver of 1975 was a simple reintroduction and not an introduction.

The overall result is that this program, which takes less than 0.5% per year of the bighorn population, has been a resounding success that keeps the island in a pristine state inconceivable under other conditions. And further: with the arrival of outside visitors occasionally patches of the invasive Buffelgrass appear, a plant that has caused serious damage throughout North America. The Comcaac community gets organized every year to conduct constant inspections on the island and remove by hand (which is the most effective way) every last tuft of Buffelgrass they encounter. At the same time, the Tiburon sheep population has been the source of subsequent reintroduction programs in Chihuahua and Coahuila, where there are already incipient populations that have continued to grow. The lesson of this story is that avoiding polarized positions that only consider absolute preservation or "use it or lose it", and using common sense, pragmatism and vision of solidarity with the Comcaac people, today Tiburón Island and its program of sustainable use and conservation of bighorn sheep is a worldwide reference that benefits everyone involved.

RODRIGO A. MEDELLÍN

Deer

Thanks to its breathtakingly diverse biota, Mexico embraces innumerable opportunities to become a model country in the construction of projects focused on nature and wildlife watching and the sustainable use of biodiversity.

More than 500 mammal species live in Mexico and only a couple of countries —Brazil and Indonesia— have more species. Of the group of ungulates or hooved animals, Mexico has ten species: a tapir, two peccaries, a bison, a sheep, a pronghorn, and four deer. We have deer throughout the Mexican territory: White-tailed deer occupy almost all of Mexico except Baja California, mule deer is distributed in Baja California and northern Mexico from Sonora to Coahuila, Durango, and Zacatecas, the red brocket deer live from Veracruz and San Luis Potosí to Oaxaca, Chiapas and the Yucatan peninsula, while the brown brocket deer is endemic to the Yucatan peninsula. Mexican deer vary in size and weight. For example, the red brocket deer reaches a maximum weight of 30 kilos, while the Chihuahua and Sonora mule deer can reach 120 kilograms.

For almost the whole of the twentieth century, deer suffered from the so-called "tragedy of the commons": In the face of the ambiguity of property rights, the apparent gratuitousness and free exploitation of the good (in this case, animals), no one was responsible for them, protected or cared for their survival, and the deer fell victim to the first to appear with a firearm.

This determined that the deer almost disappeared of many areas of the country. With the advent of the Management Units for the Conservation and Sustainable Use of Wildlife (UMAs) in 1997, the concept of deer changed. The possibility of establishing breeding sites and implementing measures for the management of deer populations under conditions of confinement or in the wild was opened, with mainly hunting purposes. Owners of small, medium or large

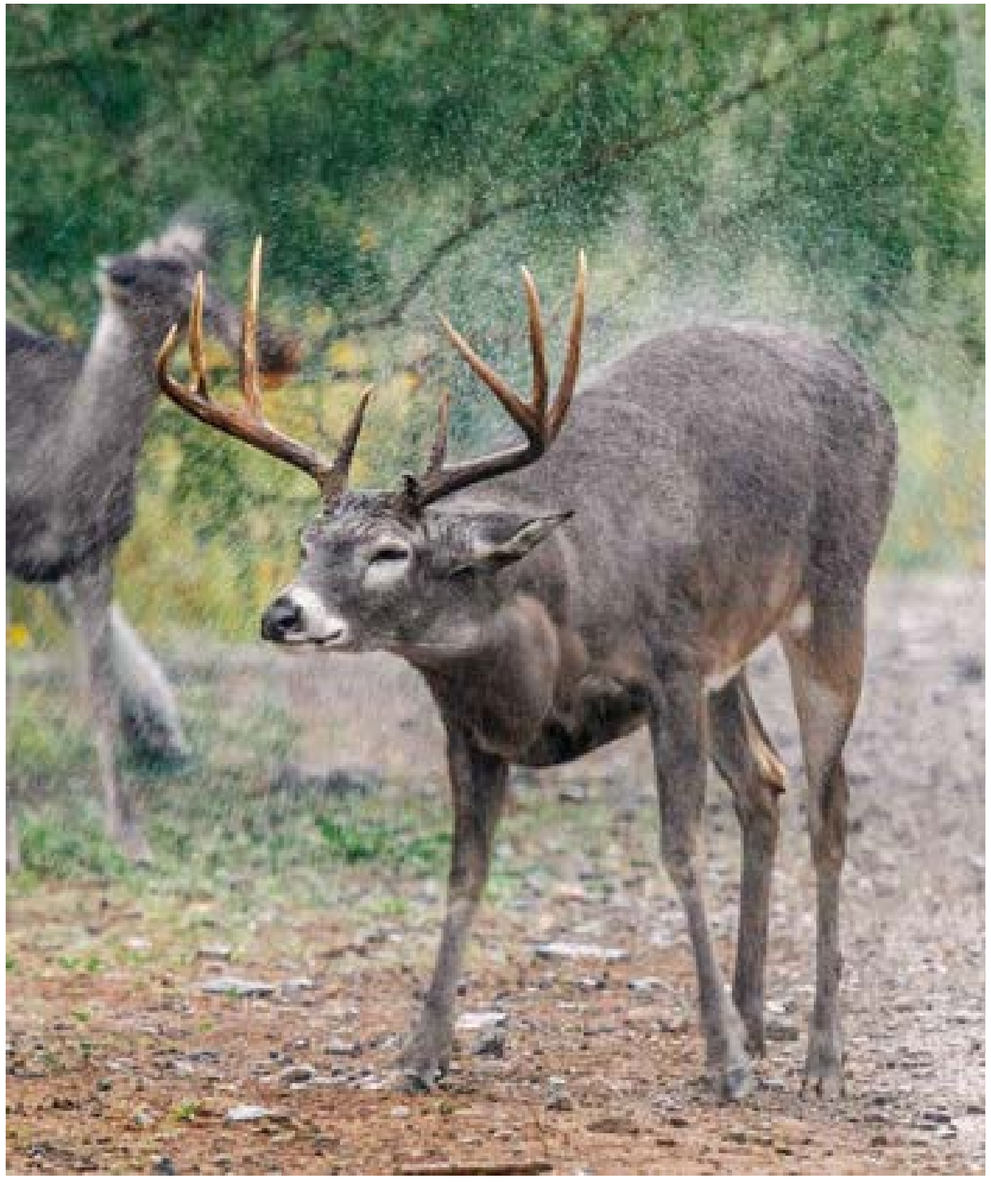
Conservation of the mule deer relies, to a large extent, on an efficient regulation of hunting, which has proven to be a solid tool to protect their habitat and populations. (DGT)

tracts of land (under a private, ejidal or communal regime) finally saw a direct interest and clear benefit in caring for deer populations and their habitat, and began to explore the planned sustainable use of deer and other wild animals.

Organizations such as the National Association of Diversified Cattle Raisers (ANGADI), in collaboration with Semarnat, created schemes to ensure that deer became a catalyst for the conservation of ecosystems and wildlife populations. The program began with the Texas and Coues white-tailed deer, two of the Mexican subspecies distributed in the north of the country and with greater demand in the hunting market, and soon expanded to other species including mule deer.

To broaden the hunters' interest in the white-tailed deer of central and southern Mexico, which were not valued as trophies for being much smaller than those of the north, some organizations applied the idea of a Grand Slam. This is a journey in which the different types and morphologies of animals (or golf courses, which is where the idea originally arose) are gathered in a collection that reflects the complete variation within the species. Only then the smaller subspecies began to gain value, because to complete a Grand Slam each hunter must travel to different regions and collect their trophy of each type of deer. Today the Grand Slam of white-tailed deer considers and values both the small deer from the south and the center as well as the great ones from the north. There is much interest also in the red brocket and the brown brocket deer.

Currently, protected natural areas cover approximately 17% of Mexican territory. However, there are many places outside these areas that contain a great diversity of flora and fauna that already represents an important source of food, handicrafts, firewood, medicinal products, ornamental plants, among many other products, that are harvested and marketed by the communities of our country. That is why the UMAs, which allow the propagation and legal and sustainable use of both wildlife and wild flora, extend the benefits of conservation to the rest of the national territory, through the use of biodiversity in a planned and sustainable way. Because of their location in mainly wild areas

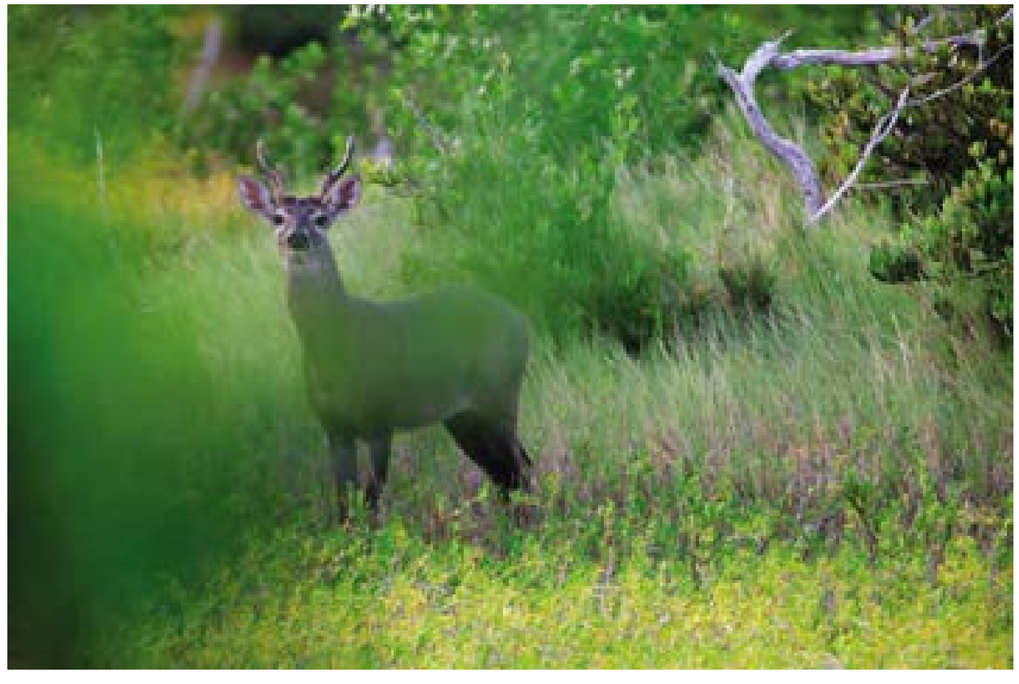


Despite having been on the brink of extinction in the 1960's, today there are up to 25 white-tailed deer per square kilometer in Coahuila and Nuevo Leon states, where their economic value has promoted conservation, management and responsible use programs. (DGT)

and the need to have healthy ecosystems that have good vegetation cover and clean water flows for the maintenance of populations of deer —or wild turkeys, white-winged doves or peccaries, for example— many of these sites have a high potential for nature-watching activities, so that they can be part of comprehensive ecotourism projects, including organic production and fair trade.

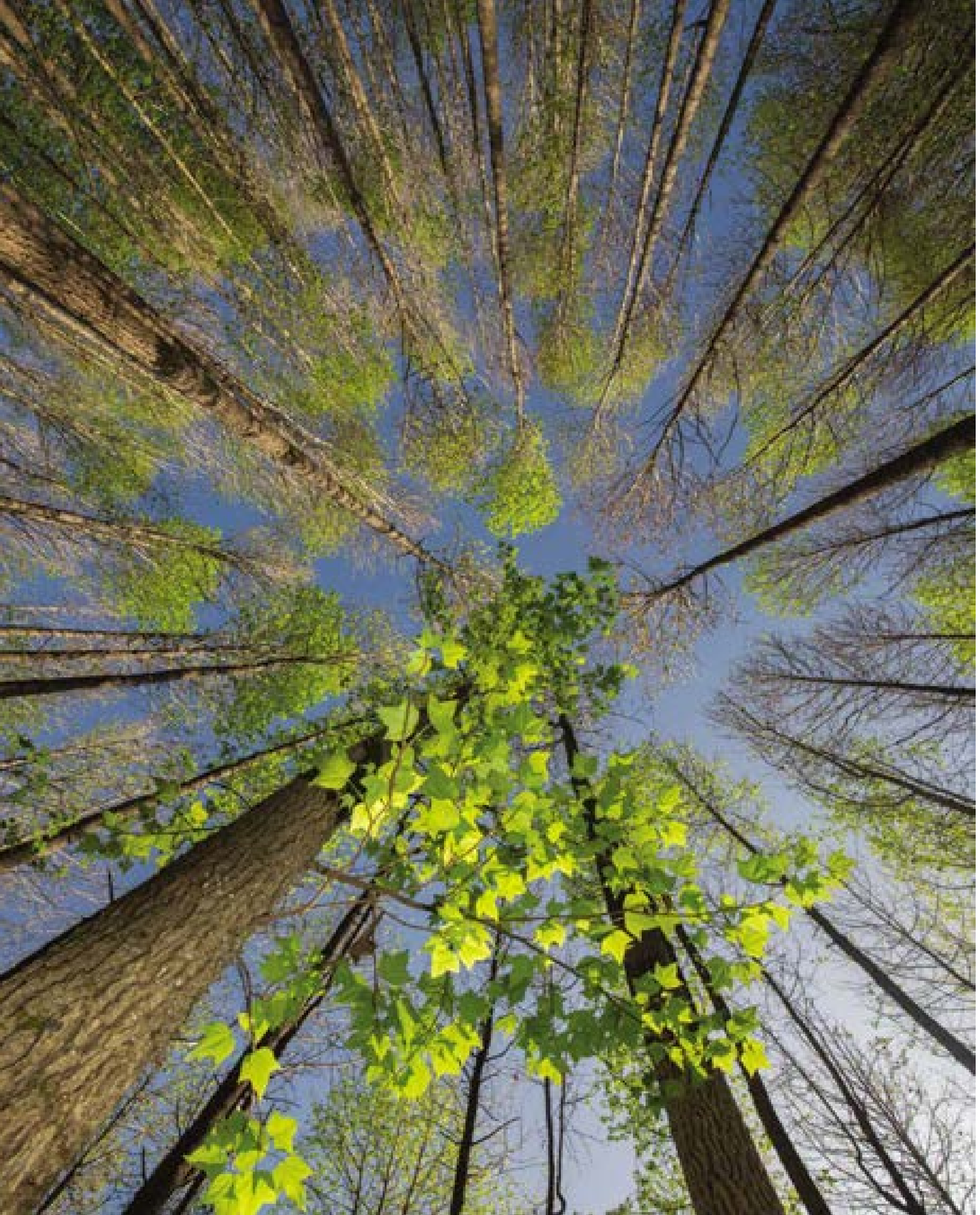
While in the case of the deer demonstrates that the benefits of these management areas are extensive and important, reaching out to marginalized communities and private owners, implementation of the idea still shows weaknesses. The concept of hunting is still controversial and misunderstood by certain sectors, but when a well-planned program is implemented, with the direct participation of landowners and over the years the harvest of few individuals can lead to integral conservation of the entire ecosystem, including the species harvested, the concept is vindicated. Deer populations in regions such as Coahuila, Nuevo León, Tamaulipas, and other states have increased in the last twenty years as a result of these programs. Increasingly, the owners invest more resources to have large and abundant animals that are attractive to the hunters. Whenever this happens, Mexico wins and biodiversity becomes an engine for the development of the most unprotected regions of the country. It is time to put all the elements on the table and make a balanced judgment that recognizes the benefits of this type of sustainable use

Rodrigo A. Medellín



There are dozens of natural protected areas in the country that maintain healthy deer populations. Habitat conservation is the basis for the recovery of the species. (*above, JR; below, CCK*)

Temperate Forests



Sierra Gorda

Central Mexico offers beautiful landscapes. The mountain ranges that cross it are covered with tropical forests, oak forests, and more, while countless rivers and waterfalls quench the thirst of many animals, including the six wild felines that exist in Mexico —mountain lion, jaguar, ocelot, jaguarundi, bobcat, and margay—, deer, collared peccaries, crested guans, green macaws and toucans, among many other terrestrial, volant, and aquatic species. The region we are talking about is located in the northeastern part of the state of Querétaro and occupies a third of its area: almost 384,000 hectares. The Sierra Gorda is part of the central portion of the Sierra Madre Oriental and ranges from the desert section of Querétaro to the tropical sub-deciduous forests of the Gulf slope of the Sierra Madre, known as Huasteca. Thanks to its location it contains a mixture of biodiversity of arid, temperate and tropical areas: we can find xerophilous scrub, coniferous forest, cloud forest and tropical forest. The juxtaposition of ecosystems produces very characteristic ecotones —transition zones— that make the landscape of the Sierra Gorda a living lesson of biogeography. We can begin our journey in a purely desert area, such as Peña de Bernal, and cross the surprising Queretaro desert until we reach the Extoraz River, 60 kilometers to the northeast, right on the edge of the Sierra Gorda and the boundary of the Reserve. We will then start a 30 kilometer journey along a steep, curvy road surrounded by precipices, rivers, forests and peaks. After passing the spectacular Puerta del Cielo we will reach Pinal de Amoles, surrounded by a vegetation so exuberant and full of life that the previous route feels like a dream or a hallucination. From Pinal to Jalpan de Serra, in the heart of the Sierra Gorda, we can clearly appraise the important wealth of this majestic region and the challenges it faces.

