NATURAL WEALTH OF MEXICO

environmental services and conservation

Gerardo Ceballos
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RA infinitum

Protection and conservation of the environment

The Carlos Slim Foundation and TELMEX support a wide strategy of biodiversity conservation and the sustainable development of Mexico. Therefore, strategic alliances have been established with the World Wildlife Fund (WWF), the Secretary of the 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 Protected Natural Areas (Conanp), amongst other equally relevant.

We highlight in this program the work carried out with the WWF in 6 regions of the country (Gulf of California, Chihuahua Desert, the Monarch Butterfly Biosphere Reserve, Oaxaca, Chiapas and the Mesoamerican Reef System), where 18 priority areas are grouped together.

Also, the Carlos Slim Foundation and TELMEX joined efforts since 2005 to support the national strategy for the conservation of jaguars and reduce the impact of the activities that threaten it, based on compatible policies to the sustainable development of each region. To date, eight national and an international symposia have been held and that have analyzed the jaguar problem and solutions and actions have been proposed for its conservation.

On the other hand, nine books have been published that disseminate topics on the biological diversity of Mexico, America and the world, their natural wealth, importance and threats they face and possibilities for its conservation in the long term.

Book I. Tierra mexicana: selvas, desiertos y mares (2007)
Book II. Naturaleza mexicana: legado de conservación (2008)
Book III. Fauna mexicana: esplendor de la naturaleza (2009)
Book IV. Los felinos de América: cazadores sorprendentes (2010)
Book V. Animales amenazados de América: el reto de su sobrevivencia (2011)
Book VI. Animales de América: migraciones y grandes concentraciones (2012)
Book VII. Mamíferos del Mundo: regiones biogeográficas (2013)
Book VIII. Áreas naturales de México: legado de conservación (2014)
Book IX. Los mares de México y del Mundo (2015)
Book X. Natural Wealth of Mexico,: environmental services and conservation (2016)

The Carlos Slim Foundation and TELMEX ratify their commitment with the natural surroundings and environment.

FUNDACIÓN Carlos Slim

TELMEX® está contigo

Cover: Flamingo with chick. © Claudio Contreras Koob
Back cover: La Venta Canyon, El Ocote, Chiapas. © Jorge Silva

NATURAL WEALTH OF MEXICO

environmental services and conservation

Nature... will only be saved if man loves it,
simply because it is beautiful...
For that, too, is an integral part of the
human soul.

Before Nature Dies
Jean Dorst

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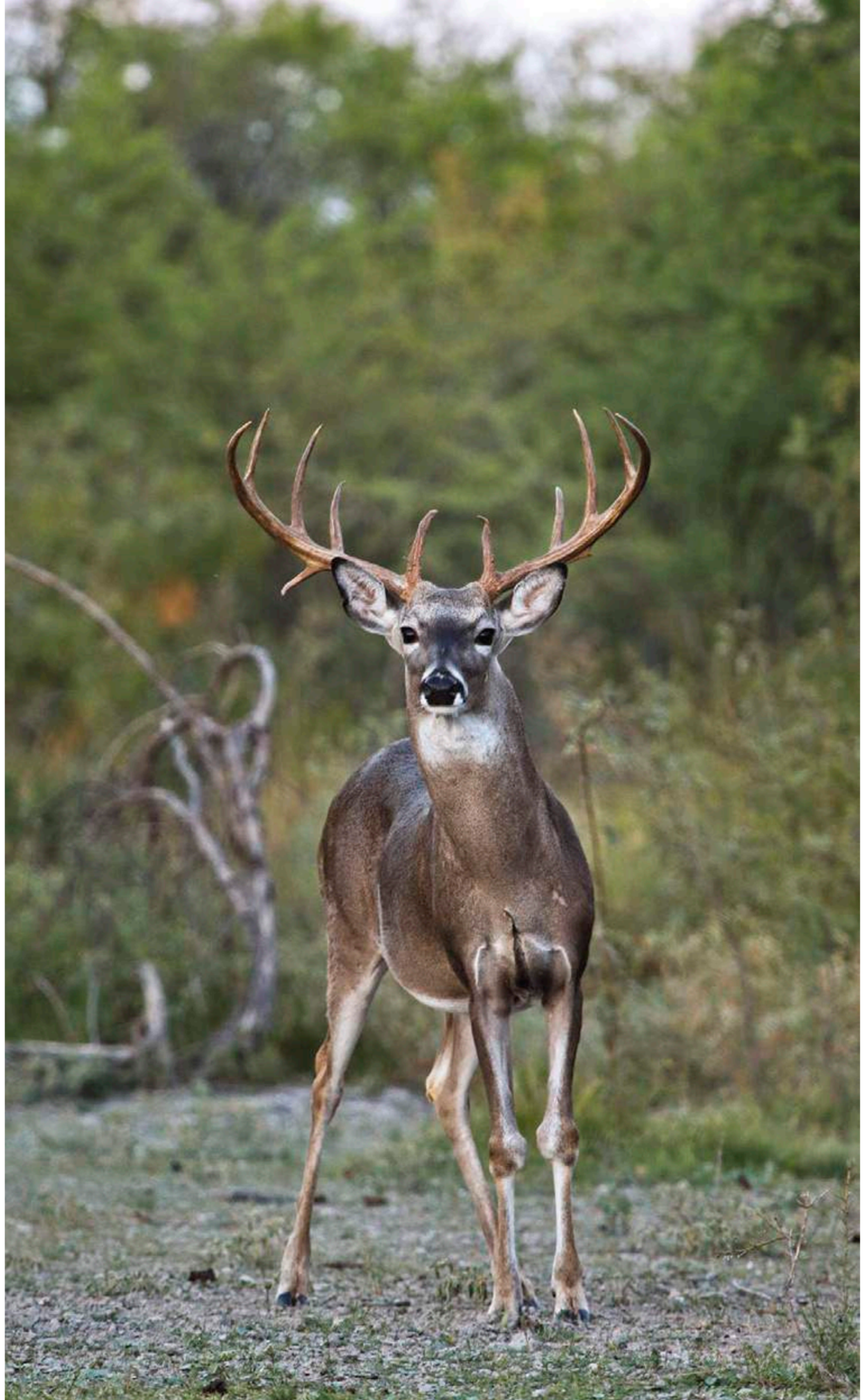
CONTENTS



PRESENTATION

Mexico is not only rich for its vast culture, history and traditions, but also for its unique life forms. Its biodiversity is its matter of pride and one of the greatest responsibilities it possesses. Maintaining the health of its ecosystems and wildlife is imperative to ensure that these life forms, which underwent millions of years of evolution, continue thriving alongside humankind. All forms of life from bacteria and fungi to plants and animals play an important role in the proper functioning of our ecosystems. These, provide us with all the necessary resources and environmental services that allow our own subsistence; from the air we breathe to the raw materials necessary for the manufacture of tools and clothing, and the oil that once upon a time was slowly transformed from plants, animals, and microorganisms into one of the most valuable fuels we depend on.

We are in the midst of one of the greatest global crises of devastation in our planet. We must act now before reaching the point of no return. This year marks the 23th anniversary of the implementation of the Convention on Biological Diversity included within the framework of the UN's Earth Summit held in Rio de Janeiro in 1992; which recognizes that the conservation of biological diversity is "a common concern for all humanity" and an integral part of the development process.

Mexico is one of the member countries taking action to achieve this colossal objective. Natural Protected Areas, The List of Endangered Species and the Environmental Management Units (UMA) are its main axis to achieve this task. During 2016, Mexico will hold the XIII Conference of the Parties (COP -13), where progress towards its objectives will be reviewed and new local and global actions will be proposed.

In view of the foregoing, this book has as main goal to promote the beauty of the natural resources of Mexico, as well as the urgent need of its conservation. This is the tenth volume of a solid editorial program of Telefonos de Mexico (TELMEX) that has become a benchmark in matters of promoting Mexico's nature and biodiversity. And which reinforces the activities that the Carlos Slim Foundation has developed for the protection and conservation of the environment, including the strategic alliance signed with the World Wildlife Fund for Nature (WWF) in 2003, covering six priority regions in the National Territory (the Mesoamerican Coral Reef, the Chihuahuan Desert, the Gulf of California, the Monarch Butterfly, Oaxaca, and Chiapas) as well as Climate Change and the conservation of the Mexican Jaguar through 95 projects.

These activities highlight the importance of the collaboration between The Secretariat of Environment and Natural Resources (SEMARNAT) and The Mexican Secretariat of National Defence (SEDENA), which has had a significant contribution in the production of trees, reforestation activities, treatment of residual water, use of compostable materials, and fire fighting programs. It is also worth noting the recent creation of the Environmental Gendarmerie by the Federal Government, which joins the task of the country's Natural Protected Areas.

With these actions, Carlos Slim Foundation and Telmex declare their commitment to building a better future for all Mexicans.

Héctor Slim Seade
Chief Executive Officer
Telmex

Prologue

SECRETARIAT OF ENVIRONMENT AND NATURAL RESOURCES

SEMARNAT
SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES

Our country is renowned worldwide for harbouring an exceptional natural capital. It is one of the five countries with highest biological diversity and the second with the largest variety of ecosystems. It is remarkable that it maintains more than 10% of all known species in only 1% of the Earth's surface.

Mexico is considered a megadiverse country along with Colombia, Ecuador, Peru, Brazil, Congo, Madagascar, China, India, Malaysia, Indonesia and Australia. It has the second highest number of reptiles, it is third in the number of mammals, and fifth in number of vascular plants and amphibians. Coupled with this, a considerable percentage of its biodiversity cannot be found anywhere else in the world; in other words, there is a high number of species endemic to Mexico, as a result of factors such as microclimates, geography, and evolutionary history. For example, nearly 31% of its mammals and over 55% of its conifers are endemic to Mexico.

Because of the natural wealth, we enjoy goods and services, such as air and water purification, flood and drought mitigation, soil generation and conservation, crop pollination, seed dispersal, cycling and movement of nutrients, protection of coastal erosion from sea level rise, and the stabilisation of the climate.

So, it is in our best interest to maintain Mexico's diversity of ecosystems, its biological and cultural richness, and the environmental goods and services. The conservation of these assets is fundamental for the country's and citizens' develop-

ment , and to which the Government of President Enrique Peña Nieto has pledged as high priority in matters of environmental policy.

With the approval of the Strategic Plan for Biological Diversity 2011-2020 and the Goals of Aichi, Mexico formally confirmed its commitment to the international community to increase, by 2020, the protection of its land and continental waters in natural reserves to at least 17% and 10% of its coastal and marine areas. That is the goal to achieve by the Present Administration by 2018.

The challenge to conserve Mexico's ecosystems and to achieve a sustainable use of its natural resources requires joint efforts of all three levels of government, civil society organizations, academic institutions, private corporations, and local communities inhabiting the natural areas and its buffer zones.

In December of this year, Mexico will be hosting the XIII Conference of the Parties (COP 13) to the Convention on Biological Diversity, which main topic will be the integration of conservation and the sustainable use of biodiversity. The integration of biodiversity is defined as the process of internalization of conservation and sustainable use of biological diversity in the plans, programs and sectoral and intersectoral policies. This implies that biodiversity needs to be an integral part of the sectors to maintain the health and resilience of the ecosystems,so that such ecosystems continue to provide the services vital to the survival of the diversity of life in our planet.

Our biological diversity must be treasured and protected; it should be wisely used and restored when necessary, for it is the key to ensure human well-being and to reduce poverty. The integration of biodiversity will contribute to achieve the sustainable development objectives and the 2030 agenda of the United Nations.

I am delighted to present the book *Natural Wealth of Mexico: environmental services and conservation*. The book is part of the Telmex series of books on environmental issues and a great example of the company's effort to contribute to the knowledge and dissemination of the value of Mexico's main natural resources. It represents a suitable approach in view of the Conference of the Parties COP 13.

I am confident that with its more than 300 pages and splendid photographs, readers will find new motivation to join the efforts to protect our natural resources.

Rafael Pacchiano Alamán
Secretary of Environment
and Natural Resources

To advocate the values and importance of conserving the environment, the Secretariat of National Defence organizes tree-planting programmes in schools.

THE MEXICAN SECRETARIAT OF NATIONAL DEFENCE IN THE PROTECTION OF THE ENVIRONMENT

The Mexican Secretariat of National Defence (SEDENA) coordinates actions for the conservation and improvement of the environment with The Secretariat of Environment and Natural Resources (SEMARNAT) and The National Forestry Commission of México (CONAFOR). Mainly, with the production of trees and the reforestation of areas affected by excessive logging, pests, diseases, fires and population increase; the latter causes the establishment of housing areas and industries that affect wildlife and disturb the biodiversity in the Mexican territory.

In an effort to recover Mexican woodlands, the National Reforestation Program was launched in 1992 as a permanent and socially targeted agenda accounting the importance of public participation. It´s objective is the sustainable development of forests and jungles to create employments and to build a common heritage that is used to directly benefit the local population and humanity. As an active participant, SEDENA contributed to the positive results in coordination with the dependencies that at that moment were in charge of the forestry sector.

The strategies of CONAFOR to tend the forestry sector are highlighted by the need of inclusion of all participants and the coordination among dependencies that relate to the rural development. With the aim of aligning programs, pooling resources, and take maximum advantage of the synergies and competencies existing for the use, conservation, and recovery of environmental resources.

TOP *SEDENA contributes to the conservation of the environment, ecological balance, and public health with waste water treatment plants in military camps, recharge of ground water and water saving plans.*

BOTTOM *The Secretariat of National Defence, The Secretariat of Environment and Natural Resources, and The National Forestry Commission of Mexico have a sexennial goal of producing 360 million trees and reforesting 6 million trees within military premises.*

At the beginning of the current administration, agreements were signed by SEDENA, SEMARNAT and CONAFOR to participate and coordinate in the activities of the National Forestry Program (PRNAFOR), which manages 25 military tree nurseries, to reach a sexennial production of 360,000,000 trees and the reforestation of 6 million trees in natural protected areas, national parks and military premises. In addition, the production of fruit and ornamental trees was agreed as an effort of the Presidency to contribute in The National Crusade Against Hunger.

In order to comply with the applicable regulations referring to the maximum limits allowed for water discharge to urban or municipal sewers and its reuse in public services, SEDENA has 207 water treatment plants in military fields and military housing units that process approximately 16 million cubic meters of residual water every year; treated water is mostly used to irrigate green areas.

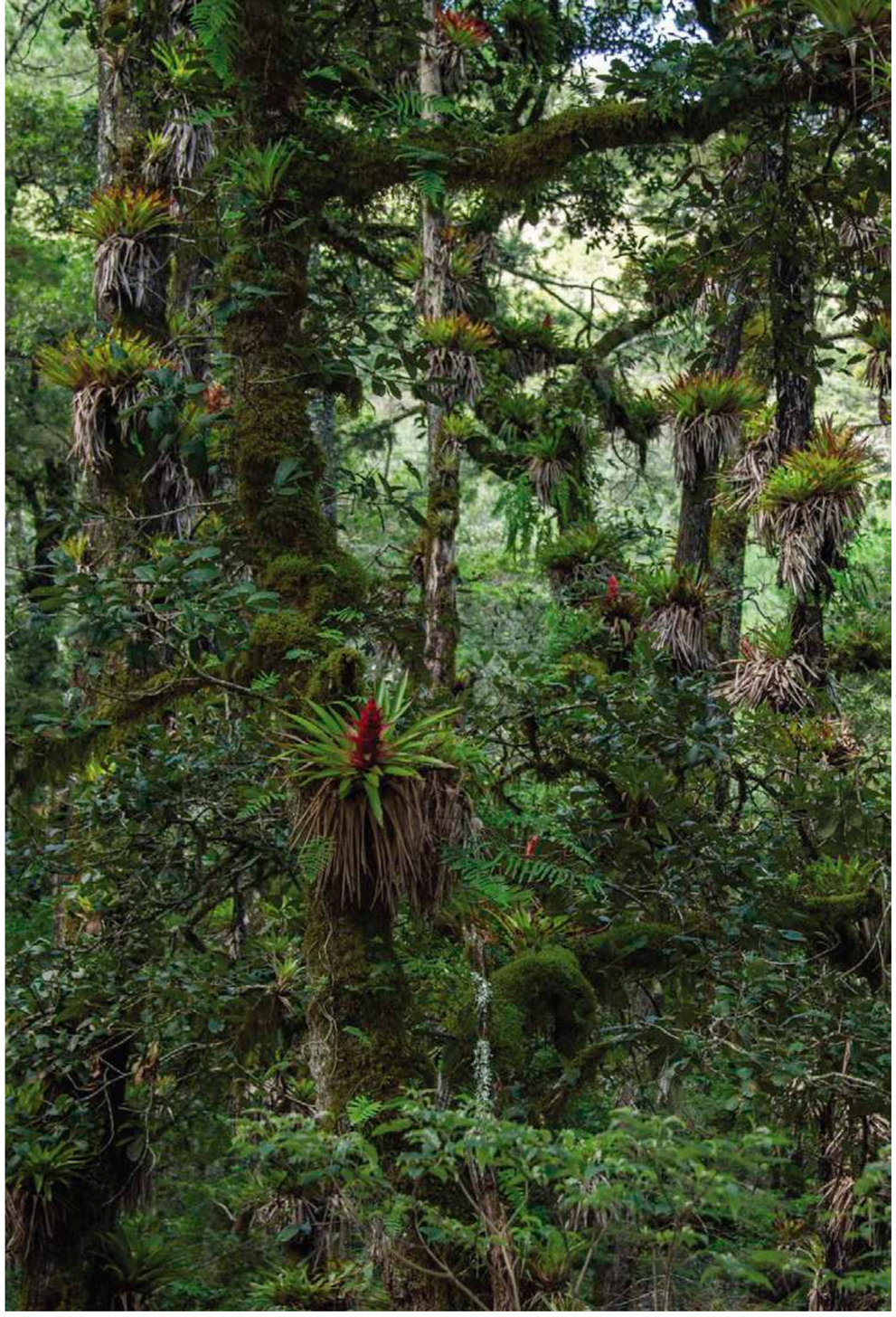
To use the organic waste generated in military camps, 55 compost plants actively process residues and produce organic fertilizer that is used on site in an effort to return nutrients to the land, control erosion, prevent soil depletion caused by rain, increase water retention, and the act as a antibiotics for harmful microorganisms.

Every year in the dry season, numerous fires occur across the National Territory threatening the life of people and the preservation of biodiversity. SEDENA collaborates with CONAFOR to mitigate the impacts of this problem. In the last three years, the fire brigade troops controlled fires that occurred in the states of Chiapas, Yucatan, Coahuila, and the State of Mexico. Helicopters equipped with bambi buckets successfully delivered water to areas with difficult access.

The conservation and sustainable use of forests is a strategic priority to contribute to the welfare of the Mexican people. These ecosystems generate environmental services and are the livelihood of a vast population. They are the basis for the maintenance of biodiversity and are valuable components in actions aimed at mitigating and adapting to Climate Change. In accordance, SEDENA complies with the provisions of article 4/o of the Constitution, which establishes that every person has the right to a healthy environment for its well-being and development; the State has to guarantee the respect for this right, endorsing its firm commitment to participate in activities for the benefit of the people of Mexico.

TOP *Helicopters of the Mexican Air Force, equipped with bambi buckets, are used to combat forest fires; consolidating the effort of the Federal Executive Power in actions to benefit the population.*

BOTTOM *The Secretariat of National Defence uses available human material resources to combat forest fires.*



Gerardo Ceballos and Paul R. Ehrlich

BIOLOGICAL DIVERSITY AND ENVIRONMENTAL SERVICES

In its simplest definition, biological diversity is the set of plants, animals and microorganisms of a region or the planet. The diversity of life is truly astounding and the variety of forms, sizes, colors and habits of living organisms surpass imagination. Some organisms, such as most bacteria and fungi, may consist of a single cell and are not visible to the unaided eye, while at the other extreme, many organisms consist of trillions of cells and a few are enormous in size, the blue whale, the largest animal that has ever existed. The life cycle of some bacteria can be measured in minutes while some trees live for thousands of years. Despite the enormous scientific advances and use of increasingly sophisticated technology, the number of distinct kinds (species) that currently exist on Earth is not known. Some estimates suggest the number is between 15 million and 100 million, and this wide variation in number is another complicating factor in the conservation challenges we face today.

Only about 2 million species of plants, animals and microorganisms have been described scientifically. This number increases by about 18,000 each year, and at this pace it would take more than 700 hundred years to describe the lower estimate of the remaining species. With the exception of most of our domesticated food sources (plants, animals), many of the well-known animal and plant groups with which we share the planet and on which we depend for goods and services

are not fully described. We are often surprised at the magnitude of the discoveries of groups of conspicuous and supposedly well-known animals. For example, 10% of the known mammals, charismatic animals with whom we have a close evolutionary relationship, were described as between the years 1993 and 2006. Both the scientific and general community at large share in the excitement and surprise when new discoveries are made and often celebrate their beauty, peculiar characteristics or rareness. Some examples of recent discoveries that garnered widespread public attention were the Burma leaf deer, the smallest deer in the world weighing only 8 kilos; a new species of fanged frog, endemic to Sulawesi, Indonesia, that, unlike other frog species, gives birth to tadpoles; the Aragualan pink dolphin that inhabits freshwater river basins of Brazil; and the Deraniyagala's beaked whale from the Pacific Ocean. Among the numerous discoveries recently in Mexico are two magnolia species (seen in photos before being scientifically describe), the highly vulnerable emerald horned pit viper, referred to as "torito" (little bull) by locals, in the endangered cloud forests of the Sierra Madre Oriental in Veracruz; and the Chiapas catfish, a member of a new family of catfish, in the Usumacinta River basin in Chiapas.

Megadiverse countries

The distribution of native plants and animals on the planet is heterogeneous and the result of a complex interaction of multiple factors such as evolutionary history, geology, soil, climate, altitude and latitude. The geographic pattern of plant and animal communities, recognized centuries ago, was fundamental to the development of the theory of evolution based on natural selection, first advanced by Charles Darwin and Alfred Wallace in the middle of the 19th century. Since that time eight biogeographic regions or realms have been recognized, characterized by peculiar faunas and floras, which are the result of their geographic location and their geologic and evolutionary histories. These biogeographic regions are the Nearctic (North America to the center of Mexico); Neotropical (southern Mexico to South America); Palearctic (Europe, Asia and northern Africa); Oriental (Asia to the southern edge of the Himalayas); Ethiopian (Africa to the southern edge of the Sahara); Australian (Australia and New Guinea); Oceanic (Oceanic Islands); and Antarctica. In this biogeographic division of the world, Mexico is unique as the only country that incorporates two regions, the Nearctic and the Neotropical. Consequently, Mexico's fauna and flora are a mix of temperate and tropical species.

In 1998, Conservation International, an environmental conservation organization, identified the 12 countries, referred as Megadiverse countries, that have 60% to 70% of all the biological diversity of the world's terrestrial surface. The exceptional biological wealth of these countries, generated through billions of years of evolution, is a treasure for all humanity. Mex-

Cacti are a symbol of diversity in Mexico; these plants show extraordinary adaptations by thriving in the most arid and inhospitable places in the country.

ico, with 28 thousand species of vertebrates and plants, is the fifth most species-rich country. The only countries, which exceed Mexico in diversity, are Brazil, Peru, Colombia, Indonesia, and China. Of these five countries, Mexico has the smallest landmass.

Megadiverse Mexico

To understand the magnitude of Mexico's biological diversity, it is important to note that number of plant and animal species is much greater than one would expect based on the size of the country. Mexico occupies only 1% of the Earth's landmass but it has approximately 10% of all plant and animal species. With the exception of polar climate, all of the major climate types can be found in Mexico. Climate, geography, topography, and geologic history provide conditions for the development of different ecosystems such as arid scrubland, grasslands, temperate pine, fir, and oak forests, mangroves, tropical dry and rain forests(and the spectacular biodiversity rainforests support). Shaped by the waters of the Pacific and Atlantic oceans, the Caribbean Sea and the Sea of Cortez, Mexico's coastline of more than 11,000 kilometers is a complex of numerous shallow and deep-water marine ecosystems. Some parts of the coastal marine environment have unique features such as hydrothermal vents where boiling water wells up from volcanic activity or where tectonic plates meet. The extensive fields of sea grass in the coastal areas of Campeche and the numerous large lagoons and estuaries, such as Laguna de Terminos in Campeche and Laguna Madre in Tamaulipas, are critical habitats that support a vast array of marine life and significant economic activities. The Mesoamerican Barrier Reef, stretching for about 1,000 kilometers from Quintana Roo to Honduras, is the largest reef in the western hemisphere and the second longest continuous reef in the world. Mexico boasts more than 1,000 islands and islets off its vast coastal network of habitats, many supporting unique flora and fauna, such as Guadalupe and Cedros off the Baja California coast, the hundreds of islets in the Gulf of California, the Revillagigedo and Marías archipelagos in the Pacific off the Nayarit and Colima coast, and the island of Cozumel in Quintana Roo, The freshwater ecosystems in Mexico are also biodiversity hotspots and support a vast array of uses by people, from the generation of electricity to sources of water for industries and municipalities to recreation. Some examples include Lake Chapala, the largest in Mexico (in terms of surface area), the majestic Usumacinta and Grijalva rivers, and many other types of wetlands such as marshes, estuaries, mudflats, swamps, and floodplains. Mexico has more than 142 sites designated as Wetlands of International Importance by the Ramsar Convention.

The most recent evaluation carried out by the National Commission for Knowledge and Use of Biodiversity (CONABIO –Spanish acronym) revealed that almost 100,000 animal, plant, fungi and microorganism species in Mexico have been fully catalogued. The number of species identified in Mexico is nothing short of spectacular: almost 26,000 species of plants and fungi, including the highest diversity of pine and oak trees, agave, and cactus in the world; 33,000 species of anthropoids such as beetles and spiders; 5,800 species of vertebrates including 2,833 species of marine and freshwater fish; 388 amphibian, 888 reptilian, 1,150 bird, and 555 mammal species. Mexico has the largest number of species of reptiles in the world, is fourth in the number of mammal species, and sixth in amphibians.

Megadiverse countries are also unique in the extent of endemism, meaning that they have many species restricted to the country as a result of factors such as isolation or in response to other environmental conditions. The concentration of endemic flora and fauna species is extraordinary in Mexico and there are only a few continental (non-island) areas in the world that have a higher percentage of endemic species: up to 60% of the plants (about 15,000), 67% of the amphibian, 57% of reptilian, 17% of the bird, and 27% of the mammal species are Mexican endemic.

Superlative phenomena

The richness of Mexico's biological diversity is in full display in the behavior exhibited by many species. Their behaviors, such as in nesting, sheltering, feeding and migrating are often peculiar, extraordinary and unique, and they can best be described using superlative adjectives or poetry. One of the better-known examples is the migration of the monarch butterfly, a unique mass movement of the entire population of the species. Weighing less than a gram each, these butterflies journey every winter more than 4,000 kilometers from southern Canada and northern United States to the fir-covered mountain forests in Michoacán and the State of Mexico in central Mexico, as well as a scattering of overwintering sites in coastal California and the southern fringe of the United States.. At the same time, millions of ducks and geese migrate from the colder regions in North America to feed and overwinter in the lagoons and ponds along the central and the northern coasts of Mexico. Consisting of more than 107,200 hectares of near-pristine estuaries, mangroves, and tropical forests, Mexico's Ría Celestún and Ría Lagartos Biosphere Reserves in the Yucatan Peninsula offer a winter haven for more than 15,000 flamingos which feed and rest there in one of the world's largest annual migrations of this bird species. Further north of this area, in a narrow pass between the Sierra Madre Oriental Mountains and the flat lands of Veracruz, millions of birds of prey pass each year in October on their way to South America. Known as the River of Raptors (Río de Rapaces), more than 700,000 raptors may pass over the municipalities of Chichicaxtle and Cardel, Veracruz in a single day.

Birds such as the Mexican Trogon play an important role in seed dispersal and pest control in tropical and temperate forests. Jose Mariano Mociño a remarkable Mexican naturalists form XIX century did an excellent job at documenting the diversity of birds in Mexico.

The nesting of sea turtles on local beaches is another spectacular phenomenon. The continuation of this annual event was threatened until aggressive conservation measures were put in place. Up until the 1960s, thousands of sea turtles, such as the olive Ridley came out of the water to nest on specific beaches over the course of a few days or weeks, usually about the same time every year. However, indiscriminate exploitation of the turtle eggs and the turtles themselves for meat and other threats such pollution, coastal development and the incidental capture by the fishing industry caused the populations to decrease so much that these annual nesting arrivals almost disappeared. Playa Escobilla, on the coast of Oaxaca, was the last beach where there was any large number of nesting turtles on the Pacific coast of Mexico. Concerned about the likely loss of this nesting event and the threat it presented to the well-being of the entire species, appropriate conservation policies were put in place. Fortunately, these measures have been successful and nesting populations of the olive Ridley have returned, and hundreds of thousands again come out of the sea to nest each year. Other examples of unique and spectacular phenomena are the dense concentrations of shark whales off the coast of Quintana Roo; mating and calving of grey whales in the coastal lagoons of Ojo de Liebre, Bahía Magdalena and Guerrero Negro on the Pacific coast of Baja California; and the mating of hundreds of thousands of fur seals, elephant seals and sea lions mate on the rocks and beaches of the Pacific islands such as Guadalupe.

