Madrean Discovery Expeditions Program, Sonora, Mexico

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***Abstract**--There are 55 Sky Island mountain ranges or mountain complexes connected by oak woodland corridors in the Madrean Archipelgo between the Sierra Madre Occidental in Sonora and the Mogollon Rim in Arizona. Thirty-two of them ar in Sonora, Mexico. In 2009 Sky Island Alliance began the Madrean Archipelago Biodiversity Assessment (MABA) Program to document the biodiversity of Sonoran Sky Islands. MABA biotic inventory Expeditions explored nine Sky islands, and Mini-Expedtions to three other areas. All observations of animals and plants are publicly available in the MABA database. In 2015 GreaterGood.org (GGO) created the Madrean Discovery Expeditions (MDE) Program and the MDE database (madreandiscovery.com) to continue documenting the animals and plants of the Sonoran Sky Islands. Groups of biologists, land managers, teachers, students, photographers, etc. participated in MDE Expeditions to the Sierras Buenos Aires, Cucurpe, Elenita, Juriquipa, and el Tigre. Mini-Expeditions visited the Sierras el Alacrán, de la Madera (Magdalena), Manzanal, and San José, and the lower Río Bavispe Valley. There were 30-80 participants/Expedition, on 33 field days, and 26,276 participant/hours on six MDE Expeditions. About 1000 biological observations are made on each Expedition. The MDE and MABA databases are the primary sources of of biological information for conservation, research, and education in Sonora.*

INTRODUCTION

In 2007, Conservation International designated the Mexican Madrean Pine-oak Woodlands as a global biodiversity hotspot. This was a very large area that included both the Sierra Madre Oriental in eastern Mexico and the Sierra Madre Occidental (SMO) in western Mexico. Biodiversity has been defined as the variety of life in a particular hábitat or ecosystem. In practice, we simply record the numbers of species of animals and plants in an area. The Sierra Madre Occidental (SMO) extends in western Mexico from Jalisco and Zacatecas north to Chihuahua and Sonora (Figure 1), reaching its northern limit in Sonora in the Sierra Huachinera (30.25 N).

In 1870, geologist Raphael Pumpelly said "The region is crossed by parallel granite ridges, running generally north or northwest, and rarely more than sixty miles long and ten to thirty miles apart. The intervals between the mountains are occupied by plains rising gently from the centre to the ridges on either side, and extending around the ends of these. Thus the whole country is a great plain, out of which rise the many outlying sierras of the Rocky range, as islands from the sea" (Wallace 1965).

On the 1892-1894 expedition to resurvey the United States-Mexico boundary, Lieutenant David Dubose Gaillard described the Arizona-Sonora borderlands as "bare, jagged mountains rising out of the plains like islands from the sea" (Mearns 1907; Hunt and Anderson 2002). Gaillard was likely quoting Pumpelly! Later Galliard was the lead engineer on the Panama Canal construction project. Weldon Heald, a resident of the Chiricahua Mountains, coined the term 'Sky Islands' for the range where he lived more many years (Heald 1951).

Between the SMO and the Mogollon Rim in central Arizona, there are 55 isolated Sky Island (*Isla Serrana* in Spanish) mountain ranges or complexes of several ranges connected by oak woodland corridors (Deyo et al. 2013; Van Devender et al. 2013). Sky Islands crowned with oak woodland or pine-oak forest emerge from lowland 'seas' of desert grassland, foothills thornscrub, or tropical deciduous forest (TDF). Madrean Archipelago is an equivalent term to the Sky Islands Region that was first used by University of Arizona herpetologist/ecologist Charles H. Lowe. McLaughlin (1995), Warshall (1995), and Van Devender et al. (2013) expanded and refined the area and concept.

Figure 1. View from the Sierra el Tigre. Photo by Luis Gutiérrez, photoluis1, NortePhoto.com.

'Desert seas' in valleys surrounding the Sky Islands are desert grassland and Chihuahuan desertscrub in the north, Sonoran desertscrub to the west, and foothills thornscrub and tropical deciduous forest in the south. The analogy to oceanic islands (Warshall 1995) is limited because Sky Islands differ from true insular areas in high species diversity, low local and regional endemism, and low percentages of non-native species (McLaughlin, 1995). While any isolated area has potential for speciation in small populations, there are relatively few species restricted to the Sky Island mountains.

BIODIVERSITY

Species richness is enhanced in the Sky Island Region for many reasons. The western half of North America is mountainous, with topographically diverse habitats and vegetation zoned along elevational-climatic gradients. Biotic communities are concentrated in small geographic areas compared to the eastern United States where vegetation mostly changes along a north-south latitudinal gradient in relatively flat terrain.

