

# A BRIEF HISTORY OF SONORA (Vers. 29 September 2017)

© Richard C. Brusca

*NOTE: Being but a brief overview, this essay cannot do justice to Sonora's long and colorful history, but it hopefully provides a condensed introduction to this marvelous state. Readers with a serious interest in Sonora should consult the fine histories and geographies of the region, many of which are cited in the References section. The topic of Spanish colonial history has a rich literature, in particular, and no attempt has been made to include all of those citations in the References (although the most targeted and comprehensive treatments are included). Also see my "Bibliography on the Gulf of California" at [www.rickbrusca.com](http://www.rickbrusca.com). All photographs by R.C. Brusca, unless otherwise noted. This is a draft chapter for a planned book on the Sea of Cortez; the most current version of this draft can be downloaded at [http://rickbrusca.com/http\\_\\_\\_www.rickbrusca.com\\_inde.html/Sea\\_of\\_Cortez.html](http://rickbrusca.com/http___www.rickbrusca.com_inde.html/Sea_of_Cortez.html)*

For many reasons, Sonora has historically been rather isolated from the rest of Mexico. It is the farthest state from Mexico City, except for Baja California, and it has long been viewed by the country's strong central government as a "frontier region" or, worse, a dry desert wasteland. Its colonial history is not as deep or rich as that of central-southern Mexico, and its archeological past lacks remains of the great civilizations from the south (Aztecs, Mayas, Toltecs, etc.). Even today, many Sonorans feel the government of Mexico City largely ignores their presence. In fact, until the completion of the "Yécora Highway" (Mex Hwy 16) in 1992, Sonora was even largely isolated from its neighbor state of Chihuahua. For these reasons, and because of the state's location on the border with the U.S., cultural and economic ties often seem stronger between Sonora and Arizona than between Sonora and Mexico City (despite the recent construction of the much-despised border fence).

## LAND AND BIOTIC DIVERSITY

The State of Sonora encompasses 69,249 mi<sup>2</sup> (179,355 km<sup>2</sup>), making it the second largest of Mexico's 31 states (not including the Federal District). Located west of Chihuahua (Mexico's largest state), Sonora shares its northern border almost exclusively with Arizona, and it is topographically, ecologically, and biologically diverse. It is the most common gateway state

for visitors to the Sea of Cortez (Gulf of California). Its population is about three million.

The origin of the name "Sonora" is unclear. The first record of the name is probably that of explorer Francisco Vásquez de Coronado, who passed through the region in 1540 and called part of the area the *Valle de La Sonora*. Francisco de Ibarra also traveled through the area in 1567 and referred to the *Valles de la Señora*.

Four major river systems occur in the state of Sonora, to empty into the Sea of Cortez: the Río Colorado, Río Yaqui, Río Mayo, and massive Río Fuerte. Several smaller rivers originate almost entirely within the state, including the Río Sonoyta, Río Magdalena-Altar-Asunción-Concepción, Río San Miguel, Río Zanion, and Río Sonora, and these also once (at least intermittently) emptied into the Gulf of California although they no longer do. The headwaters of the San Pedro River also originate in Sonora, but the river flows northward, crossing into the U.S. as one the last remaining undammed rivers in Arizona. The Santa Cruz River originates in Arizona, flows South into Sonora, and then turns North again to re-enter the U.S. at Nogales, eventually running all the way to the Gila River in central Arizona.

The eastern part of the state comprises the western slopes of the Sierra Madre Occidental range—part of the great North American Cordillera. The highest elevations are in the Sierra de los Ajos and Sierra San Luis in northeastern Sonora. In addition to the Sierra Madre range, about 35 high isolated ranges (often called Sky Islands) are found west of the Sierra Madre in the northern half of the state (and another 33 Sky Island ranges occur in southeastern Arizona/southwestern New Mexico). The six highest mountains in the state are Cerro Pico Guacamayas (2625 m), Sierra Los Ajos (2620 m), Sierra San José (2540 m), Sierra La Charola (2520 m), Sierra San Luis (2520 m), and Sierra La Mariquita (2500 m).

Sonora encompasses a biological transition zone, with tropical ecosystems in the south, subtropical deserts in the north, and montane transitions in the sierras. The northern limit of Mexico's Tropical Deciduous (Dry) Forest

and Sinaloan Thornscrub lies near the center of the state, whereas some of the most arid desert regions of North America occur in the northwest, in the Gran Desierto de Altar. This topographic and climatological mix makes Sonora one of the most biologically diverse regions of the world. An estimated 5,000 species of vascular plants are reported from Sonora—20% of Mexico's total flora, in an area of less than 10% of the country.

In general, precipitation in Sonora decreases from higher to lower elevations, from south to north, and from east to west. In the pine-oak forests around Yécora (1550 m; 5085 ft) average annual precipitation exceeds 90 cm (35.5 inches), and in the tropical deciduous forests near Alamos (440 m; 1444 ft) it is around 65 cm (26 in). However, in the volcanic desert of the Pinacate region in northwestern Sonora, average annual precipitation is less than 25 cm (9 in) per year, and in the extremely arid Gran Desierto de Altar (near the lowermost Río Colorado) average annual precipitation is just 4-7.5 cm (1.5-3.0 in) per year. During summer months, temperatures exceeding 38°C (100°F) are common in the Gran Desierto, and the high summer air temperatures here drive up evapotranspiration (i.e., loss of water from plant leaves and soil).

Historically, the highest temperature recorded for anywhere in northwestern Mexico was 56.7°C (134°F) in the Sierra Blanca of the Pinacate region (near where the El Pinacate y Gran Desierto de Altar Biosphere Reserve's visitor center is today). In spring and fall, rain is infrequent at best, although occasional tropical storms do reach Sonora in the fall. Summer temperature extremes are mitigated by rains, called monsoons (or *las aguas*—the waters), characterized by strong afternoon thunderstorms. Less violent winter storms, called *equipatas*, are derived from Pacific frontal storms with ultimate origins as far north as Alaska. (The name *equipatas* comes from the Yaqui language and literally means “gentle winter rains.”) This biannual rainfall pattern is a key reason that the Sonoran Desert has one of the highest biological diversities in the world. Almost all of the summer and fall moisture comes from the Sea of Cortez and adjacent tropical Pacific Ocean that border the Sonoran Desert, thus making this a maritime desert. The traditional start of the monsoons (*las aguas*) is June 24, Saint John the Baptist's Day, or el *Día*

*de San Juan*. Saint John, who baptized Jesus in the River Jordan, is celebrated in many ways throughout the Catholic world.

The Pinacate area of northwest Sonora is unique for being home to North America's second largest lava flow region (the Snake River Plain basalt fields of Idaho are slightly larger) and its largest active sand dune field, the latter running northwestward from just north of Puerto Peñasco (Sonora) to Yuma (Arizona). The dune field embraces the western slopes of the Sierra Pinacate, and it completely surrounds the isolated granitic Sierra del Rosario (probably the westernmost Basin-and-Range mountain in North America). This 5700 km<sup>2</sup> (2200 mi<sup>2</sup>) dune field is estimated to have developed during and following the last Glacial Maximum (~20,000 years ago). The dunes were built almost entirely from wind-transported Colorado River deltaic sands piled up over the centuries from prevailing Westerlies. Thus, these dunes are largely the eroded rocks of the Grand Canyon! East of the Pinacates, along Hwy 8 between the town of Sonoyta and the entrance to the Pinacate Biosphere Reserve, is a field of ancient, stabilized dunes. These are much older dunes, perhaps hundreds of thousands of years in age, but their origin is unclear.



**Pillowed pahoehoe lava, Pinacates**

Topographically and demographically, the State of Sonora can be thought of as having two

great regions, with different geological and cultural histories (see West 1993). The eastern mountain region, called *La Serrana* (the highland), comprises the western slopes and foothills of the Sierra Madre Occidental. It was originally inhabited by Native American (indigenous) hunters and gatherers, later by indigenous farmers, and then in the 17th and 18th centuries by Jesuit missionaries and Spanish and mestizo miners and ranchers. Today it is losing population because its younger generation is moving to the cities, and it has become major marijuana and heroine-poppy growing areas and is confronting narcotrafficking as drugs move north to the U.S. The Western Lowland, on the other hand, was originally only sparsely populated by indigenous people. In the late 18th century, the lowlands were exploited by Spanish and Indian/mestizo gold seekers. Today the lowlands are characterized by recently developed government-sponsored irrigated agriculture (the so-called *Distritos de Riego*), with wells that exploit underground water sources, as well as coastal mariculture and tourism—all of which has given rise to dense farming, industrial centers, and rapid urbanization.



Sand dunes of the Gran Desierto de Altar  
(Photo by Rick Westcott)

Since prehistoric times, people have relied heavily on the native plants of Sonora, especially the legumes—mesquite, paloverde, ironwood, etc. The most important native grasses for grazing purposes were the gramas (*Bouteloua* spp.), 18 species of which have been identified from northeast Sonora alone. The gramas turn green and lush after summer rains, drying to nutritious hay during the fall dry season. The fruits of the pitahaya dulce, or organ pipe (*Stenocereus thurberi*), saguaro (*Carnegiea gigantea*), and cardón (*Pachycereus*

*pringlei*, also called sahuero) cacti were all important food sources, and are still collected and consumed by the Seri People (*Comcáac*) and others, as well as being enjoyed as delicacies by modern Sonorans.

The introduction of corn (*Zea mays*), which was first domesticated in south-central Mexico, into Sonora and the American Southwest is usually attributed to Uto-Aztecanspeaking groups who spread throughout much of the region between 3000 and 1000 B.C. A popular hypothesis suggests that the timing of the dispersal is likely related to environmental conditions following the end of the warm and dry Altithermal Period (middle Holocene), as Uto-Aztecans descended from refugia in the Sierra Madre Occidental to colonize the low country. The oldest occurrence of early maize in archaeological context is ~5000 B.C. (south-central Mexico), and the earliest records of domestic corn is from the Tehuacan Valley ~3600 B.C. (south-central Mexico). In the U.S., domesticated corn has been found in Arizona and New Mexico archaeological sites date ~2000 B.C.

The hearts, or trunk and leaf bases of agaves (what many Mexicans call *maguey*), known as *cabezas*, were gathered and slow roasted by native people to prepare a sweet and nutritious food called *mezcal*. Spaniards quickly learned to ferment and distill the *mezcal* to create the liquors we know today as mescal (and its regional variants, e.g., bacanora) and tequila. By law, tequila is always made from the blue agave, a variety of *Agave angustifolia* known as *A. angustifolia tequilana* (or *A. angustifolia weberiana*), and only in certain designated regions of west-central Mexico. Mescal can be made from many of the 400+ known species of agave (and may also have other added ingredients), although it is typically made from regional varieties of the very widespread *Agave angustifolia*. In *La Serrana* today, certain native agave plants also are used to distill *mezcal de Bacanora*, a potent artisanal mescal similar to "white lightning." [Endnote 1]

Of the native mammals, mule deer (in low elevations), white-tailed deer (largely restricted to higher elevations), rabbits, and perhaps bighorn sheep were the most commonly consumed meats in prehistoric times. Today, as in centuries past, Yaqui and Mayo People use small stuffed heads with antlers of white-tailed deer as headdresses for special



**Sideoats grama (*Bouteloua curtipendula*)**

dancers (deer dancers) during certain religious ceremonies, suggesting the prominence and importance of deer in those cultures. Hunted less commonly were pronghorn and javelina. Predators have rarely, if ever, been hunted for meat (e.g. mountain lion, jaguar, ocelot, black bear, coyote, gray wolf, and foxes). In addition to large quantities of fish and shellfish (and some sea lion), the Seri People also used to eat pelicans seasonally. However, sea turtles were their primary source of protein.



**An agave plant used for making mescal in Oaxaca (not the blue agave variety)**



**The heart ("cabeza") of an agave, ready for roasting to make mescal**



**An agave roasting pit, the same design used since Pre-Columbian times**



**Burro-power drives a stone wheel that grinds roasted agave cabezas into pulp and liquid for subsequent fermentation**



A still used to recover the alcohol from cooked agave



Larva (caterpillar) of the saturniid moth *Rothschildia cincta* (Photo by E. Pfeiler)



The famous mescal or maguey worm – usually larvae of the cossid moth *Comadia redtenbacheri* (above), but sometimes a weevil larva (*Scyphophorus acupunctatus*) is used, or the larva of a skipper butterfly (*Aegiale hesperiaris*)



The tequila bar at the Hacienda de los Santos, Álamos, Sonora, offers up ~100 varieties of the liquor. Salud!



Leg rattles (*ténaborim*) used by Yaqui and Mayo dancers are made from cocoons of the saturniid moth *Rothschildia cincta*

### **La Serrana**

Seven major rivers drain La Serrana: Río San Miguel, Río Sonora, Río Mayo, Río Moctezuma, Río Matape, and the upper and lower Río Bavispe, both of which drain into the Río Yaqui, historically the largest river in Sonora (not counting the Río Colorado). Each of these is fed by snowmelt, rain, and springs in the Sierra Madre. In times past, these rivers reached the Sea of Cortez, but today they rarely flow to the ocean due to damming and irrigation diversion. The river valleys of *La Serrana* were prehistoric sites of agriculture and permanent settlement. During Spanish colonial times these valleys continued to provide most of the food for Sonora. The rugged hills and mountain ranges of *La Serrana* held silver, gold, and copper where great mineralization activity had taken place along fault-block lines. The presence of

these ores has attracted miners since the 17th century.

### **The Western Lowlands**

Geologically, Sonora is underlain by the ancient and massive North American craton, and its dominant rocks were formed 1.2-1.7 billion years ago. Many of the mountain ranges west of the Sierra Madre Occidental and its Sky Islands have been eroded down nearly to their roots, forming isolated rock masses called *inselbergs*, separated by wide bajadas (flood plains) and basins. Rich deposits of gold dust and nuggets, eroded from the former mountains, have left placers (nuggets and flakes washed downslope through erosional and sedimentary action). The northern part of western Sonora includes the Altar Desert, part of the Lower Colorado River Valley region of the Sonoran Desert and one of



**La Serrana, the rugged western slopes of the Sierra Madre Occidental; photo taken east of Álamos (Rancho Santa Barbara)**

the driest areas in North America. However, the rivers draining *La Serrana*, over millennia, deposited copious amounts of groundwater in aquifers below the desert surface in the Western Lowlands. These aquifers have sustained rapid growth of population and agriculture in coastal Sonora since the 1950s. However, there is now little water reaching these aquifers, the rivers have been dammed for decades, and the aquifers are being pumped at a much faster rate than they are being recharged.

### **ABORIGINAL CULTURES**

Sonora was first populated by indigenous hunter-gatherers such as the Seri (Comcáac), Yaqui, and Mayo Peoples. But in the 16th century the Spanish conquest and the spread of diseases decimated these Native American populations.

The major indigenous groups of Sonora that are still with us today are the Kwapa or Cucupás (in the Colorado River Basin south of the border), O'odhams (in northern Sonora), the Comcáac or Seris (in coastal central Sonora), the Yaquis and Mayos (closely related Cahitan People of the Yaqui and Mayo River Valleys), and the little-known Guarijíos of southeastern Sonora. The Tarahumaras inhabit the high country of the Sierra Madre, or the "spine of the Sierras," but live primarily in Chihuahua.

Aside from the Comcáac (Seris) and Kwapa (Cucupás), most extant aboriginal cultures in Sonora belong to the Uto-Aztecan language group, which is widespread in Mexico. In southern Sonora this includes the Yaqui and Mayo languages (collectively known as Cáhita). In the eastern and central parts of Sonora it included the Ópata and Pima Bajo languages. In the northwest, it was Pima Alto and the closely related O'odham (previously known as Pápago) dialects. The origin of the isolated Seri tongue, on the other hand, largely remains a mystery, although some evidence suggests a relationship with languages from the Baja California peninsula. The now vanished "Guaymas people" (*Guaímas*) evidently were the southernmost band of Seris. The Apaches, especially the Chiricahua Apache, ranged (and raided) in the northeastern corner of Sonora; they spoke an Athapascan tongue typical of northwestern America, indicating their relatively recent arrival from the north.

Even before the Spanish began to settle northwestern Mexico, aboriginal populations had dwindled, presumably due to introduced European diseases. During the 16th Century, disastrous scourges of smallpox, typhus, measles, and other diseases swept through central Mexico soon after the Spanish Conquest and probably reached all the way to Sonora. It is known that by 1592 smallpox had, at least, reached southern Sonora, causing death and famine among the Yaquis and Mayos. During the Jesuit missionization, epidemics are thought to have killed half of the Mayo population.

### **Farming Cultures**

*The Río Sonora Culture.* Most of the Indians of *La Serrana* were farmers, utilizing agricultural techniques similar to those used in Mesoamerica. Taken together, this farming culture of eastern Sonora is sometimes called

the "Río Sonora Culture." Among these people were the Ópata and Pima Bajo, who practiced both dryfield (rain dependent) and small-scale irrigation farming. Spanish explorers (and recent archeological work) document the complex pueblos and farming of the Ópata, which included cultivation of maize, beans and squash. The Ópata region of northeastern Sonora, with an estimated 10,000 to 100,000 inhabitants, may have been the most densely populated area of northwestern Mexico when the Spanish arrived. The Ópata probably had strong trade routes to the Casas Grandes (Paquimé) people in what is now northwestern Chihuahua. However, by the time the Jesuits and miners arrived in *La Serrana*, populations had dwindled. In the south, the Yaqui and Mayo tribes used mainly natural floodplain farming along the Yaqui and Mayo rivers, as did many O'odham and Kwapa peoples until very recent times.