The mountain ranges of Querétaro are part of a megadiverse region. Not only do they have a high richness of vertebrate and plant species, but also the highest ecosystem diversity coexisting in the same natural protected area. (RPR)

For most of the twentieth century, as in so many other places in Mexico, the Sierra Gorda saw devastated much of its original forests and soils through extensive uncontrolled cattle ranching, logging, and unplanned expansion of agriculture. More than 25 years ago the Sierra Gorda Ecological Group decided to focus its work on this wonderful region of the center-east of Mexico to ensure its future and that of its inhabitants in a harmonious way. Because it is located right in the transitional zone between the Neotropical region, whose fauna and related flora connects the south of Mexico with Central and South America, and the Nearctic, which links the mountainous elevations of the center and north of our country with the boreal flora and fauna, is one of the most diverse protected areas. But if it were not for the timely action of the Sierra Gorda Ecological Group, today we would not have its extensive and diverse vegetation, its wonderful landscapes and rivers.

Working tirelessly over several decades with unparalleled commitment, Paty Ruiz Corzo and her Sierra Gorda Ecological Group dedicated their efforts to visit each one of the communities of the region to promote the environmental conscience and to explain the necessity to protect its ecosystems. They also established ties with federal, state and local authorities, as well as with the private sector, to promote conservation and sustainable development in the region.

Like all battles to protect the environment, the fight has been long and difficult, with a combination of success, frustration, and delays. In 1997 President Ernesto Zedillo Ponce de León, through the Secretariat of the Environment, Natural Resources and Fisheries, decreed the creation of the Sierra Gorda Biosphere Reserve. This great step contributed to a great extent to reorganize the use of the land and to integrate the majority of the inhabitants to the conservation project. However, economic and social pressures have remained in place, and various productive and extractive activities still cause damage to about 5,000 hectares of forest each year. Fortunately, the Sierra Gorda Ecological Group continues to advance and today spearheads the Sierra Gorda Conservation Alliance, a group of five non-governmental organizations supported by a number of well-known national and international companies, foundations and institutions. Thanks to the efforts of several decades, today the Sierra Gorda enjoys an extraordinary reputation as an integral conservation and sustainable development project to which institutions such as National Geographic, the United Nations Development Program, the BBVA Foundation, Rolex, Champions of The Earth and the International Union for the Conservation of Nature (UICN), among others, have pledged to support.

Some of the initiatives that have managed to consolidate this regional project are ecotourism projects with activities of kayaking, camping and visits to its many natural attractions, the creation of nurseries that produce hundreds of thousands of seedlings to be planted in degraded areas, and a holistic livestock management program that allows for stable and harmonious production conjoined with the natural processes of the forest. The Sierra Gorda Conservation Alliance also provides various courses and open workshops on soils and healthy food, ecosystem services and community tourism, involving participants directly in the programs and processes that are implemented in the Sierra with the objective to replicate, expand and maximize the positive influence of the lessons they have learned in nearly thirty years of work. Today the Sierra Gorda is a benchmark that shows how dialogue, innovation and planning across strategic sectors for the population, consolidated through educational activities that integrate the principles of sustainable development, are able to achieve success and ensure the future of ecosystems and communities.

Rodrigo A. Medellín and Eduardo Ponce

The Sótano del Barro *(Basement of the Clay) in the Sierra Gorda of Querétaro is one of the deepest vertical caves in the world. 465 meters deep, it protects the healthiest green macaw population in Mexico.* (JR)

PAGE 154 *Vast mountains covered by pine and oak forests rise throughout Mexico. These forests represent 24% of the national territory and concentrate the greatest diversity of pine and oak trees in the world.* (RPR)

PAGE 158 *The Sierra Gorda possesses some of the best preserved woodlands of the country. These forests harbor an extraordinary biodiversity and supply clean water to multiple human settlements.* (RPR)

PAGE 159 *There are an estimated 30,000 species of orchids in the wild, on the ground or on top of trees. They represent the second most diverse family of plants on Earth.* (MAS)

Since 2016, the Nevado de Toluca Flora and Fauna Protection Area allows the involvement of land owners in the sustainable management of the natural resources. (IMOC)

Nevado de Toluca

The Nevado de Toluca or Xinantécatl, the fourth highest mountain in the country, is a grand massif that dominates the geography of the Toluca Valley. The volcano, extinct for thousands of years, rises from the valley located at an elevation of 2,600 meters to 4,680 meters at its highest peak, the Pico de Fraile. The crater, which sits at 4,200 meters above sea level, holds two waterbodies, the Sol and Luna lagoons, separated by a tongue of land called El Ombligo (Spanish for navel). These lagoons are the highest bodies of water in the country, and the archeological relicts uncovered from the region are important vestiges of Mexico's cultural heritage.

Located in the temperate region, the large number of ecotypes of this region support a large diversity of flora and fauna and provide important and numerous environmental services to the local communities. The high-altitude grasslands, or alpine moors which are located near the top of the mountains, are an ecosystem found only on the great volcanoes of central Mexico. Pine, pine-oak, oak, fir, and common juniper forests cover the slopes and lower elevations of the massif and of mesophilic forests occupy the glens. In addition to the 800 plant species, this unique area supports more than 43 mammal species, such as bobcats and deer; 475 bird species such as the Long-tailed wood partridge; 19 reptile species like the barisia lizard; and 13 amphibians such as the endemic Nevado deToluca salamander.

Decreed as National Park in 1936 because of its timber, water, biological, and cultural values, the category was changed to Wildlife Protection Area in 2013. The Nevado de Toluca protected area belongs to 56 communities. There are 2,800 inhabitants within its boundaries and another 10,000 who are settled outside the protected area but are under its direct influence. The change in status

LEFT *Each year, the snow of the Nevado de Toluca melts and feeds the ponds where the ajolote, a species of salamander, lives. This salamander can only be found in these water bodies.* (TB)

BELOW *The high mountains represent touristic attractions and are an aesthetic delight, as can be appreciated at the top of the Nevado de Toluca.* (DGT)

Mexico has an enormous diversity of biological resources that contribute to the social and economic development of the country. (MALR)

was controversial. Like many other national parks, Nevado de Toluca National Park lacked effective and adequate management policies. During the presidency of General Lázaro Cárdenas, numerous national parks were decreed and lands within them were expropriated. In most cases, however, compensation was never made and landowners continue to illegally use the lands for their personal gain at the expense of the environment. Lack of appropriate management of public lands, and the exponential growth of Mexico's human population, from 19 million in 1940 to more than 115 million today, has contributed to the serious deterioration and loss of public lands. To date, 24 national parks have turned completely into agricultural and urban areas and their national park status has been revoked. Examples include Los Remedios in the State of México, Cerro de la Estrella in Mexico City, and Tula in Hidalgo.

Productive activities are prohibited inside a National Park because, in theory, no one lives inside them. Their sole purpose is to benefit the conservation of biodiversity. However, a great percentage of the land in National Parks belongs to peasant communities (known as ejidos) and communal and private landownerships. The deterioration of some national parks and other public and privately-held ecologically significant and unique lands has had major environmental impacts, including the loss of numerous populations of endangered species, such as the volcano rabbit and the Long-tailed wood partridge and the loss of other resources and services such as diminished water storage to supply the human population in the Toluca's and Mexico City's valleys.

The new decree of the Nevado de Toluca is a bold attempt to foster social justice and effective environmental conservation. Among other targets, it will promote forest conservation and reforestation projects for agricultural and livestock lands and the payment for environmental services. Landowners will be able to legally develop some production enterprises prescribed by conservation and protection-oriented guidelines. These initiatives are a start of what could be an unprecedented effort for the restoration and conservation of the region and increased protection of its naturally rich biodiversity.

GERARDO CEBALLOS

Monarch Butterfy

Each year, fir forests in central Mexico, between Michoacán and the State de México, are painted orange from the end of autumn till the beginning of spring, when millions of monarch butterflies arrive to spend the winter. Butterflies finish in this region an extraordinary journey in which they escape from icy winter temperatures of the Northern Hemisphere. Weighing less than a gram, these seemingly fragile, winged insects make the only migration of insects of this magnitude, and one of the hardest and most astonishing of the planet. Every year, the monarch butterflies migrate up to 4,200 kilometers from southern Canada and northcentral United States to the mountains of central Mexico, facing all kinds of obstacles, predators, and inclement weather. Once in their winter refuges, they will spend the cold days clumped among the branches of the firs, in groups of up to hundreds of thousands. In sunny days, they will go in search of water and will fill the blue sky with a thousand shades of orange.

In the 1960s, it was known in the United States and Canada that the monarch butterflies disappeared during winter, but no one knew where they went to. In the south, where the winter refuges are found, the communities had known about this natural phenomenon for a long time and gave it a special meaning. For the purépecha indigenous people, the butterflies represented the soul of dead loved ones who came and visited the world of the living; the otomí and mazahuas indigenous people associated the butterfly arrival to agricultural cycles.

Canadian zoologist Fred Urquhart made the scientific discovery of the refuge areas. Since the beginning of the 1930s, he started deciphering this mystery. Between 1950 and 1970 he marked hundreds of thousands of butterflies. With the help of an advertising campaign, he was able to recover thousands of the marked butterflies and started mapping the route they followed. In 1972, he wrote to Mexi-

The efforts to protect the Monarch, carried out since the 1970's, have shaped one of the most successful cases in Mexico's conservation movement. (JR)

can newspapers asking for support to gather information. On February 26th 1973, he received a letter from Kenneth C. Brugger in Mexico City and they started collaborating and exploring possible refuge areas. Their effort paid off years later. In 1975, Brugger called him to let him know that he had found the butterflies in the mountains of central Mexico. In 1976, Urquhart visited the colonies and wrote for National Geographic: "I gazed in amazement at the sight. Butterflies —millions upon millions of monarch butterflies! They clung in tightly packed masses to every branch and trunk of the tall, gray-green fir trees. They swirled through the air like autumn leaves and carpeted the ground in their flaming myriads on this Mexican mountainside."

Migration of the monarch involves a complex life cycle that includes four generations throughout the year. The first three live four to five weeks and occur when adult butterflies are flying to the north of the continent. Each generation moves a little further until reaching southern Canada during the summer. The fourth generation, the last of the annual cycle, is the most astonishing one. The butterflies of this generation live eight months and it is them who, from the north, start the migration to the winter refuges, in which they have never been, following a route of thousands of kilometers they have never made.

In 1976, large conifer forests covered the region of winter areas of the monarch. However, the tranquility of the forests disappeared in the next few decades. Organized groups of loggers cut down tens of thousands of firs and pines, many times in agreement with the authorities. The forest slowly gave in, threatening the monarch. Because of this, in the year 2000, the government established the Monarch Butterfly Biosphere Reserve that covers 56,259 hectares in four municipalities of the State of Mexico and six of Michoacán. Due to its biological and cultural importance, the UNESCO declared the reserve as World Heritage Site in 2008. To this day, we know eleven sanctuaries —groups of mountains in which the colonies are established— and nineteen winter colonies — Sierra Chincua and El Rosario, in Michoacán; Piedra Herrada, La Mesa, and El Capulín, in State of México— that jointly cover 5 hectares of the forest. The reserve receives more than 600,000 visitors each year, which makes it the most visited natural protected area in the country.

The conservation of the monarch faces many challenges. Since the 19th century, the region has registered mining activities. The agricultural and forest zones

The Sierra Chincua Sanctuary, located at the heart of the Monarch Biosphere Reserve, is considered one of the world's wonders. (JS/NGC)

PAGE 174 *In the State of Mexico and Michoacán, the Monarch seeks refuge in the fir forests, that rise up to more than 3,000 meters above sea level.* (CCK)

PAGE 176 *In addition to the resources provided by woodland ecosystems like food, fuel, construction material and medicine, they also generate essential services such as recycling of nutrients, greenhouse gases sequestration and climate regulation.* (MALR)

have grown at the expense of forest space; firewood —main source of energy for communities— and wood extraction have been illegal or inadequate; and the presence of masses of tourists has degraded the forest. Nowadays, illegal logging and avocado plantations are the greatest dangers.

Among the researchers who have, with relentless effort, laid the foundation for the conservation of the monarch are Lincoln Brower, from the University of Florida, and Eduardo Rincon, from World Wildlife Fund in Mexico. The actions made by Secretariat of Environment and Natural Resources, the National Commission of Natural Protected Areas, and the Federal Attorney for Environmental Protection), along with local communities, local governments, and the Carlos Slim Foundation - WWF Alliance and the Mexican Fund for the Conservation of Nature have drastically reduced logging. They have also supported alternative activities, such as ecotourism and trout farming, to prop up the economy of the communities. In, and around, the protected area, live about 500,000 people, in 59 peasant communities (known as ejidos) and 13 indigenous communities, who own most of the land. In this sense, the creation of Monarch Butterfly Conservation Fund, represents one of the most important strategies for payment for environmental services, both hydrological and conservation, that is given to owners of plots located in the core zone, who now participate in monitoring activities, and in actions intended to conserve and improve the forest coverage.

On the top of the Piedra Herrada Sanctuary, it is possible to observe the silhouette of the breathtaking mountains that are lost in the horizon as if they were never ending. At evening, after visiting the sanctuary, it is clear that the efforts to preserve the Monarch ennoble both Mexicans and the country itself. Many more challenges will have to be faced in the future; but when the last sunrays disappear and the Monarch quietly rests on tree branches, the calm that surrounds the forest might be a sign of better times.