The Madrean Archipelago is a convergence zone for six biotic provinces (Figure 2). The Rocky Mountains and Colorado Plateaus to the north have temperate climates. Chaparral vegetation and Mediterranean climates are Californian influences below the Mogollon Rim in Central Arizona. In the mid-continent, the grasslands of the Great Plains extend from Canada south onto the Mexican Plateau and westward into southeastern Arizona and northeastern Sonora as a mosaic with desert grassland in the valleys and Chihuahuan desertscrub on adjacent limestone slopes. On the western edge of the Sky Island Region, Sonoran desertscrub surrounds Sky Island ranges. In the lowlands of southern Sky Islands, foothills thornscrub (FTS) and tropical deciduous forest are in the lowlands. Oak woodland and pine-oak forest are in the uplands of the Sky Islands and the Sierra Madre Occidental. The transition between the New World tropics and the northern temperate zone is at about 29°N in east-central Sonora. The northern limits of FTS are at about 30°11'N east of Sinoquipe in the Río Sonora Valley and 30°26'N at Presa Angostura on the Río Bavispe. FTS does not reach Arizona,

but the northern limits of quite a few FTS species are in desert grassland or oak woodland in southern Arizona Van Devender et al. 1994).

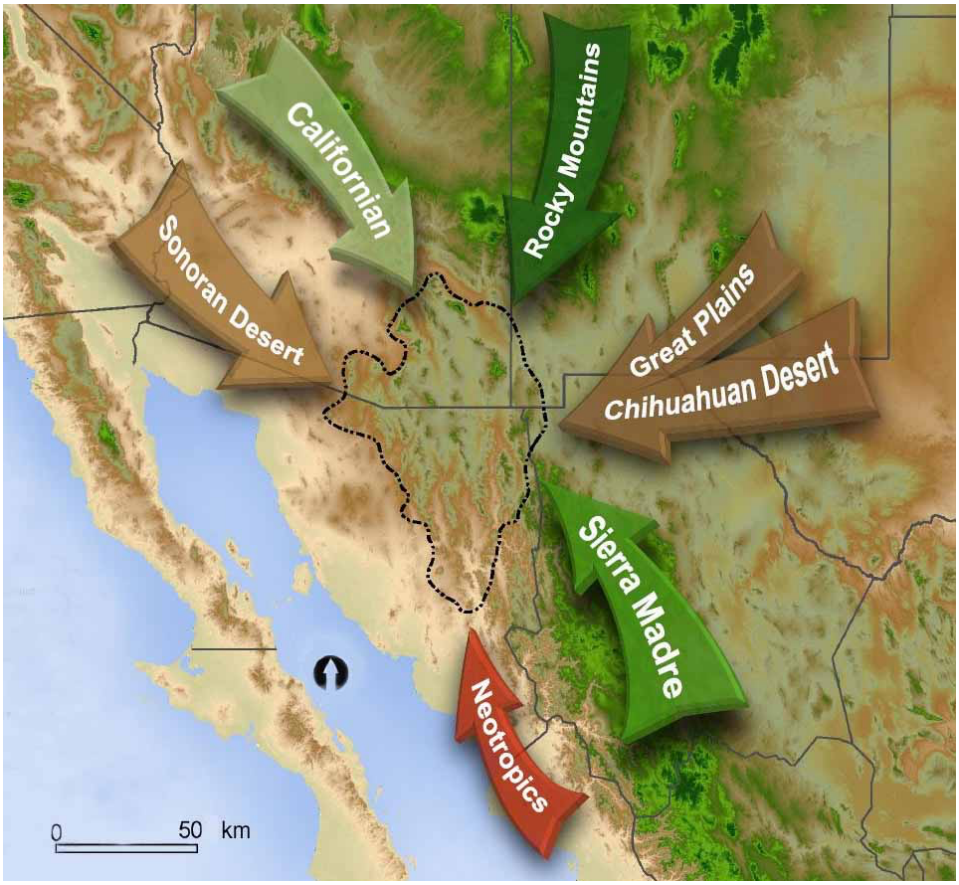

Figure 2. Biotic affinities of the Sky Islands Region (dotted line).

Sonoran Biotic Expeditions

By the 2010s, a great deal had been learned about the animals and plants of the Sky Islands in Arizona, but relatively little in the 32 Sky Islands in Sonora. In 2009, Sky Island Alliance began the Madrean Archipelago Biotic Assessment (MABA) program to document the animals and plants of the Sonoran Sky Islands. Expeditions of 20 to 60 biologists from Mexico and United States went to Sonoran Sky Islands to record animals and plants. Expeditions were important binational cultual gatherings that often resulted in new collaborations, knowledge-sharing, long-term friendships, greater appreciation of the landscapes and natural history of Sonora, and the need to protect them. MABA Expeditions went to the Sierras Aconchi, de los Ajos, Bacadéhuachi, de la Madera (Oposura), Mazatán (= Huérfana), la Púrica, San Antonio, San Luis, and el Tigre, and the Ciénega de Saracachi (Figure 3). MABA Expeditions Sierras la Mazatán and la Púrica were funded by GreaterGood.org. Smaller MABA Mini-Expeditions went to the Sierras el Alacrán, Anibácachi, Azul, las Avispas, Manzanal, and Murrieta, and the Northern Jaguar Reserve and Rancho el Valle.

