Natural History of the Ironwood Forest National Monument:

A Sonoran Desert Primer



By Royce E. Ballinger and Young D. Cage

Natural History of the Ironwood Forest National Monument:
A Sonoran Desert Primer

Dedication

To our friends, neighbors, and visitors who enjoy the IFNM and Sonoran Desert

To the staff of the Bureau of Land Management
for their hard work and dedication to managing IFNM

To the Friends of Ironwood Forest
for their passion to promote and preserve the landscape and resources of IFNM

To the memory of Young Cage, a friend and scholar of IFNM

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Royce E. Ballinger, Ph.D.
Young D. Cage

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Preface

The beauty of North American Deserts is perhaps nowhere better displayed than in the Sonoran Desert of southern Arizona. Furthermore, one of the public places that best displays the magnificence of the Sonoran Desert is in the Ironwood Forest National Monument (IFNM). The beauty of the desert varies with the seasons. Its variety also depends on the complex life cycles of constituent plants and animals, the realm of natural history. Much research has revealed the intricacies of biology and ecology of these desert organisms in both the technical literature and reference books like *A Natural History of the Sonoran Desert*.

Our purpose with this book is to provide an introduction of the main elements and characters in the complex natural history of this beautiful place. Our hope is that this primer will stimulate a better understanding and appreciation of our desert environment in this special place in our backyard. We believe greater public knowledge of the natural history of IFNM will provide an enhanced appreciation of the desert by our friends, neighbors, and visitors. Perhaps it will stimulate future students to add to our knowledge of our desert.

REB
YDC*
February, 2012

*On May 28, 2012, Young Cage lost his battle with a chronic autoimmune disease of the liver. This was very sad for me because we had only begun this book which we had been talking about for several years. Young was a great friend and desert scholar. I will always remember him when I go to the desert.
REB
(Spring, 2014)

Acknowledgments

In Young Cage's absence, I know that this section will be incomplete. He would certainly want to acknowledge many friends and colleagues who assisted him over the years in his photography efforts as well as those who shared his many field trip adventures. I can only say, you know who you are, and you know that there was no person more gracious, thoughtful, or appreciative than Young, so on his behalf thank you. Most importantly he would be especially thankful for the support and love that he enjoyed from his wife, Cheryl Cage. Cheryl has been supportive of this project from the beginning, and I appreciate her continued support and interest throughout this endeavor. Young asked his son Matthew to make any of his photographs available to me as the project progressed. Matt has done this with cheer and efficiency and I am grateful for his support and efforts without which this book would not have been possible.

Perhaps we should first acknowledge the many dedicated students and scientists whose insights and hard work have revealed the complexities of Sonoran Desert natural history. Secondly, we have been inspired by many of our friends and colleagues, especially those with whom we have worked during our short stint on the Board of Directors of the Friends of Ironwood Forest (FIF). Lahsha Brown (Executive Director, FIF) and Gaile James (President, FIF) have made specific contributions, but Gordon Hanson has been especially helpful and supportive through his photographic contributions and as a regular field trip companion.

Many friends and acquaintances have provided specific images with which they are identified in the captions. All of these photos were critically important, thanks. Allan Morgan, a professional photographer, must be singled out for his many excellent images that filled in major gaps essential to our coverage. Allan's support and dedication to the project are gratefully acknowledged. Gordon Hanson also provided many important and excellent images. For one or more important photos that have been used, thanks are due to Robert Ashbaugh, Jeff Babson, Lahsha Brown, Scott Cossel (Special Collections, University of Arizona), Jillian Cowles, Jay Eldredge, Martin Feldner, Dan Fischer, Dr. Kim Franklin, Dr. Hans-Werner Herrmann, Dr. Stefan Hertwig, Dr. James Platz, Ted Richardson, Sandy Rowley, Joe Sheehey, Dr. Ronnie Sidner, and Fred Wilson.

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Many staff members of the Tucson Sector of the Bureau of Land Management (BLM) have provided valuable assistance to us over the past few years. Their hard work and dedication to the management of IFNM are gratefully appreciated. We especially

want to thank Claire Crow (Monument Manager), Francisco Mendoza, and Darrell Tersey for their assistance in providing the map for our book.

A variety of people with specific subject matter expertise have been involved in the reading or editing of the manuscript. For these often thankless but critically important tasks special appreciation is due to: Jeff Babson (naturalist, Pima County Parks), Lahsha Brown (Executive Director, Friends of Ironwood Forest), Dr. Martin Cody (Professor, UCLA), Allen Dart (Executive Director, Old Pueblo Archaeology Center). Dr. Jim Gessaman (Professor, Utah State University), Dr. Joe McAuliffe (Director of Research, Desert Botanical Garden), Carl Olson (entomologist, University of Arizona), Roger Repp (President, Tucson Herpetological Society), Dr. Phil Rosen (Research Scientist, University of Arizona), Dr. Ronnie Sidner (mammalogy consultant, private sector), and John Wiens (botanist, Arizona-Sonora Desert Museum). For advice on specific technical issues we thank Rich Bailowitz (entomology, Tucson), Dr. Kim Franklin (ants, Arizona-Sonora Desert Museum), Dr. Ed Moll (Professor, Eastern Illinois University), Bob Schmalzel (botany and geology consultant, private sector), Dr. Cecil Schwabe (Professor, University of Arizona), and Dr. Howard Topoff (Professor, Hunter College of City University of New York). Special thanks go to Dr. Wade Sherbrooke (one of the endorsers who reviewed the final manuscript) for providing some critical and important comments on several technical points, and photographs of the cochineal scale insect. Assistance in crafting the manuscript into its production readiness I thank the careful and diligent work of Robert Ashbaugh (layout and design) and particularly Tom James (editorial assistance). Without all of this help, the project could not have been completed. Errors that may remain are my responsibility.

REB

April, 2014

Introduction

Ironwood Forest National Monument (IFNM) is northwest of Tucson, Arizona, approximately centered on the west side of Avra Valley. It consists of 129,000 acres of undeveloped landscape that is relatively undisturbed and provides prime examples of Sonoran Desert habitats and species. Of the six subdivisions of the Sonoran Desert, two subdivisions occur in IFNM. IFNM was established by presidential proclamation in 2000 and is managed by the Bureau of Land Management (BLM) as part of the National Landscape Conservation System (NLCS). The NLCS includes a number of monuments and open lands, mostly in the western United States. This system is intended to provide permanent protection of biological, geological, archaeological, and historical resources for present and future generations. These lands also offer recreational opportunities such as camping, hiking, photography, bird watching, and in-season hunting with appropriate state game licenses.

Location: Access to the IFNM can be made from Interstate 10 at Exit 236; go west toward the Circle K store and turn right on Trico-Marana Road for 2 miles; turn right at Silverbell Road and follow this road until reaching the entrance sign after which the paved road will soon become a dirt road, but is still called Silverbell Road. Alternatively, you can take Exit 242 off I-10 and follow Avra Valley Road west to the entrance sign (about 5-6 miles). This is a loop road that circles around the west side of the Silver Bell Mountains and connects with the Silverbell Road mentioned above. The rough road loop

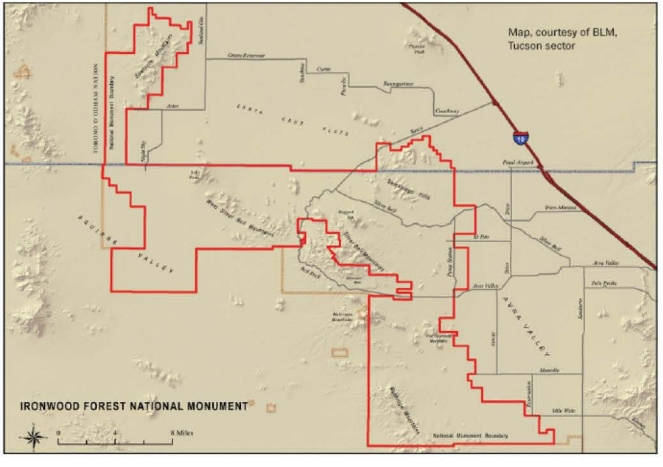


requires about an hour to traverse without stops, but the spectacular desert scenery, especially during the spring in a good year for blooming wild flowers, will require more time particularly for avid photographers, bird-watchers, and nature lovers.

The northern section of IFNM, including the Sawtooth Mountains, is connected only by primitive roads to the southern section described above. Routes between the two sections are obscure and confusing. They require a 4 X 4 vehicle and are not recommended for the casual visitor. The northern section may be accessed from I-10, Exit 200, south through Arizona City on Sunland Gin Road.

If You Go to IFNM

Permits or entrance fees are not required, but it must be noted that IFNM is a remote desert environment with many potential hazards including extreme heat, flash flooding, unmarked routes, abandoned mine shafts, and poisonous reptiles and insects. Most roads are unimproved, primitive, and not regularly maintained. There are no bathroom facilities or water sources. Motorized vehicles are limited to existing routes. Use of vehicles off-road, cross country or in washes is prohibited. Take plenty of water and use precautions such as telling someone where you are going and when you expect to return. Cell phones may not work in remote areas. The area is in a corridor of frequent drug and human smuggling. BLM and the U.S. Border Patrol maintain patrols of law enforcement officers for security, but this is a large area and visits, especially at night, are not recommended. You may call the BLM Tucson Field Office (520-258-7200) to check travel and safety conditions. If you see something that shouldn't be happening, call 911 or report the incident to the BLM at 800-637-9152.


Map, courtesy of BLM, Tucson sector
IRONWOOD FOREST NATIONAL MONUMENT
8 Miles
National Monument Boundary
TOHONO O'ODHAM NATION
SANTA CRUZ FLATS
AVRA VALLEY
AGUIRRE VALLEY
Picacho Peak
Red Rock
Marana
Tortolita
Silver Bell
Sandario
Twin Peaks
Ironwood Forest National Monument
Picacho Peak State Park
Avra Valley
Silver Bell Mountains
Picacho Mountains
Tortolita Mountains
Roskruge Mountains
Waterman Peak
Sawtooth Mountains
Sandario Peak
Ragged Top Mountain
Black Mountain
Twin Peaks Mountain
Saddle Peak Hills
Brawley Wash
Santa Cruz River
Los Robles
Cortaro
Thornydale
Sanders
Camino Manzanita
Camino Rosa
Camino Verde
Camino Arturo
Camino Del Cobre
Camino Del Oeste
Camino Del Sol
Camino Del Rio
Camino Del Norte
Camino Del Este
Camino Del Sur
Camino Del Rey



A Note About the Science of Natural History

Although of fundamental importance, natural history is an old science without much favor in the realm of modern biology. The father of the scientific method, Sir Francis Bacon (1561-1626 CE), is credited with coining the specific use of the term "natural history" to mean knowledge obtained by observation as compared to science



LEFT: *Samanigo Hills. (RB)*

(by reason) and poetry or literature (by fantasy). Bacon may have been the first to provide a definition, but the term's use was common centuries before his time. The Greek intellect Aristotle (384-322 BCE) combined the term "istoria" (knowledge obtained by investigation or inquiry) when he wrote his *Historia Animalium* summarizing all that was known about animals in the 4th century BCE. Roman scholar, Pliny the Elder (23-

79 CE) used the title *Naturalis Historia* for his encyclopedic summary of all fields of ancient knowledge.

The term natural history was used until the early 20th century to include scientific knowledge about all things of nature from astronomy to zoology. As each discipline developed its own traditions, natural history narrowed to become the observations of the living world or biology of nature, although some authors would argue that it would also include other components of nature such as covered by geology and meteorology. But within biology, recent emphases on processes, mechanisms, or specific natural groups have created a plethora of subdivisions of knowledge according to the kind of organism (zoology, herpetology, ornithology, mycology, etc.) or kind of process or question (embryology, ecology, physiology, etc.).

Below: Golden Hedgehog with Ragged Top in the background. (Gordon Hansen)



We use the term natural history to include observations of nature, but particularly those of living organisms. We might include the processes that interconnect the living components under the term functional natural history, but this would crowd the topics of ecology, ethology, and evolutionary biology. So natural history is an observational endeavor that mostly informs us about the living characters in the play of nature. This knowledge is essential to asking questions about roles, interactions, and usefulness, which we will mention occasionally, if only briefly.

A Note About Technical Names

Humans have given names to plants and animals for eons. These common names varied according to language, location, and purpose. To provide a baseline and point of stability, scientists devised a method of giving each species of plant or animal a unique scientific name in Latin. Rules about how this is done are governed by international commissions of nomenclature for plants and animals respectively. This technical

name is recognized and used worldwide. Each species name consists of two parts (binomial), *genus* (plural *genera*) and a specific epithet (*species*). The genus name is always capitalized and the species name is never capitalized, but both names are italicized or underlined. Thus for humans the scientific name is *Homo sapiens*, and for the giant cactus or saguaro it is *Carnegia gigantea*. Sometimes a third name (trinomial) is added to differentiate "*races*" or variants of a species. For animals, this is called the *subspecies*. Botanists often use "*variety*." For example the Nichol's Turk's Head cactus that occurs in IFNM is *Echinocactus horizonthalonius nicholii*. When we enumerate the number of kinds of plants or animals, we collectively call these *taxa* (singular *taxon*), thus each *taxon* is counted whether it is a binomial or trinomial name.

For most purposes, you can simply use the common name. Remember, however, that whereas common names vary greatly between region and reference source, their scientific names will be the same.

The Environment



Lsrt. *Arizona Upland Sonoran Desert, Silver Bell Peak in background. (RB)*

Ironwood Forest National Monument is an excellent representative area of the Sonoran Desert. The Sonoran Desert extends from central Baja California, Mexico and around the northern end of the Gulf of California then southward beyond Guaymas, Sonora. Just south of Guaymas, the desert grades into the Sinoloan Thornscrub Biome along the coast. Among the four North American

deserts (Chihuahuan, Great Basin, Mojave, and Sonoran), the Sonoran Desert has the greatest variety and diversity of plants, especially cacti. The greatest number of cactus species in North America occurs in the Sonoran Desert just north of San Ignacio, Baja California. The increased number of cacti in that part of the Sonoran is in part a result of the moisture supplied by regular fog events from the west. The northern most part of the Sonoran Desert in Arizona, nevertheless, has a splendid variety of cacti including several large ones such as the saguaro and organ pipe cactus, both of which occur in Ironwood Forest National Monument.

Ecological Setting: IFNM resides in the southwest desert biome of low mountains and wide valleys, the "basin and range province" of geologists. It contains two of the major subdivisions of the Sonoran Desert. About 55 per cent of IFNM is classified in the Arizona Upland subdivision. The remainder of IFNM is classified as part of the Lower Colorado River Valley subdivision.

Left: *Cactus forest in southern Sonoran Desert near San Ignacio, Baja California.*
Right: *Sonoran Desert in Baja north of San Ignacio. (Both RB)*





Left: *Arizona Upland Sonoran Desert. (Gordon Hanson)*
Right: *Lower Colorado River subdivision. (RB)*

The Arizona Upland occurs on the sides, slopes, bajadas, and ravines of the low desert mountains from about 1800 to 4000 feet elevation. The soils are thin and rocky. The vegetation is dominated by saguaro cactus, foothill paloverde, and desert ironwood trees. There is an assortment of cacti, shrubs, grasses, and scattered annual flowers and herbaceous plants in early spring or after monsoon rains. The uplands have many ravines and steep canyons with boulders of various sizes.

The Lower Colorado River Valley subdivision is an extension of the lowlands along the Colorado River. Terrain slopes gently toward major rivers such as the Santa Cruz River east of IFNM and is traversed by dry arroyos and washes. Dominant vegetation includes velvet mesquite, creosotebush, bursage, and a variety of shrubs and cacti.

Blue paloverde, desert hackberry, wolfberry, and several other bushes are common along major washes. Spring flowers such as desert marigold, Mexican gold poppy, and various mustards are common after good winter rains.

Climatic setting: In general, temperature and moisture are highly variable from season to season and year to year. Summers are hot (frequently to 110 F) and winters are mild (no or few days of freezing temperature). Temperatures also vary according to microhabitats due to the amount of plant cover versus exposed rocky desert soils. This helps explain phenomena like "nurse plants" such as desert ironwood trees that provide shelter for seedling growth. Also see photo on page 64.



Above: *Example of a nurse plant, note saguaro that has grown up within an desert ironwood tree. (Robert Ashbaugh)*

Arizona deserts have a bi-seasonal rainfall pattern. Late fall and winter rainfall comes from the west with storms originating in the northern Pacific Ocean. These storms turn inland along the west coast but many do not reach as far south as Arizona. Those that do, may lose much of their moisture as they pass over the mountains of California. As a result, winter rains tend to arrive gradually, be widespread, and of low intensity. Abundant rain in late fall with at least scattered rain through the winter tends to account for the best spring flower occurrences. Lack of rains during late fall and winter (such as occurred in 2010-2011 in IFNM) results in few or no springtime flowers.

Summer rainfall is the result of a shift in seasonal winds that pull subtropical moisture into the region from the Gulf of California and Pacific Ocean although some moisture has long thought to originate from the Gulf of Mexico. As this moisture laden air rises over the hot desert, large thunderstorms are produced during a monsoon season that tends to begin abruptly near the first of July. Monsoon rain is usually localized, covering only a few square miles, but is intense and frequently causes rapid run-off and swollen streams and washes. At the tail end of the summer monsoon season in late September through October, moisture from the Pacific Ocean tropical



Left: *Winter rains approaching from the western Sonoran Desert.* **Right**: *Haboob just north of IFNM. (Both RB)*

cyclones (hurricanes) occasionally bring large amounts of rainfall to the Sonoran Desert. These storms are infrequent and unpredictable, but when they occur, they often deliver record-breaking amounts of rainfall. Rainfall in IFNM varies greatly from year to year but averages about 10 inches per year with about 50 per cent falling during the summer monsoon season.

Geological setting: IFNM lies in the Basin and Range Province of southwest North America. The major features are mountains and valleys that are oriented from the southeast to the northwest. This area has a complex geological history with some rock formations that date as far back as 1600 million years ago. This is evident in IFNM for example by the presence of grayish green rock deposits in certain places (e.g. Waterman Mountains) that represent the pre-Cambrian or Proterozoic age.

The current basin and range configuration of the alternating mountain and valley geology of southwest Arizona results from at least three prominent geological events.

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8,000 BCE the area had dried and warmed sufficiently to promote the invasion of large cacti and thorn-scrub vegetation from the dry tropics to the south.

A note about desert soils: Perhaps the most important part of the geosphere to the natural history of a place is its soils. About 70 per cent of the landscape of the IFNM is covered by gravelly alluvial fans. Those deposits range in age from less than centuries to two million years. Soils that have developed in those gravelly parent materials vary according to the ages of the alluvial deposits. The older deposits often contain clay-rich, red-brown subsoil horizons called argillic horizons underlain by cemented, white calcic horizons often called caliche. One of the principal sources of the fine clay minerals and calcium carbonate in these horizons is the deposition of dust over thousands of years. Water moves these fine materials downward into the soil where they accumulate within distinct horizons or layers.

The surface of desert soils may vary greatly depending on slope, parent rock, and rainfall. Two interesting surface types are desert pavement and desert crusts. Desert pavement develops in areas where small to tiny pebbles form continuous surfaces that are cemented together by sand, calcium, and clay particles. This usually occurs in very arid areas (e.g. west of IFNM such as near Yuma) on stony alluvial fan deposits along low mountains, but they can occur in smaller patches where small stones become tightly packed over long periods of time. We have not found typical desert pavement development in IFNM but they may occur in the lowermost basins.

Another interesting surface is known as desert crusts that form on flatland deserts with fine textured surfaces. These are called microphytic crusts because they contain a wide range of small organisms including blue green algae, cyanobacteria, green algae, lichens, fungi, mosses, and liverworts that form a living crust. These organisms become active with the slightest rain and then return to their dormant state during dry periods.



Above. *Example of desert pavement near Gila Bend, AZ (RB)*

Their activity welds the soil surface together over long periods of time. These surfaces are resistant to being blown by the wind. Disruption of this crust allows soil particles to be blown away. Thus, it is no wonder that southern deserts of Arizona and New Mexico periodically experience major, life threatening dust storms (haboobs) when the winds blow. Most of the microphytic crusts of the lowland desert have been trampled to varying degrees by people, their livestock, and their vehicles. Additionally, the conversion of much of the original desert shrub-covered vegetation to farmland in the area around Casa Grande has exposed the soil directly to wind erosion. Furthermore, many of these areas have failed to become revegetated even after they have been abandoned for agricultural use, worsening the problem.

Natural History Synopsis of IFNM Major Areas

Ironwood Forest National Monument has eight mountain ranges and two large valleys with elevations ranging from 1550 to 4195 feet. The area's complex geological history has some areas of entirely volcanic rocks and others having significant components of limestone and other rocks. This variability impacts the plants and animals that live here. The mountain areas are mostly part of the Arizona Upland subdivision of the Sonoran Desert whereas the valleys represent the Lower Colorado River Valley subdivision. The following section provides an overview summary of the natural history of the major areas within the IFNM.

Avra Valley: This valley, just west of the Santa Cruz River, borders the eastern edge of the IFNM. Some valley agriculture occurs, but natural areas of IFNM are dominated by velvet mesquite trees and creosotebush. A total of 246 plant taxa are recorded in this area of Sonoran Desert scrubland. Blue paloverde and large velvet mesquite trees with an occasional desert hackberry and wolfberry are common along the major washes as well as a diversity of lush bushes and abundant flowers following good spring rains.



Left: *Southern Ajo Valley dominated by creosotebush; note Dos Tizos of Roskruge Mtns in background. (RB)*

Roskruge Mountains: This is a long mountain range oriented south to north in the southern part of IFNM. Its main body extends south of the IFNM where its maximum altitude is 3,717 feet. A total of 327 taxa of plants are recorded and 21 taxa are unique in IFNM to this area. This is the only area in which an organ pipe cactus (see page 66) occurs. Typically found west and south into Baja California, one large old organ pipe cactus represents the third most easterly occurring plant of this species in the United States. Some of the largest desert ironwood trees are found in these mountains. Staghorn cholla (*Cylindropuntia versicolor*) occurs in IFNM only in the Roskruge



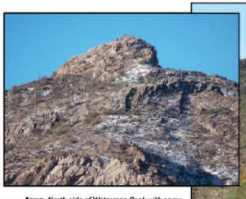


Top Left: *Closer view of Dos Titos of Roskruge Mtns. (RB)*
Top Right: *Interior of central Roskruge Mtns. (RB)*
Bottom Right: *West side of Pan Quemado Mtns. Allyson Kumatzka restoration site in foreground. (Gordon Hanson)*



Mountains. In other areas of IFNM the staghorn cholla is replaced by buckhorn cholla (*Cylindropuntia acanthocarpa*).

Pan Quemado Mountains: The "burnt bread mountains" are a small range near the southeastern border of IFNM east southeast of the Waterman Mountains. Two of the 276 plant taxa here are unique in IFNM.





Above: *North side of Waterman Peak with snow. (Gordon Hanson)*
Right: *Waterman Mountains. (RB)*

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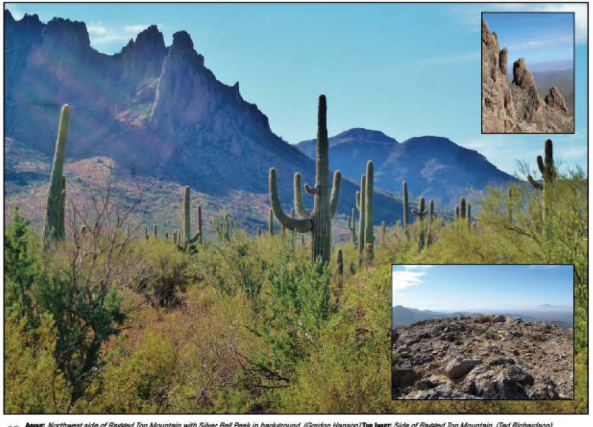
Above: *Sunset with Silver Bell Mtns. on the left and Ragged Top on the right. (RB)*



Left: *Ragged Top with Wolcott Peak on left. (Gordon Hanson)*

Samaniego Hills: The low hills north of Ragged Top have 252 plant taxa but only one unique species, an exotic weed. Desert ironwood, saguaro, foothill paloverde, and many cholla species dominate the slopes as elsewhere in IFNM. Some of the largest desert ironwood trees in IFNM occur on the south and eastern edges of these hills and Ragged Top Mountain.

West Silver Bell Mountains: These mountains northwest of the main Silver Bell Mountains are relatively low (to 2947 feet). They have 213 plant taxa but only one unique species, a grass.



Above: *Northwest side of Ragged Top Mountain with Silver Bell Peak in background. (Gordon Hanson)* **Top Inset:** *Side of Ragged Top Mountain. (Ted Richardson)* **Bottom Inset:** *Top of Ragged Top Mountain looking southwest. (Ted Richardson)*



Left: *Looking south toward the Samaniego Hills. (RB)* **Top Right**: *West Silver Bell Mtns. (Gordon Hanson)*

Sawtooth Mountains: These mountains extend along the northwestern edge of the monument and are not easily accessible from Avra Valley roads. They are very dry (only 9" of rain per year) with 323 taxa including 22 unique to IFNM. A distinctive sand-hills area and its associated biota including big galleta grass, a sand hills endemic, occur here. Greene's Wash that cuts through IFNM near the northeast edge of the Sawtooth Mountains may explain the increased number of plant taxa compared to other small desert mountains.

Aguirre Valley: This valley occurs to the west of the Sawtooth Mountains south to the Silver Bells. It has 165 taxa, including one unique species, a barrel cactus (*Ferocactus emoryi*).



Above: *Sawtooth Mtns. (Gordon Hanson)*
Right inset: *Sawtooth Mtns. panorama. (RB)*

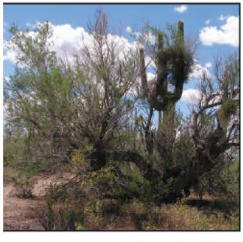
Keystone and Iconic Species



Above: *Representative species associated with Ironwood Forest National Monument. Ragged Top mountain in background. (Young Cagle)*

In any particular ecosystem that may be composed of hundreds of different species, invariably a few of these species are more abundant or functionally more important than other species. These species are called keystone species. In the Ironwood Forest National Monument (IFNM) of the Sonoran Desert, perhaps a dozen or more species could be identified as keystone in importance





Top: *Desert ironwood blossom.* **Bottom**: *Desert ironwood tree.* (Both RB)

to the ecosystem. Other species are clearly prominent symbols or icons of the area. Here we discuss a few of the most iconic or those of keystone importance in IFNM.

Desert Ironwood Tree

The desert ironwood tree (*Olneya tesota*) has been studied more carefully than perhaps any other species with regard to its importance in the Ironwood Forest National Monument (IFNM). The distribution of the desert ironwood tree almost exactly coincides with the Sonoran Desert. In the IFNM (and the Tucson Mountains nearby) the desert ironwood is near its eastern distributional limit where it is found most commonly along the slopes of the Arizona Upland. However, in most of its southern and western range in hotter and drier areas, for example in the desert east of Yuma, this tree occurs more frequently along washes of the flatland desert.

Desert ironwoods are long-lived (presumably up to 800 years or more), slow-growing, with trunks of extremely dense wood that will not float in water. The wood has been used for beautiful carvings, first started by the Seri Indians of Sonora, Mexico under the artistic tutelage of Jose Astorga. The subsequent industry by Mexican carvers and the practice of making charcoal resulted in near extinction of large, old trees in Sonora. Collection of ironwood for charcoal is now prohibited, and the plant is protected in the United States.

Perhaps no other plant in the Sonoran Desert serves such an important ecosystem role as the desert ironwood. Over 500 species of plants and animals have been documented to be directly impacted by the tree. It produces a microenvironment that shelters many species. It serves as a "nurse plant" for seedlings to germinate under its canopy. Its flowers and foliage provide food for bees and other insects as well as

browse for deer, desert bighorn sheep and other herbivores. The seed (a bean) provides food for hundreds of animals ranging from rodents to birds. Its canopy is used as a perch and nesting site for numerous birds. A symbiotic bacterium in its roots produces nitrogen that enriches the soil.

In IFNM, the desert ironwood usually blooms beginning in mid to late May, but earlier in very warm springs. A given tree blooms for about 10-18 days, but the staggered flowering of the forest may extend the bloom period for as much as a month or more. The pea-like flower of this legume (Family Fabaceae) is lavender and cream and much of the landscape in IFNM is blanketed with this color during this period when many of its gray-green leaves are shed. Leaves are also drought-deciduous, falling off during extremely dry periods, and also typically during the flowering period. Seed maturation occurs at the time of the summer monsoon. The beans contain 1-8 hard seeds that are collected by many animals. Some of the seeds germinate from caches in rodent burrows. The seeds can be ground into flour but they contain some bitter chemicals that cause gastric distress in some people. They can also be eaten raw. When mature they are crunchy and have a nutty flavor, but take precautions against insect larvae in the seeds.



Above: *Desert ironwood tree in bloom. (RB)*

Saguaro

This giant cactus (***Carnegiea gigantea***) is almost synonymous with the Sonoran Desert if not Arizona although it also occurs in extreme southern California and southward into Sonora, Mexico. In IFNM, the saguaro is most common along the slopes and bajadas of the Arizona Upland areas. This stately cactus reaches heights of 40-50 feet and may have as many as 20-30 arms over its 200 year lifespan. The first arm is





Top: *Saguaro blossoms.*
Bottom: *Ripe saguaro fruit.*
(Both RB)

said to develop at ages 50-75 years depending on the amount of moisture available in a particular area. Saguaros have a short central tap root of about two feet but mostly depend on a shallow and wide-spreading root system to assist in water absorption. Large saguaros are said to be able to absorb up to 790 gallons of water in 10 days. They may not compete well with other plants in deep soils and may be limited in valley bottoms by cold air drainage.