GERARDO CEBALLOS AND PAOLA GUADARRAMA

Tropical Forests

Chamela - Cuixmala

Tropical dry forests, also know as tropical low forests in Mexico, are the plant community that dominates the coastal plains of the Pacific slope from Mexico to Panama. These forests are widely distributed in Mexico, from the south of Sonora to Chiapas and in small areas of other Regions, such as north of the Yucatan peninsula. However, today more than half of the dry forests have been destroyed, mainly by the advance of the agricultural and livestock activities, as well as by the establishment of tourist infrastructure.

Until recently dry forests were poorly-known ecosystems, considered of low biological value, because of the lack of the exuberance and biological diversity of tropical rain forests such as those of Lacandon region in Chiapas. Such view changed after extensive scientific research has showed that these forests harbor a great diversity of flora and fauna, and a great number of endemic species— meaning that they are exclusive of Mexico— such as the pygmy spotted skunk, the Magdalena rat, and the beaded lizard.

Tropical dry forests are marked by periods of life and latency, hot and cold weather, rainy and dry seasons, dualities that have marked nature's rhythm of dry forests since the beginning of time. In winter, dry forests seem to lack life, for the last leaves abandon the trees, overwhelmed by the relentless sun. Without leaves, the trees reduce their water loss while they wait for the much-desired rain. Frogs, toads, insects, and some reptiles will spend the season buried, under rocks or logs. Other animals, like hummingbirds and trogons, will migrate to nearby mountains where they will find shelter, water and food. For the animals that stay, it will be a difficult time, mainly because of the lack of drinking water.

However, an exceptional phenomenon occurs during the dry season: many tree species blossom at the same time, painting the landscape with their white,

The plants that inhabit the dry forests of the mountain slopes of the Pacific watershed are able to survive the months of drought by losing their leaves for five to six months. (CCK)

During summer, when rain falls, the dry forest becomes a lush place, full of life. About 60% of the plants that grow here only occur on the coast of the Mexican Pacific. (MALR)

PAGE 180 *Tropical rainforests are one of the most diverse ecosystems on Earth. In Mexico, the tropical evergreen rainforest of Chiapas concentrates more than half of all the plants and animals living in the country.* (SGI/DN)

yellow, pink, and purple flowers. It is a season in which nectar and pollen flourish, and insects, bats and birds pollinate the plants. Many species —mammals, birds, and reptiles— reproduce during this season in anticipation of the abundance of food that will come with the rain. On an unexpected summer day, the horizon is covered with lightning and dark clouds. The cycle starts all over again. Once the rain has become frequent, the forest is covered in thousand shades of green. The animals leave their refuges and the forest is again filled with the songs of insects, frogs, and toads. Everything is life and abundance for some months, before the naked trunks and branches rule the horizon once again.

The wide dry forests of the Pacific have disappeared rapidly in the last decades due to the relentless deforestation to clear land for crops and pasture. Once trees and bushes have been cut, they are set into fire and turned into croplands or pastures for cattle. There are some days in which the burning is so intense that smoke covers the sun. The destruction of the forest has many consequences: the soil and fertility are lost to erosion, the microclimate changes, the quality and quantity of fresh water diminishes, flora and fauna disappear, and the environmental services collapse.

Until the early 1970s the largest extension of dry forest was in the isolated region of Jalisco's coast. The construction of the highway changed things and the region started developing. In 1971, the National Autonomous University of Mexico (UNAM) received a land donation to establish the Chamela's Biological Station, which started the study of the biology and ecology of these forests. In few decades it became clear that these forests are unique ecosystems especially because of the concentration of endemic species. It also became evident that the Chamela-Cuixmala region was threatened by deforestation. Fortunately, in the early 1990s James Goldsmith, an eccentric Franco-English philanthropist, led the effort to establish the first protected natural area dedicated to the conservation of the tropical dry forests in Mexico. In 1993, after years of joint work of the Ecological Foundation of Cuixmala and the UNAM, the Chamela-Cuixmala Biosphere Reserve, located in the municipality of La Huerta in the state of Jalisco, was established in 1993 by a presidential decree. The buffer zone of the reserve includes the Cuixmala and Teopa beaches, declared protected sanctuaries for sea turtles in 1986. Additionally, the islands in Bahía de Chamela, off the reserve's coasts, started to be protected in 2002 under the category of Sanctuary. The es-

The beaded lizard is one of the two species of venomous lizards in Mexico. It inhabits arid areas, rocky deserts and dry forests. (MALR)

PAGE 189 *The coasts of Chamela protect 68 species of reptiles, 42 of them endemic to Mexico and 10 endangered. They also preserve 72 species of mammals, 18 of them endemic and at least 22 under some level of threat. Some of the protected species are the tlacuachín (mouse opossum, endemic) and the Yucatan banded gecko (endangered). (above, ER; below, MALR)*

tablishment of a National Marine Park is being analyzed at this moment. And an adjacent 500 hectare private reserve called Zafiro has also been established.

Chamela-Cuixmala was the first private reserve decreed by the Federal Government as Biosphere Reserve. The reserve protects 13,000 hectares of dry forests, semi-evergreen tropical forests, mangroves, wetlands, and coastal dunes. It protects jaguars, crocodiles, white-tailed deer, migratory birds, and beaded lizards, among other species. The American crocodile population went from less than 20 to more than 600 individuals. The yellow-headed parrot, almost extinct throughout the Pacific coast, still nests in the reserve. Jaguars are observed with certain frequency. The roseate spoonbill and the black-bellied whistling-duck live in the reserve's wetlands. The leatherback sea turtle, the biggest one in the planet, and the olive ridley nest in the reserve's beaches.

More than 25 years later, the hills of the reserve are still covered in thick forests and the mangroves are still abundant. The reserve is indeed a sanctuary and refuge for many species in a landscape that has lost great part of its vegetation. The reserve is an enormous success story in the conservation of nature.

Gerardo Ceballos

Calakmul

Most of the Calakmul region is located in Campeche state and, to a lesser extent, in Quintana Roo state in the southeastern corner of the Yucatan Peninsula. Calakmul means "two mounds" in Maya and it refers to the two great pyramids, Structure I and Structure II, which dominate the landscape. High in the great Structure II, the first sunrays of the new day slowly open the immense rainforest that extends for dozens of kilometers in any direction. The region's vast rainforest covers more than one and a half million hectares and, along with the adjacent forests of Petén in Guatemala and Belize, represent the largest tropical rainforest extension in the American continent, north of the Amazon. Unfortunately, there are few places in Mexico and other countries where it is possible to observe such vast intact rainforests. The relative inaccessibility of the region kept the development and exploitation to a minimum until the 1970s. Conditions have changed in the past fifty years.

The sight of these vast forests, with innumerable shades of green, yellow, and orange in treetops, and the symphony of singing and squawking produced by flocks of birds, including toucans and parrots, is overwhelming. Thousands of plant and animal species inhabit these forests, which have, with the Lacandon region in Chiapas and Los Chimalapas in Oaxaca, the highest biological diversity of the country. Calakmul protects the most abundant populations of endangered species such as the jaguar, tapir and white-lipped peccary. The jaguar population in Calakmul is estimated at 600 individuals, representing more than 15% of the country's population.

Calakmul was one of the first Mayan sites during the Classic period (250-909 A.D.) and Tikal's main rival. Its political force was based on one of the most advanced religious, economic, and military systems in the Northern Hemisphere.

The ocellated turkey is a representative bird of the Yucatan Peninsula. Its distribution is restricted to the states of Quintana Roo, Campeche, Yucatán, Tabasco, and Chiapas, where it is easy to observe them in the early morning in the rainforests or crossing the roads. (CCK)

Calakmul is one of the few places in the world where an exceptional cultural and biological wealth concentrates. The protection of sites like this has allowed the natural regeneration of the rainforests that gave shelter to the extraordinary Mayan civilization. (JMH)

Hydraulic systems used for the transport of water facilitated a diversified and productive agriculture that, at its peak, supported at least 50,000 people. A city of about 6,000 structures and spread over 70 square kilometers, it contained numerous magnificent public buildings that were referenced in the hieroglyphics found in other Mayan sites in Mexico, Belize, and Guatemala, reflecting the significant influence of this Mayan kingdom.

There is a very high plant diversity in Calakmul with more than 1,500 species registered, including sapodilla, kapok, lignum vitae, and mahogany trees that grow up to 25 meters height and provide a cover of dense foliage over the lower stratum of vegetation where palm trees, lianas, ferns, orchids, and bromeliads grow. It is esteemed that tens of thousands of insects live here and consist of innumerable forms, sizes, and colors, from inconspicuous ants to striking multicolored butterflies. Tucked among the roots, or on the leaves and bromeliad covered branches and in wet areas by, and in the limestone crevices in the wet areas, at least 70 reptile and amphibian species inhabit. One of those species is the fer-de-lance, the most poisonous snake in Mexico. The forest also houses more than 350 birds and 86 mammal species, many of them in danger of extinction like the jaguar, the ocelot, the tapir, and the white-lipped peccary.

Due to its biological and cultural value, the federal government decreed the Calakmul Biosphere Reserve in Campeche in 1989, which, with 723,000 hectares, is one of the largest natural protected areas in Mexico. A decade later, the Campeche government decreed the Balam-Kin and Balam-Kú Areas Subject to Ecological Conservation, protecting an additional 520,000 hectares. And in 2005, the federal government decreed 128,000 hectares as the Flora and Fauna Protection Area Bala'an K'aax in Quintana Roo. This reserve complex protects more than 1,300,000 hectares of rainforest, and it represents the largest protected rainforest in Mexico and one of the 30 largest tropical reserves in the world. This is why, due to its cultural richness, it was declared a world Heritage site in 2000 and a mixed World Heritage in 2014 because of its unique cultural and natural richness. It is one of the few sites in the planet that has received both distinctions.

The protected areas of the Calakmul region are not free of threats, the conservation efforts must continue. Illegal logging of highly-valued timber like mahogany and cedar, and poaching has increased in last years. The conservation efforts include local peasant lands (known as ejidos) like Yohaltun and Pustu-

The king vulture does not tolerate human presence. Currently, it survives in the most remote areas, far away from human settlements, in the tropical rainforests of southeastern Mexico. (SGI/DN)

The red-capped manakin is a small but flashy bird, not only because of its color but for its courtship dance. Males jump from branch to branch to call the females attention, who probably choose the best dancer in the forest. (JAGT)

nich receive compensation for environmental services from Amigos de Calakmul, a non-governmental organization, and the National Forestry Commission or CONAFOR, for its acronym in Spanish. The support of the Carlos Slim Foundation - WWF Alliance has allowed the National Autonomous University of Mexico (UNAM) to carry on studies and conservation strategies inside the reserve and in the communal lands such as Laguna Om. With these efforts, now more than 70,000 hectares of reserve land and 35,000 hectares of communal land are being protected and the biggest effort in jaguar conservation is being achieved.

We are forever grateful to the visionaries who dreamed and planned to make this area a rainforest conservation stronghold, one of the last on the continent. Fortunately for us and the countless future generations, the inspiration that motivated these visionaries and conservation leaders is still alive among the communities of the region, the archeologist that are constantly restoring Mayan remains and the researchers and naturalists who come here to piece together the complex web of human and natural history, and those unsung heroes, activists and supporters who are driven to ensure our natural and cultural history are protected in this great region of Calakmul.

Eduardo Ponce and Gerardo Ceballos

The ocelot has been able to survive in the most preserved tropical and subtropical regions of Mexico, despite years of persecution. Currently, hunting this cat is prohibited at an international level, allowing the gradual recovery of its populations. (SGI/DN)

The Lacandon and the Zoque Rainforests

There are many places in Mexico that have inspired amazement and passion for life. The case of the Selva Lacandona, or Lacandon rainforest in the state of Chiapas, is perhaps one of the most often cited but least known among Mexicans. In most cases, to evoke this rainforest is to speak of mystery, of myths, of almost unknown animals, of indigenous groups with deep roots. All this is justified, because the Lacandon rainforest is almost the last frontier of tropical Mexico.

Lacandon protects more than 25% of Mexican mammals and its largest reserve, the Montes Azules Biosphere Reserve, represents only 0.16% of Mexican territory. There is no other site in Mexico with a higher concentration of plant and animal species than the Lacandon rainforest. This region, which originally covered two million hectares, today has been reduced to just over 500,000 hectares. Even with this reduction, this is the most important tropical rainforest area in North America. In this fragment of Mexican territory a cluster of species of Amazonian origin are represented, including one-third of the birds and almost half of all the butterflies of Mexico. The Lacandon indigenous group has maintained control of protected lands and recently, through a linkage mediated by the Mexican organization Natura, Professor Julia Carabias, Biol. Javier de la Maza, and others, an agreement has been reached that determines that there will be no further invasions of protected areas and that the remaining forest will be preserved for the future.

The history of the destruction of the Lacandon is long and begins with the Spaniards invading the then called "Desert of the Solitude". Once the colonists realized the great timber riches of this rainforest, a process of excessive extraction began that continued for four hundred years, until the twentieth century. Different actors, different governments, different companies, different abuses, but

The chestnut-colored woodpecker is a resident bird of the humid rainforests and one of the 300 bird species protected in the Lacandon rainforest of Chiapas. (DGT)

the surface area of the Lacandon rainforest continued to shrink and myths and legends grew. Bruno Traven immortalized the abuses in the timber camps in his short story entitled The Rebellion of the Hanged.

The continuous process defending the Lacandon has had many actors and organizations, but for forty years Javier de la Maza has been a leader of the movement. From diverse trenches, first from the organization Conservation International, later from the government, and then from the organization Natura Mexicana, Javier has kept alive the flame and the commitment for the conservation of this treasure. Since the mid-1990s, Julia Carabias, first as Secretary of the Environment and later from Natura Mexicana, has mediated and convinced, always from an open, democratic and creative position, to achieve conservation of the region with all sectors involved. Indigenous groups, ejidatarios, companies, scientists, developers, government in its three levels, foundations and individuals, children and young people of diverse origins, are all involved in these efforts. Today the Lacandon is a bastion of conservation that marks a milestone in the protection of biodiversity. Organizations such as the Carlos Slim Foundation have strongly supported these efforts and with it the protection of the treasure of the most important Mexican tropical rainforest. The Lacandon indigenous community has also been a crucial element of the protection of the forest through its leaders and members. When an indigenous group has lived with biodiversity for centuries, a very special connection is established between the two. Respect for life and sustainable use must be constant in these strategies. This has happened in the Lacandon, although due to population growth in the area the pressure on natural resources such as forest, water and wildlife has grown. Today, indigenous groups are joining forces with other social actors through very creative initiatives and new approaches, and this is the best way to achieve the shared goal of conservation.