The discovery of diversity

The wealth of information and knowledge of Mexico's diversity of flora and fauna has been derived from the work of naturalists and scientists and the observations of thousands of citizens in all sectors of society. The population in prehispanic Mexico was knowledgeable about the flora and fauna in their environment. Using information derived from artifacts uncovered in archaeological digs and oral traditions and stories passed on by the Spaniards during the initial period of colonization, historians and other researchers believe the prehispanic cultures had a close relationship with nature and that they incorporated nature into their spiritual beliefs. Quetzalcóatl, the feathered serpent, that likely was a quetzal, had a prominent role in both the Mayan and Aztec cultures. Some of this ancient knowledge was assimilated into the Spanish language and is expressed in the current names of animals and plants, such as the words ocelotl (for ocelot) and cempasúchil-cempoalxochitl (for a marigold cultivar) from the Aztec language of náhuatl.

The first Spanish explorers were impressed by the variety of plant and animal species they encountered when they arrived in what is now Mexico, more than 500 years ago. Fran-

Islands that have been separated for a long time from mainland are the perfect setting for plants and animals to develop particular evolutionary traits. The pygmy racoon is one of the many species that contributes to the study of animal speciation.

cisco Hernández, a famous Spanish naturalist and doctor, explored the geographic features and natural history of Mexico between 1571 and 1577. Charged by King Phillip II of Spain to describe the plants, animals and minerals potentially useful to the crown, Francisco Hernández completed the first modern cataloging of the natural environment in America. His work was published after his death in a monumental work called *History of the Plants of New Spain*. However, it was until the 19th century when naturalists and scientists started a systematic exploration of the biological diversity of Mexico. The findings of these explorations were recorded in books and texts that today provide a glimpse of the biological conditions of the country at a time when human population was very small and the wild fauna and flora were much less disturbed than they are today.

Another naturalist and explorer, the Baron Alexander Von Humboldt, explored the cross country route from Acapulco on the Pacific coast to Mexico City and onward to port city of Veracruz on the Gulf of Mexico in 1803-1804. His discoveries and observations, published in The Political Essay on the Kingdom of New Spain (*Ensayo Político sobre el Reino de la Nueva España*), provide a detailed insight of the environmental conditions of the region. For example, Von Humboldt describes the climate and the extraordinary forests in the region of Chilpancingo, state of Guerrero; today bushes dominate the area. In his book Sea Mammals in the Northeastern Coast of North America, Charles M. Scammon, an explorer and whaler, describes in detail his impressions of the terra incognita of the Baja California coasts and the hunting of the grey whales in the Ojo de Liebre Lagoon. He commented that the abundance of whales in the Pacific Ocean and the adjacent Gulf of California waters was so great that it attracted whaling ships from remote regions, such as Russia and Japan. Today, this lagoon is one of the most important nurseries for the gray whale which were nearly hunted to extinction by the beginning of the 20th century.

The legendary naturalist, Edward Palmer, visited the Island of Guadalupe in 1875 and described it as an endangered biological paradise. Situated 200 kilometers west of the Pacific coast of Baja California, the island supported a highly diversified flora and fauna community, most of it unknown to science at that time. Palmer noted that there were approximately 30 species of endemic plants, such as the Guadalupe cypress and 20 species and subspecies of endemic birds including the Guadalupe caracara, and the Guadalupe Storm-petrel. The waters around the island were supported thousands of pinnipeds such as the Guadalupe fur seal, northern elephant seal, and sea otter. The ecology of the island changed dramatically after Palmer's visit in large part due to the introduction of goats by whalers and furriers in the mid-19th century to provide a supply of fresh meat, and within a few decades, the goat population was estimated at about 100,000. This large goat population did severe damage to the native vegetation and turned the island into a wasteland. The altered vegetation, in turn, resulted

in the demise of the caracara, petrel and other bird species. Additionally, the domestic cat, introduced during this same period, preyed on vulnerable endemic land birds and breeding seabird. Fortunately, a timely and unprecedented effort by the government of Mexico and the Island Conservation Organization in the beginning of the current century has begun to arrest the deterioration of the island ecology and restore some elements of its historical ecological integrity. A goat eradication project successfully eliminated more than 10,000 goats in 2007. Researchers and project managers have noted a remarkable recovery of the vegetation since the goat eradication, and several plant and bird species, once thought to be extinct, have been reestablished on the island.

Sponsored by the Department of Agriculture of the United States, Edward Goldman and Edward Nelson carried out what is perhaps the most ambitious exploration of Mexico's fauna between 1892 and 1904. This effort, which collected more than 17,000 mammal and bird specimens that represented approximately 354 vertebrate species and subspecies, showcased the enormous biological diversity of the country and the importance of its conservation. Reflecting on the extraordinary human effort and challenges of this expedition and the exhilaration it provided, Gerardo described a few years ago the scientific expedition made by Nelson to Chihuahua; "The icy dawn took Edward W. Nelson by surprise; he was already awake and still under the blanket in his cot. In the fire, still the last embers burnt slowly as if they refused to be extinguished by a strike of dew. With nostalgia he remembered that that he had been travelling almost continuously during the last seven years through the big land of Mexico, collecting mammals for an ambitious project to which he would devote 14 years of his life, under the official appointment of Officer in Charge of the Field for the Ornithology and Mammalian Zoology of the United States of America Department of Agriculture. He foresaw the return home still far away in this month of June 1899. Nelson had set up camp at the top of a broad plateau, covered with enormous pines and firs. The landscape was awesome. How could he forget these mountains that seemed endless in the horizon, with their sudden canyons and the deep blue sky? It had been a long, very long journey to get all the way over here. Most of the road he travelled on a mule, but in Ciudad Juárez he moved by wagon to Casas Grandes and from thereon he rode a horse to Colonia García, a small village at the base of the mountain range. A week later, he had reached the height of the most northern foothills of the Sierra Madre Occidental, the name Mexicans gave to the largest mountain range that covered more than 1,000 kilometers the western part of the country. The previous night wolf howls had awaken him. The fauna was still very abundant in this region. Recently he had crossed white tail deer, black bears, pumas, wild turkeys and "*pitorreales*", that were the biggest woodpeckers of the world (…). His biggest surprise had been the huge silver or grey bears, of more than 300 kilograms of weight that were abundant in this region...."

Hundreds of plants in the tropical forests of Mexico and the world represent a valuable source of chemical compounds. Their extraordinary medicinal and nutritional properties have benefited millions of people. The vanilla orchid was first domesticated in Mexico and has been used to flavour many products. Its cultivation requires intense work as flowers must be pollinated manually and beans need to be dried and fermented following a strict process. Mexico is one of the main producers of vanilla along with Indonesia, Madagascar, China, and Turkey.

José Mariano Mociño was one of the most important Mexican naturalists. Born in 1751 in Temascaltepec, State of México, he participated as a member of the Royal Botanical Expedition to New Spain in 1787-1803, and his collection samples, illustrations and comments described many species, including the quetzal, a brilliantly colorful bird found in the humid montane cloud forests of southern Mexico and in other Mesoamerican countries. Other notable Mexican naturalists who contributed to the understanding of Mexico's biodiversity include Pablo de la Llave (specialized in botany), Alfonso L. Herrera, Manuel M. Villada (ornithology) and Alfredo Dugès (herpetology).

Sponsored by the American Museum of Natural History, the Norwegian ethnographer and naturalist Carl Lumholtz arrived in Mexico in 1890 and made several expeditions to northern (Chihuahua) and western (Nayarit, Jalisco and Michoacán) Mexican states. While he is internationally recognized for his study of the Tarahumaras, Native American people of northwestern Mexico, the 1902 publication of his book *The Unknown Mexico* cites his encounters with the Imperial woodpecker, now probably extinct, and other "wild and natural" conditions of that region of Mexico.

Today there are numerous universities and other institutions dedicated to the study and conservation of the biological diversity of Mexico. The National Commission for the Knowledge and Use of Biodiversity (CONABIO) is a public institution whose mission is to develop and gather knowledge on the biological diversity of the country. CONABIO recently published a digital platform called *Enciclovida* (Encyclopedia of Life) where one can look for information on the 100,000 species of plants, animals, fungi, and microorganisms known to inhabit in Mexico.

Environmental services

Mankind has enough ethical, moral, intellectual curiosity, cultural, religious, and philosophic arguments, to conserve biodiversity. There is, however, a more fundamental reason: to maintaining the environmental conditions that allow the existence of life on Earth —such as the proper combination of the gasses of the atmosphere and the primary productivity, which is the conversion of solar energy by plants and microorganisms into energy available for other organisms like us. The life-sustaining goods and services we receive from a healthy natural environment are called "environmental services." To sustain these environmental services it is necessary to preserve the ecosystems, the wild animal and plant species that form the biological processes they perform. Environmental services include maintenance of the quality and quantity of water, formation and fertility of the soil, pollination of food crops and other plants, generation of compounds that provide a host of goods such as medicines and cosmetics, control of diseases and plagues, the prevention of natural disasters such as landslides, flooding and erosion, the provision of natural spaces for entertainment and recreation, moderation of local and regional weather events, and countless other services. A startling, current example of the connection between health of flora and fauna and global ecological services is climate change, and the very severe negative effects it has on humans (and non-human inhabitants of our world). Such effects are exacerbated by the extensive loss of forests and other vegetation types to resource extraction and land conversion adds to concentrations of carbon dioxide and methane in the atmosphere, which, in turn, results in a general pattern of a warmer Earth and other changes in weather patterns to which many plant and animal species cannot adapt.

The value of the environmental services is incalculable. While there have been attempts to put a monetary value on them, some of the benefits cannot be measured in monetary terms. The introduction of the microscopic fungus penicillin in the 1940s ushered in the era of antibiotics that has been credited with preventing the deaths of millions of people and countless heads of livestock. It is estimated that 75% of the active compounds used in today's medicines were originally made from compounds first derived from wild plants, animals, and microorganisms. These compounds were subsequently synthesized in laboratories. For example, the active compound of the first contraceptive pills was derived from barbasco, a tropical plant (from the family Dioscoreaceae) found in southern Mexico. Healthy ecosystems provide a guard against emerging and re-emerging diseases, and loss of key species can jeopardize this protection. In some regions of Africa the increase of rodents, which carry infectious diseases, is directly linked to the elimination of elephants and other large herbivores.

The pollination of many economically important crops and plants critical to a sustainable environment are dependent on a wide range of insects, birds and mammals, and in the absence of specific pollinators, food production and many natural ecosystems would collapse. For example, bees are the principal pollinator agent for crops such as alfalfa and sunflowers. The production of the alcoholic beverages tequila and mescal, a major economic activity, depends on wild and cultivated agaves. In a mutualistic relationship, the agave plants depend on bats for pollination and the bats feed on the nectar of the agave flowers. In another example of the importance of "natural systems" in the production of high value crops, studies show that Costa Rican coffee farms surrounded by forest had a 40% higher yield than those farms that were isolated from surrounding natural vegetation. The coffee plants close to the forest benefited from the birds and the bats that ate insect pests and the bees that pollinated the coffee bean flowers.

Unfortunately, the increasing use of pesticides has resulted in a drastic reduction of the bee populations, and if this trend continues unabated, the longer-term outlook is likely to include reduced productivity (and earnings) and a compromised environment that cannot

The seas and oceans are an abundant source of goods and services, and offer multiple alternatives to conventional extraction activities. The observation of marine life has replaced commercial fishing in many parts of the country. New generations of fishermen have adopted sustainable tourism as a more profitable and rewarding source of income.

provide the goods and services needed by its occupants. Studies in Indonesia and the United States have estimated insectivorous bats consume tons of insect pests and thereby precluding the toxic and other negative impacts of insectide use. Often overlooked, environmental services are critical to the mental health of a community. Numerous studies have shown that the activities such as observing birds and other wildlife, hiking and boating, undertaken in a "natural environment" help reduce stress and the risk of depression.

A world in silence

Humans have been the cause of extinction of animal and plant populations and species for many millennia. Propelled by a growing human population and increased consumption patterns, humanity is losing those very basic elements which have supported the human experience for hundreds of thousands of years. It seems that as the wildness of the world gives away to ever more development, the connection to our roots is becoming weaker and the sounds of the natural world more silent.

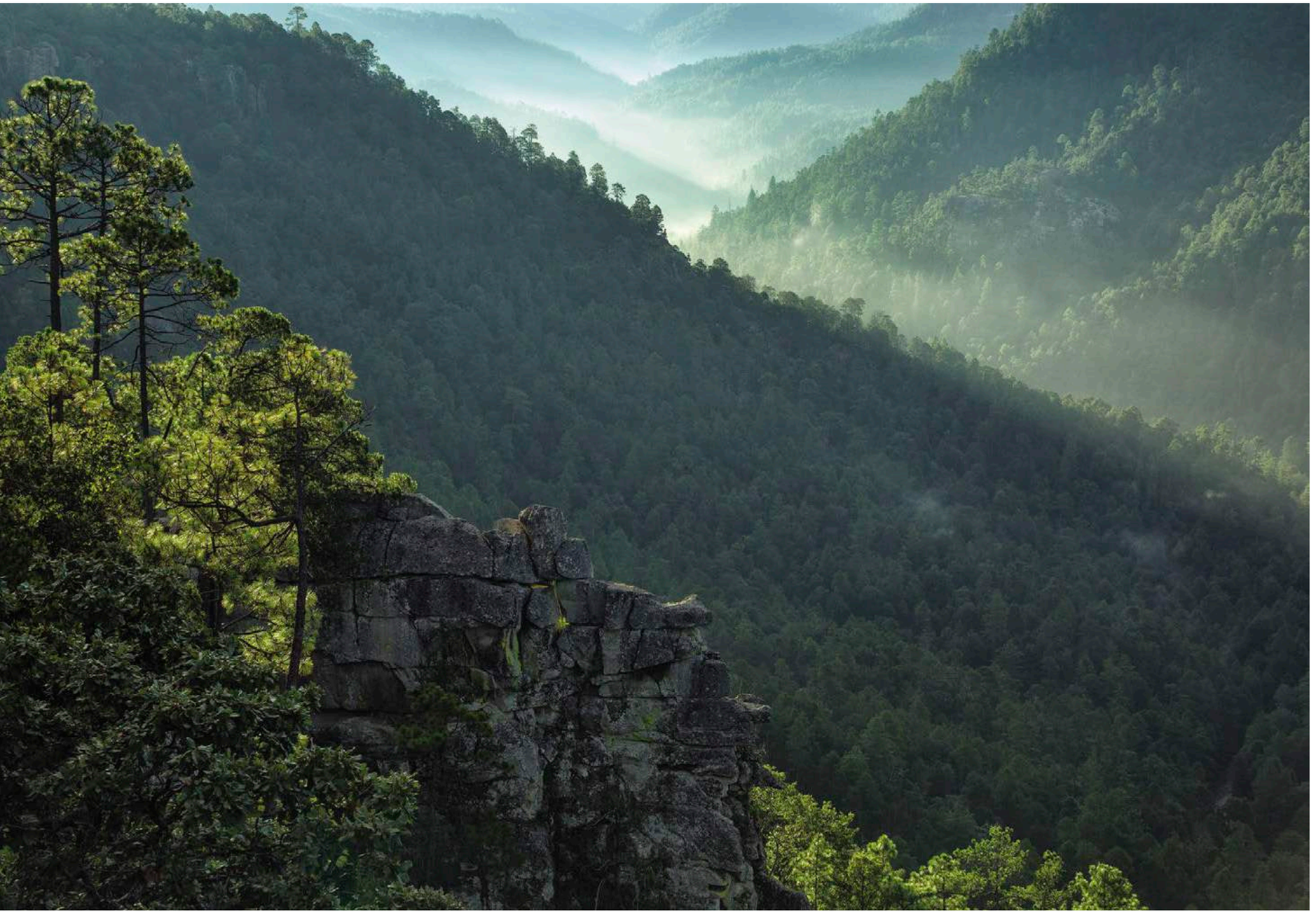
More than a year ago, I evaluated with some colleagues the magnitude and severity of species extinction. We analyzed data to evaluate if the extinction of vertebrates caused by man in the last century happened at a faster pace than those that occurred naturally during the last two million years. The importance in determining current extinction rates relative to historical values has fundamental implications to understanding the magnitude of the environmental crisis humanity currently faces and the ramifications for future generations. The results of our analysis and evaluations dumbfounded us. We concluded that the extinction of species in the last century alone due to anthropogenic activities would have taken up 10,000 years under natural conditions. In other words, the impact of humans has increased the rate of extinction by a factor of up to 100 times the natural background rate.

This data, new information on the gigantic problem of extinctions of vertebrate populations, and information of gleaned from other groups of plants and animals reveal that the Sixth Mass Extinction in the history of our planet has begun. Given the very high rates of extinction of the different life forms, it is impossible for the Earth to maintain its current suite of environmental services. The drastic loss of biodiversity, coupled with other global environmental crisis such as global climate change, represents one of the most serious challenges to the future trajectory of the human species and is no less threatening than war or a global financial collapse. Today, more than ever before, we must renew our effort to preserve nature through commitment and with the belief that the human community can and will use its capacity to secure is own destiny.

Megadiverse Mexico

Since the time of the great contributions of notable nineteenth-century naturalists such as Alfred Russel Wallace, William Sclater and Charles Darwin, it was established that the distribution of animals and plants on the planet is very heterogeneous. Tropical regions and coral reefs, for example, have more species than temperate regions and deep seas, respectively These distribution patterns are evident also amomg countries, with some fconcentratring exceptional numbers of species. Those countries, known as megadiverse since the 1980s, concentrated around 70% of all wild species on the planet.

Mexico is a megadiverse country. It ranks sixth in biodiversity, after Brazil, Peru, Indonesia, China, and Colombia. It is distinguished by being the country with the greatest diversity of reptiles and amphibians together, cacti, agaves and pines, among other groups of living beings. Another feature is extremely important is that a large percentage of its species are endemic. that is unique to the country. The great biological wealth of Mexico is also related to its cultural richness, ranking among the three countries most diverse biological and cultural wealth.



Natural landscapes

Mexico has different plant communities that give each region a unique aspect, such as the tropical evergreen forests of the Sierra Madre de Chiapas; the tropical deciduous forests of the Balsas River basin; the cloud forests of the Sierra Madre Oriental; the temperate coniferous forests of the Transvolcanic axis; the xerophytic scrubs of the Tehuacan valley; the deserts of Baja California Peninsula; the Chihuahuan grasslands; and the wetlands of Tabasco.

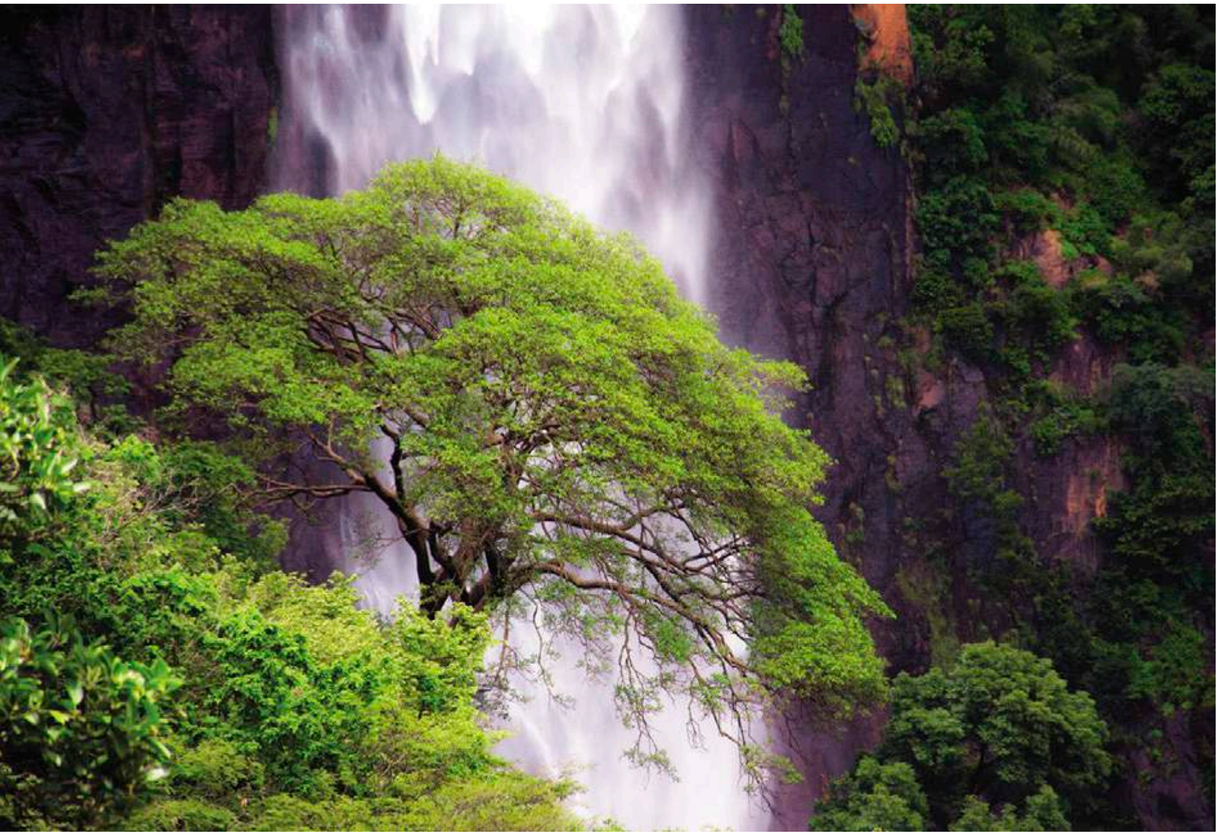
PAGES 50 AND 52 *Tropical forests maintain more than 60 % of terrestrial plant species in Mexico. Trees such as mahogany, cedar and ceiba, which grow in places like El Ocote Biosphere Reserve in Chiapas, house in their branches and trunks epiphytic plants such as vines, bromeliads, orchids, and ferns. These plant communities provide shelter and food to myriads of animals such as birds, frogs, salamanders, ants, butterflies and beetles. While most of these species are conspicuous, others remain hidden, and many have yet to be discovered. They survive secretly among the leaves, roots and hollows of the tropical giant trees.*

PAGES 54, 56 AND 58 *Although temperate forests, rainforests, and deserts extend beyond borders, Mexico's unique topography and climate diversity allow these ecosystems to harbour hundreds of exceptional species. Traversing from north to south, the large and rugged mountain ranges gave rise to the temperate forests of Victoria, Durango (page 54), the Mixtec knot between Puebla and Oaxaca (page 56), and the tropical forests in the Sierra Madre de Chiapas (page 58).*

In less than two million square kilometres, Mexico has almost all types of vegetation on the planet. Its geographical position and its complex topography defined areas with highly contrasting rain and moisture regimes. Some of the drier areas of the country such as the Pinacate and Gran Desierto de Altar, Sonora (left) receive only about 50 mm of rain per year; others, as the oak forests of Jalisco and Nayarit (above) receive more than 1,500 mm of annual rainfall.

Mexico is a country with intense volcanic activity. The west coast is part of the so-called Ring of Fire, where tectonic plates are constantly moving and colliding. In Central Mexico, a volcanic mountain range stretched from Veracruz to Colima along parallel 19°N. The Volcan de Fuego in Colima, is located at the intersection of these two regions and is the most active volcano in Mexico. During the last decades it has produced tons of volcanic material and has help researchers understand the behaviour of these natural giants.

The Chihuahuan Desert, with over 450 000 square kilometres, is considered the largest desert in the continent. Its extensive valleys surrounded by mountain ranges were admired by naturalist Aldo Leopold at the beginning of the twentieth century. He highlighted the biological richness of this region in northern Mexico. Presently, the Janos Biosphere Reserve preserve the conservation efforts that Leopold began almost a century ago.



Water is a source of life. The Mexican territory is fortunate enough to receive water from both the Pacific Ocean and the Gulf of Mexico. From central Mexico, as in the Sierra de Nanchititla in the State of Mexico (left) to the Lacandon Jungle in Chiapas (right), this moisture condenses on the mountain ranges creating rivers, waterfalls and lakes. These waters quench the thirst of many organisms inhabiting aquatic ecosystems and human communities established in these regions. Conserving places that provide water is essential to protect the biodiversity of a mega-diverse country and to ensure supply to its citizens.

PAGE 68 *The Riviera Maya is recognized worldwide for its caves and cenotes. This little-known underground world, where life seems non-existent, hides numerous species that thrive away from sunlight. Explorers around the world have discovered new passages, gradually mapping these caves and expanding our knowledge of the unique species that adapted to live in this natural underworld.*

After rain water condenses in the mountains, it flows through rivers and slowly percolates back down to the seas and oceans. During this wonderful journey, water gives life to the places it traverses dragging nutrients and minerals that are essential to maintaining the health of coastal marine ecosystems. For instance, the coastal lagoons and mangroves of the Biosphere Reserve La Encrucijada in Chiapas (page 70), and the coral reefs on the shores of the Gulf Islands of California (left and page 74).

Flora

With its more than 23 000 species of plants, Mexico is positioned as one of the most diverse countries in plant diversity. More than 15 000 are endemic, i.e. exclusive, to the country.

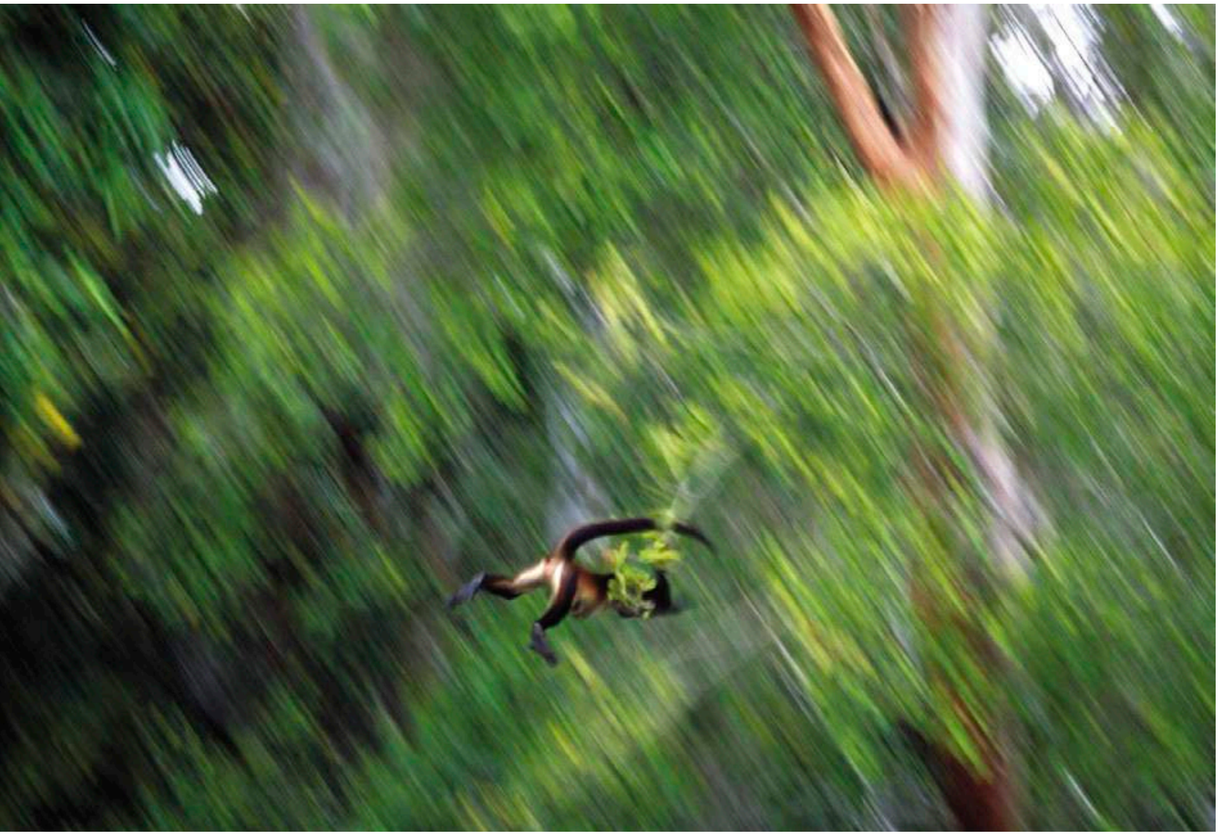
Aridlands, scrublands, grasslands, and deserts cover 30% of Mexico. Those ecosystems concentrate the greatest number of endemic species, which dominate these landscapes. Mexico is a centre for diversification of cacti. Of the 1 400 species that exist in the world, Mexico harbours 670, of which, 518 are exclusive to its scrublands and deserts.