Saguaros produce flowers in May through early June with fruit ripening through early July. Many animals, especially bees, birds, and bats pollinate the flowers and feed on its nectar, but perhaps the white-winged dove depends as much on the saguaro as any animal. In April and May this dove arrives in IFNM from its winter range just as the saguaros begin to flower. They feed on the flower nectar and then the fruit before heading back south by the end of July or early August. In addition to providing flower and fruit, the saguaro also provides a structure for homes of birds (e.g., Gila woodpecker and gilded flicker). Hawks and other birds may build a nest among the arms, but woodpeckers and flickers peck holes into the saguaro and dig out chambers large enough to accommodate their nest. If these chambers are abandoned they may be used by owls and other birds later.

The ripe fruit of the saguaro is red, sweet, and juicy and contains up to 2000 tiny black seeds. Native Americans had celebrations and festivals during the period of saguaro fruit harvesting. The Tohono Oodham consider saguaros to be one of them and have creation and life stories that involve the saguaro. As the fruit splits open some of the seeds find suitable conditions to germinate but most seeds are consumed by birds, rodents, and other mammals. Some seeds eaten by birds pass through the gut and are dispersed to other areas.

Favorable germination conditions require above average moisture and shelter under a nurse plant such as a triangle-leaf bursage, desert ironwood tree, or paloverde.

Favorable conditions for survival and early growth are rare but when they occur many saguaro seedlings may survive. This results in pulses of new saguaros which can be seen across the landscape with cohorts of saguaros of the same size and age. Once germination occurs, the relatively few seedlings that survive take about five years to reach a height of 2-3 inches of which many of these are eaten by mice, rabbits, and other animals. If they survive to 10 years saguaros are about 3-5 inches high. This is followed by a relatively rapid burst of growth such that by the fifteenth year they may be 9-12 inches tall. Saguaros first produce flowers at about six to eight feet at an age of 40-50 years.

Like other desert cacti, the saguaro has a number of special adaptations for survival in the desert. The skin has a waxy coating that prevents water loss. Photosynthesis occurs under this layer in special chlorophyll bearing cells thus reducing the surface area for water loss compared to plants with leaves. Cacti have a special metabolic pathway called CAM (crassulacean acid metabolism) in which stomates open only at night to take in carbon dioxide in order to minimize water losses from the plant. Other adaptations include the spines, which in addition to protection from herbivores, help shade the surface of the cactus. Furthermore, the large volume of the cactus is about 90 per cent water that provides a thermal inertia balance resisting rapid temperature changes. There is a woody internal structure but much of the mass of the saguaro is water storage tissue. It is said that a saguaro weighs about 80 pounds per foot when fully hydrated.

Based on fossil and pollen studies, saguaros have been in the IFNM area since about 10,000 years ago as the climate began to dry and the area changed from a grassland to desert. They occur only in the hottest United States desert, the Sonoran. The majesty of the saguaro brings delight to residents and visitors alike.



Above: *Saguaro cactus in bloom. (RB)*

Paloverde Trees



Right: *Foothill paloverde tree in bloom. Ragged Top Mountain in background. (RB)*

Another important keystone plant is the paloverde tree, among the most abundant and widespread species in IFNM. These are the trees with green branches and trunk that are covered with yellow flowers in the spring. Like the desert ironwood and saguaro, the distribution of the paloverde almost exactly outlines the Sonoran Desert in Arizona. However, there are three species of paloverde of which two species are common in the IFNM. The common Arizona Upland species is the foothill paloverde (***Parkinsonia microphylla***) whereas the blue paloverde (***Parkinsonia florida***) is typically found along rivers, washes, and flood plains of the lower desert. A third species, the Mexican paloverde (***Parkinsonia aculeata***) occurs farther south in Arizona and is introduced with

a few specimens in IFNM in Cocio and Greene's washes and along Silverbell Road and in Avra Valley. Several hybrids are used in the horticultural business but are not found naturally in the IFNM. The most common hybrid, "Desert Museum" type, was developed by Dr. Mark Dimmitt of the Arizona-Sonora Desert Museum. This hybrid species has a number of characteristics such as no spines and large, long lasting flowers, that make it an excellent yard plant.

Paloverdes are especially suited to survive in a dry desert environment. Their tiny leaves, actually leaflets of a compound leaf, have a decreased surface area that reduces transpirational water loss and minimizes leaf surface heating. The leaves are also drought deciduous, that is they fall off during very dry periods. Even some branches can be drought deciduous. Trunks and branches are photosynthetically active, thus their green color. Paloverde means green stick in Spanish.

Paloverde trees have soft wood of little use except as firewood. They grow fast but probably rarely exceed 100 years old. These trees are an important resource for desert animals for food, shelter, and shade. They serve as a nurse plant for plant seedlings and provide pollen for bees, flies, and beetles. These trees are a legume (Family Fabaceae) whose beans were an important food for native peoples. The beans are produced from the conspicuous yellow flowers that appear from February through May, but the exact time of flowering and other characteristics differ between the species.

The blue paloverde (BPV) may begin to flower as early as February and continue through May, with a peak in late April depending on moisture conditions. These tend to be large trees to 30-40 feet tall with a central large trunk. The bright yellow flowers (18-25 mm wide) have five petals including a larger one called the banner that is yellow with scattered red flecks at its base. The banner turns reddish orange with age. There is a spine at the branch nodes, but these are sometimes deciduous. The ends of the



Top: *Blue paloverde blossom.*
Bottom: *Foothill paloverde blossoms.*
(Both Jillian Cowles)

branches tend to curve upward and do not end with a spine. The compound leaf has 1-2 pinnae (stems bearing leaflets) that connects to the branch with a short petiole (stalk) and 3-8 leaflets per pinna. The leaves and branches are bluish green, thus the name blue paloverde (BPV). The bean pods are flat, 3-7 cm long and not restricted between seeds. The beans are said to taste like green peas when eaten while green. BPV are most abundant along major washes and riverine floodplains.

The foothill paloverde (FPV) has a flowering cycle that is typically two weeks later than the BPV, usually mid-March through May with a peak in early May. FPV are smaller trees or shrubs (to 20-25 feet tall) with many branches emerging from the base of the trunk. The limbs are yellowish green. The pale yellow flowers are small (12-18 mm wide) with the banner petal being white and fading to light yellow to orange with time. Leaves lack a petiole thus attach directly to the branch. There are 2-3 pinnae (1-5 cm long) with 4-5 pairs of leaflets on each pinna. Pods are 3-10 cm long with constrictions between the seeds. There is a prominent spine are the ends of branches. FPV are abundant on slopes, ridges, canyons, and bajadas.

Although not as long lived as some other desert plants, paloverdes play a critical keystone role in the IFNM ecosystem where they are prominent and conspicuous members of the flora.

Nichol's Turk's Head Cactus

This cactus (*Echinocactus horizonthalonius nicholii*) is remarkable for its rarity and unique beauty. This subspecies, of a common cactus occurring in the Chihuahuan Desert of Texas, New Mexico, and southward on the Mexican plateau, is found on only one mountain in northwestern Sonora and on three small mountains in southern Arizona





Left: *Nichol's turk's head cactus.*
Right: *Nichol's turk's head cactus blossom. (Both Young Cage)*

including one in the IFNM. All of these locations have a soil derived from limestone in hills or alluvial fans. The subspecies found here was designated as an endangered species by federal authorities in 1976 and thus its status is carefully watched. It is also protected by CITES (Convention on International Trade in Endangered Species) and the Arizona Native Plant Law.

The Nichol's turk's head cactus is named for its general shape, resembling a grayish-green turban. It is a small barrel-shaped cactus that usually has a pronounced right or left swirl to the ribs. At the top of the plant and down each of the 5-13 (usually 8) ribs are stiff, recurved spines that protect the cactus from herbivores. However,

we have seen evidence that bighorn sheep can penetrate the center of this cactus apparently using their horns and thus eat the inside during extremely dry periods. The Nichol's Turk's head cactus usually reaches a maximum height of 10-12 inches with a width of six inches, but most that we have seen are smaller. We have measured an exceptionally large specimen to be 16 inches. In IFNM, the flower usually first appears in late April to early May after a rain with all cacti flowering at about the same time for 1-2 days. If no rain occurs in April-May, we have seen this cactus to flower later in the summer following a period of rainfall or after a heavy moonson rain storm. The delicate flowers with thin petals are bright reddish pink and 2-4 inches in diameter. The fruit is oblong and semi-dry. The numerous and tiny black seeds often roll down the ribs and often germinate at the base of the plant (see photo page 78).

These small cacti are certainly an iconic if not signature plant of IFNM.



Above: *Male desert bighorn sheep. (Joe Sheehey)*

Desert Bighorn Sheep

Ranging across the mountains of IFNM, this iconic animal is a subspecies (*Ovis canadensis mexicana*) of the North American bighorn sheep that occurs from southwestern Canada along the Rocky Mountains to northern Mexico. Endemic desert bighorn sheep populations have been extirpated in interior Arizona over the past 50 years, and many populations have been subject to reintroductions. The Silver Bell Mountain population in IFNM is the last endemic population of native bighorns that once ranged over the Santa Rita, Catalina, Tucson, and Rincon Mountains. This herd of about 80 sheep is down from about 120 animals that were present before an outbreak of bacterial pinkeye disease contracted from domestic animals in 2000-2002.

Desert bighorn sheep are robust animals standing up to almost 4 feet at the shoulder and weighing up to 190 pounds. Females are slightly smaller and have smaller horns. The horns of males can be 17 inches in diameter at the base and extend in a spiral to 40 inches tip to tip. Color varies from gray to dark brown with a distinctive white rump patch.

Desert bighorn sheep are adapted to survive in the rugged low mountains of the Sonoran Desert. Their double hooves (a character of the order Artiodactyla) are padded, allowing them to cling to amazingly steep cliffs away from potential predators such as the mountain lion, bobcat, or coyote. They are also well suited for long periods of dry conditions often going for weeks or months without drinking water and losing up to 30 per cent of their body weight during this time. They may supplement their usual diet of grasses, forbs, and bushes with cacti such as the barrel cactus which they break into with their horns. During the heat of the day they seek shelter in caves or crevices or under rock cliffs.

The mating season for our desert form extends for an unusually long period from July to December. Rams compete in head butting contests for access to ewes. Lambs are born in late winter, usually February after a gestation of 150-180 days. Most ewes produce one lamb but twins are not uncommon and up to four lambs are born occasionally. Hiking into the mountains during the lambing season, December through March, is strongly discouraged.

In IFNM, the desert bighorn is only infrequently observed. Consider yourself very lucky if you see one. They range over the Waterman, Silver Bell, Ragged Top, and West Silver Bell Mountains. If you hike to the top of any of these mountains, it is not unusual to see their hoof prints or pellets. These animals are an important and especially iconic member of the IFNM ecosystem.



Above: *Female desert bighorn sheep. (Robert Ashbaugh)*

Gila Woodpecker

Of the several common and important bird species, we have selected the Gila woodpecker (***Melanerpes uropygialis***) as the iconic bird because of its abundance in the dense saguaro forests. It is frequently heard from its perch atop a large cactus or seen darting from one saguaro to another in the typical undulating flight pattern



Right: *Gila woodpecker flying into saguaro nest hole. (Young Cage)*

of woodpeckers. Although these birds nest in a variety of trees in riparian areas, they clearly prefer saguaros. They are residents in IFNM throughout the year and do not migrate. The distribution of the species in the United States centers on the Sonoran

Desert, but it occurs in extremes of southwestern New Mexico, southern Nevada, and southeastern California. It is found southward in Mexico as far as Aguascalientes and Jalisco states.

The Gila woodpecker is 8-10 inches long with a stout blackish bill. The head, throat, breast, and neck are tan. The back and wings are barred with black and white and there is a white rump patch. There is a white wing patch in flight, and the male has a red cap on the top of the head.

Gila woodpeckers feed mostly on insects but also eat saguaro fruit and seeds as well as mistletoe berries. They build a nest cavity in saguaro pulp between the outer skin and the inner woody column. Nests, about 6-30 feet above ground depending on the size of the saguaro, are built a few months before the breeding season which allows time for the cavity to dry and form a callous tissue that makes a smooth seal on the inner surface. This cavity is about 10-15 inches deep and is used by a variety of birds after the woodpeckers have abandoned their nest. It is said that Gila woodpeckers tend to build a new nest the following season.

The breeding season usually starts in March and lasts into late June or early July. A clutch of 2-7 (but usually 3-5) eggs is attended by both parents. Eggs hatch in 12-14 days, and young birds fledge at about four weeks of age. A pair may raise two and occasionally three broods per year.

The Gila woodpecker is a delightful, if sometimes noisy, companion in the saguaro forest of IFNM.



Above: *Male Gila woodpecker. (Robert Ashbaugh)*

Sonoran Desert Tortoise

The Sonoran desert tortoise (*Gopherus morafkai*) is a quiet and infrequently seen gem in IFNM. But seeing one lumbering through the desert on its daily activities is an exciting sight not easily forgotten. This would also be a rare occasion because the desert tortoise spends about 95 per cent of its life in underground burrows which it digs with its powerful front claws. Desert tortoise populations east of the Colorado River and southward in Mexico to Sinaloa state have recently been designated as a new species distinct from populations in California and Nevada.



Above: *Sonoran desert tortoise. (Dr. Stefan Hertwig)*







Left: *Three Sonoran desert tortoises hibernating.*
Above top: *Sonoran desert tortoise.*
Above bottom: *Baby Sonoran desert tortoise. (All Young Cage)*

Desert tortoises are long-lived. Large adults in the wild may be 40-50 years old, but captive individuals have been observed to attain 70-80 years. These tortoises reach a length of 12-14 inches and weigh up to 15 pounds. Males, slightly larger than females, can be distinguished by a larger gular horn (a projection of the lower shell under the chin), a slightly concave plastron (lower shell), and a longer tail. Older individuals tend

Many friends and acquaintances have provided specific images with which they are identified in the captions. All of these photos were critically important, thanks. Allan Morgan, a professional photographer, must be singled out for his many excellent images that filled in major gaps essential to our coverage. Allan's support and dedication to the project are gratefully acknowledged. Gordon Hanson also provided many important and excellent images. For one or more important photos that have been used, thanks are due to Robert Ashbaugh, Jeff Babson, Lahsha Brown, Scott Cossel (Special Collections, University of Arizona), Jillian Cowles, Jay Eldredge, Martin Feldner, Dan Fischer, Dr. Kim Franklin, Dr. Hans-Werner Herrmann, Dr. Stefan Hertwig, Dr. James Platz, Ted Richardson, Sandy Rowley, Joe Sheehey, Dr. Ronnie Sidner, and Fred Wilson.

Many individuals have accompanied us on field trips to IFNM over the past few years. Each trip has invariably revealed new information and experiences and none of these trips could have been made without the company of friends and colleagues whose appreciation is acknowledged here. Gordon Hanson and Jay Eldredge have been frequent companions. Others who have made the trek on at least one occasion include Robert Ashbaugh, Gary Borax, Dr. Jon and Louise Burton, Bill and Carol Coburn, Wesley Cregg, Carol Eldredge, Dr. Kim Franklin, Brian Hallmark, Dr. Stefan Hertwig, Marianne and Bob Jackson, Gaile James, Mark Lambert, Dr. Karin Lilje, Jean Martin, Pat and Carol McDonald, Allan Morgan, Dr. Jim Platz, Dr. Jack and Jane Reamy, Roger Repp, Ted Richardson, Dr. John Scheuring, Bob Schmalzel, Audrey Sears, Dr. Bill and Carol Warren, and John Wiens.

Many staff members of the Tucson Sector of the Bureau of Land Management (BLM) have provided valuable assistance to us over the past few years. Their hard work and dedication to the management of IFNM are gratefully appreciated. We especially

disrupting its water balance. Desert tortoises store water in their bladder for use during long periods of dry weather. When they are picked up, they frequently discharge their bladder water as a defensive response. Loss of this water greatly jeopardizes their survival over the following weeks and months. So if you are fortunate enough to see one of these fascinating animals, take its picture but give it plenty of space. They are a true icon of IFNM.

A Note on Other Iconic Species

There are a number of other plants and animals that could be selected as iconic species. Among plants, important ones would include mesquite trees, jojoba bushes, cholla cacti (7 species), hedgehog cacti (3 species), barrel cacti (3 species), white ratany, brittlebush, and triangle leaf bursage. Among a number of herbaceous flowers should be mustards, lupines, Mexican gold poppies, Arizona jewel flower (a mustard), and desert zinnia among others.

Important animals might include tarantula spiders, centipedes, rattlesnakes (5 species), two herbivorous lizards (desert iguana and chuckwalla), bobcats, javelina, mule deer, and a number of insects especially ants and termites.

All of these plants and animals will be mentioned in subsequent sections.

Plant Life



Left. *Foothill paloverde in bloom. (Gordon Hanson)*

Plants are the single most important component in what we have referred to as the functional natural history of any self sustaining ecological system. Plants, in the process of photosynthesis, take energy from the sun in combining carbon dioxide and water to produce and store energy in simple organic compounds[1]. These simple sugars are modified in various metabolic

[1] There are living systems that are dependent on chemosynthesis rather than photosynthesis. The deep ocean system is one example.

pathways that add additional compounds, especially nitrogen, to form amino acids and subsequently proteins that make many of the constituent chemicals in living organisms. It is informative to know the kinds and characteristics of the plants of a specific area, but it is equally important to appreciate their vital importance to the desert landscape.

Most plants that are common in Ironwood Forest National Monument are typical representatives of the Sonoran Desert. Almost 600 different types or taxa of plants have been identified within the monument boundaries. The sunflower family (Asteraceae) has the most representatives, about 90. There are 82 species of grasses (Poaceae), 43 are cacti (Cactaceae), 36 are bean/pea relatives (Fabaceae), and 61 (about 10% of the total flora) are exotic, that is introduced non-native species. Non-native species frequently have a detrimental impact on a natural system by imposing new processes or new outcomes that disrupt those equilibrium events that have evolved over past millennia. Of these introduced species, only six seem to be widespread and aggressive, with buffelgrass being the most problematic (see section on "threats" page 242).



Above: *Mushroom. (RB)*

For our purposes, we divide plants into lower plants (including some forms that are not technically plants such as lichens and fungi as well as non-vascular types) and higher plants (those with vascular tissue) This approach will help the casual observer to locate and develop an appreciation for the diversity of plants in Ironwood Forest National Monument (IFNM).

Lower Plants

These are non-vascular plants. They lack special tissues to transport water and nutrients. They also lack true leaves and roots.

Fungi are not true plants but rather form a separate kingdom among the modern five kingdoms of life recognized by biologists. Thus fungi are comparable to plants

(kingdom Plantae) and animals (kingdom Animalia). Once considered a plant, fungi are actually more closely related to animals. Among other characteristics, fungus cell walls contain chitin, a chemical that forms the basis of exoskeletons in arthropods such as insects and centipedes rather than cellulose that is the basis of cell walls in plants. Also like animals, fungi are heterotrophic, feeding on other organic (living or dead) life forms instead of producing their food through a chemical process as do plants (autotrophic). It is estimated that there are some 1.5 million species of fungi in the world of which about sixty thousand have been officially described and named. Common fungus types include mushrooms, bracket fungi, molds, and yeast.

In the desert, fungi occur in association with plant roots (mycorrhizal fungi) and are important components of lichens and desert soils. They play a major decomposition role in the cycle of nutrients. We do not know of any studies of fungi in IFNM, but one should be aware of their importance to the desert ecosystem and on the lookout for their presence. Perhaps a future mycologist (scientist who studies fungi) will enhance our knowledge of fungi in IFNM.

Below: *Examples of lichens in IFNM. (All RB)*



Lichens, like fungi, are not true plants. They are a symbiotic association between a fungus and a green or blue-green alga species. Algae are autotrophic and produce food through photosynthesis, and the fungus absorbs water and nutrients as well as provides the structure for the associated species. We know of no studies of lichens in IFNM, but their presence is evident on rocks and trees throughout the monument. According to the 777 distributional maps of species given in Lichens of North America (2001), 116 (15%) of the lichen species could potentially occur in IFNM.

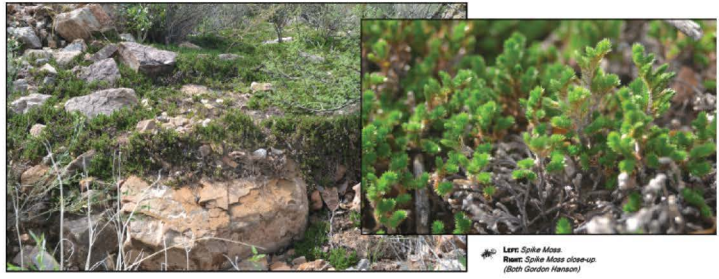
We have seen several common and distinctive lichens on rocks in IFNM including gray, green, and orange types (see photos). In IFNM, lichens occur most commonly on north and northeast facing surfaces of rocks and cliffs and rarely on south or southwest faces. Lichens also occur most commonly on igneous rocks rather than on sedimentary or conglomerate rocks.

Mosses are primitive green plants belonging to the phylum Bryophyta. These plants have no internal structures to transport water and nutrients. Thus they tend to be small, depend on simple diffusion, and usually live in moist environments. Nevertheless, they do occur in deserts and we have seen many examples of mosses in the IFNM but are unaware if these have been studied or identified.

Higher Plants

Botanists distinguish higher plants as those with internal vascular tissues capable of transporting water and nutrients from the soil to the stems and leaves. Higher plants include ferns, fern allies (like spike moss), Gymnosperms and Angiosperms.

Spike moss, a "moss-like" plant, *Selaginella*, occurs abundantly on the slopes of Ragged Top and other mountains in IFNM. This plant which was formerly classified as a bryophyte is called a spike moss (Phylum Lycophyta). It can remain dormant for many



Left: *Spike Moss.*
Right: *Spike Moss close-up.*
(Both Gordon Hanson)

months but develops quickly after winter or monsoon rains and can make the entire ground surface appear green (see photo). After a few days of dry weather, it quickly disappears from our notice. Mosses and spike mosses can withstand long periods of dryness and come to life seemingly overnight with the presence of rain.

In the desert, **ferns** are small vascular plants (phylum Filicinophyta, formerly Pteridophyta) that also appear after winter or summer moisture events. They tend to be larger than mosses because they do have internal tissues that transport water and nutrients and are thus vascular like higher flowering plants. However, they produce neither flowers nor seeds but rather reproduce by producing spores that are amazingly resistant to desiccation. Clusters of spore producing sporangia can often be seen on



Top Left: *Cochise scaly cloak fern. (Gordon Hanson)*
Top Middle: *Close up of fern sporangia on back of frond. (Gordon Hanson)*
Top Right: *Dried clumps of Cochise scaly cloak fern on hillside. (RB)*
Bottom Left: *Graceful lip fern. (Ted Richardson)*
Bottom Middle: *Spiny cliff brake. (RB)*
Bottom Right: *Star cloak fern. (RB)*

the underside of the "leaves" (actually fronds) of ferns. Ferns are usually found in damp and shady places but due to their larger size they may be apparent in a dried-up state (see photo). We observed large clumps of the **Cochise scaly cloak fern** (*Astrolepis cochisensis*) on the southeast facing slope of the Waterman Mountain, and have seen this species in several other localities throughout IFNM. We have also seen the **star cloak fern** (*Notholaena standleyi*) and **spiny cliff brake** (*Pellaea truncata*) on the slopes of Ragged Top Mountain in the range of 2400 feet elevation, and the **graceful lip fern** (*Cheilanthes yavapensis*) in shady areas near the summit of Ragged Top. Surveys by

John Wiens and associates of the Arizona-Sonora Desert Museum have recorded 7 additional species of ferns in IFNM including **Jones' false cloak fern** (*Argyrochosma jonesii*), **fairy sword** (*Cheilanthes lindheimeri*), **Pringle's lip fern** (*Cheilanthes villosa*), **Wright's lip fern** (*Cheilanthes wrightii*), and **goldback fern** (*Pentagramma triangularis*). The careful study of ferns of IFNM in terms of time and space of occurrence would be a rewarding endeavor for an energetic naturalist.

Gymnosperms are called the "naked seed" plants that produce seeds in a cone-like (usually) fruiting structure not as part of a flower as in true flowering plants (Angiosperms). Conifers such as pine, fir, and juniper are common types of gymnosperms (not a recognized phylum but several related plant phyla are included within gymnosperms). Unique among gymnosperms is the genus *Ephedra* (see photo) in the phylum Gnetophyta that occurs widely throughout the western United States. *Ephedra* is a scraggly shrub, 2-5 feet high and 3-6 feet in diameter. It has a network of practically leafless and brittle small branches resembling twigs (1.5 mm in diameter) that are green and photosynthetic. Plants are unisexual (dioecious) with male plants bearing pollen producing cones and female plants having ovule producing cones that appear in early spring, usually February-March. Native Americans used *Ephedra* for medicinal purposes and early settlers made a hot brew from the twigs giving the plant one of its common names, **Mormon tea**. Two species occur in IFNM including *Ephedra trifurca* and *Ephedra nevadensis*. *Ephedra trifurca*, sometimes called **Mexican tea**, has tiny leaves in threes at nodes and seeds in threes. The terminal twigs tend to be longer than in *Ephedra nevadensis* which is sometimes called **boundary tea**. It has paired leaves and seeds at the twig nodes. The twigs tend to be shortened, making the overall plant look bushier.



Top Left: *Ephedra plant serving as a nurse plant to a saguaro. (Gordon Hanson)*
Top Right: *Ephedra being examined by John Wiens. (RB)*
Bottom Left: *Ephedra closeup of female cone. (Gordon Hanson)*
Bottom Right: *Ephedra closeup of male cone. (RB)*

The remaining plants in Ironwood Forest National Monument (IFNM) belong to the phylum Anthophyta (formerly Angiospermophyta) and are commonly called **angiosperms.** They are characterized by the presence of flowers and seed bearing fruits that develop from the female flower (or flower part). Male and female flowers may be in a single structure (perfect flower) or separated into two different flower structures. Some plants have only one sexual flower type on a plant whereas others

may have both. Plants having both male and female flowers are said to be monoecious (one sex) whereas plants with sexes on separate plants are dioecious (two sexes). The **jojoba bush** in IFNM is a good example of a dioecious species (see page 86). For organizational purposes we group the higher plants into general growth form groups.

Cactus plants

Among the most fascinating desert plants, cacti belong to a single family, the Cactaceae. With the exception of a single genus (*Rhipsalis*) found in Africa, Madagascar, and Sri Lanka, all members of the family are native to the New World. Although they occur in a variety of habitats, they are especially abundant and adapted to the desert environment. The fleshy succulent stems store water, and their green stems conduct photosynthesis using the CAM mechanism as described for the **saguaro** (see page 43).



Left: *Crested saguaro east of Ragged Top.*
Right: *This unusual saguaro has over 80 arms.*
(Both Gordon Hanson)

Briefly, CAM (crassulacean acid metabolism) restricts uptake of carbon dioxide and discharge of oxygen to night hours, thus reducing water loss. Desert cacti lack prominent leaves found in some tropical cacti, but most have spines that represent highly modified leaves. Spines, and usually flowers, originate from patches of special tissue called areoles that are unique to cacti. Cactus flowers are usually large and conspicuous with bright colors of yellow, white, or red depending on species. The flowers have both female and male components, and the fruits are often large. The fruits are eaten by many animals.



Above. *Organ pipe cactus near southern border of IFNM in Roskruge Mountains. (RB)*

There are 26 native species of cacti and two exotic or introduced species in IFNM. In addition, several of the **cholla** and **prickly pear** species hybridize easily thus producing several intermediate types. The most prominent cactus, the iconic saguaro (*Carnegiea gigantea*) was described previously (see page 41). The plural for cactus is cacti (Latin base) or cactuses (English based)

Organ pipe cactus (*Stenocereus thurberi*) occurs abundantly farther west in the Sonoran Desert, but is represented by one large specimen in the Roskruge Mountains of IFNM. This species has multiple stems that originate at the base of the plant. It can reach a height of 20 feet or more. Its stems are about eight inches in diameter with 12-20 ribs. Flowers appear in early summer (May-June) and are white to pale lavender. They open at night and bats are the principal pollinator. The fruits are spherical and said to be among the sweetest of any cactus. Indigenous peoples used the fruits extensively including drying them for winter use.

Barrel cacti are usually large, column-shaped unbranched plants bearing many spines from areoles along the many ribs. These plants flower during the day and are pollinated primarily by bees. The fruits are edible, but not tasty, and are eaten by a number of birds and mammals. Two species of barrel cacti are common in IFNM.