One of the ways in which this wonderful space has been protected is through building and launching biological and research stations such as Chajul and Tzendales. These facilities encourage the presence of conservation professionals and their interaction with the inhabitants of diverse origins that populate the Lacandon and its environs. The Chajul Station has become a keystone generating knowledge. No less than 100 scientific papers in refereed journals, more than 50 theses and at least 20 books or book chapters have been published on the basis of research conducted in Chajul. At the same time, dozens of na-

The distribution of Baird´s tapirs in Mexico is restricted to a few tropical rainforests in Veracruz, Oaxaca, Chiapas, Campeche, and Quintana Roo, where the destructive human activities have not arrived yet. (SGI/DN)

PAGE 200 *Natural protected areas such as the Montes Azules Biosphere Reserve have become landmark priority regions for the conservation of the world's biological diversity.* (LFR)

PAGE 204 *Treefrogs are the second most diverse group of amphibians in Mexico and one of the most representative of the tropical rainforests.* (EGP)

tional and international projects have created infrastructure and employment for thousands of people. Today anyone can visit the Selva Lacandon and stay in charming hotels in the forest that make this visit an unforgettable experience. There are very well trained local guides and visitors can engage in wildlife observation and visits to rivers, lagoons, waterfalls and archeological sites that enrich and educate those who lend themselves to this memorable adventure.

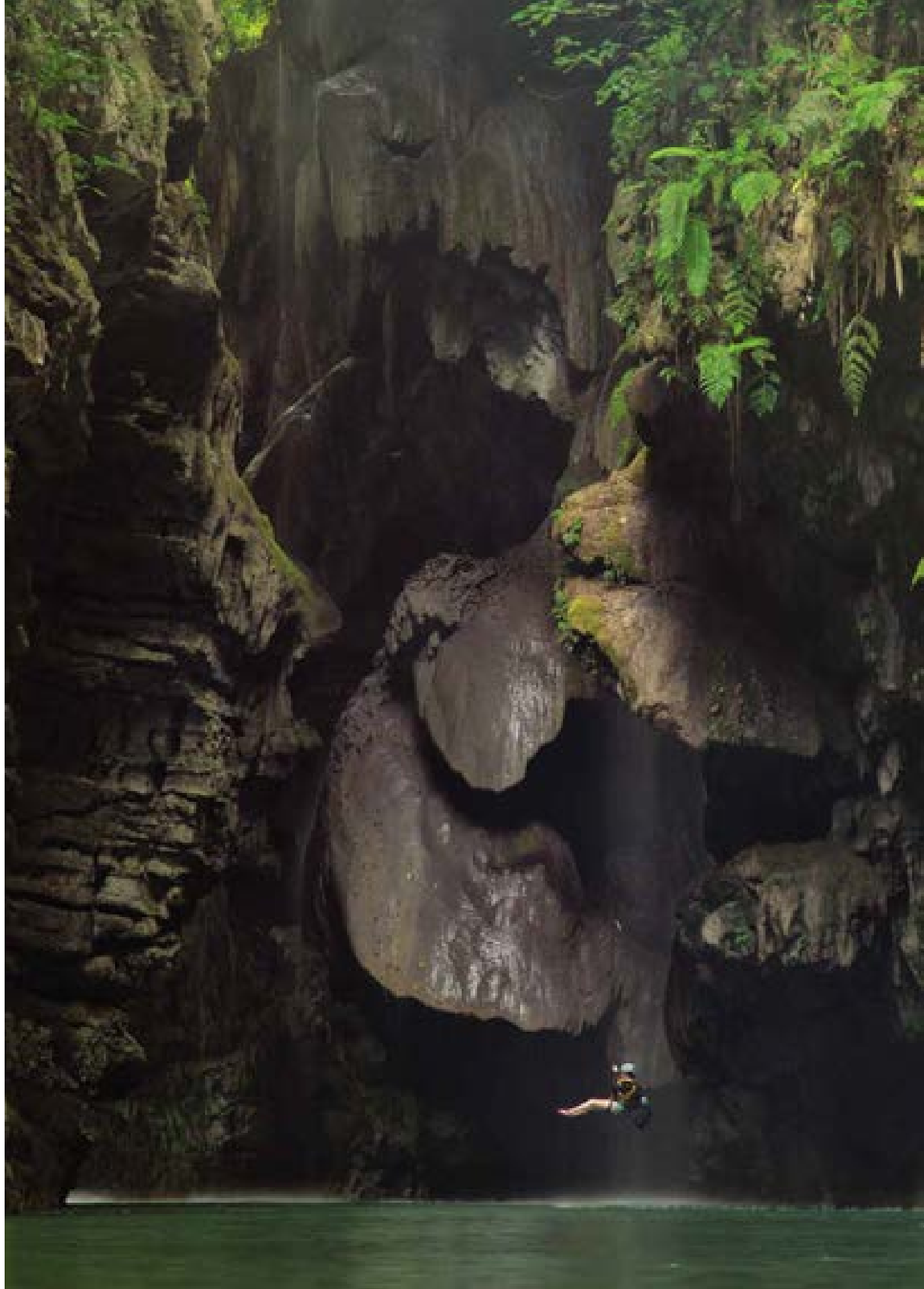
Although the history of the conservation of the Lacandon rainforest is punctuated by some harsh and difficult episodes, many agreements have been achieved in recent months and today the outlook is hopeful.

The Zoque rainforest, a region with more than one million hectares in the area between the states of Oaxaca, Veracruz and Chiapas, is another treasure of Mexican biodiversity that is less well known than the Lacandon but probably more threatened. The Veracruz portion of the Zoque rainforest, called Uxpanapa, has been devastated to such a degree that it is now impossible to reverse its disappearance. In the Chimalapas, the Oaxacan part of the Zoque rainforest, the situation is less serious, although there are important social clashes that do not allow a clear assessment of the levels of biodiversity that still exist or what are the perspectives for its conservation into the future. In El Ocote rainforest, in the municipality of Ocozocoautla, Chiapas, there are conditions for hope. The La Venta river traverses tens of thousands of hectares of tropical rainforest in very good condition, whose poor and stony soils do not allow clearing for agricultural or livestock purposes. In addition, residents and institutions such as Pronatura Chiapas and the Institute of Natural History and Ecology of the state government of Chiapas have made very important advances to secure the protected area, a well-founded management plan, and research and sustainable development programs that strengthen efforts to conserve this region. Although not as well known as the Lacandon rainforest, the Zoque rainforest is another jewel that emblazons southern Mexico as a dense forest, rich in biodiversity and with a hopeful, bright future.

Rodrigo A. Medellín

Surrounded by the Lacantún, Jataté and Lacanjá rivers, the Montes Azules Biosphere Reserve is one of most extensive hydrological basins of Mexico. There, the Usumacinta river, the greatest river in the country, is born. One of the largest discharges of water and nutrients to the sea in North and Central America occurs where the Grijalva and the Usumacinta rivers meet. (JSR)

RIGHT *Enormous geologic faults cross the Zoque rainforest, creating impressive canyons and caves. The La Venta canyon is an 80 kilometers long rift with spectacular walls up to 400 meters tall. (JSR)*



El Triunfo

Under the blanket of a thick fog, the Sierra Madre of Chiapas is one of those fabulous places that invite us to let our imagination loose. In dense vegetation, immersed in a cloud of cold drops always suspended, the trees grow in narrow gorges, sheltered by thick garments made of mosses, ferns and orchids. This amazing cloud forest, also known as mesophilous forest, hides numerous natural treasures.

The horned guan, a beautiful, iridescent green bird that carries a strange red horn on top of its head, finds in El Triunfo one of the very few refuges in which it is safe of hunters, people destroying forests, and traffickers of exotic birds. Of course this bird is not the only treasure that this Biosphere Reserve protects. Here are populations of one of the most beautiful birds in the world, so much so, that emperor Moctezuma ordered a headdress to be prepared with its tail feathers: the quetzal. The blue tangara and other 375 birds, 112 mammals and several thousand species of plants, live in El Triunfo. The jaguar and tapir are two of its most emblematic inhabitants.

The Reserve was decreed in 1990 and covers almost 120,000 hectares. With an altitude range that goes from 450 to 2450 meters above sea level, it has a large number of different ecosystems, from tropical rainforest to montane paramo, so it has the greatest diversity per unit area in Mexico. Its value is so evident that UNESCO took only a few years to declare it World Heritage of Humanity in its nature modality.

The benefits that originate in El Triunfo are not limited, in any way, to the protection of its splendorous biodiversity. If you turned on the light in your home today, whether you live in Villahermosa, Mexico City or Monterrey, that energy comes from one of the hydroelectric dams that are fed by the water accumu-

The vast tropical rainforests that once extended continuously from southeast Mexico to South America, have been severely deforested and fragmented. Currently, there are only isolated remnants that, fortunately, have been protected since recent decades. (JR)

lated and released in El Triunfo: Malpaso, Chicoasén or La Angostura. The three are fed by the Grijalva river, whose springs originate precisely in El Triunfo. In this region it is common to register 4,500 millimeters of rainfall per year, that is to say, four times more rain than in Ajusco, which represents the wettest region of Mexico City! There are climatological stations that have registered even 7,500 millimeters of rain.

As in so many other protected areas, to make conservation a reality in this region was a very difficult task that required the collaboration of several sectors: farmers, coffee growers, cattle ranchers, academics, NGOs, and, of course, various foundations such as the Carlos Slim Foundation - WWF Alliance. Nature photographers have played a key role in spreading the importance of this site with beautiful images of extraordinary animals and magnificent plants.

The beginnings of the conservation movement in the area occurred in the first half of the twentieth century. The coffee estates of German families that settled at medium altitudes depended on the "water factory" that the montane forests above represented. The streams and rivers begin to form on the peaks of the mountains thanks to their forest cover capturing the humidity that comes from the Pacific Ocean and it is precisely thanks to this dense coverage that they run all year with a regulated flow: they can be increased or reduced but never disappear. The presence of clear and cold water in abundance is perfect for the early stages of coffee processing —the coffee bean soaking— which includes pulping, mucilage removal and grain washing. Thanks to the fact that these farms established shade-grown coffee systems, a good part of the tree cover was conserved in these areas, and the farmers protected their water sources by caring for the forests, mostly located on the internal slopes of the Sierra Madre de Chiapas .

But gradually deforestation, driven by livestock practices on the Pacific slope, began to climb the mountains. After the almost complete disappearance of tropical forests at low altitudes, the forests above began to be destroyed. It was then in the 1980s that the movement to protect El Triunfo began with the decisive impetus and the joint participation of all the sectors involved.

Currently, the production of shade-grown organic coffee, fair trade and respectful of birds and other wildlife represents one of the most important activities in the Reserve, not only because of its ecological benefits but also because

Protected since 1990, the horned guan has recovered thanks to management, surveillance and environmental education policies implemented in the Sierra Madre of Chiapas. (JSR)

PAGE 212 *In the Sierra Madre of Chiapas, the mountains touch the sky. The dense vegetation captures most of the humidity from the Pacific Ocean, making this region one of the rainiest and also one of the most diverse in Mexico. (JR)*

The mountain lion is the cat with the widest distribution in Mexico, as it possesses an exceptional ecological versatility. Despite having been extirpated from some places, it survives in generally secluded and hard-to-reach sites, from tropical and temperate forests to scrublands. (SGI/DN)

of the economic value of this activity. Chiapan coffee is among the most highly prized in the world. Civil society organizations, researchers, photographers, tour operators, producers, farmer organizations and authorities are actively working on the construction of sustainable development strategies compatible with the conservation of this exceptional region, for the benefit of all involved. El Triunfo is one of the priority sites for the activities of the Carlos Slim Foundation - WWF Alliance. Efforts then crystallize and, although there are still threats and occasional clearings and confrontations, conservation continues to secure new achievements. The populations of jaguars, tapirs, quetzals, ornate hawk-eagles, horned guans, among many others, are well protected under the blanket of clouds that covers El Triunfo every afternoon, the emerald jewel of the south of Mexico.

Rodrigo A. Medellín

ABOVE *The gray fox is a carnivore distributed throughout the country. Generally, it can be spotted near human settlements. (JAGT)*

RIGHT *The natural protected areas shelter not only species but the necessary interactions for the ecosystems' persistence such as pollination. Plants provide food for birds and insects, thus ensuring the development of their fruits and seeds. (JSR)*

Priority sites for the conservation of the jaguar in Mexico have been established in the Calakmul region –in Campeche and Quintana Roo–, the Lacandon region in Chiapas, the Sierra Madre Occidental –in Sonora and Sinaloa–, the Sierra Madre Oriental –in Tamaulipas, Nuevo León and San Luis Potosí–, Marismas Nacionales –in Sinaloa and Nayarit–, and the dry forests from Nayarit to Chiapas. (SGI/DN)

Jaguar

"Around the camp fires of Mexico, there is no animal more talked about, more romanticized and glamorized, than el tigre. *The chesty roar of a jaguar in the night causes men to edge toward the blaze and draw serapes tighter... In announcing its mere presence in the blackness of night, the jaguar puts the animate world on edge. For this reason, it is the most interesting and exciting of all the wild animals of Mexico." More than half a century ago, the acclaimed naturalist Aldo S. Leopold accurately described in his book* Wildlife of Mexico, *the human perception of the wild jaguar in rural Mexico and Latin America. Fascination and fear evoked by this enigmatic animal are legendary and date back to the earliest Mesoamerican civilizations. The jaguar often was featured in cosmogony and the exercise of aristocratic power in many pre-Hispanic cultures, including the Olmecs, Mayas, Toltecs, Zapotecs, and Aztecs.*

The jaguar has a large distribution range and is adapted to many types of environments, from semi-desert zones to lush rainforests, and from sea level to an altitude of 2,000 meters. In Mexico, it inhabits tropical and subtropical environments throughout the Pacific coast, from Sonora to Chiapas, and the Gulf of Mexico, from Tamaulipas to the Yucatan Peninsula. The most magnificent predator of the American tropics, it can kill prey as large as 300 kilograms. If feeds on a great variety of mammals, birds, reptiles, and fish, and in Mexico, its main prey are collared and white-lipped peccaries, tapirs, white-tailed, red and brown brocket deer, white-nosed coatis, agoutis, armadillos, turtles, and crocodiles.

An adult jaguar, which requires about 1,000 to 3,000 hectares to survive, may share the territory with other jaguars, and the maintenance of a healthy, sustaining population requires the protection of large extensions of contiguous land. When Leopold wrote his book, more than 100,000 jaguars inhabited the

The jaguar is not only found in the humid rainforests of southeast Mexico. This cat´s kingdom extents also to the dry forests and arid scrublands off the Pacific coast. (AP)

PAGE 222 *Despite being persecuted for decades; the jaguar survives in refuges like the Chamela-Cuixmala Biosphere Reserve.* (MALR)

tropical and subtropical regions of the continent, from the United States-Mexico border south to Argentina with about 20,000 animals in Mexico. Many forces caused a severe decline in Mexico's populations: large scale alteration of its habitat such as conversion of land for agricultural production and clearing of forests; indiscriminate hunting for their skin; and diseases transmitted by domestic animals. The collection of skins on a commercial basis was permitted in Mexico up to the 1970s. Between 1950 and 1970, thousands of skins were exported to the United States and Europe. In 1970 alone, 1,500 jaguar and ocelot skins were legally exported to the United States. Fortunately, the regulations of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) globally prohibiting the trade of jaguar products, went into effect in 1975, possibly saving the jaguar from extinction.

The situation of the jaguar in Mexico at the beginning of the 21st century was precarious. Basic information about its distribution, abundance and ecology were not well known. Research projects to close the information gap about the jaguar's ecology in the Calakmul region of Campeche, near the border with Guatemala, began in 1997. These and subsequent studies allowed to learn important aspects about its needs, diet, and other habits. One of the most successful and effective strategies to collect the information entails the capture jaguars to take body measurements such as weight, length, age, and sex, and to put radio telemetry collars. These collars send signals to a satellite and helps researchers know the location of the jaguars at any given time. This information is critical for the development and implementation of conservation actions.