PAGES 80 AND 81 *Seven million years ago, when the Panama Canal was closed and joined the south to the north, a major interchange of wildlife led to the migration of tropical species that reached Mexico. Ferns, palms and trees of tropical affinity settled in tropical climates as the Lacandon jungle in Chiapas (page 80). Meanwhile, arid areas such as the Sierra Gorda in Queretaro, were gradually populated by cacti and bushes (page 81). The novel composition of northern ecosystems formed by organisms of southern origin explains the large number of unique species currently present in our country.*

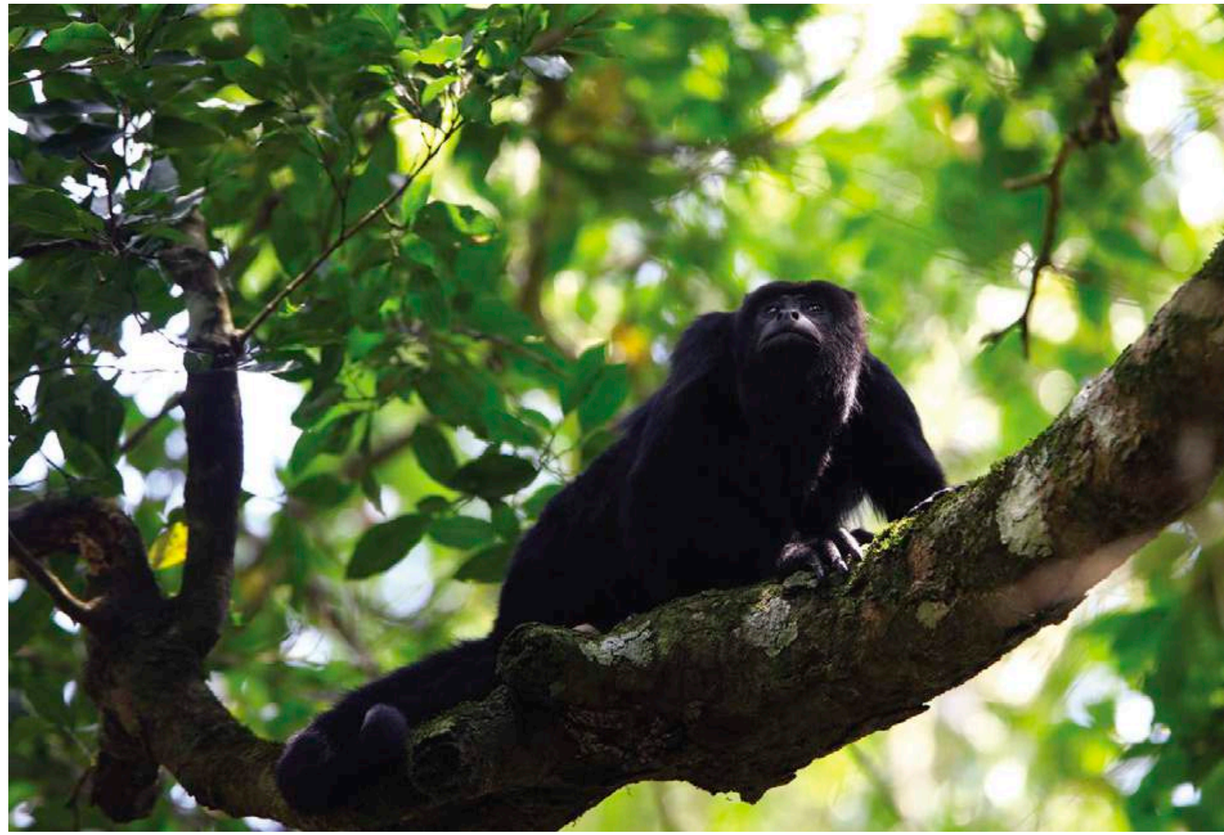
In 1859 Charles Darwin wrote "Flowers rank amongst the most beautiful productions of nature; but they have been rendered conspicuous … so that they may be easily observed by insects. I have come to this conclusion from finding it an invariable rule that when a flower is fertilized by the wind it never has a gaily-coloured corolla. … Hence we may conclude that, if insects had not been developed on the face of the earth, our plants would not have been decked with beautiful flowers". Darwin's exceptional observations proved the existence of natural selection and opened the door to one of the greatest theories in the history of Biology: The Theory of Evolution.

The mammals

There are more than five thousand species of mammals in the world. In Mexico there are 565, including 522 terrestrial and 42 marine species, respectively. Mexico is the one of the most diverse countries of the World.

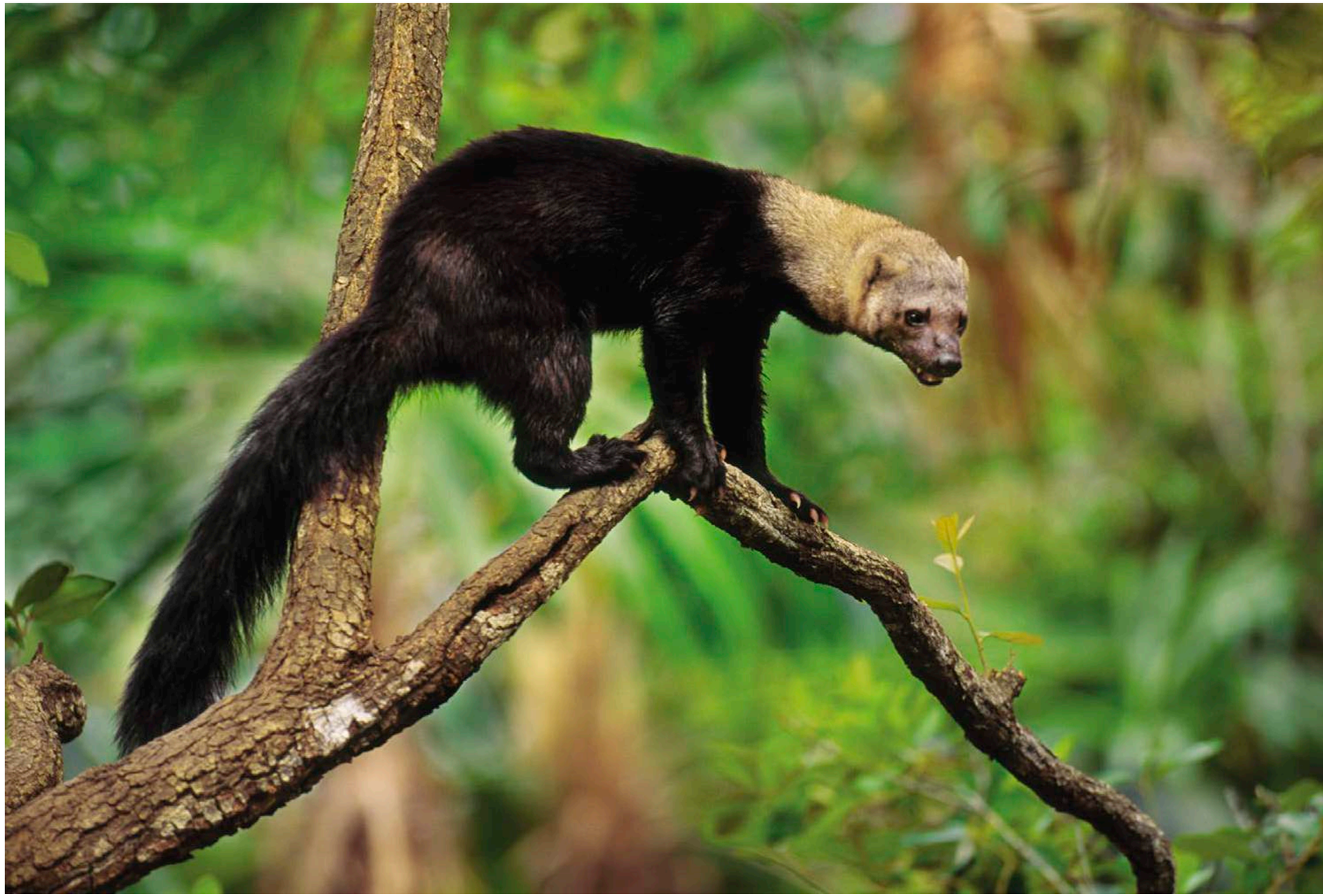


PAGES 84, 86 AND 88 *Mammals can be found in all ecosystems from the rainforests in the southeast to the temperate forests in the north. Mammals exhibit variety of shapes and habits. Their size ranges from the large jaguars (page 84) and bears (page 86) weighing between 60 and 100 kg, to the smallest bats (page 88) and weasels of only a few grams.*



In addition to humans, Mexico harbours two other species of primates: the spider monkey (left) and the howler monkey (above). These species peacefully inhabit the rainforests of Chimalpas in Oaxaca and Veracruz, the Lacandon Jungle in eastern Chiapas, the Pantanos de Centla in Tabasco, Calakmul and Balam-Ku in Campeche, and Sian Ka'an to Yum Balam in the state of Quintana Roo.

Six species of felines inhabit Mexico: the jaguar, the puma, the ocelot (left), the margay, the jaguarundi and the bobcat (above). The bobcat inhabits arid and temperate forests while the others species live in forests, coasts, dry forests and cloudy forests. The strength and beauty of these cats have led them to be part of the pre-Hispanic world as symbols of power, warriors, rulers, priests, sorcerers and gods.

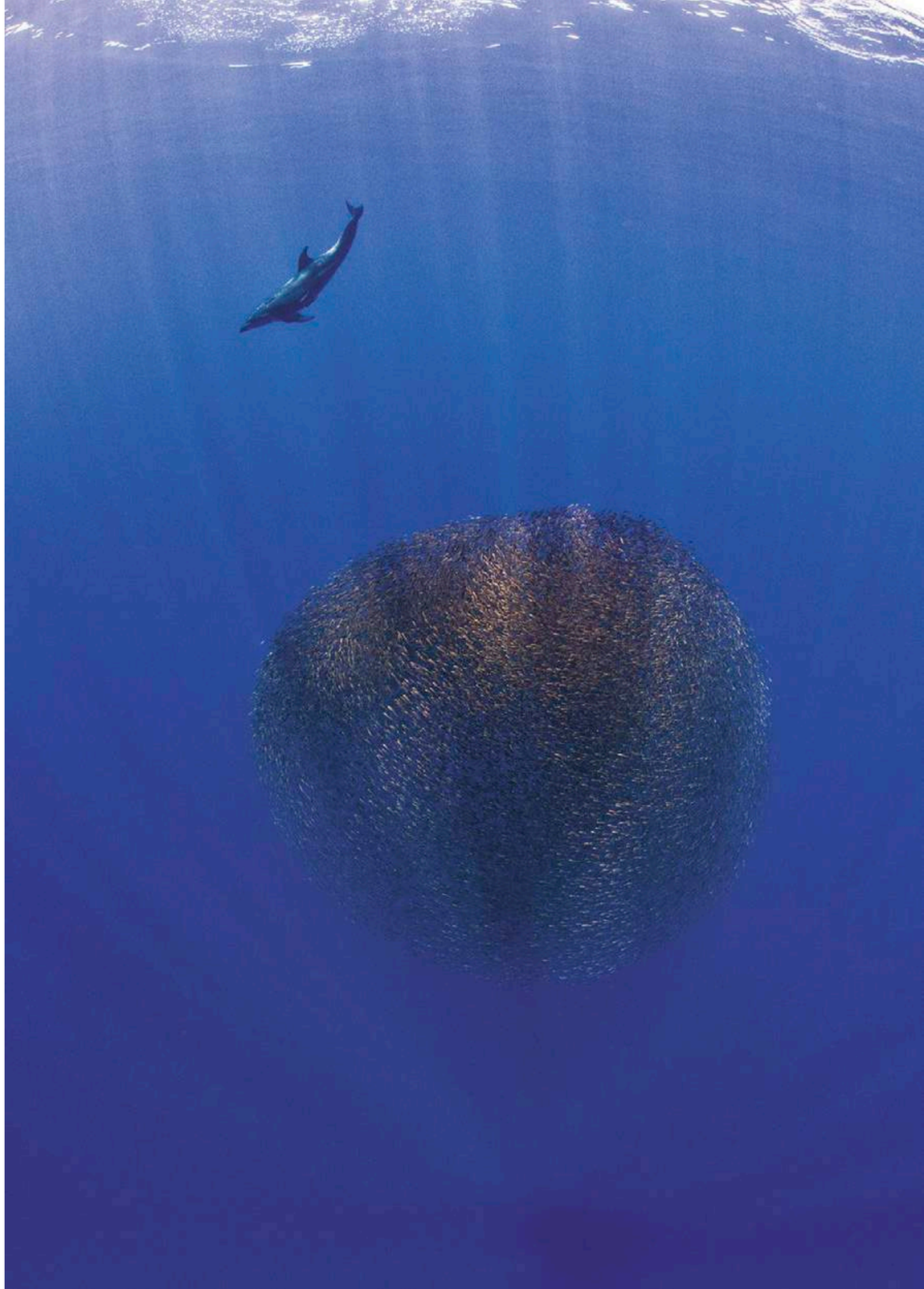


The forests in the south of Mexico, which are shared with Central and South America, have a high diversity of mammals. The state of Oaxaca has the greatest diversity of terrestrial mammals and the greatest diversity of carnivores in the entire Neotropical region. The tayra is a skilful carnivore that finds food in the branches and vines of these rainforests.

Bats are the only group of mammals that can fly. They are the second most diverse group in the world with 925 species distributed in every ecosystem except Antarctica. Mexico has 144 species of bats whose habits, shapes and sizes contribute to their remarkable diversity.

Marsupials like kangaroos, koalas and possums are known mainly in the tropics of Australia, Papua New Guinea, Central and South America. Although this group of organisms originated in the southern hemisphere during the Great American Interchange, seven species colonized Mexico. One of them is the mouse opossum, a marsupial that evolved in dry forests and scrublands.

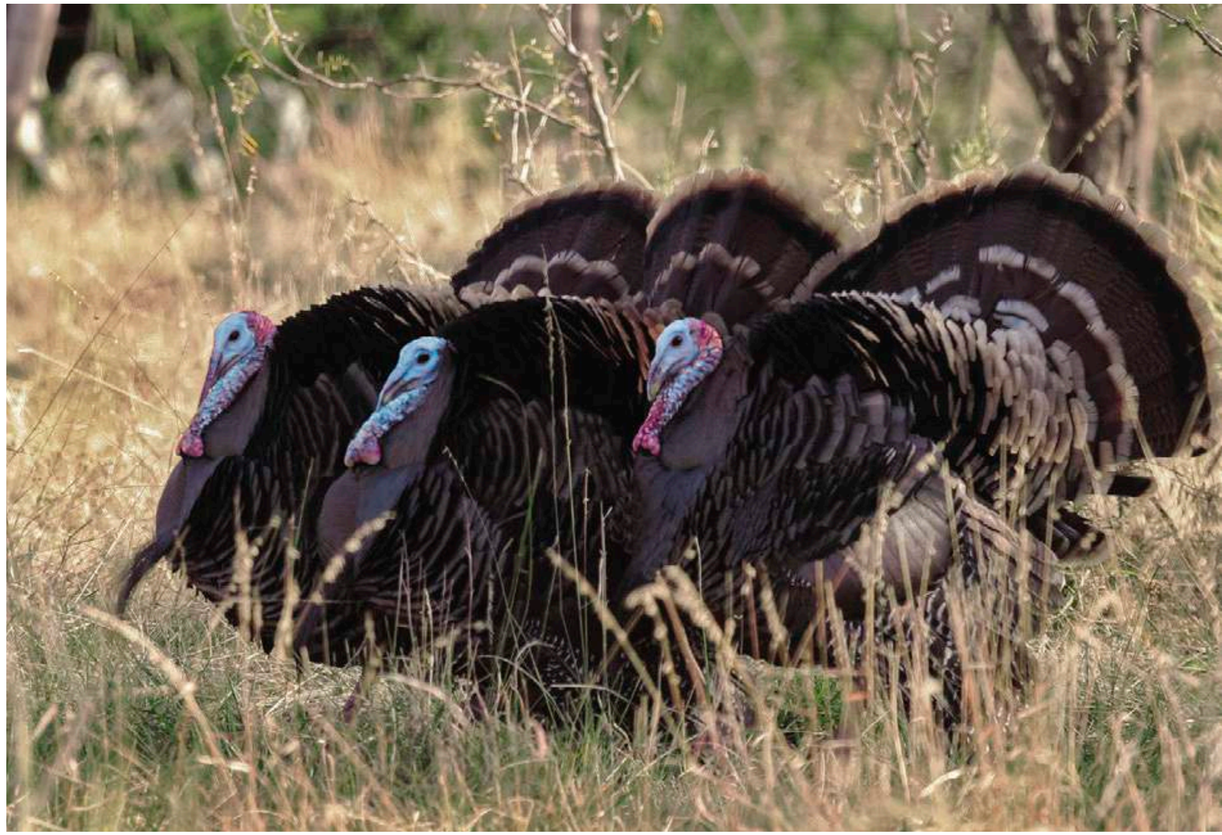
Seas and oceans cover 70% of the Earth's surface. The only mammals adapted to live and feed in the water are dolphins, whales, orcas, sea lions, seals, walruses, otters and manatees. The rich feeding seas surrounding Mexico are home to a third of the world's marine species: six species of seals and sea lions, and 37 species of whales, dolphins and orcas.



The birds

Of the near 10 000 species of birds in the world, 10% can be found in Mexico. This bird diversity positions Mexico as one of the eleven countries with greatest variety of species.

PAGES 102 AND 104 *The more than 1 350 islands and islets in Mexico represent a sanctuary for many endemic bird species. For example, the pacific islands of volcanic origin, appeared hundreds of kilometres offshore and were colonized exclusively by birds like the blue-footed booby (page 102) and the osprey (page 104). These species adapted to their environment and took advantage of the absence of predators and abundance of food in the new territories.*



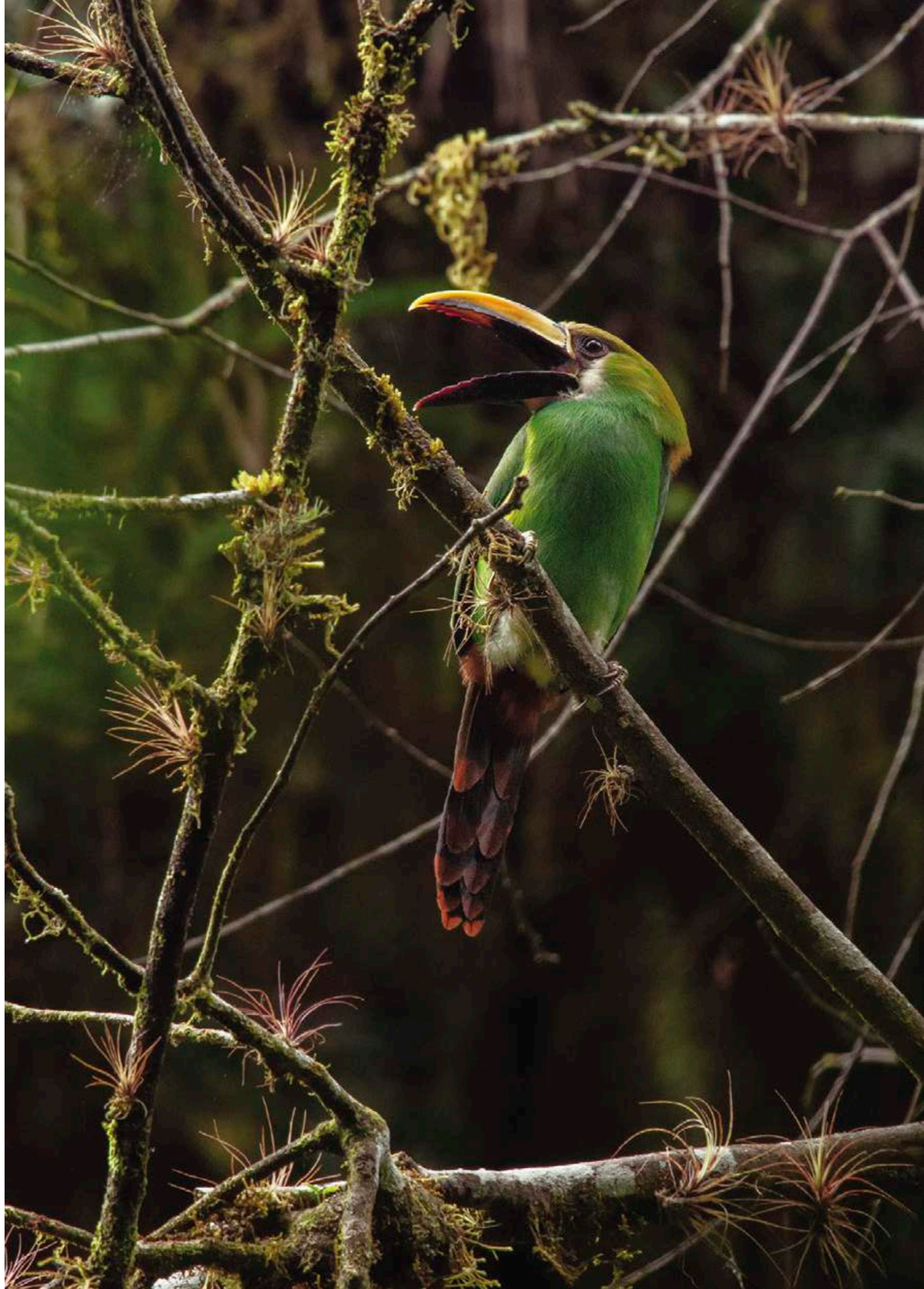
The Great American Interchange is also reflected in the diversity of birds. While some species like the curassow, guans and chachalacas migrated from the south, North American turkeys ventured into more southern latitudes. In their migration, both groups encountered physical and environmental barriers that limited their distribution.

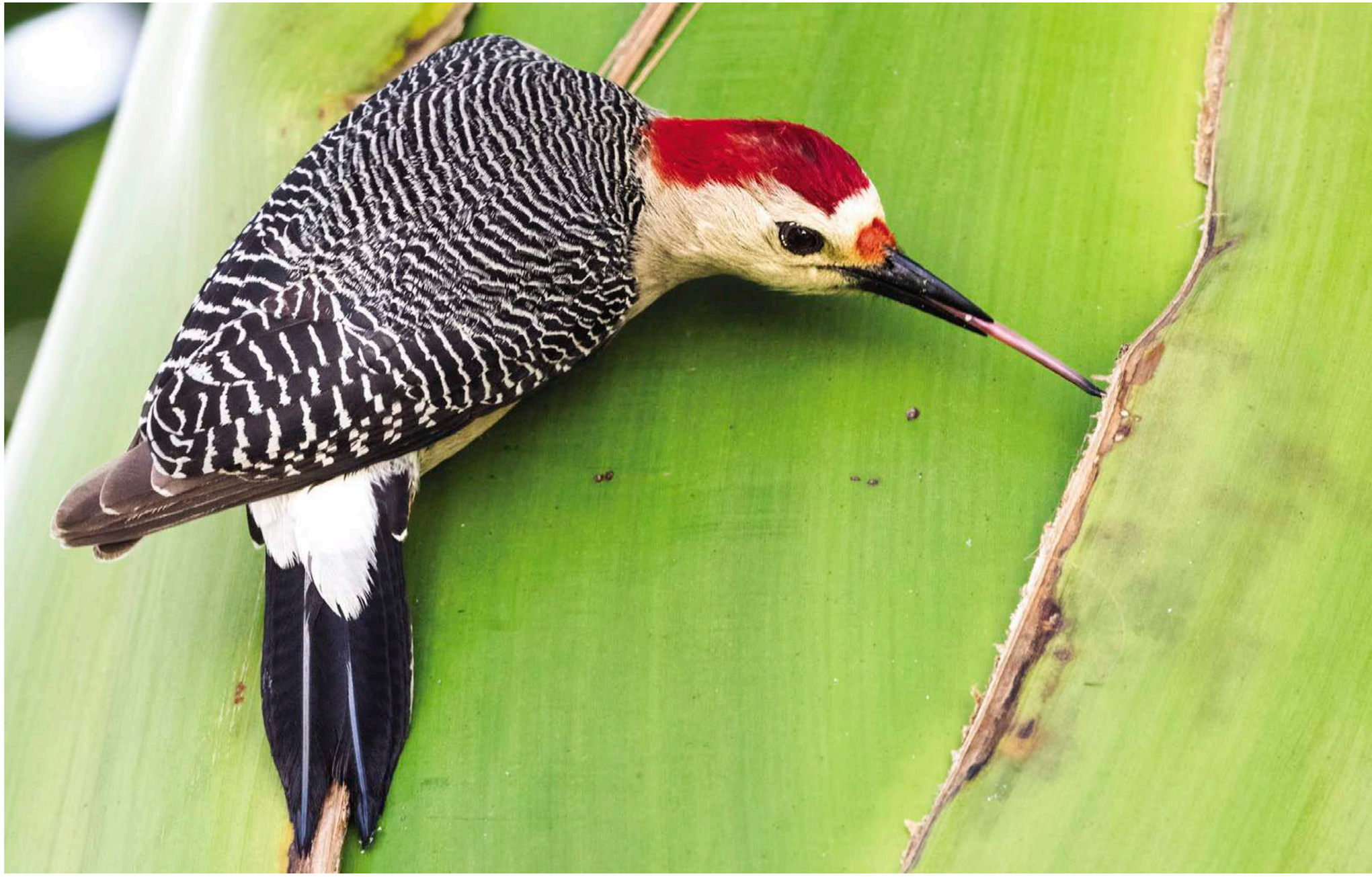
PAGE 108 *Pelicans are distinctive for their large size and peculiar beaks. They are the largest Mexican birds. Although they are commonly associated with the coasts, each year they migrate inland to freshwater lagoons rich with small crustaceans and fish, where they establish temporary colonies of thousands of individuals.*

Regardless of their size, these birds are skilled hunters that eat a variety of meats. Owls, barn owls and tecolotes feed on small rodents, reptiles and amphibians; while herons and seabirds feed mainly on fish.

Raptors play a key role in the ecosystem as links of the food chain. They regulate populations of rodents, birds, reptiles and amphibians. Mexico has 52 species of birds of prey, including hawks, eagles, owls and vultures.

Sea currents are associated with a high concentration of nutrients that feed many fish and crustaceans, which in turn represent a feast for the great diversity of marine birds inhabiting our waters.





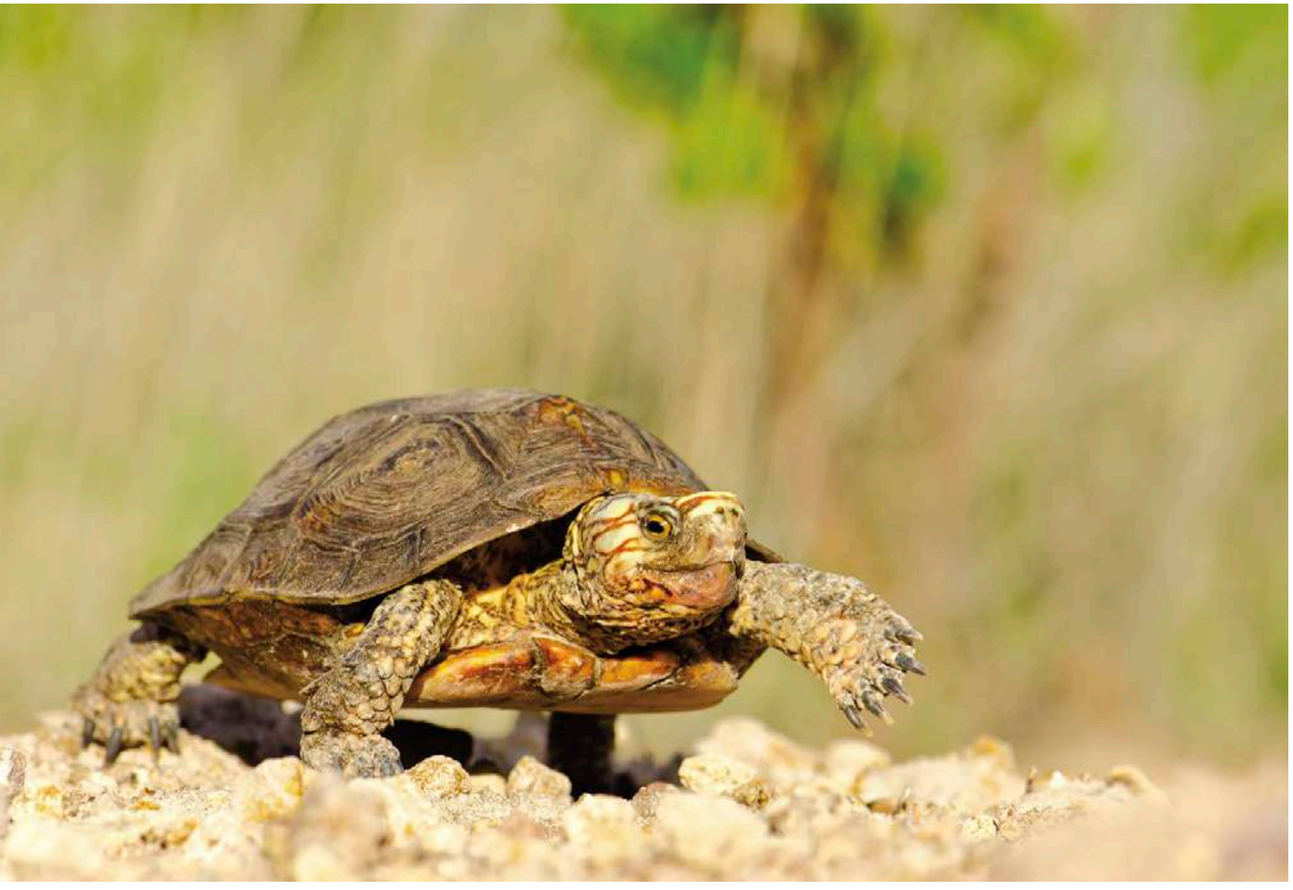
PAGES 116, 117 AND RIGHT *Birds exhibit peaks characteristic to their feeding habits. Some, like toucans (pages 116 and 117) use their beaks to break very hard seeds, while woodpeckers (right) have short and very hard beaks that perforate tree trunks in search of insects and larvae.*

Thanks to the variety of niches, birds exhibit a variety of sizes, colours and shapes. Of the 10 500 described species in the world, about 200 are found exclusively in Mexico. Like other vertebrates, the highest concentration of endemic birds occurs in the southwest of the Pacific Ocean and the mountains of the Eje Neovolcanico and the Sierra Madre Occidental.