In 2015 GreaterGood.org started the Madrean Discovery Expeditions (MDE) program to continue biotic inventories in the Sonoran Sky Islands. MDE Expeditions have gone to the Sierras Buenos Aires, Cucurpe, Elenita, Juriquipa, and Tigre, and Cajón Bonito (Figure 3). There were 30 to 80 participants (av. 54.2) on 33 field days. Most of the 26,276 man-hours

on the Expeditions were from volunteer citizen scientists and students. Mini-Expeditions went to the Sierras de la Madera (Magdalena) and San José, and Ranchos el Hoyo and Pueblo Viejo, lower Río Bavispe Valley. Two Expeditions are planned for the MDE program in future years.

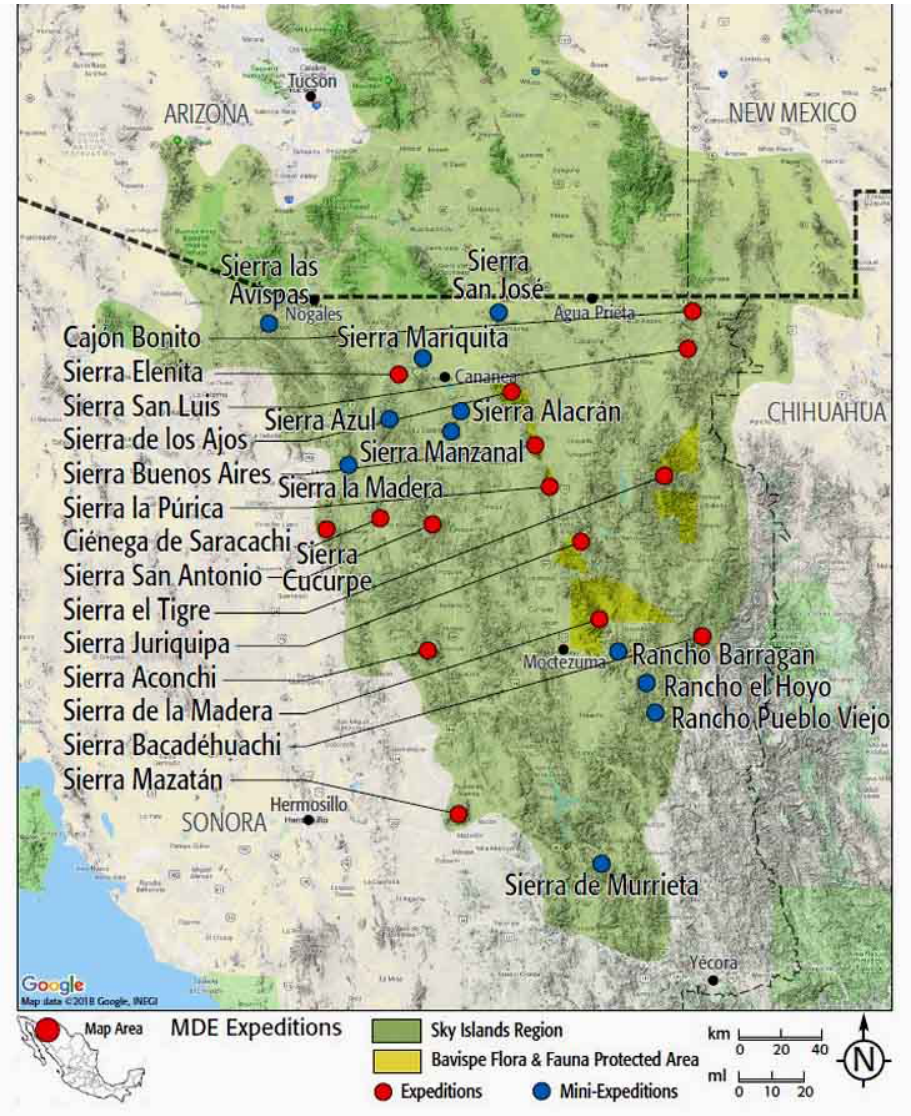

Figure 3. Map of the Sky Islands Region. Blue spots – MABA Expeditions. Blue triangles – MABA Mini-Expeditions. Red spots – MDE Expeditions. Red triangles – MDE Mini-Expeditions. Drafted by Dennis Caldwell.