*The Pima Bajo and Pima Alto Cultures.* The terms "Bajo" (lower) and "Alto" (upper), probably introduced by the Jesuits, are geographical, not linguistic categories, and the people in both regions largely spoke the same basic language. Pima Bajo extended from the middle Río Sonora (around Ures) east to the middle of the Río Yaqui, and then into and over the Sierra Madre as far as La Junta in western Chihuahua. The Pima Alto lived in the more arid northwestern Sonora and southern Arizona, especially along the Gila and Salt Rivers.

The Desert Pima (later called Papago, and now Tohono O'odham) inhabited the arid Sonoran Desert in northwestern Sonora and southern Arizona, with the most arid region inhabited by the Hia C-ed O'odham (the "Sand Papago"). Several other related tribes lived farther to the east and south, including the Soba Pima (in the lower Magdalena and Altar River Valleys), Himiris (upper Magdalena), and Sobaipuri (San Pedro, Santa Cruz and middle Gila Rivers). After the Spanish conquest, all of these peoples (including any remaining Arizona Hohokam) were considered residents of the Pimería Alta. The O'odham were hunter-gatherers who farmed scattered fields during summer rains, although near present-day Sonoyta (Sonora) they used limited canal agriculture. The Riverine Pima of Arizona had permanent villages and canal irrigation.

Of all the prehispanic cultures, one of the most interesting was that associated with

curious sites called *trincheras*—terraced hillside habitations constructed on mountain slopes overlooking arable land along streams. One of the largest of these sites (and the namesake) is *Cerro de Trincheras*, located at the railroad village of Trincheras, near the town Santa Ana, Sonora. *Trincheras* sites are abundant in the Magdalena, Concepción, and Cocóspera River Basins, in the Altar Valley, and from the San Miguel and Santa Cruz River Valleys as far north as Sells, on the modern Tohono O'odham reservation in Arizona, and near Redrock (between Tucson and Phoenix). The *trincheras* are generally interpreted as having been both agricultural and defensive sites, possibly places of refuge when villages and fields were attacked by enemies. The Trincheras Culture had ties with the Hohokam Culture to the north and may have been a forerunner of Piman Culture. Evidence of Trincheran visitation is also common along the Gulf of California coast of northern Sonora, and inland to the Caborca and Santa Ana areas.

### **Hunting-Gathering Cultures**

When the Spaniards arrived, two widely separated hunter-gatherer groups lived in parts of Sonora: the Seri People along the central Gulf coast (including the Guaímas people), and several Apache-related tribes of present-day Chihuahua, New Mexico and Arizona. In contrast to the Native American farming cultures, these two groups strongly resisted both Jesuit and secular attempts to "civilize," or acculturate them. The Seris were a collectively small group of fewer than 5,000, living in distinct bands along the coast between Guaymas and Cabo Lobos (Puerto Libertad), inland nearly to modern-day Hermosillo, and on Tiburón and San Esteban Islands. They spoke a distinctive language, and might have originally migrated across the Gulf from the Baja California peninsula where several Yuman-related languages were (and continue to be, e.g., Cucapá, Kiliwa, Kumiai) spoken. Seris were primarily fishers, especially for sea turtles, and shellfish gatherers, who occasionally foraged inland where they used more than 100 different plant species for food and medicines. The Seris have probably inhabited coastal Sonora in the region of Isla Tiburón for at least 2,000 years. Today, there are fewer than 1,500 Seris, and they are one of the last functioning aboriginal hunter/fisher-gatherer societies remaining in North America. The Apaches were latecomers, probably not arriving from their gradual migration

from Canada into Arizona, New Mexico and Chihuahua until the last decades of the 1500s.



The border fence at Naco, Arizona  
(looking south from the U.S.)

### THE SPANISH ARRIVE IN SONORA

In 1528, the Spanish explorer Alvar Núñez Cabeza de Vaca was shipwrecked off the Gulf Coast of what is now Texas. Thus began the epic journey on foot of he and three companions, including a North African named Esteban de Dorantes, who traveled westward, passing through Sonora and eventually reaching Mexico City. Their journey probably took them through New Mexico and Arizona (or perhaps across Coahuila and Chihuahua), and during this time they heard stories of great Indian kingdoms to the north “where there were cities with large populations and great houses.” Today, these are thought to have been the Zuni Pueblos of New Mexico. Cabeza de Vaca and his party traveled south from Sonora along the coast, eventually reaching Mexico City, where their stories of great northern Indian civilizations encouraged Viceroy Antonio de Mendoza to launch a series of expeditions in search of the “lost cities.”

The first expedition was that of Fray Marcos de Niza. The Franciscan took Esteban along as his guide. They traveled up the Pacific Coast, passing through Sonora, wherein Esteban moved forward and traveled as far north as the Zuni Pueblos. The Zunis killed Esteban, and there is no clear record of what he saw or learned at the pueblos. Whether or not Fray Marcos eventually reached the Zuni Pueblos is debatable, but he returned to Mexico City with claims of reaching Cibola, one of what he called the “great seven cities in the north.” It was the stories of Fray Marcos that led to Francisco Vázquez de Coronado’s great *entrada*

north. Coronado, then Governor of Nueva Galicia in western Mexico, led at least 358 Europeans, their servants, slaves and women companions, and more than 1300 Indians from central and western Mexico on a well-organized expedition that took them from Nayarit all the way to central Kansas. Coronado also sent his lieutenant, Melchor Díaz, north along a coastal route, and Díaz eventually crossed the Colorado River into California—the first European to do so. Another of Coronado’s lieutenants, Hernando de Alarcón, traveled by ship northward in the Gulf of California and into the delta waters of the Colorado River. Coronado never found the “Great Cities in the North,” and ended up convinced that Fray Marcos was a liar.

Spanish settlement of Sonora did not occur for nearly a century after Francisco Vázquez de Coronado’s great *entrada*, much later than in Central and Southern Mexico due to the inclemency of the terrain and conflict with the native peoples of the region. Also, the missionary system of colonialism was distinctive from the rest of Mexico. Early in the 17th Century, the Jesuit Order began to establish missions in northwest Mexico. By the 1640s Spanish lay settlers, mainly miners from central Mexico, had crossed the Sierra Madre Occidental into Sonora. Both forms of settlement were originally restricted to *La Serrana*, along the river valleys.



The border fence at Lukeville (AZ)-Sonoyta (SON)

Actual missionary work in Sonora (called Nueva Andalucía Captain Pedro de Perea) began around 1614 when the Jesuit Padre Pedro Méndez began to administer the Mayo Indians, near what today is the Sonora-Sinaloa border. By 1636 the Jesuit missionary frontier had pushed up to the Río Sonora Valley and a mission was established in the vicinity of Ures (Padre Bartolomé Castaños was the first resident priest). Pedro de Perea had difficulty

getting along with Jesuits, and in the early 1640s he began to replace them with Franciscans, especially in the Sonora River Valley. Here, for a short time, five Franciscans were scattered in the region that was otherwise claimed by the Jesuits. The two orders clashed, and despite de Perea's desires, no Franciscans ever settled in the Pimería Alta region (northern Sonora/southern Arizona). Upon de Perea's death in 1644, the Franciscans were ordered out of the region by the authorities, leaving the Jesuits in undisputed possession of that missionary region.

Some of the most beautiful and interesting Spanish-era missions are in the Sonoran Desert. Those mission sites with still visible remains north of the border are San Xavier del Bac, San José de Tumacácori, Los Santos Ángeles de Guevavi (now an adobe ruin), and the *visita* of Calabazas. San Xavier del Bac is still an active parish, serving the descendants of the original Pimans (O'odham) for whom it was founded. The others are under the care of the U.S. National Park Service. All of these missions (though not all of the churches) were founded by the Jesuit Father Eusebio Francisco Kino. Photographs of some of the churches of Sonora (and Baja California) founded during the colonial era, by Kino and others, are provided below and in Appendix 1. [ENDNOTE 2]

The Jesuits dominated mission activity in Sonora for more than 150 years, from their initial entry (via Sinaloa) among the Mayo and Yaqui People (1614-1617) until the order was expelled from the Spanish colonies in 1767 by edict of King Charles III. The Jesuits were replaced by Franciscan missionaries, who arrived in the Pimería region in 1768. They quickly set out to repair or replace the Jesuit churches, often constructing new ones on or near sites of the original Jesuit churches. Before the mid-19<sup>th</sup> century, the Franciscans (of Spanish origin) were themselves banished from the northern missions, this time by the Republic of Mexico, and the buildings were left to fend for themselves. The Kino mission sites include 3 in Arizona and 13 in Sonora (see Appendix 1), although few of these have churches surviving from Kino's time. One of the Sonoran churches, Caborca, is now a museum, and five other Sonoran mission-site churches are still in use—San Ignacio, Magdalena, Tubutama, Oquitoa, and Pitiquito. The “mother mission” for all of Pimería Alta, Nuestra Señora de los Dolores

(near Cucurpe), founded by Kino in 1687, no longer has a standing church, and today there is only a small cemetery (of uncertain age) and a large ranch at the site. Locals have erected an “altar” at the site, where they hold occasional pilgrimages. See Appendix 1 for photographs of some of the churches from Padre Kino's 16 missions in the Pimería Alta.

It is important to distinguish between a mission and its church. Although the latter was typically the largest building dominating the site, it was not the mission proper, which was the whole enterprise established by the founding priests. Missions were settlements and centers of activity where the church introduced Native Peoples to a church-based belief system and European ways of life, which, in the Pimería Alta, included the introduction of European livestock, farming, and culture. Missions often grew into towns, and some missions had “oversight” for several pueblos in the surrounding area. The mission's outlying buildings surrounding the church were the lifeblood of the enterprise. Typically the church had a convento, which included the priests' quarters, kitchen, storerooms, etc. There also would have been blacksmith shops, loom rooms, milling rooms, etc., as well as the agricultural fields.

Padre Eusebio Francisco Kino arrived in Mexico from Spain in 1681. Although he was not the first Jesuit in Sonora, he pushed the Spanish Empire far to the north (to Tucson) and became the most celebrated of all northwest Mexico's Jesuits. He tried to missionize Baja California, without success (mainly due to lack of support from his superiors), but succeeded beyond anyone's imagination in Sonora and southern Arizona. His northernmost settlement was San Xavier del Bac, near Tucson (Arizona). [Endnote 3] He established a mission program there in 1692 and had plans for a church, but it was not built until the 1750s. This first church was a simple adobe structure. The church we call San Xavier today was built by the Franciscans and dedicated in 1797. San Xavier church represents the finest example of baroque style architecture (with strong Moorish influence) in the borderlands region, and it maintains an almost complete, late-eighteenth century construct. To find an equally elaborate baroque church, one must travel to San Antonio (Texas) or Santa Fe (New Mexico), and even there what you will find are details, not an entire church of

this genre and elegance. Walking through the front door of the San Xavier church is like stepping through a time machine into the late-18<sup>th</sup> century.

Today, one can view the skeletal remains of Padre Kino at the handsome domed crypt in the town of Magdalena de Kino, Sonora, near the church of Santa María Magdalena. Although there is evidence that Kino himself might have established a chapel near this site (perhaps in the 1690s), the existing church dates to 1832 and has been reworked several times.



**Statue of Padre Kino in the city of Magdalena de Kino, Sonora. In the plaza with statue is a memorial to Kino's remains and a 19<sup>th</sup> century church. Built around 1833, the present church does not stand on the site of the original Jesuit church.**

Aside from his missionary work, Kino's other great contributions stemmed from his exploratory and cartography skills. He re-discovered that Baja California was indeed a peninsula, and not an island (Francisco Ulloa had discovered this in 1539, Melchior Díaz proved it again in 1540, and Juan de Oñate again in 1604, but their writings went largely unnoticed). His maps of northwestern Mexico and southwestern United States (the Pimería Alta region) were the most accurate made to that date, and they can still be used with good precision, although there had been several earlier maps showing Baja California as a peninsula (e.g., the French Guillaume de l'Isle's

*L'Amérique Septentrionale*, Paris, 1700; the Italian di Arnaldi map, *America*).



**All that remains of the Jesuit mission at Santa Rosalía, Baja California Sur**



**The Jesuit mission of San Francisco Xavier, west of Loreto, high in the Sierra La Giganta (Baja California Sur). Founded in 1699, in an area then inhabited by Guaycura Indians, it was the first mission in Baja California to have glass windows. Construction was completed in 1758 under the direction of Padre Miguel del Barco.**



**An original mission olive tree, 300 year-old, still living at San Francisco Xavier mission in the Sierra La Giganta, Baja California Sur.**



The spartan Jesuit mission at Mulegé, Baja California Sur, built in 1707



Mission Nuestra Señora de Loreto, the first mission built in the Californias; founded by Padre Juan María de Salvatierra in 1697 and completed in 1752 (Loreto, Baja California Sur)



The old mission church at El Triunfo, about an hour south of La Paz (Baja California Sur) was built by the Franciscans in the 1800s. Established as a gold and silver mining town, El Triunfo drew miners from all over the U.S. and Mexico. Once the largest city in B.C.S., it was home to over 10,000 miners in its heyday. Now a remnant of the past, the town's 115 ft-high smokestack was designed by Gustav Eiffel (of Eiffel Tower fame). Today the town has fewer than 500 inhabitants.

Kino's expeditions to the Lower Colorado River and the Sierra Pinacate relied on the springs at Quitobaquito (now part of Organ Pipe Cactus National Monument), as well as other, smaller springs and *tinajas* that his Indian guides led him to. He made four expeditions into the Pinacates: October 1698, March and April 1701, and November 1706. [Endnote 4]



The Franciscan-built church in La Paz (Baja California Sur). Hernán Cortés first landed at this site in 1535 (naming it Santa Cruz). Father Kino tried to establish a colony here in 1683, naming it Nuestra Señora de la Paz, but failed. In 1720, Jesuit Padre Jaime Bravo founded the first successful mission here, and in 1861 Bishop J. F. Escalante y Moreno began construction of the church that stands today.



**Memorial housing Padre Kino bones, in the zócalo of Magdalena de Kino, Sonora**



**Bust of Padre Kino in the zócalo of Magdalena de Kino, Sonora**



**The skeletal remains of Eusebio Kino, in the zócalo of Magdalena de Kino, Sonora**

By the end of the 17th Century, the Jesuits had founded 38 primary missions and 59 *visitas* in Sonora. According to Spanish law, a mission was to be dissolved 10 years after its founding, based on the supposition that by then the natives should be sufficiently versed in Christianity that they could be left on their own. However, the Jesuits had a habit of developing ranching and farming missions that were so economically successful that they tended to forego the 10-year rule. When they were finally

expelled from the New World in 1767 (by royal edict), at the promulgation of jealous lay officials who coveted the land and cheap native labor, most of their missions were taken over by the Franciscans (or by the Dominicans, in northern Baja California). The Jesuit enterprise of Sonora was one of the most successful endeavors of the order in the New World, on par with that of Paraguay, which was established at about the same time (recall the book "The Mission," and the movie of the same name filmed at Iguazu Falls where the countries of Brazil, Argentina and Paraguay meet).



Although Padre Kino founded the town of Caborca in 1688, the mission itself was founded by Francisco Javier Saeta, in 1694. The original Jesuit church was built on the banks of the Asunción River (today known as the Río Concepción), east of the present town center, although the church standing there today was built by Franciscans (1803-1809). This Franciscan church is gradually being destroyed by erosion, especially during flood events along the river. In 1857 the church was the scene of violent fighting when the people of Caborca were driven into the church by American filibusters led by Henry A. Crabb. Crabb and his men were eventually smoked out of their adobe house-fort opposite the church, and promptly executed. The standing church in the city today (pictured above) was built by the Franciscans in 1790.

Probably the most enduring cultural changes that the missions made on native life were in agriculture, through the introduction of Old World crops (especially wheat), farm tools and techniques, and domesticated animals. During the planting and harvest periods, all men in the mission settlement were required to work the church lands 3 days/week, and their own plots 3 days/week—Sundays and feast days were reserved for compulsory church attendance. It was the introduction by the Jesuits of wheat that led to the invention of northwestern Mexico's famous flour tortillas. In Sonora to this day, thin flour tortillas (and beans and chilies) are the norm of rural diets; elsewhere in Mexico, native maize (corn) is the dietary staple. The later-arriving Franciscans

were a more devotional-based sect and, not surprisingly, brought with them to Sonora the growing influence of Our Lady of Guadalupe. [Endnote 5]

While Kino and his colleagues missionized the Pimería Alta, other Jesuits, and eventually Franciscans, worked in the foothills of the Sierra Madre—La Serrana. A drive down the Río Sonora Valley today, from Cananea to Urés, takes one through a half-dozen charming colonial villages, each with its own Jesuit or Franciscan church (see images following, from north to south). This was the land of the Ópata People, and most of the names of these towns were derived from the Ópata language (e.g., Arizpe, Banámichi, Baviácora).