PAGE 122 *Raptors need large areas with sufficient sites to feed and nest. The presence of these birds is an indicator of good health of an ecosystem. These species are considered as "umbrella" for their protection facilitates the conservation of other species and large extensions of forests they inhabit.*

The reptiles

Mexico stands out as the country with greatest number of reptiles worldwide. Currently, 864 species have been documented; from which, more than half (493) are endemic to the country.



PAGES 124, 126 AND 128 *Reptiles are considered to be the first vertebrates to conquer mainland. Its scaly body made of keratin allowed them to adapt to a variety of terrestrial environments. The greatest diversity of reptiles can be found in the tropical forests of southwestern Mexico.*

Although turtles adapted to live outside water, they maintain close contact with this vital liquid during the embryonic stage; inside the egg hatchlings maintain moisture. Several species have adapted to a variety of environments from rainforests and temperate forests to scrublands, grasslands and deserts.

Mexico is inhabited by 417 species of lizards that represent 48 % of all reptiles in the world. They are very diverse in terms of shape and colour and can be found in arboreal, terrestrial and semi-aquatic environments. They are more active during the day when they feed on small insects like ants, butterflies and beetles, although some can be seen at night.

Four of the twenty-three species of caimans and crocodiles in the world have been observed in México. Although these animals can tolerate salt water, they prefer to inhabit fresh or brackish water like streams, swamps, mangroves, rivers, lagoons and estuaries. They are abundant in places with dense vegetation where they can find small crabs, snails, shrimp, fish and small vertebrates.

There are 393 species of snakes in Mexico. Most of them are harmless to humans with a few exceptions. The majority have limited mobility and are distributed in small areas; consequently, about 50% are endemic mainly to the Gulf of California, the Sierra Madre del Sur and the Eje Neovolcanico.

The amphibians

With its 1240 species, Mexico is the fifth country in numbers of amphibians; of which, 376 are endemic. This group includes caecilians, salamanders, axolotls, frogs and toads.

PAGES 142 AND 144 *The tropical forests of Oaxaca, Chiapas and Veracruz are home to the greatest diversity of amphibians in the country. The dry forests and scrublands of Puebla, Guerrero and Michoacan harbour the largest number of endemic species.*

Amphibians are characterized by their dependency on water to survive during the early stages of life. However, some lineages have gradually abandoned these environments and managed to colonize dry areas where water is available for short periods during the year. Mexico has nearly 100 species of frogs distributed mainly in tropical ecosystems.

Salamanders are the largest group of amphibians. They can be found in forests with high humidity. Some species spend their entire lives in water while others come ashore to continue their life cycle. A unique feature of salamanders is their ability to regenerate any part of their body if this was amputated, allowing them to recover and survive attacks from predators.

To survive, amphibians must maintain their skin moist all the time. Because the humidity in the air may not be constant, many species have developed glands that produce the necessary moisture.

The fish

Mexico is renowned for the richness of fish that inhabit its waters. Currently, 2 763 species have been documented in freshwater and marine habitats, which represents 10% of all known fish species.

PAGES 152, 154 AND ABOVE *Coral reefs are essential to sustain life at sea. Many species use corals during their early stages of development to find shelter. The high diversity of marine species in the sea of Cortez led to the creation of biosphere reserves as the Alto Golfo de California and Delta del Río Colorado, Isla San Pedro Martir, El Vizcaino and Islas Marias, the National Parks of Bahía de Loreto, Cabo Pulmo and Isla Isabel, as well as Natural Protected Areas of Flora and Fauna of the Gulf of California and Cabo San Lucas.*

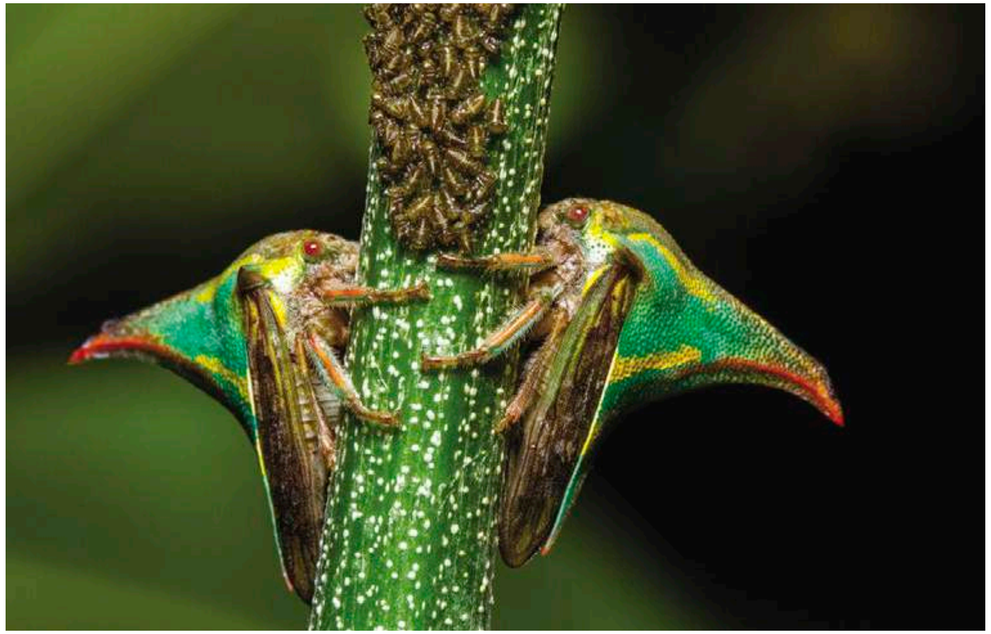
PAGE 156 *Mexico is a country with high diversity of freshwater fish. More than 505 have been documented in lakes, ponds, rivers and streams, representing about 6% of freshwater species worldwide. Most species (350) are able to tolerate some degree of salinity.*

The invertebrates

Arthropods are the most diverse group of the animal kingdom with more than one and a quarter million species described to date. Surprisingly, it is estimated that these species represent less than 20% of all arthropods that inhabit the planet.

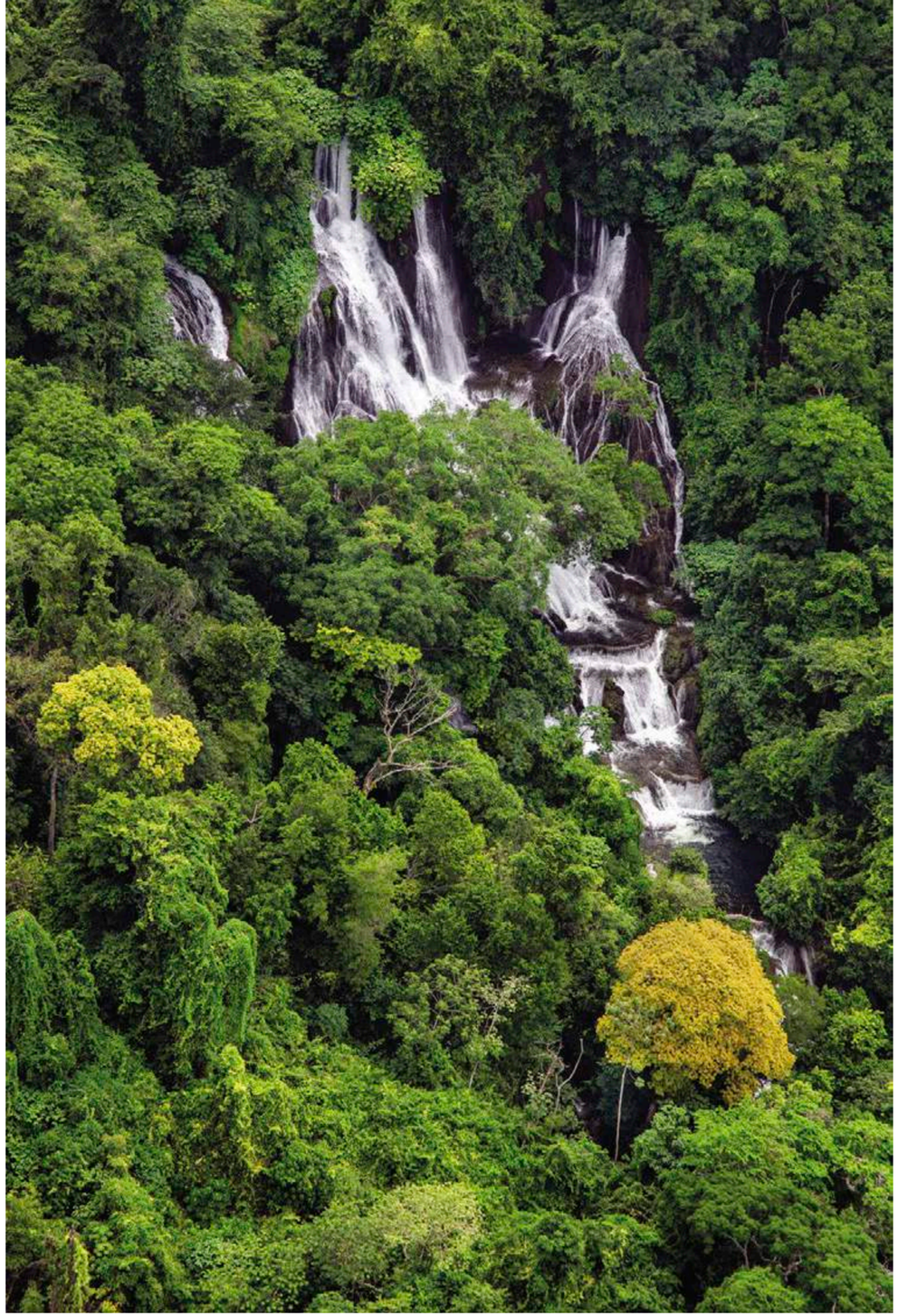
PAGES 158 AND 160 *The ecological importance of arthropods is immense and is due mainly to their feeding habits. There are species that feed on carcasses and are responsible for reintegrating this matter to the environment; others that feed on plants, and some others that act as bio-controls feeding on other arthropods, thus preventing pest infestations.*

Arachnids comprise a very common group that includes scorpions (left), spiders (above), solifugae, whipscorpions, pseudoscorpions, mites and ticks. There are more than 5 000 species in Mexico with a high variety of shapes and habits. They inhabit all ecosystems, from the deserts and scrublands in the northwest to the rainforests of the southeast.



PAGES 164 AND 165 *With more than 33 000 species known in Mexico, arthropods exhibit very different life styles. Despite being such a large group they all have jointed legs that give them that peculiar way of moving. Insects are equipped with three pairs of legs, spiders with four and centipedes with several dozens.*

In the world of insects, beetles are by far the most diverse. About 300 000 species have been documented worldwide, representing more than 70% of all known insects. Beetles have been able to colonize all types of habitats from sea level to altitudes of over 4 000 meters, including scrublands, temperate forests, rainforests and even rivers and lakes.



Rodolfo Dirzo

ANTHROPOGENIC THREATS TO BIODIVERSITY

A long evolutionary lethargy and a biological explosion

The history of life on our planet is a fascinating journey of discovery and change. Life on Earth began approximately 4 billion years ago (Ba), but its most recent distinctive characteristic is the presence of the human species. The evolution of life, from its earliest forms to the rich biodiverse tapestry we experience today, has been a long odyssey, lasting the equivalent of a succession of 160 to 180 million generations of humans. Another fascinating aspect about the origins and changes in life is that for much of the Earth's history and for a long period of time after life first appeared, life forms were relatively few and limited to the marine environment, probably because of the unstable and harsh planetary conditions. However, "only" about 541 million years ago (Ma), the *tempo* of the diversification of life forms increased dramatically and many different species evolved, each with unique morphologies, ecological needs, and habits designed to exploit the available resource base (e.g., food intake, self-preservation and reproduction). These changes first took place in the seas and later in the terrestrial environment as life forms evolved to occupy an ever-expanding array of niches and habitats. A major period of evolutionary experimentation and adaptive radiation of species,

which laid the framework for many of the animal groups we encounter today, began during the Cambrian period (about 541 to 500 Ma) in the Phanerozoic eon, which extends to the present time. Phanerozoic is a Greek word that means "visible or obvious life" (under an initial belief that it was at that time that life started on the planet).

The proliferation of life forms during the Phanerozoic eon is beyond the imagination. During the infancy of this eon, life forms mainly consisted of bacteria, algae, filamentous fungi and parazoa (animal sub-kingdom that includes the sponges), but in an exuberant burst of evolution anthropoids, snails, urchins, jellyfish, coral, worms, tunicates, and cephalopods soon developed. Somewhat later, about 530 million ya, the first true vertebrates evolved. The evolution of land plants and land fungi (about 1.3 Ba) had a profound effect on Earth's climate and atmospheric composition with the increasing concentration of oxygen fueled by photosynthesis. During the Carboniferous period, extensive forests covered the Earth, providing habitats for another wave of animal evolution including the emergence of reptiles (about 310 Ma) and dinosaurs (middle of the Triassic period, 232-234 Ma) and eventually a proliferation of birds and mammals. Ancestors of the human species, hominids, appeared at the tail end of this remarkably complex evolutionary journey.

Two aspects of this journey deserve particular attention here: the increasing diversification of life during the Cambrian Explosion (early part of the Cambrian period), and the pulses of mass extinction that have taken place throughout the past 541 million years. Punctuated by five major extinction pulses, the direction of biological diversification during the Phanerozoic eon has been relatively constant, and fossil evidence suggests that there never been as much biological diversity as that which currently inhabitants the planet. We are at the pinnacle of biological diversification, the product of millions of years of evolutionary change. The biodiversity we enjoy today reflects a celebration of life, not only because of the countless number of living forms, but also because their unique adaptations to the environment are part of the complicated web of life that is a hallmark of planet Earth. For example, the multitude of variations of flower characteristics, such as size, color, structure, shape, aroma, and periodicity and timing of blossoming are matched by pollinator agents that have unique physical and behavioral adaptations. While seeking out the flowers to extract food resources (nectar), these agents effectively transfer pollen and thereby ensure both the continuity of the plant characteristics as well as the potential emergence of slight variations resulting from the mixing of genetic material. A striking example of this interplay is the bee-shaped orchid flower that exudes an aroma which mimics animal pheromones. Attracted to the flower by the aroma, bees unavoidably transfer the pollen from one orchid to another orchid as they attempt to "copulate" with the

PAGE 168 *thirds of Mexico's forests are in the hands of "ejidos" (common land) and agrarian communities. Many of them during the last 50 years have accumulated significant experience for the sustainable management of forests, extracting and trading products such as wood, ornamental plants, and edible mushrooms. Community forestry companies, besides being a source of employment and income for families, generate resources for fire fighting and plagues, and also illegal logging thus stopping deforestation and planning the regeneration of the forests in the long term.*

Mexico is the country with the highest diversity of lagomorphs (hares and rabbits) in the Americas. Some species, wich only live in small regions in Mexico, are increasingly affected by environmental degradation. Conservation of natural areas has been essential to the conservation of this and many other species in the country.

flower. Another example is the attraction of the carrion beetle to the orchid that emits an odor similar to decaying flesh. Similarly, the many bat species are dependent upon different types of food sources, such as nectar, fruit, insects and animal blood, and the unique feeding behavior and morphology of each of these interacting species has been shaped by the evolutionary paths that such species interactions bring about. These "co-evolutionary relationships" add to the complexity of the web of life and, simultaneously, represent not only a feedback to biodiversity and decoration of our planet, but a rich source of resources we enjoy—inspiration, health, and the raw materials upon which our ancestors have developed much of the food we have today.

The biodiversity which we enjoy today is so extensive that we have catalogued only a relatively small portion of the plant, animal, fungi and microorganism species, which may number 10 million to 100 million, or more. Additionally, we know little (or nothing) of the natural history, ecology, behavior and evolution of most of the species we have identified. However, based on our current knowledge, we have come to understand that species richness is not homogeneously distributed throughout the planet, and with some exceptions, it tends to be greatest in the equatorial regions and decreases as one moves poleward. In addition to the overarching factor of latitudinal variation, other abiotic (e.g., geologic history, disturbance patterns, climatic regime) and biotic (e.g., community structure, type and age) factors contribute to species richness. As an example of the consequences of the amalgamation of ecological and historical factors, Mexico, one of the megadiverse countries in the world, harbors approximately 10% of the vascular plant species, of several megagroups of animals, and most ecosystem types of the world.

Nature has an astonishing capacity to recover after the impact of human iactivities is halted or regulated. Protected Natural Protected Areas promote the conservation of the natural wealth of Mexico.

The dawning of the Anthropocene

There is a flipside of the coin of this evolutionary history. The planet's biodiversity and other features of environmental integrity are seriously threatened today by human activities. These threats jeopardize not only populations or entire species, but they have the potential of undermining environmental services and goods upon which the human community depends. In short, humans, individually and collectively, have an ethical responsibility to modify its habits and ensure that the rich tapestry of biodiversity (and all the benefits it accrues) is protected and preserved. Failure to take up this challenge now will ensure that a sixth great extinction of the Phanerozoic eon will become a reality and the future of life on Earth as we know it will be radically altered.

The previous five mass extinction events in the history of the world, which occurred long before the evolution of hominids (ancient ancestors of modern humans), were the result of natural causes. The last extinction event, which occurred between the Cretaceous and Paleogene periods, was marked by the cataclysmic impact of a large meteor in the Chicxulub region of the Yucatan Peninsula about 65 Ma. This event most likely contributed to the other multiple stressors that resulted in the extinction of dinosaurs, among other animal groups. The demise of the dinosaurs, in turn, at least partly provided the opportunity for mammals to rapidly diversify and evolve.

Researchers suggest that in addition to being driven entirely by human activities, it is likely the newest (sixth) mass extinction pulse will occur over a much shorter period of time and be equal to or greater than the previous extinction events in terms of biodiversity loss. Rather than the combined impact of multiple forces, this impending extinction event will be triggered by a single species, humans. While more than 75% to 90% of all organisms that have ever lived on Earth are now extinct, single mass extinction events have resulted in the loss of 50% to more than 90% of all living species within a short period of geologic time. Diversification of forms and behaviors characterizes the continuation of life, and research suggests that successful recovery of the biological wealth after a major extinction event requires tens of millions of years. Additionally, the communities of species that reappear are significantly different from those that existed before the event. Therefore, there is no doubt that if we experience the sixth great extinction event a biodiversity recovery will occur over a long time period (from the human perspective), and the biological actors and the ecosystems that reappear will be very different from those that we have and are adapted to today.

The biophysical nature of the human impact or footprint on Earth has become so omnipresent that the 1995 chemistry Nobel Prize laureate Paul Crutzen has referred to this new geologic epoch as the Anthropocene. Humans, individually and collectively, have a responsibility to understand what is at stake with the advent of the Anthropocene and the impact it will have on the descendants of humans and other life forms.

Effects and synergies of the anthropogenic agents in global changes

The decline of biodiversity we are now witnessing is symptomatic of a serious deterioration of Earth's life's support systems. While the human-caused or anthropogenic assaults vary in type, severity, location and timing, the common characteristic is the threat they pose to all living organisms and the ecological processes on which life depends. While some currently high profile agents of environmental impacts garner global attention, such as climate change, other agents such as fragmentation of the landscape and removal or change of the land cover, pollution (air, water and land), and the invasion by exotic species are no less threatening to biodiversity.

More than 50% of the land surface originally covered with vegetation has been deforested, fragmented or significantly altered. The ocean floors, similarly, have been severely impacted in an area equivalent to at least twice the current territory of the United States of America.

Pollutants in the air, water, soil and sediment continue to pose a threat to the flora and fauna as well as to human health and can be found throught the planet. Some pollutants, which have a long residency period before they are broken down by natural processes, are the legacy of previous generations of human activity. Some pollutants have been recorded from tree bark at all latitudes, whale blubber, the umbilical cords of newborns and breast milk of mammals, suggesting their ubiquitous nature even in relatively protected environments.

The spread of exotic species has a significant impact on biodiversity, and the effects can cascade throughout the ecosystem. For example, the invasion of the exotic coconut palm in the remote Palmyra Atoll in the central Pacific Ocean displaced the native trees in some islands therein. In turn, seabirds dependent on the native trees, and unable to use the invasive coconut palms died off or moved to other areas. The absence of seabirds deprived the infertile soil of the coralline atoll of the nutrients in the guano deposits which would normally enrich the coastal waters and support the phytoplankton, zooplankton, and higher order marine communities, including mantarays.

The Totoaba is a fish that exclusively lives in the Golf of California. It critically endangered because overfishing that has caused its populations to plumbeted 95% in the last 60 years. Although it is l protected, illegal fishing to supply its air bladder to the Chinise black market. The vaquita porpoise gete entagled and dies in the nets used to get the totoaba. Saving tthose species is a proirity of Mexico.

The introduction of rats in insular systems, such as Hawaii or the Island of Guadalupe in Mexico, has decimated or driven to extinction multiple species of birds, invertebrates and plants.

The human population, which is projected will be 9.5 billion by the middle of this century and possibly 11 billion by the beginning of the next century, is central to the issue of biodiversity. The increasing growth of the human population and the per capita are probably the greatest threats to biodiversity. In the drive to address individual and community needs, humans historically have extracted goods from and manipulated their environment, often simplifying it, with the resultant loss of species and the complex linkages they provide.

Although each type of agent affects biodiversity in unique ways, they do not function in isolation but rather in a complex range of interactions that include:

i) indirect effects which occur when an agent affects another agent and the response cascades through the ecosystems. For example, excessive use of agricultural fertilizers contributes to the release of nitrogen, phosphorous and other nutrients which, in turn, promotes the invasion of exotic species that take up the nutrients. Nutrients flowing into the northern Gulf of Mexico from the agricultural lands in the eastern portion of the United States are responsible for the large algal blooms which, when they die and decompose, cause depleted oxygen conditions, a lethal effect to much of the marine life that historically inhabited the area.

ii) feedback loops which occur when the effects of an agent self-perpetuate and result in furthering the initial impacts. For example, in the fragmented tropical forests of Latin America, winds that strike the edge of forest patches are a dominant cause of the windthrow of primary trees such as the emblematic "ojoche" or Mayan nut. The open spaces favor colonization by secondary-forest species such as lianas and small trees such as the pumpwood. This newly established vegetation is weaker and more easily damaged by winds than the native species and, in turn, becomes a relentless wave of disturbance moving inward, into the remnant forest.

iii] synergies that occur when two or more agents enhance the effect of the other(s). For instance, in the forests of the Los Tuxtlas region in southern Veracruz, hunting has severely reduced the native animal community. At the same time, deforestation and fragmentation of the vegetation represents a reduced habitat, insufficient to maintain viable populations of the native fauna. As a syn-

ergy, reduced and fragmented forests facilitate the accessibility to the area and thereby enhance the impact of the contributing agents of change. In a similar way, global climate facilitates other impact agents, such as increased temperatures of coastal waters that promote growth of algal blooms in waters in turn enriched by nutrient runoff.

The joint effect of these impact agents is readily expressed in the loss of biodiversity. While a focal point of biodiversity is species extinction, other measures of the health of species richness are the reduction of the populations that continue to exist and rate of regional (even if not global) extinctions. Loss of plant and animal habitat leads to local species population extinctions and a loss of diversity from ecosystems. Research data suggest that during the past forty years, global populations of vertebrates have declined at least 25% and almost twice that number for those living in the tropical regions. Likewise, recent studies show that the historical geographic range of 25 species of the large herbivorous mammals of the African savannas, such as elephants, the black rhinoceros and hippopotami, has now been reduced more than 80% from its original extent.

Similarly, 96% of the area that once constituted Brazil's unique Atlantic jungle is devoid of the top predators, seed dispersal monkeys, and large grazers such as tapirs and boars that it supported until a few decades ago.

One of the most worrisome aspects of the expanding Anthropocene epoch is the extinction of species and the irretrievable loss of the services they provide. The magnitude of the extinctions of the Anthropocene is already 10 to 100 times greater than the rate experienced in "normal" periods. A conservative estimate suggests that more than 600 vertebrate species have become extinct over the course of the last 500 years. In addition, species are not isolated biological entities; they are linked to many other organisms in complex interactions, such as mutualism and antagonism and to the environment that they modify to varying degrees. For all practical purposes, extinction represents the irreversible finality of a species. While most conservation biologists today focus their attention on the prevention of extinction, there is a core of scientists that support the resurrection of species already extinct. This reversal of extinction, or de-extinction, applies a variety of techniques such as cloning and genetic engineering. While techniques are improving, this strategy to protect (and benefit from) biodiversity brings to the forefront many practical, moral and ethical questions that have not yet been addressed. In a recent article (2014), conservation biologist Paul Ehrlich articulated the case against de-extinction; "Even if reviving extinct species is practical, it's an awful idea. It would take resources away from saving endangered species and their habitats and would divert us from the critical work needed to protect the planet. " He added, "If people take a 'Jurassic Park' future seriously, they will do even less to stem the building sixth great mass extinction.".

From the species to the biological community: interaction networks

Species interact within ecological communities and between communities and their abiotic environment, and understanding these ecological interactions is critical in preparing for and addressing global changes, especially those resulting from human activity. The ecological niche theory postulates that each species (plant, animal, fungus and microorganism) requires a fundamental ecological niche, a set of specific abiotic environmental conditions in order to survive, such as temperature and availability of water. When the environmental conditions change, a species may die out, adapt to the new condition(s) or migrate to another place where the condition(s) are similar to those of the fundamental niche. In addition to the physical environmental conditions, availability of food resources, and the presence or absence of competitors, mates and predators, are critical biological factors determine a species survival probability and reproduction success. Such specific combination of environmental and biological conditions defines the realized niche of the species.

The impact od Anthropogenic climate change on interactions that define the realized niche of many species is especially important in tropical regions because of the larger number of species involved, countless microenvironments, and the complexity of linkages among the organisms and between the organisms and the physical environment. These impacts are particularly crucial in Mexico's tropical forests where this ecosystem type reaches its northernmost limit on the continent and where the vegetation cover has been significantly modified and the landscape fragmented.

Species interaction is also a critical factor in survival. Consider the scenario of an insect eating bird, adapted to a lowland tropical environment, migrating because of global warming to a higher elevation to maintain its optimum temperature. Different scenarios may play out that directly affect the survival of the bird. The insects upon which the bird fed may also migrate to a higher elevation thus preserving the specific food resource. Alternatively, the bird may adapt to and feed on a different composition of the insect community. Additionally, the migrating bird may experience increased competition for food and nesting opportunities from other bird species or populations that initially occupied

The golden eagle is the national emblem of Mexico. It nets in rocky areas of the north and center of the country. The species is endangered. Its conservation is based in strategies involving the social organizations, private sector, and government agencies.

that newer niche. This suggests that changes in the distribution of one species will also affect other species.

