National Park Service
U.S. Department of the Interior
Organ Pipe Cactus National Monument

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Superintendent's 2010 Report on Natural Resource Vital Signs

Organ Pipe Cactus National Monument
National Park Service
Ajo, Arizona

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Suggested citation: Organ Pipe Cactus National Monument. 2011. Organ Pipe Cactus National Monument: Superintendent's 2010 Report on Natural Resource Vital Signs. National Park Service, Ajo, Arizona.

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Acronyms and Abbreviations

AADT	average annual daily traffic
AGFD	Arizona Game and Fish Department
AQRV	air quality related value
cfs	cubic feet per second
DHS	Department of Homeland Security
EMP	Ecological Monitoring Program
ft	feet
IMPROVE	Interagency Monitoring of Protected Visual Environments
m	meter
NADP/NTN	National Atmospheric Deposition Program/National Trends Network
OPCNM	Organ Pipe Cactus National Monument
POE	port of entry
SODN	Sonoran Desert Network
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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Organ Pipe Cactus National Monument (OPCNM) was established by Presidential proclamation in 1937 to preserve approximately 330,000 acres of the Sonoran Desert for the public interest. In 1976, the monument was declared an International Biosphere Reserve by the United Nations and in 1978, Congress designated nearly 95% of monument lands as wilderness. The purpose of OPCNM, as stated in the park's foundation plan (2006), is to:

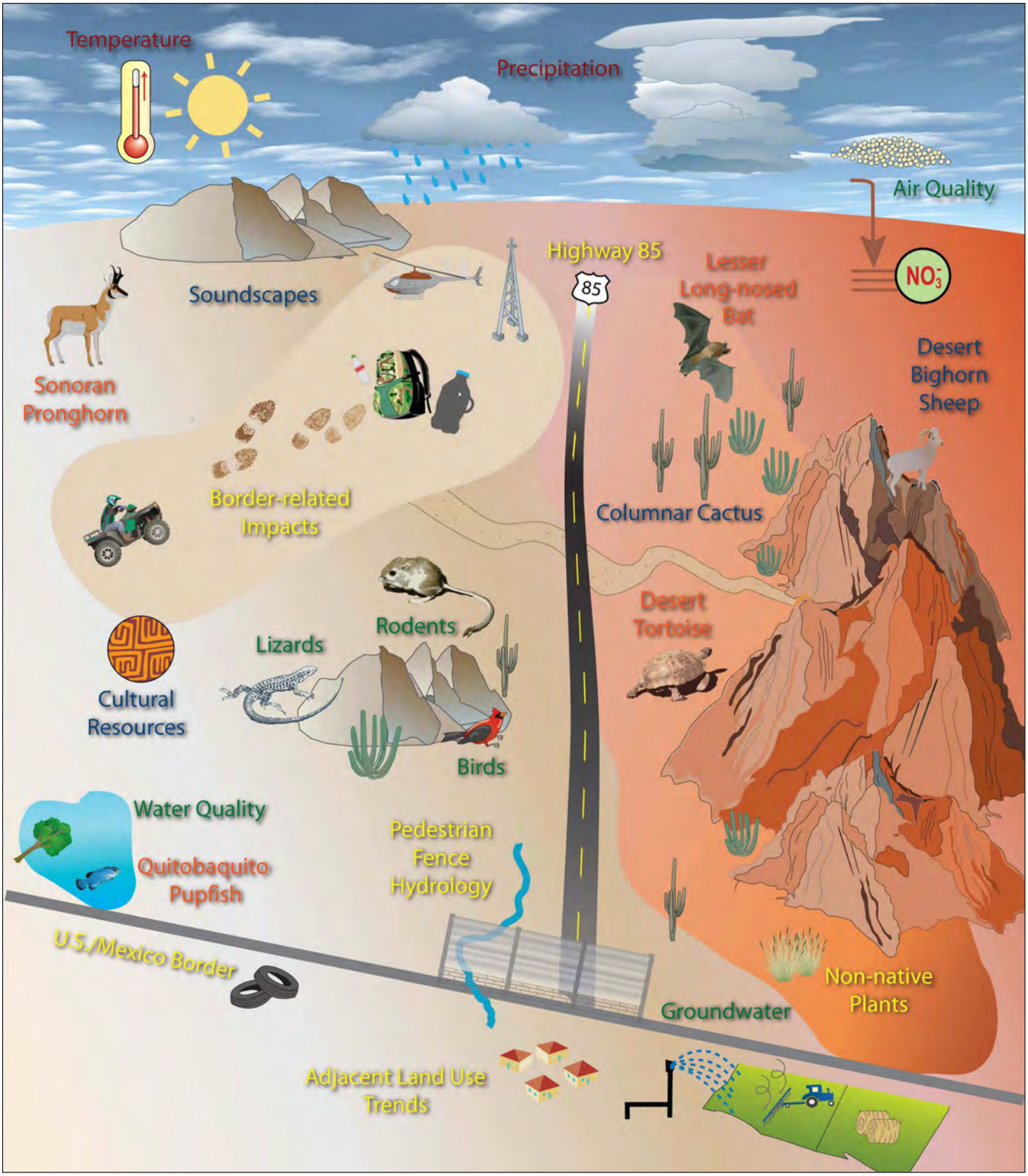
- Perpetuate for future generations a representative sample of the natural and cultural resources of the Sonoran Desert and provide for public understanding, safe use, and enjoyment of the same;
- Serve as a natural laboratory for understanding and managing the Sonoran Desert ecosystem;
- Serve as a baseline indicator against which environmental changes can be identified; and
- Preserve for future use and enjoyment the character and values of this designated wilderness.