Jaguar's information in Mexico was very anecdotic till a couple of decades ago. With the technological advances like telemetry and camera traps, that record and photograph wildlife automatically, this changed drastically. The Wildlife Ecology and Conservation Laboratory at the Institute of Ecology (UNAM), with the support of the Carlos Slim Foundation - WWF Alliance and other institutions like the National Commission of Natural Protected Areas (CONANP) has carried out a long-term study about the ecology and conservation of the jaguar in the Calakmul region. Thanks to these efforts, Mexico decreed the year 2005 as the Year of the Jaguar and the first annual symposium "The Mexican Jaguar in the 21st Century" was organized. In 2017 the twelfth symposium was

celebrated. The purpose of the symposia was to plan conservation initiatives, and one of the outputs was the creation of the National Alliance for Jaguar Conservation. The work of this National Alliance has been developed in coordination with CONANP and supported by the Carlos Slim Foundation - WWF Alliance. Among the most important achievements of the National Alliance is the First National Jaguar Census, the only effort of this kind in the whole continent. The census estimated 4,000 jaguars in the country in 2011. The National Strategy for Jaguar Conservation has also been developed and it identifies nine fundamental topics for the conservation of the species, among which are monitoring, jaguar-cattle conflict strategies, road infrastructure and mortality avoidance plans, and community participation in the monitoring and safeguarding of the jaguar.

The National Alliance has identified the main biological corridors and the priority natural protected areas for the conservation of the jaguar. In an unprecedented event, the Secretariat of Environment and Natural Resources agreed in December 2016 to establish more than 10 new reserves, which together encompass almost 2.5 million hectares of rainforests and other forest types where jaguar populations live. Finally, the National Alliance also worked with the Livestock Insurance of the Secretariat of Agriculture and Livestock to provide compensation to rural communities when jaguars prey on cattle.

Walking in the Calakmul rainforests, or other regions of the country where jaguars live, is an enormous privilege that future generations can continue to enjoy. The continuous work of researchers with the support of government institutions, the Carlos Slim Foundation - WWF Alliance, non-governmental organizations and the local communities, will help with this difficult task. It is a commitment to maintain the extraordinary biological diversity of the country.

Gerardo Ceballos and Eduardo Ponce

The beauty and strength of the jaguar have been the source of inspiration for many Mexicans who, for decades, have designed and implemented ambitious conservation programs for this specie. La Goleta Private Reserve, State of Mexico. (RL)

American Flamingo

Mexico is a wonderful country that offers dozens of natural spectacles such as the migration of monarch butterflies or the birth of gray whales, and invokes indescribable feelings when one crosses the path of a troop of howler monkeys in the jungle or see a large pink spot rise in flight and cross the horizon. The rippling of long, slender necks of the flamingoes, and the synchronized beating of their wings to the sound of incongruous and graceful cries is a spectacle that beautifies the coasts of the Yucatan Peninsula. Walking in short and synchronized steps in a compact group, flamingoes unexpectedly take flight, rising to the sky like a cloud of pink, orange and black tones.

But not always the flamingoes were safe in Ría Lagartos, in the north coast of Yucatán, and in Celestún, to the west. It was only in the 1980s that more than 90,000 flamingoes inhabited the northern coast of the peninsula, but unplanned urbanization, excessive depredation of eggs and chickens, and disturbance of nesting couples began to cause severe population declines throughout the region. The simple incursion of a person into a nesting colony meant that the parents abandoned the nest, leaving their only unprotected egg or chicken to be killed by gulls, raccoons, rain or the inclement sun. Thus, without vigilance and little interest on the part of settlers, academics and authorities, the colonies of flamingoes were languishing and many of them disappeared. A few years later there were only 10,000 animals left. And then a true, coordinated and solidly based effort began, based on scientific information. Ría Lagartos —the main site of flamingo nesting in Mexico— and Celestún were declared Biosphere Reserves in 1999, although since 1979 they were recognized as areas of refuge of fauna and flora.

The conservation of species that travel great distances, like the American flamingo, is a challenge. Mexico has worked since 1979 to protect their breeding, feeding and resting sites. (CCK)

LEFT *The American flamingo is protected by a network of natural protected areas throughout the coast of the Yucatan Peninsula. There, actions like monitoring of their populations and restoration of wetland ecosystems –essential for the flamingos– are continuously carried out.* (CCK)

ABOVE *Mexico has the largest breeding colonies of the American flamingo in the Caribbean Sea. Despite considerable fluctuations in the populations size each year, 40 000 individuals have been recorded in the Mexican hypersaline wetlands.* (CCK)

The nesting colonies received the protection and study they needed, stabilized and were able to initiate their recovery. Towards the end of the twentieth century the flamingoes showed an incipient recovery with about 30 000 individuals. The Center for Scientific Research of Yucatan (CICY) and the organization Niños y Crías A.C. played a strategic role in the recovery of the species. In addition, the protection of flamingoes as an iconic species of these marshes has also made it possible to protect the mangroves and reed wetlands that shelter hundreds of migratory bird species, as well as small portions of dry forest where numerous threatened mammals such as jaguar, ocelot and jaguarundi.

However, there were still some years in which they had serious problems, as in 2000 when a jaguar entered the nesting colony, causing the disbandment of couples and the loss of more than half the offspring. Fortunately these situations are rare. Much more common is the partial flooding of the colony by torrential rains, but this only causes the loss of 10% or less of the offspring, unless it is a hurricane that destroys the entire colony. In fact, climate change represents one of the most severe threats to flamingoes. It is difficult to anticipate how the future of the flamingo colonies will be. Global climate prediction models have already announced a temperature increase of between 1.5 and 3 degrees Celsius by 2030, in just 13 more years. The most reliable predictions suggest that sea level in that area will rise by several centimeters in two to three decades.

Visiting today Ría Lagartos and the other colonies on the coast of the Yucatan peninsula is an experience that continues to enrich many generations of Mexicans and other visitors thanks to the efforts of Niños y Crías A.C. and the CICY, the participation of the Pedro and Elena Hernández Foundation, as well as the first incipient but constantly increasing commitment of the residents and academic institutions, always under the coordination of the National Commission of Natural Protected Areas.

The experience in these areas helps us to glimpse solutions in other places in Mexico in which we have not reached a fine coordination of the level and the magnitude reached in the case of the Mexican flamingoes. Participants in sectors such as tourism, fishing, transport, local population, academics, NGOs and federal, state and local authorities each contribute from their trench to an operation that today is a world example for other attempts to protect flamingoes. The flamingoes of Celestun and Ría Lagartos are part of a metapopulation shared with the Florida peninsula, with Cuba and even with the Caribbean coast of Colombia! Some of our flamingoes have been ringed and monitored to all these destinations. It is time to launch a regional Caribbean strategy to protect flamingos throughout the area.

Rodrigo A. Medellín and Eduardo Ponce

The population of American flamingos has doubled thanks to the conservation, restoration and education efforts that have been implemented in Mexico over the past three decades. (CCK)

The conservation of the American flamingo benefits many other species of flora and fauna that also live in the wetlands of the Peninsula and are threatened due to the contamination and urbanization of the coasts. (MC)

Long-nosed Bats

In the late spring, the rocky landscape around the Pinacate volcano is heated to the extreme of damaging the human skin; the constant wind and almost total absence of humidity make this spectacular site —located in the northwest end of the state of Sonora—a seemingly hostile place. But at nightfall, a few shadows begin to come out of the cave; at first two or three bats explore the entrance and fly back in, but in a few minutes the fleeting flutters become a torrent of thousands of bats per minute leaving the cave in search of the abundant flowers produced by the saguaros and pitayas, which grow in vast expanses of the Sonora and Arizona desert.

More than 90% of the nectarivorous bats that live under the volcano are females in an advanced state of gestation. They arrive at this cave in late April and early May, synchronously coupled to the flowering process of the columnar cacti of the Pinacate Desert. These lesser long-nosed female bats spend the winter much farther south, in central and southern Mexico. At the beginning of the year they mate with males that do not migrate, but live all year round in caves such as that in Don Panchito Island, located in the Bay of Chamela, Jalisco. A few weeks later the females begin this migration of up to 1,500 kilometers to the north, traversing the most productive areas in nectar and pollen. But in addition to the abundant food, there is another condition hidden below the volcano, in the remote and isolated lava tunnels that remain empty from September to March: the heat trapped underground. High temperatures are important so that the baby bats, who are born hairless and unable to maintain their temperature constant, can survive without risk of dying of cold.

When after a few hours the flow of bats diminish almost to the point of disappearing, I can enter the cave to witness an exceptional spectacle: large expanses of the ceiling are covered by a warm pink mass covered with small eyes, ears and wings.

The "Bat Volcano" in the heart of the Mayan jungle is a unique natural show in which every night more than 3 million bats leave their cave in search for food. Some species eat insects, others fruits and others nectar from the flowers. (KS/NPL)

The bat mothers leave their babies in this kind of kindergartens for many thousands of babies and fly up to 90 kilometers to feed in the saguaro forests. The other half of the year, during their stay in the center and south of the country, bats obtain their food from the flowers of agaves and other plants. In exchange for providing this sweet source of energy, the plants will be pollinated and can produce seeds. This is where bats become central actors for the future of one of the most idiosyncratic products in Mexico, the distillates obtained from agaves: tequilas and mezcales.

For millions of years, bats and agaves have coexisted and increased their interdependence of one another. The result is that the agaves accumulate in the heart of the plant, called the head, large amounts of sugars for several years, to then invest every last gram of all that energy in a single event of spectacular flowering that allows them to produce thousands of seeds. But that costs the life to the plant. About nine thousand years ago, inhabitants of the territory that would become Mexico and the southern United States of America discovered that if they harvested the plants before they bloomed and cooked these heads underground, they could consume them as sweet food. Much later, with the arrival of the Spaniards, the techniques of distillation came to Mexico and it was possible to transform these sugars into alcohol, thus creating the first mezcales.

In the nineteenth century tequila producers intensified the production of blue agave and, in order to replant the fields, exclusively used the offshoots that grow at the base of the parent plant, which are exact genetic copies or clones. The clonal reproduction and the decision to use exclusively blue agave, among several cultivars used at the beginning of the century, caused almost all the genetic diversity of these plants to be lost, which led to various pest and disease problems.

At the same time, an unwarranted fear towards bats led to poisoning campaigns and the destruction of numerous colonies, and the lesser long-nosed bat was listed in Mexico as Threatened and in the United States as Endangered. Then the Program for the Conservation of Bats in Mexico approached tequila producers to tell them about their unknown ally. For 20 years nothing happened, but in 2013 finally some producers coordinated by Tequila Interchange Project of Philadelphia (TIP) and the Institute of Ecology of UNAM succeeded: a pilot program in which 5% of agaves are allowed to flower to feed the bats and to promote pollination and thus exchange of genes between wild and cultivated plants, improving their genetic diversity.

The Jamaican fruit-eating bat is an efficient seed disperser that contributes to the regeneration of the tropical rainforests and dry forests where it feeds every night. (GC)

PAGE 239 *Many plants economically and ecologically important in Mexico are pollinated by bats, establishing a tight relationship. This interaction has had profound benefits for the human communities profiting from the cultivation of agave, pitaya, guava, sapota and many other tropical fruits.* (*above, JeR; below JDBP*)

In November 2016 the production of bat friendly tequila began, welcomed by its consumers with much enthusiasm. Today this also happens with the mezcal produced around Morelia, Michoacán. The interest of the bartenders has been essential: they are responsible for spreading the message among their consumers and thus support the project.

Thanks to the work of decades, with much research and environmental education, lesser long-nosed bats recovered to become the first mammals to be removed from the list of endangered species protected by Mexican legislation. The future is bright today for these distillates and, of course, for consumers. The commitment unites entrepreneurs, landowners, producers, academics, authorities, bartenders and consumers. Again, the alliance between various economic and social sectors determines success in conservation. As we sit down to enjoy a tequila or a mezcal that is friendly with bats, we can today toast the health of bats, our unsuspected winged allies.

Rodrigo A. Medellín

Coasts and Tropical Seas

Marismas Nacionales

The best way to appreciate the magnitude and beauty of this region off the coast of Nayarit and Sinaloa is from the air, where the blue of the Pacific Ocean is replaced by the brilliant greens of the coastal wetlands that seem to stretch on, almost infinitely. Marismas Nacionales, the largest expanse of mangroves in Mexico are part of a complex system of coastal brackish water lagoons, fresh water springs, mangrove forests, swamps, deltas, and marshes. High above the land it is possible to see this unique landscape where the mangrove forests, that form more than 160 bars of seemingly endless length, run parallel to the coast and are separated from one another by sandy stretches.

Marismas Nacionales is home to a rich diversity of aquatic and terrestrial flora and fauna. Some threatened or endangered animal species live in these wetlands, such as the jaguar, military macaw, roseate spoonbill, American crocodile, and sea turtles. It is a winter refuge for hundreds of thousands of aquatic birds such as ducks and wading birds that migrate to the area for food. A resident jaguar population has adapted to the environmental conditions, which are flooded for most of the year. The abundance of jaguars in these marshes is legendary as described by the famous hunter Arturo Imaz Baume. Coveted by trophy hunters during the 20th century, Baume wrote how jaguars were hunted with hounds and noted that these expeditions were one of the most difficult in Mexico because of the intricate system of mangrove forests.

The ecological benefits of wetlands extend beyond their high diversity; they are very important for human safety, economic well-being, and security of our infrastructure. Wetlands serve as a natural barrier against climate events such as hurricanes and storms; they absorb rain and surface water flow and filter it; and they prevent the buildup of salt in the soils through the flushing action of the

Not only do wetlands harbor a huge biological diversity but are also key to the reproduction of commercially important fish species and in the protection of the coasts against catastrophic climatic events. They also provide food and income for thousands of families who rely on fishing and ecotourism. (JR)

PAGE 240. *Mexico is very fortunate by having territorial waters both on the Pacific and the Atlantic oceans. Crystalline and full-of-life waters harbor spectacular reefs on each side. The reefs are the most diverse ecosystems on Earth but also the most fragile and threatened. (LJS)*

Mexico is member of the Ramsar Convention, focused on the preservation of the most important wetlands worldwide. Marismas Nacionales is one of the more than 2,000 Ramsar sites around the world, and it protects more than 130,000 hectares and dozens of species of resident and migratory birds. (AHR)

water. Numerous fish species of commercial importance reproduce in the mangroves and spend their first life stages in them before migrating to the open sea. Wetlands are vital to avoid coastal erosion and they regulate greenhouse gasses in the atmosphere by the sequestration of carbon dioxide. The wetlands forests also provide food and other resources for local communities and are a destination for visitors because of their beauty and uniqueness.

