

Madrean Discovery Expeditions Education Program in Sonora, Mexico

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Abstract—Since 2015 the Madrean Discovery Expeditions (MDE) of GreaterGood.org (GGO) has completed biotic inventories in the Sierras Buenos Aires, Cucurpe, Elenita, Juriquipa, and el Tigre in northeastern Sonora, Mexico. The MDE Education program shares the results of the Expeditions with residents who live in the adjacent river valleys. Raising awareness about the amazing diversity of animals and plants will help protect these unique Sky Island mountain ranges for the future. MDE educators have given presentations to about 1751 students and 101 teachers in 25 schools in 22 towns in northeastern Sonora. Ten schools were telesecundarias – middle schools that receive class material via satellite. Power Point presentations on various aspects of the biodiversity, biogeography, and natural history of the Sky Islands Region were given to each class. Students were asked to identify animal photographs taken as part of GGO's Project WILDCAT in the lower Río Bavispe Valley south of Granados. The images included four native cats: jaguar (*Panthera onca*), ocelot (*Leopardus pardalis*), mountain lion (*Puma concolor*), and bobcat (*Lynx rufus*). Students in the smaller towns had better local knowledge of plants and animals than students from bigger, more urban towns. School visits included observing insects, flowers, and leaves under a binocular microscope, and students reading text about bats, hummingbirds, pollination, and migration. Materials given to each school included a booklet on Sonoran natural history in Spanish, hummingbird feeders, seeds for a pollinator garden, and a field guide to birds in Spanish.

INTRODUCTION

Mexico and Sonora are mega-diversity country and state. The Sonoran Sky Islands are part of the Madrean Pine–Oak Woodland Hotspot, meaning that this area is recognized globally for its high diversity of plants and animals (The Critical Ecosystem Partnership Fund 2018). There are 55 Sky Islands or Sky Island complexes of mountain ranges connected by oak woodland in the Madrean Archipelago or Sky Islands Region between the Sierra Madre Occidental (SMO) in Sonora and the Mogollon Rim in Central Arizona (Van Devender et al. 2013). Each Sky Island is unique because of differences in area, elevational range, nearness to the SMO, substrates, etc. (Fig. 1). These isolated mountains are similar to oceanic islands. The lowland ‘seas’ around the Sky Islands are desertscrub, thornscrub, or tropical deciduous forest.

GreaterGood.org is an independent charitable organization working to protect people, pets, and the planet. It includes the Madrean Discovery Expeditions (MDE) Program to document the diversity of plants and animals of the Sky Islands in Sonora, Mexico. Through MDE expeditions, groups of 30-80 biologists, land managers, professors, students, and photographers document the flora and fauna on these isolated mountain ranges. All the records and images are publicly available in the MDE database (madreandiscovery.org).

As Baba Dioum once said, “In the end we will conserve *only* what we *love*; we will *love only* what we understand; and we will understand *only* what we are taught.” Sharing the MDE information and new biological discoveries through the Sky Island Environmental Education Experience (SIEE) is an important component of the Madrean Discovery Expedition Program. The SIEE goal is to encourage pride in natural surroundings, profound sense of place, and motivation for a vision of nature protection in middle school students in the towns adjacent to the mountain ranges surveyed. Through class presentations that include bear, jaguar, deer, wild turkey, and hummingbirds, and habitats up to high forests with pines, oaks, and a myriad of wildflowers, the SIEE school visits raise awareness of the natural wonders that occur close to them. Here we summarize our environmental education activities in the Sky Island Region from 2016 to 2018.



Figure 1--Pine-oak forest view in the Sierra el Tigre. Photo by Sky Jacobs.

Environmental Education in the Sonoran Sky Islands

Environmental education is about the environment and the people's close relationship to nature (The Oregon Community Foundation 2006). According to the USA Environmental Protection Agency environmental education is a process that allows people to explore environmental issues, engage in solutions, and take action to improve the environment. Thus, individuals have a deeper understanding of environmental topics and have the skills to make educated and responsible decisions (United States Environmental Protection Agency 2018). To understand and appreciate the environment, basic knowledge of the diversity and natural history of animals, plants, habitats, and landscapes is crucial. Environmental education helps residents to value their natural heritage and make environmentally friendly decisions and actions in their lives.

Área de Protección de Flora y Fauna (APFF) Bavispe (formerly the Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe; equivalent to a combined National Forest and National Park in the United States) has an area of 456,382 acres and includes eight Sky Island mountain ranges. The APFF Bavispe educational staff has done outreach program in many towns in the area, including a 2006-2008 Pride Campaign by Rare (an international non-profit conservation organization). Workshops and surveys in seven communities addressed water use and conservation, river pollution, toxic waste, garbage, cleaning activities along river beds, etc. (Miranda-Álvarez 2008).