Top Left: *Fishhook barrel cactus with red flowers. (RB)*
Top Middle: *Spiny barrel cactus. (Gordon Hanson)*
Top Right: *Dr. Karin Lilje by large fishhook barrel cactus north of Ragged Top. (RB)*
Bottom Left: *Orange flowers on fishook barrel cactus. (Gordon Hanson)*
Top Right: *Mature fruit of fishhook barrel cactus. (RB)*

These are the **fishhook barrel cactus** (*Ferocactus wislizeni*) and the **spiny barrel cactus** (*Ferocactus cylindraceus*). The fishhook barrel is usually 2-4 feet tall and 10-14 inches in diameter, but some have been reported to reach 10 feet high. This cactus has strongly hooked central spines and several radial spines for each areole but these do

not obscure the main stem. Flowers are produced in August and September and vary in color from red to orange and yellow. The yellow fruits look like miniature cacti and may remain on the top of the plant for months before being eaten by animals. The spiny barrel tends to be slightly thinner (10-12 inches) and somewhat taller (to 10 feet) than



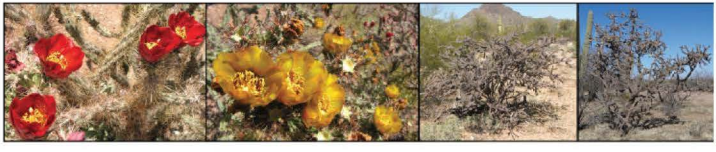
Top Left: *Teddy-bear cholla on Waterman Mtn. ridge.*
Top Right: *Chain-fruit cholla.*
Bottom Left: *Gordon Hanson standing by mature chain-fruit cholla.*
Bottom Right: *Flower of chain-fruit cholla. (All RB)*

the fishhook barrel. Its spines are so dense that they tend to obscure the body of the cactus. The central spine is long, stiff, and slightly curved but not hooked. Spines may be yellow, brown, or red. Flowers usually appear in late spring and are typically yellow.

Cholla and Prickly pear cacti: These unique cacti are unusual in the way they grow. They grow in distinctly jointed segments. Unlike most cacti that grow continuously from their upper growing tips (the apical meristem), these cactuses grow by adding new stem segments at the beginning of the growing season. The segments usually originate from an areole as do the flowers and spines. Prickly pear cacti (genus *Opuntia*) have flattened stems called pads. In addition, *Opuntia* have tiny hair-like, barbed spines called glochids on the areoles. These glochids are easily detached and embedded in your skin on contact and are irritatingly painful and difficult to remove. Cholla (genus *Cylindropuntia*) has cylindrical stem segments. Although cholla is not ribbed, these cacti have variously knobby (tubercled) rather than smooth surfaces.

Cholla (name is derived from its Spanish origin so the double "ll" is pronounced like a "y", as in you) is a single-stalked bush sized cactus of many cylindrical spiny stems (usually 1.5 to 2 inches in diameter) stacked and branching on top of earlier stems. Typical sizes are 3-5 feet but some species can reach 10-12 feet or more in height.

Left: *Buckhorn cholla with red flowers.*
Middle Left: *Buckhorn cholla, close-up of yellow variant.*
Middle Right: *Staghorn cholla.*
Right: *Cane cholla. (All RB)*



There are seven species of cholla in IFNM but several of these hybridize so many intermediate types are common. The **teddy-bear cholla** (*Cylindropuntia bigelovii*) is a distinctive form that typically occurs on higher, rocky slopes. It has the greatest density of spines compared to other cholla thus appearing to have a fuzzy, straw colored stem. The growing stem at the top of the plant may be green but the spines quickly hide the lower stem's color. Older and lower branches become dark brown to black as they appear to die and eventually fall off the plant. Joints detach easily (as occurs in many cholla species) and root quickly to create dense thickets on steep hillsides. These plants can reach nine feet but are usually 3-5 feet tall. Flowers, green to yellow streaked with lavender, are 1.5 inches wide and appear in spring (February-May). The **chain-fruit cholla** (*Cylindropuntia fulgida*) is an impressive, almost tree-like species that can reach 15 feet tall and is usually on lower slopes and at the base of bajadas. These very spiny plants have a grayish green color and distinctive long chains of fruit from several years of flowers that hang down at the ends of branches. The flowers are small (pink), rarely produce fertile seeds, and appear in May-July. Reproduction is usually vegetative by segments or fruits that fall off and sprout roots to form a new plant. Sometimes this



Left: *Fruit of cane cholla.*
Right: *Pencil cholla. (Both RB)*

species is referred to as the jumping cholla (other species acquire this name as well) due to the character of segments often sticking to a passing person as if it jumped. This large species is a favorite site for bird nests, especially cactus wrens and curve-billed thrashers. **Buckhorn cholla** (*Cylindropuntia acanthocarpa*) and **staghorn cholla** (*Cylindropuntia versicolor*) are very similar and quite variable in appearance. Staghorn cholla occurs in IFNM only in the Roskruge Mountains and the buckhorn cholla occurs elsewhere in IFNM. The stems of these species vary from green to reddish to purple in color. Buckhorn cholla is shrubby from 3-6 feet tall. Flower color varies from yellow to copper/orange, wine or red. **Cane cholla** (*Cylindropuntia spinosior*) is a shrubby species with green to bluish green stems and much shorter but numerous spines to three quarters of a inch long. Its vibrant magenta flowers appear in late spring (May-June) and produce a wrinkled, yellow fruit that persists through the winter. **Pencil cholla** (*Cylindropuntia arbuscula*) is generally a smaller, shrubby species, but they have been seen to reach as high as 15 feet. Their stems are only about half (to one half inch) the diameter of most cholla with fewer spines such that the green to bluish green smooth



Left: *Desert Christmas cholla, note red fruit.*
Right: *Devils club cholla. (Both RB)*

stem is clearly evident. Flowers (yellow to greenish or brownish red) appear in May-June. The pear-shaped fruits (green turning purplish) may persist through the winter. **Desert Christmas cholla** (*Cylindropuntia leptocaulis*) is a small species (to three feet except taller and vine-like if growing at the base of a desert tree) with dark green stems less than a half inch in diameter. The flower (May-June) is greenish yellow, and a tiny, egg-shaped red fruit persists through the winter. A final cholla sometimes included in *Cylindropuntia* by some authors is the **desert club cholla** or **devil cholla** (*Grusonia kunzei*). Rather than upright like other cholla, this species grows in spreading mats along sandy ground, reaching no more that 6-8 inches tall. Its segments are covered with many spines up to two inches long and its flowers in late spring are whitish yellow. In IFNM, this species is found on the sand dune area west of the Sawtooth Mountains as well as scattered on bajadas on the south and southeast sides of this range.

Below *Arizona queen of the night. (Young Ogle)*



Arizona queen of the night cactus

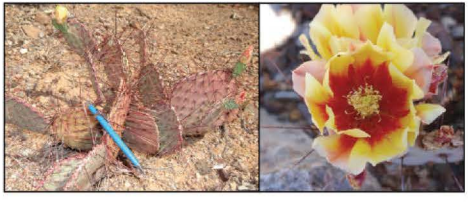
This is a special cactus whose growth form resembles a cholla but its large flower with many petals is very distinctive. This cactus, known by several names including **desert night-blooming cereus** (*Peniocereus greggii*), is a folk hero among plants in the Sonoran Desert because of its spectacular blooming habit. For most of its life it is obscure, mingled among underbrush of trees and shrubs with its squarish stems being prostrate or vine-like. But on one or two nights usually in June, its magnificently large and fragrant flower appears and is pollinated by moths. All flowers in a single population usually bloom on the same nights. When daylight appears the flower wilts away to make the cactus again almost invisible. Another of its unusual features is its root, a large turnip- shaped tuber that is said to weigh as much as 40 pounds. Its stems are not heavily spined and subject to being eaten by pack rats, beetles, and other herbivores, but new shoots can be produced readily from reserve energy stored in the tuberous root.

Prickly Pear Cacti are named because of their large fruits that are widely eaten. In Mexico these are called tuna, but are often called pears in the southwestern United States where they appear in many grocery stores. These fruits are sweet to tart and can be eaten directly or used to make jellies and drinks. They were a staple of the indigenous population. Their circular-shaped pads vary from four to ten inches in diameter and some horticultural varieties approach two feet in diameter. The pads have spines of



Top Left: *Sprawling prickly pear.*
Top Right: *Engelmann's prickly pear; note new pads with leaves.*
Bottom Left: *Engelmann's prickly pear, flower close-up.*
Bottom Right: *Fruits of Engelmann's prickly pear.*
(All RB)

various lengths depending on species as well as glochids mentioned earlier. Prickly pear lack leaves except in the very early stage of pad development when pads have tiny, fleshy leaves. There are four species of prickly pear cactuses occurring naturally in IFNM and another two species have been introduced. Three of the species hybridize among themselves easily so some populations contain intermediate types that are not easily distinguished as to species. The **sprawling prickly pear** (*Opuntia phaeacantha*) and **Engelmann's prickly pear** (*Opuntia engelmannii*) appear to be the most common and widespread types in IFNM. The sprawling prickly pear tends to form wide spreading clumps with series of pads extending along the ground at a height usually less than two feet. The flowers are yellow with red petal bases, and the pads appear yellowish green. In IFNM this species is uncommon in its purest form, but its hybrids with Engelmann's prickly pear are very common and taller, to about three feet. Engelmann's prickly pear tends to be bluish green and reaches greater heights (to 5-6 feet). Its flowers are yellow although hybrids have orange at the base of the petals. Both species have large fruit that ripen to a bright or deep red, but that of the sprawling prickly pear tends to



Left: *Long-spinned prickly pear, blue part of pencil is four inches.*
Right: *Flower of long-spinned prickly pear.*
(Both RB)

John Wiens and associates of the Arizona-Sonora Desert Museum have recorded 7 additional species of ferns in IFNM including **Jones' false cloak fern** (*Argyrochosma jonesii*), **fairy sword** (*Cheilanthes lindheimeri*), **Pringle's lip fern** (*Cheilanthes villosa*), **Wright's lip fern** (*Cheilanthes wrightii*), and **goldback fern** (*Pentagramma triangularis*). The careful study of ferns of IFNM in terms of time and space of occurrence would be a rewarding endeavor for an energetic naturalist.

Gymnosperms are called the "naked seed" plants that produce seeds in a cone-like (usually) fruiting structure not as part of a flower as in true flowering plants (Angiosperms). Conifers such as pine, fir, and juniper are common types of gymnosperms (not a recognized phylum but several related plant phyla are included within gymnosperms). Unique among gymnosperms is the genus *Ephedra* (see photo) in the phylum Gnetophyta that occurs widely throughout the western United States. *Ephedra* is a scraggly shrub, 2-5 feet high and 3-6 feet in diameter. It has a network of practically leafless and brittle small branches resembling twigs (1.5 mm in diameter) that are green and photosynthetic. Plants are unisexual (dioecious) with male plants bearing pollen producing cones and female plants having ovule producing cones that appear in early spring, usually February-March. Native Americans used *Ephedra* for medicinal purposes and early settlers made a hot brew from the twigs giving the plant one of its common names, **Mormon tea**. Two species occur in IFNM including *Ephedra trifurca* and *Ephedra nevadensis*. *Ephedra trifurca*, sometimes called **Mexican tea**, has tiny leaves in threes at nodes and seeds in threes. The terminal twigs tend to be longer than in *Ephedra nevadensis* which is sometimes called **boundary tea**. It has paired leaves and seeds at the twig nodes. The twigs tend to be shortened, making the overall plant look bushier.



Top Left: *Strawberry hedgehog cactus.*
Top Middle: *Robust hedgehog cactus.*
Top Right: *Golden hedgehog cactus.*
Bottom Left: *Flower of robust hedgehog.*
Bottom Right: *Flower of golden hedgehog. (All RB)*

These cacti occur on the upper rocky slopes of mountains and their lower distribution overlaps with the robust hedgehog on the northwest aspect of Ragged Top and the Waterman Mountains.

Pincushion cacti are normally much smaller than other cacti discussed above. They form clusters of stems that rarely exceed a dozen in number and 6-8 inches in height. These cacti belong to a large and diverse genus (*Mammillaria*) of over 170

species that are distributed from the southwestern United States to South America. The unique feature of the genus is the split nature of the areole which is borne on the tips of raised tubercles on the sides of the stems. The upper part of the areole bears the spines and the base of the areole bears the flower and fruit. There are three species in IFNM. The **Arizona fishhook pincushion** (*Mammillaria grahamii*) is most likely encountered. The **common fishhook pincushion** (*Mammillaria tetrancistra*) is also known as the corky-seed pincushion due to its black seeds having a brownish corky base. Both species have dark brown central spines of which at least one per areole is hooked in *M. grahamii* but typically more than one in *M. tetrancistra*. The radial spines are white in both species and larger in *M. tetrancistra* almost obscuring the green stem compared to the shorter radial spines of the *Mammillaria grahamii*. The flowers in the common fishhook pincushion are rosey pink (1.5 inches wide) and darker pink to wine and larger (to 2 inches wide) in the Arizona fishhook pincushion.

Left: *Arizona pincushion with fruit.*
Middle: *Flowers of Arizona pincushion.*
Right: *Thornber's pincushion.*
(All Gordon Hanson)



This species occurs broadly across IFNM and tends to reach higher elevations than the common fishhook, but the common fishhook pincushion is rare and occurs in the Sawtooth Mountains. Another field identification character concerns the nature of the stem when lightly pressed with a stick or stone: the common fishhook appears soft and flabby whereas the side of the Arizona fishhook is firm. The third species, **Thornber's fishhook pincushion** (*Mammillaria thornberi*) is not as common as *M. grahamii* but is readily found in IFNM on lower bajadas of the Roskruge Mountains and along the edge of Avra Valley to the Samaniego Hills. The dark central spine is hooked, but its base is tan and the radial spines are much shorter with the tubercles clearly evident on the green stem. Thornber's fishhook pincushion tends to have smaller diameter stems and a habit of clumping at the base. The flowers are white tipped with rose colored centers. Pincushions may flower beginning in late spring but especially after summer rains.

The **Nichol's turk's head cactus** (*Echinocactus horizonthalonius* var. *nicholii*) was previously discussed (see page 46).

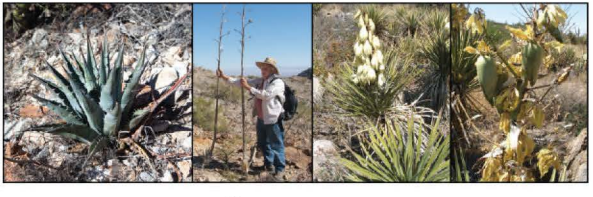


Left: *Nichol's turk's head cactus flower.*
Right: *Nichol's turk's head cactus with three young plants and thorns from a dead plant.*
(Both Gordon Hanson)

Century plants and yucca

Three species of the family Asparagaceae (formerly Agavaceae) occur naturally in IFNM. These are typical plants of the southwestern deserts that have a basal rosette of rigid leaves with a tall central flowering stem. ***Agave deserti*** (**desert century plant**) is distributed westward to California and northwestern Mexico. In Arizona, it occurs on rocky slopes of dry desert mountains with its eastern most population in the Waterman Mountains of IFNM. As with most other *Agave* the rosette of this plant dies after flowering which can take as much as 30-100 years, usually 25-30 for this species. ***Agave deserti*** is a relatively small species with spine-tipped leaves reaching 8-18 inches long and 2-3 inches wide. The grayish-green leaves, sometimes transversely banded, have teeth along their margins. The flower stalks reach heights of 6-15 feet with flower branches (paniculate type) on the upper quarter of the stalk. The yellow flowers are pollinated by insects, bats, and birds that feed on the nectar and pollen of the flowers. The plant also reproduces from shoots at its base. The center of the plant was roasted in pits and eaten by native peoples.

Left: *Desert century plant. (Young Cage)*
Middle Left: *Bob Schmaltz holding two old flowering stalks of desert century plant. (RB)*
Middle Right: *Arizona yucca in bloom. (RB)*
Right: *Arizona yucca with fruit. (RB)*



Many friends and acquaintances have provided specific images with which they are identified in the captions. All of these photos were critically important, thanks. Allan Morgan, a professional photographer, must be singled out for his many excellent images that filled in major gaps essential to our coverage. Allan's support and dedication to the project are gratefully acknowledged. Gordon Hanson also provided many important and excellent images. For one or more important photos that have been used, thanks are due to Robert Ashbaugh, Jeff Babson, Lahsha Brown, Scott Cossel (Special Collections, University of Arizona), Jillian Cowles, Jay Eldredge, Martin Feldner, Dan Fischer, Dr. Kim Franklin, Dr. Hans-Werner Herrmann, Dr. Stefan Hertwig, Dr. James Platz, Ted Richardson, Sandy Rowley, Joe Sheehey, Dr. Ronnie Sidner, and Fred Wilson.

Many individuals have accompanied us on field trips to IFNM over the past few years. Each trip has invariably revealed new information and experiences and none of these trips could have been made without the company of friends and colleagues whose appreciation is acknowledged here. Gordon Hanson and Jay Eldredge have been frequent companions. Others who have made the trek on at least one occasion include Robert Ashbaugh, Gary Borax, Dr. Jon and Louise Burton, Bill and Carol Coburn, Wesley Cregg, Carol Eldredge, Dr. Kim Franklin, Brian Hallmark, Dr. Stefan Hertwig, Marianne and Bob Jackson, Gaile James, Mark Lambert, Dr. Karin Lilje, Jean Martin, Pat and Carol McDonald, Allan Morgan, Dr. Jim Platz, Dr. Jack and Jane Reamy, Roger Repp, Ted Richardson, Dr. John Scheuring, Bob Schmalzel, Audrey Sears, Dr. Bill and Carol Warren, and John Wiens.

Many staff members of the Tucson Sector of the Bureau of Land Management (BLM) have provided valuable assistance to us over the past few years. Their hard work and dedication to the management of IFNM are gratefully appreciated. We especially

3-4 feet. The flower stalks are only 3-4 feet tall with densely packed white flowers that are also pollinated by a yucca moth. The fruit of *Yucca baccata* var. *brevifolia* is large and fleshy. It does not split open but rather drops to the ground. The seeds are large, heavy, and about the size of a corn kernel.

Trees and shrubs

This is an arbitrary grouping of plants intended to include the larger, perennial, and woody angiosperms, especially those that might be noticed on a first visit to IFNM. Of course these plants gradually grade into species that are smaller shrubs that a casual observer might rather call a flower. For example, the ubiquitous **brittlebush** is a perennial plant that forms a low shrub, but its large display of yellow flowers in early spring obscure its shrub-like characteristics so we have arbitrarily placed it in the next section on wildflowers.

We have previously discussed the **paloverdes** (see page 44) and **desert ironwood trees** (see page 40) that comprise the dominant tree types. Among the other larger trees include the **velvet mesquite** (*Prosopis velutina*) that is distributed across southern

Left: *Gordon Hanson by velvet mesquite.*
Middle: *Mesquite flowers.*
Right: *Mesquite fruit/beans. (All RB)*



Arizona and southward into Sonora, Mexico. The technical name varies with author and is currently called *Prosopis juliflora* var. *velutina*. This tree reaches heights of 30 feet with trunk diameters to two feet, but it is usually much smaller. It is common in the lower bajadas and washes in IFNM. The leaves are bipinnately compound with small ovate leaflets to 1.3 cm long and covered by short, fuzzy pubescent hairs as seen with a magnifying glass. Flowers are tiny, yellow to white, arranged in creamy yellow spikes to four inches long and one-half inch in diameter. Flowering occurs in late spring (April-May) and again in July to August. Fruit is a long (to eight inches) bean. The fragrant flowers attract bees in large numbers. A sweet-tasting meal ground from the entire pod was a staple food of the indigenous people. This is the only mesquite in IFNM but can be distinguished from other mesquite in the southwest (except for foreign cultivars) by the velvety surfaces of its leaves created by the tiny pubescent hairs.

Two other trees in IFNM are the **crucifixion thorn** (*Canotia holacantha*) and the **elephant tree** (*Bursera microphylla*). Both of these trees occur as distributional relicts in IFNM in the Waterman Mountains. *Canotia* is one of several desert plants with

Left: *Gaile James examining elephant trees in Waterman Mountains. (RB)*
Middle: *Crucifixion thorn, Canotia, bush in Waterman Mtns. (RB)*
Right: *Flower of Canotia. (Gordon Hanson)*





the common name of crucifixion thorn owing to its leafless, thorny stems. The yellow green stems accomplish photosynthesis and minimize water loss. These plants can reach heights of 18 feet with trunk diameters of eight inches. Its small yellow flowers presumably appear May-August (we have observed flowers in IFNM on 11 September). and fruits are a woody capsule. *Canotia* is much more common in central (near Globe) to northwestern Arizona (near Wickieup). The elephant tree is near its northeastern distributional limit and occurs on dry desert mountains southward to Sonora and Baja California where many more related species of the torchwood family are found. It is

Left: *Catclaw Acacia greggii. (RB)*
Middle: *Close-up of flower of catclaw acacia. (RB)*
Right: *White-thorn acacia: flower, early fruit, thorns. (Dr. James Platz)*



characterized by its reddish brown twigs and sprawling habit (to 20 feet) with many limbs originating near its base (due to continual frost damage, otherwise it would be an upright tree). The trunk (to one foot) and lower branches have a papery bark that peels away. Its fragrant leaves and stems smell of camphor from the copal resin that is used as an incense in Mexican churches. Frankencence and myrrh originate from resins of

two torchwood relatives in the deserts of the Middle East. The pinnately compound leaves have leaflets to one inch long and the whitish flower is tiny (to one quarter inch). It blooms in July. It has a low tolerance for cold (under 21° F). The winter of 2010-2011 killed most plants in IFNM back to their base, but by November, 2011, new green shoots were evident (see photo).

Three related *Acacia* occur in IFNM, of which the following two are very common.[1] The **catclaw acacia** (*Acacia greggii*) reaches heights of 20 feet along washes but is a smaller shrub on mountain slopes. It has numerous cat-claw shaped spines and three-inch long, bipinnately compound, grayish-green leaves. Its cylindrical flower clusters are whitish-yellow spikes to three inches long and very fragrant. These produce flattened and twisted bean-shaped pods that reach six inches long. The **white-thorn acacia** (*Acacia constricta*) is usually a smaller bush, occasionally to ten feet high, distinguished by its numerous white thorns that are paired at the stem nodes. The light green leaves are deciduous in the winter. The stems are noticeably reddish-brown as opposed to

Left: *Fairy duster plant.*
Middle Left: *Fairy duster red flower close-up.*
Middle Right: *Fairy duster white/green flower close-up.*
Right: *Fairy duster mature beans/fruit opened. (All RB)*

[1] **Recent taxonomic changes include** *Acacia greggii* **is now** *Senegalia greggii*; *Acacia constricta* = *Vachellia constricta*.



silvery-gray for *Acacia greggii*. Flowers appearing in May through August are fragrant yellowish orange globes to one-half inch in diameter. Flowers produce a 3-5 inch long bean pod that turns from a bright red to a reddish brown color as they mature. The pods are flattened and constricted between the seeds. Another *Acacia*-like plant is the **fairy duster** (*Calliandra eriophylla*) which is one of the earliest plants to bloom in IFNM, often in January. It is a thinly spreading, thorn-less shrub with *Acacia*-like leaves and a puffball pink (occasionally red or white) flower (1-2 inches in diameter). It also flowers in other seasons in response to rain. The two inch long seed (bean) pods split open when ripe and the halves of the bean pod remain for a long period of time.

Although there are a dozen species of **oak trees** in Arizona, only a few bushes of the **desert scrub oak** (*Quercus turbinella*) occur in IFNM near the top of Ragged Top Mountain. This species which can reach a height of over ten feet has a holly-like leaf. Its separate male and female flowers occur on the same plant and appear in the spring. The fruit is a typical acorn variety to three-quarters of an inch long. These trees usually occur at elevations above 4,500 feet, so the few on Ragged Top are remnants of an earlier and wetter climate.

The **creosotebush** (*Larrea divaricata* var. *tridentata*) is the most widespread evergreen shrub of the southern flatland deserts of North America. Its green foliage adds a special smell to the desert especially after rain storms. Although the creosotebush may have a pungent aromatic odor resembling creosote wood preservative, the shrub is not the source of the petroleum-based oil product that is used as a wood preservative. The creosotebush is among the most drought-tolerant plants in the desert but their cold sensitivity keeps them out of the northern deserts. Branches spread from a common base and can reach ten feet tall but are usually less than four feet except in areas of abundant drainage. The yellow flowers appear in late winter or early spring (February-

Top: *Creosotebush stand in southern IFNM, Avra Valley. (RB)*
Bottom: *Flowers and fruit of Larrea. (Jay Eldredge)*





March) and the globe shaped, fuzzy white fruits follow by late April or early May. It is said that over 60 species of insects are associated with the creosotebush including as many as 22 species of bees, of which some occur only on creosote. This is one of the longest lived plants in the desert. One study in the California desert discovered creosote plants to be as much as 11,000 years old. These old plants form ring-like clumps that may be several tens of feet in diameter. The larger the diameter of the ring, the older is the plant. Some smaller ring-like clones of creosotebush do occur within Avra Valley and some of these clones range from 10 to 15 feet in diameter. Native peoples used creosotebush in many medicinal ways including the treatment of respiratory ailments (vapors or tea made from the boiled leaves), as an antibacterial agent for cuts and abrasions, and to relieve aches and pain of rheumatism.



Left: *Darker green jojoba bushes in foreground. (Jay Belnadje)*
Middle: *Green, newly developed jojoba fruit. (RB)*
Right: Ripe, opening jojoba fruit. (RB)

The **jojoba bush** (*Simmondsia chinensis*) is a robust, evergreen shrub reaching seven feet tall although it is usually 2-5 feet tall. Its thick foliage of leathery green to grayish green leaves provide a stark contrast to the brown colors of the desert. It is common on upper rocky slopes and in washes in IFNM from Ragged Top southward. It forms a large chaparral thicket on the north slope of Silver Bell Mountain. The tiny

greenish yellow flowers usually appear in January-February and produce an acorn-like fruit by March which turns from green to brown as it matures by late spring. Male and female flowers appear on separate plants. The fruit was used by Native Americans and early settlers as a food and coffee substitute. The oil from the seeds is used in medicines and cosmetics and as fine machine oil. The plant is one of the few desert plants to have been cultivated commercially.



Left: *Stand of leafless ocotillo in Waterman Mtns.* **Middle**: *Ocotillo flowers.* **Right**: *Ocotillo with leaves. (All RB)*

Ocotillo (*Fouquieria splendens*) is a uniquely desert shrub with straight spiny branches that can reach to 20 feet tall. They occur on rocky well drained soils and respond to rain events by rapidly producing leaves on the slender branches. For most of the year the branches are leafless. Bright red flowers appear at the tips of branches in early March and usually again after summer rains. The tubular red flowers are a favorite nectar source for hummingbirds. For most of the year the branches are leafless.

Several species of small to medium sized shrubs represent some of the most abundant plant species that are commonly encountered in IFNM. Though perhaps nondescript and unimpressive, each species plays an important role in the Sonoran Desert of IFNM. The **canyon ragweed** (*Ambrosia ambrosioides*) is common along canyon



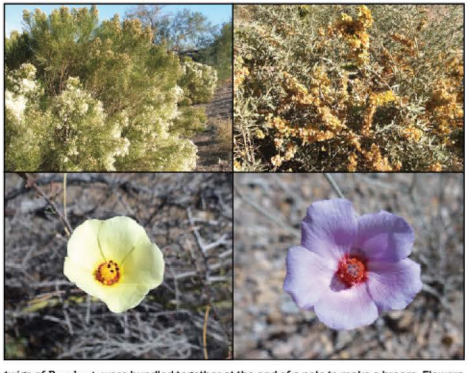
Top Left: *Canyon ragweed. (RB)*
Top Right: *Triangleleaf bursage with fruit. (RB)*
Bottom Left: *Jay Eldridge photographing white ratany. (RB)*
Bottom Right: *Flower of white ratany. (Jay Eldredge)*

and sandy washes. It is conspicuous by the presence of large, dark green leaves (to five inches long) and forms a five to six feet high bush with broadly spreading branches. Its tiny yellowish green flowers appear in early spring (February to March). Its spiny fruit (bur) is dispersed by clinging to the fur of passing mammals. Like other shrubs, canyon ragweed serves as a nurse plant as well as to collect debris and sand in soil production. The large leaves were used in sweat baths as a treatment for arthritis by indigenous peoples. The **triangleleaf bursage** (*Ambrosia deltoidea*) is a densely

John Wiens and associates of the Arizona-Sonora Desert Museum have recorded 7 additional species of ferns in IFNM including **Jones' false cloak fern** (*Argyrochosma jonesii*), **fairy sword** (*Cheilanthes lindheimeri*), **Pringle's lip fern** (*Cheilanthes villosa*), **Wright's lip fern** (*Cheilanthes wrightii*), and **goldback fern** (*Pentagramma triangularis*). The careful study of ferns of IFNM in terms of time and space of occurrence would be a rewarding endeavor for an energetic naturalist.

Gymnosperms are called the "naked seed" plants that produce seeds in a cone-like (usually) fruiting structure not as part of a flower as in true flowering plants (Angiosperms). Conifers such as pine, fir, and juniper are common types of gymnosperms (not a recognized phylum but several related plant phyla are included within gymnosperms). Unique among gymnosperms is the genus *Ephedra* (see photo) in the phylum Gnetophyta that occurs widely throughout the western United States. *Ephedra* is a scraggly shrub, 2-5 feet high and 3-6 feet in diameter. It has a network of practically leafless and brittle small branches resembling twigs (1.5 mm in diameter) that are green and photosynthetic. Plants are unisexual (dioecious) with male plants bearing pollen producing cones and female plants having ovule producing cones that appear in early spring, usually February-March. Native Americans used *Ephedra* for medicinal purposes and early settlers made a hot brew from the twigs giving the plant one of its common names, **Mormon tea**. Two species occur in IFNM including *Ephedra trifurca* and *Ephedra nevadensis*. *Ephedra trifurca*, sometimes called **Mexican tea**, has tiny leaves in threes at nodes and seeds in threes. The terminal twigs tend to be longer than in *Ephedra nevadensis* which is sometimes called **boundary tea**. It has paired leaves and seeds at the twig nodes. The twigs tend to be shortened, making the overall plant look bushier.