The region's landscape has changed markedly since the arrival of the conquistadors in the 16th century. The Franciscan religious order, which arrived in 1540, established precarious villages that were later destroyed. Isla Mexcaltitán, another relict of the early occupation and a small fishing village was decreed an Historic Monuments Zone in 1986. Subsequent waves of immigrant Europeans established large haciendas that were built around livestock operations, in part because of the expanding market for meat products and because the saline conditions of the soil limited crop production. In the 18th century, construction of the San Blas port engendered the expansion of agriculture at the expense of the native forestlands. During the Porfirio Díaz's government, the fish and shrimp industries expanded to meet the needs of the national market and the American crocodile was intensely exploited for the international market for reptile skins. Despite the constant, but relatively slow encroachment on the natural resources of the area, wide swaths of the wild mangroves on the Pacific coast were relatively intact as late as the beginning of the 20th century. This tepid disturbance was not unlike that found in other Pacific coast mangroves such as those of Cuyutlá lagoon in Colima and La Encrucijada in Chiapas, Mexico, Sierpe in Costa Rica and Guayaquil, Ecuador. As human enterprises such as agriculture, animal husbandry, fishing, and tourism grew, the pace of wetlands degradation quickened. For example, the mangrove environment is well suited for shrimp farming, but the impacts of this industry are severe and cause habitat modification, including removal of vegetation. Today, land conversion for shrimp farming is a major cause for the loss of mangroves in Mexico and other countries with such ecosystems.

Currently, about 20% of the country's mangroves are in the Marismas Nacionales; it is the largest intact remnant mangrove ecosystem in Mexico. However, human activities pose severe threats to this robust, productive and vital system of vegetation and water, the wetlands. Dams have been built across rivers, such as the San Pedro Mezquital, to support the needs of livestock operations, agriculture

ABOVE *The roseate spoonbill, as the flamingo, obtains its coloration from its food. With their spoon-shaped beaks, they stir the bottom of shallow waters catching mollusks, fish and crustaceans. (JR)*

LEFT *Social involvement is essential to achieve the protection and restoration of Mexican ecosystems. Fortunately, the message of conservation is arriving, slowly but steadily, to more people integrating actions of protection into their lives. (JR)*

and shrimp farming. These dams interrupt the supply fresh water to the marshes, resulting in changes to the downstream biota. In the year 2010, the 133,000 hectare Marimas Nacionales Nayarit Biosphere Reserve was established to protect this expanse of the wetlands. An even larger portion of the wetlands, the 170,000 hectares of coastal Sinaloa, was not included in the decree and still lacks environmental protection. Human enterprises compatible with conservation and ecosystem protection should be promoted as a means for the region to enjoy long-term social and environmental sustainability. Responsibly managed ecotourism is one such activity. In this matter, the support of the Carlos Slim Foundation - WWF Alliance has been key.

The sound of the jaguar's roar during clear spring nights sets the imagination in motion. It is one of the cacophony of sounds of the wetlands that have been repeated for millennia, and hopefully will continue for many future generations. The conservation of the irreplaceable Marismas Nacionales, with its mangrove forests, coastal lagoons, tongues of moving water and sand bars, all bursting with life, is a cause for hope for the protection of Mexico's rich biological diversity and an example of what can be accomplished to ensure we, and future generations, are able to enjoy and benefit from our natural heritage.

Paola Guadarrama and Gerardo Ceballos

While visiting Sian Ka'an it is not hard to understand why the Mayans called it the place where the sky is born. Its spectacular "cenotes" (natural freshwater limestone sinkholes), rainforests, beaches and wetlands remind us about the kindness of nature. (SA/NGC)

Sian Ka'an

The spectacular archaeological sites of Tulum, Coba and Xcaret, among many others on the Yucatan Peninsula and Central America built since the fifth century, show that the ancient Maya —as well as Europeans and Mexicans today— fully enjoyed the astonishing natural environment of this wonderful region of southeastern Mexico. Turquoise blue waters, clear and calm, extensive mangroves and the second largest coral reef in the world, all framed by a sumptuous forest, abundant and well preserved fauna, represent the Sian Ka'an Biosphere Reserve.

More than thirty years ago, the Mexican government decreed the creation of this protected area, which is highly innovative because it is one of the first mixed areas to include terrestrial, marine and underwater ecosystems. The reserve, which protects more than half a million hectares, contains the largest underground rivers in the world, part of the Mesoamerican Reef —the second largest in the world— more than twenty Maya archaeological sites, mangroves and wetlands that are among the most significant of the continent, as well as populations of jaguars, tapirs and white-lipped peccaries, which are three Mexican flagship and umbrella species that face a serious danger of extinction. In fact, the white-lipped peccary faces the worst situation among these three species, since we only have significant populations in the Zoque Jungle, the Lacandona, Calakmul and Sian Ka'an; we have lost the species in the rest of the country.

The commitment, vision and courage of many conservation professionals, fishermen, ejidatarios, academics, students and numerous municipal, state and federal government officials have been crystallizing for decades in diverse initiatives that converge in the protection of the entire region of Sian Ka'an. A

On the warm coasts of southeast Mexico, the magnificent frigatebird swiftly steals a fish while in flight from other birds, who have little opportunity against these two-meter-wingspan giants. (JAGT)

PAGE 252 *The black howler monkey lives in the tropical rainforests of southeast Mexico. Primates are among the most threatened mammals but thanks to the establishment of reserves like Sian Ka'an, Yum Balam and Calakmul, this and other primate species are protected from attacks from their human relatives.* (GC)

key organization for the advancement of this work has been the organization Amigos de Sian Ka'an A.C., who since 1987 has led the actions and coordinated the programs in the region. All this has happened with the constant support of organizations such as the Carlos Slim Foundation - WWF Alliance and the Gonzalo Río Arronte Foundation, among others.

Protection actions and sustainable development programs in the Sian Ka'an region are extensive, diverse and long lasting. For example, it has worked for 30 years without interruption and in collaboration with dozens of communities along the coast to take care of the nests of the sea turtles that arrive each year. Today there are many millions of turtle eggs, such as hawksbill, hawksbill, green, loggerhead and other seaturtles that have been rescued each year under protection schemes for adult turtles and offspring. Also every year they clean tons of garbage from the beaches. Today Sian Ka'an is World Heritage of Humanity, recognition that gives importance at the global level. Recently, and replicating the federal Environmental Services Payment initiative, a consortium of conservation institutions, private drinking water companies and the government sector represented by the National Forestry Commission have created the Quintana Roo Fund for Payment for Environmental Services. It is a tool that can be replicated in other states such as Oaxaca, Chiapas or Veracruz, and can also be an inspiration for other countries that take this example and adapt it to their local conditions.

In their water program they have achieved the largest studies to understand the hydrology of the Yucatan peninsula, they have reduced the contamination of the fragile aquifer thanks to the impulse they have given to the communities, including the controversial seemingly uncontrolled growing Tulum, to connect to the drainage network instead of simply discharging its sewage directly into the aquifer —a practice sadly common still in the peninsula. The knowledge of the cenotes in Quintana Roo is crucial and Amigos de Sian Ka'an has made its first census. They have also supported the creation and operation of water treatment plants.

Sian Ka'an is one of the first protected areas in the world to have a formal component of mitigation and adaptation to the damages that climate change is causing: the State Action Plan for Climate Change in Quintana Roo. The organization of this program was developed by several local and federal government

The grison is a skilled hunter related to the weasels and ferrets. Considered as a species threatened with extinction, it is sheltered by the protected tropical rainforests of southeast Mexico. (JAGT)

institutions. Among its goals are the design and implementation of measures aimed at protecting human infrastructure: housing, hotels, roads, as well as generating a low-CO_2 strategy for the tourism sector, and monitoring reefs for the early detection of bleaching of corals.

The platform of the Sian Ka'an Biosphere Reserve and the organizations that work there have pushed for the creation of additional protected areas — such as the Cozumel Protected Area of North Wildlife that now protects nearly 38,000 hectares— the most important terrestrial and marine reorganization plan of the coast of Quintana Roo and the updating of management plans. Amigos de Sian Ka'an is also involved in the creation of sustainable tourism infrastructure through environmentally friendly hotels and other initiatives. In the case of Sian Ka'an there are many lessons that can be replicated in other protected areas, as well as in other regions of the country and even the planet. The dynamic and solid collaborative capacity deployed in Sian Ka'an by civil society organizations, local, state and federal government agencies, academics from different institutions, private companies, hotels and other companies, with the support of foundations, shows that It is possible to do a lot by joining wills strongly based on values such as honesty and hard work, and resorting to intelligence and creativity, particularly from younger generations.

Rodrigo A. Medellín and Eduardo Ponce

The great biodiversity and extraordinary conservation state of Sian Ka'an earned UNESCO's recognition as World Heritage Site, a legacy for Mexico's and the world's peoples. (ME/NGC)

Mesoamerican Reef

Coral reefs are very diverse and intricate ecosystems. Looking from above them, these seemingly calm and harmonious underwater fields, are systems with very complex interactions involving the coexistence of thousands of living organisms, all competing for survival. Exploring the reefs of Mexico's Caribbean turquoise waters is a unique and exhilarating experience. The marine landscape of the reef which is close to Cozumel, an island and natural reserve only 18 kilometers from the Quintana Roo coast, begins a few meters below the surface. Its beauty is equal to that of the Great Barrier Reef in Australia. Extraordinary species inhabit this ecosystem: seahorses, thousands of colorful fish, giant manta rays that seem to calmly fly across the water, nurse sharks hiding among the rocks and corals of myriad shapes and colors, and many other strange looking creatures that behave in ways that are foreign to most visitors of this underwater paradise.

The Cozumel reefs are part of the Mesoamerican Barrier Reef System, which extends along the Caribbean coast from Cabo Catoche, north of Quintana Roo to the southern islands of Bahía and Cayo Cochinos in the northern reaches of Honduras. The more than 1,000 km long Mesoamerican Barrier Reef System, was officially delimitated in 1997 with the signing of the Tulum Declaration by Mexico, Belize, Guatemala, and Honduras, in the International Year of the Reef. It includes more than 60 natural protected areas, 11 of them listed as Biosphere Reserves and 13 designated as RAMSAR site by The Convention of Wetlands of International Importance. These sites, which are located near the continental shelf and are about five kilometers from shore, include a group of bays, coves, cays, islands, lagoons, and reefs that are unparalleled in the world for their beauty and composition. One such site, Banco Chinchorro, is a large circular reef that

Life appears in every corner of the shallow waters of tropical Mexico. Among the great variety of shapes and colors that characterize the coral reefs, the sponges stand out as the most diverse group. (CCK)

The marine reserves provide shelter for the bull shark and show the tameness of these animals. With a 350-million-year history in our planet and keen intelligence, sharks have been unfairly judged as dangerous animals. (CV)

PAGE 262 *Each year, thousands of spotted eagle rays come together in the waters of the Mexican Caribbean. People all over the world marvel at these animals that seem to fly peacefully in the crystalline waters. (RF)*

covers almost 600 square kilometers, is the largest in Mexico and one of the best protected in the region. Mahahual, on the coast and facing Banco Chinchorro, has one of the largest spawning aggregations of Nassau groupers in the world. Additionally, Cozumel Island has a notable collection of terrestrial animals, some of which are endemic such as the Cozumel raccoon.

The reef system is part of the Mesoamerican Biological Corridor, which contains about seven percent of the biodiversity of the world, and the Carlos Slim Foundation - WWF Alliance has designated the Mesoamerican Barrier Reef System a priority conservation region. The biodiversity of this reef complex is extraordinary; more than 3,330 species have been catalogued in just the Mexican portion. Four sea turtle species, including the leatherback, hawksbill, green, and loggerhead lay their eggs in the nearby white sandy beaches where they themselves hatched decades earlier and feed in the reef area. Thousands of migratory birds feed and rest on the cays and islands, the American manatee inhabits the Chetumal area of the Yucatán Peninsula, whale sharks feed in the largest congregation of the country near the reef, and larva of the queen conch settle and the juveniles grow in the southern reaches of the Mexican portion of the reef. There is a very high diversity of edible fish species, echinoderms, such as sea urchins and starfish, sponges, and crustaceans including the highly prized Caribbean spiny lobster. These resources are harvested by the coastal fishing cooperatives and other commercial enterprises and sold on the domestic and international markets. The coastal areas have large areas of mangrove forests which serve as natural barriers against extreme climate events, common and potentially disastrous in this region.

The reef structure, built on calcium carbonate deposits called stony corals, are dominated by corals, especially the elkhorn type which grows at the relatively slow rate of about 3 to 11.5 cm per year. Coral structures are formed by tiny colonial organisms called polyps in a symbiotic association with zooxanthellae, algae that provide oxygen and some nutrients from photosynthesis to their hosts. The algae also possess pigments that protect the coral from solar radiation and is responsible for the varied and brilliant colors often associated with coral reefs. However, increase in global temperature of ocean waters, the result of climate change, has caused zooxanthellae algae to be expelled by polyps resulting in a bleaching of the structure and increasing their vulnerability to disease and death.

The manatee inhabits rivers and costal lagoons mainly in the states of Tabasco, Yucatan, Campeche and Quintana Roo. The populations of this species have recovered thanks to the establishment of a network of reserves and national parks that protect the coasts of the Caribbean Sea. (CV)

PAGE 266 *The conservation of the coral reefs of the Riviera Maya relies on preserving the intricate network of interactions between corals, anemones, fish, crabs, shrimps and many other species that give life to this wonderful ecosystem.* (CCK)

Other serious threats to the reefs are physical destruction by boat traffic, pollution, and unregulated or poorly managed tourism.

The complex interaction among the Mesoamerican Barrier Reef System and the coastal and deep-sea ecosystems provide a unique environment that is one of the richest in the world in biomass productivity and diversity. From the ecological, economic and social/cultural perspective, conservation and protection of the region's species and ecosystem is critically important and warrants the investment of resources and ecosystem-based management policies. The common conservation and protection effort of the four countries have succeeded in blending nature protection and sustainable growth for the communities that depend on its richness. It only takes one visit to the "El Cielo" beach in Cozumel to experience the marvels of nature as one gazes out at the sea that is home to a fantasyland of animals and plants and a source of inspiration for the human that share this region. It is our responsibility to care for this special place and ensure that the magic it holds for us now will still be there for future generations.

PAOLA GUADARRAMA AND GERARDO CEBALLOS

Whale Shark

A true giant of world's temperate and tropical oceans is the whale shark. Closely related to sharks, the whale shark is the largest cartilaginous fish on Earth and can grow to 15 meters in length and weigh more than 20 tons. It is long-lived, and 100 years of age is not unusual for this giant of the sea. Locally known as "domino" because of its dark blue color with white dots and lines traveling down its back, the whale shark feeds on small fish and plankton, microscopic algae and invertebrates suspended in the water column, by filtering large amounts of sea water through its gills.

Whale sharks live in the warm and temperate waters around the world, with the largest concentrations in southeastern Asian, especially near the Philippines. Whale sharks embark on long migrations, following sea currents; there are accounts of individuals traveling more than 13,000 kilometers over a three-year period. Around Mexico, they are in the Pacific Ocean off the coasts of the Baja California Peninsula and the central coastal state of Nayarit and from Isla Mujeres to Isla Holbox in the Caribbean Sea.

The Caribbean Sea off the coast of Mexican may be the best region in the world for whale shark watching, and the tourism industry has capitalized on the annual movement of these magnificent animals. This special attraction creates hundreds of jobs, contributes significantly to the local economy, and helps promote the conservation of this and other species and the marine environment.