Although the period of initial Spanish conquest of Mexico (sometimes referred to in central Mexico as “The Rape of Mexico”) and the destruction and devastation brought by Hernan Cortés was not felt in Sonora initially, a trip to the old Playa de Cortés Hotel near Guaymas will provide a vivid glimpse of those events. In the bar of this seaside resort are four large, exquisite, and disturbing, bas-relief panels that depict Cortés’s subjugation of the Aztec people. [Endnote 6]



The Jesuit church at Huépac, founded 1639-1644, *Iglesia San Lorenzo de Huépac*. An original copy of the Mexican Act of Independence from 1810 is said to be protected inside Huépac’s City Hall.



The beautiful church at Banámichi, on the zócalo. Although the mission (and town) was founded by Jesuits in 1639, the present church—*Iglesia de Nuestra Señora de Loreto*—dates from Franciscan times.



The Jesuit church at Arizpe, founded in 1646 by Jerónimo de la Canal. Once the capital of northern New Spain, it was from Arizpe (Horcasitas) that Juan Bautista de Anza’s expedition to Alta California was launched (in 1775), eventually leading to his establishment of the city of San Francisco. De Anza’s remains are believed to lie in the church at Arizpe (though probably still buried, the exhumed bones likely being from one of De Anza’s soldiers).



Although the town of Aconchi, Sonora, was founded by the Jesuits in 1639, the modern church dates from the 1700s, was built by the Franciscans, and features a legendary Black Christ.



The town and mission at Baviácora, Sonora, were founded by the Jesuit Bartolomé Castañón in 1639. The original church stands to the left of the newer church, built by Franciscans in the 18<sup>th</sup> century—Iglesia Nuestra Señora de la Concepción de Banácora.



The beautiful Jesuit mission at Ures, along the Río Sonora, built between 1636 and 1644.



Portrait of Hernán Cortés

### SPANISH SETTLEMENT: MINES AND RANCHES

Spanish settlers began colonizing Sonora about the same time the Jesuits were founding missions. By the end of the 17th Century, ranching and silver mining had become firmly established in Sonora, eventually rivaling (but not eclipsing) the silver towns of Taxco and Zacatecas in central Mexico. The silver deposits were mostly superficial (to 150-200m depth), but below them lay copper, and after the silver ore had been mined American companies moved in during the 1800s to begin mining copper ore. Some of the original copper mines are still producing, and Sonora is the top-ranking state in Mexico for mineral extraction.

One of the most productive mining centers of Mexico was the area around Álamos in southeastern Sonora, where silver was mined for more than 200 years. In 1776, nearly two-thirds of the silver produced in northwestern Mexico came from the Álamos mines. Today Álamos is one of the most charming, largely restored colonial towns in northern Mexico.



Sketch of Eusebio Kino, by Frances O'Brien. Several interpretations of what Kino might have looked like have been prepared, including a bust in the zócalo in Magdalena de Kino



Shrine to the Virgin of Guadalupe, just south of Hermosillo, Sonora

With the mines came merchants, and the Sierra Madre Occidental foothills town of Hidalgo de Parral (in southern Chihuahua) came to be the merchant center for the region, being strategically positioned between the mining areas of Sonora and central Mexico. Most of the silver ore was packed out to Parral where it was assayed and then shipped to Durango or Mexico



A portion of Kino's famous 1701 map of the Pimeria Alta Region, showing Baja California as a peninsula rather than an island (based on his 9 expeditions between 1698 and 1706).



The enigmatic *Iglesia de la Virgen de Fatima* in Magdalena, Sonora. Built by two brothers who had a vision, or calling. Construction began ~1980 and the church is still not fully finished, although it is functional. In front are two "Kino Heritage Fruit Trees," a peach and a loquat (and a large *el Guaje* tree on the right, from far to the south).

City. The Jesuits of the missions supplied food to the miners in return for silver, which was used to purchase church furnishings and luxury items such as cloth and tobacco.

### THE INDIAN WARS

During the 18th and 19th centuries, Indian raids on mines, missions and ranches were frequently made by Apaches, Jocomes, Janos, and Sumas from the north, and Seris from the west. The Apaches began raiding in the 1680s and continued for 200 years, until the last of the bands, led by renowned chief Geronimo, was finally defeated by combined Mexican and U.S. troops in the 1880s. The nomadic Apaches probably attacked simply because it was an easy way to acquire food, horses and slaves. Apaches became excellent horsemen, raiding the Spanish settlements for their mounts and, it is said, always choosing the best animals for riding. The American Southwest was not fully opened to colonization until Geronimo had been captured. But even the Yaqui, who were powerfully missionized throughout most of their history, rose up against the Spanish briefly (1740-1742).

It has been said that destruction by these tribes (mainly Apaches) became so rampant in the mid-18th century that Spanish officials issued regulations that all houses in Sonora were to be constructed of adobe walls with flat roofs covered with sod or dirt to avoid destruction during Indian attacks. Their weapons were bow and arrow, and occasionally the lance. Eventually, the Spaniards built a series of *presidios*, or forts, at strategic places. In addition to protecting the local population against Indian depredations, another important activity of the sierra *presidios* was escorting mule trains carrying goods from Parral over the Sierra Madre into Sonora, and returning with silver bullion. The last of the northern *presidios* was established at Tucson in 1775, from which arose the present city of Tucson, originally on the banks of the Santa Cruz River. General small-scale warfare with the Apaches continued in Sonora and Chihuahua for most of the 19th century. In the mountains of Sonora (the Sierra Madre Occidental), isolated occurrences of Apache resistance actually continued until the 1920s.

The failure of the Spanish, and later the Mexican military to make peace with the

Apaches may have been due, in part, from differences of sociopolitical thought between Europeans and Indians. European ideas of hierarchy and subordination did not exist among the Apaches, each band having temporary leaders who were not necessarily recognized by the other bands. Thus, a truce made with one group likely did not apply to members of other bands. Farther east, the states of Texas, Coahuila, Nuevo León, and Tamaulipas confronted Comanche raids. Comanche were High Plains bison hunters of Shoshone stock that are said to have been the best riders among all the nomadic tribes of western North America. Some historians have suggested that the position of the present U.S.-Mexico border may have been largely determined by the presence of nomadic Indian bands that stopped and forced back Spanish settlement in southern Arizona and Texas.



The colonial town of Alamos, Sonora



The main zócalo and church at Alamos, Sonora

### THE U.S. INVASION OF MEXICO

The short but significant Mexican–American War lasted from spring, 1846 to fall, 1847. It followed

in the wake of the 1845 U.S. annexation of Texas, which was part of Mexico's territory. Once the war began, American forces quickly occupied New Mexico and California, and then invaded parts of northern Mexico from Baja California and Sonora, to Nuevo Leon. A force eventually captured Mexico City, ending the war in a victory for the U.S. The Treaty of Guadalupe Hidalgo (*Tratado de Guadalupe Hidalgo*) was signed on February 2, 1848, spelling out the terms of the victory and forcing the cession of Mexico's territory of Alta California and a large area comprising New Mexico, Arizona, Nevada, Utah, and parts of Wyoming and Colorado, in exchange for \$15 million. Mexicans living in those areas had the choice of relocating to within Mexico's new boundaries or receiving American citizenship with full rights (over 90% chose to become U.S. citizens). The treaty was signed in Villa de Guadalupe Hidalgo, now a neighborhood of Mexico City. In addition, the U.S. assumed a \$3.25 million debt owed by the Mexican government to U.S. citizens. Mexico accepted the loss of Texas and thereafter the Rio Grande was recognized as the border between the two countries. The war was controversial in the U.S., with the Whig Party, anti-imperialists, and anti-slavery elements strongly opposed. The Whig Party opposed Manifest Destiny and rejected this Mexican expansion strongly. The financial cost and loss of American lives was high.

### **THE SONORAN GOLD RUSH**

In the last half of the 1700s, long before the California gold rush, Spanish Sonorans (and some Indians, mainly Yaqui and Mayo) began panning gold from placer deposits in the Sierra Madre. As the mainly pre-Cambrian rock slowly weathered down, gold in the form of nuggets and flakes eroded from quartz veins and washed down across the alluvial fans of the mountain bajadas to form placer deposits. Most placers in southwestern U.S./northwestern Mexico were formed (trapped) between a layer of caliche (hardened calcium carbonate deposits) and the underlying bedrock. Nuggets could be obtained by "dry placering" -- tossing the broken earth, sand and gravel into the air and permitting wind to remove all but the heavier gold nuggets. "Wet placering" with running water recovered even the finer gold dust. The most productive areas were in the Altar Desert of northwestern Sonora, and there the first authentic gold rush in North

America took place from 1775 to 1825. Unlike lode or ore mining, working placer deposits could be a one-person operation, or at most a small group association. It required simple tools and nuggets of pure gold needed no further refinement. Deposits were small, however, so placer camps were ephemeral, at best lasting only a few years. Gradually the gold miners pushed farther and farther north, into Arizona and eventually west to California. When news of the discovery of large gold deposits in the foothills of California's Sierra Nevada Mountains reached Mexico in 1848, some 5,000 fortune hunters from Sonora migrated to the new gold fields. Among the many marks they left is the namesake town of Sonora, in California's Mother Lode country.

### **THE WAR OF INDEPENDENCE AND THE MEXICAN REVOLUTION**

So remote was Sonora from the rest of Mexico and the United States (and the world, really), and so caught up in the gold rush and other immediate affairs, that Mexico's War of Independence (early 1800s) was little more than background noise in the northwest of the country.

On October 15, 1853, with 45 men, the American soldier of fortune William Walker set out on his first of several filibustering expedition: the conquest of the Mexican territories of Baja California and Sonora. He succeeded in capturing La Paz, the capital of sparsely populated Baja California, which he declared the capital of a new "Republic of Lower California," with himself as president. Although he never gained control of Sonora, less than three months later he pronounced Baja California part of the larger "Republic of Sonora." Lack of supplies and an unexpectedly strong resistance by the Mexican government quickly forced Walker to retreat.

Sonora also played no important role during the first part of the Mexican Revolution, the so-called Maderista Period (1910-1913). However, after the killing of the great revolutionary leader Francisco Madero, in 1913, Nogales was strategically targeted by those opposed to President Victoriano Huerta. On March 13, 1913, Álvaro Obregón began his military career with the taking of this border town. The advantage that Nogales provided was access to weapons, communications, and

foreign sources of financing for the revolution. Thus, Nogales came to be the place where the revolutionary government was formed by Venustiano Carranza after Madero's murder, and it remained a principal base of the revolution between 1914 and 1929.

The famous revolutionary, Francisco "Pancho" Villa, often entered Sonora from his main hangouts in the Sierra Madre of Durango and Chihuahua, and several of his most important meetings took place in Nogales. The battle that ended Villa's dominance during the revolution took place at Agua Prieta, Sonora (in 1916), when Obregón's army defeated him. Like so many Mexicans of fame, Pancho Villa's legacy is controversial; he is both revered as a hero of the Revolution and remembered as a notorious border bandit and killer! The statue of Villa in downtown Tucson was a gift to Arizona by the Mexican government in 1981. Obregón eventually won a post-Revolution presidential election with overwhelming support, and his presidency oversaw massive education reform, the rise and flourishing of Mexican muralism, land reform, and new labor laws. Plutarco Elías Calles (who founded the PRI political party, which ruled Mexico for nearly 70 years) also came from Sonora (Guaymas). [Endnote 7]

### "NEW SONORA"

For most of its early years, Sonora was dominated culturally and economically by its eastern hills and mountainous *La Serrana* region. During the last half of the 20th Century, however, the arid Western Lowlands region experienced rapid economic growth, especially in irrigated agriculture along the river tracks and floodplains. This shift left the older mountainous region somewhat of a cultural backwater, characterized by quaint colonial era villages, like Álamos, Ures, Sahuaripa, Ariveche, Arizpe, Tecoripa, Suaqui Grande, Banámichi, Sinoquipe, and Bacanora. Thus, the present-day state of Sonora reveals its dual geographical personality—eastern, colonial, "Old Sonora," and the modern western "New Sonora." First to develop there were the towns of Guaymas (around 1820), the main seaport of the state, and Hermosillo, which became Sonora's capital in 1879. The first wagon road between Hermosillo and Tucson was established by 1860. The first rail line to Hermosillo opened in 1880, between Guaymas and Hermosillo, and to Nogales in 1882, which

connected to southern Arizona. Grains went from Guaymas (by boat) and Hermosillo (overland) to the U.S., and machinery for the Sonoran mines was shipped to Guaymas from San Francisco.

Guaymas is one of the best natural harbors in all of Mexico. During the 19th century, large Mexican, U.S., and English mercantile firms were established there, and a regularly scheduled steamship line to San Francisco and much of the Pacific Rim developed.



Part of the fishing fleet (sardines and shrimp) at the new dock, outer Guaymas Harbor, Sonora

Hermosillo, in 1700, was no more than a small settlement (called Pitic) housing a few Spaniards and Pima Bajo Indians. It came to serve as a *presidio* against the rebellious Seri Indians, but eventually grew to become the city of Hermosillo (named in honor of a Mexican hero of the War of Independence).

After the final subjugation of the nomadic Indians in the 1880s, U.S. companies began to invest heavily in Mexico's mining industry. Foreigners and their Mexican partners reopened many of the abandoned silver, gold and copper mines (called *antiguas*), using modern techniques to exploit the deeper, poorer lode ores. Important copper mining towns such as Cananea, Nacozari de García, La Colorada, as well as Minas Pieta grew up along the southern end of the great Arizona copper belt. For a while, Cananea, with 20,000 inhabitants, was the largest city in the state. The revival of Sonoran mining was short-lived; it was arrested by the outbreak of the Mexican Revolution in 1910. Today, only the rich copper mines of Cananea and Nacozari still remain highly productive, although new mines have recently

opened west of the federal highway (near Querobabi).

### ***Agriculture in the Western Lowlands***

Irrigated commercial farming on the coastal river floodplains and deltas of Sonora and Sinaloa began slowly in the 1890s, but it came to be the most significant factor in the “modernization” of Northwestern Mexico in the 1950s. The fertility of floodplain and deltaic soils was well known to both indigenous peoples and Spanish settlers.

Throughout much of the latter 19th century and early 20th century, coastal farming settlements in the Río Yaqui region were ravaged by fighting between rebellious Yaqui and the Mexican military. Eventually, the government declared a campaign of extermination on the Yaqui, including taking many of them as indentured servants to work plantations in the far-away states of Nayarit, Yucatán and Oaxaca. Many escaped government persecution by fleeing to Arizona, where some families still live on the Pasqua-Yaqui and other reservations in Tucson.

After the end of the Mexican Revolution (beginning in the 1930s) the federal government set out to provide new opportunities for the public by developing numerous new irrigation districts in rural areas. Many of these were in the western lowlands of Sonora and Sinaloa, along the fertile alluvial plains of the Ríos Fuerte, Mayo, and Yaqui, and also on the deltaic plains of the Colorado River in the Mexicali Valley. These projects brought deep-well drilling, dams, electrification, refrigeration, and air conditioning to some of the most remote regions of the northwest. They prompted the colonization of these areas, which, until then, had been largely only sparsely settled. These efforts, which also took place in Chihuahua, promoted the growth of cities such as Monterrey, Monclova, Torreón, Juárez and Tijuana.

The first modern farmlands to be developed through the *Distrito de Riego* were along the Río Yaqui and Río Mayo in southern Sonora. Then came the Río Colorado and, finally, in the mid-20th Century, the Río Sonora and Río Magdalena-Asunción-Concepción. All were developed through government economic planning processes with no apparent regard whatsoever to water or land conservation issues. For the past half-century, the coastal

plains of Sonora and Sinaloa have been Mexico’s most important agricultural (and more recently, shrimp farming) lands. Major land crops include wheat, corn, rice, soy, sugar cane and vegetables, much of which finds its way to Arizona and California.

These developments also opened the way to ranching, and cattle grew to become an important economic driver in Sonora. As land was cleared of its native Sonoran Desert flora (and fauna), it gradually was replaced with vast regions of invasive (native) *Opuntia* cacti and, more recently, non-native and highly invasive buffelgrass (*Pennisetum ciliare*).

In 1926, Mexico passed the National Water Law, which committed the federal government to develop large-scale irrigation projects throughout the country. To administer the law, the government formed the Comisión Nacional de Irrigación, the main duties of which were to undertake construction of large-scale dams and canals, and to colonize the newly formed irrigation districts. In 1946, the Comisión was replaced by the Secretaría de Recursos Hidráulicos, which had cabinet-level status and thus increased access to federal funds. This initiated a period of rapid dam construction and expansion of irrigated lands. Along the larger rivers, annual summer floods were controlled by the construction of large dams and reservoirs in the 1940s and 1950s.

By the 1960s, the first signs of increasing soil salinity were appearing in the Yaqui and Mayo deltas. Excessive application of water to the land was viewed as the cause, so deep drainage ditches were built to carry excess irrigation runoff to the Sea of Cortez. Extraction of water from aquifers in the Río Sonora delta (the “Costa de Hermosillo” District) has far exceeded natural replenishment, leading to a rapid fall in the water table. Since the turn of this century, depletion of the water tables and rivers of Sonora has become a significant threat that is amplified by a 15-year drought in southwestern U.S./northwestern Mexico. [Endnote 8]. Currently, Hermosillo is developing a highly controversial (and contested) plan to harvest water from the Río Yaqui, moving it north via a huge system of aqueducts and pumps.