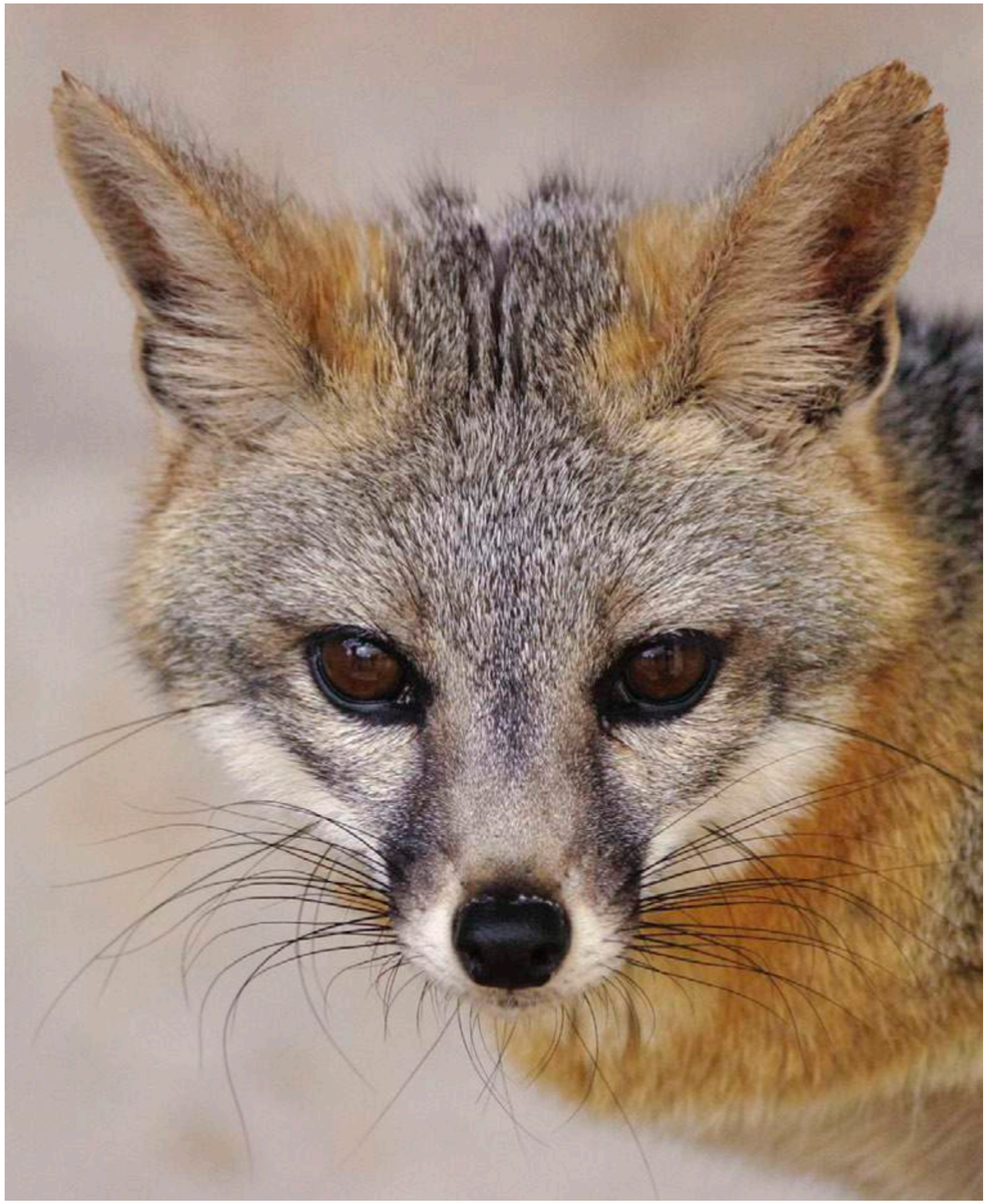
The effects of climate change extend well beyond warmer temperatures and include modifications to the extent of cloud cover, precipitation and moisture regime, and the relative difference between daytime and night time temperatures. These subtle impacts have been identified as one of the indirect causal agents for the rapid decline of many amphibian populations, and in some cases extinction, such as some species of the harlequin toads in many tropical regions of the world including Mexico and Mesoamerica. While the amphibian chytrid fungus is responsible for the massive die-off of the amphibians, this fungus prospers better in cold conditions than in relatively warmer conditions. Studies have shown that the cloudy day ratio has increased in the last forty years in the Costa Rican cloud forests causing a slight decrease in temperatures during the day and warmer temperatures during the nighttime period, thus providing ideal conditions for the growth of the fungus and the rapid infection and die-off of the amphibian populations. In a similar vein, increased water availability in a dry deciduous forest, historically characterized by a highly marked dry season, can indirectly affect the reproductive success of the lilac-crowned Amazon parrots. Researchers of this system noted a strong correlation between the parrot clutch size and offspring survival rates with rainfall. Greater amounts of precipitation and higher humidity levels in consecutive years resulted in greater abundance of fruits the parrots feed on. Thus climate has a direct effect on fruiting trees and an indirect effect on the parrots. Another example of plant-animal interactions and interdependence is presented in the reproduction of the fig trees (family Moraceae). These largely tropical trees produce large amounts of fruit throughout the year that are consumed by a range of animals including birds and monkeys, which serve as seed dispersal agents. The fig tree's flowers are pollinated by very specific wasps (family Agaonidae) that, when laying the eggs inside the flower structures, transfer the pollen and fertilize the flowers, thus allowing the development of the fruit. When the small wasp eggs hatch, the larvae eat some of the fig seeds before leaving the flowers. This close dependency between reproduction of the wasp and fig tree suggests that the response of these trees to climate change will have a direct effect on the pollinators, the animals feeding on the fruit and, clearly, the effect of climate on the wasps will impact the pollination of the flowers. Fig trees, by virtue of fruiting throughout the year, operate as keystone species upon which many fruit-eating animals depend, all of which however, depends on the pollinating wasps and their susceptibility to climate change.

When considering the effect of global changes of the Anthropocene on the planet's biological diversity, it is important to recognize that interactions among species

are vital for the maintenance of ecosystem services upon which the human and other living communities depend. Protection of these interactions is especially critical in the tropics and in countries such as Mexico, where there is an exceptional concentration of the world's biodiversity.

Epilogue

There is a survival and moral imperative to prevent the loss of the world's biodiversity. Failure to take up this challenge now puts at risk the goods and services the human community and other species need. We must recognize our inescapable responsibility to safeguard the cumulative wealth of the planet's biodiversity for the wellbeing of our descendants. While we still have an opportunity to modify our actions, scientific evidence suggests that the amount of time to make substantive changes is rapidly diminishing.



There are animals such as the grey fox that are able to survive in areas dominated by human acrivities including forests, grasslands, and crolands.

Conservation

More than six decades ago, the famous natural scientist Aldo Leopold described our planet as "a world of wounds". His description could not be more accurate because our activities have had a major negative impacts, such as the destruction of natural environments, the extinction of species, pollution, and climate change. These impacts represent in Mexico and in the rest of the world, the major challenge in this century because the well being of humanity depends upon the conservation of nature and the maintenance of environmental services. The most important environmental challenges of Mexico are related to the harmonizing economic development and conservation of nature. Especially important is to halt the destruction of the Earth's natural ecosystems, extinction of species, contamination of water sources and the soil, and global climate change.

México has made major conservation achievements that date back to the beginning of the 20th century when the exploitation of sea mammals in the Baja California waters was banned. This saved the grey whale, the Guadalupe fur seal, and the elephant seal from extinction. Currently the conservation of nature in Mexico is based on the protection of endangered species, the establishment of protected natural areas, and the development of sustainable management strategies.

PAGE 186, ABOVE AND RIGHT *The pronghorn antelope used to be a common inhabitant in grasslands and scrublands in central and northern part of Mexico. Since the beginning of the 20th century, however, hunting reduced its distribution to certain regions in Chihuahua, Sonora and Baja California Sur. Fortunately, the timely intervention of the Mexican government, universities as well as social and private organizations has allowed its recovery of species. The critical situation faced by pronhorn antelope in the 1970s, promoted the creation of the biosphere reserves of El Vizcaíno, in Baja California Sur, El Pinacate and Grand Altar Desert in Sonora, and more recently in Janos, in Chihuahua. These reserves are important in preserving many other animal and plant species that coexist with the pronghorn.*

PAGE 190 *The silouete of the California Condor, the biggest birdfrom North America, disapperaerd from the skies between 1970 and 1980, when a handful of surviving individuals remained in the wild, The condor is species of common interest of Mexico and the United States, so a binational collaboration started in2002 to design and implement a plan to reintroduce the species to Mexico. Thanks to this collaboration, today more than 30 specimens of this majestic bird fly once again the mountain ranges and the cliffs of the San Pedro Mártir National Park in the Baja California Peninsula.*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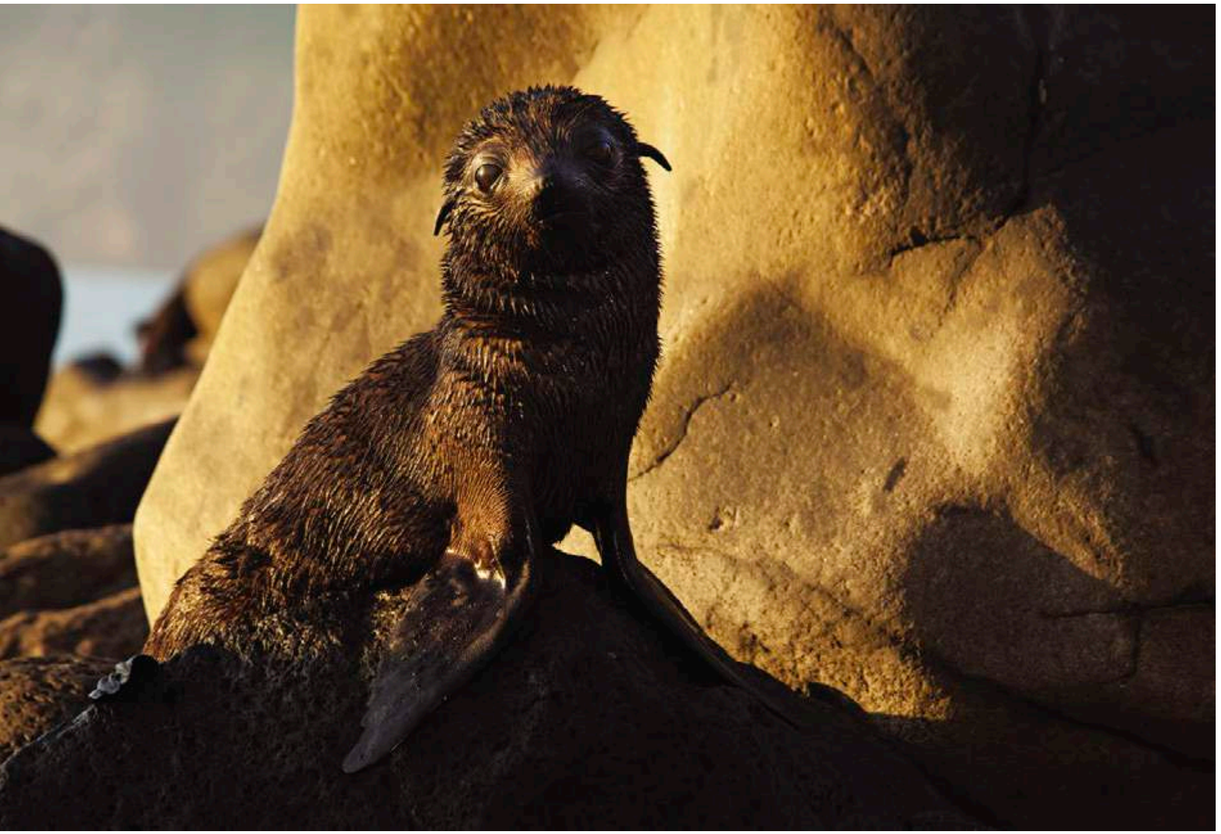


The Guadalupe fur seal was heavily exploited in the nineteenth century by the fur industry. It is estimated that more than 52 000 individuals were captured in Mexican coast bringing the species to the brink of extinction. However, national and international pressure to reduce the fur trade has allowed the recovery of their populations. Of the 20 surviving individuals less than 100 years ago today there are more than 9,000 thanks to the design and implementation of bans on exploitation and the protection of Guadalupe Island, its main breeding area, as a natural reserve.

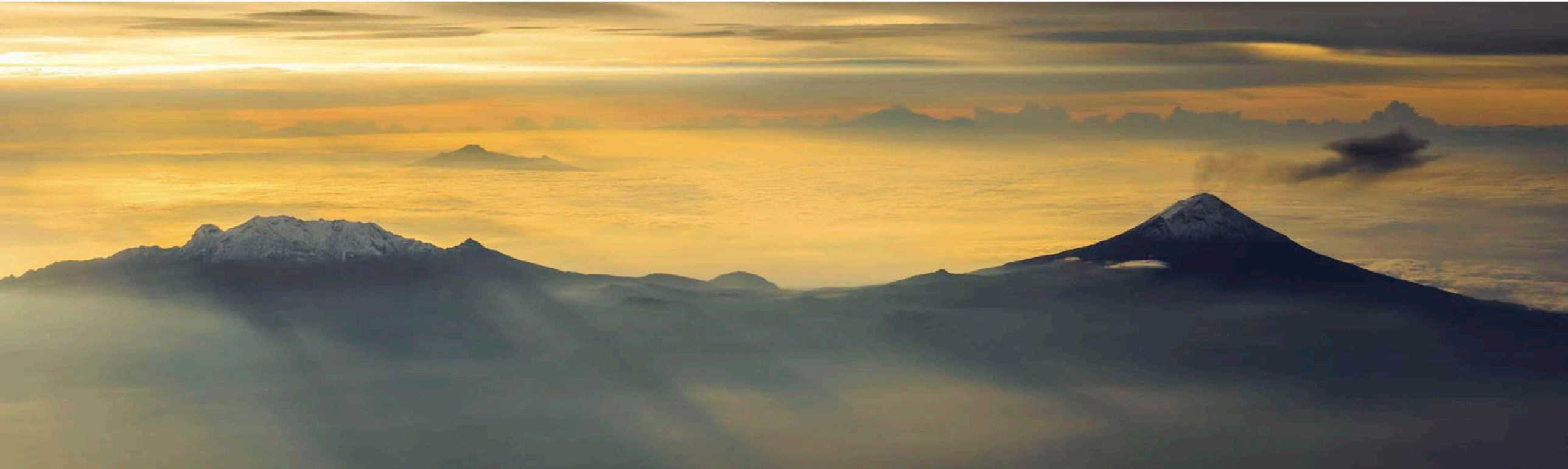
The conservation of the vaquita porpoise is a fight against time. This cetacean, the only endemic to Mexico, has been heavily affected byillegal fishing the totoaba, a fish with high demand in the China black market. The vaquita is accidentally caught in the fish nets, where it drowns. To try to save the vaquita and other marine species in the Gulf of California, the Mexican government, through the Ministries of the Environment and the Navy, civil society organizations, and academia have implemented actions to curb poaching of totoaba.

In the year 2009 a group of 23 American bisons donated by the National Wind Cave Park in South Dakota, United States of America, were releases on the the Janos Biosphere Reserve in Chihuahua. That event represented the reintroduction of this species in Mexico, where it disaaperaed at the end of the nineteen century. Currently, there are more than 100 bisons. The successful recovery program will likely continue, guaranteeing that this majestic animal roams free again on grasslands in northern Mexico.

The black-footed ferret (top right) is a weasel declared extinct in 1980. A few years later, however, some ferrets were surprisingly discovered in the Wyoming prairies in the United States of America. The 18 surviving individuals were captured to start a a successful captive recovery program that has allowed the return of thousands of ferrets to North American prairies. In Mexico, the Janos Biosphere Reserve is the only site in Mexico that participate in the recovery program. The ferret is a natural predator of the prairie dog (right below), so its recovery is fundamental to maintain the structure and function and of grassland where both species live.

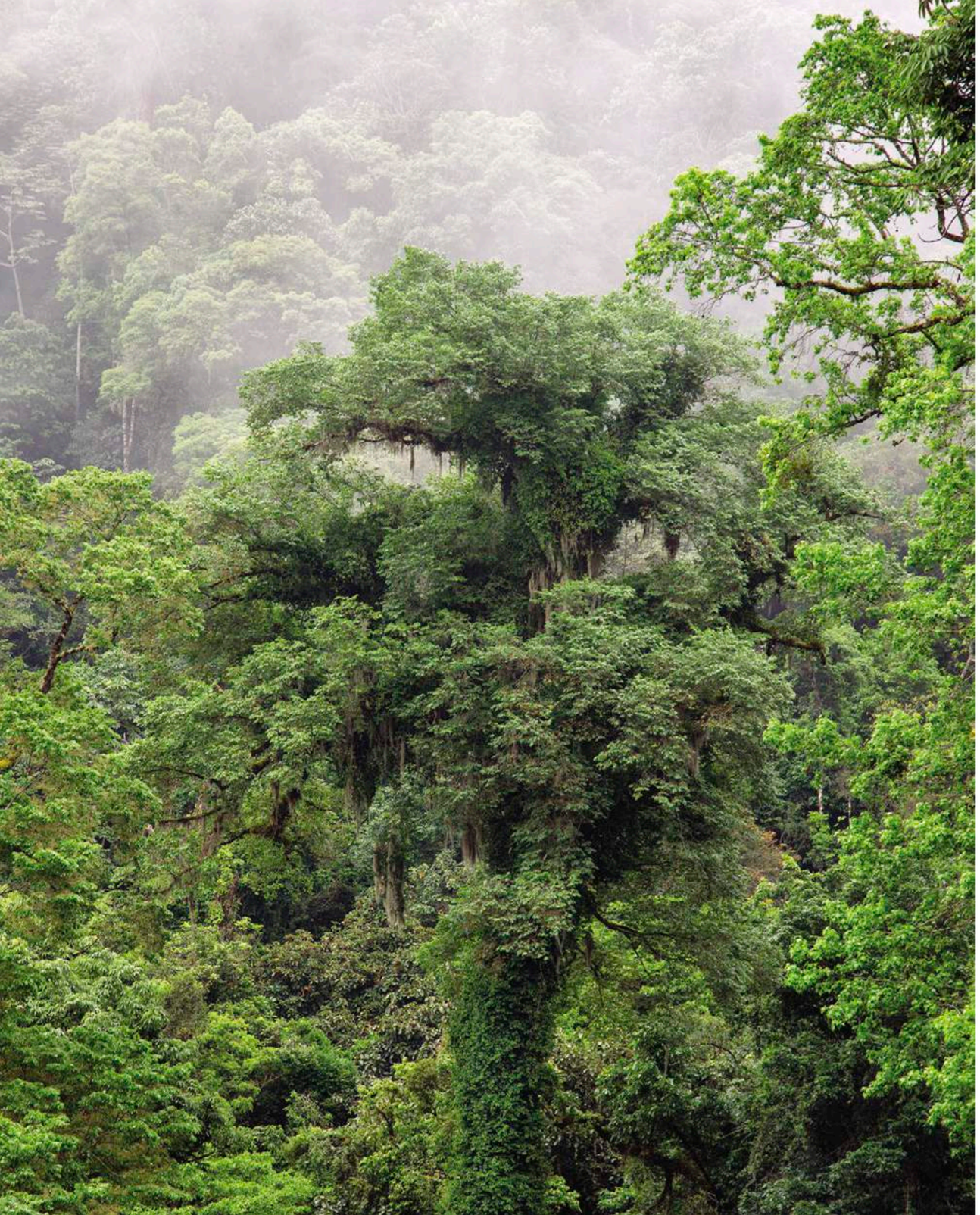
There are 22 species of parrots and macaws in Mexico, which have been important in the country's culture since pre-Hispanic times. Illegal trade and the destruction of the forests they inhabit are the most important risks they face. In Mexico, trade of parrots and macows is is prohibited, but there are still illegal traffic. The Thick-billed parrot is an endemic species of Mexico that is in danger of extinction. It is protected in several reserves such as the Janos Biosphere Reserve, Chihuahua.

There are 30% (164 species) endemic species of mammals in Mexico. The volcano rabbit o zacatuche is an endemic rabbit to Mexico. It lives at a more than 3 000 meter altitude in the alpine grasslands of the Transvolcanic Belt. Climate change represents a serious threat to this species since the increase of temperature in the planet may reduce or make disappear the high mountain ecosystems, taking with them all the species that live there.



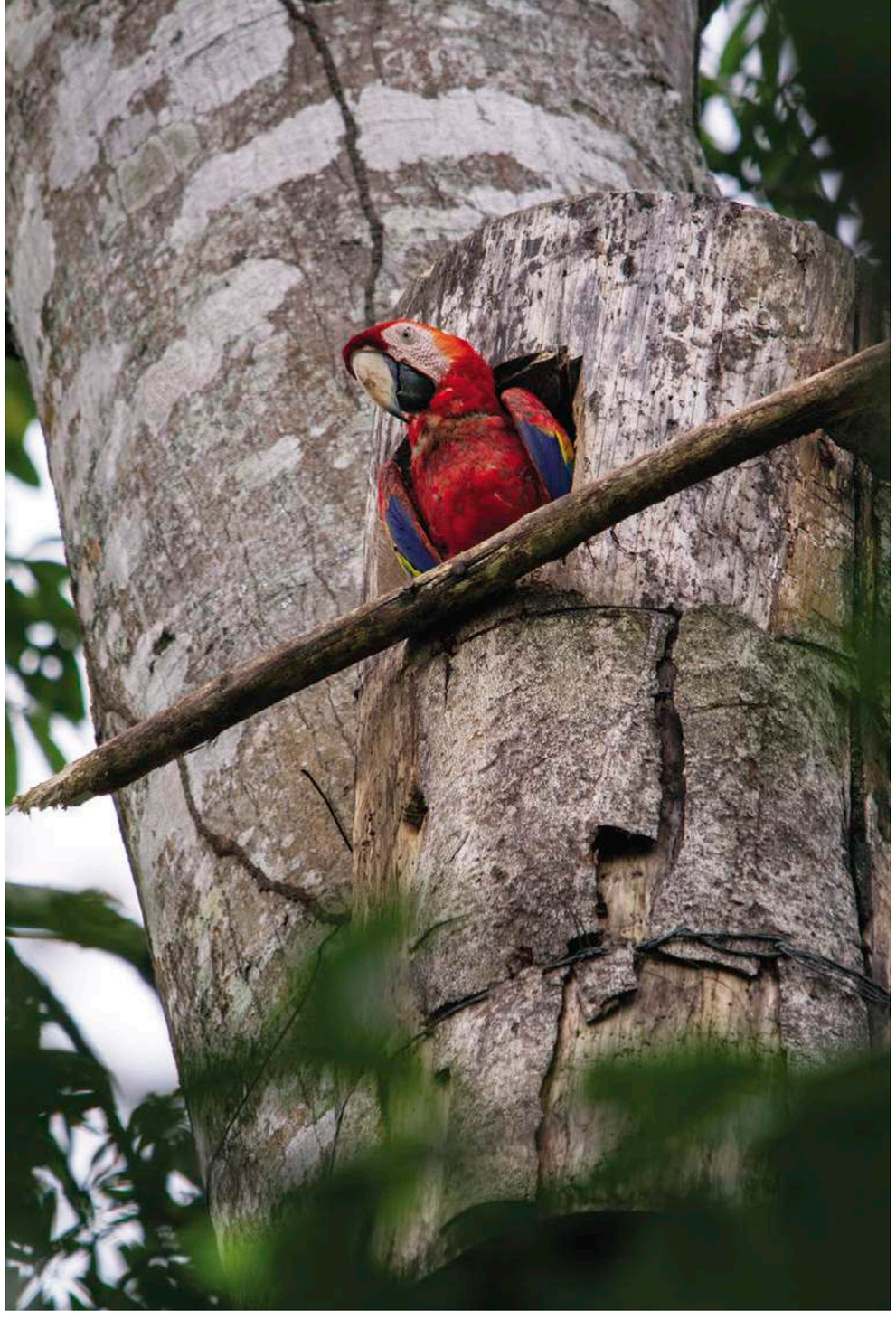
The monarch butterfly is a symbol of international cooperation between Mexico, the United States and Canada, to promote the recovery of migratory species. Thanks to this joint effort has established a network of protected areas through the migration route of more than 8 000 km that each year travel the butterflies from Canada to the central highlands of Mexico . In Mexico , more than 50 million butterflies each winter refuge in sanctuaries that make up the Biosphere Reserve Monarch Butterfly internationally recognized by UNESCO as World Heritage .

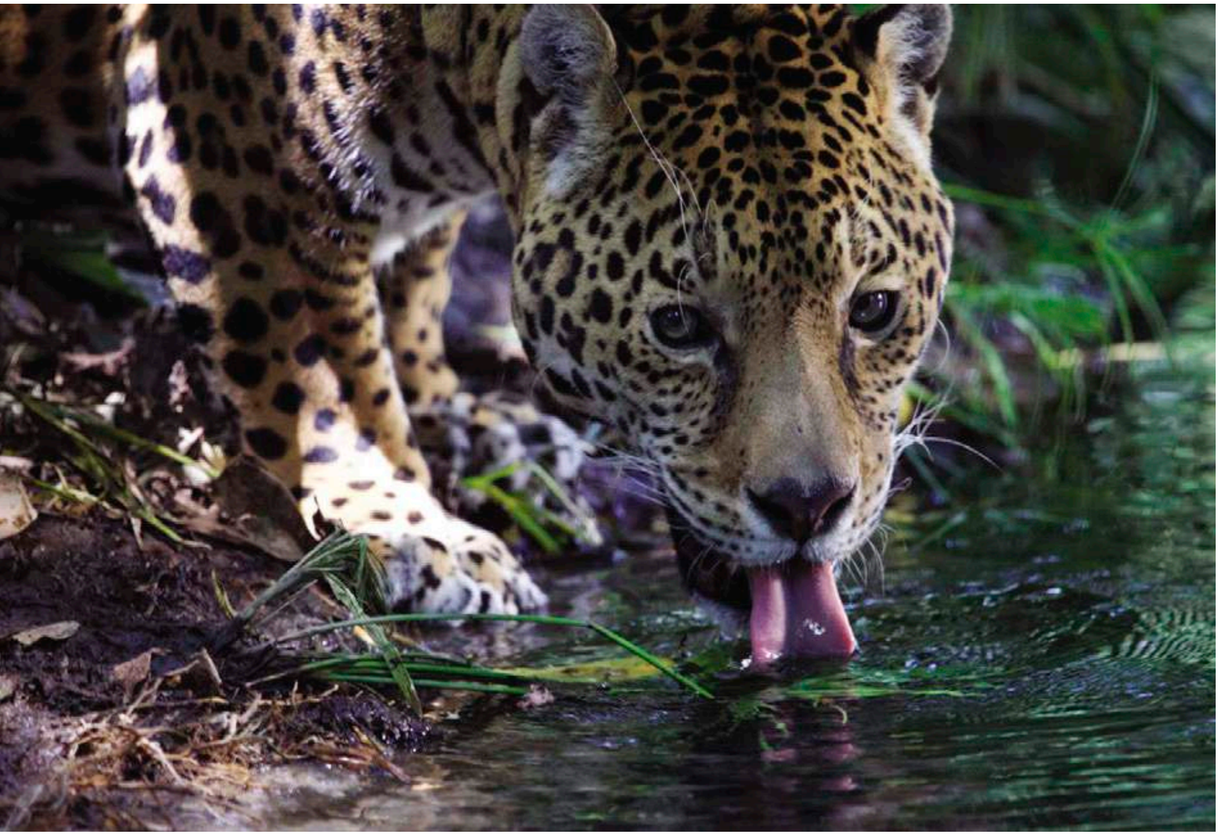
During the dry periods there are hundreds of forest fires in different areas of the Mexican territory that put at risk the life of their inhabitants and the preservation of biodiversity. The Secretariat of the National Defense together with the Comision of Natural Protected Areas and the National Forestry Commission help in fighting these fires assisting the firefighting brigades with troops and helicopters equipped to discharge water in areas where access is difficult.



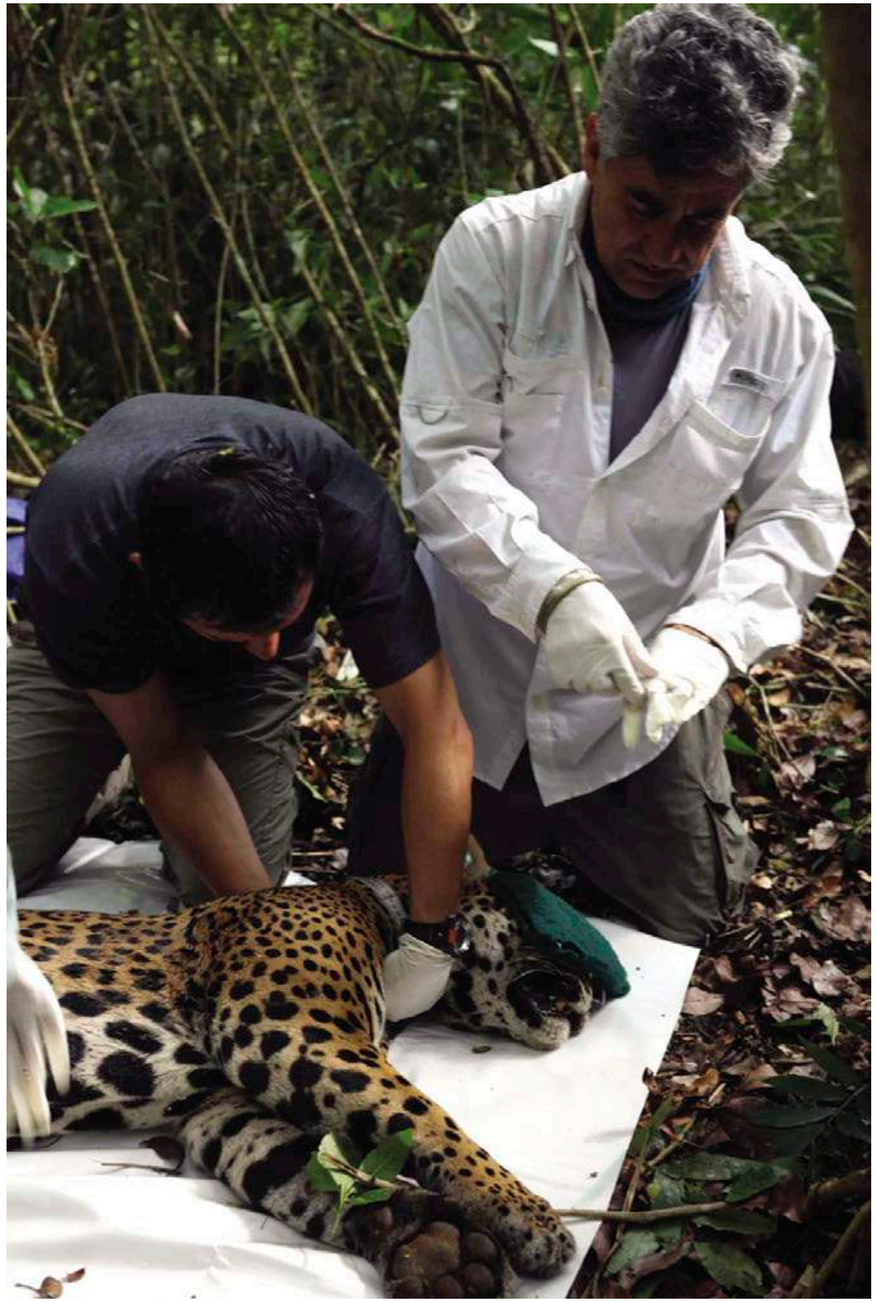
The guan (page 206) and the quetzal (above) are two representative birds of the southern rainforest of Mexico and Central America. Since prehispanic times these two birds astonished the jungle inhabitants and they continue to do so since visitors from all over the world come to watch these birds. At present, these and close to 375 more species of birds are protected in the El Triunfo Biosphere Reserve in Chiapas (left).