The Caribbean region is also one of the main feeding areas in the world for whale sharks. From March through September, up to 1,000 individuals gather

Each summer hundreds of whale sharks gather in the crystalline waters off the coast of Quintana Roo to feed and be the star of one of the most fascinating natural phenomenons in the world. (BC/NPL)

because of the rich feeding grounds, the result of upwelling. This oceanographic phenomenon where the colder, nutrient-rich waters from the Gulf of Mexico mixes with the warmer Caribbean waters "fertilizes" surface waters, meaning that surface waters often have a potentially high biological productivity and the plankton is abundant. Some whale sharks migrate as far east as Cuba and to the southern reaches of the Caribbean Sea, and some may cross the Atlantic and reach the African coasts. The Pacific population, is considerably less numerous with the estimated 250 individuals distributed in the Gulf of California and along the central Pacific coasts from which they migrate to the Galapagos Islands in South America. After the feeding season, whale sharks continue their migration to other seas.

The whale shark was considerably more numerous by the end of the 20th century, but illegal harvesting for its meat and fins, incidental capture in fishing nets, collision with ships, pollution, and other factors associated to human activities have caused a significant decrease in the population. The species now is listed as threatened in Mexico and in danger of extinction, globally.

Since 2003, the National Commission of Natural Protected Areas has established policies and guidelines regulating the tourist industry that entails interactions with the whale shark. Support given by the Carlos Slim Foundation - WWF Alliance has been central to Mexico's conservation research projects for the whale shark. Many reserves such as the Islands of the Gulf of California and Bahía de Loreto National Park in the Baja California Peninsula have been established to protect the critical habitat for the whale shark. The Whale Shark Biosphere Reserve in the Mexican Caribbean, which covers 146,000 hectares, was decreed in 2009. In December 2016, the Mexican Caribbean Biosphere Reserve was established. It covers more than 5 million hectares, an area the size of the state of Campeche, and stretches from the Quintana Roo coastline to the border with Belize. With this new reserve, the entire Mexican portion of the Mesoamerican Reef is protected. In addition to the whale shark, this reserve protect other emblematic species such as the bull shark, golden eagle ray, and sea turtles that inhabit or migrate through this reef area. The reserve also includes "no take" areas to protect those habitats critical for reproducing, feeding,

Whale sharks wander the waters accompanied by giant manta rays that also take advantage of the plankton's abundance of the Caribbean. (CCK)

PAGE 272. *Whale shark populations are being monitored in the Yum Balam Flora and Fauna Protection Area and Isla Contoy National Park to regulate the touristic activities and secure their long-term permanence.* (CCK)

and breeding marine species central for the economic activity of many fishing cooperatives of the area. The reserve is also considering implementing a closed season policy with no fishing allowed in some areas.

The observation season ends in September. Shortly after, the whale sharks will migrate to other seas. These transparent diaphanous blue waters, which are an oasis that provides shelter and food for them, will continue to wait each year for their return.

Gerardo Ceballos and Paola Guadarrama

Each year between May and September, thousands of whale sharks congregate off the coast of Quintana Roo. The Whale Shark Biosphere Reserve is a world-renowned site where you can swim with these marine giants. (MH/NGC)

Sea Turtles

Some of the most amazing spectacles of nature are the congregation of tens of thousands, in some cases hundreds of thousands, of individuals of a species either to seek shelter in the winter, to feed, or to reproduce. For example, the monarch butterfly migrates from southern Canada and the United States to the mountains of central Mexico to spend the winter there, while the gray whale travels from Alaska to the coastal lagoons of Baja California to reproduce in the winter.

These biological phenomena are generally restricted to certain places that have the necessary characteristics for the congregation of a particular species. In some beaches of few countries of the planet an extraordinary phenomenon occurs every year, where thousands or tens of thousands of sea turtles arrive simultaneously to nest. Known as arribadas in Spanish, the simultaneous nesting phenomenon of thousands of sea turtles only occurs now in 12 beaches in the world, of which three are in Mexico: Playa Morro and Playa Escobilla in Oaxaca and Rancho Nuevo in Tamaulipas. Until the 1960s, arribadas of different magnitude, some huge, other small, were a common phenomenon in Mexico. The massive arrival of sea turtles occurred in the months of June to December in diverse beaches of the Pacific Coast like Mismaloya in Jalisco, Mexiquillo in Michoacán, and Escobilla, and in at least one of the Gulf of Mexico: Rancho Nuevo in Tamaulipas. However, exploitation of sea turtles to commercialize their skin and meat, looting of nests for the sale of eggs, and development of urban and tourist areas on nesting beaches have drastically reduced their populations.

The leatherback, green, olive ridley, hawksbill, loggerhead, Kemp's ridley, and the Pacific black turtles live in the seas of Mexico. The leatherback is the biggest sea turtle on the planet: a giant of more than 2 meters in length, and up to 600 kilograms in weight. Other species are smaller. Some, such as the Kemp's Ridley,

The Mexican government has supported the legal protection of sea turtles and the conservation of nesting beaches for more than 50 years, contributing significantly to their recovery. (CV)

weigh around 45 kilos, while others, such as the olive ridley, around 150 kilos. All sea turtles went, in a few decades, from being abundant to being considered in danger of extinction. Their skin was used to make bags and shoes. Their meat was sold as a delicate and expensive dish even in big cities such as Hermosillo, Guadalajara, and Mexico City. In some Oaxaca beaches, thousands of turtles were killed every year, by being caught up in nets or by hand when they came close to the shore for nesting. Only in 1968, more than 14,500 tons of olive ridley were commercialized, equivalent to more than 185,000 specimens. In those beaches' slaughterhouses, the smell of the remains was unbearable. Additionally, millions of eggs, which were said to be aphrodisiacs, were commercialized every year. The poachers —or hueveros— wandered around the beaches at night, stalking the nesting turtles to plunder the nests.

The impact of the exploitation was colossal. For example, the Kemp's ridley—which mainly nested in the beaches of Tamaulipas and Veracruz—was abundant in the 1940's. In 1947, more than 45,000 Kemp's ridley turtles nested in Rancho Nuevo, the main nesting area for the species. By the end of the 1970s, the number of nesting females had declined to less than a thousand. The history of the decline of other species was similar. Of the millions of olive ridley that nested in beaches from Jalisco to Chiapas up to the 1960s, less than 50,000 did in 1980. Turtles are very vulnerable to disturbances, due to their life cycle. They experience a high mortality rate when young; of every 100 hatchlings, only one or two get to adulthood; they have a late sexual maturation, and are highly migratory. While they are at sea—which is most of the time, for they only leave the water to nest—they are stranded in fishing nests.

The huge reduction of turtle's numbers alerted scientists, conservationists, local people, and authorities. Some researchers, like René Márquez, formerly the National Fisheries Institute, would become the pioneers of conservation programs to save sea turtles from extinction in Mexico. He pushed a national program to protect the most important beaches and to establish turtle camps to secure the reproduction of the species. Twelve camps were established in 10 states of the country. Volunteers, villagers, scientists, and authorities patrolled the beaches to pick up the eggs and bring them to protected enclosures, where they would hatch and then, tiny born new turtles would be brought back to the sea. Important aspects of this strategy were the involvement of communities

in monitoring programs and the economic support that was given to reduce pressure over turtles. To this day, there are dozens of camps and hundreds of millions of turtles have been saved. Besides, camp facilities have allowed scientific research to be done for their protection, through blood samples for genetic analysis, female tagging, and survival rates records, which allow us to know more about the demography, behavior, and ecology of these species.

In 1990 the federal government established a complete and permanent ban on the exploitation of sea turtles and their eggs in waters under national jurisdiction, a key step for their long-term conservation. In 1993, the use of devices to prevent the capture of turtles in bottom trawls used in shrimp fisheries was established. Little by little, populations began to recover. Even if the leatherback is the scarcest of all, Mexican populations are among the most important ones on the planet.

The beaches of Mexiquillo in Michoacan, Tierra Colorada in Guerrero, and Chacahua and Barra de la Cruz in Oaxaca are sanctuaries for sea turtle nesting. The hawksbill turtle, considered critically threatened worldwide, has recovered substantially in the Mexican Caribbean, especially on the coasts of Yucatan and Quintana Roo. The greatest success has been the one of the olive ridley turtle. The arrivals of more than 30 thousand turtles are now common in the nesting season, which are repeated several times a year. In the arrivals the beach is completely covered with turtles. By 2016 more than 30 thousand turtles arrived to nest. That year, there were almost one million and a half nests of olive ridley in the beaches of the Pacific and 20 thousand of kemp's ridley in Rancho Nuevo. The large arribadas are once again a natural phenomenon on the beaches of Mexico. In the uncertain horizon, the conservation of sea turtles in Mexico is a case of enormous hope.

Gerardo Ceballos and Paola Guadarrama

ABOVE. *The most important nesting beach for Kemp's Ridley turtle is located in Rancho Nuevo, Tamaulipas. Since 1978 the recovery of their populations has been steadily making progress through the massive protection of nests, becoming a worldwide example.* (SGI/DN)

RIGHT. *Scientific research is essential to preserve endangered species. Technological advances have allowed us to know details about the turtle's movement patterns to establish priority sites for their conservation.* (LM)

PAGE 278. *The hawksbill turtle spends much of its life in tropical and subtropical waters, including the Caribbean Sea, Gulf of Mexico, Gulf of California, and some northwestern states. There, it visits coral reefs, estuaries and costal lagoons.* (OA)

PAGE 280. *Turtles have an excellent memory. Each year between October and November, thousands of turtles are born and head to the sea in the Morro Ayuta and La Escobilla beaches in Oaxaca. After traveling the world a few times, they decide to return to the same place that saw them being born to repeat once again the cycle of life.* (JDBP)

Crocodiles

In the 1950s, Miguel Álvarez del Toro, one of the most acclaimed Mexican naturalists, described the encounter he witnessed between a jaguar and a crocodile in the Pijijiapan swamp in the Chiapas coastline: "With the binoculars, a jaguar was discovered, it dived and then came out to the surface, creating a big splash… it was a jaguar fighting against a considerably sized crocodile… The jaguar came to the shore dragging the crocodile… of more than two meters in length, by its neck." During that period, a countless number of animals inhabited the tropical regions of Mexico. On any dark night, one could jump into a dugout in a coastal lagoon with a lamp and see the reflection of immense numbers of lagartos*, the term used in the rural areas for crocodiles and caimans. Rivers like the Pánuco, Balsas, Grijalva, Usumacinta, and Lacantún, were considered dangerous for humans and domestic animals because of the crocodiles that swarmed their waters, and attacks on some villagers were not uncommon.*

Crocodiles are ancient animals; their lineage traces back more than 250 million years. The collision of a large asteroid 66 million years ago into the area of Earth that is now the Gulf of Mexico precipitated the Cretaceous mass extinction in which more than 90% of the planet's biodiversity was eliminated. Many reptile groups disappeared, but the ancestors of the 24 species of today's crocodiles, alligators, caimans, and gavials survived, and they now live in diverse ecosystems of fresh and salt water in tropical and warm areas of the world.

The American crocodile, the Morelet's crocodile, the spectacled or common caiman, and the American alligator live in Mexico. The American crocodile is the largest species, and specimens 5.30 m long and weighing more than 300 kg weight have been recorded. This species has the most extensive distribution; it is found in lagoons, swamps, and rivers from Sinaloa to Chiapas and from Tam-

In Mexico there are four species of crocodiles and alligators that inhabit swamps, lagoons and rivers, both in the Gulf of Mexico and the Pacific Ocean watershed. (DP/NPL)

The American crocodile was on the verge to extinction in the 1980's but thanks to the legal protection of their populations and the wetlands where it lives, this species has recovered remarkably. (FCMB)

PAGE 288. *The cenotes of the Mayan Riviera provide an opportunity to enter the habitat of the Mexican or Morelet's crocodile, a very attractive encounter for adventurers who enjoy watching wildlife.* (LJS)

aulipas to the Yucatan Peninsula and southward into South America. Morelet's crocodile, which can measure up to 4 m long, inhabits the wetlands of Chiapas and the Yucatan Peninsula and south to Central America. The spectacled caiman has pointed scales on top of each eye, which gives it its name. In Mexico, it is found only along the coasts of Chiapas, where it was identified during the mid-20th century. Its range extends into South America. The American alligator is an occasional species of the Bravo or Grande River delta in Tamaulipas, but apparently does not have any resident populations in Mexico.

The pelt industry began using crocodile skins in the 19th century, and after the Second World War the demand increased significantly for use in purses, shoes, belts, and jackets. Crocodile skin apparel was in fashion while the skin of caimans was not used because it was considered to be of poor quality. Crocodiles were hunted primarily at night; cocodrileros or crocodile hunters, blinded them with powerful lamps and killed them with rifles, harpoons, and sticks. Even during the day, they were stalked and hunted. Mexico became the main exporter of crocodile skin for the United States market. The unprocessed skins were sold for a very low price and readied for shipping to major commercial centers such as Tenosique and Tuxtla Gutiérrez in Chiapas; Culiacán, in Sinaloa; and the city of Veracruz in Veracruz. In his book Los reptiles de Chiapas, Álvarez del Toro describes the hundreds of "cemeteries" with rotting crocodile remains. In Chiapas state alone, more than one thousand skins were harvested every month. Tens of thousands of skins were exported annually and the uncontrolled exploitation reduced populations throughout the country.

The market for crocodile skins was very lucrative, and pushed by the growing global demand for reptile skins, the crocodile populations in the Amazon, Nile, and other river systems from Africa to southeast Asia declined precipitously. By the end of the 1950s, populations of most of these reptile species, once so abundant, were seriously threatened throughout the world and some, such as the Morelet's crocodile, were on the verge of extinction.

Alarmed by the rapid disappearance of these reptiles, naturalists Álvarez del Toro and Gonzalo Pérez Higareda, and biologist Gustavo Casas Andreu, pioneered studies of their ecology and conservation strategies. Additionally, the Crocodile Specialist Group (CSG) of the International Union for the Conservation of Nature (IUCN) was founded in 1971 and it initiated aggressive conservation

The populations of Morelet´s crocodile have recovered thanks to multiple efforts of population management based on breeding centers located in Campeche, Tabasco, Chiapas, Oaxaca and Colima. The crocodile's recovery is another example of the success in safeguarding threatened species. (above, JDBP; right, IMOC)

programs. Internationally, many governments implemented measures to stop the indiscriminate hunting, and in 1979 the Mexican government decreed a total ban on the harvesting of all species of wild crocodiles in the country. Since then, they have been protected in their habitat and the establishment of crocodile farms for commercial and conservation purposes was promoted. The protection of the American, and Morelet's crocodile and spectacled caiman by national legislation has enabled their populations to reach more than 100,000 individuals.

In 2011, the National Commission for the Knowledge and Use of Biodiversity (CONABIO) published the Morelet's Crocodile Monitoring Program: Mexico, Guatemala and Belize, which implements the evaluation and monitoring of populations in the three countries, an unprecedented program that several countries have used as a model. In a joint effort with the United States and the the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), Mexico, through CONABIO, successfully down listed the Morelet's crocodile to Appendix II of the CITES, allowing its controlled use. CONABIO also worked with dozens of producers throughout the country to promote the recovery of wild populations and ensure the sustainable use of animals produced in captivity.

Today, captive breeding programs produce about three thousand individuals annually, destined to the sale of skins in the international markets of high fashion. Thanks to these achievements, the pelt trade is no longer a threat, but an incentive for its conservation and reproduction. Despite this, it is still necessary to move forward on other fronts. Its conservation in the long term involves avoiding the destruction and contamination of their habitat, ilegal hunting and climate change.