Desert broom (*Baccharis sarothroides*) has the same growth form and flower structure as seep willow but is a smaller plant and blooms in the fall. The thin terminal



Top Left: *Seep willow alongside road.*
Top Right: *Fourwing saltbush with mature fruit.*
Bottom Left: *Desert rose mallow.*
Bottom Right: *Rock hibiscus. (All RB)*

twigs of *Baccharis* were bundled together at the end of a pole to make a broom. Flowers of these plants attract butterflies and other insects. They have seeds with white tassels that are distributed by the wind, facilitating their role as a pioneer plant invading bare

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Top Left: *Limber bush, black handle of snake stick is 30 inches. (RB)*
Top Middle: *Heart-shaped leaf of limber bush. (Gordon Hanson)*
Top Right: *Chuparosa. (RB)*
Bottom Left: *Wolfberry with fruit. (RB)*
Bottom Middle: *Desert Hackberry. (RB)*
Bottom Right: *Gray thorn showing young fruits developing. (Gordon Hanson)*

at 1800 to 3000 feet. Its red tubular flowers appear in January-February and are a favorite source of food of hummingbirds. The flowers, which may appear throughout the year, were eaten as a salad by native peoples. Try some and see if they taste like cucumbers.

Finally, there are three common shrubs frequently encountered on trails and along ravines that should be familiar to most hikers. The **spiny wolfberry** of the genus *Lycium* is a shrub to six feet high. The leaves are generally small such that the thin stems are noticeably perpendicular to the main stem. These plants flower in early spring (February-March) and produce a berry that ripens to a bright red color. The berry is tasty and a favorite food of wildlife. Seven species of *Lycium* have been recorded in IFNM, and the slight distinctions between species makes it difficult to know which species

is the most common without careful study. The **desert hackberry** (*Celtis pallida*) is an evergreen shrub that may reach to ten feet high. Its dark green leaves hide the zig-zag terminal branches and many thorns. Its small summer flowers attract an abundance of butterflies. The dense foliage makes a good cover for Gambel's quail and rabbits where it occurs on slopes and in open areas along bajadas. **Gray thorn** (*Ziziphus obtusifolia*), a very thorny shrub (to six feet tall) has gray bark. The tiny flowers and leaves are quickly deciduous. Thorns are 1-3 inches long and we have observed fruit by early April so flowering in IFNM may occur in early March although some references give May-September. The berries are eaten by birds, and indigenous peoples used roots of gray thorn as a soap substitute.

Another small shrub that will be commonly encountered is **Coulter's brickellbush** (*Brickellia coulteri*). This is a roundish shrub with brownish, hairy, brittle, and sticky stems. It has triangular light green leaves. Its yellowish green, rayless flowers (sunflower family) appear in loose terminal clusters from March-November in canyons with rocky, dry slopes.

Wildflowers

Here we provide information on some of the plants that have displays of attractive flowers that are typically seen in IFNM. Some are perennial (grow from the same root stock each year), others are biennial (grow from a rosette developed the previous year), and others are annuals (grow from seeds produced the previous year). There are too many species to be comprehensive in coverage. If you are interested in identifying all the flowers you see, we recommend that you consult a field guide such as the ***Falcon guide on plants of Arizona*** published in 2012.



Above: *Coulter's brickellbush.* (Gordon Hanson)

The appearance and abundance of flowers in the desert is highly variable and dependent on seasonal rainfall. It is said that over a typical decade in the desert, there might be one year with a spectacular display of flowers, 2-3 years with modest development, and at least one year with almost no flowers at all. Both good winter and fall rainfall periods are important to a vibrant spring flowering season. The timing of the appearance of flowers, including those on trees and shrubs, depends greatly on the days of high temperatures. Warmer than average years can result in blooms that appear as much as two to four weeks before their normal appearance. Therefore, times given for flowering of specific species may vary considerably, but in general these times would vary less for perennial plants and deep rooted woody plants.

It is worth remembering that wildflowers, and plants in general, play a critical role in the ecological functions of our desert. Indeed, they beautify our place and inspire our love of the desert, but more importantly plants provide a crucial link between abiotic resources and consumers (animals) in the desert ecosystem. Plants are the base of the food web, providing forage as well as cover for animals. But in the case of wildflowers in particular, many animals (especially insects) are dependent on the nectar, pollen, fruits, and seeds produced. Because plants compete for pollinators to insure that they successfully complete their life cycles, plants have developed a wide range of special shapes and colors which are also pleasing to our sense of beauty.

Below: *Hummingbird feeding on Parry's penstemon. (Young Cage)*



Below we divide wildflowers into those that start blooming early in the spring and those that tend to bloom later, usually late spring or summer. Some of the perennials that produce flowers early may also flower again in the summer or fall if favorable conditions appear. We have attempted to select species that are consistently present and common. However, under proper conditions others not selected here may appear common in a given year.

Early spring flowers: These begin blooming in February or March and continue through the spring as conditions permit. However, a few have an extended flowering season through the fall. The order given are those that are not yellow or white followed by those that are this common color.

Parry's penstemon (*Penstemon parryi*) is one of the earliest flowers to appear usually in March. The pinkish to lavender flowers are bell-shaped and arranged along one of several tall stalks that can reach to four feet. This is a perennial herb whose flowers may last to late April. It is visited by hummingbirds and insects and can be found on well-drained soils, canyons, and roadsides.



Left: *Trailing four o' clock. (Gordon Hanson)*
Middle: *Barestem larkspur. (Ted Richardson)*
Right: *Desert lupine. (RB)*

Trailing four o'clock (*Allionia incarnata*) is a low-growing, almost vine-like perennial plant that can be ten feet long. This is a perennial herb with sticky and hairy leaves and stems. Its pinkish-purple flowers (occasionally white) appear in March, but it usually blooms again in the summer after a May-June hiatus and until October especially after summer rains. It occurs on lower slopes and sandy soils in IFNM.

Barestem larkspur (*Delphinium scaposum*) has a flowering stem to 30 inches tall with royal blue blossoms (March – May) having a backward projecting spur. This

perennial herb has a basal rosette of dark green leaves. This plant produces delphinine, a toxic alkaloid that affects the cardiovascular system of animals. In small doses, it has some herbal medicine uses and was used to treat body lice. Hopi Indians used ground flowers in religious ceremonies.

Desert lupine (*Lupinus sparsiflorus*) is a perennial herbaceous legume appearing very early (January-May) in the spring. With good winter rainfall they can cover the ground along roadsides and open desert slopes. The flower stem can reach 16 inches and the roots harbor nitrogen fixing bacteria. This is the **common desert bluebonnet** of the desert. Of the 25 species of lupines in Arizona, one other species, the **bajada lupine** (*Lupinus concinnus*) occurs in IFNM. This latter species is lower growing (to six inches) with pale purple flowers.

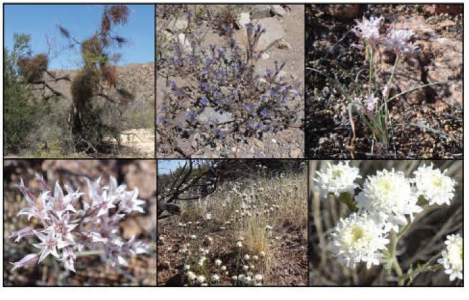
Desert globemallow (*Sphaeralcea ambigua*) is an early spring (March-early April) and summer flower, usually orange or bluish lavender in IFNM but other colors (white, pink, magenta) are known. This is a perennial herb with many flowering stalks (to 40 inches) from its basal rosette. The five-petal flower forms cups that are scattered along the tall stalk. It is common along roadsides, washes, and desert flats and is an important wildlife food. There are four other *Sphaeralcea*, including *S. coulteri*, a spring annual common on valley bottoms after wet winters.



Left: *Desert globemallow.* **Middle**: *Annual desert globemallow.* **Right**: *Desert mistletoe with fruit. (All RB)*

Desert mistletoe (*Phoradendron californicum*) is not the typical wildflower, but is a conspicuous plant in the desert. Mistletoe is a common parasitic plant on trees and shrubs in IFNM. Although its bushy stems and tiny leaves are green and photosynthetic, its roots obtain water and nutrients by invading the tissues of its host, especially desert ironwood, paloverde, and mesquite trees. Its seeds are dispersed by birds, especially phainopepla. If enough mistletoe plants occur on one tree, they can eventually cause its death. Mistletoe produces tiny yellowish green flowers in early spring (January- February). Male and female flowers are on separate plants. The fruits are small pinkish berries.

A small purple to bluish flowering plant is often seen on the desert floor early in the spring. There are several common representatives of the family Hydrophyllaceae



Top Left: *Desert ironwood near death with mistletoe.*
Top Middle: *Scorpionweed.*
Top Right: *Wild onion.*
Bottom Left: *Wild onion flower.*
Bottom Middle: *Stand of popcorn flower in Roskruge Mountains.*
Bottom Right: *Narrow-leafed popcorn flower close-up. (All RB)*

Many friends and acquaintances have provided specific images with which they are identified in the captions. All of these photos were critically important, thanks. Allan Morgan, a professional photographer, must be singled out for his many excellent images that filled in major gaps essential to our coverage. Allan's support and dedication to the project are gratefully acknowledged. Gordon Hanson also provided many important and excellent images. For one or more important photos that have been used, thanks are due to Robert Ashbaugh, Jeff Babson, Lahsha Brown, Scott Cossel (Special Collections, University of Arizona), Jillian Cowles, Jay Eldredge, Martin Feldner, Dan Fischer, Dr. Kim Franklin, Dr. Hans-Werner Herrmann, Dr. Stefan Hertwig, Dr. James Platz, Ted Richardson, Sandy Rowley, Joe Sheehey, Dr. Ronnie Sidner, and Fred Wilson.

Many individuals have accompanied us on field trips to IFNM over the past few years. Each trip has invariably revealed new information and experiences and none of these trips could have been made without the company of friends and colleagues whose appreciation is acknowledged here. Gordon Hanson and Jay Eldredge have been frequent companions. Others who have made the trek on at least one occasion include Robert Ashbaugh, Gary Borax, Dr. Jon and Louise Burton, Bill and Carol Coburn, Wesley Cregg, Carol Eldredge, Dr. Kim Franklin, Brian Hallmark, Dr. Stefan Hertwig, Marianne and Bob Jackson, Gaile James, Mark Lambert, Dr. Karin Lilje, Jean Martin, Pat and Carol McDonald, Allan Morgan, Dr. Jim Platz, Dr. Jack and Jane Reamy, Roger Repp, Ted Richardson, Dr. John Scheuring, Bob Schmalzel, Audrey Sears, Dr. Bill and Carol Warren, and John Wiens.

Many staff members of the Tucson Sector of the Bureau of Land Management (BLM) have provided valuable assistance to us over the past few years. Their hard work and dedication to the management of IFNM are gratefully appreciated. We especially



Left: *Desert-chicory. (RB)*
Middle Left: *Desert zinnia along pipeline road east of Ragged Top. (RB)*
Middle Right: *Desert zinnia. (RB)*
Right: *Arizona jewel flower. (Lahsha Brown)*

tight clusters on a stem of gray-green hairy leaves. Of the 26 species of *Cryptantha* in Arizona, seven species occur in IFNM all of which are herbaceous annuals although others elsewhere may be biennial or perennial.

Desert-chicory (*Rafinesquia neomexicana*) is a conspicuous early blooming (mid-February to May) white flower (1.5 inches wide) that appears singly on a tall stalk to 20 inches. It is an annual herb frequently found under trees such as paloverde. This species occurs in the lower desert and lower slopes in IFNM. The petals of the ray flowers are unequal in length and tend to have square ends with indentations like teeth on a comb. The teeth represent petals that make up each ray flower. *Rafinesquia neomexicana* occurs up to 3000 feet and a second, locally uncommon species, *Rafinesquia californica* occurs at 3000 to 4500 feet.

Silver bells or **Arizona jewel flower** (*Streptanthus carinatus*) is a small (usually 10 inches or less) annual herb which flowers early (January to April). We have seen it be very common on lower slopes of the Waterman Mountains in early spring. Its pinkish to tannish white flower has a unique pitcher-like shape.



Left: *Brittlebush. (RB)*
Middle Left: *Desert marigold. (RB)*
Middle Right: *Paperflower. (Jay Eldredge)*
Right: *Mexican gold poppy. (RB)*

Desert zinnia (*Zinnia acerosa*) produces flowers early (March) and can continue to flower through the summer to October. This is a small (to 10 inches), compact, and rounded perennial herb with narrow leaves and a crown of white flower heads. It occurs on the bajadas and lower slopes of mountains throughout IFNM.

Brittlebush (*Encelia farinosa*) is a perennial bush 3-4 feet high that blooms early in the spring (early March-May), but with abundant water it can bloom throughout the winter from November through May. The prominent yellow flower heads (to 2 inches in diameter) are on stems that extend above the leaves of the globe-shaped bush with grayish leaves. In IFNM, this species is common on roadsides, slopes, washes, and desert flats. The stem can be broken to obtain a resin or gum exudate that was chewed by native peoples and burned as an incense in early Mexican missions.

Desert marigold (*Baileya multiradiata*) has a typical daisy-like yellow flower head on stalks up to two feet high. The leaves are grayish and fuzzy. This herb produces flowers throughout the spring and summer (March-October) under favorable conditions. Common along roadsides and slopes on sandy or gravelly soil, it is moderately toxic to sheep and goats.

Paperflower (*Psilostrophe cooperi*) is a showy and bushy herb to two feet high that is topped with bright yellow flower heads. It occurs on slopes and washes in IFNM. This plant has much pubescence, and stems are often white to gray, giving its alternative common name as white-stemmed paper flower.

Mexican gold poppy (*Eschscholzia californica* subspecies *mexicana*) is an annual herb with yellow-orange flowers appearing from mid February to May. With good winter rain this flower can blanket large areas of desert slopes and foothills on IFNM. The juice of this plant is said to be mildly narcotic and was used by Indians in California to treat toothache.

Fiddleneck (*Amsinckia menziesii* and *A. tessellata*), two essentially indistinguishable annual herbs, flower in early spring (March – May). Their tiny yellow funnel-shaped flowers are arranged on a spike that coils like the tail of a scorpion. As flowers open the coiled spike uncurls. Both species are common in early spring in IFNM along roadsides and open areas of the desert.

The **evening primrose** family (Onagraceae) is represented by three genera and seven species in IFNM. We have seen the **bottle evening primrose** (*Oenothera primiveris*) in the south end of IFNM, but it is said to occur commonly in deserts below 4500 feet, thus probably occurs throughout the monument. It is an annual species usually with a robust basal rosette. It has yellow flowers with four petals that are deeply lobed, and blooms from mid-February through May. The larger stemmed perennial **California evening primrose** (*Oenothera californica*) or **Arizona evening primrose** (*Oenothera californica* var. *arizonica*) has white flowers. Note the X-shaped terminus of the stigma which is typical of the genus.

Later spring and summer flowers: Some of these plants begin to bloom in late spring or early summer but many do not appear until after the beginning of the summer monsoon. A few others do not start to bloom until late August or September. The order



Top: *Fiddleneck.*
Middle: *Bottle evening primrose.*
Bottom: *Arizona evening primrose. (All RB)*

of presentation below is first, non-yellow flowering plants followed by white and then those with yellow flowers.

Silver-leaf nightshade (*Solanum elaeagnifolium*) is a perennial herb and poisonous weed with spiny stems to three feet tall. Leaves are silvery green. Its blue to violet flowers with bright yellow central anthers appear in May to October. It is common along roadsides and desert washes at low elevations. The half-inch yellow berries produce a protein digesting enzyme that Pima Indians used to curdle milk and make cheese.



Left: *Parry's false prairie-clover.* **Middle**: *Bluestem prickly poppy.* **Right**: *Fruit stage desert thorn-apple. (All RB)*

Parry's false prairie-clover (*Marina parryi*) sometimes called **Parry dahlia** is a perennial herb producing stiff stems, highly branched to two feet tall. Pea-like flowers (deep blue to purple upper petals with white lower petals) occur in terminal spike-like clusters. It flowers as early as March but typically in late spring until June on desert flats and in washes.

Stinking milkvetch (*Astragalus lentiginosus*) is a sprawling perennial herb to four feet with reddish stems. Its pea-like flowers which are cream colored appear May to August. The fruit is a waxy inflated pod typically found in sandy soil. This plant is toxic to sheep and closely related to locoweed. There are over 70 species, many with purplish flowers, of *Astragalus* in Arizona of which six occur in IFNM.

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Left: *Desert tobacco with rattlesnake. (Young Cage)*
Middle: *Desert mariposa. (RB)*
Right: *Snake-weed. (RB)*

Desert tobacco (*Nicotiana obtusifolia*) is a perennial herb with yellowish white tubular flowers occurring throughout the year. It grows to three feet in washes and sandy areas in IFNM. Desert tobacco was used in a variety of ways by indigenous peoples as a medicine to treat toothache, snakebite, and skin or joint problems as well as through smoking, especially by shamans in various rituals.

Desert mariposa (*Calochortus kennedyi*) is a lily that grows from a bulb that was eaten by native peoples. The three inch wide flower can be yellow or orange and is among the most beautiful of all Arizona flowers. Height of the flower stalk depends on location, in the open they tend to be short (less than 10 inches) but are long stemmed (to two feet) when among shrubs. They typically occur on north facing rocky slopes.

Desert chinchweed (*Pectis papposa*) is a low growing annual with small bright yellow flowers. It appears quickly after late spring or summer rains when it can carpet open, especially disturbed areas. It has a pungent aromatic smell and was used medicinally by native peoples.

Two species of **snake-weed** occur in IFNM. These are late summer to December flowers of the sunflower family. They are perennial herbs that form small bushes to

two feet tall. Their tiny yellow flowers form dense clusters at the end of branches. **Threadleaf snake-weed** (*Gutierrezia microcephala*) has fewer flower heads that are more slender. **Broom snake-weed** (*Gutierrezia sarothrae*) has a more prominent flower display. Often a sign of over-grazing, these plants are poisonous to livestock if eaten in large quantities, but the seeds are eaten by birds. Their leaves have been used medicinally for snakebites as well as to reduce swelling from ant, bee, and wasp stings by native peoples.

Grasses

Grasses belong to the family Poaceae (Graminae of some authors) and include over 80 representative species in IFNM. Grasses are important species in all ecosystems by providing food for herbivores and in serving to prevent soil erosion. They are unique in their growth characteristics in having growth originate at or below the surface of the ground. This means that their leaves and culms (stems) can totally disappear whether by clipping, fire (not a natural part of the desert ecosystem), or drying. With time and moisture, grasses regenerate their leaves and grow as if nothing happened. This is a great adaptive strategy for the desert environment. As a result, many grasses seemingly disappear during the dry season only to suddenly reappear with the onset of the rainy season. There are both summer and winter annual species that respond to rain in their respective seasons. Below we present several common or distinctive species of grasses found in IFNM. Most of these will be more evident after the summer monsoon, although some may be seen in damp places, under trees, in shady canyons or during early spring rains after good winter moisture.

Of the 17 species of **three-awn grasses** (*Aristida* sp.) found in Arizona, seven taxa (4 species and 3 varieties) occur in IFNM. These common grasses are named



Top Left: *Three-awn grass. (Gordon Hanson)*
Top Middle: *Sideoats grama grass. (RB)*
Top Right: *Fluffgrass. (Gordon Hanson)*
Bottom Left: *Bush Muhly with Bouteloua gracilis in front. (RB)*
Bottom Right: *Buffelgrass. (RB)*

for the three bristles or projections (awns) on the lemma (a leaf-like bract at the base of the floret). The awns can be up to six inches long (to only one inch in taxa in IFNM) and add to the spiky, needle-like nature of these species that are sometimes called **needlegrass** or **speargrass.** This character makes them less favorable to livestock, so an abundance of *Aristida* can indicate overgrazing. Two species, **purple three-awn** (*Aristida purpurea*) and **spider three-awn** (*Aristida ternipes*) are herbaceous perennials common throughout IFNM. Both species are a **bunchgrass** up to two feet in diameter

John Wiens and associates of the Arizona-Sonora Desert Museum have recorded 7 additional species of ferns in IFNM including **Jones' false cloak fern** (*Argyrochosma jonesii*), **fairy sword** (*Cheilanthes lindheimeri*), **Pringle's lip fern** (*Cheilanthes villosa*), **Wright's lip fern** (*Cheilanthes wrightii*), and **goldback fern** (*Pentagramma triangularis*). The careful study of ferns of IFNM in terms of time and space of occurrence would be a rewarding endeavor for an energetic naturalist.

Gymnosperms are called the "naked seed" plants that produce seeds in a cone-like (usually) fruiting structure not as part of a flower as in true flowering plants (Angiosperms). Conifers such as pine, fir, and juniper are common types of gymnosperms (not a recognized phylum but several related plant phyla are included within gymnosperms). Unique among gymnosperms is the genus *Ephedra* (see photo) in the phylum Gnetophyta that occurs widely throughout the western United States. *Ephedra* is a scraggly shrub, 2-5 feet high and 3-6 feet in diameter. It has a network of practically leafless and brittle small branches resembling twigs (1.5 mm in diameter) that are green and photosynthetic. Plants are unisexual (dioecious) with male plants bearing pollen producing cones and female plants having ovule producing cones that appear in early spring, usually February-March. Native Americans used *Ephedra* for medicinal purposes and early settlers made a hot brew from the twigs giving the plant one of its common names, **Mormon tea**. Two species occur in IFNM including *Ephedra trifurca* and *Ephedra nevadensis*. *Ephedra trifurca*, sometimes called **Mexican tea**, has tiny leaves in threes at nodes and seeds in threes. The terminal twigs tend to be longer than in *Ephedra nevadensis* which is sometimes called **boundary tea**. It has paired leaves and seeds at the twig nodes. The twigs tend to be shortened, making the overall plant look bushier.

Many friends and acquaintances have provided specific images with which they are identified in the captions. All of these photos were critically important, thanks. Allan Morgan, a professional photographer, must be singled out for his many excellent images that filled in major gaps essential to our coverage. Allan's support and dedication to the project are gratefully acknowledged. Gordon Hanson also provided many important and excellent images. For one or more important photos that have been used, thanks are due to Robert Ashbaugh, Jeff Babson, Lahsha Brown, Scott Cossel (Special Collections, University of Arizona), Jillian Cowles, Jay Eldredge, Martin Feldner, Dan Fischer, Dr. Kim Franklin, Dr. Hans-Werner Herrmann, Dr. Stefan Hertwig, Dr. James Platz, Ted Richardson, Sandy Rowley, Joe Sheehey, Dr. Ronnie Sidner, and Fred Wilson.

Many individuals have accompanied us on field trips to IFNM over the past few years. Each trip has invariably revealed new information and experiences and none of these trips could have been made without the company of friends and colleagues whose appreciation is acknowledged here. Gordon Hanson and Jay Eldredge have been frequent companions. Others who have made the trek on at least one occasion include Robert Ashbaugh, Gary Borax, Dr. Jon and Louise Burton, Bill and Carol Coburn, Wesley Cregg, Carol Eldredge, Dr. Kim Franklin, Brian Hallmark, Dr. Stefan Hertwig, Marianne and Bob Jackson, Gaile James, Mark Lambert, Dr. Karin Lilje, Jean Martin, Pat and Carol McDonald, Allan Morgan, Dr. Jim Platz, Dr. Jack and Jane Reamy, Roger Repp, Ted Richardson, Dr. John Scheuring, Bob Schmalzel, Audrey Sears, Dr. Bill and Carol Warren, and John Wiens.

Many staff members of the Tucson Sector of the Bureau of Land Management (BLM) have provided valuable assistance to us over the past few years. Their hard work and dedication to the management of IFNM are gratefully appreciated. We especially

Animal Life



Left: *Bobcat on saguaro. (Young Cage)*

Mammals

Among the most familiar but perhaps least seen of all vertebrates in IFNM are mammals. The hot and dry environment necessitates many mammal species to restrict their activity to nocturnal or twilight periods. The few that are active during the day, such as squirrels, must be aware of diurnal predators such as hawks, and thus quickly

retreat to underground burrows. In addition to avoiding heat, many desert mammals consume food with high water content and some have highly efficient kidneys.

All mammals have three unique characteristics: skin covered by fur (hair), three ear bones with acute hearing abilities, and mammary glands that produce milk for feeding young during reasonably long periods of development. Beyond these characteristics, there is much variation among mammal traits. Mammals are endothermic, that is they generate sufficient metabolic heat to maintain a reasonably high and constant body temperature of about 37 degrees C (98° F). Bats however, drop their temperature during inactivity in the day. Most mammals, all in North America, are viviparous (bear living young) and most have well-developed brains and sense organs. Mammals are not generally brightly colored and many live underground. Mammals occur on all continents and in all oceans and have special adaptations that permit survival in particular environments.

Approximately 60 species, of the 125 mammals in Arizona, occur in the Sonoran Desert, of which most may be found in IFNM. These represent five orders and 19 families. Below we discuss the most common species likely to be encountered in IFNM and for which we are fortunate to have photographs. We arrange them by Order with greatest to least number of species.

The order Rodentia has at least 21 species in the Sonoran Desert representing four distinct families. **Rodents** have enlarged front teeth (incisors) that grow continuously throughout life which must be worn away by gnawing. Among the most conspicuous rodents are the squirrels, family Sciuridae. These animals are active during the day and are relatively common in IFNM. The **rock squirrel** (*Spermophilus variegatus*) is the largest sciurid (19 inches including the 8.5 inch tail) in IFNM. It occurs in rocky outcrops and canyons. Although it resembles a tree squirrel with its long bushy tail, this species is



Left: *Rock squirrel family (Young Cagle)*
Right: *Rock squirrel (Jillian Cowles)*

mostly terrestrial in spite of its ability to climb trees. This grayish-brown squirrel is found widely in the southwestern United States from Utah and Nevada to central Mexico. It may live solitarily in a rock pile but often occurs in colonies consisting of a dominant male and several females and their young. A repeated sharp and clear whistle warning-call serves to alert the colony of danger. Females build a burrow or nest at the base of a boulder or cliff which they tend to defend from their immediate neighbors. Rock squirrels are omnivorous, eating a wide variety of items including seeds, mesquite beans, cactus fruit, young leaves, roots, insects, young birds, and even carrion. They become dormant in the cold winter months, but probably do not truly hibernate in southern locales such as IFNM because they can be seen occasionally on warm winter days. Mating presumably occurs in early spring through early summer with birth of litters occurring in late March and again in August. The gestation period is 28-30 days. Number of young per litter varies from 1-7 (usually 2-5). Young may be seen out of the burrow at 6-8 weeks of age.



Left: *Round-tailed ground squirrel. (Young Cagle)*
Middle: *Round-tailed ground squirrel on alert. (Rill)*
Right: *Harris' antelope squirrel. (Young Cagle)*

The **round-tailed ground squirrel** (*Spermophilus tereticaudus*) is common in IFNM, especially in sandy soils, creosotebush flats, and lower alluvial fans with relatively deep soils. They tend to occur in small colonies and resemble small prairie dogs both in appearance and behavior. They can be seen standing upright or making alarm calls if danger is spotted. They may hibernate through the cold months, but this is likely a winter torpor or deep sleep rather than true hibernation because periods of activity can occur during warm periods. Emergence from winter sleep occurs in February as spring plants begin to appear. They depend heavily on newly produced green vegetation because their food averages about 80 per cent water. They also eat seeds, cactus fruits, and insects. Mating activity occurs in early spring and a litter of 1-12 (usually 5-6) pups is produced after a gestation period of 28 days in late March or early April.

The third sciurid is **Harris' antelope squirrel** (*Ammospermophilus harrisii*) which resembles chipmunks that occur at higher altitudes. Like chipmunks, it has light stripes on its sides (but not face) and holds its tail high above its back. especially while running. This small squirrel (body to 6 inches, tail to 3 inches) is active year-round. It is found in the low deserts of Arizona, extreme southwestern New Mexico, and southward through the state of Sonora, Mexico. In IFNM, it occurs in rocky soils and on higher

slopes somewhat between the habitats of the round-tailed ground squirrel and rock squirrel. Harris' antelope squirrels have a high body temperature (97-107° F) and use a heat reduction behavior called heat dumping. This involves moving into a shady area and sprawling, "spread eagle", against the cool ground. They feed on cactus fruits, mesquite beans, and insects, often storing food in their burrows which may occur singly or in small groups. It breeds only once per year with a litter of 4-9 pups being born in early spring. Gestation takes 30 days and maturity is reached in their first year after birth.

A second family of rodents, the Geomyidae, contains one species that is common in the Sonoran Desert and IFNM. **Botta's pocket gopher** (*Thomomys bottae*) ranges widely from southern Oregon to Central Texas and southward into Mexico including Baja California. This animal lives almost entirely underground in burrows that it excavates with its powerful front limbs, large front claws, and incisors. It rarely is found above ground except during dispersal of young and when it searches for a mate. Its presence can be seen in the form of small mounds of fresh dirt that it pushes up above the surface as it cleans or extends its tunnel. These tunnels may extend for 200 yards and are of two types. Those closest to the surface are feeding tunnels where the gopher grazes on the roots of plants, sometimes pulling plants into the tunnel from below. Gophers are almost exclusively vegetarian. The second type of tunnel may extend from three to nine feet deep with side tunnels for nesting, storage, or latrine purposes. Botta's pocket gopher is a medium sized (body 9-10 inches) gopher with a short (three inches) almost naked tail. The tail is used as the gopher backs up, which it can at rates about as fast as its forward movements. Males are larger than females. Females stop growing during their first pregnancy while males grow throughout life. The front limbs are large and muscular with very large claws. Its large front teeth grow constantly (about 9-14 inches per year), so constant gnawing is required to maintain an optimum



Above: Botta's pocket gopher. (Allan Morgan)

size. The mouth closes behind the front teeth to prevent dirt from entering the mouth. There is a fur-lined pocket on each side of the mouth that is used to transport food. The fur is short and velvety which gives little resistance regardless of which direction the gopher is moving in its tunnel. The fur varies widely in color (white, brown, or black) and typically matches the soil color. **Gophers** are active year around, and one study in Utah estimated that a single gopher moved over a ton of soil per year as it constructed and maintained its underground maze of tunnels. Gophers are highly territorial and strictly solitary. They seek company only during the mating season, about once or twice per year in the desert, but reproduction in the population may occur throughout the year in very productive places such as an alfalfa field. Litters vary from 2-10 young after a gestation period of about 19 days and young may mature in as little as three months.