Growth in the population of the Hermosillo area (over 700,000 residents today) has exacerbated this water problem. Intrusion of salt

water from the Sea of Cortez into the aquifers, caused by the falling water table, made much of the groundwater along the coast too saline for agricultural use. In response to these problems, the government, in 1989, limited the number of permitted wells to 498, which halved the annual amount of ground water pumped, from 800 million to 400 million cubic meters per year. It was hoped that this would shift agriculture away from water-intensive crops like wheat and cotton, toward crops requiring less irrigation. However, over-exploitation of fossil water is now taking place in the Caborca area, where hundreds of wells supply water for wheat, cotton, olive groves and vineyards. [Endnote 9] Hermosillo faces serious water shortages and is in the process of completing an extensive, expensive, and highly controversial aqueduct project to bring water from the Río Yaqui to the city (over strong objections from the Yaqui community).

### **Fishing**

About the same time that government-sponsored irrigation districts were being established in western Sonora, commercial fishing was evolving along the Sea of Cortez coast. The first Mexican shrimp boats were operating out of Guaymas in the 1920s. In the 1930s the Japanese, with permission of the Mexican government, began exploiting shrimp stocks off Guaymas. John Steinbeck and Ed Ricketts observed the Japanese operations during their 1940 Sea of Cortez expedition, describing the destructive fishing methods in their classic book, *The Sea of Cortez. A Leisurely Journey of Travel and Research*. The Mexican government eventually banned the Japanese fleets from the Gulf, but their success led to the establishment of the three major fishing centers of Sonora: Guaymas, Puerto Peñasco, and Yavaros.

Due to its high productivity and subtropical location, the Gulf of California teems with many species of finfish, crustaceans, and molluscs. Over 6000 species of animals have been reported from this sea, and many still remain undescribed. One-third of the world's cetacean species can be found in the Gulf, as well as 5 species of sea turtle. The majority of the fisheries catch today is shrimp, Gulf corvina, squid and sardine. Nearly three-fourths of the shrimp catch is exported to the U.S., and today the shrimp harvest (including farmed shrimp)

from the Sea of Cortez makes up about 60% of Mexico's total fishery by dollar value. Industrial ("high seas") shrimpers use one of the most destructive fishing methods known—dragging large trawls across the sea floor, ripping up the top few inches of the sea bed, capturing (and killing) virtually every animal the nets encounter. Limited data suggest that the entire benthic ecosystem of the shallow Gulf has been dramatically altered because of this continual disturbance, year after year, since the 1920s. The principal change appears to be greatly reduced species diversity, loss of rare species, and hypoxia (severe oxygen depletion) due to the rain of decomposing by-catch dumped off the shrimp boats day after day. However, no thorough scientific study of this long-term disturbance has been undertaken. The sardine catch (comprising mainly *Sardinops sagax* and *Opisthonema libertate*, and the recently reestablished northern anchovy *Engraulis mordax*) is six times the shrimp catch by tonnage, but of relatively less value. Sonora accounts for 60% of Mexico's sardine take. Most of it is processed for poultry feed and fishmeal fertilizer. It is likely that every commercial species in the Sea of Cortez is unsustainably fished today.



Shrimp boat, working out of Puerto Peñasco, 2013

### **ENVIRONMENTAL CONSERVATION IN SONORA**

Much of Sonora is still sparsely populated, simply because of the aridity of the area and the rugged ranges of the Western Sierra Madre. However, much of the seemingly "natural" landscape of the region has been significantly disturbed over the past 60 years by ranching and by the spread of various invasive plants.

Sonora has over 7,000 sq mi (>18,130 sq km) of protected wildlife areas. Federally-protected natural areas in Mexico are of six types: biosphere reserves, national parks, areas for the protection of flora and fauna, protected natural resource areas, natural monuments, and shrines. The state of Sonora has about 10 federally protected areas, around 20 state-protected sites, and a number of private natural reserves. Among these is the *El Pinacate and Gran Desierto de Altar Biosphere Reserve* (both a Mexican and a UNESCO Biosphere Reserve, and a UNESCO World Heritage Site, and also one of Mexico's designated "13 natural marvels"), located between Puerto Peñasco and the U.S. border in the Altar Desert. The reserve comprises rich Sonoran Desert habitat, massive dune fields, and hundreds of dormant volcanic craters. Bordering the western edge of the Pinacate reserve is the 3,609 sq mi (9,348 sq km) *Alto Golfo de California y Delta de Río Colorado Biosphere Reserve*, at the head of the Gulf of California. This, and the Pinacate reserve, were created in 1993. The *Sierra de Ajos-Bavispe Natural Resource Area* is in the central interior of Sonora. The 156 sq mi (405 sq km) *Reserve for the Protection of Flora and Fauna, Sierra de Alamos-Río Cuchujaqui* is in the far southern foothills of the Sierra Madre Occidental in Sonora.

In addition to these, and others, all of the islands of the Sea of Cortez comprise the *Protected Natural Resources of the Flora and Fauna of the Islands of the Gulf of California*. Additionally, the entirety of Bahía Adair, between the towns of Puerto Peñasco and El Golfo de Santa Clara, is a Ramsar Designated Wetland. Also, the Seri coast is a designated Ramsar Wetland. The Convention on Wetlands of International Importance, known as the Ramsar Convention, is an international treaty that defines actions and areas of cooperation for conservation of sustainable wetlands.

When you travel the byways of Sonora, admiring its natural beauty, keep in mind how the geological landscape has shaped its human history. And remember that the mountains and rocks you see were formed millions of years before the first human being ever set foot in these lands, and they will be here for millions of years after the last human perishes. Native Americans, Spanish colonists, and modern inhabitants of the region have been nothing but

a passing breeze in geologic time. For these reasons, the land inspires awe and respect.

### ACKNOWLEDGMENTS

My deepest appreciation to friends and colleagues who read and commented on early drafts of this essay, including: Clare Aslan, Michelle María Early Capistrán, Dan Lynch, Larry Marshall, Cathy Moser Marlett, Ed Pfeiler, Alberto Suarez, and especially ace editors Lloyd T. Findley and Linda M. Brewer. Thanks to John Palting, Wendy Moore, and Ricardo Castroprefe for help with agave "worm" identifications.

## ENDNOTES

*Endnote 1.* According to one popular myth, the Aztecs discovered the beverage *pulque* (later distilled into mescal/tequila by the Spaniards) when a bolt of lightning struck an agave field. The bolt instantaneously cooked the heart of one of the plants, and caused it to quickly ferment. The Aztecs noticed the aromatic nectar exuding from the cooked plant, and deemed it to be a miraculous gift from the gods (which they named *pulque*). Subsequently, during colonial times, it was distilled into *vino mezcal* ("mezcal wine"), the most popular version of which came to be tequila. (In Mexico, it is usually spelled *mezcal*; in the U.S. it is usually spelled *mescal*.) There are today around 30 tequila distilleries in Mexico, producing hundreds of brands/varieties of tequila in six categories (fixed by federal law): (1) 100% agave tequilas are required by law to be made from 100% fermented juices from the blue agave, with no additives, not even sugar. (2) *Mixto* tequilas must be at least 51% fermented juices from the blue agave, but additives may be used, such as fermented cane sugar juices (ethanol). (3) *Blanco* tequila is tequila in its youngest and purest form, just as produced by the distillation process, without the effects of any barrel aging. Blancos can be 100% agave, or *mixto*. (4) Gold (*joven abocado*) tequilas are usually *mixtos*, unaged blanco tequila to which additive colors (usually caramel) and flavors are mixed after the distillation process. (5) *Reposado* tequilas are, literally, "rested." By law, a *reposado* must be aged in wood for at least 60 days, but most are actually aged closer to a year. They are aged in large wooden tanks, or sometimes in small oak barrels. (6) *Añejo* tequilas are "aged" or "old." By law, *añejos* must be aged for at least 12 months in government-sealed barrels that are no larger than 600 liters. Often, the barrels used are old 190-liter whisky barrels from Kentucky. The longer the aging process (in wood), the darker the tequila becomes.

Many mescal makers put a "worm" in the bottle, said to enhance the flavor (also said to be a marketing ploy). The "worm" is actually an insect larva, typically either of a cossid moth (*Comadia redtenbacheri*, =*Hypopta agavis*), a skipper butterfly (*Aegiale hesperiaris*), or a weevil (*Scyphophorus acupunctatus*). All are found associated with living agaves, but only the weevil causes any real damage to the plants. In Oaxaca, these dried and ground-up larvae are

often added to chile (and other secret ingredients) to concoct a tasty powder that one sprinkles on a citrus slice to accompany a glass of mescal. Locals insist the insect larva enhances the flavor and enjoyment of the drink, and perhaps even gives the drinker temporary special powers of love and intellect. Recent research suggests mescal was being distilled in southern Mexico by Native Americans before the arrival of Europeans in the New World.

*Endnote 2.* Padre Kino's 12 missions in Sonora were located at (east-to-west): Cucurpe, Dolores, Cocóspera, San Ignacio, Magdalena, Tubutama, Santa Teresa, Atil, Oquitoa, Pitiquito, Caborca, and Bisaniig

*Endnote 3.* San Xavier del Bac, about 12 miles south of Tucson, is the best known and most elaborate colonial mission church in the Pimería Alta. Padre Kino first visited this site in 1692, and that year he established a mission program for the Piman (O'odham) People that lived in the area. Although the villagers built a small adobe home that served as a mission church, Kino's plans for a full-fledged church never came to fruition. In the 1750s, a simple adobe hall church was constructed by Jesuits, supervised by Father Alonso Espinosa. In 1767 the Jesuits were expelled from the Spanish colonies and replaced (a year later) by Franciscans, and it was they who built the church that stands today, under the supervision of Father Juan Bautista de Velderrain and Juan Bautista Llorens between 1783 and 1797. The old Jesuit adobe church was dismantled and moved in the early 19<sup>th</sup> century, piece by piece, to the east side of the new one, where it was recycle into the convento wing that still stands. The eastern bell tower was never finished, perhaps because the builders ran out of money. The famous cat and mouse that occupy the front church facade have been there since the church was built, but no one today knows what they represent (although there is no shortage of interpretations). Today the church functions under the auspices of the Franciscans (the Order of Friars Minor), and it continues to serve the local O'odham community (although everyone is welcome at the services).

It is often said that all Jesuit churches in the Pimería Alta were built with the entrance facing south. While this is true for San Xavier church, it is not the case for all, many of which face west, south-by-southeast, or west-by-northwest.

*Endnote 4.* On Kino's first Pinacate expedition, he saw the mountains of Baja California and judged that there could be no seaway separating them from the mainland. On his second and third expeditions, he saw the head of the Gulf of California, the actual land connection between Baja and the mainland, confirming the peninsular nature of the former; on these trips he also reached the Sea of Cortez, on the coast of Sonora. On his fourth expedition, he took "official witnesses" to the top of Sierra Pinacate, to prove to them the peninsular nature of Baja California. Kino was 61 years of age on this fourth expedition to the Pinacates.

*Endnote 5.* The Virgin of Guadalupe has been known by many names (the Dark Virgin, the Virgin of Tepeyac, *La Criolla*, etc.), and the hold that devotion to Our Lady of Guadalupe has on the Mexican people is legendary and profound. In fact, she has come to be venerated throughout Latin America and is sometimes referred to as the Empress of the Americas. This devotion is based on the story of the Virgin Mary's appearance to the newly converted Aztec (Náhuatl) Indian, Juan Diego Cuauhtlatotzin, in 1531, in the village of Tepeyac (today, a northern suburb of Mexico City). The apparition occurred early in the conquest of Mexico, just ten years after the Aztec capital of Tenochtitlán fell to the conquistador Cortés. Not only did the Virgin appear, but also she left her beautiful image on Juan Diego's agave-fiber cloak (*tilma*), in which he carried "miraculous roses" (Castilian roses, unknown in the New World at that time) from Tepeyac Hill to Bishop Zumárraga, with a request from the Virgin that a new church be built on the hilltop site. Zumárraga was a compassionate man who built the first hospital, library and university in the Americas. He was also the "protector of the Indians," entrusted by Emperor Charles V to enforce his decree of 1530 that Indians could not be made slaves. Shortly after the miracle, an adobe structure was built atop Tepeyac Hill in honor of the Blessed Mother, Our Lady of Guadalupe. It was dedicated on December 26, 1531, the feast of St. Stephen the Martyr. All this was 76 years before the first permanent English colony was established in the New World (Jamestown, 1607). A mortar-and-stone chapel was built around the original adobe structure in 1556. Eventually, a larger church was built nearby and dedicated in 1622. A much grander baroque church was consecrated at the base of Tepeyac Hill in 1709 (and dedicated as a basilica in

1904). A modern new basilica (the "New Basilica of Our Lady of Guadalupe") was built between 1974 and 1976 next to the old one, and today Juan Diego's cloak is still on exhibit there. In Mexico, December 12<sup>th</sup> is the "official" feast day in honor of Nuestra Señora de Guadalupe.

The first published account of the apparition came more than 100 years later, in 1648, by the Oratorian priest, Miguel Sánchez. Sánchez's account was responsible for the popularization and spread of the devotion among the *criollos* of Mexico City – that is, among those people of European stock who had been born in the New World. Though the only difference between *criollos* and Spaniards from Europe (from the Iberian Peninsula) was their place of birth, the *criollos* saw themselves as marginalized. Disdained by the Spaniards of New Spain (the Spanish colonies of the New World), excluded from the topmost positions of local government, and suppressed by what they regarded as second-class citizenship, they reacted by developing a strong sense of group and regional identity. Thus, Sánchez's book was not only a devotional treatise but a complex celebration of *criollismo* that used the vision of the Virgin of Guadalupe as proof of special divine favor toward the *criollos* – the Virgin Mary had revealed herself to the *criollos*, even if through the agency of a lowly Náhuatl Indian. But of course, the image on Juan Diego's cloak was of a dark-skinned virgin, so the Native Americans (and those of mixed blood) also viewed the apparition as meant for them. The devotion quickly spread throughout New Spain. It reached Europe through the efforts of Pedro de Gálvez, a former *visitador* in New Spain and a member of the Council of the Indies, who in 1662 subsidized publication of Mateo de la Cruz's version of the apparition story.

The first political use of the Virgin of Guadalupe as a national symbol was during the Mexican War of Independence (1810), when the Virgin appeared on the banners of the military general Miguel Hidalgo, while his troops proclaimed long life to her and death to the Spaniards. Thus, the long-standing rivalry between the Virgin of Guadalupe (*La Criolla*) and the Virgin of Remedios (*La Conquistadora*) became clearly marked along nationalistic and political lines. It is not surprising, therefore, that, after independence was attained, the Virgin of Guadalupe emerged as the preeminent national religious symbol of Mexico. As the famous writer-philosopher Octavio Paz once observed,

“The Mexican people, after more than two centuries of experiments and defeats, have faith only in the Virgin of Guadalupe and the National Lottery.” The narration of the Virgin of Guadalupe is sometimes called the “fifth gospel.” It has been one of the most important evangelizers in the history of the Americas.

Two hundred years after Juan Diego’s vision, in the 18th Century, the road to fame for aspiring composers in Italy had come to be the writing of operas. For their Latin American, New World counterparts, however, the most prestigious genre was *Maitines* (or *Matins*), a Roman Catholic service traditionally performed in the early hours of the morning. The *Matins* provided a range of opportunities to display compositional skill, as it juxtaposed a wide variety of textures and style, commonly paralleling that of an Old World opera but with monophonic *Psalms* in chant, intoned *Lecciones* that could preach or weave a story, and sets of *Responsorios* that elegantly combined voices with instruments. In 1742, the Italian composer Ignacio de Jerusalem was recruited to Mexico City to help strengthen the music resources of New Spain’s growing empire. In 1750 he was appointed to the top post of Chapel Master at the Cathedral. In 1764, in Mexico City, he presented his masterpiece, “*matins* for the Virgin of Guadalupe.” Jerusalem’s *matins* have rarely been recorded, but several versions of this stunning composition do exist; my favorite is “*Matins* for the Virgin of Guadalupe, 1764,” by Chanticleer (Teldec 3984-21829-2).

The name “Guadalupe” may derive from the Aztec word *tlecuatltecupe*, which means “one who crushes the head of the serpent.” When pronounced correctly, the name sounds like “Guadalupe,” and this is how the Spaniards interpreted it. There is, in Spain, a town (with a prominent Marian shrine) by the name of Guadalupe, in the province of Cáceres. Although the feast day of Our Lady of Guadalupe is December 12, the feast day for Juan Diego, who was declared a saint in 2002 by Pope John Paul II, is December 9 (the day of the first apparition). And, the Virgin of Guadalupe in Spain is also dark skinned!