All-species databases

A critical component of the MABA and MDE Expeditions is making biological observations publicly available for use in conservation, research, and education. In 2009, the all-species MABA database was created. MABA FLORA is directly linked to the SEINet herbarium databases. MABA FAUNA was an independent database. The MABA database mostly ceased activity since 2015, with 120,537 georeferenced records in the MABA database, including 75,921 animal (3,738 species) and 35,834 plant (2,188 species) récords from Sonora, Mexico. The MDE database (Madreandiscovery.org) was created in 2015 with the same structure to continue documenting the Sky Island biodiversity. Currently, there are 25,939

georeferenced records in the MDE database, including 9,771 animal (2438 species) and 10,911 plant (1296 species) récords from Sonora, Mexico. Previous récords are available through a link to the MABA database.

The MABA and MDE datasets are managed in a shared database in collaboration with iDigBio, SEINet, and >180 university collections. Records are both from historical sources (museum collections, literature, field notes, etc.) and new observations generated on biotic inventories to Sonoran Sky Island mountain ranges and a wide variety of trips on other projects. The FLORA databases are directly linked to the SEINet herbarium database network. The FAUNA databases are independent databases. With a combined total of 314,156 records (163, 119 animals, 151,037 plants), the MABA/MDE datbases are the best sources of biological records for Sonora.

Acknowledgments

Ed Gilbert wrote the SYMBIOTA software and set up the MABA and MDE databases. Sue Carnahan pointed out Pumpelly's 1870 use of the mountain islands. Careful reviews by Sky Jacobs and Frank Reichenbacher polished the text. Dennis Caldwell drafted the map. GreaterGood.org has strongly support the MDE program.

REFERENCES

Deyo, N.; Van Devender, T.R.; Smith, A.; Gilbert, E. 2013. Documenting the biodiversity of the Madrean Archipelgo: an analysis of a virtual flora and fauna. Pp. 292-299 in Gottfried, G.J.; Ffolliott, P.F.; Gebow, B.G.; Eskew, L.G.; and Collins, L.C. (comps.). Merging science and management in a rapidly changing world: biodiversity and management of the Madrean Archipelago III and 7th Conference on Research and Resource Management in the Southwestern Deserts. 2012 May 1-5, Tucson, AZ. Proceedings RMRS-P-67. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Heald, Weldon F. 1951. Sky Islands of Arizona. Natural History 60: 56-63, 95-96.

Hunt, R.; Anderson, W. 2002. A rapid biological and ecological inventory and assessment of the Cajón Bonito watershed, Sonora, Mexico. Part 1: Natural history Desert Plants 18: 3-20.

Lowe, Charles H. 1992. On the biogeography of the herpetofauna at Saguaro National Monument. Pp. 91-104 in Stone, C. P.; and Bellantoni, Elizabeth S. (eds.) Proceedings of the Symposium on Research in Saguaro National Monument, Tucson, Arizona.

McLaughlin, S.P. 1995. An overview of the flora of the Sky Islands, southeastern Arizona: Diversity, affinities, and insularity. Pp. 60-70 in DeBano, L.F.; Ffolliott, P.F.; Ortega Rubio, A.; Gottfried, G.J.; Hamre, R.H.; Edminster, C.B. (coords.) Biodiversity and Management of the Madrean Archipelago: The sky Islands of Southwestern United States and Northwestern Mexico. USDA Forest Service, General Technical Report, RM GTR 264.

Mearns, Edgar A. 1907. Mammals of the Mexican Boundary of the United States. Part 1. Smithsonian Institution. Bulletin 56. Government Printing Office.

Van Devender, T.R.; Avila-Villegas, S.; Emerson, M.; Turner, D.S.; Flesch, A.D.; Deyo, N.S. 2013. Biodiversity in the Madrean Archipelago of Sonora, Mexico. Pp. 10-16 in Gottfried, G.J.; Ffolliott, P.F.; Gebow, B.G.; Eskew, L.G.; and Collins, L.C. (comps.). Merging science and management in a rapidly changing world: biodiversity and management of the Madrean Archipelago III and 7th Conference on Research and Resource Management in the Southwestern Deserts. 2012 May 1-5, Tucson, AZ. Proceedings RMRS-P-67. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Van Devender, T.R.; Lowe, C.H.; Lawler, H.E. 1994. Factors influencing the distribution of the neotropical vine snake Oxybelis aeneus in Arizona and Sonora, Mexico. Herpetological Natural History 2: 27-44.

Wallace, A. 1965. Pumpelly's Arizona. The Paloverde Press, Tucson, AZ, 141 pp.

Warshall, P. 1995. The Madrean Sky Island Archipelago: a planetary overview. Pp. 6-18 IN: DeBano, L.F.; Ffolliott, P.F.; Ortega Rubio, A.; Gottfried, G.J.; Hamre, R.H.; Edminster, C.B. (coords.) Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico. USDA Forest Service, General Technical Report, RM GTR 264.