The remaining rodents might be termed **rats** and **mice**, although two different families are represented. One family (Muridae) includes over 1,300 species of rats and mice that occur around the world, with 85 species in North America, 19 of these occurring in some part of the Sonoran Desert. Murids have three cheek teeth on each side of both jaws. They lack external cheek pouches, and are very mouse-like in appearance. Murids are predominately nocturnal, although some may venture out at other times. Among the most familiar, in the desert southwest, are the **woodrats** or **packrats** as they are commonly called. Of species in Arizona, the most common one in IFNM is the **western white-throated woodrat** (*Neotoma albigula*). It builds large (3 by 4 by 8 feet) nests of sticks, cholla stems, and cactus pads. It rarely occurs in residential areas. It is especially common in areas diverse in cacti. Woodrats feed on cactus fruit, mesquite and paloverde beans, and cholla stems. Some of these items may be stored in the base of their nest while others may be added to their house of sticks. Many animals, including **snakes** and **Gila monsters**, find refuge in packrat nests. Otherwise

Below *Packrat nest. (Robert Ashbaugh)*





Left: *Western white-throated woodrat (Young Cage)*
Right: *Southern grasshopper mouse. (Allan Morgan)*

these animals are solitary except during the mating season or when they are raising their young. Reproduction occurs in spring or summer and typically two litters are produced each year. Gestation requires 37-38 days with 2-3 young born in spring or early summer. In western Arizona, weaning occurs at 27-40 days and sexual maturity is reached in 80-87 days. Lifespan is about 45 months in nature but has been observed to reach 72 months in captivity. Mating is promiscuous and no pair bonding occurs.

A very different murid, the **southern grasshopper mouse** (*Onychomys torridus*) is common in the Sonoran Desert. This mouse is small bodied (3.5 inches) with a short (2 inch) tail. It has medium sized ears, and the stocky body is covered with fine, dense fur that is tan to gray above (depending on soil color to which it is adapted) but white or cream on the belly. Unlike most other mice, *Onychomys* is carnivorous, eating insects, scorpions, and even mice, although its diet can consist of as much as 10-25 per cent of seeds or vegetable matter. It forms pair bonds and defends a large home range (2-3 hectares) using a variety of vocalizations. It has been observed to stand on its hind legs and emit a loud, clear shrill call that can be heard up to 100 yards away.

retreat to underground burrows. In addition to avoiding heat, many desert mammals consume food with high water content and some have highly efficient kidneys.

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Deer mice are among the most abundant of mammals in the Sonoran Desert. They are a primary food source for many predators including hawks, owls, coyotes, bobcats, and snakes. Population sizes of these mice can fluctuate greatly depending on available food and predator pressure. *Peromyscus* is known to be a host to hantavirus, plague, and Lyme disease, although none of these have been reported in IFNM to our knowledge.

The last group of rodents is the family Heteromyidae, the **pocket mice** and **kangaroo rats**. The 60 species of this family are found only in the New World from southern Canada to northwestern South America. Of 41 species in the United States, 11 occur in some part of the Sonoran Desert. Heteromyids have four cheek teeth on each side of both the upper and lower jaw. They have external cheek pouches, usually small ears, large heads, often enlarged hind-limbs for jumping, and generally long tails. The external cheek pouches are lined with fur and are used to store and transport seeds. The cheek pouches open outside of the mouth, and they can be emptied quickly with actions of the small front legs to deposit seeds in a storage cache which is often in their underground burrow system.

Kangaroo rats are noted for their jumping ability. They can leap 6-9 feet, depending on species. Of the 17 species in the western United States, two species are especially common in the Sonoran Desert and IFNM. **Merriam's kangaroo rat** (*Dipodomys merriami*) occurs broadly across southern Arizona in a variety of habitats. In IFNM it occurs from washes to creosotebush flats. It is much smaller (head and body to 4 inches; tail to 5.5 inches) than its cousin, the **banner-tailed kangaroo rat** (*Dipodomys spectabilis*) which ranges from 5.75 to 7.75 inches in these dimensions. Merriam's kangaroo rat makes much smaller tunnels at the base of bushes and typically places seeds in small caches outside its tunnel. The banner-tailed kangaroo rat makes an extensive tunnel

Below: *Banner-tailed kangaroo rat. (Allan Morgan)*



retreat to underground burrows. In addition to avoiding heat, many desert mammals consume food with high water content and some have highly efficient kidneys.

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Bailey's pocket mouse (*Chaetodipus baileyi*) weighs up to 1.5 ounces and prefers rocky slopes among cacti and shrubs. In addition to mesquite beans and other seeds, it is known to eat jojoba nuts which are toxic to most mammals. It is active year round and breeds from April – August producing two litters of 1-6 young each. It occasionally aestivates during the hottest part of the summer.

The **rock pocket mouse** (*Chaetodipus intermedius*) weighs 0.2 to 0.6 ounces. It occurs on rocky slopes, avoiding sandy soils, and often uses cracks or crevices for shelter. Its burrow is usually near or under a rock. It becomes inactive (torpid) November to February. It breeds in the spring or early summer producing one or more litters of 1-7 young.

Bats (Order Chiroptera) make up the order with the highest number of species in the Sonoran Desert although relatively few species occur in IFNM perhaps due to the limited number of roosting sites. To our knowledge, at least six species have been recorded in IFNM, but we are unaware whether or not a comprehensive bat survey has been done.

Bats are unique among mammals in several respects. This is the only group of mammals capable of true flight. Others, such as **flying squirrels**, are simply able to glide. The wings of bats consist of a membrane stretched over the bones of the forelimb and hand. Some species have longer and narrower wings that are suited for long-distance flight whereas other species have wider, shorter wings that permit high maneuverability. In most species, a second membrane occurs across the hind-limbs and tail. Bats are mostly nocturnal and possess the unusual ability of echolocation. They emit high frequency sounds inaudible to humans. This sound bounces off objects in a manner like sonar. The returned sound tells them the location of objects ahead, including insects upon which they feed. Echolocation is so well developed in some

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slow fluttering but highly maneuverable flight pattern. Its reproductive pattern involves mating in the fall, delayed development through the winter, and rapid development until birth in May or June.



Left: *Bats at hummingbird feeder. (Allan Morgan)* Right: *Lesser long-nosed bat. (Dr. Ronnie Sidner)*

The lesser long-nosed bat (*Leptonycteris yerbabuenae*) has a smaller nose-leaf and shorter ears than *Macrotus*. It is migratory and arrives in southern Arizona in late spring to bear young during May-June at the time of peak saguaro flower availability. They roost in large colonies. These bats feed on nectar and pollen of large cacti and agaves. The long snout and very long tongue aid in feeding. These bats return southward to southern Mexico, feeding on agaves at higher altitudes. The lesser long-nosed bat is on the United States Endangered Species List. At least four colonies of these bats are known in southern Arizona, with those bats in IFNM probably associated with a large abandoned mine within 25 miles of Ragged Top. When the species was listed endangered in 1988, their numbers were thought to be in great decline. More roosts and more bats of this species are now known in southern Arizona.

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The order Carnivora represents meat-eating predators, although many take fruits, nuts, and other vegetable matter. They are usually large and wide-ranging with teeth adapted for piercing and tearing flesh of their prey. In the Sonoran Desert and IFNM, 13 species and four families are represented.

The Canidae includes **foxes**, **wolves** and other dog-like predators. The **coyote** (*Canis latrans*) is perhaps the most familiar and commonly heard, if not seen. A highly intelligent and adaptable animal, this is one of the few mammals that has increased its population size and range in the face of human encroachment on its habitat. These canids are the size of a medium-large dog, 24 inches high at the shoulder with a body length of 31 inches and weighing about 25 pounds, although desert coyotes tend to be skinny. They tend to sleep during the day in dense vegetation and hunt at night and at twilight. Coyotes eat a variety of items from carrion to small mammals, birds, reptiles, insects, fruit, and vegetable matter. They may hunt alone but frequently in small packs of 3-7 individuals. The pack typically consists of a mated pair and their offspring of various ages. They tend to maintain scent marked territories of 150 to 1,500 acres. Mating occurs once per year (January-March) with a litter of pups (up to seven but usually 4-6) being born in April-May following a two month gestation period. After weaning, males disperse but females tend to stay with the natal pack for several years, helping to raise the next litters. Life span is 3-7 years.

The **gray fox** (*Urocyon cinereoargenteus*) is smaller than the coyote, measuring 14 inches at the shoulder, to 28 inches long and 5-15 pounds. There is a black stripe down the midline of the tail. Gray foxes tend to prefer rocky canyons and hills, compared to the coyote, but like coyotes they are omnivores feeding on carrion to small mammals, snakes, birds, insects, and plant matter. They may climb trees to escape predators or feed on fruit. Gray foxes tend to occur singly or in mating pairs and are not as social as

Top: *Coyote*
Bottom: *Gray fox. (Both Young Cubs)*





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rodents, insects, and vegetable matter but occasionally takes a deer. It occurs in the Sonoran Desert uplands especially in areas of canyons and heavy brush. It occasionally ventures into cities and towns. Mating occurs in early spring and a litter (2-3 kittens) is produced after two months gestation.

The **cougar** or **mountain lion** (*Puma concolor*) is a large animal (3-5 feet head-body; 24-40 inches tail; 65-260 pounds) with a large home range (10-300 square miles). It prefers habitats with heavy underbrush and rocky areas. In the Tucson area, studies



Left: *Female bobcat with yearling (Young Cage)*
Right: *Mountain lion. (Robert Ashcraft)*

have shown that a single individual cougar ranged over several mountain ranges (e.g. Picacho, Tortolita, and Santa Catalina Mountains, an area of 636 square miles). We are unaware if similar studies have been done in IFNM. These animals are solitary, territorial, and mostly nocturnal. The larger territory of a male may overlap with several females. They generally take large prey (e.g. deer, javelina, bighorn sheep, etc.) which they stalk and ambush, but they are generalists and also will eat small prey from

rodents to rabbits. A meal of a single deer takes a couple of days to consume and after such a catch the cougar may not feed for 6-12 days. These powerful predators can leap as high as 18 feet or 40 feet horizontally. They have excellent sprint speed, but they do not have the endurance for a chase exceeding 100 yards. Males and females remain apart except for a few days during mating which can occur during any time of the year. After a gestation period of 91 days a litter of 1-6 (typically 2-3) young are born. The initially spotted kittens are weaned at about three months of age, but they remain with their mother for eighteen months before striking out on their own. Lifespan in the wild is 8-13 years but up to 20 years in captivity.

Historically, two other felids may have occurred in the Sonoran Desert. These include the **ocelot** (*Leopardus pardalis*) and **jaguar** (*Panthera onca*), but recent sightings of these species have only been in southeastern Arizona.

At least one representative of the family Procyonidae is found in IFNM. This is the **ringtail** (sometimes erroneously called a **ring-tailed cat**, *Bassaricus astutus*). Other members of this family including the **raccoon** (*Procyon lotor*) and the **white-nosed coatil** (*Nasua narica*) probably do not occur in IFNM. They do occur in the Sonoran Desert in specific habitats.

Below: Ringtail (Young Cage)



Ringtails are common in the rocky desert habitats that occur in IFNM. They are distributed in the southwestern United States and along the west coast to central Oregon, the southern plains, and southward to Oaxaca state, Mexico. Ringtails are about the size of a housecat with head and body of 12-15 inches, tail 13-17 inches, and 1.75-3.3 pounds. They are nocturnal, solitary, and shy. They are excellent climbers and leapers. The long, bushy, black and white ringed tail is often used as a counter-balance. Like other procyonids, their omnivorous diet consists of berries, fruits, nuts, rodents, rabbits, small birds, snakes, lizards, insects, and vegetable matter. Mating

occurs in March-April with 1-4 young being born in June after a 45-50 day gestation period. Young begin hunting at 2-3 months of age and mature at 10 months. The ringtail lives about seven years in the wild. It is the state mammal of Arizona.

One member of the family Mustelidae is the **American badger** (*Taxidea taxus*). This species is distributed broadly from southwestern Canada, western and central United States, and southward to central Mexico. It prefers areas of sandy loam soil in which it digs its den. In IFNM, it likely occurs in creosotebush flats which harbor many rodent species. We found a skeleton of a badger in the Samaniego Hills. They are fairly large animals, the largest mustelid (head and body to 26 inches; tail to 6 inches; and 11-26 pounds) with a stocky and short-legged body. The front feet have very large claws (2-3 inches in length) suited to proficient digging for their favorite prey of burrowing animals such as mice, kangaroo rats, and ground squirrels. Badgers are solitary and nocturnal predators. A badger digs several dens, some up to 30 feet long and 10 feet deep. These are scattered in its home range of up to 2,000 acres. In bad weather, the badger may remain in the den for extended periods, but they do not hibernate. Mating occurs in late summer or fall, and young (1-5 but usually 3) are born in late March or early April due to delayed implantation of embryos. Young badgers first emerge from the natal den at 5-6 weeks but remain with their mother until mid to late summer. Females may mate at one year of age, but males do not breed until their second year. Lifespan in the wild is about 9-12 years but as much as 15 years in captivity. Badgers are eaten in some cultures including Native Americans, but we are not certain if there are specific records for the southwestern cultures in our area.



Below: *American badger. (Allan Morgan)*

The last group of carnivores in IFNM had been considered part of the family Mustelidae. Recently, the **skunks** have been separated into their own family, the Mephitidae. Skunks are commonly known by most people, even if only because of their

characteristic odor as one passes a DOR (dead-on-road) specimen on the highway. Skunks spray this odor from glands at the base of their tail. It is an effective predator defense mechanism. Their worst enemy is the great horned owl which has little sense of smell.

Chemistry of Skunk Spray

The noxious odor of skunk spray results from specific chemicals, especially of two major groups of compounds. These include thiols and acetate derivatives of thiols. Thiols are basically the sulfur analogue of alcohols where sulfur takes the place of oxygen in the hydroxyl group of an alcohol. They are highly odiferous and can be detected by the human nose in extremely low concentrations (10 parts per billion). Thiols are used as odorants to assist in the detection of natural gas which is usually odorless unless some sulfur compound is present. Each skunk species has a unique composition of its spray. The striped skunk has seven specific volatile thiol compounds in its spray whereas the spotted skunk has only three. To deodorize skunk spray, the thiols can be oxidized to compounds that have little or no odor such as sulfonic acids. Among the many oxidizing agents that can be used are hydrogen peroxide, baking soda, and liquid laundry bleach.

In the Sonoran Desert, there are four species of skunks. It is possible that all four occur in IFNM, but we are unaware of such records. Based on general abundance and habitat requirements, we discuss two species, the **striped skunk** and the **western spotted skunk**, that likely occur in IFNM.

The striped skunk (*Mephitis mephitis*) is distributed widely across North America from the Northwest Territories, Canada, to the Mexican plateau of Chihuahua, Mexico. They occur in the Arizona Uplands and along wooded washes of the Sonoran Desert

and IFNM. Striped skunks are so named because of two prominent white stripes along the back of the black body that meet on the back of the head to form a narrow white stripe down the center of the face. This is a medium-sized skunk (head and body of 12-20 inches; tail 9-14 inches; weight of 2-11 pounds). They are typically solitary and nocturnal but may form small groups in dens or while foraging for food. They feed on insects, birds, bird eggs, fruit, vegetation, and carrion. They are active year round and mate in late winter or early spring. A litter of 3-10 young are born in May. Lifespan is about 2-3 years in the wild.



Left: *Striped skunk.* Right: *Western spotted skunk. (Both Young Cage)*

The western spotted skunk (***Spilogale gracilis***) occurs throughout the western United States from southwestern British Columbia, Canada southward into northern Mexico. It occurs in brushy and rocky canyons in the Sonoran Desert. This species is noted for its spotted and irregularly blotched white on black color pattern, and for its habit of standing on its front feet as it sprays potential predators. It is smaller (head and body of 8-11 inches; tail of 4-6 inches; weight of 7-30 ounces) than other skunks. Nocturnal and secretive, it is the only skunk that climbs into trees for protection or in search of its omnivorous diet of insects, lizards, mice, birds, and bird eggs. It also eats carrion

and some vegetable matter. Mating occurs in September-October, but implantation of embryos is delayed such that birth occurs in April-May. Litters of young (2-6) stay with their mother for 3-4 months before dispersing as occurs in other skunks. Lifespan is probably 3-4 years in the wild but there is a record of over 8 years in captivity.

Ungulates, hoofed mammals, include two orders. Perissodactyla include those with an odd number of toes. No native species occur in the Sonoran Desert today although at least two (now extinct) -- a **tapir** and the **North American horse**-- were present at the time of the Paleoindian culture about 10,000 BCE. The even-toed ungulates (Order Artiodactyla) are represented in the Sonoran Desert today. These include the **pronghorn**, **mule deer**, **javelina**, and **bighorn sheep** (see page 48). The pronghorn is not known to occur in IFNM, but both the javelina and mule deer are common. **White-tailed deer** are sometimes found along dense riparian drainages.

The javelina or **collared peccary** (*Tayassu tajacu*) occurs from the southwestern United States (AZ, NM, TX) southward through Mexico and Central America to Peru and northern Argentina of South America. The peccary is pig-like in appearance, but a member of the New World family Tayassuidae rather than Suidae that only occurs in the

Left: Javelina feeding on cholla. (RB)
Middle: Javelina with new born (Young Cage)
Right: Javelina herd with young. (RB)





Bailey's pocket mouse (*Chaetodipus baileyi*) weighs up to 1.5 ounces and prefers rocky slopes among cacti and shrubs. In addition to mesquite beans and other seeds, it is known to eat jojoba nuts which are toxic to most mammals. It is active year round and breeds from April – August producing two litters of 1-6 young each. It occasionally aestivates during the hottest part of the summer.

The **rock pocket mouse** (*Chaetodipus intermedius*) weighs 0.2 to 0.6 ounces. It occurs on rocky slopes, avoiding sandy soils, and often uses cracks or crevices for shelter. Its burrow is usually near or under a rock. It becomes inactive (torpid) November to February. It breeds in the spring or early summer producing one or more litters of 1-7 young.

Bats (Order Chiroptera) make up the order with the highest number of species in the Sonoran Desert although relatively few species occur in IFNM perhaps due to the limited number of roosting sites. To our knowledge, at least six species have been recorded in IFNM, but we are unaware whether or not a comprehensive bat survey has been done.

Bats are unique among mammals in several respects. This is the only group of mammals capable of true flight. Others, such as **flying squirrels**, are simply able to glide. The wings of bats consist of a membrane stretched over the bones of the forelimb and hand. Some species have longer and narrower wings that are suited for long-distance flight whereas other species have wider, shorter wings that permit high maneuverability. In most species, a second membrane occurs across the hind-limbs and tail. Bats are mostly nocturnal and possess the unusual ability of echolocation. They emit high frequency sounds inaudible to humans. This sound bounces off objects in a manner like sonar. The returned sound tells them the location of objects ahead, including insects upon which they feed. Echolocation is so well developed in some



Above: Mule deer in velvet. (Young Cage)

Mule deer are browsers, feeding on leaves, twigs, and fruit of trees and shrubs, although they will take grass and herbs when available. The buck is often solitary during the summer while does are with their young. They occupy a home range of 1-2 square miles. Breeding season is late October through December and both sexes may mate with several partners during the rutting season. After a gestation period of about 190 days, 1-2 fawns are born by mid-summer. Fawns are reddish brown with small white spots which are lost in a couple of months. Fawns stay with their mother until the following spring and become sexually mature in about 18 months. Bucks lose their antlers during the winter and begin almost immediately to grow new ones. The new antlers are developed under a layer of skin called velvet. As the antlers reach their maximum size in the early fall, velvet is shed as fighting between bucks occurs for access to does for mating. Lifespan is about 10 years.

The order Lagomorpha is the last order of mammals and the one with the fewest (1 **rabbit** and 2 **hares**) species in IFNM and the Sonoran Desert. Lagomorphs are closely related to rodents. Both have large incisor teeth that grow continuously throughout life and are used for clipping vegetation during feeding. Rodents have a single pair of upper incisors whereas lagomorphs have three pairs of incisors at birth. The outer pair is soon lost and the third pair is situated as small pegs behind a large pair of front incisors. Lagomorphs also have an unusual process of digesting vegetable matter. They produce two types of fecal pellets, wet and dry. The wet pellets are reingested, passing through the digestive tract a second time. This allows food to be broken down by bacterial action in the caecum before it is passed through the gastrointestinal tract a second time.

Cottontails are rabbits and **jackrabbits** are hares, but the difference is more about their life history than their taxonomy. Both are in the same family, Leporidae.



Left: *Desert cottontail. (Dr. Jim Pietz)*
Right: *Black-tailed jackrabbit (Young Cagle)*

Hares tend to be larger, more solitary, have longer legs, depend on speed (up to 35-45 miles per hour) and long-distance runs to escape predators, and have precocial young. The young are born with hair and open eyes and ready to leave the nest and fend for themselves soon after birth. Rabbits are more social, depend more on crypsis, have a zig-zag run then hide escape strategy, have shorter ears, and have altricial young. The young are born with eyes closed, are hairless, and unable to leave the nest for a few weeks. Furthermore, rabbits have been domesticated, but no species of hare has been so tamed.

retreat to underground burrows. In addition to avoiding heat, many desert mammals consume food with high water content and some have highly efficient kidneys.

All mammals have three unique characteristics: skin covered by fur (hair), three ear bones with acute hearing abilities, and mammary glands that produce milk for feeding young during reasonably long periods of development. Beyond these characteristics, there is much variation among mammal traits. Mammals are endothermic, that is they generate sufficient metabolic heat to maintain a reasonably high and constant body temperature of about 37 degrees C (98° F). Bats however, drop their temperature during inactivity in the day. Most mammals, all in North America, are viviparous (bear living young) and most have well-developed brains and sense organs. Mammals are not generally brightly colored and many live underground. Mammals occur on all continents and in all oceans and have special adaptations that permit survival in particular environments.

Approximately 60 species, of the 125 mammals in Arizona, occur in the Sonoran Desert, of which most may be found in IFNM. These represent five orders and 19 families. Below we discuss the most common species likely to be encountered in IFNM and for which we are fortunate to have photographs. We arrange them by Order with greatest to least number of species.

The order Rodentia has at least 21 species in the Sonoran Desert representing four distinct families. **Rodents** have enlarged front teeth (incisors) that grow continuously throughout life which must be worn away by gnawing. Among the most conspicuous rodents are the squirrels, family Sciuridae. These animals are active during the day and are relatively common in IFNM. The **rock squirrel** (*Spermophilus variegatus*) is the largest sciurid (19 inches including the 8.5 inch tail) in IFNM. It occurs in rocky outcrops and canyons. Although it resembles a tree squirrel with its long bushy tail, this species is

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Animal Life



Left *Sonoran Desert toad (Young Cage)*

Vertebrates

When most people hear the word animal, they think about vertebrates. These animals are the larger, more conspicuous types that include birds, mammals, reptiles, and amphibians. All have an internal skeleton with a backbone of individual elements

called "vertebrae." In addition, there is a distinct cranium, or skull bone, enclosing the brain, and usually four limbs which may have been modified into an anterior pair of wings as in birds, fins in fish, or absent as in snakes and some lizards. In IFNM, all vertebrates are typical Sonoran Desert species.

Amphibians

There are likely seven species of toads in IFNM although only two species are confirmed. All of these desert species generally occur in the lower Colorado River subdivision of the Sonoran Desert at the base of mountains or in the flatland of the intervening valleys. They spend most of their time buried underground. They emerge after rain storms, particularly during the summer monsoon. As in other amphibians, the skin is bare (without the scales, feathers, or hair of other vertebrates), so to prevent desiccation they must remain in a moist environment, in the desert usually underground. Desert amphibians must also return to water to breed where they lay eggs that develop into tadpoles before metamorphosing into small toadlets that resemble a miniature adult. Toads in IFNM are not typically seen until it rains, at which time they quickly emerge from their underground burrows. Males begin making their species-specific mating call to attract females. This can occur within an hour or less following a heavy thunderstorm. Some studies suggest that emergence is stimulated by the vibrations from thunder as much as by the moisture of the rain.

All species of amphibians in IFNM are toads in the order Anura. Anurans are characterized by large heads, without a noticeable neck, and four legs – with the hindlegs enlarged for jumping. The two species that have been confirmed (i.e., collected with voucher specimens deposited in a museum reference collection) include the **Sonoran Desert toad** (*Bufo alvarius*) and the **red-spotted toad** (*Bufo punctatus*). The Sonoran Desert toad (also known as the Colorado River toad) is large (to almost



Left: *Sonoran Desert toad*
Right: *Red-spotted toad*
(Both Young Cagle)

eight inches). It has smooth, olive-green to brownish, skin with widely scattered small warts. There is a large parotoid gland behind and above the ear drum that produces a potent toxic secretion that can cause paralysis or death in dogs and other vertebrates if ingested. It eats large insects as well as lizards, mice and other amphibians and breeds in temporary pools in the monsoon. Its mating call is a short, low-pitched grunt, and not very loud. Like other toads, it hides under rocks, debris, or in burrows during the dry season.

The red-spotted toad is a small (to three inches) pale gray to tan toad with numerous small red tubercles scattered across the back. The head is flattened and the eyes have a horizontal pupil, as do all species of *Bufo*. There is a small round parotoid gland on each side of the head just posterior to the small ear drum. These small toads emerge after late spring or summer rains and breed in temporary pools. Their mating call is a high pitched trill that lasts a few seconds. They feed primarily on insects.

The remaining toads that likely occur in IFNM include three species in the family Bufonidae, two in the family Pelobatidae, and one in the family Microhylidae. Although not yet confirmed, we believe they occur in IFNM based on habitat availability and

known distributions (see Brennan and Holycross, 2006, *A Field Guide to Amphibians and Reptiles in Arizona*).

The additional bufonid toads that likely occur in IFNM include the **Great Plains toad** (*Bufo cognatus*), a medium sized toad (to 4.5 inches) with bold olive, tan. to green blotches on its back. The males have a sausage shaped vocal sac that extends above the front of the head when inflated during the mating call. The call is an extremely loud, long, piercing trill that can be heard at least as far as a mile away. They also have a prominent, black "spade" (metatarsal tubercle) on the bottom of the hind feet that is used to dig their way backward into the ground. **Woodhouse's toad** (*Bufo woodhousii*)



Right: *Great Plains toad.*
Above: *Calling male.*
(Both Young Cagle).



is a medium-sized toad (to five inches) with a light vertebral stripe on brown back having scattered tubercles and darker (and sometimes lighter) brown spots. This toad may occur along the Santa Cruz River or lowlands in the northern part of IFNM. The **Sonoran green toad** (*Bufo retiformis*) is a small (to 2.5 inches) yellowish green toad with a network of black reticulations. It would occur in flats and valleys within the lower Colorado River subdivision of the Sonoran Desert. Its distribution would be restricted to extreme south central Arizona and southward into Sonora, Mexico. It should be noted that some recent authors use the genus *Anaxyrus* for *Bufo*.

Two pelobatid toads, **Couch's spadefoot** (*Scaphiopus couchi*) and the **Mexican spadefoot** (*Spea multiplicata*) should be found in IFNM, although neither has been confirmed. These spadefoot toads (or simply spadefoots) are especially noted for their quick development. Their eggs may hatch within 12 hours and toadlets may emerge in



Left: *Woodhouse's toad. (Young Cage)*
Right: *Sonoran green toad. (Dr. Stefan Hertwig)*

less than two weeks after a summer rain. This is an adaptation to an arid land where open pools are extremely ephemeral. They have prominent metatarsal tubercles (the spade of spadefoot) used in digging as described above for the Great Plains toad. Spadefoots also have vertical pupils (not horizontal as in the bufonids) and no parotoid



Above Left: *Couch's spadefoot male.*
Above Middle: *Couch's spadefoot female.*
Above Right: *Mexican spadefoot.*
(All Young Cage).

glands. They also have noxious skin secretions that are very irritating to the eyes and nasal passages when handled. Couch's spadefoot has a squawking call described as like a bleating lamb lasting about 3-4 seconds. That of the Mexican spadefoot is described as a long vibrating snore.

The **Great Plains narrow-mouthed toad** (*Gastrophryne olivacea*) might occur in the flatland areas of the lower Colorado River subdivision of the Sonoran Desert in flooded fields, irrigation ditches, or farm ponds. These are tiny (to 1.5 inches) toads with sharp pointed heads. They eat ants and termites and are active after summer rains. The call is a faint but distinctive peep followed by a 1-4 second buzz.



Above: *Great Plains narrow-mouthed toad. (RB).*

Two additional anurans, frogs of the family Ranidae, should be mentioned. The **American bullfrog** (*Rana catesbiana*) has been introduced widely across southeastern and central Arizona and may occur in farm ponds and irrigation ditches. Also, the **lowland leopard frog** (*Rana yavapaiensis*) that once occurred in the Gila River and the upper Santa Cruz River drainage, perhaps bordering IFNM, has been extirpated from most of these areas, although it still occurs along the rim country from southeastern Mohave County to eastern Pima County.