Throughout history, collectors and bird traffickers throughout the world have coveted the scarlet macaw. In view of an unreasonable capture of chicks and adults and the destruction of rain forests, the Mexican government, in collaboration with social and private organizations, started a monitoring, reproduction and reintroduction programs of the macaw on its natural habitat to promote its recovery. Thanks to the efforts sustained during decades, the rainforests in Chiapas and Veracruz are colored once again with the presence of the scarlet macaw.

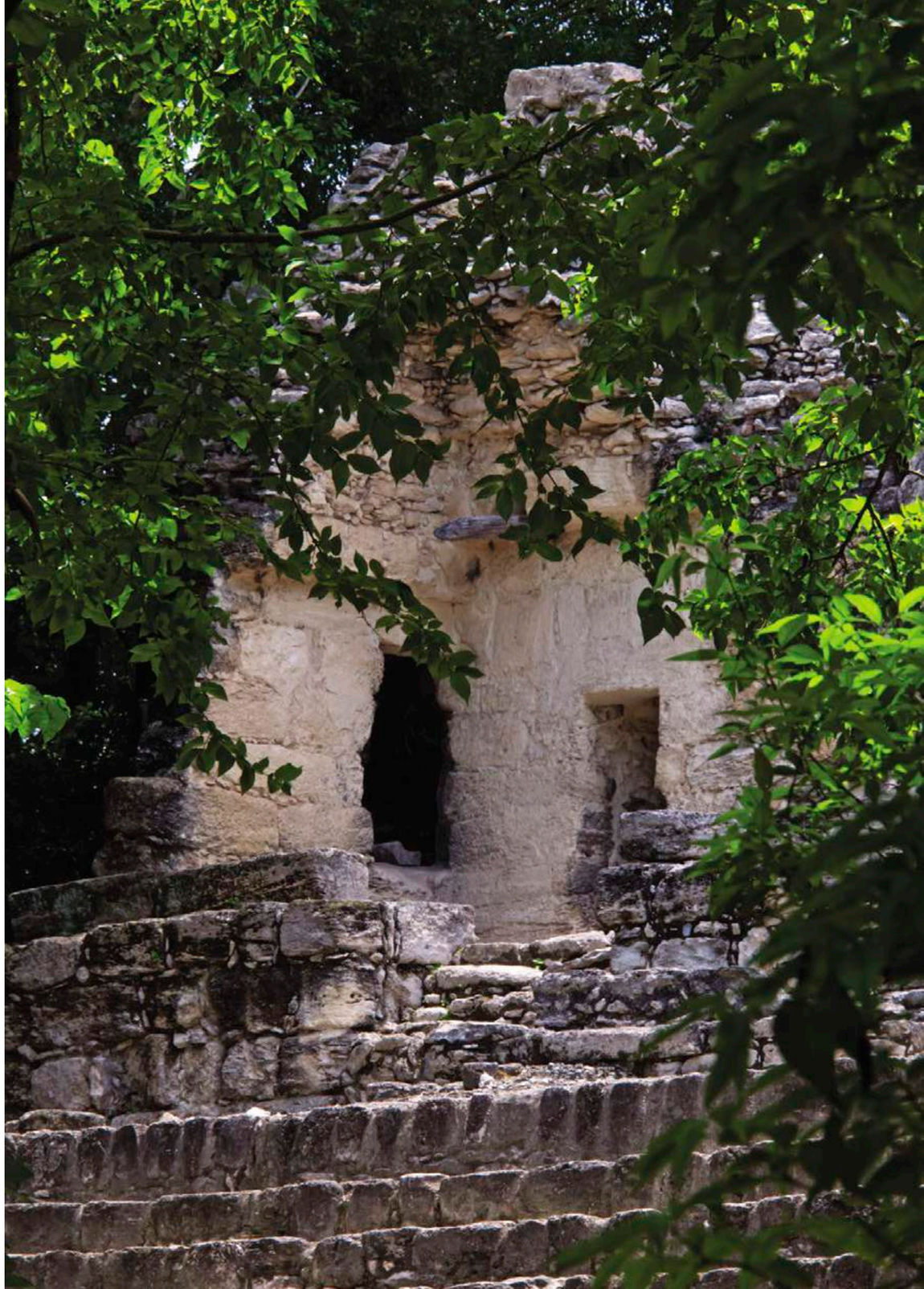




The conservation of big predators like the jaguar is an especially challenge because it requires the protection of millions of hectares to maintain healthy populations. In Mexico approximately 4 000 jaguars live distributed from the north of Sonora desert bushes to the Mexican southeast rainforests, including a large variety of tropical and subtropical forests. With the participation of a large number of priority sites and organizations, the National Alliance for the Jaguar Conservation was consolidated to know in detail the conditions of the jaguar populations and then define the necessary actions to be taken to protect the king of Mexican jungles.



"Hunting meat" –wild animals hunted for human consumption– has been fundamental in the development of Mesoamerican cultures. Tapir represented a substantial food extracted during hundreds of years in a sustainable manner. However, its disappearance from its habitat in the jungle and poaching have caused this magnificent animal to be found today only in remnants of jungles in faraway areas of Campeche, Tabasco, Chiapas and Quintana Roo.

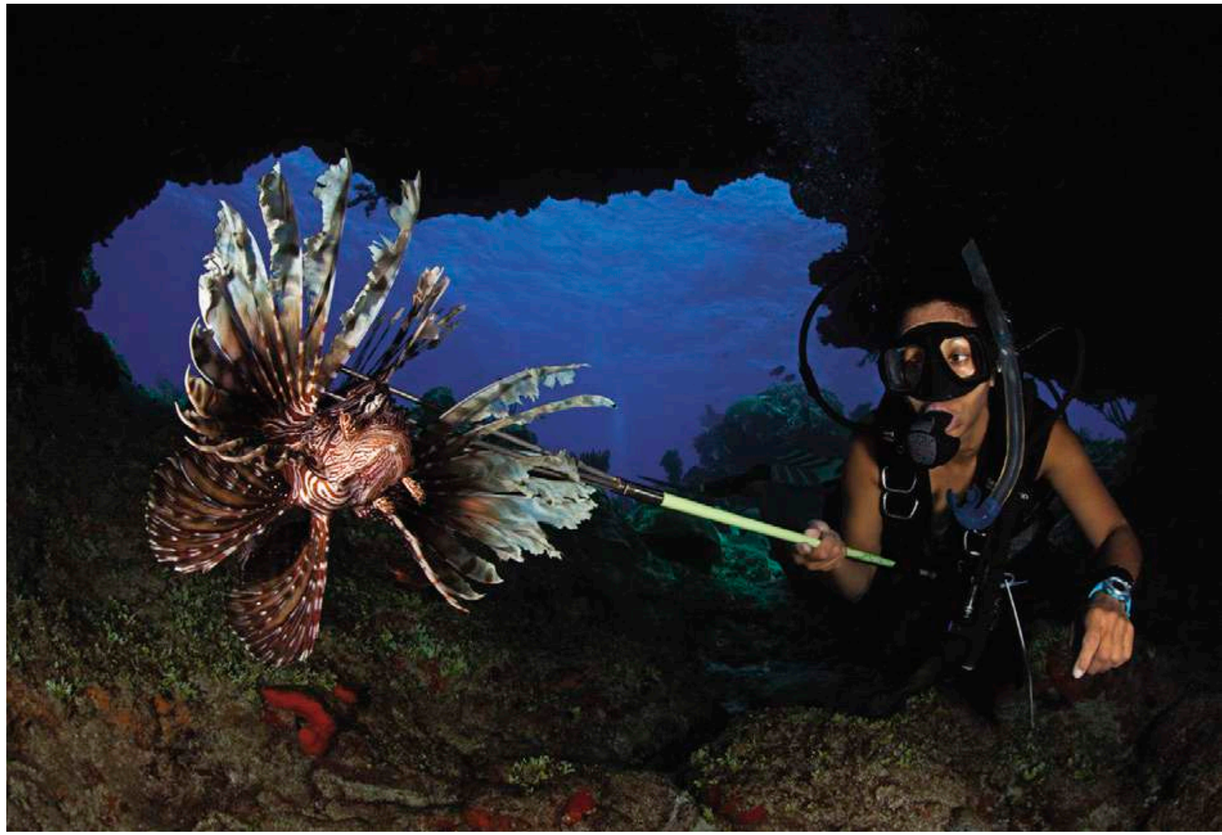


Some species and ecosystems are especially fragile in view of the changes in the quality of the environment. The American flamingo has been severely affected by the pollution of the hyper saline lagoons that reduces the amount of crustaceans available as food. Biosphere Reserves have been established like those in Ría Lagartos, Los Petenes and Ría Celestún, in Campeche and Yucatán, to recover these populations.

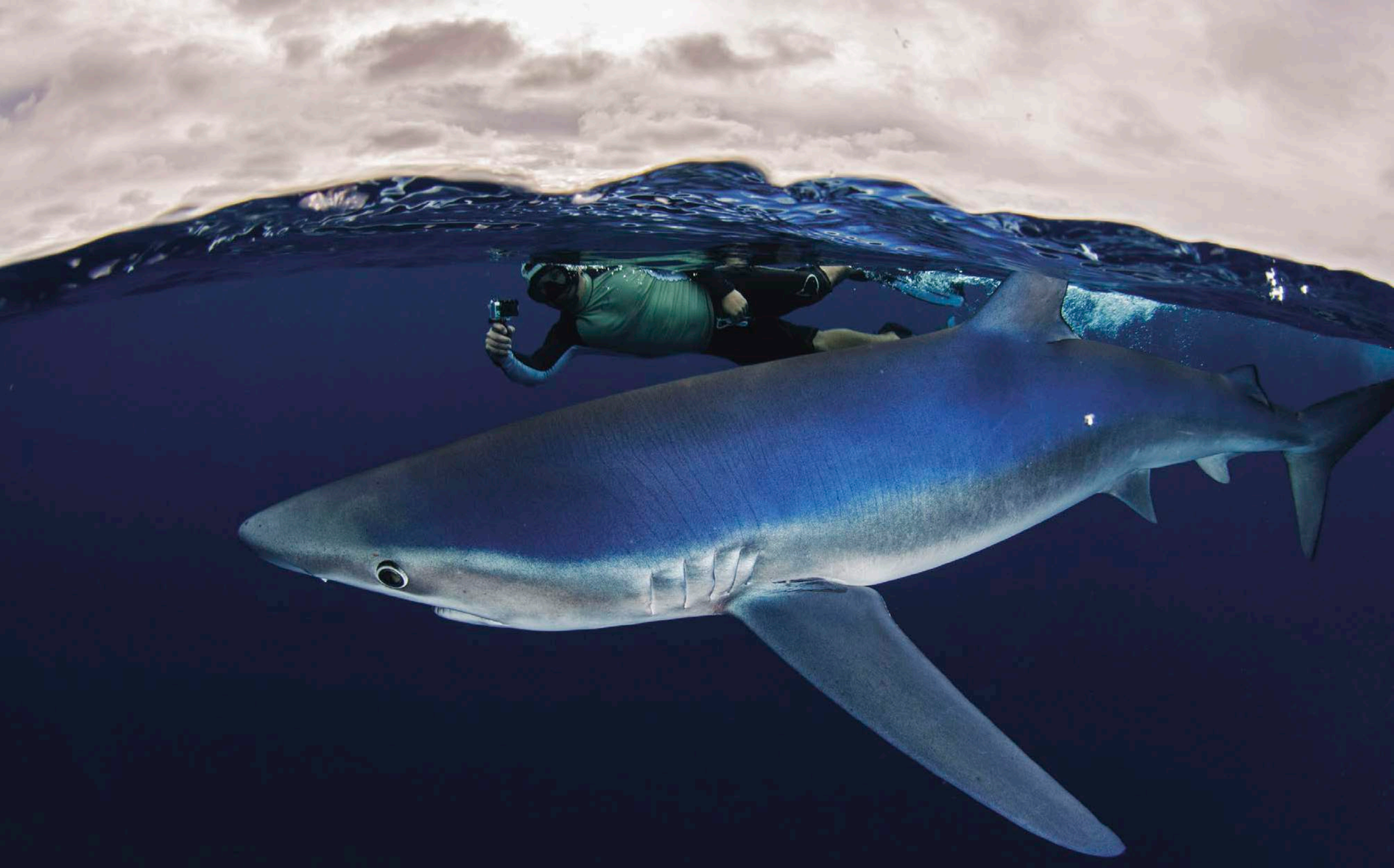
In the entire world, bird watching represents an ecotourism activity and it represents a significative income to the regions where native birds fly free. The huge diversity of birds in Mexico represents an opportunity to promote this activity amongst nature lovers, promoting the conservation of this group and improving the socioeconomic world of the communities that live in Mexican forests, jungles and deserts.

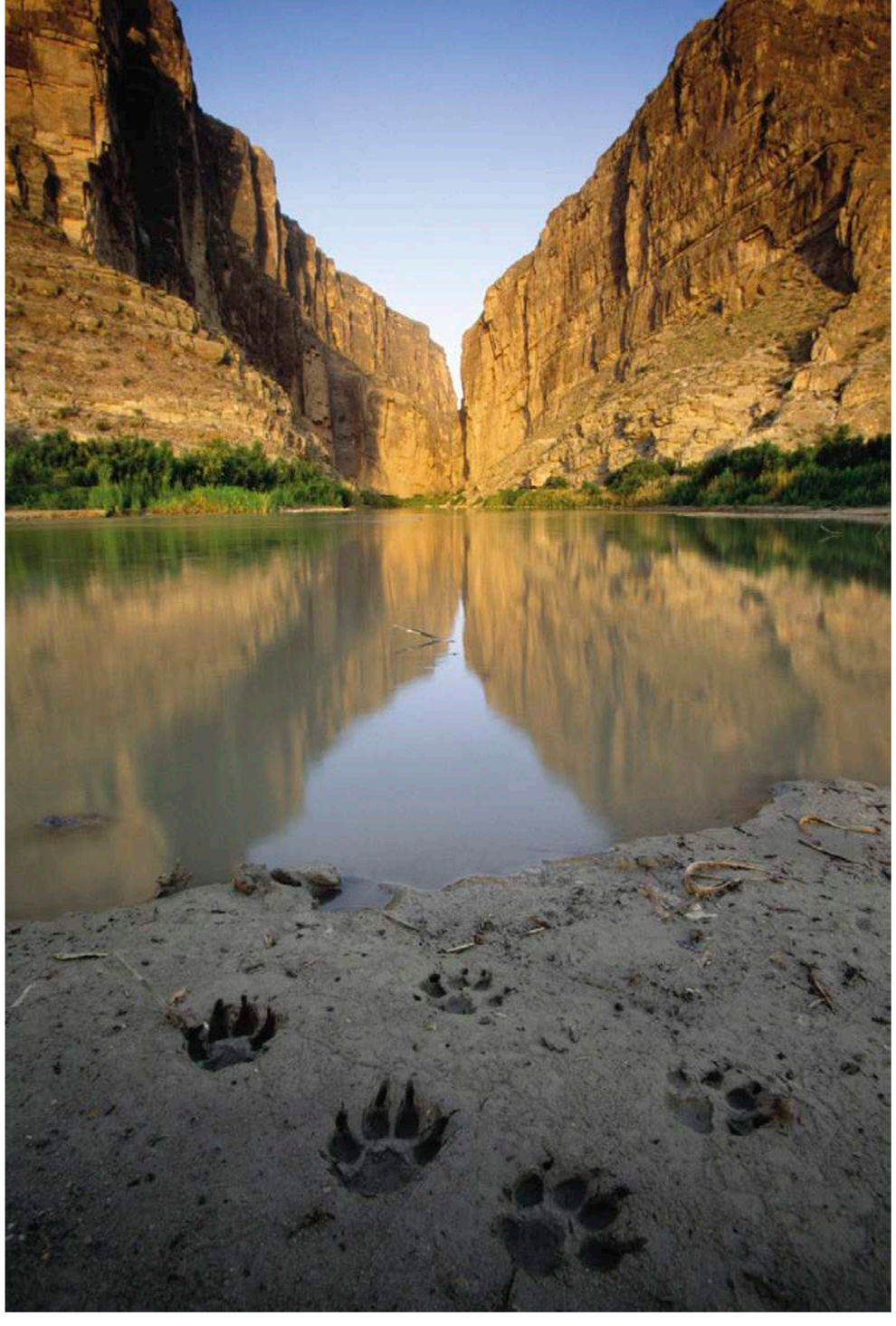
Luckily for Mexico, it is the nesting site of six of the seven sea turtles that live in the world's oceans and seas. These species are considered a conservation priority in the Mexican government agenda. The collaboration between federal and local institutions, universities, civil organizations and private companies has promoted for more than half a century now, the recovery of the turtles and the protection of their main nesting sites in the coasts of Oaxaca, Guerrero, Michoacán, Tamaulipas, Veracruz and Quintana Roo.

Mexico, Belize, Guatemala and Honduras have collaborated for decades, to establish a Protected Natural Areas network along the second largest reef barrier in the world that they proudly share. The Mesoamerican Reef, as is known, faces the invasion of the lionfish, species introduced by human beings that has become a plague and a threat to other species. In Mexico, some innovating strategies have been implemented to eradicate this exotic species, including sports hunting and fishing permits that give an incentive to capturing it.



PAGE 226 *The conservation of rays and sharks is a global challenge, since most of these species travel the sea currents around the world and there is a strong international demand for the products obtained from them. In Mexico, that has more than 200 species of rays and sharks, for their protection legal initiatives have been promoted, such as the Mexican Official Norm NOM-029-PESC. This regulation allows the extraction of some species and definitively protects other, thus allowing the conservation of these animals that have erroneously been considered dangerous for human beings.*





Gerardo Ceballos and Rodrigo Sierra

ACHIEVEMENTS AND CHALLENGES OF PRESERVATION

Planet Earth, our home in a vast universe, is a place of wonder, complexity, bounty and raw beauty. Unfortunately, much of humanity hardly acknowledges these attributes. Despite the fact that survival of the human community is closely bound to the natural world, modern societies seem to share a disconnect from the wildness of the natural environments that has shaped human history. Unless one has had the opportunity to witness the majesty of a millenary pine tree, the immensity of the sea, the serenity of the prairies, the lushness of forests, the beauty of a polychrome coral reef, or the stunning presence of a jaguar, it is difficult to explain the excitement and sense of wonder and even reverence the natural environment can elicit. Even though our history is closely linked to nature, modern societies are farther and farther away every day from the wilderness, and its plants and animals, which have being our companions since our origins. Little by little we have lost the way, and little by little we have lost the appreciation and interest for nature. We are losing our wonder and joy over the simple sounds of the wind passing through the leaves of the trees, the noise of rain in the forest, the whisper of strange sounds in a dark night and the diversity of countless species of wild plants and animals. The price of this detachment is very high and manifests itself in the severe environmental problems such as global climate change, loss of the wilderness and landscape fragmentation, species extinction and pollution, and

economic and social problems such as the severe wealth disparities and widespread social discontent now confronting most societies. We live in a world or wounds as the great naturalist Aldo Leopold appropriately described it many decades ago.

Nature is threatened by human activities. One of the most serious of challenges humanity faces this century is the loss of biological diversity or the countless varieties of life forms that inhabit and shape our planet, the genetic wealth they contain and the ecosystems they form. Conservation of nature is a critical need, more important today than ever before in human history because of the proven ability of humans to cause species extinction and irretrievably disrupt the normal functioning of ecosystems. Effective conservation efforts aimed at protecting this interlocking web of lifeforms require the participation of all the sectors of a society and all societies globally. The popular religious leader, Pope Francis, implored in his encyclical Laudato Si (Praised thou be) in 2015, "I invite you to urgently open a new dialogue on how we are building the future of the planet. We need a conversation that unites us all, because we are interested in the environmental challenge we live in and its human roots impact all of us."

Conservation in Mexico

Mexico's biodiversity conservation efforts are implemented through three complementary strategic axis: development and maintenance of natural areas, protection of endangered species, and establishment of sustainable use practices to ensure the preservation of species diversity and ecosystem functioning. These axis provide the fundamental priority guidelines for simultaneously developing the country, protecting the ecosystems and their species, and providing goods and services to the Mexican people.

Mexico's long tradition of conservation and protection of nature dates back to the pre-hispanic period. One of the first efforts in recent modern times to preserve nature took place in 1861 with the passage of the National Forestry Act under the presidency of Benito Juárez. The statute required the replanting of "ten mahogany and cedar trees for every tree" that was cut on public lands. In the period when General Porfirio Diaz came to power, between 1876 and 1910, Mexico developed rapidly. He enacted El Mineral del Chico, in the state of Hidalgo, as a National Forest. El Chico National Park as it is know now, retains to this day its forest cover and is a major ecotourism destination. Protection of this area occurred during a period of increasing domestic political upheaval leasing to a military revolution and very rapid expansion of the railway, mining, forestry, and cattle industries.

Near the end of the Mexican revolution, then President and General Venustiano Carranza established Mexico's first national park in 1917, continuing the legacy of protecting natural resources. Located in the greater Mexico City, Desierto de los Leones (Lions Desert) is a pine, oak and fir forest of more than 1,800 ha and the site of a 17th century Carmelite monastery. During the presidency of Lázaro Cárdenas (1934-1940), 33 national parks were established.

The Cárdenas administration also decreed other flora and fauna shelters, placed limits on hunting and cancelled some forestry and mining concessions. As part of a major social revolution, the objectives of these actions were to protect the health of the environment and to attend to the needs of the local populations.

Unfortunately, agrarian reform programs of subsequent administrations, reclassified some of the previously protected land to ejidos (common land). This change permitted the large cale agricultural exploitation of the land resources, a far different use than the non-exploitation principles of national parks.

A wakeup call: Earth Day

Like a siren's call, the first Earth Day, 22 April 1970, awakened a drowsy human community to the catastrophic assaults of human actions on our environment: air, soil and water pollution; significant loss of natural vegetative cover; fragmentation of the landscape; rapid increase in rate of species extinction; invasion of exotic species in the marine and terrestrial environments; emergence of new diseases; loss and degradation of environmental services, to name a few. In many parts of the world, especially in the more developed regions, the decade of the 1970s witnessed a wave of concern about conservation and environmental protection and the ensuing policy initiatives and project implementation. While concern for the environment and the welfare of other species has long been the focus of naturalists, the scientific community, and populations whose livelihoods are intimately linked to the land or sea, the advent of Earth Day represented a coming together of disparate communities, globally. Emerging from discussions about environmental sustainability was the recognition that the scale of human activities and the methods it employs to try to meet its needs must be modified sustainability is to be achieved. Efforts focused on human over-population, reduction in fossil fuel use, waste reduction and increased resource use efficiency are more likely to lead to improved conservation, environmental protection and social and economic developmental goals.

In 1971, the United Nations Organization for Education, Science and Culture (UNESCO) launched the Man and the Biosphere (MAB) program to establish a scientific basis for the efficient management of natural resources for the well-being of both human populations and the environment. One of the objectives was the establishment of a network of a protected areas or biosphere reserves representative of the diversity of global habitats and human

PAGE 228 *Since its creation in the year 2000, the National Comission of Protected Natural Areas has made a big effort to protect the biological diversity of Mexico, establishing more than 170 protected areas in more than 26 million hectares.*

Conservation in Mexico is dynamic, adapted to various socioenvironmental conditions throughout time. The decree that protects the Nevado de Toluca volcano has experienced a series of transformations that have changed it from being a National Park to a Protection Area of Flora and Fauna, allowing the settlers to use, in a sustainable and regulated way, the resources they find there.

communities where economic activities do not compromise the ecological value of the site. Currently there are 669 designated biosphere reserve sites in 120 countries around the world. Mexico ranks third in the world in number of. Mexico's first sites, established in 1977 are the 342,388 ha fragile warm and semi-desert ecosystems of Mapimí and the 9,421 ha La Michilia site which has a high degree of relief; both sites are located in Durango State.

Protected natural areas

Biosphere reserves and other categories of protected areas are very important in Mexico, because much of the country's territory is in private holdings and the federal government holds only 5% land. Biosphere reserves impose restrictions in the use of the land, but maintain in the land of its owners, allowing the Mexican government to decree protected areas do not require that the land is expropriated. The National Commission of Protected Natural Areas (CONANP), a decentralized body of the Secretariat of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT), manages and protects Mexico's natural heritage. Working with the support of local populations, universities, civil organizations, state governments and the private business sector, CONANP currently manages 179 natural areas. While Mexico's Federal Agency of Environmental Protection (Procuraduría Federal de Protección al Ambiente, PROFEPA) advances, monitors and implements federal environmental laws, CONANP is charged with providing biodiversity information through research promoting conservation. Some national conservation organizations that support the work of CONANP are the Carlos Slim Foundation - WWF México Alliance, Pronatura, Naturalia, Natura and Mexican Ecosystems, Conservation of Islands, and the WWF Mexico-Telcel Alliance.

Approximately 13% of Mexican territory enjoys some level of environmental protection and are representative of some of the most beautiful, scenic and biologically diverse and rich regions throughout the country. Currently there are 42 MAB reserves (127,874 km^2), 67 national parks (14,453 km^2), 5 national monuments (162 km^2), 8 natural resources protection areas (44,400 km^2), 37 fauna and flora protection areas of (66,872 km^2) and 18 sanctuaries (1,462 km^2). Additionally, there are hundreds of state, local and private nature areas that are managed sustainably. These protected areas incorporate the wide swath of biome types of the country including the dry brush and arid lands of the north, moist mountain forests, rain forests, wetlands, coastal plains of the Pacific and the Gulf of Mexico, near-shore shallow waters, coral reefs, and the deep hydrothermal windows of the ocean. Some examples of Mexico's crown jewels are El Alto Golfo de Califonia, El Pinacate and Gran Desierto de Altar

Biosphere Reserve (Sonora); Janos (Chihuahua); Chamela-Cuixmala (Jalisco); Cuatro Ciénegas (Coahuila); Izta-Popo and Nevado de Toluca (State of México); El Triunfo and Montes Azules (Chiapas); Calakmul (Campeche); and Sian Ka'an (Quintana Roo).

Species conservation tools

The United Nations Conference on Environment and Development (the Rio Earth Summit) adopted the Convention on Biological Diversity in 1992 and Mexico ratified it became a party to it the following year. The Convention, an international legal instrument for the conservation and sustainable use of biological diversity, commits signatories to develop national targets and strategies to fulfill the objectives of the agreement, including identification of its flora and fauna diversity and level of risk each faces. In Mexico, this agreement resulted in the development of The Mexican Official Standard (Norma Oficial Mexicana, NOM-059-ECOL-2001) which established a list of four categories (probably extinct in the wild, in danger of extinction, threatened, and subject to special protection) to identify wildlife species risk. Listed endangered species are protected by federal law, and their use and destruction are considered federal crimes, regardless of property ownership. As the most important legislation for the protection of endangered species, currently there are more than 2,000 plant and animal species listed. Some measures to protect endangered species are the reintroduction of populations of endangered species to areas from which they have been locally extirpated protection of nesting and breeding sites, and the creation of new protected areas and biological corridors.

Reappearing on the horizon

The very rapid expansion of European settlers into the North American prairies produced startling and severe changes in the landscape, especially the native flora and fauna. Within 100 years of the mass migration to and through this vast and unique grassland ecosystem, more than 60 million American bison that had lived in this enormous region had been killed for food, leather, sport, and primarily as a tactical move to eliminate Native American populations that depended on them. The extermination of the bison opened the grasslands for the production of domestic cattle for a growing meat market. By the end of the 19th century, the population of the American bison was estimated to be about 25.