The monument is an important protected area, providing habitat for a diverse flora and fauna, including threatened, endangered, and sensitive species. Adjacent lands include Cabeza Prienta National Wildlife Refuge to the west, Bureau of Land Management and Barry M. Goldwater Range to the north, the Tohono O'odham Nation to the east, and Mexico to the south. Adjacent lands in Sonora, Mexico include a mosaic of developed and undeveloped lands. The Pinacate Biosphere Reserve (the monument's official international "sister park") lies to the southwest.

OPCNM's contributions towards conservation are highlighted by: its biological diversity; the continuance of natural ecological and evolutionary processes within an expansive desert wilderness; the monument's abundant prehistoric and historic cultural resources; and the opportunities it presents for research, education, and recreation. NPS staff work to understand monument resources and processes in order to help protect and maintain them within a normal and sustainable range of variation. Management concerns have grown from a focus on adjacent land use and recovery from grazing and mining to include climate change, invasive species, highway traffic, and illegal immigration.

OPCNM has a long and rich history of scientific research and monitoring. The monument first began long-term monitoring of environmental and ecological parameters of interest in the 1980s. Today, these parameters are known as "vital signs"—key resources that are indicative of park ecological conditions and changes within the monument. A synthesis of research, monitoring, and public scoping helps to develop monument goals. This report presents examples of in-situ and ex-situ conservation, law enforcement, public outreach, and habitat restoration, which reflect some of the monument's recent management priorities.

The park considers this vital signs report to be useful for communication purposes because it brings into focus the status and trends of diverse park resources and natural processes. This report is intended to evolve as monitoring programs continue to develop, as well as in response to user feedback.



Conceptual diagrams provide a means for organizing and communicating the relationship between resource components and key processes in an ecological context. This conceptual diagram of OPCNM's natural resource vital signs begins to tell the stories of how these resources interact on the landscape. Vital signs color code: **Ecosystem Drivers, Landscape-scale Indicators, Rare and Sensitive Species, Stressors, Focal Resources.**

OPCNM VITAL SIGNS fall into five categories, according to the role they play in the Sonoran Desert ecosystem. A brief description of those categories, and how they relate to the conceptual model on page 5, is provided below. Please note that a given resource or vital sign may belong to multiple categories, and there are often many more indicator parameters monitored for a given vital sign than provided in this report.