Left *Black-tailed rattlesnake. (Young Cagle)*

Reptiles

This familiar category of vertebrates includes turtles, lizards, snakes, and a few others (not in IFNM) most of which are extinct, such as dinosaurs. Modern systematic biologists no longer recognize Reptilia as a natural group. In fact, some reptiles, such as alligators and crocodiles, are more closely related to birds than other "reptiles."

Thus, for important technical reasons, birds are now considered a part of Reptilia (for details of modern classification of reptiles, you should consult a text such as Zug et al. Herpetology, 2001 or later editions). For our general purposes here we will continue to consider reptiles in the classical vernacular sense to include traditional groups with scales on the outer surface of the skin (turtles, lizards, and snakes in IFNM).

Turtles in IFNM include a single documented species, the **Sonoran desert tortoise** (*Gopherus morafki*) which was considered in detail previously (see page 52). A second species, the **desert box turtle** (*Terrapene ornata luteola*) occurs in extreme south



Right: *Sonoran desert tortoise. (Young Cagle)*

central Arizona and eastward. It might conceivably be recorded in the southern end of IFNM, although more likely as a former pet than a natural occurrence.

Lizards in IFNM include 18 species. Lizards are closely related to snakes (both are in the order Squamata). Both have a skin covered by scales that is shed periodically, but lizards are easily distinguished by the presence of four legs (absent in some species that are not found in IFNM) and an external ear opening (not found in one species in IFNM *Cophosaurus texanus*, the **greater earless lizard**). Lizards are generally diurnal (active during the day) and most eat insects (exceptions are noted below).

The **Gila monster** (*Heloderma suspectum*) is one of two beaded lizards (family Helodermatidae) found only in the western hemisphere (southwestern United States and Mexico). These are large (body to 14 inches), heavy bodied with a short fat tail, and thick bead-like scales. Color consists of black, white, red, or yellow marks that are variously banded or reticular (net-like) in appearance. Helodermatids were once thought to be the only truly venomous lizards in the world, but recent reports have confirmed that some varanids (monitor lizards in Asia and Australia) also have venom. Gila monsters are active from spring to fall, but they avoid high temperatures and are often crepuscular (active during twilight), but they are commonly diurnal during their peak activity in late spring. They lay eggs (up to 12) in July. It is illegal to collect or harm these animals. Food varies from carrion to eggs and small mammals, nestlings and lizards. They are noted for hanging on tenaciously while the venom is released along the grooves in the teeth. Few deaths of humans have been recorded but their bacterial laden mouth can cause serious infections and considerable pain. Although their gait is slow and lumbering, they are capable of sudden and quick movement, so give them a wide and respectful distance. Do not attempt to pick them up.



Right: *Gila monster. (Both Young Cagle)*

The **western banded gecko** (*Coleonyx variegatus*) is entirely nocturnal. These small (body and tail to four inches) brown and yellow lizards occasionally may be seen crossing the road at night as they search for mates and food. *Coleonyx* belongs to the terrestrial gecko family Eublepharidae whose feet lack the villi of true geckos that are capable of climbing vertical surfaces. These geckoes produce several clutches of 1 or 2 eggs during the spring and summer months. They are insectivorous.



Right: *Western banded gecko. (Young Cagle)*

There are two whiptail lizards in IFNM including the abundant **tiger whiptail** (*Aspidoscelis tigris*) and the **Sonoran spotted whiptail** (*Aspidoscelis sonorae*). Until recently, the generic name was *Cnemidophorus* which will be found in older references. Whiptails are known for their active-searching feeding strategy and a preference for high temperatures. Thus they are active from spring to early fall and maintain body temperatures in excess of 100F. Like other lizards and reptiles generally, whiptails maintain a constantly warm body temperature by alternately basking in the sun and



Left: *Tiger whiptail.*
Right: *Sonoran spotted whiptail. (Both Young Cagle)*

shade. There are no internal metabolic mechanisms for thermoregulation as occurs in birds and mammals. The Sonoran spotted whiptail is also interesting because it is one of several species of whiptails in the desert southwest that represents an all female species. The origin and reproductive process is quite remarkable but suffice it to say, these species reproduce by parthenogenesis (reproduction without fertilization). Eggs hatch into new female lizards that are exact clones of their mother. Tiger whiptails are normal bisexual animals with males and female and normal sexual reproduction. Both

species have similar habitat and food preferences as well as activity patterns. Tiger whiptails occur in open areas throughout IFNM but are most abundant on bajadas, valley floors, and open canyons. The Sonoran spotted whiptail in IFNM is largely or entirely confined to higher elevations and is not known in valleys or on bajadas. Both species are active foragers and are continuously on the move. They eat mostly insects, especially termites, and are active during the heat of the day. The two species are easily distinguished by their different color pattern.



Above: *Desert iguana (Young Cage)*

Two species of lizards in IFNM are large and substantially vegetarian. These include the **desert iguana** (*Dipsosaurus dorsalis*) and the **common chuckwalla** (*Sauromalus ater* or *S. obesus* of some authors). The desert iguana is near its eastern distributional limit on the eastern edge of the Avra Valley. These lizards are large (body to 5-6 inches and tail to 10 inches). Their scales are small and granular except for a row of enlarged, keeled scales down the midline of the back. They prefer very hot temperatures (above 90-95°F) and thus are active during the warmest part of the year from late spring to September in IFNM. They typically occur in creosotebush habitats, open desert flats, or on rocks at the base of hills. They have been seen to climb into creosote bushes to eat the blossoms. They are oviparous (lay eggs) producing one clutch (2-8 eggs) in the summer.

The chuckwalla is large (body 5-9 inches) with a heavy body, and the tail is about the same length with a blunt tip. These lizards never occur outside of rocky areas. They can be observed basking on large rocks from which they will quickly retreat to a nearby crack when approached. Thus they are sometimes easier seen in cracks in which they wedge themselves by puffing up their lungs and from which they are difficult to extract. They vary from black to brown or red. Chuckwallas are active from March to September but may be active on warm winter days. They feed on spring blooms as well as cactus fruits. Eggs (usually 6-8) are laid in midsummer.



Top Left: *Common chuckwalla. (Fred Wilson)*
Top Right: *Common chuckwalla in crevice. (Dr. Hans-Werner Hermann)*
Bottom Left: *Sonoran Desert collared lizard. (Martin Feldner)*
Bottom Right: *Long-nosed leopard lizard. (Young Cage)*

Many friends and acquaintances have provided specific images with which they are identified in the captions. All of these photos were critically important, thanks. Allan Morgan, a professional photographer, must be singled out for his many excellent images that filled in major gaps essential to our coverage. Allan's support and dedication to the project are gratefully acknowledged. Gordon Hanson also provided many important and excellent images. For one or more important photos that have been used, thanks are due to Robert Ashbaugh, Jeff Babson, Lahsha Brown, Scott Cossel (Special Collections, University of Arizona), Jillian Cowles, Jay Eldredge, Martin Feldner, Dan Fischer, Dr. Kim Franklin, Dr. Hans-Werner Herrmann, Dr. Stefan Hertwig, Dr. James Platz, Ted Richardson, Sandy Rowley, Joe Sheehey, Dr. Ronnie Sidner, and Fred Wilson.

Many individuals have accompanied us on field trips to IFNM over the past few years. Each trip has invariably revealed new information and experiences and none of these trips could have been made without the company of friends and colleagues whose appreciation is acknowledged here. Gordon Hanson and Jay Eldredge have been frequent companions. Others who have made the trek on at least one occasion include Robert Ashbaugh, Gary Borax, Dr. Jon and Louise Burton, Bill and Carol Coburn, Wesley Cregg, Carol Eldredge, Dr. Kim Franklin, Brian Hallmark, Dr. Stefan Hertwig, Marianne and Bob Jackson, Gaile James, Mark Lambert, Dr. Karin Lilje, Jean Martin, Pat and Carol McDonald, Allan Morgan, Dr. Jim Platz, Dr. Jack and Jane Reamy, Roger Repp, Ted Richardson, Dr. John Scheuring, Bob Schmalzel, Audrey Sears, Dr. Bill and Carol Warren, and John Wiens.

Many staff members of the Tucson Sector of the Bureau of Land Management (BLM) have provided valuable assistance to us over the past few years. Their hard work and dedication to the management of IFNM are gratefully appreciated. We especially



Left: *Desert horned lizard.* **Middle and Right**: *Regal horned lizard.* *(All Young Cagle)*

as well as spines on their back, side, and short tails. Their food consists almost entirely of ants but other insects are occasionally taken. They lay eggs (up to 30 per clutch) that hatch in late summer. Horned lizards have the remarkable ability to squirt blood from the corner of the eye socket. Tucson's own Dr. Wade Sherbrooke and colleague Dr. George Middendorf (Howard University) demonstrated this to be an anti-predator mechanism, mostly against canids (coyote, fox, etc.). Their studies have shown that this blood squirting occurs frequently when a canid attempts to pick them up. The canid will immediately drop the horned lizard and shake its head while attempting to wipe away the blood. Apparently, a substance in the blood (yet to be chemically identified) is highly distasteful. The same reaction can occur with felid (bobcats) predators. Horned lizards are sometimes incorrectly called horny toads. Horned lizards were considered an important animal by the ancient Hohokam of southern Arizona and there are many examples of horned lizards in their art and culture.

Among the most commonly seen lizards in IFNM, the **zebra-tailed lizard** (*Callisaurus draconoides*) is noted for its black-banded tail curved up above its back which it waves



Right: *Zebra-tailed lizard (Young Eagle)*

in the air like a flag after its escape sprint. This is undoubtedly a predator distraction mechanism, because if a predator strikes and only gets the tail, the animal escapes and the tail can be regenerated (see box on page 171 on tail regeneration escape in lizards). This is a small to medium sized lizard (body to 4 inches) with a flat, black-banded (to 6 inches) tail and long hind legs. The grayish body has tiny granular scales and various light spots and brown blotches. There are two black bars on the side just behind the front legs. These are insectivorous and oviparous (laying one or more clutches of 1-15 eggs in the summer). They tend to be found in open terrain such as desert flats, bajada slopes, and sandy areas.

Perhaps the most abundant lizard in IFNM is the **common side-blotched lizard** (*Uta stansburiana*), so named because the dark blue spot behind each front leg. This small lizard (body length to 2.5 inches) has small scales and is sexually dimorphic in color pattern. Males are mostly uniformly brown with small light spots (yellow to blue)



Left: *Common side-blotched lizard. (Young Cage)*

with blue scales predominating on the first half of the tail. Females lack the blue scales and may have dorsolateral light stripes or chevrons along the side of the back from the eye to the base of the tail. *Uta* are insectivorous and oviparous producing 1-3 or more clutches of 2-6 eggs in the spring and summer. They occur in most areas on IFNM from desert flats to rocky mountain slopes, and can be seen on warm days throughout the year.

A similarly abundant diurnal lizard in IFNM is the **tree lizard** (*Urosaurus ornatus*). This small lizard (body length to 2.3 inches) occurs broadly across the desert southwest on rocks and trees (especially on fallen dead trees in IFNM). It differs from *Uta* in



Above: *Female tree lizard.*
Inset: *Male tree lizard showing dorsal color pattern.*
(Both Gordon Hanson)

lacking the side-blotch and in having two parallel rows of enlarged scales down the middle of the back. Males have bright blue or blue-green belly patches and a blue, green, orange or red throat. Females lack the belly patches but have yellow to orange throats. Male push-up behavior involves all four legs. All other lizards with this behavior in IFNM use only the front legs. It feeds on insects or spiders. Mating occurs in the spring and multiple clutches of 2-16 eggs are laid in spring and summer.

Lizard predator escape and tail regeneration

Lizards have a variety of strategies designed to escape predators such as camouflage, running, lodging themselves in a crack, etc. Some lizards can lose the tail and regenerate a "new" tail. Obviously, those lizards that use the tail for some other significant survival value such as a counter balance during running (e.g. collared lizards) or storage of fat reserves (e.g. gila monsters) would not gain an advantage by losing their tail. In species of this sort, the tail will not break off nor will it regenerate if severed. For those lizards that do regenerate the tail, a very specific mechanism is involved. The tail breaks at a specific fracture plane in the middle of a caudal vertebra. When this occurs, the tissue in this area is able to grow a new tail by producing a cartilage core beyond the point where the tail was broken. The skin and scales look a bit different, so it is generally easy to see the regenerated part. If a second tail break occurs in the future, it occurs farther up toward the base of the tail, again at an intravertebral cleavage or fracture plane. The cartilage part does not break. If the tail happens to be severed between two caudal vertebrae, the tail will not regenerate. This complex mechanism provides a means by which a lizard can escape a predator that happens to grab its tail, but regain the appendage by regeneration.

One final common lizard in IFNM is the **desert spiny lizard** (*Sceloporus magister*). This is a moderately large (body to 5.5 inches) and heavy bodied species with noticeably large, overlapping and spiny, keeled scales. They tend to be brown with various dark bars or blotches on the back. Males are especially muscular in appearance and may have scattered yellow scales along the sides and onto the tail. Males also have



Right: *Desert spiny lizard (Young Cage)*

a prominent wedge-shaped dark blue patch on the sides of the throat (this patch is smaller in females) and large patches of black and blue patches on the sides of the belly (not found in females). These belly patches sometimes extend onto the side just in front of the hind legs. These lizards are more common in the Arizona Upland area of the Sonoran Desert. They frequent desert trees and packrat nests especially along washes in the bajadas and flats, but also occur on rocks and even outcrops in desert mountains. However, a related species, **Clark's spiny lizard** (*Sceloporus clarkii*) replaces the desert spiny lizard on less arid desert mountains. Both are quick to retreat to a crevice or the opposite side of a tree or boulder. They eat arthropods as well as small lizards. One or two clutches of 2-12 eggs are produced in late spring and summer.

central Arizona and eastward. It might conceivably be recorded in the southern end of IFNM, although more likely as a former pet than a natural occurrence.

Lizards in IFNM include 18 species. Lizards are closely related to snakes (both are in the order Squamata). Both have a skin covered by scales that is shed periodically, but lizards are easily distinguished by the presence of four legs (absent in some species that are not found in IFNM) and an external ear opening (not found in one species in IFNM *Cophosaurus texanus*, the **greater earless lizard**). Lizards are generally diurnal (active during the day) and most eat insects (exceptions are noted below).

The **Gila monster** (*Heloderma suspectum*) is one of two beaded lizards (family Helodermatidae) found only in the western hemisphere (southwestern United States and Mexico). These are large (body to 14 inches), heavy bodied with a short fat tail, and thick bead-like scales. Color consists of black, white, red, or yellow marks that are variously banded or reticular (net-like) in appearance. Helodermatids were once thought to be the only truly venomous lizards in the world, but recent reports have confirmed that some varanids (monitor lizards in Asia and Australia) also have venom. Gila monsters are active from spring to fall, but they avoid high temperatures and are often crepuscular (active during twilight), but they are commonly diurnal during their peak activity in late spring. They lay eggs (up to 12) in July. It is illegal to collect or harm these animals. Food varies from carrion to eggs and small mammals, nestlings and lizards. They are noted for hanging on tenaciously while the venom is released along the grooves in the teeth. Few deaths of humans have been recorded but their bacterial laden mouth can cause serious infections and considerable pain. Although their gait is slow and lumbering, they are capable of sudden and quick movement, so give them a wide and respectful distance. Do not attempt to pick them up.

Venomous species include representatives in two families (Elapidae and Viperidae). A single elapid, the **Sonoran coralsnake** (*Micruroides euryxanthus*), is a small (rarely to 26 inches or a little longer) slender and secretive snake that is mostly crepuscular and nocturnal but occasionally active on cloudy or mild days. Elapids (including cobras,



Right. *Sonoran coralsnake. (Young Cage)*

mambas, sea snakes, etc. in other parts of the world) are known for their neurotoxic venom and short permanently erect fangs in the upper jaw. The Sonoran coralsnake is about the size of a thick pencil. It rarely attempts to bite when captured, and its small size

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and enzymes that vary with each species and even within species. Some rattlesnakes have neurotoxic venoms that affect the nerve system, but most rattlesnakes are predominately hemotoxic. That is, their venom affects the blood system and proteins causing bleeding, swelling, and tissue breakdown. The amount of injected venom is greater in large snakes, but newborn rattlesnakes have the same efficient fang system and toxic venom as their parents. Also, rattlesnakes can control the amount of venom they inject. As many as 20-50 per cent of the bites received by humans can be "dry bites," that is no venom is injected. Nevertheless, if a bite is suffered you should go immediately to an emergency facility to seek medical assistance. Treatment methods described in older books (such as cutting the wound to effect bleeding or use a tourniquet or ice pack) are no longer considered effective and can cause more damage than they prevent. The best first aid is a cell phone to call a medical facility; a picture of the snake might help with treatment, but no risk should be taken to get it. Rattlesnake antivenin can be administered if the bite is determined not to be a dry bite. All rattlesnakes are viviparous, giving birth to living young in late summer or early fall.

Below: *Western diamond-backed rattlesnake. (Young Cage)*



The **western diamond-backed rattlesnake** (*Crotalus atrox*) is the most widespread and common rattlesnake in the southwest United States and IFNM. These can be large (to 66 inches, although almost all are less than 48 inches in the Sonoran Desert). They vary from brown to gray with large brown diamond-shaped or hexagonal blotches down the middle of the back. The tail has white and black bands that are approximately equal in width. Young numbering 2-12 usually appear in mid to late summer.

The **Mohave rattlesnake** (*Crotalus scutulatus*) resembles the western diamond-backed rattlesnake except that the banded tails almost always have wider white bands than black bands and the white bands are a little bit dusky rather than pure white. They also have larger scales between the eyes. There is often a greenish- or yellowish-gray



Left: *Mohave rattlesnake.*
Right: *Tiger rattlesnake.*
(Both Young Cage)

background color, and these snakes are less obviously brown and tan than the western diamond-back. Although less common, Mohave rattlesnakes are found primarily on flats and lower bajadas, but could be found even in rocky slopes in IFNM. Their venom is among the most potent of any rattlesnake because it contains a substantial amount of neurotoxin as well as hemotoxin components, although many populations in central Arizona have little neurotoxin. Young (2-17) tend to be born in July to August.

The **tiger rattlesnake** (*Crotalus tigris*) is a medium sized rattler (to 35 inches) that varies from gray to brown or orange with darker brown to diffuse "tiger" bands across its back. The head is relatively smaller than other rattlesnakes. This snake occurs almost exclusively in the Arizona Upland areas of desert mountains in rocky habitats in IFNM, but is also active in nearby bajada washes. It feeds on small mammals and lizards and



Top: *Sidewinder.*
Bottom: *Black-tailed rattlesnake.*
(Both Young Cage)

has a potent venom containing a significant amount of neurotoxin. Birth of 2-6 young occurs early in the monsoon season.

The **sidewinder** (*Crotalus cerastes*) is a smaller species (to 25 inches) with hornlike projections above the eyes. It is most abundant in arid areas in the Lower Colorado River Valley subdivision of the Sonoran Desert, especially in relatively flat open desert such as sand dunes and creosotebush flats, although it can be found in valleys in the Arizona Upland with mesquite, paloverde, and diverse shrubs and cacti. It is mostly nocturnal and is named for the unique mode of crawling sideways and leaving J-shaped tracks in the sand. The venom is relatively low in yield and toxicity. It feeds mostly on lizards and small rodents, and gives birth to 1-20 young in the monsoon season.

The **black-tailed rattlesnake** (*Crotalus molossus*) is a large (to 48 inches) species that is olive to brown, with contrasting yellow and black highlights, dark chevrons down the back, and a black tail in front of the rattle. This species is associated with rocky or mountainous terrain. It is generally nocturnal or crepuscular in warm weather, as are all desert rattlesnakes, but like others it may wander during the day from its shady cover under bushes. It eats small mammals including rabbits. It has a large venom volume with a potent hemorrhagic toxin that can cause severe tissue damage. Young (3-16) are born in the monsoon season.

Sixteen of the remaining 17 species of snakes in IFNM are in the family Colubridae of non-venomous or mildly venomous species. Two of these, the **western lyresnake** (*Trimorphodon biscutatus*) and the **night snake** (*Hypsiglena torquata*) are well-known to be rear-fanged species with mild venom that is not dangerous to humans. The lyresnake, a medium-sized species (to 40 inches or more), has a broad head and narrow neck and smooth scales. It uses its venom to partially immobilize its prey (primarily lizards, bats, birds). It also constricts its prey as it is swallowed. It has brown patches down its



Left: *Western lyresnake.*
Right: *Night snake.*
(Both Young Cage)

back with various black and gray borders, a prominent V-shaped lyre marking on the head, and a vertical eye pupil. It often crawls into trees at night in canyons and rocky areas to feed.

The night snake's venom quickly affects its prey (lizards, snakes, toads and arthropods) but apparently does not affect mammals and is harmless to humans. This small (12-23 inches) snake is active at night where it may be encountered crossing the road. It occurs in a wide variety of habitats from hot and dry desert-scrub to montane forests and can be expected in all areas in IFNM. Its brown to gray body with brown blotches down the back is easily distinguished by two large blotches just behind both sides of the head. The pupils are elliptical and the belly is white. Mating occurs in spring and 3-4 eggs are laid in June or July.

Of the remaining 14 species of colubrids in IFNM, we discuss eight species that are relatively common and widely distributed. Of these, the **gophersnake** (*Pituophis catenifer*) is perhaps the largest (to 92 inches, although rarely over 72 inches in the desert) and most commonly encountered. This muscular snake has strongly keeled dorsal scales. It is often active diurnally on mild days but is morning-active and nocturnal during hot weather. When confronted it may mimic a rattlesnake by hissing, threatening to strike, and vibrating its tail, but some individuals are calm and easily handled. The ground color is grayish tan to cream with large rusty brown blotches down the back. The belly is light with scattered dark markings, often square-shaped.



Right: *Gophersnake (Young Cage)*

This snake is a constrictor that feeds mostly on rodents but will eat lizards and other snakes. It is known to rob bird nests. Mating occurs in spring with 2-24 eggs being laid in summer and hatching in August.

The **glossy snake** (*Arizona elegans*) superficially resembles the gophersnake but is smaller (to 42 inches). It has smooth and shiny dorsal scales. Its central blotches are reddish brown on a yellowish tan background. The white belly lacks markings. This constrictor snake lives mostly in sandier areas and eats small rodents, lizards, and snakes. It can be found active on mild days but is mostly nocturnal. It mates in spring with 2-24 eggs being laid in June that hatch in August.

The **long-nosed snake** (*Rhinocheilus lecontei*) is a medium-sized (to 35 inches) snake with a complex pattern of alternating red and black blotches or bands on the back and various yellow, black, and red flecks on the side. The belly is cream with modest speckling. The young (and some adults) have black (with white flecks) and white bands. Dorsal scales are smooth. This species is primarily crepuscular to nocturnal and eats lizards, reptile eggs, snakes, and small mammals usually by constricting. It presumably mates in the spring and lays 3-11 eggs in summer which hatch in August.

The **common kingsnake** (*Lampropeltis getula*) is a medium to large snake (to 56 inches) with a highly variable dorsal pattern. The color may be solid black, white and black banded, or black blotches separated with white or a yellow chain-like pattern. This snake is primarily nocturnal and is found in a broad range of habitats and is expected in most areas of IFNM. It is a powerful constrictor and consumes snakes (including rattlesnakes), lizards, small mammals, and birds. It is known to be reasonably immune to rattlesnake venom. The dorsal scales are smooth. Mating occurs in spring with 2-24 (usually 6-12) eggs being laid in June and hatchlings appearing in August.



Above: *Glossy snake. (Young Cage)*



Top: *Long-nosed snake.*
Below: *Common king snake.*
(All Young Cage)

There are two species of the genus *Masticophis* in IFNM. These are long thin snakes capable of very fast movement. They are diurnal, being active especially in the morning and late afternoon. They actively search for prey (lizards, snakes, birds, and small mammals) which they strike and consume directly without killing or constricting. The **Sonoran whipsnake** (*Masticophis bilineatus*) is thin and long (to 70 inches) and

has a gray dorsum in the first third of the body that fades to a golden tan farther down. There are two white lines along the side that fade toward midbody. The **coachwhip** (*Masticophis flagellum*) is similarly thin and long (to 68 inches) and variable in color. It may be pinkish or tan, with or without indistinct light brown to reddish brown bands on



Left: *Sonoran whipsnake.* **Middle and Right:** *Coachwhip showing color variation.* *(All Young Cage)*

the first half of the body or the body may be black. In either case the belly is noticeably pink especially toward the rear. Both species mate in the spring and lay 6-13 (Sonoran whipsnake) or 4-24 (coachwhip) eggs in June with hatchlings appearing in late summer. They occur in a wide variety of habitats from creosotebush flats and bajadas (the coachwhip) to rocky slopes (the Sonoran whipsnake) in IFNM.

The **western patch-nosed snake** (*Slavador hexalepis*) is a relatively thin and smaller snake (to 40 inches). It tends to be light tan with two dark mottled stripes down the back. The pale belly may be infused with pink or orange toward the tail. There is an enlarged scale on the tip of the nose which may be used to excavate reptile eggs which it eats, along with lizards and small rodents. It is found in all habitat





Top: *Western patch-nosed snake.*
Bottom: *Variable sandsnake.*
(Both Young Cage)

types in IFNM. It is active during the day, mates in the spring and lays 4-12 eggs in early summer that hatch in late summer.

The **variable sandsnake** (*Chilomeniscus stramineus*) is a small, short (to 11 inches) snake with orange and black bands. It is sometimes found out crawling at night, but is usually in loose soil or sand especially in washes in IFNM. It swims through the sand or loose soils in search of small insects or their pupae. The jaw is countersunk and there are valves that close the nasal openings. It has been found crossing roads at night. It probably mates in the spring and lays 2-4 eggs in summer that hatch in early fall.

The final snake that should be mentioned is a tiny, unusual species in the family Leptotyphlopidae. Recent taxonomic and systematic studies may result in name changes (Genus *Rena*), but until those taxonomic debates have settled, we will use the older name. The **western threadsnake** (*Leptotyphlops humilis*) is a thin and small species (most are under 10 inches but some exceed 15 inches) about as big around as a pencil in larger individuals. The tail and head are blunt, but the tail has a small terminal spine. Essentially blind, the eyes appear as small black dots under head scales. This snake is pinkish to light brown and has small scales with round posterior margins. Its ventral scales are not enlarged as in other snakes. It lives almost entirely underground but may be found under woody debris. It feeds mostly on termites, ants, and insect larvae. It lays 2-8 eggs in July or August and several females may lay eggs in the same nest and tend them as they develop. This prevents ants with which these snakes frequently associate from stealing the eggs.



Left: *Western threadsnake. (Young Cage)*

Animal Life



Lsrr. *Greater roadrunner. (Young Cage)*

Birds

Birds are perhaps the most conspicuous of all vertebrates in IFNM, in part because of their abundant types and their predominant diurnal activity. The forelimbs are modified into wings and the body is covered by feathers. These serve several functions such as for aerodynamics, for protection, and in coloration for species and



Above: *Hawk nest in saguaro. (Young Cage)*

sexual recognition. Many characteristics of birds are related to flight and a highly active lifestyle. The skeleton is very light compared to other vertebrates with bone size greatly reduced. Long bones are thin and hollow. The lung is highly specialized to exchange gases in both the inhalation and exhalation strokes. The heart has four chambers that completely separate the oxygenated and deoxygenated blood. Blood flow in the bare legs can be regulated such that heat is dissipated or conserved. Metabolic rate and temperature are generally high. Excretory products are primarily uric acid which is insoluble in water, thus conserving water which is important in the desert environment. The white material in the feces is uric acid. The mouth is without teeth making the skull lighter. The beak is modified in size and shape depending on food type. All birds lay eggs. Survival is enhanced by various vocalizations, behavioral adaptations, and breeding strategies. Two major types include precocial and altricial species. The former includes species (e.g. quail) whose chicks are ready to leave the nest at hatching whereas altricial species are usually born naked and require a long period of development after hatching (e.g. song birds, hawks, etc.).

Lack of water and excess heat pose special problems for survival in the desert environment. To minimize the impact of these factors, birds are mostly active in the early morning and late evening. They often hide in the cool microenvironments in the heat of the day.

A comprehensive list of species in IFNM is not available. The number we have seen is a small fraction of the 450 species reported in southeastern Arizona by the Tucson Audubon Society. The full range of habitat types does not exist in IFNM, and, in particular, the lack of open permanent water or significant riparian areas eliminates some entire orders of birds such as waterfowl, shorebirds, and wading birds, except as transients.

Nine common bird orders that are represented in IFNM are treated below. We will provide a summary of natural history information including unique and special features

and representative species of each order. However, the avid bird enthusiast will want to seek additional references such as the Arizona Breeding Bird Atlas or various field identification guides.

Falconiformes

Birds of prey including hawks, eagles, vultures, and the caracara are large flesh-eaters, taking live prey or carrion. The hooked bill is sharp and stout. They have large, curved talons. Sexes are similar in appearance (except in **American kestrels** treated here) but females are larger than males, and immature birds usually differ little from adults making identification sometimes difficult. More than 10 species occur in IFNM. Some are common and conspicuous such as the American kestrel and red-tailed hawk.