Endnote 6. The artist Dick Wiken was born and died in Milwaukee, Wisconsin (1913-1985). He was a self-taught sculptor, designer, and craftsman. Wiken attended the University of Wisconsin-Milwaukee for two years, studying journalism, English and history, but did not

receive a degree. During World War II, he served in the U.S. Army Corps of Engineers (1943-1946). Although self-taught, Wiken eventually became an Instructor of Sculpture at the Art Institute in Milwaukee (1934-1937), and then at the University of Wisconsin Milwaukee (1938-1943). His works in wood, stone and metal decorate many buildings and homes in the Milwaukee area and beyond. Among his most unusual and interesting work is a set of wood carved panels at the Playa de Cortés Hotel, near Guaymas (Sonora). The panels depict the “Rape of Mexico” during the Spanish Conquest. The hotel was built in 1934 by a railroad baron, to facilitate the arrival of the passenger train to Guaymas. Wiken’s four, commissioned, bas relief wood sculptures, which are displayed in the hotel’s bar, are each about 4 ft X 6 ft, and they are crafted in deep rich mahogany. The scenes are of conquistadors and naked Aztec women, and lust and violence mingle as Spanish armor meets bare skin. Wiken carved these in 1946/47, with the intent of depicting the story of the Spanish conqueror Hernán Cortés overthrowing the Aztec Empire. Wiken titled the works, “The Rewards of Conquest—Wenching, Gambling, Drinking and Indolence.” One of the panels shows Cortés and his mistress, La Malinche, who betrayed her own people. Her legacy lives on today, in the word “*malinchista*,” which refers to a person disloyal to their country. Another panel depicts Cortés mourning his losses after the great battle of *La Noche Triste* (The Night of Sorrows) where he lost many soldiers in a trap set by Aztec warriors. There is also a series of nine smaller panels by Wiken above the bar called “The Court of Cortez,” and these illustrate the sacrifices, impalings, and destruction of Aztec icons by the Spanish soldiers. All this work is beautiful, and disturbing. The juxtaposition of these carvings in the bar of a happy seaside resort is somewhat jarring, and most visitors seem to prefer drinking their margaritas to studying the details in Wiken’s exquisite art. Photos of Wiken’s four panels follow.



Shortly after the expeditions of Christopher Columbus, and for much of the time that Baja California was thought to be an island, its mystery was also shrouded in legends of gold, pearls, griffins, and beautiful Amazon women. Most of the mystique about the “island” of California came from a famous chivalric novel titled, *Las sergas de Esplandián* (The Sagas of Esplandián), by the Spanish writer Garcí Ordóñez de Montalvo. This romantic novel had become beloved in medieval Spain, inspiring the ambitions of sailors, soldiers, and adventurers. The novel was greatly admired by Hernán Cortés and, in fact, the writings of Cortés also leaned toward the fantastic, as was the tendency of the times. In Ordóñez de Montalvo’s story, the noble knight Esplandián survives the siege of Constantinople by a pagan group of Amazons from the “Island of California,” riding griffins and led by Queen Calafia. The women of California were black skinned, valiant, with wondrous bodies, great strength, and ardent hearts. Their weapons were made of pure gold, the only metal that existed in California. The Island was said to be in the New World, west of the land that Columbus had discovered, and “on the right hand of the Indies.” Many Europeans already believed that “the Indies” of Marco Polo lay not far beyond the lands of the New World. Cortés first received news of the Pacific Ocean in 1522, less than a year after the fall of Tenochtitlán (the ancient capital of the Aztec Empire), and 12 years after *Las sergas* was published. The report came from one of Cortés’ captains, Gonzalo de Sandoval, who had been sent to explore the western sea of México. De Sandoval reported seeing an island rich in pearls and gold, and populated by women who killed their male offspring—no doubt a story inspired by Ordóñez de Montalvo’s classic novel. In 1532, Cortés sent Captain Diego Hurtado to seek out the

Island of California. But what Hurtado found were primitive people (and no Amazons) living in a parched desert with no gold and little water. None-the-less, Cortés officially named the land California, reasoning it must be the place described in Ordóñez de Montalvo's novel. In 1535, Cortés embarked on his own expedition to colonize California, placing 320 people in Bahía de la Santa Cruz (now known as the Bay of La Paz). Cortés claimed it for Spain, and as navigators pushed northward, the name California came to include Spanish claims from the tip of the peninsula to Puget Sound. But the colonists could not survive in La Paz, for lack of food and water, and probably because the locals were unfriendly. María Early Capistrán (2014) notes, had they discovered that sea turtles were a rich source of food, they might have fared far better; but records suggest that, for whatever reason, they did not take advantage of that abundant seafood.

*Endnote 7.* Pancho Villa was named by his parents, Doroteo Arango Arambula. He fled from his home (in Durango) to the sierras at the age of sixteen, after shooting the master of the hacienda in the foot for trying to rape his younger sister (or so the legend goes). It was then that he changed his name to Francisco "Pancho" Villa, and took up a life of crime and rebellion. The reason Pancho Villa was killed seems to be shrouded in mystery. The Revolution was over and he was "in retirement" in the Sierras, breeding fighting cocks and running his estate at Canutillo, Durango. It is said that, when the assassins murdered him in 1923 (in Parral, Chihuahua), he had more than 8000 rifles, a half-million cartridges, and a large supply of bombs and hand grenades at his hacienda. He was, as he liked to say, "hated by thousands and loved by millions." President Obregón may have feared that Villa had more revolutionary ideas in him, and ordered his murder. Today, a statue of Villa also stands in the plaza of Canutillo—the state's most famous native son. And the Francisco Villa Museum in Parral (Chihuahua) interprets his unique and colorful history and, every year in July, reenacts his assassination. To say the man was complicated is an understatement. After invading the U.S., and sacking and burning the town of Columbus, New Mexico, General Pershing himself went after Villa in Mexico, spending nearly a year perusing him to no avail. It is said that, during the revolution, Villa once ordered the killing of 90 women by firing squad

in Camargo (Chihuahua), for consorting with the enemy. He was fearless of death, leading his cavalry charges himself. He married 26 times, and was a compulsive womanizer.

*Endnote 8.* Studies of tree-ring data inform us that northwest Mexico suffered during most of North America's major droughts, historical and pre-historical. The two most severe droughts during the 20<sup>th</sup> century occurred in the 1930s (the "dust bowl drought") and 1950s. Similar widespread droughts likely also occurred during the 1750s, 1820s, and 1850-1860s. The 16<sup>th</sup> century "megadrought" is generally considered the most severe prolonged drought over much of North America for at least the last 500 years (Meko et al. 1995, Stahle et al. 2000), and possibly the last 2000 years (Grissino-Mayer 1996). During the mid- to late-16<sup>th</sup> century, drought extended across most of the North American continent. Drought conditions prevailed throughout much of the 16<sup>th</sup> century over Mexico's Sierra Madre Occidentalis and the Rocky Mountains. In northwestern Mexico, the era of strongest and most persistent drought was the 1540s to the 1580s, and in the southwestern U.S. it was 1550s to 1590s. (The tree-ring reconstructed drought during the 1930s exceeded the 16<sup>th</sup> century droughts only in the Pacific Northwest and western Canada [Stahle et al. 2016].) The human impact of the 16<sup>th</sup> century megadrought must have been significant. The event was most severe in northwestern Mexico and southwestern U.S., and in northern Mexico severe drought is estimated to have persisted for 24 years. The term "megadrought" has been used to imply a very large-scale drought more severe and sustained than any witnessed during the period of instrumental weather observations (e.g. Stahle et al. 2000). Two other severe sustained megadroughts are recorded in tree-ring data from the 15<sup>th</sup> and 14<sup>th</sup> centuries. These three western megadroughts lasted for 16-38 years each (Stahle et al. 2006). The 14<sup>th</sup> century megadrought extended over the West from 1387 to 1402. Earlier still, was another Southwest megadrought that A. E. Douglass (1929, 1935) described as "the Great Drouth of AD 1276-1299," and it often viewed as the likely cause of the abandonment of Anasazi cliff dwellings across the Colorado Plateau.

S. Stine (1994) suggested use of the general term "Medieval Climate Anomaly," also known as the Medieval Warm Period, or Medieval

Climate Optimum. This was a time of warm climate in the North Atlantic region that may also have been related to other climate events around the world during that time, lasting from about 950 to 1250. It was followed by a cooler period in the North Atlantic termed the “Little Ice Age.” Despite uncertainties, especially for the period prior to 1600 for which data are scarce, the warmest period of the last 2,000 years prior to the 20th century very likely occurred between 950 and 1100. Proxy records show peak warmth occurred at different times for different regions, indicating that the Medieval Climate Anomaly was not a time of globally uniform change. Temperatures in some regions matched or exceeded recent temperatures in these regions, but globally the Medieval Warm Period was cooler than recent global temperatures.

Stahle et al. (2016) used Mexican Drought Atlas data to map drought periods across Mexico in four regions, southeast, central, northeast, and northwest (the latter being 22-31° N, 102.5-111° W). The most intense droughts in Mexico, since 1550, lasted from 4 to 8 years and were most severe over the northwest region. These were:

- 1566-1573 drought. Part of the 16<sup>th</sup> century megadrought, which lasted with little interruption for at least 20 years over northern Mexico.
- 1666-1669 drought: Covering most of Mexico, this was one of the two most extreme sub-decadal to decadal droughts of the past 600 years in the northeast region. This drought had well documented impacts among the Spanish and Native Americans of the southwestern U.S. (Stahle and Dean 2011), and was one of the most severe sustained droughts in the 470-year long tree-ring reconstruction of the Southwest by Griffin et al. (2013).
- Several severe sub-decadal droughts of 5-6 year duration are estimated to have occurred in the mid-18<sup>th</sup> and early 19<sup>th</sup> centuries.
- The 1950s drought (most intense from 1951 to 1957) is evident in both instrumental and MSDA data, and it may have been the most extreme decadal drought in the 600-year reconstructions for northeastern and northwestern Mexico. It began in the late 1940s and persisted into the 1960s over northern Mexico.

The two most extreme droughts during recent times (during “instrumental times” in Mexico) were the 1950s drought, and the current drought, which began in the mid- to late 1990s (Stahle et al. 2009). The current drought has had severe consequences for agricultural and

water resources sectors in Mexico and has induced widespread emigration from drought-affected regions of Mexico into the U.S. (Feng et al. 2010, Hunter et al. 2013).

The IPCC Assessment Report 4 model projections suggest that the subtropical dry zones of the world will both dry and expand poleward in the future due to greenhouse warming (Meehl et al. 2007). The U. S. Southwest is particularly vulnerable in this regard and model projections indicate a progressive drying at least to the end of the 21<sup>st</sup> century (Seager et al. 2007). Already, the west has been in a state of drought since around 1999.

Climate models suggest that Mexico, the southwestern U.S., and Central America will experience progressive drying over the 21<sup>st</sup> century (Feng and Fu 2013). Overgrazing, deforestation, and the extensive land conversion for human use are believed to have reduced evaporative cooling and sharply increased the sensible to latent heat flux, favoring higher daily temperature maxima and overwhelming the potential cooling effect of increased surface albedo (e.g., Balling 1988, Englehart and Douglas 2005).

The influence of anthropogenic land cover change on Mexican climate may have some precedent in the archaeological record. Model simulations of the climate consequences of deforestation by the ancient Maya in the lowland Yucatan indicate heightened drought conditions (Cook et al. 2012), which in turn may have contributed to the decline of certain Mayan city-states near the close of the Classic Period (Stahle et al. 2016). The conquest of the Aztec empire by a handful of Spanish conquistadores and their indigenous allies is one of the most remarkable military campaigns in the world history, and it has been suggested that it was made possible by the combination of imported disease (especially smallpox) and drought (Acuña Soto et al. 2002). The Aztec apocalypse in 1521 appears to have coincided with a severe sustained drought in central Mexico that may have begun as early as 1514 (Stahle et al. 2011) but was most extreme (based on MXDA data) from 1521 to 1524. This drought has been dubbed the “conquest drought.”

The worst famine of the colonial era in Mexico occurred in 1786, and is referred to as *El Año de Hambre*, the year of hunger (Florescano and

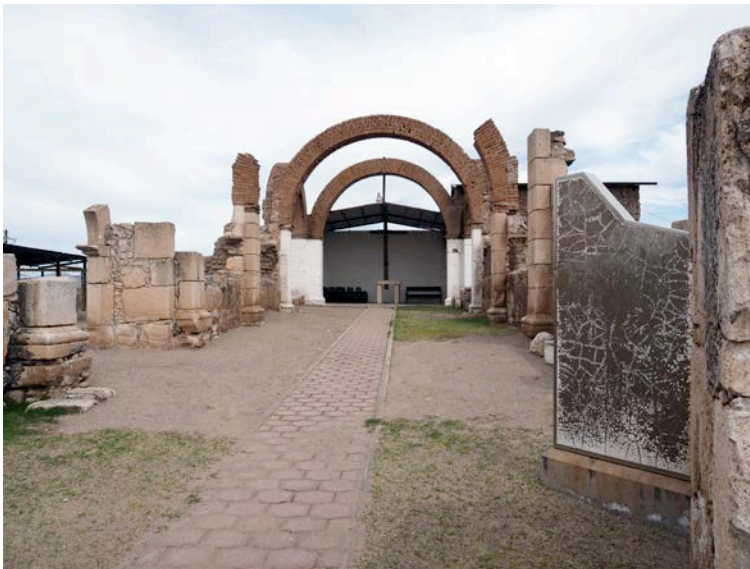
Swan 1995, Therrell 2005). Two to three years of drought and early fall frost in 1785 appear to have led to the 1786 crop failure and famine. An estimated 300,000 people died during *El Año de Hambre*, with combined famine with an outbreak of epidemic typhus (Cooper 1965, Burns et al. 2014). The Mexican Drought Atlas data indicate that drought conditions were most serious during the two-year period from 1785 to 1786, when drought extended over most of Mexico (Stahle et al. 2016). The Mexican Revolution began in 1910, driven in part by grievances related to agrarian reform, but drought conditions have long been suspected as a contributing factor (e.g., Tutino 1986). Tree-ring data indicate at least 2 years of drought over most of Mexico in 1909 and 1910 (Stahle et al. 2016). Dell (2012) suggested that the highest rates of insurgent activity occurred in those Mexican municipalities that suffered the most severe drought conditions just prior to the activity. Hunter et al. (2013) have also suggested that some of the highest rates of illegal immigration to the U.S. have tended to come from the most drought-afflicted areas in Mexico.

*Endnote 9.* The vineyards provide table grapes and also supply several wineries in northwest Mexico, including the Domeq winery, which produces second-rate brandies and wines, including the famous "Padre Kino Vino Tinto"—at about \$5/liter, an agreeable red table wine (Mexico's version of "Three-Buck Chuck." As of 2014, about 2000 acres of vineyards were under cultivation just north of Hermosillo.

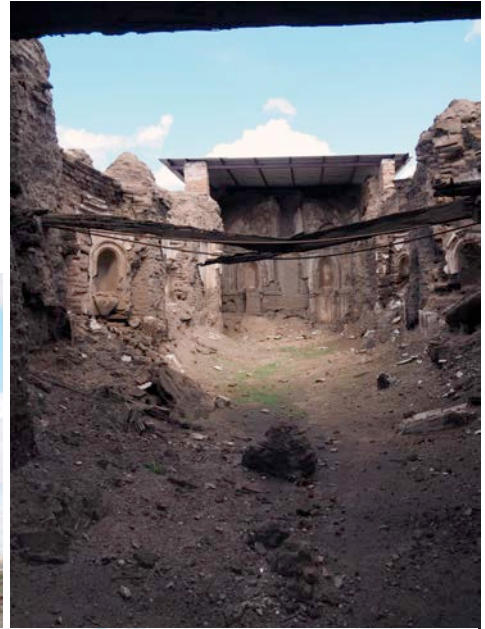
Appendix 1. Photographs of some of Padre Eusebio Kino's 16 Mission Sites in the Pimería Alta (northern Sonora and southeastern Arizona).



The “Mother Mission” of the Pimería Alta was **Nuestra Señora de los Dolores**, north of Cucurpe. Founded in 1687 by Kino, it was situated on a high bluff overlook the beautiful Río San Miguel valley. Not long after Kino's death, Dolores began to deteriorate, and the religious site was abandoned in 1762. Nothing remains of the original structures today, although locals have built a new altar (left photo) and undertake occasional pilgrimages to the area. The graves (right photo) seem to all post-date the Kino era.



Kino established his mission at Cucurpe (**Los Santos Reyes de Cucurpe**) around 1650, 30 years before Dolores. It was from here that he launched his more northern expeditions. At the time, Cucurpe was the northernmost outpost of the Spanish in Sonora. There have been three churches built at the mission site. The first stood to the west of the present structure, and only fragments of this remain. The second still stands, to the east of the present structure, and is likely the one described by Antonio de los Reyes in 1772. The present one (shown above), still unfinished, has moved forward with fits and starts. In past times, locals scavenged the cut stone slabs for their homes, but more recently there has been a move to protect and, hopefully, complete this church.



Not much remains of the **Nuestra Señora del Pilar y Santiago de Cocóspera** church today. Kino founded the mission at this site in 1687, and construction began on the church some time around 1690. In 1697 Father Ruiz de Contreras became resident priest, although construction of the church was still underway. The church was likely completed in 1704, at least that is when it was dedicated. Kino wrote that Indians came from as far away as the Colorado River (“Yuma Indians”) and brought gifts of the famous “blue shells” (abalone shells). It was the existence of these shells that led Kino to hypothesize a land passage from the Pimería Alta to California. Church construction was mainly by Pima Indians, imported from the area around Pueblo San Xavier del Bac (Tucson, Arizona). There were two chapels in the church, one dedicated to Nuestra Señora de Loreto and the other to San Francisco Xavier. However, by 1730 the church had fallen into disrepair and was abandoned, probably due to raids by Apaches and other Indian groups in 1698. The church was eventually rebuilt by the Jesuits, but in 1746 it was burned again. Just how much of the church structures were burned or destroyed, and what form the reconstructions took, is not well understood. Around 1768, Franciscans took over the mission site, and it is likely they built most of the structure visible today. However, they apparently used the old Jesuit shell as a core and simply built in and around it; thus the walls are quite thick. Recent work by INAH (Instituto Nacional Antropología y Historia) has shored up the “false front” added by the Franciscans, but the structure, inside (left photo) and outside (right photo) is still poorly protected from vandals. There is a sizable graveyard behind the church, but dates are difficult to decipher.