In the early 2000's, the Arizona-Sonora Desert Museum had a project on Migratory Pollinators that reached the town of Bacoachi in the Río Sonora. The Audubon Society and Sonoran Joint Ventures, Naturalia, and The Nature Conservancy had bird workshops for residents in the Río San Pedro. Naturalia, U. S. Fish and Wildlife Service, and Bat Conservation International had wildlife monitoring workshops for biologists in Rancho Los Fresnos. None of these activities were focused on broader regional biodiversity. Here we summarize visits to rural schools in the Sky Islands Region since 2009.

In the Mexican Sky Island region, the loss of habitat is mainly due to mining exploration and development, but is hardly noticed by people in the surrounding communities. Most of the students in these towns have not visited the nearby mountains and have little knowledge of the plants and animals that live in upland forests. The materials related to the environment available to the teachers are very limited, and often created in distant Mexico City, and not related to Sonora.

METHODS

School visits

The Sky Island Environmental Education Experience (SIEE) program started in April-May 2016, with visits to schools in rural towns near Sky Islands visited on Madrean Archipelago Biodiversity Assessment (MABA) Expeditions (Figure 2). A total of 221 students and 18 teachers were reached along the Río Bavispe on the east side of the Sierra el Tigre, including Bacerac, Bavispe, Colonia Morelos, Huásabas, and San Miguelito. SIEE part II was in January 2017, with visits to schools along the Río Sonora on the west side of the Sierras Buenos Aires and la Púrica, including Arizpe, Bacoachi, Cucurpe, and Sinoquipe (Figure 3). A total of 189 students and 12 teachers were reached on this trip. SIEE part III was in May 2017, with visits to schools along the Río Agua Prieta–Arroyo Coquiáachi–Arroyo Nacozari, drainages in the upper Río Yaqui Valley east of MDE Sierras de los Ajos, Buenos Aires, and La Púrica. The towns visited included Agua Prieta, Fronteras, Esqueda, and Nacozari. A total of 290 students and 20 teachers were reached on this trip. SIEE part IV was in December 2017, with visits to schools in northeastern Sonora, close to the Sierras de los Ajos, Elenita, and San José. Ímuris, Cuitaca, Cananea, Naco. Additionally, the same week, presentations on environmental education, and the horned lizards of Sonora were given in Moctezuma. In February 2018, the Colegio Nueva Galicia (private, bilingual middle school) was visited in Hermosillo, capital of Sonora. A total of 908 students, 39 teachers, and 8 local authorities were reached on the December and February trips. SIEE part V was in May 2018, with visits to schools in eastern Sonora close to the Sierras Bacadéhuachi, la Madera, and el Tigre. Schools in Bacadéhuachi, Nácori Chico, and el Sauz were visited. A total of 117 students and 14 teachers were reached on this trip.

Animal and plant diversity presentations

To raise awareness, a 45-minute Power Point presentation of the most exciting and colorful plants and animals observed on the MDE Expeditions to nearby mountain ranges and Project WILDCAT were given in each school (Fig. 4A). Identification tips for popular animals like monarch butterflies and coral snakes were mentioned. Unique or new species were highlighted. The students enjoyed guessing animals or features in the slide show and asking questions.

Project WILDCAT

The Power Point presentations included a series of slides about Project WILDCAT, a GreaterGood.org program to protect predators in the lower Río Bavispe Valley south of Granados. The mammals that the students commonly see are coyotes, deer, gray foxes, and ground squirrels (Fig. 4B). Wildlife camera images were shown to teach Sonoran common names of a variety of mammals, roadrunners, turkey vultures, and wild turkeys. The images of jaguars, ocelots, and bears were especially exciting to the students.