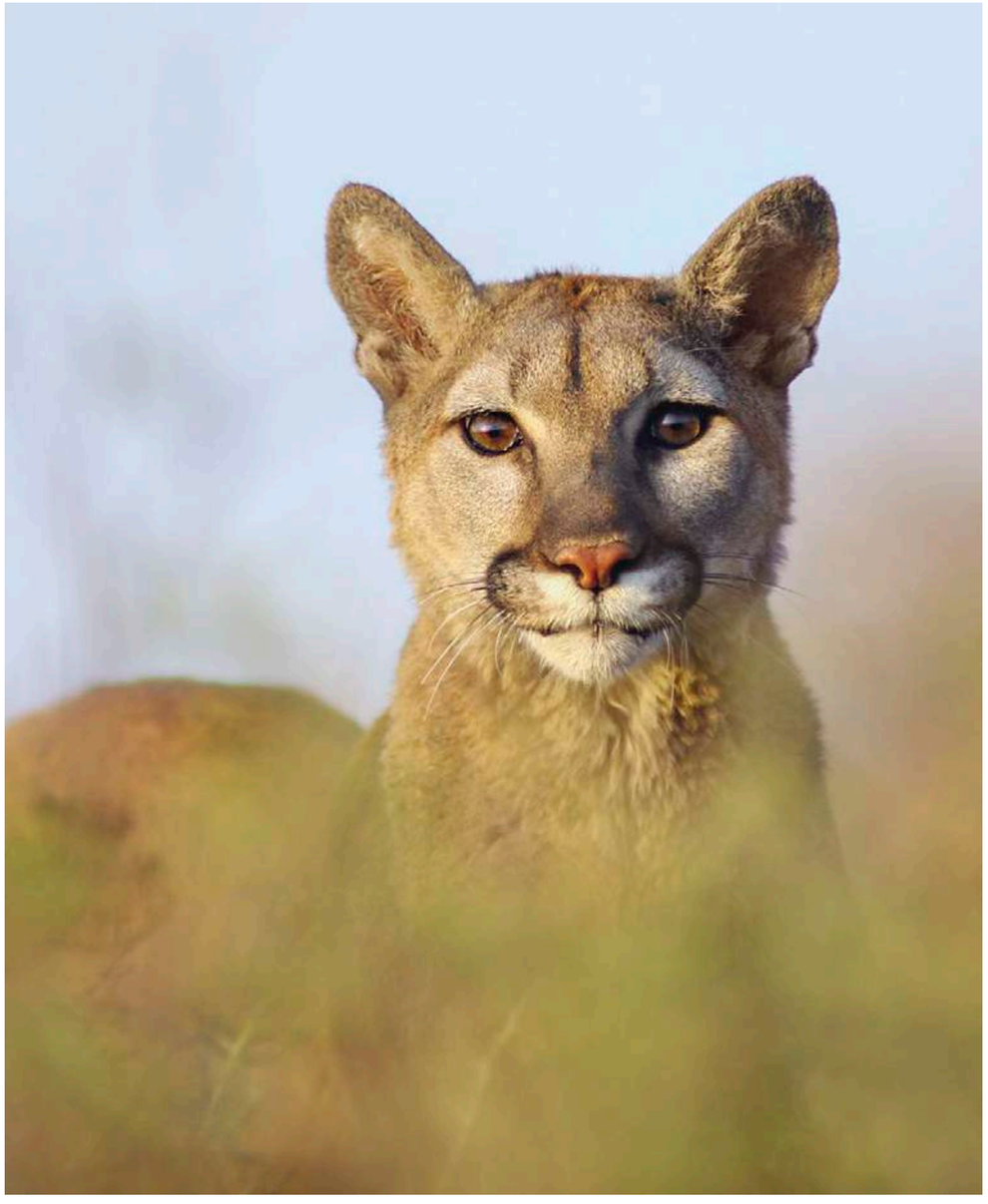
The reintroduction of species eliminated from an area, either intentionally or as a casualty of human "progress" is a significant component of the biodiversity conservation strategies

In 2014 Mexican wolfs were reintroduced in the Chihuahua mountain range.

in many countries throughout the world. This practice undoubtedly will become more commonplace as techniques improve to ensure more success and there is greater acknowledgment of the importance of biodiversity. Some countries such as South Africa, New Zealand and the United States have a lot of experience with and are pioneers in captive breeding and reintroduction techniques and post-release monitoring.

For centuries, the jagged silence of the vast Sierra Madre Occidental Mountains was constantly interrupted by the most characteristic sound of these mountains, the sound of the Mexican gray wolf howling. Hunting, the intentional destruction of wolf populations, and encroachment on their habitats effectively silenced the howls by the 1970s as the local population became extinct. In a very ambitious program to avoid extinction of this wolf subspecies from Mexico and the southwestern United States, the last remnant wolfs in northern Mexico were captured for use in a captive breeding program with the hope they can be reintroduced to their original areas of distribution at a later date. More than 30 years later, 5 wolves were released in the mountains of the northwestern state of Sonora. Despite setbacks and challenges, the increase in number of Mexican wolves to seventeen in May of 2016 is a promising sign that this keystone species may yet again reclaim its critical role in the environment.

Prairie dogs erroneously viewed as competitors to cattle for the forage and nuisances where land was cultivated, were similarly eliminated (usually with poison) throughout large swath of their former distribution. The rapid decline of prairie dog populations, in turn, put at risk the black-footed ferret depends on prairie dogs for about 90% of their diet. Originally numbering in the tens of thousands, the severely reduced prairie dog populations (food source), exotic diseases such as distemper and bubonic plague, and habitat destruction caused the wild black-footed ferret population to plummet. While the early efforts to sustain the species through a captive breeding and release program were unsuccessful, the chance discovery (by a ranch dog in the state of Wyoming) of a small remnant population rekindled reintroduction efforts that were eventually successful. Once considered extinct in the wild (in 1987), there are currently about 300 wild-born mature individuals distributed among several reestablished populations in 24 sites in the United States. While the populations in Canada still are considered extirpated, Mexico has moved ahead to reestablish the black-footed ferret in parts of its historic range. Discovery of one of the largest prairie dog colonies in North America in the Janos region in the northern Mexican state of Chihuahua was a major factor in the proposal to reintroduce the black-footed ferret there. On the cold and dark night of September 18, 2001, the first four black-footed ferrets were returned, marking their return to the grasslands of Mexico after decades of absence. Gerardo, member of the reintroduction team recalled the intensely exhilarating experience: "I will never forget that day and the feeling of fulfillment when we released them."



The puma or mountain lion, symbol of strength and power, has instilled respect and admiration in prehispanic societies. To maintain those cultural values is to keep alive the spiritual connection with nature.

In land as well as in the sea world, biological diversity interacts in surprising ways. These secrets of nature have inspired human kind from the beginning of time. Let us act now so that this is continued admired by future generations.

The last wild bison in Mexico probably disappeared in 1866 in Coahuila. In 2009, a group of 23 genetically pure animals (bison can cross with domestic cattle) was released in the Janos Biosphere Reserve, sharing the grasslands with the ferrets reintroduced seven years earlier. Other reintroductions in Mexico include the elk or wapití in the 1970s in the Burro Range in Coahuila, and the California condor in the Sierra de San Pedro Mártir in Baja California and the scarlet macaw in Los Tuxtlas, Veracruz, and Palenque, Chiapas since the beginning of the 21st century.

Jaguars, sea turtles and exotics

The story of the recent efforts to protect the jaguar is an interesting example of the collaborative efforts of civil society, government institutions, scientists, academic institutions and other parties interested in the conservation of an endangered species. The National Alliance for Jaguar Conservation, a Mexican initiative, brings together nongovernmental and governmental organizations in a new, ambitious program aimed at saving this emblematic species. A field survey in 2011 estimated a total population of 4,000 jaguars in Mexico, an 80% decline from the 20,000 at the beginning of the 20th century. Follow-on actions of this conservation initiative were the development and implementation of a national strategy to ensure the preservation of the jaguar and to address conflicting needs of the local communities, such as the threat of predation on livestock and the tradition of hunting jaguars. A key component of the national strategy is identification and delineation of biological corridors and priority areas used by the jaguar. Comprising of more than 4 million hectares, two corridors are planned, one extending between the state of Tamaulipas and the Yucatan Peninsula in eastern Mexico and the other between the states of Sonora and Chiapas in the western side of the country. Other critical components of the strategy are establishment of monitoring programs of the jaguar and its prey, development of action plans to address jaguar-cattle conflicts, improvement in the design of the highway infrastructure and other transportation corridors to minimize the potential of jaguar involved accidents, and development of a dynamitic environmental outreach education program.

The recovering sea turtle populations along much of Mexico's coasts are another example of the success of effective conservation and management efforts to protect a group of charismatic but threatened species. Sea turtles, which spend their juvenile and adult years feeding in the deeper oceans, return to their natal beaches to lay their eggs, completing a geographic circuit initiated when they entered the sea as hatchlings decades earlier. With seven of the eight global species of sea turtles nesting on its beaches, Mexico has the largest number

of sea turtle species in the world. These include the critically endangered Kemp's ridley and hawksbill sea turtles, the endangered green sea turtle, and the olive ridley, leatherback, back, and loggerhead sea turtles. The unregulated exploitation of sea turtles throughout much of human history for meat and eggs as food resources and shells for use in instruments, jewelry and artifacts, and the modern assaults of marine pollution, loss of nesting habitats, and the unintentional catch in fishing operations have severely reduced the global populations and put at risk the survival of the species. In some regions of the world they have become locally extinct. Conservation and population recovery programs on a global scale have been ongoing for the past 40 years, and Mexico has played a very critical role in this effort. Mexico has implemented a very successful strategy known as nesting/protection turtle camps where eggs are safeguarded until they hatch and the hatchlings return to the sea. The increased number of nesting turtles on Mexico's coasts is an indication of the effectiveness of the domestic and international collaboration of these and other conservation efforts.

Some of the most involved and intriguing species recovery projects involve the conservation efforts on islands off the Pacific coast and the islets in the Gulf of California. The geologic and evolutionary history of these sites is fascinating. Some islands developed as a result of tectonic plate movement and others emerged from volcanic activity. Populated by species carried on ocean currents or seabirds feeding or nesting on them, these isolated areas have a high degree of endemism where the flora and fauna are adapted to the unique abiotic and biotic conditions. These ecosystems are very fragile, and such site specific specialization makes the species very vulnerable to both natural and human-driven events, such as settlements, pollution and the introduction of exotics. Inadequate environmental protections during the development and colonization of these islands can cause significant changes to the flora and fauna and threaten extinction of endemic species. Since the 1905 construction of a large federal prison on Islas Marías, an archipelago of islands 100 km off the Pacific coast of the state of Nayarit, the invasion of domestic and exotic species, such as goats, pigs, rats, mice and cats has devastated the local flora and fauna. In the first decade of this century, plans were made to restore portions of these islands to conserve the native species. One of the first major actions after the completion of a census of the species was the eradication of exotics. The high endemism and biodiversity value of this archipelago earned it the designated a biosphere reserve under the Man and Biosphere Program even though the penitentiary there is still in use. Further conservation actions are ongoing. To date, eradication of exotic species has been completed on more than 40 islands under the jurisdiction of the Mexican government.

Management of non-endangered national resources

The sustainable management of the wild plant and animal species not listed as endangered is the third axis of wildlife conservation and management in Mexico. Grounded in biological principles and a mandate to provide sustainable beneficial use of natural resources, the Unidades de Manejo para la Conservación de Vida Silvestre (Wildlife Management Units, UMA) "must promote the conservation of local native biota by maintaining the natural richness of wild communities and local and regional species abundance and recruitment patterns, which contribute to the functioning of the ecosystems present." The UMA framework provides a detailed management plan for sustainable resource use that ensures the protection of biodiversity while meeting the social and economic needs of the community. Initially, used to manage extraction and hunting activities and the collection of plants, the framework now extends to ecotourism. Two examples of the implementation of the UMA are presented here. At the beginning of the 20th century, the desert bighorn sheep, which lived in the Baja California peninsula, Nuevo León, Coahuila, Chihuahua and Sonora, numbered in the thousands. By mid-century the population declined to no more than 3,000 individuals before robust measures were instituted to conserve the species. Hunting was prohibited, the habitat was given increased protection and reintroductions were made throughout the historic distribution range. Success of these measures permitted the reinstatement of regulated sports hunting in 1997 and has generated millions of pesos in revenue. Recent censuses showed that desert bighorn sheep had repopulated many of the areas where formerly they had been extirpated and the estimated total population was more than 9,000. A similar scenario occurred with the population of the American crocodile. During the 1970s their populations were critically reduced as a result of intensive hunting for the lucrative leather market and the fate of the species was in doubt. In order to protect this species, robust measures were put into place including a complete ban on hunting, increased habitat protection, and captive breeding programs. Success of this conservation project was reflected in the return of regulated harvesting in 2010 and the generation of revenue for use to further conservation programs.

Conservation challenges

The march of progress toward the protection of Mexico's world class biodiversity and the ecological goods and services it provides is encouraging and augers well for a healthier environment for future generations of Mexicans. Despite the severe social and economic challenges the country faces, such as corruption, organized crime and poverty, the people of Mexico

The Baja California Peninsula's abundance of sea and coastal resources allowed 10 500 years ago the establishment and blooming of the first human groups that arrived to these regions. At present, this peninsula is one of the best preserved places of the world where there are healthy populiations of sea birds, sea lions, seals, dolphin, and whale populations.

have chosen to develop new protected areas and expand existing ones as a bulwark against species extinction and the ecosystem disruptions that would inevitably follow.

However, much work remains and the path to sustainability, as a nation is long. Some of the most critical challenges the human community faces today, climate change, loss of forest and native vegetative cover, desertification, pollution and species extinction has an indeterminate number of direct and indirect effects at the local, regional, national and global levels. Conservation of nature is the key to maintaining our civilization.

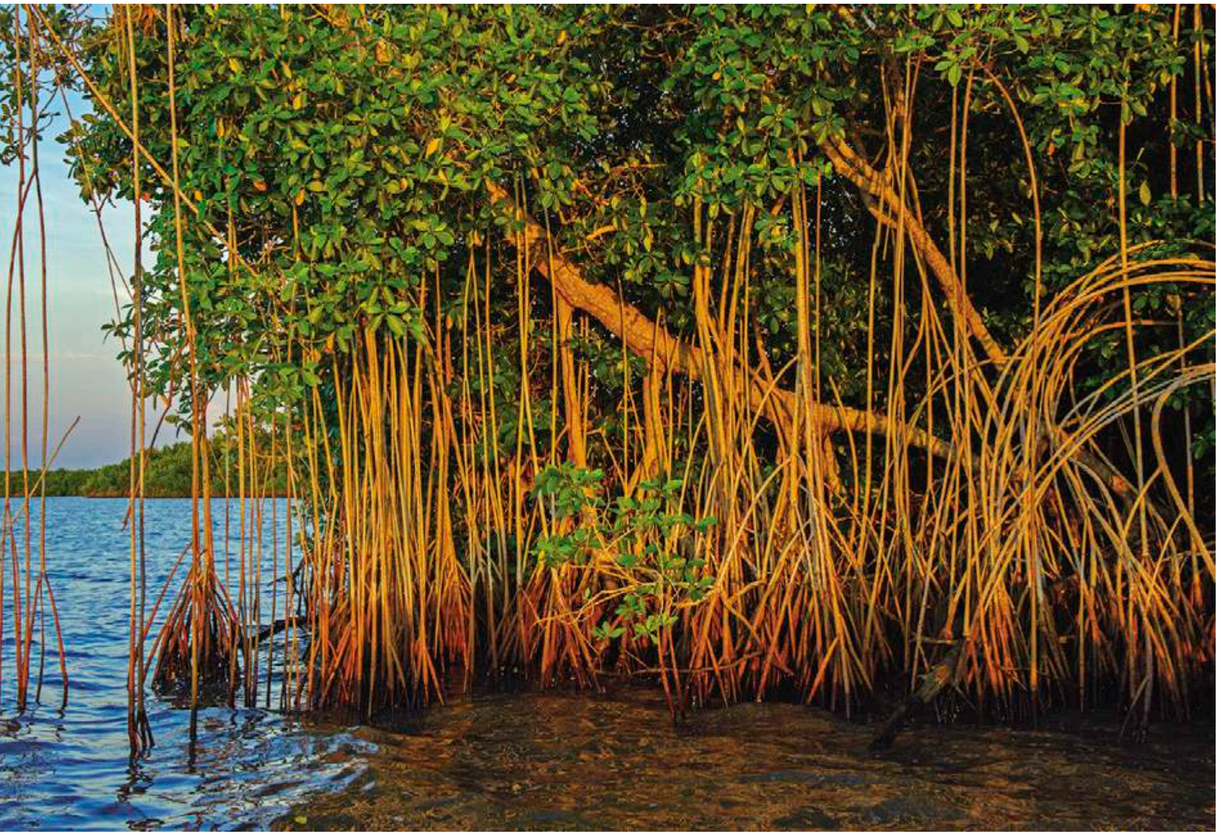
The false human-nature dichotomy has blinded us for long. The transition to sustainability and the application of environmental standards and management programs are some of the most perplexing challenges we will continue to face for the foreseeable future. As one of the many members of the web of life, we are linked to the endless cycle of energy and nutrient cycling, and while humans may be the dominant species, we are dependent upon other species. Our well-being is directly proportional to the health and integrity of natural communities we inhabit.

Using the Millennium Development Goals of the United Nations as a framework for the management of resources, Mexico has pledged to devote 17% of its territory as protected natural areas. To ensure their environmental integrity while addressing the issue of global climate change, mining and hydrocarbon extraction should be prohibited or severely limited and strictly regulated, and deforestation and degradation of existing forests must stop and be reversed. New laws that focus on the protection of our extraordinary biodiversity need to be promulgated and existing ones modified to reflect current challenges and available enforcement tools and techniques. Additionally, adequate resources must be made available to support and expand conservation programs and initiatives from all sectors of society. The efforts we extend to protect the critically endangered vaquita, a very rare porpoise species endemic to the northern portion of the Gulf of California, and the results attained from these efforts will be telltale signs of our commitment to the protection of our biodiversity and a harbinger of the fate of other species, including our own.

The future has arrived, and there is little time to act decisively. We do not have the luxury of postponing action for another time when social, economic or other concerns improve. While there is still time, we must take the baton of conservation and aggressively lead science-driven efforts to protect our rich biodiversity heritage if, for no other reason, than the welfare and survival of the human community. The window of time is closing and our collective actions will determine the future of biodiversity and civilization. Future generations will be the witness of our response to this challenge, which has no precedent in the history of our species.

The benefits

Life is the most outstanding characteristic of our planet that make it unique in the infinite universe. Two million species of animals, plants and microorganisms have been described but it is estimated that they could be more than fifty million. They are fundamental for the ecological equilibrium and the environmental conditions that allow life in the planet. The value of the biological diversity is incalculable. Its presence has been the bases of the civilization, development and well-being that we enjoy at present. The benefits that we human obtain from the good operation of nature are called environmental goods and services. The recognition of their importance for health, economics, culture and society has increased tremendously since the concept was generated in the 1990s. Environmental goods for example include clean air, drinking water and medicinal herbs. Environmental services include the appropriate combination of gasses in the atmosphere, the hydrological cycle and primary productivity (which is the transformation of solar Energy by plants and microorganisms), fertilization of soil, prevention of natural disasters such as flooding, pollination of wild plants and crops, dissemination of plants that create forests and jungles, amongst many other.

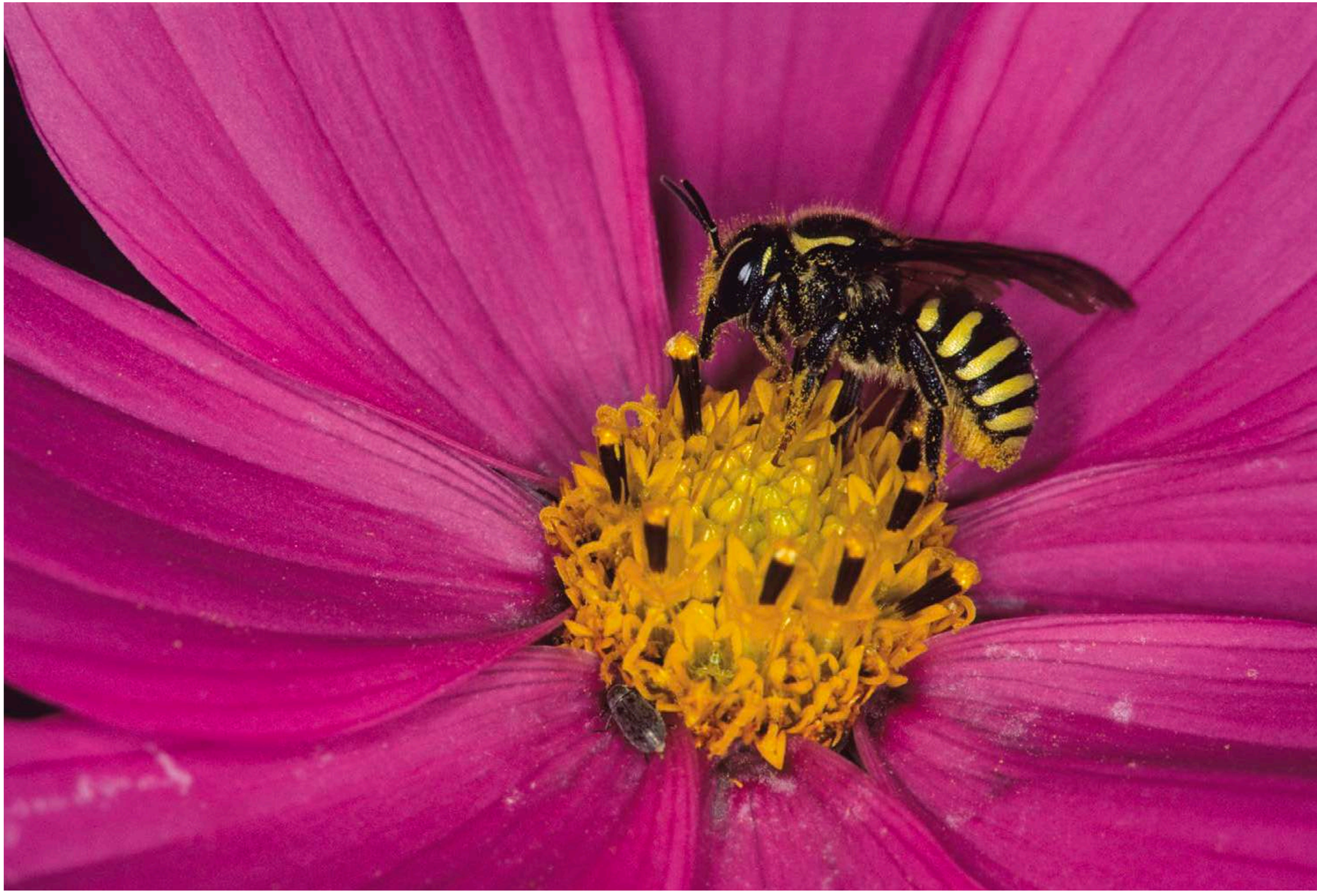


Mangroves act as natural protectors of coastal areas against the erosion caused by sea tides and hurricanes and are the home of large amounts of plant and animal species. They also allow the development of small-scale fishing, which is the main economic activity of the human communities that surround them. The variety of fish, shellfish and crustacean obtained in this ecosystem is the basis of the big gastronomic richness of the coastal regions and it represents a source of protein that significantly contributes to the health of the human population.

The search for fish gathers fishermen, predator fish and pelicans in dynamic teams. Birds are unequivocal signs of the presence of schools of fish, while under the water bigger fish await the opportunity to feed themselves. On the surface, fishermen who have seen pelicans throw their nets to extract what will become the support of many families. This alliance will benefit all at the end of the workday.

The diversity of ecosystems has also been the source of toxic and beneficial substances for human kind. Reptiles like the Gila Monster or shellfish like the nudibranchs, produce mortal poisons for human beings. On the other hand, human communities for different and diverse cures and remedies, identified throughout the centuries by a long selection and application process, regularly use roots, seeds, leaves, flowers, and stems with medicinal effects.

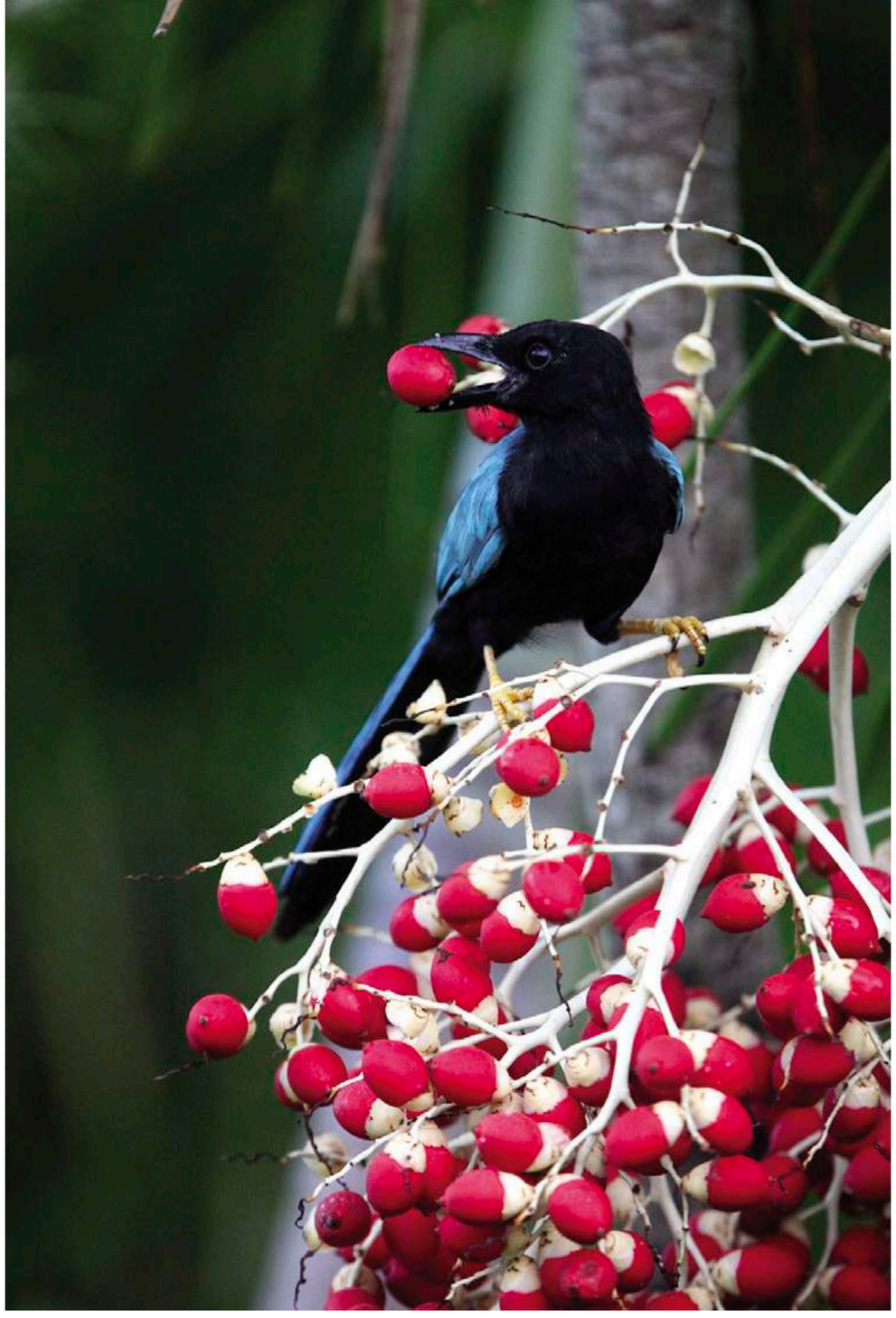
The Valley of Mexico's basin is the repository of millions of liters of water that runs off the snowy volcanos in the center of the country. The aquatic environments formed by the accumulation of these waters are known as swamps or "ciénegas" and are home of a particular group of salamanders known as "ajolote". This small amphibian is highly sensitive to water pollution; therefore, its presence is considered an indicator that it is good quality water. Unfortunately, this amphibian has disappeared in some swamps not only due to the pollution but also due to the extraction of water to quench the thirst of the growing cities of Toluca and Mexico. The disappearance of the ajolotes marks the gradual loss of the quality and quantity of water human societies need to survive.



Bees guarantee the success of world agriculture and largely the food for humankind because they are responsible of the pollination process for the flowers to turn into fruits. Besides being in charge of this vital function, they produce and conserve the precious honey, wax and royal jelly used by millions of persons throughout the world to prepare food products, medicins and cosmetics.

The agaves are the main protagonists in the preparation of one of the most famous drinks in the world, Mezcal. With close to 50 species used to produce these distillates —of the more than 150 species of agaves that grow in Mexico— different regions of the country are distinguished by their specific profile in the cooking, fermenting and distilling processes. However, the traditional Mezcals are facing a critical moment due to the growing demand in the urban market and the increase of intermediaries and bottlers. In parallel, government, companies and institutions have promoted a productive model that bets on the homogenization and industrialization of the drink, and also on an unfavorable legal framework for small producers who feel proud of keeping, maintaining alive and defending this emblematic heritage of Mexico.

Numerous trees have developed a close relationship with other organisms as birds and rodents, to whom they supply juicy fruits in exchange of disseminating seeds that will guarantee the continuity of the species and will regenerate the processes that keep the ecosystems alive. By favoring the development of sweet and fleshy fruits, interactions have played a central role in the availability of resources used by human communities. Besides harvesting wild fruits, all the cultures in the world have domesticated fruit trees, many of them fundamentally for food and the economic support of families.



The people in Mesoamerica have used more than 3 500 plant species –including gum and cacao– and have gradually integrated them to their traditions by selection and harvesting. This bicultural wealth is protected by different international treaties such as the Biology Diversity Convention signed by the Mexican State. However, the most important promoters of their conservation are us, the consumers, who when choosing products based on these resources can contribute to keeping this heritage alive.