Church (and town plaza) at the site of Kino's mission in San Ignacio, **San Ignacio de Cabórica**, on the bank of the Río Magdalena, 9 miles north of the city of Magdalena. The original mission at San Ignacio was founded by Padre Kino in the mid-1600, although by as late as 1699 an elaborate church structure still did not exist. The date of completion of the present church seems to be unclear. At one time, 8 bells hung in the bell tower but most have cracked and are now nonfunctional (these poor quality bells were probably locally cast, not imported from Europe, nor even from Mexico City). Two of the bells bear dates: 1813 and 1818. To the west of the church are the adobe ruins of the priest's quarters and other habitations, storerooms, work shops, kitchens, etc. (i.e., the convento). The circular stairs leading to the rooftop in this church are hand-carved mesquite—the only such example I have seen in the Pimería Alta (such stairs were typically carved stone).



The exquisite church at **Mission San Pedro y San Pablo de Tubutama**, in the Altar Valley. The current church at this Kino mission site (founded ~1690) is probably Franciscan, dating to the late 1780s, and its interior is more elaborate than any other churches in the region. This church underwent several major renovations in the 18<sup>th</sup> century. By 1730, the mission had four pueblos under its jurisdiction. A Pima uprising in 1695 led to the deaths of many Opatas, who had been brought in to aid in the work at Tubutama. The mission's head priest, Padre Daniel Januske was away at the time and thus survived. But, shortly thereafter, Padre Francisco Javier Saeta, resident priest at Caborca, was killed in the same uprising. The mission and church regrouped after the uprising, and it was prominent in the Altar District for many years. The famous Spanish explorer Juan Bautista de Anza (1735-1788), founder of San Francisco, visited Tubutama in January 1774 en route to California. One of the unique features of this church is the carved wooden pomegranates stuck into the ceiling under the choir loft (which itself was added during one of the renovations). Of the four bells in the tower, the oldest is dated 1740.



The grave of Padre Enrique Ruhen, the only priest ever to be in (brief) residence at **Nuestra Señora de Loreto y San Marcelo de Sonoyta**. Founded in 1693, this was Padre Kino's westernmost mission. None of the original mission structures remain at the site—only Ruhen's grave.

## SELECTED REFERENCES

- Acuña-Soto, R., D. W. Stahle, M. K. Cleaveland and M. D. Therrell. 2002. Megadrought and megadeath in 16<sup>th</sup> century Mexico. *Emerging Infections Diseases* 8: 360-362.
- Adams, D. K. and A. C. Comrie. 1997. The North American monsoon. *Bulletin of the American Meteorological Society* 78: 2197-2213.
- Ahlborn, R. E. 1974. *The Sculpted Saints of a Borderland Mission: Los Bultos de San Xavier del Bac*. Southwestern Mission Research Center, Tucson, AZ.
- Altschul, J. H. and A. G. Rankin (eds.). 2008. *Fragile Patterns, the Archaeology of the Western Papaguería*. SRI Press, Tucson, AZ.
- Anderson, D. G. and J. C. Gillam. 2000. Paleoindian colonization of the Americas: implications from an examination of physiography, demography, and artifact distribution. *American Antiquity* 65: 43-66.
- Arellano-Peralta, V. A. and L. Medrano-González. 2015. Ecology, conservation and human history of marine mammals in the Gulf of California and Pacific coast of Baja California, Mexico. *Ocean and Coastal Management* 104: 90-105.
- Aschmann, H. 1959. *The Central Desert of Baja California: Demography and Ecology*. Ibero-America 42. University of California Press, Berkeley and Los Angeles, CA.
- Aschmann, H. (ed.). 1966. *The natural and human history of Baja California—from manuscripts by Jesuit missionaries in the Decade 1752–1762*. Dawson's Book Shop, Los Angeles, California.
- Bahre, C. J. and L. Bourillón. 2002. Human impact in the Midriff Islands. Pp. 383–406 in T. Case, M. Cody, and E. Ezcurra (eds.), *A New Island Biogeography of the Sea of Cortés*. Oxford University Press, New York.
- Bahre, C. J., L. Bourillón, and J. Torre. 2000. The Seri and commercial totoaba fishing (1930–1965). *Journal of the Southwest* 42:559–575.
- Baird, J. A. 1962. *The Churches of Mexico: 1530-1810*. University of California Press, Berkeley, CA.
- Baldonado, L., OFM. 1959. The dedication of Caborca. *The Kiva* 24(4): inside back cover.
- Balling Jr., R. C. 1988. The climatic impact of a Sonoran vegetation discontinuity. *Climate Change* 13: 99-109.
- Bancroft, H. H. 1884. *History of California, Vol. 1*. A. L. Bancroft and Co., San Francisco.
- Bancroft, H. H. 1884-1889. *History of the North Mexican States and Texas. 2 vols*. A. L. Bancroft, San Francisco, CA.
- Bancroft, H. H. 1889. *History of Arizona and New Mexico, 1530-1888. Vol. 12 of, The Works of Hubert Howe Bancroft*. The History Company, San Francisco, CA.
- Bannon, J. F., S.J. 1955. *The Mission Frontier in Sonora, 1620-1687*. U. S. Catholic Historical Society, New York.
- Barth, P. J., OFM. [1945]1950. *Franciscan Education and the Social Order in Spanish North America, 1501-1821*. DePaul University, Chicago, IL.
- Bartlett, J. R. 1854. *Personal Narrative of Explorations & Incidents in Texas, New Mexico, California, Sonora, and Chihuahua. 2 vols*. George Routledge & Co., London.
- Basurto, X. 2005. How Locally Designed Access and Use Controls Can Prevent the Tragedy of the Commons in a Mexican Small-Scale Fishing Community. *Society & Natural Resources*, 18(7): 643-659.
- Basurto, X. 2007. Commercial diving and the callo de hacha fishery in Seri Territory. *Journal of the Southwest* 48 (2):189–209.
- Basurto, X. 2008. Biological and Ecological Mechanisms Supporting Marine Self- Governance: the Seri Callo de Hacha Fishery in México. *Ecology & Society* 13(2): 1-17.
- Basurto, X., A. Cinti, L. Bourillón, M. Rojo, J. torre and A. Hudson Weaver. 2012. The emergence of access controls in small-scale fishing commons: a comparative analysis of individual licenses and common property-rights in two Mexican communities. *Human Ecology* 37(2).
- Basurto, X. and E. Coleman. 2010. Institutional and ecological interplay for successful self-governance of community-based fisheries. *Ecological Economics*, 69(5).
- Bayham, F. E. 1985. Proceedings of the 1983 Hohokam Symposium, Part 1. Arizona Archaeological Society, Phoenix Chapter.
- Beals, R. L. 1932. *The Comparative Ethnology of Northern Mexico Before 1750*. University of California Press, Berkeley, CA.
- Beezley, W. H. (ed.). 2011. *A Companion to Mexican History and Culture*. Wiley-Blackwell, Oxford, England.
- Bergman, C. 2002. *Red Delta. Fighting for Life at the End of the Colorado River*. Defenders of Wildlife and Fulcrum Press, Golden, CO.
- Bertsch, H. and C. Moser Marlett. 2011. The Seris, the sun and slugs: cultural and natural history of *Berthellina ilisima* and other opisthobranchia in the central Sea of Cortez. *Thalassas* 27(2): 9-21.
- Bolton, H. E. 1917. The mission as a frontier institution in the Spanish American colonies. *American Historical Review* 23: 42-61.
- Bolton, H. E. 1930[1966]. *Anza's California Expeditions. 5 vols*. University of California Press, Berkeley, CA.
- Bolton, H. E. [1932]1963. *Padre on Horseback*. Loyola University Press, Chicago, IL. [Reprint with introduction by John Francis Bannon, J.J.]

- Bolton, H. E. [1936, 1960]1984. *Rim of Christendom: A Biography of Eusebio Francisco Kino, Pacific Coast Pioneer*. University of Arizona Press, Tucson, AZ. [Reprint with introduction by John L. Kessel]
- Bolton, H.E. (translator and editor). 1948. *Kino's Historical Memoir of Pimería Alta*. University of California Press, Berkeley, CA.
- Bowen, T. 2000. *Unknown Island. Seri Indians, Europeans, and San Esteban Island in the Gulf of California*. University of New Mexico Press, Albuquerque, NM.
- Bowen, T. (ed.). 2002. *Backcountry Pilot: Flying Adventures with Ike Russell*. University of Arizona Press, Tucson, AZ.
- Bowen, T. 2004. Archaeology, biology and conservation on islands in the Gulf of California. *Environmental Conservation* 31: 199-206.
- Bowen, T. 2009. The record of Native People on Gulf of California Islands. *Arizona State Museum Archaeological Series No. 201*, 101 pp.
- Brand, D. D. 1935. The distribution of pottery types in Northwest Mexico. *American Anthropologist* 37: 287-305.
- Braniff, B. and R. S. Felger (eds). 1976. *Sonora, Antropología del Desierto*. Colección Científica Diversa 27. Instituto Nacional de Antropología e Historia. Mexico City. 592 pp. (Reprinted 1994, Centro INAH Sonora, Hermosillo, Mexico.)
- Brown, D. E. and C. A. Lopez Gonzalez. 2001. *Borderland Jaguars | Tigres de la Frontera*. University of Utah Press, Salt Lake City, Utah.
- Browne, J. R. 1869. *Adventures in the Apache Country: A Tour Through Arizona and Sonora, with Notes on the Silver Regions of Nevada*. Harper & Bros., New York.
- Broyles, B. and M. P. Berman 2006. *Sunshot. Peril and Wonder in the Gran Desierto*. University of Arizona Press, Tucson, AZ.
- Broyles, B. and D. E. Boyer. 2011. *Field Man. Life as a Desert Archaeologist. Julian D. Hayden*. University of Arizona Press, Tucson, AZ.
- Broyles, B., G. H. Hartmann, T. E. Sheridan, G. P. Nabhan and M. C. Thurtle. 2012. *Last Water on the Devil's Highway. A Cultural and Natural History of Tinaja Altas*. University of Arizona Press, Tucson, AZ.
- Brusca, R. C. 2007a. Father Eusebio Kino, the Baja California Peninsula, and the Sea of Cortez. *Sonorensis*, Winter 2007:6–13. Arizona-Sonora Desert Museum, Tucson, AZ.
- Brusca, R. C. 2007b. Harvesting the Sea of Cortez: from Kino's era to modern times. *Sonorensis*, Winter 2007:42–47. Arizona-Sonora Desert Museum, Tucson, AZ.
- Brusca, R. C. and G. C. Bryner. 2004. A case study of two Mexican biosphere reserves: The Upper Gulf of California/Colorado River Delta and Pinacate/Gran Desierto de Altar Biosphere Reserves. Pp. 21–52 in N. E. Harrison and G. C. Bryner (eds.), *Science and Politics in the International Environment*. Rowman and Littlefield, New York.
- Burckhalter, D. 1998. *La Vida Nortehña: Photographs of Sonora, México*. The Southwest Center Series, University of Arizona Press, Tucson, Arizona
- Burckhalter, D. 1999. *Among Turtle Hunters and Basket Makers. Adventures with the Seri Indians*. Treasure Chest Books, Tucson, AZ.
- Burckhalter, D. 2013. *Baja California Missions*. University of Arizona Press, Tucson, AZ.
- Burquez, A., A. Martínez-Yrizar and P. S. Martin. 1992. From the high Sierra Madre to the coast: Changes in vegetation along Highway 16, Maycoba-Hermosillo. Pp. 239-252 in, K. F. Clark, J. Roldán-Quintana, and R. H. Smith (eds.), *Geology and Mineral Resources of Northern Sierra Madre, Mexico*. El Paso Geological Survey, El Paso, Texas.
- Burrus, E. J. 1965. *Kino and the Cartography of Northwestern New Spain*. Arizona Pioneers' Historical Society, Tucson, AZ.
- Burrus, E. J. 1971. *Kino and Manje: Explorers of Sonora and Arizona*. Rome: Jesuit Historical Institute.
- Cariño, M. 2000. *Historia de las Relaciones Hombre: Naturaleza en Baja California Sur 1500–1940*. 2nd ed. UABCS, La Paz, México.
- Cariño, M. 1998. *El porvenir de la Baja California está en sus mares. Vida y legado de Don Gastón J. Vives, primer maricultor de América*. H. Congreso del Estado de Baja California Sur, La Paz.
- Cariño, M. and M. Monteforte. 1999. *El primer emporio perlero sustentable del mundo*. UABCS-SEP, México.
- Carpenter, J. P., G. Sanchez and M. E. Villalpando. 2002. Of maize and migration. Mode and tempo in the diffusion of *Zea mays* in Northwest Mexico and the American Southwest. Pp. 245-256 in, S. H. Schlanger (ed.), *Traditions, Transitions, and Technologies. Themes in Southwestern Archaeology*. University Press of Colorado, Boulder, CO.
- Cartron, J.-L. E., G. Ceballos, and R. S. Felger (eds.). 2005. *Biodiversity, Ecosystems, and Conservation in Northern Mexico*. Oxford University Press, New York.
- Carvajal, M. A., E. Ezcurra, and A. Robles. 2004. The Gulf of California: natural resource concerns and the pursuit of a vision. Pp. 105–123 in L. K. Glover and S. A. Earle (eds.), *Defying Ocean's End: An Agenda for Action*. Island Press, Washington, D. C. xxiv + 283 pp.
- Carvajal, M. A., A. Robles and E. Ezcurra. 2010. Ecological conservation in the Gulf of California. Pp. 219-250 in, R. Brusca (ed.), *The Gulf of California. Biodiversity and Conservation*. University of Arizona Press, Tucson, AZ.

- Cavallero Carranco, J. 1966 [1668] *The Pearl Hunters in the Gulf of California 1668*. Transcribed, translated and annotated by W. Michael Mathes. Baja California Travel Series 4, Dawson's Book Shop, Los Angeles.
- Chapman, C. E. 1921. *A History of California: the Spanish Period*. Macmillan, New York.
- Cinti, A., W. Shaw, R. Cudney-Bueno and M. Rojo. 2010. The unintended consequences of formal fisheries policies: Social disparities and resource overuse in a major fishing community in the Gulf of California, México. *Marine Policy* 34(2): 328-339.
- Cinti, A., W. Shaw, W. and J. Torre. 2010. Insights from the users to improve fisheries performance: Fishers' knowledge and attitudes on fisheries policies in Bahía de Kino, Gulf of California, México. *Marine Policy* 34(6): 1322-1334.
- Clavigero, F. J. 1937 [1789] *The History of [Lower] California*. Translated by Sara E. Lake and edited by A. A. Gray. Stanford University Press, Stanford, California.
- Cook, B. I., K. J. Anahukaitis, J. O. Kaplan, M. J. Puma, M. Kelley and D. Guekyffier. 2012. Pre-Columbian deforestation as an amplifier of drought in Mesoamerica. *Geophysical Research Letters* 39: 1-5.
- Cook, B. I. and R. Seager. 2013. The response of the North American Monsoon to increased greenhouse gas forcing. *American Geophysical Union*, doi: 10.1002/jgrd.20013.
- Cook, E. R., R. Seager, M. A. Cane and D. W. Stahle. 2007. North American drought: Reconstructions, causes, and consequences. (in press)
- Cook, E. R., R. Seager, R. R. Heim Jr., R. S. Vose, C. Herweijer and C. Woodhouse. 2009. Megadroughts in North America: Placing IPCC projections of hydroclimatic change in a long-term palaeoclimate context. *Journal of Quaternary Science*, doi: 10.1002/jqs.1303
- Coolidge, D. and M. R. Coolidge. 1939. *The Last of the Seris*. E. P. Dutton, New York.
- Congalton, R. G., M. Balogh, et al. 1998. Mapping and monitoring agricultural crops and other land cover in the lower Colorado River basin. *Photogrammetric Engineering and Remote Sensing* 64(11): 1107-1113.
- Crosby, H. W. 1981. *Last of the Californios*. Copley Books, La Jolla, CA.
- Davis, E. and E. Y. Dawson. 1945. The savage Seris of Sonora—1. *Scientific Monthly* 60(3): 193-202; II. *Scientific Monthly* 60(4): 261-268.
- De Francia, G. 1930 [1596] Memorial of Gonzalo de Francia. Pp. 218-220, in H. R. Wagner, Pearl Fishing Enterprises in the Gulf of California. *Hispanic American Historical Review* 10(2): 188-220.
- Del Barco, Miguel. 1768. *Correcciones y adiciones a la historia o noticia de la California en su primera edición de Madrid, año de 1757*. (edited by M. León-Portilla under the title *Historia Natural y Crónica de la antigua California*; Universidad Nacional Autónoma de México, Instituto de Investigaciones Históricas, 1988; México, D.F.)
- Del Barco, Miguel. 1980 [ca. 1770-1780] *The Natural History of Baja California*. Translated by Froylán Tiscareno. Baja California Travel Series 43. Dawson's Book Shop, Los Angeles.
- Dobie, J. F. 1985. *Apache Gold and Yaqui Silver*. University of Texas Press, Austin, Texas.
- Donohue, J. A., S.J. 1969. *After Kino: Jesuit Missions in Northwestern New Spain 1711-1767*. Jesuit Historical Institute, Rome, Italy.
- Douglass, A. E. 1929. The secret of the Southwest solved with talkative tree rings. *National Geographic*, December 1929, pp. 736-770.
- Douglass, A. E. 1935. Dating Pueblo Bonito and other ruins of the Southwest. *National Geographic Society, Contributed Technical Papers. Pueblo Bonito Series 1: 1-74*.
- Dozier, C. L. 1963. Mexico's transformed northwest: The Yaqui, Mayo and Fuerte examples. *Geographical Reviews* 53:548-571.
- Duell, P. 1919. *Mission Architecture as Exemplified in San Xavier del Bac*. Arizona Archeological and Historical Society, Tucson, AZ.
- Duell, P. 1921. The Arizona-Sonora chain of missions. *The Architect and Engineer* 66 (July, September, December).
- Eckhart, G. B. and J. S. Griffith. 1975. *Temples in the Wilderness: The Spanish Churches of Northern Sonora*. Arizona Historical Society, Tucson, AZ.
- Englehart, P. and A. Douglas. 2005. Changing behavior in the diurnal range of surface air temperatures over Mexico. *Geophysical Research Letters* 32, L01701.
- Engelhardt, Z. OFM. 18999. *The Franciscans in Arizona*. Holy Childhood Indian School, Harbor Springs, Michigan.
- Ezcurra, E. 2003. Conservation and sustainable use of natural resources in Baja California. Pp. 279-296 in J. G. Nelson, J.C. Day, and L. Sportza (eds.). *Protected Areas and the Regional Planning Imperative in North America*. University of Calgary Press and Michigan State University Press, Calgary, Alberta.
- Ezcurra, E. 2007. Hornaday, Lumholtz, and the grandeur of nature. In "Science on Desert and Lava: A Pinacate Centennial, Part I," Special Issue of *Journal of the Southwest* 49(2): 135-140.
- Ezcurra E., O. Aburto-Oropeza, L. Rosenzweig. 2009. Los riñones del mundo: ¿por qué debemos proteger los manglares de México? *Investigacion Ambiental* 1(2): 202-206.