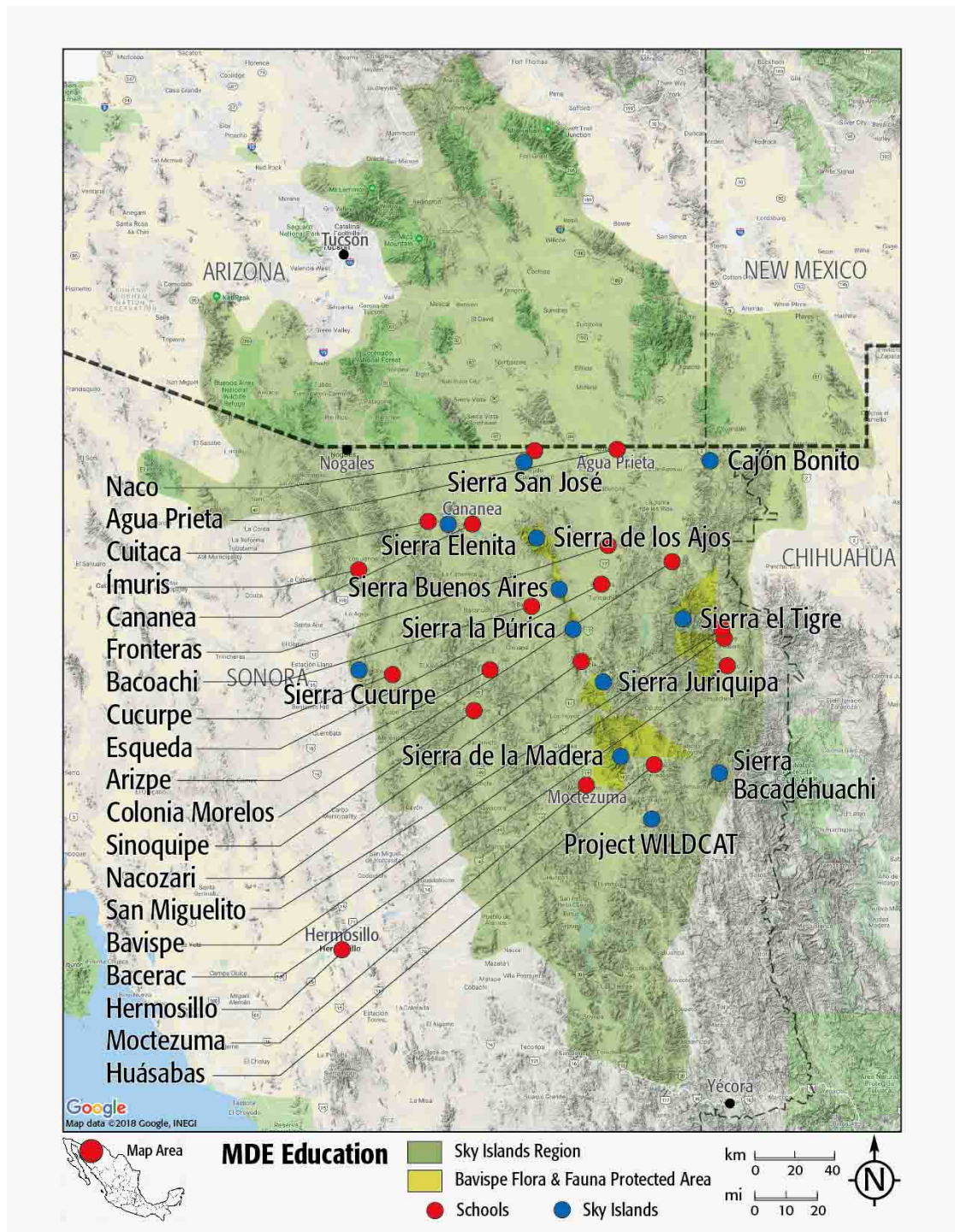


Figure 2--Map of the Madrean Archipelago. Blue dots are Sky Islands visited on MABA or MDE Expeditions. Red dots are towns visited on MDE school trips. Drafted by Dennis Caldwell.



Figure 3--Students and teachers in the Cucurpe *telesecundaria*. Photo by Ana L. Reina-G.



Figure 4. A: Students in the Bacadéhuachi *escuela secundaria* watching MDE presentation. Photo by Ana L. Reina-G.
B. Wildlife camera image of jaguar (*Panthera onca*) from Rancho Pueblo Viejo. Photo by J. M. 'Memo' Galaz-G.

Observing nature

Students looked at leaves, scorpions, a butterfly, and their fingertips through a binocular microscope. They were excited by the scorpion's stinger, and especially their own fingerprints. Hummingbird feeders, sugar to prepare hummingbird food, and Sonoran natural history booklets were left at the schools. Bird field guides in Spanish provided by Sonoran Joint Ventures were left at many schools. After the activities indoor, students went out in the school campus to look for animals under rocks and check out the plants, in some schools. One of the objectives of the SIEE is to encourage

students to be better observers of animals and plants in the environment where they live, and to appreciate that everything looks different when observed in different ways. Hans Christian Andersen stated “Nature gives us all the things we need to be happy and we can become explorers who find meaning and beauty in nature’s diversity.”



Figure 5. A: Students reading natural history notes and **B:** looking through a microscope with Van Devender in the Bacadéhuachi *escuela secundaria*. Photos by Ana L. Reina-Guerrero.

Sonoran natural history booklet.

We prepared a 70-page natural history booklet in Spanish with essays written by specialists on the different habitats in the State of Sonora, including the Sky Islands Region. It also includes information about pollinators, bats, and gardens to attract hummingbirds and butterflies. This booklet has classroom activities on monarch butterflies, bats, and other animals. It is well illustrated with beautiful, color photographs from the MDE program. This booklet was well received by teachers and students, and two copies were given to teachers in each school. While students were taking turns looking through the microscope, the rest of the class read essays from the booklet on the life cycle of the monarch butterfly and the natural history of bats. After reading, students were asked questions from the text. Students who gave the right answer were rewarded with magnifying glasses or other small prizes. This is a very effective and fun way to get students attention and encourage them to learn about animals. As Kosova once remarked “Personal development of students is impossible without instilling in them environmental values” (Kostova 2003).