Coffee plantations develop wonderfully well under the shadow of tropical trees in which many birds live. Thanks to the birds who eliminate the insects that could damage the coffee tree fruits, these species act as a natural plague control and this relationship is well known by traditional producers. There are success organization and management of coffee plantations stories in Mexico in more than 100 000 hectares, many of them under the organic production scheme that promotes the conservation of forestry coverage, quality of soil and water. Numerous organizations of high quality coffee producers have been able to place their coffee grain as one of the best in the world and have generated a fundamental economic benefit for the communities who live in rainforests in Mexico.

The good health of the forests depends on an intricate network of relationships amongst the species that live there. At ground level, some mushroom species provide nutrients and minerals to the plants that surround them, while the plants contribute carbohydrates they cannot generate themselves. This kind of association is known as symbiosis and is common in nature. After being underground some time as delicate fibers called hyphae, the mushrooms produce magnificent reproductive structures –typical of these organisms– that provide gratifying food to rodents in exchange of taking with them the spores that will perpetuate the indispensable mushroom populations for the operation of ecosystems.

Mexico City, one of the biggest cities in the world, maintains in its territory a channel system in which the ancient agricultural methods that have survived for centuries are still being safeguarded by the ancient people of this lacustrine area. Corn, vegetables, grains such as field beans, beans and amaranth, forage, fruit trees and a large variety of ornamental plants.

Wood and plant fibers have been used by many communities to meet some needs that go from the construction of roofs, walls and fences for their homes, up to the making of recipients, baskets, rucksacks and hats. In addition, the making of ornamental objects have found their own arts and crafts market and they have become an additional inclusion option for the communities that have printed their own seal on them. The art of knitting and basketwork have traditionally been in the hands of women, who through their work maintain the knowledge of this craft and strengthen the community links.

The taming and diversification of corn carried out by Mesoamerican cultures has generated a broad range of varieties of this grain and converted it in "the big gift of Mesoamerica to the world". The extraordinary knowledge acquired about corn even allowed the taming of a mushroom fhat grown on the corncob grains, "huitlacoche", which is part of the collective memory of Mexico. The conservation of this biological and cultural heritage was agreed upon in the world with the Biology Diversity Convention, based on which are initiatives that promote the conservation of knowledge and the traditions of the peoples of Mexico.

Besides the central role played in the diet, plants and animals are integrated to the culture of the peoples through other equally important uses. The cactus' cochineal is an insect whose bright red color insides was used by Mesoamerican peoples to make the ceremonial paint, and also to dye the fabrics used to dress religious and political authorities. During the Colonial period, the Spaniards called this dye "the golden red", because due to its tones and the dyeing quality was obtained, this was the most solicited color by church authorities who were willing to pay big amounts of money for it.

The high hunting value bighorn sheep is a representative species of Mexican desert. In the so called Environmental Management Units (UMA, as per initials in Spanish), the hunting of these sheep is regulated and the conservation of millions of hectares is promoted, as they are necessary to maintain feasible populations of this species. For example, the game exploitation of sheep in Isla Tiburon, Sonora has left an economic benefit of more than 3 million dollars since the project was started and, although hunting is a controversial issue, this scheme represents an opportunity to recover native species.

The warm water that laps the Baja California Peninsula, is the place chosen by the grey whale to give birth to the baby whales during the winter months. Each year inhabitants of this region with the coordination of the National Comision of Protected Natural Areas to make expeditions to watch the whales and this gathers thousands of tourists, photographers and scientists of this wonderful passage. Numerous services associated to this activity contribute significant amounts for the support of their families who live in this region.

PAGES 282 AND 283 *The impressive natural formations country-wide in Mexico have been highly appreciated by adrenaline addicts and extreme sportsmen that want unique contact experiences with nature in its vertiginous rivers or impressive vertical walls. Mexico has been the seat of extreme sports world competitions that represent an alternative to appreciate the scenic beauty of its landscapes, one more environmental service nature gives us.*

The Baja California landscapes have inspired ancient cultures very much and also modern lovers of adventure tourism. Eco tourism, as is known, represents a significant income for the villagers who are fortunate to be the custodians of these places. Besides guaranteeing their support, these activities promote amongst the villagers the knowledge of their environment and the development of a genuine feeling of pride for the place they grew up in, maintaining these spaces free of harmful activities for the environment.

Gerardo Ceballos

EPILOGUE
THREE DECADES, CLIMATE CHANGE AND THE FUTURE OF HUMANITY

A big meteorite crashed on the surface of the Earth 66 million years ago, left a 185 kilometer diameter crater, and caused a huge mass extinction in which 75 percentage of animal species, including the dinosaurs, disappeared. The meteorite crashed, in the area where much later the Yucatán Peninsula would emerge, at a 64 000 kilometers per hour speed and a 100 billion ton dynamite power. The Chicxulub crater, as was called, is visible from outer space in the northeastern end of the Yucatan Peninsula. At the time of the impact all living beings within a 1 000 kilometer round area were vaporized. Tsunamis with up to 400 meter high waves followed the explosion. Then, the explosion debris blew to half the distance between the Earth and the Moon and on its return caused countless fires. This moment dramatically changed the history of life on Earth.

Regardless of how difficult it may seem, the increase of human population and its impacts on the environment are provoking the sixth mass extinction, comparable in its effects to the extinction caused by the Chicxulub crater meteorite. Global climate change, the extinction of species and populations, pollution, emerging diseases amongst many other factors are in the source of the current predicament the human race is facing. It is estimated that thousands, perhaps hundreds of thousands of species will be extinguished in future decades. It is also estimated that these drastic environmental changes will irretrievably affect humanity. Sound projections predict that there is only a one or two decade time window to act and unless the impact human activities are having on land and sea ecosystems decrease, there is a real possibility of a collapse in obtaining food, drinking water and other necessary resources to support civilization. Never before have we faced a challenge of this magnitude. What is at stake is the very future of humanity.

APPENDIX
CONSERVATION ACTORS

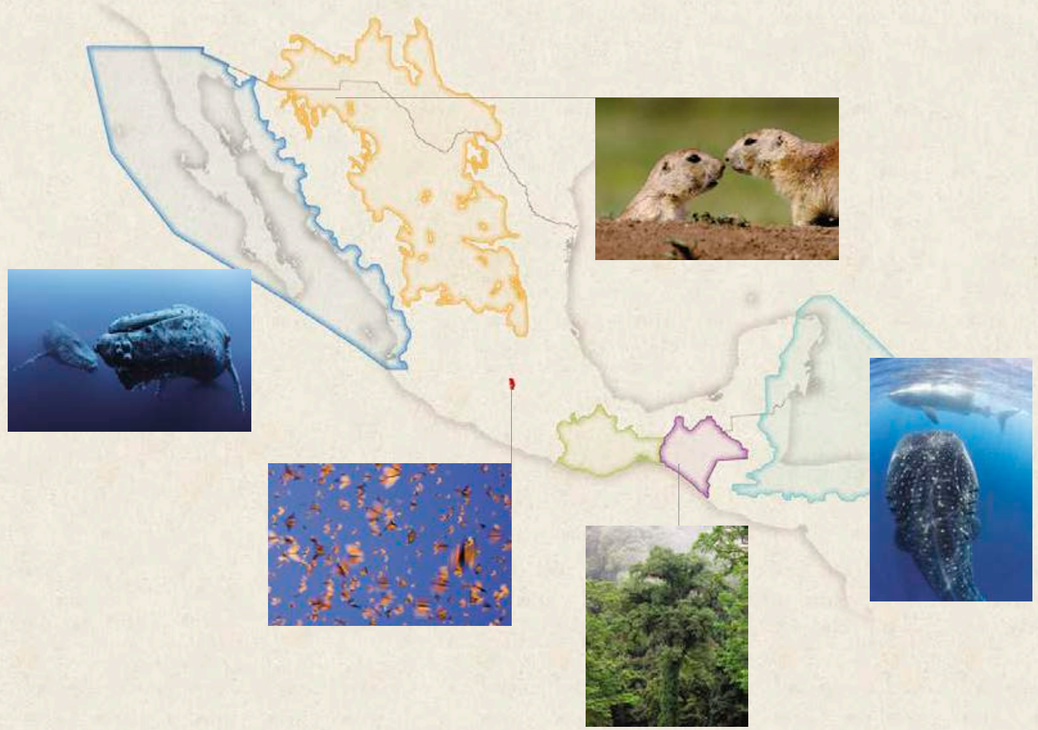
The conservation of nature requires the coordinated efforts of the government, civil society, private sector, and academia. In Mexico, the conservation agenda of the federal government rests with the Secretariat of Environment and Natural Resources –through the National Commission of Natural Protected Areas, the General Directorate of Wildlife, the Attorney General for Environmental Protection and the Natioanl Forestry Commission, which coordinate actions with with the ministries of Defense and the Navy. There are many organizations from the civil society and the private sector that focus on the conservation of biological diversity at local, regional, state and national levels. Some of the most important are the Carlos Slim Foundation, WWF-Mexico, Pronatura, Naturalia, the Mexican Fund for the Conservation of Nature, and the National Alliance for Jaguar Conservation Foundation, among many other. Here we present as examples of the different conservation actors playing important, complemantary roles, the activities of the Secretariat of Defense, the WWF-Fundacion Slim Alliance, and the National Alliance for the Conservation of Jaguar.

ALIANZA WWF-FUNDACIÓN CARLOS SLIM

In the year 2009 WWF-México and the Carlos Slim Foundation, jointly with a group of highly prominent of conservationists, diverse communities and the Federal Government —through the Secretariat of the Environment and Natural Resources (Semarnat, as per initials in Spanish)— formed an Alliance for the conservation of the natural patrimony and the sustainable development of México. Sixty Mexican organizations of the civil society and academia as well as private donors and national and international foundations have joined this Alliance, to contribute to revert the deterioration trends of natural resources in 6 regions and 18 priority areas in the country. This Alliance's main strategy is to consolidate and catalyze the efforts locally carried out to escalate the positive impacts in favor of communities and the conservation of biodiversity in México. The initiatives supported by the Alliance include from the implementation of community projects to the contribution to formulation of public policies focused on reaching a sustainable economy. Our deepest appreciation to all the organizations and scientists who with their work make this initiative a reality come true. The challenges are huge, as is also the commitment of all those of us who are part of this national effort.

ACHIVEMENTS 2009-2015

Conservationof Ecosystems and Species	*Strengthening of Capacities*	*Social Benefits*
• 306 621 hectares of protected jungle, forest and desert and with community surveillance • 1 011 545 hectares of priority ecosystems under sustainable management • 8 thousand reforested and restored hectares • Reduction of the illegal felling in the core area of the Monarch Butterfly Biosphere Reserve • 40 forest nurseries in operation • 65 natural protected areas (public, private and community areas) under strengthened management • 23 community management plans • 1 784 km of firewall holes built • 6 priority sites with climate change adaptation means • 25 under monitoring priority species	• 47 782 students and 286 professors participating in environmental education activityies • 39 fishing cooperatives strengthened for the sustainable use of sea resources • 163 local surveillance brigades equipped and trained • 379 ships using sustainable fishing techniques • 21 new facilities built for conservation and research purposes • 55 local committees for fire management and 437 trained brigades • More than 2 500 fishermen, members of local and communities and trained technicians • More than 135 persons participate in conservation and environmental education activities	• 800 (permanent and temporary) jobs created • 18 community established businesses • 13 community business plans • 2 545 persons from communities and "ejidos" (common land) and they participate in conservation projects • 60 civil society organizations and academic entities implement conservation projects • 218 experts directly participate in the Alliance conservation projects



Sea of Cortés

- Support to the erradication of invading exotic species in the the Gulf of California (rats, cats, goats). So far exotic species have been eradicated from the following islands: San Pedro Martir, the Loreto Bay Archipelago, the San Ignatius Cliff island, (Farallón de San Ignacio), Isabel Island and the Marietas Islands. These places have seen the recovery of the ecosystems in view of the absence of invading species.
- 12 natural areas protected with monitoring and surveillance systems reinforced by the participation of the federal government, civil society and the private sector.

Chihuahua Desert

- Protection of more than 62 thousand hectares or arid pastureland. Cattle growers own most of this area and they work with civil society organizations to improve their productive practices to guarantee the preservation of native pastureland.
- Support the construction of facilities for the reproduction in captivity of the Mexican wolf. This species has been declared probably extinct in the wild (NOM 059-SEMARNAT-2010). A wolf cub was born there and this encourages our efforts to restore their populations in the wild in the future.
- Strengthening of capacity of the 22 students of Centro de Bachillerato Tecnológico Agropecuario located in Cuatrociénegas. More than 60 fellows have received academic, technical and financial support to carry out their scientific skills and to aspire to a better quality of life.

Chiapas

- More than 28 thousand hectares under some conservation category or sustainable improvement (this includes payment areas for environmental services, extraction of resin and Palma Camedor (Chamaedorea elegans), also the production of organic coffee).
- Reinforcing surveillance in three federal protected natural areas: Reserve of the Montes Azules (Blue Mountains) Biosphere, Lacantún Biosphere Reserve and ElTriunfo (the Triumph) Biosphere, which cover more than 500 thousand hectares
- Three tourist centers (Canto de la Selva, Campamento Tamandúa (Camp), Centro Ecoturístico El Pirú (Ecotourist Center) in operation.
- Ten classrooms equipped with computers and internet in operation, used by the Marqués de Comillas Municipality children.

Mesoamerican Reef

- Eradication of invading exotic species in the Chinchorro Bank Biosphere. In the three previously invaded cays, the absence of the black rat was confirmed.
- Reduction of 38% of fire in the periority areas of the Yucatan Peninsula.
- More than 17 consolidated cooperatives to promote sustainable tourism in Quintana Roo, protecting more than 10 thousand hectares of jungle cooperatives.

Oaxaca

- 18 thousand hectares under better use sustainable forestry.
- An Action State Plan against the established Climate Change.
- Strengthening of the protection of sea turtles via surveillance in 13 turtle protection camps.

NATIONAL ALLIANCE FOR JAGUAR CONSERVATION

Jaguar is an endangered species in Mexico, and its long-term conservation faces serious problems. Therefore, a group of approximately 45 experts in different disciplines from universities, non-government organizations and government authorities decided to create the National Alliance for Jaguar Conservation (ANCJ, as per initials in Spanish). The objective of this Alliance is to promote and foster projects that contribute to establish the environmental policy that guarantees the conservation of the jaguar, its prey and habitat in México.

The National Strategy for Jaguar Conservation focused on identifying the problems that affect the jaguar and determine its solutions has been created. The strategy is focused on nine key components of the ecological as well as the political, economic and social environment that together form a unique document of its kind. The components are: Priority Areas, Monitoring of Jaguars and their Prey, Jaguar Care <protocol, Human-Jaguar Conflict, Strengthening of the Legal Framework, Infrastructure, Communication, Dissemination and Education, and community management.

Some achievements

- 10 national and one international symposia "The Mexican Jaguar in the 21st Century".
- Participation in the Recovery Program of Jaguar Priority Species and in the Species Conservation Action Program of Conanp.
- Elaboration of the first Jaguar National Census in Mexico. This was the first evaluation in the American continent designed to estimate the size of the jaguar populations at a country level.
- Press Conference, in June 2015, where the National Jaguar Conservation Strategy was presented with Semarnat, Conanp, ANCJ, WWF-Telcel Alliance and Telmex.
- Elaboration of the Jaguar Conservation National Strategy as an environmental policy instrument in México.
- Active participation of the civil society, non-government organizations and key stakeholders in the conservation of the jaguar. Participación activa de la sociedad civil, organizaciones no gubernamentales y academia como actores clave en la conservación del jaguar. The Ecology Institute of the National Autonomous University of Mexico and the Protected Natural Areas National Commission (Conanp, as per initials in Spanish), and the sponsorship of the WWF-Telcel Alliance, Telmex, the Slim Foundation and the Servicios Ecológicos y Científicos, A.C. (Ecologic and Scientific Services) organization.

Members of the National Alliance for Jaguar Conservation

Chiapas Epigmenio Cruz (Zoomat), Gabriela Palacios (Zoomat), Marco Huerta (Conanp). **Colima** Andrés García (Instituto de Biología, UNAM). **Ciudad de México** Horacio Bárcenas (Facultad de Ciencias, UNAM), Carmen Bolaños (Instituto de Ecología, UNAM), Dulce Brousset (Facultad de Medicina Veterinaria y Zootecnia, UNAM), Ivonne Cassaigne (Wildlife Pharmaceuticals Mexico SA de CV), Arturo Caso (SEMARNAT), Gerardo Ceballos (Instituto de Ecología, UNAM), Greta Cerecedo Palacios (Instituto de Ecología, UNAM), Cuauhtémoc Chávez (Universidad Autónoma Metropolitana-Lerma), Nancy de la Cruz (Umbrales), Antonio de la Torre (Instituto de Ecología, UNAM), Luis Fueyo (SEMARNAT), José F. González Maya (Instituto de Ecología, UNAM), Karla G. Hernández-Aguilar (Instituto de Ecología, UNAM), Génesis López (Instituto de Ecología, UNAM), Rodrigo Medellín (Instituto de Ecología, UNAM), Oscar Moctezuma (Naturalia AC), Pilar Rueda Zozaya (Universidad Autónoma Metropolitana-Xochimilco), César Sánchez (Conanp), Valeria Towns (Natura y Ecosistemas Mexicanos AC), Heliot Zarza (Universidad Autónoma Metropolitana-Lerma/ Instituto de Ecología, UNAM). **Estado de México** Octavio Monroy (UAEM). **Guerrero** Fernando Ruiz (Proyecto Guerrero Jaguar/Universidad Autónoma de Guerrero). **Hidalgo** Daen Morales (BioFutura, AC) Jonatan J. Morales (BioFutura AC). **Jalisco** Martha Collignon (Alianza Jaguar, AC), Rodrigo Núñez (Proyecto Jaguar AC). **Morelos** David Valenzuela (Universidad Autónoma de Morelos). **Nayarit** Erik Saracho (Alianza Jaguar AC). **Oaxaca** Alfonso Aquino (Preconjaguarrh AC), Karla Rojas (Jaguares en la Selva AC), Víctor Rosas Vigil, Víctor Rosas Cosio (Yaguar Xoo AC). **Puebla** Alejandro Juárez (Colin, Consultores en Vida Silvestre), Osvaldo Erik Ramírez (Iukapalli). **Querétaro** Roberto Pedraza (Grupo Ecológico Sierra Gorda). **Quintana Roo** Marco A. Lazcano-Barrero (La Voz del Jaguar/ Reserva Ecológica El Edén AC), Pablo Navarro (Onca Maya AC). Sandra Ortiz (Soluciones Éticas Ambientales), Francisco Remolina Suárez (consultor independiente). **San Luis Potosí** Octavio Rosas Rosas (Colegio de Postgraduados). **Sinaloa** Yamel Rubio (Universidad Autónoma de Sinaloa). **Sonora** Gerardo Carreón (Naturalia AC). **Yucatán** Carlos Alcérreca (Biocenosis AC), Almira Hoogesteyn (Cinvestav-Mérida), Luis Pereira (consultor independiente).

Climate change is a global problem with severe environmental, social, economic, distributive and political dimensions and presents one of the main current challenges humankind faces.

Encyclical Letter, Laudato Si'

Pope Francisco

INCREASED REALITY

In this book of the editorial series of TELMEX, presents once again the Increased Reality infinitum. 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 Increased Reality infinitum are identified by the symbol **RA** in the following pages:

- Cover
- Page 30
- Page 73
- Page 209
- Page 214

Common and scientific names

American bison • *Bison bison*
American flamingo • *Phoenicopterus ruber*
American white pelican • *Pelecanus erythrorhynchos*
Amphibian chytrid fungus • *Batrachochytrium dendrobatidis*
Araguaian river dolphin • *Inia araguaiaensis*
Baird's tapir • *Tapirus bairdii*
Bighorn sheep • *Ovis canadensis*
Black bear • *Ursus americanus*
Black footed ferret • *Mustela nigripens*
Black-banded spider monkey • *Ateles geoffroyi*
Black sea turtle • *Chelonia agassizi*
Black-tailed prairie dog • *Cynomys ludovicianus*
Blue footed booby • *Sula nebouxii*
Bobcat • *Lynx rufus*
California condor • *Gymnogyps californianus*
Chiapas catfish • *Lacantunia enigmatica*
Corn • *Zea mays*
Cozumel raccoon • *Procyon pygmaeus*
Deraniyagala's beaked whale • *Mesoplodon hotaula*
Elk • *Cervus canadensis*
Fig trees • *Ficus* spp.
Giant manta ray • *Manta birostris*
Golden eagle • *Aquila chrysaetos*
Gray fox • *Urocyon cinereoargenteus*
Gray whale • *Eschrichtius robustus*
Grayish mouse opossum • *Tlacuatzin canescens*
Great curassow • *Crax rubra*
Green sea turtle • *Chelonia mydas*
Guadalupe caracara • *Caracara plancus*
Guadalupe cypress • *Cupressus guadalupensis*
Guadalupe fur seal • *Arctocephoca townsendi*
Guadalupe storm-petrel • *Oceanodroma macrodactyla*
Harlequin toads • *Atelopus* spp.
Hawksbill sea turtle • *Eretmochelys imbricata*
Horned guan • *Oreophasis derbianus*
Horned pitviper • *Ophryacus smaragdinus*
Imperial woodpecker • *Campephilus imperialis*
Jaguar • *Panthera onca*
Kemp's ridley turtle • *Lepidochelys kempii*
Lerma salamander • *Ambystoma lermaense*
Leatherback turtle • *Dermochelys coriacea*
Lilac-crowned Amazon parrot • *Amazona finschii*
Lionfish • *Pterois antennata*
Loggerhead turtle • *Caretta caretta*
Magnolia • *Magnolia rzedowskiana y M. predaza*
Mantled howler • *Alouatta palliata*
Mexican gray wolf • *Canis lupus baileyi*
Monarch butterfly • *Danaus plexippus*
Morelet's crocodile • *Crocodrylus moreletti*
Mountain lion • *Puma concolor*
Northern elephant seal • *Mirounga angustirostris*
Ocelot • *Leopardus pardalis*
ojoche or Mayan nut • *Brosimum alicastrum*
Olive ridley turtle • *Lepidochelys olivacea*
Opuntia cochineal • *Dactylopius coccus*
Osprey • *Pandion haliaetus*
Penicillin • *Penicillium notatum*
Pronghorn • *Antilocapra americana*
Pumpwood • *Cecropia* spp.
Quetzal • *Pharomachrus mocinno*
Scarlet macaw • *Ara macao*
Sea otter • *Enhydra lutris*
Sulawesi fanged frog • *Limnonectes larvaepartus*
Tayra • *Eira barbara*
Totoaba • *Totoaba macdonaldi*
Vanilla • *Vanilla planifolia*
Vaquita • *Phocoena sinus*
Volcano rabbit • *Romerolagus diazi*
Whale shark • *Rhincodon typus*
White tailed deer • *Odocoileus virginianus*
Wild turkey • *Meleagris gallopavo*

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Photographs first and last pages

PAGE 2 *Mexico is the seat and transit station of majestic migrations. Birds, land and aquatic mammals, insects and other species find in our territory the ideal scenario to pause before they continue their journey. Many birds annually meet in the mangroves and water bodies in the Yucatan Peninsula; the emblematic monarch butterfly takes the advantage of the winter to mate before going back to the north, the grey and hump whales mate and have their offspring on our coasts. Year after year they meet in different places in Mexican territory offering an unforgettable show on earth.*

PAGE 4 *Perhaps the most emblematic animals of the Central American jungles are the felines, especially in the Yucatán Peninsula. From immemorial times they have been a fundamental part of the cosmo vision of prehispanic cultures that identified them as one of their most important and powerful deities. Even today, deprived of their sacred character, they continue inspiring respect and admiration in those that have been fortunate enough to see them. Although in severe danger of extinction their magnificent figure continues promoting legends and encouraging those that from a scientific, literary and art perspective continue endorsing their powerful presence.*

PAGE 6 *The cloud forest and tropical rainforests in Mexico are among the most biologically diverse places in the world, however, is also one of the most threatened ecosystems. Receiving moisture from the Atlantic and Pacific Oceans, this empire dominated by trees such as cedar, mahogany, and ceiba has been fundamental in the development of large pre-Columbian civilizations who obtained food, clothing, firewood and medicines in abundance. The Biosphere Reserve El Triunfo, in Chiapas, protects one of the last cloud forests in the country where majestic trees rise above 30 meters.*

PAGES 8 AND 10 *Mexico enjoys a privileged position because it is surrounded by the Caribbean Sea, the Gulf of Mexico, the Pacific Ocean and the Gulf of California. They still have natural riches unexplored, unique species and breathtaking landscapes. In addition, the seas provide food and source of recreation to a large share of the population, and this makes them a central axis of the national economy and food security.*

PAGES 14, 16 AND 18 *Mexico's mountains, coasts and islands have also been the home of numerous human communities, who by generations have found shelter in these majestic landscapes, abundant food and sources of medicines to treat diseases. Places like the Gulf of California in Baja California Sur, Cuatrocienegas in Coahuila, Sierra Gorda in Queretaro, have also been schools, sacred worship centers, recreation and workplaces. Despite the fact that nature has been decimated by man whom it has steadily protected, she, sacred and majestic continues giving us reasons to thank and protect her tireless generosity.*

PAGE 22 *The Sierra Madre Occidental and Sierra Madre Oriental foothills support healthy populations of whitetail deer. Although this species is found from the south of Canada to the north of South America, half of the subspecies recognized are in found in Mexico. Its meat is highly appreciated in rural and urban communities and therefore its reproduction and use has been promoted in Environmental Management Units from the arid areas in the north to the tropical areas in the southeast of Mexico.*

PAGE 24 *Mexican seas, especially the Gulf of California and the Caribbean Sea are home of the whale shark. This up to 12 meter long big fish normally visits Mexican waters to feed on plankton, which it traps thanks to a peculiar water filtration system in their mouth. During the summer, a big number of whale sharks meet in the Caribbean coasts and offer an exceptional show. This phenomenon has represented an opportunity to earn income, to the communities in the region who safeguard and sustainably benefit from the biological wealth of our country.*

PAGE 26 *The Valley of Tehuacan and Cuicatlán, between Puebla and Oaxaca, host one of the most diverse plant communities in Mexico. In this region, comprising less than 1% of the country it has registered 10% of the plant species described in the country, besides being the site with more endemic species in the country. Regions like this, with a high biological diversity, have been the center of development of many cultures that for centuries recognized and took advantage of the benefits that the plants provide. On these valleys and mountains, prehispanic cultures recognized more than 800 useful plants, and were the scene of domestication of the three most important crops in the country: beans, squash and corn.*

PAGE 32 *The expressions of life in Mexican deserts throughout the centuries have surprised scientists, poets and artists who have been fortunate and have appreciated the spectacular landscapes of the El Pinacate Biosphere Reserve and the Gran Desierto de Altar, in Sonora.*

PAGE 34 *The Sierra Gorda Biosphere Reserve in Queretaro and Guanajuato protects one of the regions with the most diverse ecosystems in the country between an altitude ranging from 200 to 3,000 m above sea level. In both states, social participation has increased achieving coexistence and harmony with nature through implementation of sustainable and traditional practices that preserve and improve environmental services provided by their temperate and tropical dry forests.*

PAGE 294 *294 In the Humming bird and Bromeliad duo we find a huge range of colors and a significant amount of teachings. Humming birds and their lightweight speaks to us about eternity, continuity and resurrection. Their capacity to fly backwards reminds us of the need to look into our past without stopping there, their skill in remaining in one place tells us to be present here and now benefiting from each effort and their speed when they leaver, tells us to always continue. Bromeliads tell us about the capacity of adaptation and permanence, of taking what is necessary from the environment, to thank it by filling it with beauty and continue in constant renewal.*

PAGE 296 *Water and its permanent movement is the clearest example of generosity and equilibrium. In all its forms, it fosters life, besides being a source of inspiration in its constant movement back and forth it feeds and supports us. About water, we only have to feel gratitude, admiration and respect.*

PAGE 298 *Once more, and as always, nature stands out as majestic, is here to remind us that she will outlive us, with integrity and generosity and that it will do it despite our actions, with or without us. It came before us and will remain after humankind. Our mission is to learn from it, enjoy it, respect and maintain it*

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Art Wolfe, pages 104, 228
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Daniela Medellín, page 215
Daniel Garza Tobón, pages 4, 18, 22, 56, 86, 93, 107, 138, 183, 197 abajo, 220 centro y abajo, 237, 286
Fernando Constantino Martínez Belmar, pages 42, 84, 92, 130, 144, 147, 164 arriba, 200 abajo, 257
Frans Lanting/National Geographic Creative, page 94
Gabo Reed, pages 52, 180, 206
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Jorge Douglas Brandon Pliego, pages 140, 146 derecha arriba, 164 abajo
Jorge Silva, pages 6, 50, 54, 58, 70, 122, 168, 173, 208, 213, 284, 294
Leopoldo Islas, pages 126, 204
Lorant Voros, page 110
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Marco López, pages 66, 82, 246, 254 arriba, 256
Miguel Ángel de la Cueva, pages 14, 72, 288
National Geographic, page 285
Octavio Aburto, pages 8, 10, 48, 88, 114, 152, 250, 251, 252
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Roberto Pedraza, pages 34, 76, 81, 146 derecha abajo, 171, 184
Rodrigo Friscione/Pelagic Life, pages 99, 226, 281
Rodrigo Sierra, page 64
Rurik List, pages 196, 197 arriba
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