- Ezcurra, E., L. Bourillón, A. Cantú, M. E. Martínez, and A. Robles. 2002. Ecological Conservation. Pp. 417–444 in T. Case, M. Cody, and E. Ezcurra (eds.). *A New Island Biogeography of the Sea of Cortés*. Oxford University Press, New York.
- Felger, R. S., M. B. Johnson and M. F. Wilson. 2001. *The Trees of Sonora, Mexico*. Oxford University Press, New York.
- Felger, R. S. and E. Joyal. 1999. *The Palms (Areaceae) of Sonora, Mexico*. *Aliso* 18(1):1-18.
- Felger, R. S. and M. B. Moser. 1970. Seri use of Agave. *Kiva* 35: 159-167.
- Felger, R. S. and M. B. Moser. 1973. Eelgrass (*Zostera marina* L.) in the Gulf of California: discovery of its nutritional value by the Seri Indians. *Science* 181:355–356.
- Felger, R. S. and M. B. Moser. 1974. Columnar cacti in Seri culture. *Kiva* 39: 257-275.
- Felger, R. S. and M. B. Moser. 1985. *People of the Desert and Sea: Ethnobotany of the Seri Indians*. University of Arizona Press. Tucson. 438 pp. (reprinted 1991).
- Felger, R. S. and M. B. Moser. 1987. Sea turtles in Seri Indian culture. *Environment Southwest*, Autumn, pp. 18–21.
- Felger, R. S., M. B. Moser, and E. W. Moser. 1980. Seagrasses in Seri Indian Culture. Pp. 260–276 in R. C. Phillips and C. P. McRoy (eds.), *Handbook of Seagrass Biology, and Ecosystem Perspective*. Garland STPM Press, New York.
- Feng, S. H., A. B. Krueger and M. Oppenheimer. 2010. Linkages among climate change crop yields and Mexico-U.S. cross-border migration. *Proceedings of the National Academy of Sciences* 107: 14257-14262.
- Feng, S. and Q. Fu. 2013. Expansion of global drylands under a warming climate. *Atmospheric Chemistry and Physics* 13: 10081-10094.
- Florescano, E. and S. Swan. 1995. *Breve Historia de la Sequía en México*. Universidad Veracruzana, Xalapa, Mexico.
- Fontana, B. L. 1961. Biography of a desert church: the story of Mission San Xavier del Bac. *The Smoke Signal* 3: 1-24.
- Fontana, B. L. et al. 1962. Papago Indian Pottery. *Monographs of The American Ethnological Society*, No. 37. University of Washington Press, Seattle, WA.
- Fontana, B. L. 1981. *Of Earth and Little Rain: The Papago Indians*. Northland Press, Flagstaff, AZ.
- Fontana, B. L. 1981. Pilgrimage to Magdalena. *The American West* 18(5): 40-45.
- Fontana, B. L. 1983. *Pima and Papago: Introduction*. Pp. 125-136 in, A. Ortiz (ed.), *Vol. 10 Handbook of North American Indians*.
- Fontana, B. L. 1987. Santa Ana de Cuiquiburitac: Pimería Alta's northernmost mission. *Journal of the Southwest* 29: 133-159.
- Fontana, B. L. 1994. *Entrada. The Legacy of Spain and Mexico in the United States*. Southwest Parks and Monuments Association, Tucson (AZ), and The University of New Mexico Press, Albuquerque (NM). 286 pp.
- Fontana, H. M. and B. L. Fontana. 2000. *Trails to Tiburón, the 1894 and 1895 Field Diaries of W. J. McGee*. University of Arizona Press, Tucson, AZ.
- Forbes, R. H. 1952. Crabb's filibustering expedition into Sonora, 1857. *Arizona Silhouettes*, Tucson, AZ.
- Foster, M. S., D. R. Mitchell, G. Huckleberry and D. L. Dettman. 2008. Observations on the archaeology, paleoenvironment, and geomorphology of the Puerto Peñasco area of northern Sonora, Mexico. *Kiva* 73(3): 263-290.
- Foster, M. S., R. Riosmena-Rodríguez, D. L. Steller, and W. J. Woelkerling. 1997. Living rhodolith beds in the Gulf of California and their implications for paleoenvironmental interpretation; Pliocene carbonates and related facies flanking the Gulf of California, Baja California, Mexico. *Special Paper—Geological Society of America* 318:127–139.
- Fradkin, P.L. 1984. *A river no more: The Colorado River and the West*. University of Arizona Press, Tucson.
- Fujita, H. and G. Poyatos de Paz. 1998. Settlement patterns on Espíritu Santo Island, Baja California Sur. *Pacific Coast Archaeological Society Quarterly* 34(4): 67-105.
- Gardea, A. A., L. T. Findley, J. A. Orozco-Avitia, N. Bañuelos, M. Esqueda and T. H. Huxman. 2012. Bacanora and sotol: so far, so close. *Estudios Sociales* 20, Segundo Número Especial: 149-168.
- Gehlbach, F. R. 1993. *Mountain Islands and Desert Seas: A Natural History of the U.S.-Mexican Borderlands*. 2<sup>nd</sup> Ed. Texas A&M University Press, College Station, TX.
- Gehrels, G. E. and J. E. Spencer (eds). 1990. *Geologic Excursions Through the Sonoran Desert Region, Arizona and Sonora*. Field-Trip Guidebook for the 86<sup>th</sup> Annual Meeting of The Geological Society of America. Arizona Geological Survey, Special Paper 7.
- Gentry, H. S. 1942. *Rio Mayo Plants*. Carnegie Institution of Washington, Publ. No. 527. Washington, D.C.
- Gentry, H. S. 1963. The Wariho Indians of Sonora-Chihuahua: An Ethnographic Survey. *Anthropological Papers*, No. 63, Bureau of American Ethnology Bulletin 186: 61-144, pls. 28-38. U.S. Printing Office, Washington, D.C.
- Gentry, H. S. 1982. *Agaves of Continental North America*. University of Arizona Press, Tucson, AZ.
- Gerald, R. E. 1968. *Spanish Presidios of the Late Eighteenth Century in Northern New Spain*. Museum of New Mexico Press, Santa Fe, NM.
- Gifford, E. W. 1946. Archaeology in the Punta Peñasco region, Sonora. *American Antiquity* 4: 215-221.

- Glenn, E. P., F. Zamora-Arroyo, P. L. Nagler, M. Briggs, W. Shaw, and K. Flessa. 2001. Ecology and conservation biology of the Colorado River delta, Mexico. *Journal of Arid Environments* 49:5–15.
- González-Abraham, C., E. Ezcurra, P. P. Garcillán, A. Ortega-Rubio, M. Kolb and J. E. Bezaury Creel. 2005. The human footprint in Mexico: Physical geography and historical legacies. *PLoS ONE* 10(3): e0121203. doi:10.1371/journal.pone.0121203.
- Goss, R. C. 1975. The churches of San Xavier, Arizona, and Caborca, Sonora, A comparative analysis. *The Kiva* 40(3): 165-2179.
- Greenberg, J. B. and C. Vélez-Ibáñez. 1993. Community dynamics in a time of crisis: An ethnographic overview of the upper Gulf. In T. R. McGuire and J. B. Greenberg (eds.), *Maritime Community and Biosphere Reserve: Crisis and Response in the Upper Gulf of California*. Occasional Paper No. 2, Bureau of Applied Research in Anthropology. University of Arizona, Tucson. 169 pp.
- Griffin, D., C. A. Woodhouse, D. M. Meko, D. W. Stahle, H. L. Faulstich, C. L. Carillo, R. Touchan, C. L. Castro and S. W. Leavitt. 2013. North American Monsoon precipitation reconstructed from tree-ring latewood. *Geophysical Research Letters*, doi.org/10/1002/gri.50184
- Griffith, J. 2011. *A Border Runs Through It*. Rio Nuevo Publishers, Tucson, AZ.
- Grissino-Mayer, H. D. 1996. A 2129-year reconstruction of precipitation for northwestern New Mexico, USA. Pp. 191-204 in, J. S. Dean, D. M. Meko and T. W. Swetnam (eds.), *Tree Rings, Environment, and Humanity*. Radiocarbon 1996.
- Harrison, L. S. 1986. Tumacácori Museum. Pp. 425-439 in, *Architecture in the Parks, National Historic Landmark Theme Study*. National Park Service, Washington, D.C.
- Hartmann, W. K. 1989. *Desert Heart. Chronicles of the Sonoran Desert*. Fisher Books, Tucson.
- Hartmann, W. K. 2014. *Searching for Golden Empires. Epic Cultural Collisions in Sixteenth-Century America*. University of Arizona Press, Tucson, AZ.
- Hayden, J. D. 1956. Notes on the archaeology of the central coast of Sonora, Mexico. *Kiva* 21: 19-22.
- Hayden, J. D. 1972. Hohokam petroglyphs of the Sierra Pinacate, Sonora and the Hohokam shell expeditions. *Kiva* 37(2): 74-83.
- Hayden, J. D. and J. W. Dykinga. 1998. *The Sierra Pinacate*. Southwest Center Series, University of Arizona Press, Tucson.
- Hedgpeth, J. W. 1978a. *The Outer Shores. Part 1. Ed Ricketts and John Steinbeck Explore the Pacific Coast*. Mad River Press, Eureka, CA.
- Hedgpeth, J. W. 1978b. *The Outer Shores. Part 2. Breaking Through*. Mad River Press, Eureka, CA.
- Henderson, D. A., 1972. *Men and Whales at Scammon's Lagoon*. Dawson's Book Shop, Los Angeles. 313 pp.
- Hernandez, L. 1926. *Datos Históricos Sobre los Filibusteros de 1857 en Caborca, Sonora, México*. Mexico City.
- Hilton, J. W. 1947. *Sonora Sketchbook*. Macmillan, New York.
- Hinton, T. B. 1955. A survey of archaeological sites in the Altar Valley, Sonora. *The Kiva* 21(1/2): 1-12.
- Hodgson, W.C. 2000. *Food Plants of the Sonoran Desert*. University of Arizona Press, Tucson.
- Hornaday, W. T. 1908. *Campfires on Desert and Lava*. [reprinted in 1985] University of Arizona Press, Tucson.
- Hundley, N., Jr. 1966. *Dividing the Waters: A Century of Controversy Between the United States and Mexico*. University of California Press, Los Angeles, CA. 266 pp.
- Hunter, L. M., S. Murray and F. Riosmena. 2013. Rainfall patterns and U. S. migration from rural Mexico. *International Migration Reviews* 47: 847-909.
- Ives, R. L. 1950. Puerto Peñasco, Sonora. *Journal of Geography* 49:349–361.
- Ives, R. L. 1989. *Land of Lava, Ash, and Sand. The Pinacate Region of Northwestern Mexico*. Compiled by J. W. Byrkit, Edited by K. J. Dahood. The Arizona Historical Society, Tucson, AZ.
- Johnson, A. E. 1963-1964. The Trincheras Culture of northern Sonora. *American Antiquity* 29(2): 74-186.
- Johnson, J. B. 1950. *The Opata: An Inland Tribe of Sonora*. University of New Mexico Publications, Anthropology No. 6.
- Johnson, Jr., R. 2005. *The Quiet Mountains: A Ten-Year Search for the Last Wild Trout of Mexico's Sierra Madre Occidental*. The Southwest Center Series, University of New Mexico Press, Albuquerque, New Mexico.
- Jones, G. and P. Ward. 1998. Privatizing the commons: reforming the ejido and urban development in Mexico. *International Journal Urban and Regional Research* 22:76.
- Jordán, F. 1951. *El otro México: Biografía de Baja California*. Biografías Ganesa, México, D.F.
- Karns, H. J. 1954. *Luz de Tierra Incognita*. Arizona Silhouettes, Tucson. [Karns' English translation of Juan Mateo Manje's diary by the same name.]
- Kessell, J. L. 1970. *Mission of Sorrows: Jesuit Guevavi and the Pimas, 1691-1767*. University of Arizona Press, Tucson, AZ.
- Kessell, J. L. 1976. *Friars, Soldiers, and Reformers: Hispanic Arizona and the Sonoran Mission Frontier, 1767-1856*. University of Arizona Press, Tucson, AZ.
- Kessell, J. L. 1980. *The Missions of New Mexico Since 1776*. University of New Mexico Press, Albuquerque, NM.
- Kino, F. E. 1954. *Kino Reports to Headquarters: Correspondence of Eusebio Francisco Kino, S. J. from New Spain to Rome*. English translation and notes by Ernest J. Burrus, S. J. Jesuit Historical Institute, Rome.