Pollinators

These have a very important role in natural environments. They carry pollen from one flower to another, from one plant to another, pollinating the flowers and helping set seeds. Many pollinators like flies and bees, are small and not easily observed. Hummingbirds are very active, highly visible, and not shy. Hummingbird feeders are an excellent way to get students to see these beautiful birds in their school or home. We left two hummingbird feeders, a feeder brush, sugar, and instructions on syrup preparation in each school. Two students were chosen to hang and take care of the feeders, while other students volunteered to take turns later. Butterflies are also important pollinators and excellent nature ambassadors. There are often flower gardens in homes in rural Sonora that attract a great variety of colorful butterflies. We usually left packages of flower seeds to start a garden.



Figure 6. A: Students in the Bacadéhuachi *escuela secundaria* with International Biodiversity Week poster, hummingbird feeder, and natural history book reading prizes. Photo by Ana L. Reina-Guerrero. **B:** Hummingbird feeder. Photo by Thomas R. Van Devender. **C:** Broad-billed hummingbird (*Cyanthus latirostris*) visiting chilicote (*Erythrina flabelliformis*) flowers. Photo by Stephen L. Minter.

RESULTS

Since SIEE started in April 2016, 1751 students, 101 teachers, and 25 schools in 22 towns (Table 1) in the Sky Island Region of Sonora, Mexico have participated in SIEE educational programs. Trips in May 2016 and 2018 coincided with the International Biodiversity week. Ten schools visited were *telesecundarias*, middle schools with one or two teachers in remote areas that receive most of their materials by satellite through a TV monitor. Nine schools were regular middle schools. One visit was to an elementary school. Also, two high schools, two *telebachilleratos*, and an undergraduate class were visited. To attract butterflies and hummingbirds to the school yards, 16 schools planted flowers and hung hummingbird feeders.

DISCUSSION

Visiting middle schools in rural towns in the Sonoran Sky Island region was a great experience for the students and us. The teachers are very receptive to these activities and welcomed us without hesitation, often on short notice. The interactive Power Point presentations, where students are encouraged to name the animals and plants, is a fun way to interact with the class. It helps us to understand how much time students have spent learning with adults in their lives, especially parents, extended family, or neighbors. Students who have explored their surrounding area or ranches with an experienced local person know regional local common names. We noticed that students in the smallest, more rural towns like Cucurpe, Cuitaca, Nácori Chico, and Sinoquipe know more traditional local common names than students in cities. Students in larger schools in Agua Prieta, Arizpe, Cananea, and Hermosillo misidentified regional animals as cheetahs, comodo dragons, and other names learned from cable channel programs like Animal Planet. Traditional common names for tigre, tigrillo, cholugo, escorpión, and chuparosa are being replaced by new names used in popular media and education material from Mexico City, e.g., jaguar, ocelote, coatimudi, monstruo de Gila, and colibrí. We think that it is very important that young Sonorans preserve local knowledge as part of their cultural inheritance, and that keeping local knowledge alive is an asset in our globalized world. Thus, on these school visits, we encourage teachers and their students to value and preserve local knowledge.

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Table 1. Schools visited during Madrean Discovery Expeditions Education Program.

School/town	Residents	Date	Students	Teachers
Agua Prieta	79,138	22-May-17	120	8
Arizpe	1,743	10-Jan-17	64	4
Bacadéhuachi	1,083	21-May-18	35	5
Bacerac	1,342	5-Apr-16	56	2
Bacoachi	924	9-Jan-17	59	4
Bavispe	710	6-Apr-16	95	12
Cananea	31,560	7-Dec-17	290	10
Colonia Morelos	156	8-Apr-16	18	1
Cucurpe	798	12-Jan-17	48	3
Cuitaca	424	5-Dec-17	30	2
Esqueda	6,749	24-May-17	70	4
Fronteras	834	23-May-17	20	2
Hermosillo	812,229	9-Feb-18	80	5
Huásabas	966	6-May-16	60	2
Imuris	9,921	4-Dec-17	60	3
Moctezuma	3,798	5-Dec-17	198	7
Naco	6,401	8-Dec-17	250	10
Nácori Chico	2,051	22-May-18	62	6
Nacozari	12,751	25-May-17	80	6
San Miguelito	550	7-Apr-16	18	2
Sauz	161	23-May-18	20	2
Sinoquipe	379	11-Jan-17	18	1
Total			1751	101

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