The **turkey vulture** (*Cathartes aura*) is perhaps the most commonly seen species in IFNM. This large, black bird can be seen soaring in the sky throughout IFNM, especially during the warm months, or occasionally feeding on carrion along the road. Its bright red head distinguishes it from the **black vulture** (*Coragyps atratus*) with its black head that occurs in much smaller numbers in IFNM. Juvenile turkey vultures also have black heads. In flight, the turkey vulture holds its wings in a low v-shape compared to the level in-line pattern of the black vulture. The turkey vulture occurs from southern Canada to the tip of South America. It migrates south in the winter and a few individuals from northern populations may be seen in southern Arizona in the winter, but increased numbers appear as individuals migrate back from the south in late January. Vultures are noted for their unusual mode of keeping cool. They urinate on their legs and the evaporation serves to reduce the temperature in the blood vessels in their naked legs and feet.



RIGHT: *Turkey vultures. (Young Cage)*

Turkey vultures have an unusually well developed sense of smell which they use to locate dead animals. Black vultures lack this good sense of smell but are more aggressive and will sometimes chase turkey vultures away from food. Turkey vultures breed from early spring to early summer, raising a brood of 1-3 offspring. They may re-

nest if the first clutch fails. Vultures do not construct a nest, but rather use open ground in a secluded location. Eggs hatch in 38-41 days and chicks fly at 65-90 days of age.

The **red-tailed hawk** (*Buteo jamaicensis*) is a heavy-bodied bird. It is the most common hawk across North America as well as in IFNM. The rusty-red on the top surface of the tail is evident as it soars overhead or perches on a saguaro or utility pole. Resident red-tails remain in pairs year round in the Sonoran Desert, but the population increases with north-bound spring migrants and south-bound fall migrants. These predators feed mostly on small rodents. They breed in early spring and frequently build nests in saguaros. The 1-5 eggs, usually 2-3, hatch in about 30 days and young leave the nest in about 45 days later. Both sexes build and attend the nest.

Harris's hawk (*Parabuteo unicinctus*) is distributed from South America into the extreme southwestern United States, from southern Texas to southern California, where it is a common year-round resident in southern Arizona and IFNM. This hawk is slightly smaller than the red-tailed hawk, and is distinguished by a broad white band across the base of the tail and rufous shoulders. It feeds on small mammals and birds, and frequently hunts in a group of 5 or 6 hawks. This cooperative hunting effort is said to be among the most elaborate ever documented in birds. Nesting activity is concentrated from early spring to mid-summer, but when prey abundance is high, reproduction may occur throughout the year. Most clutches contain 2-3 eggs (1-7 range). Eggs are incubated primarily by the female, and hatch in 29-34 days with young leaving the nest in about 45 days after hatching. Some young may remain with the parental group for as long as four years, and even help raise successive broods.

Several other birds of prey may be encountered in IFNM. We have seen the **golden eagle** (*Aquila chrysaetos*) soaring around the cliffs of Ragged Top, where nesting is probable. These large predators feed on rodents but especially rabbits. We have





Top: *Red-tailed hawk. (Allen Morgan)*
Bottom: *Harris' hawk. (Young Cage)*



Left: *American kestrel. (Young Cagle)*
Right: *Osprey. (Ted Richardson)*

frequently seen the **American kestrel** (*Falco sparverius*) in several IFNM locations, especially in the saguaro forests between Ragged Top and the Samaniego Hills. This small falcon nests in old woodpecker cavities of saguaro. They feed mostly on insects and lizards. We observed the **osprey** (*Pandion haliaetus*) at the east end of the Waterman Mountains once on 20 April 2010. These birds are normally found around large lakes, ponds, canals, rivers, as well as along the coast. It is undoubtedly not common in IFNM, but having watched and photographed it, we couldn't resist including it here as a likely transient bird. The **crested caracara** (*Caracara cheriway*) reaches its

northern distributional limit in south-central Arizona and perhaps in the IFNM. We have seen it in the northern edge of the Samaniego Hills. This beautiful bird often feeds on carrion and may use the activity of vultures to locate food. They tend to frequent a roosting site, thus leaving large amounts of white excrement on rocks. One such site was observed east of Cerro Prieto in the Samaniego Hills.

Galliformes

This order includes mostly large bodied ground-dwelling species. They are incapable of long sustained flight, but some can produce rapid wing beats to burst quickly into full flight for short distances. Representatives include turkeys, grouse, quail, and chicken-like birds distributed world-wide. Only a single gallinaceous species is common in IFNM. A second species, the masked bobwhite, was common in south central Arizona until the 1880s and may have extended into the southern part of IFNM. This species requires lush desert grassland. When the dense grasses disappeared due to large herds of cattle, the masked bobwhite did not survive.

Gambel's quail (*Callipepla gambelli*) is common across southern Arizona south and west of the Mogollon Rim and in IFNM. It feeds on seeds and insects with a reduction in population size and reproduction in dry years. Pairing begins in January and nesting starts as early as March and continues through mid-summer or later. It is not certain whether or not late clutches represent re-nesting or production of a second clutch. Nests of grass and feathers are built on the ground under a bush. The female produces one or two eggs per day until a complement of 10-12 eggs is reached and incubation by the hen begins as the male stands as a sentinel nearby. When the female needs to leave the nest to feed, etc., the male takes over brooding temporarily. The eggs





Top: *Crested caracara. (Dan Flachar)*
Bottom: *Gambel's quail. (Young Cagle)*

hatch in 21-23 days. Clutch size in poor/dry years may be as small as five eggs but as many as 10-14 in good years. Nests with greater than 15 eggs may result from egg dumping by another female. Chicks stay in the nest for a few days because they cannot thermoregulate well, but soon are scampering to keep up with their parents as the covey searches for food. Gambel's quail occurs in the hottest and driest areas of any quail species. During the hot periods they restrict their activity to early morning and late evening and consume vegetation and cactus fruits for water.

Strigiformes

Owls are mostly nocturnal predators, although some are crepuscular, active at twilight. They have unique adaptations that permit their night-time success. Owls have exceptional vision and hearing. The forward facing eyes are large, set far apart, and immovable (set in a bony structure). They can only see items directly in front of them and must turn their heads to see to the side. They have excellent binocular vision. Furthermore, the retina is highly sensitive in low light due the high number of rods. This allows them to see in low light although they cannot see in total darkness. However, some owls are able to catch prey in total darkness because of their greatly developed sense of hearing. Most species have asymmetrically placed ears with enlarged outer ear canals and feathers that form a parabolic trough. This allows for directional hearing. The large inner ear and auditory area of the brain allows them to detect sounds with extreme precision. Some owls are able to detect location of a mouse under the snow or in complete darkness due to their acute hearing abilities.

At least six species of owls are known to occur in IFNM. One of these, the **ferruginous pygmy owl** (*Glaucidium brasilianum*) is near its northern distributional limit and on the



LEFT: *Elf owl.*
RIGHT: *Western screech owl.*
(Both Young Cagle)

endangered species list. The world's smallest species, the **elf owl** (*Micrathene whitneyi*) arrives to breed in southern Arizona by mid-March. Fall migration back to the Pacific slope of Mexico begins in late August. Here we consider two of the most frequently seen species.

The **western screech owl** (*Megascops kennicottii*) is a permanent resident across much of North America west of the Rocky Mountains. It often nests in saguaro cacti, especially in former nests of gilded flickers. Like other owls, it does not build a nest but rather nests in a cavity or in nests previously constructed by other birds. These are small birds, 8-12 inches tall with broad wings that span 22 inches. Breeding begins in March and continues into June. The female broods the clutch of 2-7 (usually 3-5) eggs while being fed by her male partner. Young hatch in 33-34 days and fledging occurs in about four weeks, but young remain near the nest and their parents for another five weeks.



Above. *Great horned owl. (Young Eagle)*

The **great horned owl** (*Bubo virginianus*) is a large bird (body length to 22 inches and wing span to 44 inches) whose crepuscular habits render it one of the easiest owls to observe. It is an opportunistic forager taking items as small as insects and rodents to as large as jackrabbits. It is a resident throughout most of North America and especially prefers open areas of desert habitats. It often nests in old hawks nests in large saguaro cacti. It begins hooting and courtship in late fall and early winter. Nestlings have been observed in Arizona in early January with fledging occurring as early as February 2, but peak nesting activity occurs in late April. Nests in the Sonoran Desert can have six eggs but 2-3 are more common. Incubation lasts for 30-37 days and young leave the nest in 5-7 weeks. Eggs do not hatch at the same time, so in times of food shortages the youngest owlet may be killed by an older sibling. Like all owls, food is swallowed whole and indigestible parts are regurgitated in pellets. It is possible to analyze these pellets, found at the base of nests, to determine types of food consumed.

Piciformes

Woodpeckers are easily identified by their undulating flight pattern. They are noted for their strong bills and long tongues with which they extract insects from trees. Their heads and bills can move at speeds of 20 pecks per second with the force of a thousand times that of gravity. The bone structure of the skull which includes much spongy bone enables it to absorb the blows and protects the brain.

Three woodpeckers are common in IFNM. We have previously discussed (page 50) the **Gila woodpecker**. Of the other two, the **ladder-backed woodpecker** (*Picoides scalaris*) is smallest, 7-8 inches, with the characteristic black and white laddering on the back. The top of the head is black in females and red in males, and both sexes have



Left: *Female ladder-backed woodpecker at nest.*
Right: *Gilded flicker.*
(Both Young Eagle)

distinctive black and white markings on the side of the head. This species is a resident throughout the year. Its range extends from the southwestern United States southward to Nicaragua. It breeds from late March to early July with a peak around the first of June. Usually 4-5 eggs are laid in cavities made in paloverde and mesquite trees. Both parents incubate the eggs that hatch in about 13 days. The period required to fledge is not known. Agriculture, urbanization, and wild fires continue to adversely affect this small desert woodpecker.

The larger (to 11 inches) **gilded flicker** (*Colaptes chrysoides*) is closely associated with the saguaro cactus in which it builds its nest within the interior wood ribs of the cactus. This contrasts with the intermediate-sized Gila woodpecker which builds its nest cavity between the ribs and the outer skin of the cactus. Nesting occurs from

mid-March to late June. Clutches are usually 3-5 eggs and require about 11 days to hatch. Nests are attended by both parents and young fledge at about 21-27 days of age. Re-nesting may occur if an early nest fails and a pair often raises two broods per year. Woodpeckers in general build a new nest each year. In addition to insects, woodpeckers feed on cactus fruits, and the gilded flicker often feeds on the ground, unlike other woodpeckers.

Caprimulgiformes



Above: *Lesser nighthawk. (Robert Ashbaugh)*

Goatsuckers or nightjars (Order Caprimulgiformes) in IFNM include two common species, the **lesser nighthawk** (*Chordeiles acutipennis*) and **common poorwill** (*Phalaenoptilus nuttallii*). These birds are crepuscular, being active at dawn and dusk and sometimes on moonlit nights. They have small beaks but very large gapes with which they scoop up insects in flight. The lesser nighthawk has long pointed wings with which it easily maneuvers to catch prey. The poorwill is a sit-and-wait predator with rounded wings. It scans the dim sky, observes a large insect above, and quickly bursts in flight to catch it. The natural history of the common poorwill is not well known. Some populations migrate as far north as central Washington in the summer and to eastern Mexico in winter. However, residents remain year round in extreme southwestern United States and northern Mexico. Two eggs are produced in early to mid-summer. A second clutch may also be produced. Some of these birds have been observed to remain in a cold torpor, in a kind of temporary hibernation for several days during cold or unfavorable conditions. This is done by reducing their activity and metabolism to a minimum, thus conserving energy.

Lesser nighthawks are summer residents in IFNM, returning from Central America in late winter or early spring. They leave the area by late October or early November.

During their summer stay, their aerobatic flights can be seen in the early evening as they catch insects. Nesting occurs from April-July with a peak in late May. Two eggs require 18-19 days to hatch and are tended entirely by the female. She guards them from overheating by shading them with her wings and even sometimes rolls them into the shade. Once hatched, the male feeds the young which can take short flights by about three weeks old.



Left: Greater roadrunner at nest. Note long-nosed snake being fed to nestlings. (Sandy Rowley)

Cuculiformes

The **greater roadrunner** (*Geococcyx californianus*) is a member of the order Cuculiformes (cuckoos and relatives), and one of the most distinctive birds in the desert southwest. Immortalized in cartoons, this bird mostly travels by foot (up to 15 mph), although it flies with great agility in short bursts if needed. It feeds on any animal life it can swallow, even small rattlesnakes, but it is especially fond of small lizards which it catches with ease. Roadrunners often build nests in cholla or a low shrub or tree. Usually two nesting periods occur, one in late spring and another in mid-summer after the beginning of the monsoon season. In a particular nest, eggs (usually 3-6 but up to 13) are laid periodically so that hatchlings of different ages may occur in the same nest. In times of food shortages, younger hatchlings may be eaten by their older siblings. Eggs hatch in 20 days and fledging occurs in 14-25 days.

Columbiformes

The order Columbiformes (pigeons and doves) includes two prominent species in IFNM although at least two other species occur in much lower numbers. Birds in this order tend to be plump with small heads. Doves eat mostly small seeds and grains. They have a large crop with glands that produce "pigeon milk" which is regurgitated to feed young hatchlings. The **mourning dove** (*Zenaida macroura*) is one of the most common and widespread species in North America and the desert southwest. These birds are residents throughout the year. It prefers open areas and may build its flimsy nest on the ground, in cholla, or in trees. Nesting peaks in late April through late May, but nests have been found in every month of the year in Arizona. Typical clutch size is two eggs that hatch in 13-14 days and young fledge in 13-15 days. Multiple clutches

Below: *Mourning dove. (Young Eagle)*



are produced at about 30 day intervals. Both sexes incubate the eggs but only the male feeds the fledglings for about 12 days as the female prepares for the next nesting.

The **white-winged dove** (*Zenaida asiatica*) occurs broadly across southern and southwestern Arizona. It is especially abundant in the Sonoran Desert where they are an important pollinator of saguaro cacti (see page 42). These migratory doves center their arrival and departure on the flowering season of saguaro. The usual 2 eggs (1-3) hatch in 13-14 days with fledging occurring in 13-15 days. Only one brood is typically produced each year except in areas of high food availability when a second nesting may occur. Some populations of white-winged doves have recently been found not to migrate, perhaps due to agriculture and urbanization which has provided resources for year round residency.



Above: White-winged dove. (Young Cage)

Apodiformes

At least one hummingbird species (order Apodiformes), **Costa's hummingbird** (*Calypte costae*) occurs across the Sonoran Desert and in IFNM, although several other species migrate through or occupy adjacent areas. Hummingbirds occur only in the new world with most species being found in the tropics where flowers are found throughout the year. Most feed actively on nectar and pollen but occasionally a small insect is taken. The highest species density of hummingbirds in the United States occurs in southeastern Arizona (Chiricahua and Huachuca Mountains).

Costa's hummingbird, common in IFNM, is 3.5 inches long and weighs up to 3.5 grams. All hummingbirds have high body temperatures (105-107 F) and high metabolic rates. At rest, the heart rate is 500 beats per minute and 1,250 beats per minute during flight. The wings beat at about 80 beats per second while they are able to move in any direction or stay in place. The high metabolism requires high consumption of food



Left: *Male Costa's hummingbird.*
Right: *Female Costa's hummingbird feeding nestling.*
(Both Young Cage)

daily (up to 70-90 per cent of their body weight in nectar). At night, some "hibernate", reducing their metabolism to a state of torpor.

Costa's hummingbirds frequent canyons and slopes of well vegetated Sonoran Uplands. They nest from early March to early June with a peak in mid-April. Only females build and tend the nest. Males do not play a role in parenting after mating. Nests are made of small twigs and held together with spider webbing. The two eggs require about 16 days to hatch with fledging occurring 20-23 days later. As the summer heat rises, these hummingbirds depart for higher mountain slopes or coastal California.

Passeriformes

The perching birds (Order Passeriformes) comprise most of the species in IFNM. These are mostly medium sized to small land birds with feet adapted for perching. Most have well developed brains and vocal abilities, thus are often known as song birds. Also, the great memory in some species allows individuals to recall the location of many hundreds of buried seeds in their home range for up to a year.

Bird songs or language?

Birds, passerines in particular, are remarkable in their ability to produce vocalizations. These acoustic communication signals are mostly used in male to male aggression and male to female attraction. Experienced bird-watchers and professional ornithologists use species distinctive bird songs to identify birds they hear in the field even if they do not see the bird. But bird songs function in more than species recognition. Males with especially good song repertoires have greater fitness. Furthermore, individual birds learn to recognize the song of their territorial neighbors. With this recognition, the birds expend less energy in potential conflicts of defending their territories against known neighbors. Some birds have been shown to exhibit an enormous number of different song elements (e.g. 3000 in brown thrashers). Knowledge of this ability has led to the study of bird song dialects, even vocabulary and syntax of communications.

Of the many passerines in IFNM, we will highlight a few of the more abundant or unique species for which we have photographs. The avid naturalist will want to use a bird field guide to learn to recognize as many song birds as possible.

The **cactus wren** (*Campylorhynchus brunneicapillus*) may be the most commonly encountered passerine in IFNM. This wren is the largest of four wren species that occur



Right: *Cactus wren. (Robert Ashbaugh)*

in the Sonoran Desert. Others are the canyon wren, rock wren, and Bewick's wren. Cactus wrens occur broadly across southwestern Arizona mostly below the Mogollon Rim. It is the designated Arizona state bird. They occur in the driest regions and obtain all the water they need from food, mostly insects. The cactus wren is not migratory and remains in pairs throughout the year. Their globular nests are placed in various thorny bushes or cacti, especially cholla. A particular pair may have several nests of which one is chosen to receive the clutch of eggs while others are used as roosting sites or perhaps as decoys from nest predators.

Breeding behavior usually begins in early February, but the timing of egg laying and nesting activity depends greatly on the pattern of rainfall. Nesting may be delayed by as many as two months in low rainfall years. Clutches tend to contain 3-5 eggs that hatch in 16-17 days with fledging about 21 days later. Pairs may raise 2-3 broods per year in Arizona.

Of the many sparrow species encountered in IFNM, perhaps the **black-throated sparrow** (*Amphispiza bilineata*), sometimes called the desert sparrow, is the most common. This is an attractive species. Although this sparrow is found throughout most of Arizona, it is a permanent resident of the Sonoran Desert. Its summer range extends as far north as Oregon. One of the most desert adapted species, it is said to exist on seeds and freshly germinated seedlings without the need to obtain free water. This



Left: *Singing black-throated sparrow. (Young Cagle)*
Right: *Black-throated sparrow nest in foothill paloverde bush. (Gordon Hanson)*

retreat to underground burrows. In addition to avoiding heat, many desert mammals consume food with high water content and some have highly efficient kidneys.

All mammals have three unique characteristics: skin covered by fur (hair), three ear bones with acute hearing abilities, and mammary glands that produce milk for feeding young during reasonably long periods of development. Beyond these characteristics, there is much variation among mammal traits. Mammals are endothermic, that is they generate sufficient metabolic heat to maintain a reasonably high and constant body temperature of about 37 degrees C (98° F). Bats however, drop their temperature during inactivity in the day. Most mammals, all in North America, are viviparous (bear living young) and most have well-developed brains and sense organs. Mammals are not generally brightly colored and many live underground. Mammals occur on all continents and in all oceans and have special adaptations that permit survival in particular environments.

Approximately 60 species, of the 125 mammals in Arizona, occur in the Sonoran Desert, of which most may be found in IFNM. These represent five orders and 19 families. Below we discuss the most common species likely to be encountered in IFNM and for which we are fortunate to have photographs. We arrange them by Order with greatest to least number of species.

The order Rodentia has at least 21 species in the Sonoran Desert representing four distinct families. **Rodents** have enlarged front teeth (incisors) that grow continuously throughout life which must be worn away by gnawing. Among the most conspicuous rodents are the squirrels, family Sciuridae. These animals are active during the day and are relatively common in IFNM. The **rock squirrel** (*Spermophilus variegatus*) is the largest sciurid (19 inches including the 8.5 inch tail) in IFNM. It occurs in rocky outcrops and canyons. Although it resembles a tree squirrel with its long bushy tail, this species is

cardinals producing two broods while pyrrhuloxia produce a second only rarely. Both are subject to nest parasitism by cowbirds, but the high attentiveness of the female cardinal that rarely leaves the nest may result in less parasitism than in the pyrrhuloxia. Clutch sizes are similar (2-5 eggs) as is incubation time (11-13 days for cardinals and 14 days for pyrrhuloxia). Fledging occurs in about 10-13 days and fledglings may be fed by parents for another two to three weeks. Both species primarily eat seeds.

The **phainopepla** (*Phainopepla nitens*) appears to be a black cardinal, but its white wing patches in flight suggest a very different species as does its biology. It is unusual in having two very different breeding preferences. In the late winter and early spring it is found in the upland Sonoran Desert where it feeds primarily on mistletoe and typically builds its nests in trees having mistletoe. By late spring it disperses from the desert to more montane habitats where it nests in oak and pine woodlands. It is uncertain

Left: *Pyrrhuloxia.*
Middle: *Northern cardinal.*
Right: *Phainopepla*
(All Young Cagle)



whether or not the same birds nest at both times or not. Phainopeplas lay 2-4 eggs that hatch in about 14 days and remain in the nest for 14-19 days before fledging. They are known to renest if the first attempt fails. Also, unlike *Cardinalis* in which the female prepares the flimsy nest and attends to incubation, the male phainopepla builds a very precise nest and participates with the female in incubation of the eggs.

Curve-billed thrashers (*Toxostoma curvirostre*) are a relatively large passerine (body to 10 inches plus long tail) that inhabits the southwestern United States south to the central volcanic belt of Mexico. It is especially common in habitats with cholla in which it prefers to build its nest. It feeds on the ground on seeds, insects, and berries. Breeding depends greatly on the variation in rainfall. In good rainfall years it may produce young as early as January, but in low rainfall years, nesting may be delayed until late April or May. The clutch size can vary from 3-4 eggs in wet years to only 1-2 in dry years. Both parents participate in nest building and egg incubation. As many as four broods can be produced in wet years. Curve-billed thrashers are common, frequently seen, and year-round residents in IFNM.



Left: *Curve-billed thrasher.* **Right**: *Northern mockingbird.* *(Both Young Cage)*

The **northern mockingbird** (*Mimus polyglottos*), a relative of the thrashers, is found broadly across North America from Canada through Mexico and the Caribbean. It is more abundant in desert areas during wetter years but is a year-round resident in IFNM. This highly adaptable species is noted for its varied and prolific repertoire of songs. It is prevalent in desert thorn scrub and dry desert washes where it feeds mostly on insects. Breeding can occur from late February through August with a peak in mid-June. Male mockingbirds may build several nests before his mate selects one for nesting. Clutches vary from 2-6 (usually 3-5) eggs that are incubated by the female for 12-13 days and both parents feed the nestlings which fledge in about 12 days. Northern mockingbirds raise two, sometimes three broods per year.

Left: *Verdin.*
Right: *Verdin nest. (Both Young Cagle)*



Verdins (*Auriparus flaviceps*) are tiny (body 3.5 inches) yellow-faced passerines with a chestnut colored shoulder patch and short, small bills. They feed mostly on insects but take some seeds, spiders, berries, and nectar. These are very active birds not easily observed, but they build substantial globular nests with thorny stems and grass that persist through the seasons and are more noticeable than the birds themselves. The nest, which is also used for roosting has a small opening situated low on one end. The opening often faces the direction of the prevailing wind. Nests are typically placed in a thorny bush such as paloverde, acacia, graythorn, or mesquite. These are year-round residents. Nesting can occur from late February through late July with a clutch of 3-6 eggs being incubated exclusively by the female for 14-18 days until hatching. The female feeds the young for about the first week at which time the male begins to contribute to feeding. Young leave the nest in 17-21 days but parental feeding may continue for another 18 days. Verdins typically raise two broods per year.

Below: *Black-tailed gnatcatcher. (Robert Ashbaugh)*



The **black-tailed gnatcatcher** (*Polioptila melanura*), like the verdin, is a very small (body four inches) bird but with a long tail. It is resident and common throughout the Sonoran Desert where it favors low elevation scrubland containing spiny legumes and cacti. These birds are probably monogamous and remain paired throughout the year. Nesting activity begins as early as mid-February with most broods being fledged before the heat of the summer. The peak of nesting occurs around the first of May. These birds feed on small insects. They build a compact, cup-shaped nest in thorny bushes, from paloverde to wolfberry, and sometimes in mistletoe clumps. Clutches of 3-5 (typically 4) eggs hatch in about 14-15 days. Both parents feed the nestlings until they fledge 9-14 days later. Parental care may continue for up to three weeks. A pair generally produces two broods and will re-nest if earlier broods fail.

Animal Life



Left: *Bobcat on saguaro. (Young Cagle)*

Mammals

Among the most familiar but perhaps least seen of all vertebrates in IFNM are mammals. The hot and dry environment necessitates many mammal species to restrict their activity to nocturnal or twilight periods. The few that are active during the day, such as squirrels, must be aware of diurnal predators such as hawks, and thus quickly

retreat to underground burrows. In addition to avoiding heat, many desert mammals consume food with high water content and some have highly efficient kidneys.

All mammals have three unique characteristics: skin covered by fur (hair), three ear bones with acute hearing abilities, and mammary glands that produce milk for feeding young during reasonably long periods of development. Beyond these characteristics, there is much variation among mammal traits. Mammals are endothermic, that is they generate sufficient metabolic heat to maintain a reasonably high and constant body temperature of about 37 degrees C (98° F). Bats however, drop their temperature during inactivity in the day. Most mammals, all in North America, are viviparous (bear living young) and most have well-developed brains and sense organs. Mammals are not generally brightly colored and many live underground. Mammals occur on all continents and in all oceans and have special adaptations that permit survival in particular environments.

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Left: *Rock squirrel family (Young Cagle)*
Right: *Rock squirrel (Jillian Cowles)*

mostly terrestrial in spite of its ability to climb trees. This grayish-brown squirrel is found widely in the southwestern United States from Utah and Nevada to central Mexico. It may live solitarily in a rock pile but often occurs in colonies consisting of a dominant male and several females and their young. A repeated sharp and clear whistle warning-call serves to alert the colony of danger. Females build a burrow or nest at the base of a boulder or cliff which they tend to defend from their immediate neighbors. Rock squirrels are omnivorous, eating a wide variety of items including seeds, mesquite beans, cactus fruit, young leaves, roots, insects, young birds, and even carrion. They become dormant in the cold winter months, but probably do not truly hibernate in southern locales such as IFNM because they can be seen occasionally on warm winter days. Mating presumably occurs in early spring through early summer with birth of litters occurring in late March and again in August. The gestation period is 28-30 days. Number of young per litter varies from 1-7 (usually 2-5). Young may be seen out of the burrow at 6-8 weeks of age.



Left: *Round-tailed ground squirrel. (Young Cagle)*
Middle: *Round-tailed ground squirrel on alert. (Rill)*
Right: *Harris' antelope squirrel. (Young Cagle)*

The **round-tailed ground squirrel** (*Spermophilus tereticaudus*) is common in IFNM, especially in sandy soils, creosotebush flats, and lower alluvial fans with relatively deep soils. They tend to occur in small colonies and resemble small prairie dogs both in appearance and behavior. They can be seen standing upright or making alarm calls if danger is spotted. They may hibernate through the cold months, but this is likely a winter torpor or deep sleep rather than true hibernation because periods of activity can occur during warm periods. Emergence from winter sleep occurs in February as spring plants begin to appear. They depend heavily on newly produced green vegetation because their food averages about 80 per cent water. They also eat seeds, cactus fruits, and insects. Mating activity occurs in early spring and a litter of 1-12 (usually 5-6) pups is produced after a gestation period of 28 days in late March or early April.

The third sciurid is **Harris' antelope squirrel** (*Ammospermophilus harrisii*) which resembles chipmunks that occur at higher altitudes. Like chipmunks, it has light stripes on its sides (but not face) and holds its tail high above its back. especially while running. This small squirrel (body to 6 inches, tail to 3 inches) is active year-round. It is found in the low deserts of Arizona, extreme southwestern New Mexico, and southward through the state of Sonora, Mexico. In IFNM, it occurs in rocky soils and on higher

slopes somewhat between the habitats of the round-tailed ground squirrel and rock squirrel. Harris' antelope squirrels have a high body temperature (97-107° F) and use a heat reduction behavior called heat dumping. This involves moving into a shady area and sprawling, "spread eagle", against the cool ground. They feed on cactus fruits, mesquite beans, and insects, often storing food in their burrows which may occur singly or in small groups. It breeds only once per year with a litter of 4-9 pups being born in early spring. Gestation takes 30 days and maturity is reached in their first year after birth.

A second family of rodents, the Geomyidae, contains one species that is common in the Sonoran Desert and IFNM. **Botta's pocket gopher** (*Thomomys bottae*) ranges widely from southern Oregon to Central Texas and southward into Mexico including Baja California. This animal lives almost entirely underground in burrows that it excavates with its powerful front limbs, large front claws, and incisors. It rarely is found above ground except during dispersal of young and when it searches for a mate. Its presence can be seen in the form of small mounds of fresh dirt that it pushes up above the surface as it cleans or extends its tunnel. These tunnels may extend for 200 yards and are of two types. Those closest to the surface are feeding tunnels where the gopher grazes on the roots of plants, sometimes pulling plants into the tunnel from below. Gophers are almost exclusively vegetarian. The second type of tunnel may extend from three to nine feet deep with side tunnels for nesting, storage, or latrine purposes. Botta's pocket gopher is a medium sized (body 9-10 inches) gopher with a short (three inches) almost naked tail. The tail is used as the gopher backs up, which it can at rates about as fast as its forward movements. Males are larger than females. Females stop growing during their first pregnancy while males grow throughout life. The front limbs are large and muscular with very large claws. Its large front teeth grow constantly (about 9-14 inches per year), so constant gnawing is required to maintain an optimum



Above: Botta's pocket gopher. (Allan Morgan)

size. The mouth closes behind the front teeth to prevent dirt from entering the mouth. There is a fur-lined pocket on each side of the mouth that is used to transport food. The fur is short and velvety which gives little resistance regardless of which direction the gopher is moving in its tunnel. The fur varies widely in color (white, brown, or black) and typically matches the soil color. **Gophers** are active year around, and one study in Utah estimated that a single gopher moved over a ton of soil per year as it constructed and maintained its underground maze of tunnels. Gophers are highly territorial and strictly solitary. They seek company only during the mating season, about once or twice per year in the desert, but reproduction in the population may occur throughout the year in very productive places such as an alfalfa field. Litters vary from 2-10 young after a gestation period of about 19 days and young may mature in as little as three months.