- Kino, F. E. 1919, 1948. *Kino's Historical Memoir of Pimería Alta*. Translated and edited by H. E. Bolton, 2 vols. Arthur H. Clark, Cleveland, OH. Reprinted as 2 vols. in one by University of California Press, Berkeley, CA.
- Kino, E. F. 1971. *Kino's Biography of Francisco Javier Saeta*, S. J. Translated and edited by Charles W. Polzer, with the original Spanish text edited by Ernest J. Burrus. Jesuit Historical Institute, Rome.
- Kira, G. S. 1999. *The Unforgettable Sea of Cortez. Baja California's Golden Age 1947-1977; the Life and Writings of Ray Cannon*. Apples and Oranges, Valley Center, CA.
- Kroeber, Al. L. 1931. The Seri. Southwest Museum Papers 6: 1-60.
- Krutch, J.W. 1961. *The Forgotten Peninsula: A Naturalist in Baja California*. W. Sloane Associates, San Francisco (Reprinted 1986, with a Foreword by Ann Zwinger, University of Arizona Press, Tucson).
- Krutch, J. W. and E. Porter. 1957. *Baja California and the Geography of Hope*. Sierra Club Books, San Francisco.
- Lange, Y. and R. E. Ahlborn. 2004. *Mission San Xavier del Bac. A Guide to Its Iconography*. University of Arizona Press, Tucson, AZ.
- Laylander, D. and J. D. Moore (eds.) 2006. *The Prehistory of Baja California*. University Press of Florida, Gainesville.
- León de la Luz, J. L., R. Coria-Benet, and J. Cansino. 1995. XI Reserva de la Biosfera El Vizcaíno, Baja California Sur. Serie Listados Florísticos de México, Instituto de Biología, Universidad Nacional Autónoma de México, México. 29 pp.
- León-Portilla, M. 1989. *Loreto, Capital de las Californias. Las cartas fundacionales de Juan María de Salvatierra*. Universidad Autónoma de Baja California, Centro Cultural Tijuana, FONATUR, México, D.F.
- León-Portilla, M. 1989. *Cartografía y Crónicas de la Antigua California*. Universidad Nacional Autónoma de México, Mexico, DF.
- Leopold, A. 1966. *A Sand County Almanac with Other Essays on Conservation from Round River*. Oxford University Press, New York.
- Lockwood, F. C. 1934. Story of the Spanish Missions of the Middle Southwest. Fine Arts Press, Santa Ana, CA.
- Lockwood, F. C. 1934. With Padre Kino on the trail. University of Arizona Bulletin 5 (No. 2); Social Science Bulletin No. 5. University of Arizona, Tucson, AZ.
- Longinos Martínez, José. 1792. *Diario* (notes and observations of the Royal Botanical Expedition to Antigua and Alta California, published in Spanish as *Diario de las expediciones a las Californias de José Longinos*; Serie Textos Clásicos, Editorial Doce Calles, 1994; Madrid; and printed in English as *Journal of José Longinos Martínez: Notes and observations of the naturalist of the botanical expedition in Old and New California and the south coast 1791-1792*; John Howell Books, 1961; San Francisco.
- Lumholtz, C. 1912. *New Trails in Mexico: An Account of One Year's Exploration in North-Western Sonora, Mexico and South-Western Arizona, 1909-1910*. T. Fisher Unwin, London (reprinted 1971, Rio Grande Press Glorieta, NM; reprinted 1990, University of Arizona Press, Tucson, AZ).
- Marlett, C. M. 2000. A Desemboque childhood. *Journal of the Southwest* 42: 411-426.
- Marlett, S. A. 2008. The form and use of names in Seri. *International Journal of American Linguistics* 74: 47-82.
- Marmaduke, W. S. and R. J. Martynec (eds.). 1993. *Shelltown and the Hind Site. A Study of Two Hohokam Craftsman Communities in Southwestern Arizona*. Northland Research Inc., Flagstaff, AZ.
- Martínez, Maximino. 1947. *Baja California: reseña histórica del territorio y su flora*. Ediciones Botas, México, D.F.
- Mathes, W. M. 1968. *Vizcaíno and Spanish expansion into the Pacific Ocean*. California Historical Society, San Francisco, CA.
- Mathes, W.M. (ed). 1969. *First from the Gulf to the Pacific: The diary of the Kino-Atondo Peninsular Expedition*. Baja California Travel Series No. 16. Dawson's Book Shop, Los Angeles, CA.
- Martin, P. L., D. Yetman, M. Fishbein, P. Jenkins, T. R. Van Devender and R. K. Wilson. 1998. *Gentry's Rio Mayo Plants: The Tropical Deciduous Forest and Environs of Northwest Mexico*. University of Arizona Press, Tucson, AZ.
- Martínez, Maximino. 1947. *Baja California: reseña histórica del territorio y su flora*. Ediciones Botas, México, D.F.
- Marshall, L. G. and C. Blake. 2009. *Land of Black Volcanoes and White Sands. The Pinacate and Gran Desierto de Altar Biosphere Reserve*. Environmental Education Exchange, Tucson, AZ. 130 pp. [available from the Arizona-Sonora Desert Museum, Tucson, AZ]
- May, L. A. 2007. Pinacate Recon. Pp. 259-303 in, B. Broyles (ed.), *Science on Desert and Lava: A Pinacate Cenennial, Part I*. *Journal of the Southwest* 49(2).
- McCarty, K., OFM. 1981. A Spanish Frontier in the Enlightened Age, Franciscan Beginnings in Sonora and Arizona, 1767-1770. Academy of American Franciscan History, Washington, D. C.
- McGuire, R. H. and A. V. Howard. 1987. The structure and organization of Hohokam shell exchange. *Kiva* 52(2): 113-146.
- McGuire, R. H. and M. Elisa Villalpando. 1989. Prehistory and the making of history in Sonora. Pp. 157-177 in, D. H. Thomas (ed.), *Archaeology of the Spanish Borderlands*. Vol. 1. Smithsonian Institution, Washington, D.C.
- McGuire, R. H. and M. B. Schiffer (eds.). 1982. *Hohokam and Patayan: Prehistory of Southwestern Arizona*. Academic Press, New York.
- McGuire, T. and J. Greenberg (eds.). 1993. *Maritime Community and Biosphere Reserve: Crisis and Response in the Upper Gulf of California*. University of Arizona, Tucson, AZ.

- Meko, D. M., C. W. Stockton and W. R. Boggess. 1995. The tree-ring record of severe sustained drought. *Water Resources Bulletin* 31: 789-801.
- Mitchell, D. R. and M. S. Foster 2000. Shell middens along the Sea of Cortez, Puerto Peñasco, Sonora, Mexico. *Journal of Field Archaeology* 27: 27-41.
- Mitchell, D. R. and M. S. Foster. 2011. Salt, seashells, and shiny stones: prehistoric Hohokam resource exploitation in the Papaguería and northern Gulf of California. *Journal Arizona Archaeology* 1(2): 176-184.
- Mitchell, D. R. and M. S. Shackley. 1995. Classic Period Hohokam obsidian studies in southern Arizona. *Journal of Field Archaeology* 22: 291-304.
- Moorhead, M. L. 1975. *The Presidio, Bastion of the Spanish Borderlands*. University of Oklahoma Press, Norman, OK.
- Moser, E. W. 1963. Seri bands. *The Kiva* 28:14–27.
- Moser, H. G., E. H. Ahlstrom, D. Kramer, and E. G. Stevens. 1974. Distribution and abundance of fish eggs and larvae in the Gulf of California. *CalCOFI Report* 17:112–128.
- Moser, M. R. 1970. Seri: from conception through infancy. *Kiva* 35: 201-210.
- Moser Marlett, C.M. 2014. *Shells on a Desert Shore. Mollusks in the Seri World*. University of Arizona Press, Tucson, AZ.
- Moser, M. B. and S. A. Marlett (compilers). 2005. *Comcáac quih yaza quih hant ihiip hac; Diccionario seri-español-inglés*. Editorial UniSon, Hermosillo & Plaza y Valdés Editores, México, D.F.
- Munro Palacio, G. 1994. Historia de la región de Puerto Peñasco. *CEDO News (Puerto Peñasco, Sonora)* 6:20–25.
- Nabhan, G. P. 2000. Cultural dispersal of plants and reptiles to the Midriff Islands of the Sea of Cortés: integrating indigenous human dispersal agents into island biogeography. *Journal of the Southwest* 42: 545-558.
- Nentwig, J., SJ. 1980. *Rudo Ensayo: A Description of Sonora and Arizona in 1764*. Translated by Albert F. Pradeau and Robert R. Rasmussen. University of Arizona Press, Tucson, AZ.
- Ortiz, A. (ed.) 1983. *Southwest. Vol. 10 of Handbook of North American Indians*, W. C. Sturtevant (gen. ed.). Smithsonian Institution, Washington, D.C.
- Pickens, B. and G. A. Grant. 1993. *The Missions of Northern Sonora. A 1935 Field Documentation*. University of Arizona Press, Tucson, AZ.
- Pitt, J., D. Luecke, M. Cohen, E. Glenn, and C. Valdés-Casillas. 2000. Two nations, one river: managing ecosystem conservation in the Colorado River Delta. *Natural Resources Journal* 40:819–864.
- Pfefferkorn, I. SJ. 1949. *Sonora: A Description of the Province*. Translated by Theodore E. Treutlein. University of New Mexico Press, Albuquerque, NM.
- Polzer, Jr., C. W. 1982. *Kino Guide II, A Life of Eusebio Francisco Kino, S.J., Arizona's First Pioneer, and A Guide to His Missions and Monuments*. Southwestern Mission Research Center, Tucson, AZ.
- Polzer, Jr., C. W. 1998. *Kino. A Legacy. His Life, His Works, His Missions, His Monuments*. Jesuit Fathers of Southern Arizona, Tucson, AZ.
- Poole, S. P. 1977. *Our Lady of Guadalupe. The Origins and Sources of a Mexican National Symbol, 1531-1797*. University of Arizona Press, Tucson, AZ.
- Ricard, R. 1966. *The Spiritual Conquest of Mexico*. Translated by Lesley B. Simpson. University of California Press, Berkeley, CA.
- Robichaux, R. H. and D. A. Yetman (eds.). 2000. *The Tropical Deciduous Forest of Alamos: Biodiversity of a Threatened Ecosystem in Mexico*. University of Arizona Press, Tucson, Arizona.
- Robles, A., and M. A. Carvajal. 2001. The sea and fishing. Pp. 293–300 in P. Robles-Gil, E. Ezcurra, and E. Mellink (eds.), *The Gulf of California. A World Apart*. Agrupación Sierra Madre, México, D.F.
- Robles Gil, P. 1996a. *Mexican Diversity of Cultures. 2nd ed.* CEMEX, Mexico, D.F. [text by Víctor Manuel Toledo; foreword by José Sarukhán].
- Robles Gil, P. 1996b. *Mexican Diversity of Fauna. 2nd ed.* CEMEX, Mexico, D.F. [text by Gerardo Ceballos and Fulvio Eccardi; foreword by Russell A. Mittermeier].
- Robles Gil, P. 1996c. *Mexican Diversity of Flora. 2nd ed.* CEMEX, Mexico, D.F. [text by Rodolfo Dirzo; foreword by Peter Raven].
- Robles Gil, P., E. Ezcurra, and E. Mellink (eds.). 2001. *The Gulf of California. A World Apart*. Agrupación Sierra Madre. Mexico, D.F.
- Robinson, W. J. 1963. Excavations at San Xavier del Bac, 1958. *The Kiva* 29(2): 35-57.
- Robinson, W. J. 1976. Mission Guevavi: excavations in the Convent. *The Kiva* 42(2): 135-175.
- Roca, P. M. 1967. *Paths of the Padres through Sonora: an Illustrated History and Guide to its Spanish Churches*. Arizona Pioneer's Historical Society, Tucson, AZ.
- Roca, P. M. 1979. *Spanish Jesuit Churches in Mexico's Tarahumara*. University of Arizona Press, Tucson, AZ.
- Rodger, K. A. (ed.). 2006. *Breaking Through: Essays, Journals, and Travelogues of Edward F. Ricketts*. University of California Press, Berkeley, CA.
- San Miguel, E. 2011. *Mission San Xavier. A Story of Saints and Angels, Art and Artists*. Arizona-Sonora Desert Museum Press, Tucson, AZ.

- Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vicchi, H-P. Huang, N. Harnik, A. Leetmaa, N-C. Lau, C. Li, J. Velez and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. *Science* 316: 1181-1184.
- Seager, R., M. Ting, M. Davis, M. Cane, N. Naik, J. Nakamura, C. Li, E. Cook and D. W. Stahle. 2009. Mexican drought: An observational, modeling and tree ring study of variability and climate change. *Atmosfera* 22: 1-31.
- Shackley, M. S. 1988. Sources of archaeological obsidian in the Southwest: an archaeological, petrological, and geochemical study. *American Antiquity* 53: 752-772.
- Shackley, M. S. 1995. Sources of archaeological obsidian in the greater American Southwest: an update and quantitative analysis. *American Antiquity* 60: 531-551.
- Shackley, M. S. and D. B. Tucker. 2001. Limited prehistoric procurement of Sand Tank obsidian, southwestern Arizona. *Kiva* 66: 345-374.
- Sauer, C. and D. Brand. 1931. Prehistoric settlements of Sonora, with special reference to Cerros de Trincheras. University of California Publications in Geography 5 (No. 3): 67-148.
- Sheridan, T. E. 1988. *Where the Dove Calls: The Political Ecology of a Peasant Corporate Community in Northwestern Mexico*. University of Arizona Press, Tucson, AZ.
- Sheridan, T. E. (ed.) 1999. *Empire of Sand: The Seri Indians and the Struggle for Spanish Sonora, 1645 – 1803*. University of Arizona Press, Tucson.
- Slaughter, M. C., D. B. Tucker and A. Lascaux (eds.). 2000. *Trade Corridors and Ethnic Boundaries: An Archaeological Survey of 12,089 Acres Along the Growler and San Cristobal Washes on the Barry M. Goldwater Range in Southwestern Arizona*. Cultural Resource Report No. 98-181, SWCA Environmental Consultants, Tucson, AZ.
- Spicer, E. H. 1962. *Cycles of Conquest. The Impact of Spain, Mexico, and the United States on Indians of the Southwest*. University of Arizona Press, Tucson, AZ.
- Stahle, D. W. and J. W. Dean. 2007. Tree ring evidence for North American climatic extremes and social disasters. *Dendroclimatology: Progress and Prospects*. Developments in Paleoecological Research, Springer. (in press)
- Stahle, D. W. and J. W. Dean. 2011. North American tree rings, climatic extremes, and social disasters. Pp. 297-327 in, M. K. Hughes, T. W. Swetnam and H. F. Diaz (eds.), *Developments in Paleoecological Research*, Vol. 11, *Dendroclimatology: Progress and Prospects*.
- Stahle, D. W., M. K. Cleaveland, R. D. Griffin, M. D. Spong, F. K. Fye, R. B. Culpepper and D. Patton. 2006. Decadal drought effects on endangered woodpecker habitat. *Eos (Transactions of the American Geophysical Union)* 87(12): 121, 125.
- Stahle, D. W., F. K. Fye, E. R. Cook and R. Daniel Griffin. 2006. Tree-ring reconstructed megadroughts over North America since A. D. 1300. *Climatic Change*, doi 10.1007/s10584-006-9171-x
- Stahle, D. W., J. Villanueva, D. J. Burnette, J. Cerano Paredes, R. R. Heim Jr., F. K. Fye, R. Acuña-Soto, M. D. Therrell, M. K. Cleaveland and D. K. Stahle. 2011. Major Mesoamerican droughts of the past millennium. *Geophysical Research Letters* 38, doi.org/10/1029/2010GL046472.
- Stine, S. 1994. Extreme and persistent drought in California and Patagonia during medieval time. *Nature* 369: 546-549.
- Spicer, E. H. 1980. *The Yaquis: A Cultural History*. University of Arizona Press, Tucson, AZ.
- Steinbeck, J. 1951. *The Log from the Sea of Cortez*. Viking Press, New York.
- Steinbeck, J. and E. F. Ricketts. 1941. *The Sea of Cortez. A Leisurely Journal of Travel and Research*. Viking Press, New York.
- Stone, C. L. 1986. *Deceptive Desolation: Prehistory of the Sonoran Desert in West Central Arizona*. Arizona State Office of the Bureau of Land Management, Phoenix, AZ.
- Sykes, G. 1937. *The Colorado Delta*. Carnegie Institution of Washington, American Geographical Society of New York, Baltimore. 193 pp.
- Sykes, L. 1968. Seismological evidence for transform faults, sea-floor spreading and continental drift. Pp. 120–150 in R. A. Phinney (ed.), *History of the Earth's Crust, A NASA Symposium*. Princeton University Press, Princeton, NJ.
- Therrell, M. D. 2005. Tree rings and “El Año de Hambre” in Mexico. *Dendrochronologia* 22: 203-207.
- Treutlein, T. E. (translator and editor). 1965. *Missionary in Sonora: The Travel Reports of Joseph Och, J. J., 1755-1767*. California Historical Society, San Francisco CA.
- Vernon, E. W. 2002. *Las Misiones Antiguas. The Spanish Missions of Baja California, 1683-1855*. Viejo Press, Santa Barbara, CA.
- Wagner, H. R. 1929. *Spanish Voyages to the Northwest Coast of America in the Sixteenth Century*. California Historical Society, San Francisco.
- Wagner, H. R. 1930. Pearl fishing enterprises in the Gulf of California. *Hispanic American Historical Review* 10(2): 188-220.
- Wagner, H. W. 1924. The voyage of Francisco de Ulloa. *California Historical Society Quarterly* 3(4): 307-383.
- West, R. C. 1993. *Sonora. Its Geographical Personality*. University of Texas Press, Austin.
- Whiffen, M. 1970. *Review of Paths of the Padres Through Sonora: An Illustrated History and Guide to Its Spanish Churches*, by Paul M. Roca. *Journal of the Society of Architectural Historians* 29(No. 2): 201-202.

- Whitmore, R. C., R. C. Brusca, J. L. León de la Luz, P. González-Zamorano, R. Mendoza-Salgado, E. S. Amador-Silva, G. Holguin, F. Galván-Magaña, P. A. Hastings, J.-L. E. Cartron, R. S. Felger, J. A. Seminoff, and C. C. Mclvor. 2005. The ecological importance of mangroves in Baja California Sur: Conservation implications for an endangered ecosystem. Pp. 298–333 in J.-L. E. Cartron, G. Ceballos, and R. S. Felger (eds.), *Biodiversity, Ecosystems and Conservation in Northern Mexico*. Oxford University Press, New York.
- Williams, J. S. 1986. San Agustín del Tucson: A Vanished Mission Community of the Pimería Alta. *The Smoke Signal* 47: 112-128.
- Williams, J. S. 1986. The Presidio of Santa Cruz de Terenate: A forgotten fortress of southern Arizona. *The Smoke Signal* 48: 129-148.
- Williams, J. S. 1988. Fortress Tucson: architecture and the art of war (1775-1856). *The Smoke Signal* 50: 168-187.
- Woodward, A. 1936. A shell bracelet manufactory. *American Antiquity* 2: 117-125.
- Woodward, A., S. DeLong, L. B. Miller, G. A. Grant, and B. Pickens. 1993. *The Missions of Northern Sonora. A 1935 Field Documentation*. University of Arizona Press, Tucson, AZ.
- Yensen, N. P. 2001. *Halófitas del Golfo de California y Sus Usos* (Halophytes of the Gulf of California and their Uses). Universidad de Sonora, Hermosillo, Sonora.
- Yetman, D. 1996. *Sonora. An Intimate Geography*. University of New Mexico Press, Albuquerque, NM.
- Yetman, D. 2002. *Guarijios of the Sierra Madre: the Hidden People of Northwestern Mexico*. University of New Mexico Press, Albuquerque, NM.
- Yetman, D. 2007. *The Great Cacti*. University of Arizona Press, Tucson, AZ.
- Zwinger, A. H. 1983. *A Desert Country Near the Sea: A Natural History of the Cape Region of Baja California*. Harper and Row, New York.