The establishment of natural protected areas was crucial for the recovery of these reptiles. For example, when the Chamela-Cuixmala Biosphere Reserve (on the Jalisco coast) was established in 1993, there were fewer than 100 American crocodiles. At that time, I carried out a census with biologist Andrés Garcia, in which after long nights of work only a few crocodiles were seen. I distinctly remember day in 1996 when we saw an idividual almost 4 meters long. Today, the population numbers more than 600 and the larger ones are 5 m long. In Chamela-Cuixmala, as in many other wetland regions in the country, crocodile populations have returned to their ancestral environments, bringing with them the hope for a brighter future.

Gerardo Ceballos

Harbor seal in San Benito Island, off the coast of Baja California.

Gerardo Ceballos and Eduardo Ponce

EPILOGUE

The majestic Sierra Madre Occidental, which extends from Michoacán to Chihuahua in the western part of the country, is a symbol of the enormous natural wealth of Mexico and how humans can both degrade and protect our environment. Considered as one of the longest and most biologically important mountain ranges of the world, it has extensive forests and deep hollows, like that seen in Barrancas del Cobre, in Chihuahua. These forests once sheltered the ivory-billed woodpecker, the largest woodpecker in the world. Unregulated and illegal logging and other poor forestry practices and indiscriminate hunting led to its demise. The last sighting of this magnificent and unique bird occurred in 1956, its characteristic squawking disappeared forever and the palette of sounds of the Sierra Madre Occidental changed completely.

Sadly, the story of the extinction of the ivory-billed woodpecker is only one of many, the product of human population growth and its negative impact on the environment, overexploitation of natural resources, pollution, and inappropriate production strategies for food and other commodities. The massive loss of populations and species of plants and animals reflect the lack of understanding and appreciation of our interdependence with the natural world and our lack of empathy with the wild species that have accompanied human evolution. The decline of wild populations and extinction of species is a symptom of the deterioration of natural systems that support human civilization, and it is a prelude to more ominous events unless we act decisively to modify those aspects of human behavior that endanger our own survival. Environmental deterioration, exemplified by challenges such as climate change, destruction of natural environments, and species extinction is probably the most significant challenge humanity has faced in its entire history. Humanity is endangering the characteristics and quality of its own support, the web of life of planet Earth.

There are many reasons why we should protect our natural world and its processes: ethical, moral, philosophical, religious and economic. For humans, the most important is our survival; that the conditions that make life on Earth possible depend on wildlife and plants and the complex of biological processes of which they are an integral part. Wild plants and animals provide humans with environmental services such as a balance of atmospheric gases, the quality and quantity of drinking water, and the pollination of crops. Whenever we lose a population of wildlife, Earth's capacity to maintain human well-being decreases. However, the destruction of nature is not a preordained destiny. In this book, we present success stories of the efforts and commitment of people, organizations and institutions to protect and safeguard the biodiversity and the environments which support it. Tempered by the reality of the enormous task citizens of the word must undertake, the message is one of hope, optimism and opportunity to answer the call for a healthier planet. The impressive success of some conservation projects, like the ones supported by the Carlos Slim Foundation - WWF Alliance, are proof that it is possible to reconcile conservation and development needs while maintaining the biological resources of the country. Earth is our home and we have a responsibility to take care of it; we owe it to ourselves, future generations, and other living creatures with which we share this magnificent home, our Earth.

Common and scientific names

Abele • *Populus* spp.
Agave • *Agave* spp.
Agouti • *Dasyprocta* spp.
Alfalfa/Lucerne • *Medicago sativa*
American Alligator • *Alligator mississippiensis*
American Bison • *Bison bison*
American Crocodile • *Crocodylus acutus*
American Flamingo • *Phoenicopterus ruber*
American lion • *Panthera leo atrox*
American Manatee • *Trichechus manatus*
Aplomado Falcon • *Falco femoralis*
Ash • *Fraxinus* spp.
Atlantic Horseshoe Crab • *Limulus polyphemus*
Baird's Tapir • *Tapirus bairdii*
Barbary Sheep • *Ammotragus lervia*
Barisia lizard • *Barisia imbricata*
Basking Shark • *Cetorhinus maximus*
Beaded lizard • *Heloderma horridum*
Bigeye Trevally • *Caranx sexfasciatus*
Bighorn Sheep • *Ovis canadensis*
Black Bear • *Ursus americanus*
Black Howling Monkey • *Alouatta pigra*
Black Jackrabbit • *Lepus insularis*
Black Sea Turtle • *Chelonia agassizii*
Black Vulture • *Coragyps occidentalis*
Black-bellied Whistling Duck • *Dendrocygna autumnalis*
Black-tailed Prairie Dog • *Cynomys ludovicianus*
Blue Agave • *Agave tequilana*
Blue Whale • *Balaenoptera musculus*
Blue-crowned Chlorophonia • *Chlorophonia occipitalis*
Blue-footed Booby • *Sula nebouxii*
Bobcat • *Lynx rufus*
Brent Goose • *Branta bernicla*
Bromeliad • *Bromelia* spp.
Brown Booby • *Sula leucogaster*
Brown Pelican • *Pelecanus occidentalis*
Buffelgrass • *Cenchrus ciliaris*
Bull Shark • *Carcharhinus leucas*
Burrowing Owl • *Athene cunicularia*
California Condor • *Gymnogyps californianus*
Californian Sea Lion • *Zalophus californianus*
Caribbean Spiny Lobster • *Panulirus argus*
Cat • *Felis silvestris catus*
Catalana Desert Iguana • *Dipsosaurus dorsalis catalinensis*
Central American Red Brocket • *Mazama temama*
Chestnut-colored Woodpecker • *Celeus castaneus*
Chuckwallas • *Sauromalus* spp.
Clarion Angelfish • *Holacanthus clarionensis*
Clarion Island Tree Lizard • *Urosaurus clarionensis*
Coastal Cholla • *Cylindropuntia prolifera*
Coastal Spotted Dolphin • *Stenella attenuata*
Coffee Plant • *Coffea* spp.
Collared Peccary • *Pecari tajacu*
Common Barn-owl • *Tyto alba*
Common Minke Whale • *Balaenoptera acutorostrata*
Common Raven • *Covoux corax*
Cope's Skink • *Plestiodon copei*
Coral Hawkfish • *Cirrhitichthys oxycephalus*
Cotton • *Gossypium* spp.
Coues Whitetail • *Odocoileus virginianus couesi*
Cougar • *Puma concolor*
Cow/Bull • *Bos primigenius taurus*
Coyote • *Canis latrans*
Cozumel raccoon • *Procyon pygmaeus*
Crested Guan • *Penelope purpurascens*
Crown-of-thorns Starfish • *Acanthaster* spp.
Domestic Dog • *Canis lupus familiaris*
Domestic Pig • *Sus scrofa domesticus*
Dragon Fruit • *Hylocereus undatus*
Elegant Tern • *Thalasseus elegans*
Elkhorn Coral • *Acropora palmata*
Emerald Toucanet • *Aulacorhynchus prasinus*
European Rabbit • *Oryctolagus cuniculus*
Extinct Western Camel • *Camelops* spp.
False Killer Whale • *Pseudorca crassidens*
Fer-de-Lance • *Bothrops asper*
Fin Whale • *Balaenoptera physalus*
French Angelfish • *Pomacanthus paru*
Frogfish • *Antennarius commerson*
Giant Kelp • *Macrocystis pyrifera*
Giant Manta Ray • *Manta birostris*
Giant North American Bison • *Bison latifrons*
Golden Cownose Ray • *Rhinoptera steindachneri*
Golden Eagle • *Aquila chrysaetos*
Grass • *Plantago tolucensis*
Gray Whale • *Eschrichtius robustus*
Grayish Mouse Opossum • *Tlacuatzin canescens*
Great Horned Owl • *Bubo virginianus*
Great White Egret • *Egretta alba*
Great White Shark • *Carcharodon carcharias*
Greater Grison • *Galictis vittata*
Green Turtle • *Chelonia mydas*
Grey Fox • *Urocyon cinereoargenteus*
Grizzly Bear • *Ursus arctos*
Guadalupe Fur Seal • *Arctocephalus townsendi*
Guadalupe Storm Petrel • *Hydrobates macrodactylus*
Gulf of California Harbour Porpoise • *Phocoena sinus*
Hammerhead Shark • *Sphyrna* spp.
Harbor Seal • *Phoca vitulina*
Hawksbill Turtle • *Eretmochelys imbricata*
Heermann's Gull • *Larus heermanni*
Horned Guan • *Oreophasis derbianus*
Humpback Whale • *Megaptera novaeangliae*
Imbricate Alligator Lizard • *Barisia imbricata*
Ivory-billed Woodpecker • *Campephilus imperialis*
Jaguar • *Panthera onca*
Jaguarundi • *Herpailurus yagouaroundi*
Jamaican Fruit-eating Bat • *Artibeus jamaicensis*
Juniper • *Juniperus* spp.
Kapok Tree • *Ceiba pentandra*
Kemp's Ridley • *Lepidochelys; kempii*
Killer Whale • *Orcinus orca*
King Vulture • *Sarcoramphus papa*
Kit Fox • *Vulpes macrotis*
Leatherback Turtle • *Dermochelys coriacea*
Lesser long-nosed Bat • *Leptonycteris yerbabuenae*
Lignum vitae • *Guaiacum* spp.
Loggerhead Sea Turtle • *Caretta caretta*
Long-nosed Bat • *Leptonycteris* spp.
Long-tailed Wood-Partridge • *Dendrortyx macroura*
Magdalena Wood Rat • *Xenomys nelsoni*
Magnificent Frigatebird • *Fregata magnificens*
Mahogany Tree • *Swietenia* spp.
Maize/Corn • *Zea mays*
Margay • *Leopardus wiedii*
Mew Gull • *Larus canus*
Mexican Flying Squirrel • *Glaucomys volans*
Mexican Grizzly Bear • *Ursus arctos nelsoni*
Mexican Lookdown • *Selene brevoortii*
Mexican Parrot Snake • *Leptophis mexicanus*
Mexican Pronghorn • *Antilocapra americana peninsularis*
Mexican Wolf • *Canis lupus baileyi*
Military Macaw • *Ara militaris*
Minkley's Cichlid • *Herichthys minckleyi*
Monarch butterfly • *Danaus plexippus*
Montezuma Leopard Frog • *Lithobates montezumae*
Morelet's Crocodile • *Crocodylus moreletii*
Mule Deer • *Odocoileus hemionus*
Nassau Grouper • *Epinephelus striatus*
Nevado de Toluca salamander • *Ambystoma rivulare*
Nine-banded Armadillo • *Dasypus novemcinctus*
North American Porcupine • *Erethizon dorsatum*
Northern Elephant Seal • *Mirounga angustirostris*
Northern Raccoon • *Procyon lotor*
Nurse Shark • *Ginglymostoma cirratum*
Oak • *Quercus* spp.
Ocellated Turkey • *Meleagris ocellata*
Ocelot • *Leopardus pardalis*
Olive Ridley • *Lepidochelys olivavea*
Ornate Hawk-Eagle • *Spizaetus ornatus*
Osprey • *Pandion haliaetus*
Passenger Pigeon • *Ectopistes migratorius*
Pearl Oyster • *Pinctada* spp.
Peregrine Falcon • *Falco peregrinus*
Pine tree • *Pinus* spp.
Potosí Pupfish • *Megupsilon aporus*
Pygmy Spotted Skunk • *Spilogale pygmaea*
Queen Conch • *Lobatus gigas*
Ray/Mobula • *Mobula* spp.
Red-capped Manakin • *Ceratopipra mentalis*
Red-footed Booby • *Sula sula*
Red-tailed Hawk • *Buteo jamaicensis socorroensis*
Resplendent Quetzal • *Pharomachrus mocinno*
Revillagigedo Burrowing Owl • *Athene cunicularia rostrata*
Revillagigedo Sea Chub • *Kyphosus lutescens*
Ridged Treefrog • *Hyla plicata*
Roberts' False Brook Salamander • *Pseudoeurycea robertsi*
Rock Wren • *Salpinctes obsoletus exsul*
Roseate Spoonbill • *Platalea ajaja*
Ross' Rhynchostele • *Rhynchostele rossii*
Royal Tern • *Thalasseus maximus*
Rufous-tailed Hummingbird • *Amazilia tzacatl*
Saber-toothed tiger • *Smilodon* spp.
Sacred Fir • *Abies religiosa*
Saguaro Cactus • *Carnegiea gigantea*
San Lorenzo Island Rattlesnake • *Crotalus ruber lorenzoensis*
Santa Catalina Island Rattlesnake • *Crotalus catalinensis*
Sapodilla • *Manilkara zapota*
Scarlet Macaw • *Ara macao*
Sea Otter • *Enhydra lutris*
Seahorse • *Hippocampus* spp.
Sheep Fescue • *Festuca ovina*
Short-beaked Common Dolphin • *Delphinus delphis*
Socorro Dove • *Zenaida graysoni*
Socorro Elf Owl • *Micrathene whitneyi graysoni*
Socorro Island Tree Lizard • *Urosaurus auriculatus*
Socorro Mockingbird • *Mimus graysoni*
Socorro Parakeet • *Psittacara holochlora brevipes*
Sotol • *Dasylirion* spp.
Spectacled Caiman • *Caiman crocodilus*
Sperm Whale • *Physeter macrocephalus*
Spider Monkey • *Ateles geoffroyi*
Spike Trisetum • *Trisetum spicatum*
Spotted Eagle Ray • *Aetobatus narinari*
Stauffer's Treefrog • *Scinax staufferi*
Sugar Cane • *Saccharum officinarum*
Sycamore Fig • *Ficus sycomorus*
Tanager • *Tangara* spp.
Tayra • *Eira barbara*
Texas White-tailed Deer • *Odocoileus virginianus texanus*
The San Quintin Kangaroo Rat • *Dipodomys gravipes*
Toluca-stream Siredon • *Ambystoma rivulare*
Townsend's Shearwater • *Puffinus auricularis auricularis*
Trogon • *Trogon* spp.
Tule • *Schoenoplectus* spp.
Violet Sabrewing • *Campylopterus hemileucurus*
Volcano Rabbit • *Romerolagus diazi*
Water Hyacinth • *Eichhornia crassipes*
Whale Shark • *Rhincodon typus*
White-lipped Peccary • *Tayassu pecari*
White-nosed Coati • *Nasua narica*
White-tailed Deer • *Odocoileus virginianus*
White-winged Dove • *Zenaida asiatica*
Wild Goat • *Capra aegagrus*
Wild Sheep • *Ovis orientalis aries*
Wild Turkey • *Meleagris gallopavo*
Yellow Treefrog • *Dendropsophus microcephalus*
Yellow-headed Parrot • *Amazona oratrix*
Yucatan Banded Gecko • *Coleonyx elegans*
Yucatan Brown Brocket • *Mazama pandora*
Yucca • *Yucca* spp.

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AUGMENTED REALITY

In this book of the editorial series of TELMEX, presents once again the Infinitum Augmented Reality. This technology is experiencing major expansion and offers the reader access and additional information besides that presented in a video, audio or 3D Model.

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In this book the images in which you can enjoy Infinitum Augmented Reality are identified by the symbol **RA** in the following pages:

- Cover
- Page 53
- Page 119
- Page 178
- Page 224

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