The remaining rodents might be termed **rats** and **mice**, although two different families are represented. One family (Muridae) includes over 1,300 species of rats and mice that occur around the world, with 85 species in North America, 19 of these occurring in some part of the Sonoran Desert. Murids have three cheek teeth on each side of both jaws. They lack external cheek pouches, and are very mouse-like in appearance. Murids are predominately nocturnal, although some may venture out at other times. Among the most familiar, in the desert southwest, are the **woodrats** or **packrats** as they are commonly called. Of species in Arizona, the most common one in IFNM is the **western white-throated woodrat** (*Neotoma albigula*). It builds large (3 by 4 by 8 feet) nests of sticks, cholla stems, and cactus pads. It rarely occurs in residential areas. It is especially common in areas diverse in cacti. Woodrats feed on cactus fruit, mesquite and paloverde beans, and cholla stems. Some of these items may be stored in the base of their nest while others may be added to their house of sticks. Many animals, including **snakes** and **Gila monsters**, find refuge in packrat nests. Otherwise

Below *Packrat nest. (Robert Ashbaugh)*





Left: *Western white-throated woodrat (Young Cage)*
Right: *Southern grasshopper mouse. (Allan Morgan)*

these animals are solitary except during the mating season or when they are raising their young. Reproduction occurs in spring or summer and typically two litters are produced each year. Gestation requires 37-38 days with 2-3 young born in spring or early summer. In western Arizona, weaning occurs at 27-40 days and sexual maturity is reached in 80-87 days. Lifespan is about 45 months in nature but has been observed to reach 72 months in captivity. Mating is promiscuous and no pair bonding occurs.

A very different murid, the **southern grasshopper mouse** (*Onychomys torridus*) is common in the Sonoran Desert. This mouse is small bodied (3.5 inches) with a short (2 inch) tail. It has medium sized ears, and the stocky body is covered with fine, dense fur that is tan to gray above (depending on soil color to which it is adapted) but white or cream on the belly. Unlike most other mice, *Onychomys* is carnivorous, eating insects, scorpions, and even mice, although its diet can consist of as much as 10-25 per cent of seeds or vegetable matter. It forms pair bonds and defends a large home range (2-3 hectares) using a variety of vocalizations. It has been observed to stand on its hind legs and emit a loud, clear shrill call that can be heard up to 100 yards away.

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Deer mice are among the most abundant of mammals in the Sonoran Desert. They are a primary food source for many predators including hawks, owls, coyotes, bobcats, and snakes. Population sizes of these mice can fluctuate greatly depending on available food and predator pressure. *Peromyscus* is known to be a host to hantavirus, plague, and Lyme disease, although none of these have been reported in IFNM to our knowledge.

The last group of rodents is the family Heteromyidae, the **pocket mice** and **kangaroo rats**. The 60 species of this family are found only in the New World from southern Canada to northwestern South America. Of 41 species in the United States, 11 occur in some part of the Sonoran Desert. Heteromyids have four cheek teeth on each side of both the upper and lower jaw. They have external cheek pouches, usually small ears, large heads, often enlarged hind-limbs for jumping, and generally long tails. The external cheek pouches are lined with fur and are used to store and transport seeds. The cheek pouches open outside of the mouth, and they can be emptied quickly with actions of the small front legs to deposit seeds in a storage cache which is often in their underground burrow system.

Kangaroo rats are noted for their jumping ability. They can leap 6-9 feet, depending on species. Of the 17 species in the western United States, two species are especially common in the Sonoran Desert and IFNM. **Merriam's kangaroo rat** (*Dipodomys merriami*) occurs broadly across southern Arizona in a variety of habitats. In IFNM it occurs from washes to creosotebush flats. It is much smaller (head and body to 4 inches; tail to 5.5 inches) than its cousin, the **banner-tailed kangaroo rat** (*Dipodomys spectabilis*) which ranges from 5.75 to 7.75 inches in these dimensions. Merriam's kangaroo rat makes much smaller tunnels at the base of bushes and typically places seeds in small caches outside its tunnel. The banner-tailed kangaroo rat makes an extensive tunnel

Below: *Banner-tailed kangaroo rat. (Allan Morgan)*



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slow fluttering but highly maneuverable flight pattern. Its reproductive pattern involves mating in the fall, delayed development through the winter, and rapid development until birth in May or June.



Left: *Bats at hummingbird feeder. (Allan Morgan)* Right: *Lesser long-nosed bat. (Dr. Ronnie Sidner)*

The lesser long-nosed bat (*Leptonycteris yerbabuenae*) has a smaller nose-leaf and shorter ears than *Macrotus*. It is migratory and arrives in southern Arizona in late spring to bear young during May-June at the time of peak saguaro flower availability. They roost in large colonies. These bats feed on nectar and pollen of large cacti and agaves. The long snout and very long tongue aid in feeding. These bats return southward to southern Mexico, feeding on agaves at higher altitudes. The lesser long-nosed bat is on the United States Endangered Species List. At least four colonies of these bats are known in southern Arizona, with those bats in IFNM probably associated with a large abandoned mine within 25 miles of Ragged Top. When the species was listed endangered in 1988, their numbers were thought to be in great decline. More roosts and more bats of this species are now known in southern Arizona.

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The order Carnivora represents meat-eating predators, although many take fruits, nuts, and other vegetable matter. They are usually large and wide-ranging with teeth adapted for piercing and tearing flesh of their prey. In the Sonoran Desert and IFNM, 13 species and four families are represented.

The Canidae includes **foxes**, **wolves** and other dog-like predators. The **coyote** (*Canis latrans*) is perhaps the most familiar and commonly heard, if not seen. A highly intelligent and adaptable animal, this is one of the few mammals that has increased its population size and range in the face of human encroachment on its habitat. These canids are the size of a medium-large dog, 24 inches high at the shoulder with a body length of 31 inches and weighing about 25 pounds, although desert coyotes tend to be skinny. They tend to sleep during the day in dense vegetation and hunt at night and at twilight. Coyotes eat a variety of items from carrion to small mammals, birds, reptiles, insects, fruit, and vegetable matter. They may hunt alone but frequently in small packs of 3-7 individuals. The pack typically consists of a mated pair and their offspring of various ages. They tend to maintain scent marked territories of 150 to 1,500 acres. Mating occurs once per year (January-March) with a litter of pups (up to seven but usually 4-6) being born in April-May following a two month gestation period. After weaning, males disperse but females tend to stay with the natal pack for several years, helping to raise the next litters. Life span is 3-7 years.

The **gray fox** (*Urocyon cinereoargenteus*) is smaller than the coyote, measuring 14 inches at the shoulder, to 28 inches long and 5-15 pounds. There is a black stripe down the midline of the tail. Gray foxes tend to prefer rocky canyons and hills, compared to the coyote, but like coyotes they are omnivores feeding on carrion to small mammals, snakes, birds, insects, and plant matter. They may climb trees to escape predators or feed on fruit. Gray foxes tend to occur singly or in mating pairs and are not as social as

Top: *Coyote*
Bottom: *Gray fox. (Both Young Cubs)*





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rodents, insects, and vegetable matter but occasionally takes a deer. It occurs in the Sonoran Desert uplands especially in areas of canyons and heavy brush. It occasionally ventures into cities and towns. Mating occurs in early spring and a litter (2-3 kittens) is produced after two months gestation.

The **cougar** or **mountain lion** (*Puma concolor*) is a large animal (3-5 feet head-body; 24-40 inches tail; 65-260 pounds) with a large home range (10-300 square miles). It prefers habitats with heavy underbrush and rocky areas. In the Tucson area, studies



Left: *Female bobcat with yearling (Young Cage)*
Right: *Mountain lion. (Robert Ashcraft)*

have shown that a single individual cougar ranged over several mountain ranges (e.g. Picacho, Tortolita, and Santa Catalina Mountains, an area of 636 square miles). We are unaware if similar studies have been done in IFNM. These animals are solitary, territorial, and mostly nocturnal. The larger territory of a male may overlap with several females. They generally take large prey (e.g. deer, javelina, bighorn sheep, etc.) which they stalk and ambush, but they are generalists and also will eat small prey from

rodents to rabbits. A meal of a single deer takes a couple of days to consume and after such a catch the cougar may not feed for 6-12 days. These powerful predators can leap as high as 18 feet or 40 feet horizontally. They have excellent sprint speed, but they do not have the endurance for a chase exceeding 100 yards. Males and females remain apart except for a few days during mating which can occur during any time of the year. After a gestation period of 91 days a litter of 1-6 (typically 2-3) young are born. The initially spotted kittens are weaned at about three months of age, but they remain with their mother for eighteen months before striking out on their own. Lifespan in the wild is 8-13 years but up to 20 years in captivity.

Historically, two other felids may have occurred in the Sonoran Desert. These include the **ocelot** (*Leopardus pardalis*) and **jaguar** (*Panthera onca*), but recent sightings of these species have only been in southeastern Arizona.

At least one representative of the family Procyonidae is found in IFNM. This is the **ringtail** (sometimes erroneously called a **ring-tailed cat**, *Bassaricus astutus*). Other members of this family including the **raccoon** (*Procyon lotor*) and the **white-nosed coatil** (*Nasua narica*) probably do not occur in IFNM. They do occur in the Sonoran Desert in specific habitats.

Below: Ringtail (Young Cage)



Ringtails are common in the rocky desert habitats that occur in IFNM. They are distributed in the southwestern United States and along the west coast to central Oregon, the southern plains, and southward to Oaxaca state, Mexico. Ringtails are about the size of a housecat with head and body of 12-15 inches, tail 13-17 inches, and 1.75-3.3 pounds. They are nocturnal, solitary, and shy. They are excellent climbers and leapers. The long, bushy, black and white ringed tail is often used as a counter-balance. Like other procyonids, their omnivorous diet consists of berries, fruits, nuts, rodents, rabbits, small birds, snakes, lizards, insects, and vegetable matter. Mating

occurs in March-April with 1-4 young being born in June after a 45-50 day gestation period. Young begin hunting at 2-3 months of age and mature at 10 months. The ringtail lives about seven years in the wild. It is the state mammal of Arizona.

One member of the family Mustelidae is the **American badger** (*Taxidea taxus*). This species is distributed broadly from southwestern Canada, western and central United States, and southward to central Mexico. It prefers areas of sandy loam soil in which it digs its den. In IFNM, it likely occurs in creosotebush flats which harbor many rodent species. We found a skeleton of a badger in the Samaniego Hills. They are fairly large animals, the largest mustelid (head and body to 26 inches; tail to 6 inches; and 11-26 pounds) with a stocky and short-legged body. The front feet have very large claws (2-3 inches in length) suited to proficient digging for their favorite prey of burrowing animals such as mice, kangaroo rats, and ground squirrels. Badgers are solitary and nocturnal predators. A badger digs several dens, some up to 30 feet long and 10 feet deep. These are scattered in its home range of up to 2,000 acres. In bad weather, the badger may remain in the den for extended periods, but they do not hibernate. Mating occurs in late summer or fall, and young (1-5 but usually 3) are born in late March or early April due to delayed implantation of embryos. Young badgers first emerge from the natal den at 5-6 weeks but remain with their mother until mid to late summer. Females may mate at one year of age, but males do not breed until their second year. Lifespan in the wild is about 9-12 years but as much as 15 years in captivity. Badgers are eaten in some cultures including Native Americans, but we are not certain if there are specific records for the southwestern cultures in our area.



Below: *American badger. (Allan Morgan)*

The last group of carnivores in IFNM had been considered part of the family Mustelidae. Recently, the **skunks** have been separated into their own family, the Mephitidae. Skunks are commonly known by most people, even if only because of their

characteristic odor as one passes a DOR (dead-on-road) specimen on the highway. Skunks spray this odor from glands at the base of their tail. It is an effective predator defense mechanism. Their worst enemy is the great horned owl which has little sense of smell.

Chemistry of Skunk Spray

The noxious odor of skunk spray results from specific chemicals, especially of two major groups of compounds. These include thiols and acetate derivatives of thiols. Thiols are basically the sulfur analogue of alcohols where sulfur takes the place of oxygen in the hydroxyl group of an alcohol. They are highly odiferous and can be detected by the human nose in extremely low concentrations (10 parts per billion). Thiols are used as odorants to assist in the detection of natural gas which is usually odorless unless some sulfur compound is present. Each skunk species has a unique composition of its spray. The striped skunk has seven specific volatile thiol compounds in its spray whereas the spotted skunk has only three. To deodorize skunk spray, the thiols can be oxidized to compounds that have little or no odor such as sulfonic acids. Among the many oxidizing agents that can be used are hydrogen peroxide, baking soda, and liquid laundry bleach.

In the Sonoran Desert, there are four species of skunks. It is possible that all four occur in IFNM, but we are unaware of such records. Based on general abundance and habitat requirements, we discuss two species, the **striped skunk** and the **western spotted skunk**, that likely occur in IFNM.

The striped skunk (*Mephitis mephitis*) is distributed widely across North America from the Northwest Territories, Canada, to the Mexican plateau of Chihuahua, Mexico. They occur in the Arizona Uplands and along wooded washes of the Sonoran Desert

and IFNM. Striped skunks are so named because of two prominent white stripes along the back of the black body that meet on the back of the head to form a narrow white stripe down the center of the face. This is a medium-sized skunk (head and body of 12-20 inches; tail 9-14 inches; weight of 2-11 pounds). They are typically solitary and nocturnal but may form small groups in dens or while foraging for food. They feed on insects, birds, bird eggs, fruit, vegetation, and carrion. They are active year round and mate in late winter or early spring. A litter of 3-10 young are born in May. Lifespan is about 2-3 years in the wild.



Left: *Striped skunk.* Right: *Western spotted skunk. (Both Young Cage)*

The western spotted skunk (***Spilogale gracilis***) occurs throughout the western United States from southwestern British Columbia, Canada southward into northern Mexico. It occurs in brushy and rocky canyons in the Sonoran Desert. This species is noted for its spotted and irregularly blotched white on black color pattern, and for its habit of standing on its front feet as it sprays potential predators. It is smaller (head and body of 8-11 inches; tail of 4-6 inches; weight of 7-30 ounces) than other skunks. Nocturnal and secretive, it is the only skunk that climbs into trees for protection or in search of its omnivorous diet of insects, lizards, mice, birds, and bird eggs. It also eats carrion

and some vegetable matter. Mating occurs in September-October, but implantation of embryos is delayed such that birth occurs in April-May. Litters of young (2-6) stay with their mother for 3-4 months before dispersing as occurs in other skunks. Lifespan is probably 3-4 years in the wild but there is a record of over 8 years in captivity.

Ungulates, hoofed mammals, include two orders. Perissodactyla include those with an odd number of toes. No native species occur in the Sonoran Desert today although at least two (now extinct) -- a **tapir** and the **North American horse**-- were present at the time of the Paleoindian culture about 10,000 BCE. The even-toed ungulates (Order Artiodactyla) are represented in the Sonoran Desert today. These include the **pronghorn**, **mule deer**, **javelina**, and **bighorn sheep** (see page 48). The pronghorn is not known to occur in IFNM, but both the javelina and mule deer are common. **White-tailed deer** are sometimes found along dense riparian drainages.

The javelina or **collared peccary** (*Tayassu tajacu*) occurs from the southwestern United States (AZ, NM, TX) southward through Mexico and Central America to Peru and northern Argentina of South America. The peccary is pig-like in appearance, but a member of the New World family Tayassuidae rather than Suidae that only occurs in the

Left: Javelina feeding on cholla. (RB)
Middle: Javelina with new born (Young Cage)
Right: Javelina herd with young. (RB)





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The **rock pocket mouse** (*Chaetodipus intermedius*) weighs 0.2 to 0.6 ounces. It occurs on rocky slopes, avoiding sandy soils, and often uses cracks or crevices for shelter. Its burrow is usually near or under a rock. It becomes inactive (torpid) November to February. It breeds in the spring or early summer producing one or more litters of 1-7 young.

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Above: Mule deer in velvet. (Young Cage)

Mule deer are browsers, feeding on leaves, twigs, and fruit of trees and shrubs, although they will take grass and herbs when available. The buck is often solitary during the summer while does are with their young. They occupy a home range of 1-2 square miles. Breeding season is late October through December and both sexes may mate with several partners during the rutting season. After a gestation period of about 190 days, 1-2 fawns are born by mid-summer. Fawns are reddish brown with small white spots which are lost in a couple of months. Fawns stay with their mother until the following spring and become sexually mature in about 18 months. Bucks lose their antlers during the winter and begin almost immediately to grow new ones. The new antlers are developed under a layer of skin called velvet. As the antlers reach their maximum size in the early fall, velvet is shed as fighting between bucks occurs for access to does for mating. Lifespan is about 10 years.

The order Lagomorpha is the last order of mammals and the one with the fewest (1 **rabbit** and 2 **hares**) species in IFNM and the Sonoran Desert. Lagomorphs are closely related to rodents. Both have large incisor teeth that grow continuously throughout life and are used for clipping vegetation during feeding. Rodents have a single pair of upper incisors whereas lagomorphs have three pairs of incisors at birth. The outer pair is soon lost and the third pair is situated as small pegs behind a large pair of front incisors. Lagomorphs also have an unusual process of digesting vegetable matter. They produce two types of fecal pellets, wet and dry. The wet pellets are reingested, passing through the digestive tract a second time. This allows food to be broken down by bacterial action in the caecum before it is passed through the gastrointestinal tract a second time.

Cottontails are rabbits and **jackrabbits** are hares, but the difference is more about their life history than their taxonomy. Both are in the same family, Leporidae.



Left: *Desert cottontail. (Dr. Jim Pietz)*
Right: *Black-tailed jackrabbit (Young Cagle)*

Hares tend to be larger, more solitary, have longer legs, depend on speed (up to 35-45 miles per hour) and long-distance runs to escape predators, and have precocial young. The young are born with hair and open eyes and ready to leave the nest and fend for themselves soon after birth. Rabbits are more social, depend more on crypsis, have a zig-zag run then hide escape strategy, have shorter ears, and have altricial young. The young are born with eyes closed, are hairless, and unable to leave the nest for a few weeks. Furthermore, rabbits have been domesticated, but no species of hare has been so tamed.

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Bailey's pocket mouse (*Chaetodipus baileyi*) weighs up to 1.5 ounces and prefers rocky slopes among cacti and shrubs. In addition to mesquite beans and other seeds, it is known to eat jojoba nuts which are toxic to most mammals. It is active year round and breeds from April – August producing two litters of 1-6 young each. It occasionally aestivates during the hottest part of the summer.

The **rock pocket mouse** (*Chaetodipus intermedius*) weighs 0.2 to 0.6 ounces. It occurs on rocky slopes, avoiding sandy soils, and often uses cracks or crevices for shelter. Its burrow is usually near or under a rock. It becomes inactive (torpid) November to February. It breeds in the spring or early summer producing one or more litters of 1-7 young.

Bats (Order Chiroptera) make up the order with the highest number of species in the Sonoran Desert although relatively few species occur in IFNM perhaps due to the limited number of roosting sites. To our knowledge, at least six species have been recorded in IFNM, but we are unaware whether or not a comprehensive bat survey has been done.

Bats are unique among mammals in several respects. This is the only group of mammals capable of true flight. Others, such as **flying squirrels**, are simply able to glide. The wings of bats consist of a membrane stretched over the bones of the forelimb and hand. Some species have longer and narrower wings that are suited for long-distance flight whereas other species have wider, shorter wings that permit high maneuverability. In most species, a second membrane occurs across the hind-limbs and tail. Bats are mostly nocturnal and possess the unusual ability of echolocation. They emit high frequency sounds inaudible to humans. This sound bounces off objects in a manner like sonar. The returned sound tells them the location of objects ahead, including insects upon which they feed. Echolocation is so well developed in some

Changes and Threats to IFNM



Left. *Abandoned vehicle used for target practice. (Gordon Hanson)*

Environments on earth constantly change. As the planet has warmed and dried over the past 10,000 years, the Sonoran Desert developed from relatively wet grassland with marshy areas and flowing streams. Savannahs having trees and shrubs supported the now extinct megafauna and Paleoindian culture. Continued drying was partly responsible for the disappearance of

ancient cultures (e.g. Hohokam) from the Sonoran Desert in the 14th and 15th centuries. Effects of global warming, which is accelerating due to increased atmospheric carbon dioxide accumulation (a recent record of over 400 parts per million at Mauna Loa lab in Hawaii) from industrialization, portends an uncertain future for our world. But what is certain, it will continue to change. It will likely mean a hotter and drier Sonoran Desert. A water shortage crisis may once again lead to the demise of agriculture as urbanization and industrialization march forward until perhaps modern society will suffer the same fate as the Hohokam.

Regardless of long-term environmental changes, immediate and significant threats to IFNM are already upon us. Most of these immediate threats can be attributed to human activities. These include both direct and indirect threats and impacts. Direct impacts involve impacts on the soil and life forms as well as the deposition of trash and litter. Designation of the area as a national monument was intended to preserve the natural and historical resources of IFNM for future generations. Furthermore, actions and efforts by the Bureau of Land Management (consult the BLM's Resource Management Plan) to restrict target firearm shooting, close some roads, and close washes to ATV traffic has minimized some direct environmental degradation. However, illegal movement of drugs and people through the area continues to pose problems as does the occasional juvenile assaults on the saguaros and vandalism of petroglyphs. Vigilance by both BLM rangers and the public to enforce the resource management plan recently adopted will be needed to reduce the immediate detrimental impact on the environment in IFNM. A recent clean-up effort by the Friends of Ironwood Forest and their partners, most notably the Dove Mountain Hikers, resulted in the removal of over a ton of trash in one area on one day. Perhaps the greatest threat to habitats in IFNM is that of past, sometimes purposeful introduction of non-native species. These



Above: *Saguaro used for target practice. (Gordon Hanson)*



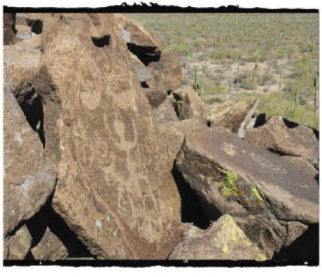
Above: *Example of trash in a ravine in IFNM. (Lahaha Brown)*
Below: *Collecting trash in the Sawtooth Mountains. (Gordon Hanson)*

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Postscript: Anthropomorphs



Left: Hohokam (Gila style) petroglyphs. (Gordon Hanson)

Few works of natural history consider anthropomorphs as part of the story unless they are concerned with locales where *Pan* or other great apes are indeed a regular part of nature. Almost by definition, any area occupied by *Homo sapiens* is no longer natural. Humans have had such a dominating impact on nature that most natural historians regard their role as extra-

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great ice sheets retreated from North America, it is believed that the Paleoindians followed the megafauna northward. Archaeological evidence indicates that big-game hunting did not continue after Clovis time in the southern deserts.

The next recognized culture in the area of IFNM is referred to as the Archaic peoples. At the end of the Pleistocene, the Southwest became very dry and did not support sufficient grasslands for big-game animals that had existed previously. This was the beginning of the Holocene, with people whose economies were adapted to collecting plants and small game. The flint points changed from Clovis to a variety of smaller non-fluted types that were shafted for smaller delivery. Milling stones and hand stones (manos) became common, indicating the processing of plants. Like their predecessors the Paleoindians, however, the Archaic people still were very nomadic, probably to take advantage of different wild plant resources that became available elsewhere with the passing of the seasons. A 2005 cultural resources survey of the IFNM identified numerous scatters of stone artifacts and lithic quarry sites where people sought stone material suitable for use as tools, probably used by Archaic peoples during their exploitation of desert resources over thousands of years. Some of these sites are associated with Archaic-style projectile points, cleared trails through the desert pavement, concentrations of thermally altered stones indicating the presence of hearths, or small rock rings interpreted as supports for baskets used in resource-gathering. There are also a number of rock art sites in IFNM and in nearby desert mountains with unique motifs that have been identified as Archaic in origin. The Archaic culture is believed to have developed in southern Arizona after about 8000 BCE as people adapted from the mammoth-hunting way of life to more reliance on wild plant resources and small game, and expanded their range into areas beyond the regions used primarily by the former Paleoindians. It is easy to imagine how these

Archaic peoples hunted and gathered resources among the very mountain ranges in IFNM that we see today. They no doubt enjoyed much the same set of flora and fauna that we do presently.



Ruin: *Petroglyphs: Perhaps a mixture of Western Archaic and Gila style. (RB)*

Evidence of the existence of peoples of the Early Agricultural period (2100 BCE to 200 CE) is found in a variety of places in the Tucson Basin. These peoples presumably transitioned gradually to an economy dependent on plants purposefully

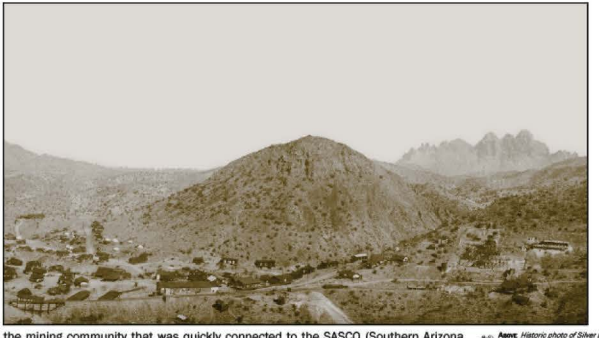
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Above: *Historic photo of Silver Bell Camp, 1918 looking north toward Ragged Top (courtesy of University of Arizona Libraries, Special Collections)*

the mining community that was quickly connected to the SASCO (Southern Arizona Smelting Co.) smelter by rail. The town, situated where the western boundary of IFNM was later placed, was short lived. Its memory now exists only as masonry building foundations and a cemetery with graves dating to as early as the 1880s. Most of the graves were founded in 1918-1919 for those who succumbed to the Spanish Flu epidemic. The fate of the Silver Bell mine has waxed and waned with the price of copper over the years. Always a part of the landscape on the western side of the

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About the Authors



Royce E. Ballinger (Ph.D. Texas A&M University) is Professor Emeritus of Biological Sciences at the University of Nebraska-Lincoln. During his academic career in Texas (Angelo State University) and Nebraska, he served in several leadership positions including Director of the School of Biological Sciences, Director of Nebraska EPSCoR, Assistant Executive Vice President (UN system), and President of the UNL Academic Senate. He taught over 35 different college courses in his specialty area of ecology and vertebrate zoology and focused his field research in the southwestern United States and Mexico. After moving to Arizona in 2004, he has continued his study of the desert southwest, including its natural history and archaeology. He served on the Board of the Friends of Ironwood Forest.



Young D. Cage was trained in aeronautical engineering (B.S. University of Colorado) and served as a pilot for United Airlines for 35 years. He retired as Captain of the Boeing 777 after having served in several leadership capacities in the airline industry. He retired to the desert southwest to pursue his life-long passion for nature, especially herpetology and photography. He was twice President of the Tucson Herpetological Society and previously President of the Colorado Herpetological Society. Many of his excellent photographs can be found in homes and businesses around Tucson. He served on the Board of the Friends of Ironwood Forest and was honored by having his name attached to the award given by FIF, the "Young Cage Volunteer of the Year" award. It was only after his unexpected passing on May 28, 2012 that many of us realized what his many friends and colleagues had always known. Young's greatest talent was his skill with people, an ability to command the respect, attention, and admiration of people, young and old. He was a natural leader.

Endorsements

"Ironwood Forest National Monument is a wonderful preserve full of the desert plants and animals that are the heroes of Royce Ballinger's fine introduction to this place. Read the book, admire the superb photographs by Young Cage, and come away with an enhanced appreciation for an American treasure, the Sonoran Desert of Arizona."
Dr. John Alcock, Regents Professor Emeritus, Arizona State University and author of several books including *When the Rains Come: A Naturalist's Year in the Sonoran Desert*

"Lavishly illustrated with gorgeous color photographs and encylopedic in its Sonoran Desert content, this is the one field guide you shouldn't be without. Not just about things only found in the Ironwood Forest National Monument, this is a welcome guide for desert newcomers and seasoned naturalists. Congratulations to Ballinger and Cage on this fine book."
Dr. Stephen Buchmann, Affiliate Scientist in entomology, University of Arizona and author of books including *Letters from the Hive: An Intimate History of Bees, Honey, and Humankind* **and** *The Forgotten Pollinators*

"Ironwood Forest National Monument is a new natural treasure in southern Arizona. Located a short distance west of Tucson and the western unit of Saguaro National Park, it has received little publicity since its creation in 2000, so it is nearly unknown even to most local people. And until now there was no easy way to learn about it. Ballinger and Cage's book Natural History of Ironwood Forest National Monument: A Sonoran Desert Primer is a wonderful introduction to those who want to become familiar with the geography, plants, animals, and other resources in this splendid piece of Sonoran

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"...an amazing breadth of treatment with remarkably beautiful... photographs... [IFNM] will enrich your life." *Dr. Wade Sherbrooke, Director Emeritus, Southwest Research Station of the American Museum of Natural History, Portal, Arizona*

(See complete endorsement statements on page 255)

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