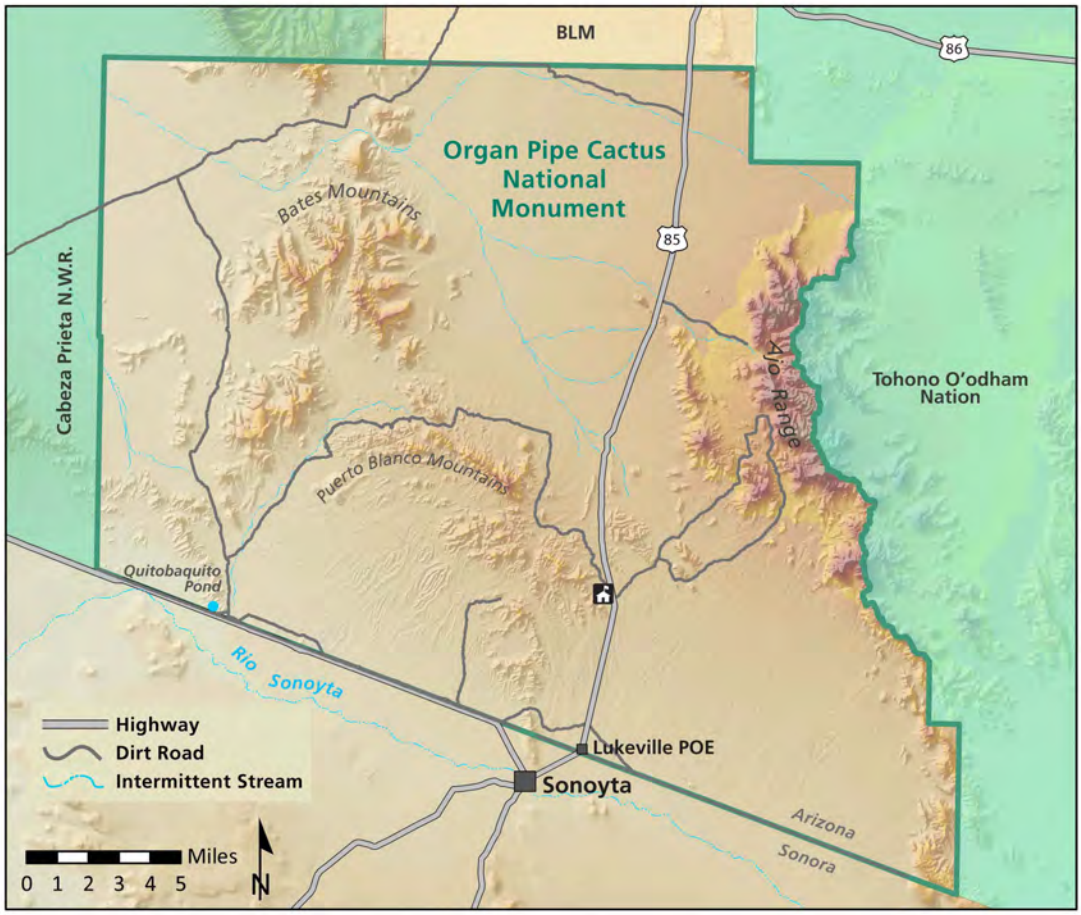
Ecosystem Drivers: Climate, wildfire, and severe disturbance events are all primary ecosystem drivers (external forcing factors) affecting the composition, structure, and dynamics of natural systems in the American Southwest. Ecosystems drivers affect key processes, such as energy flow, hydrologic cycling, geologic processes, nutrient cycling, physiology, and population interactions. Climate, especially the spatial and temporal distribution of moisture and temperature, is the primary ecosystem driver of interest at OPCNM. The monument currently maintains an array of 9 rain gauges, 10 automated weather stations, a National Weather Service COOP station, and an Arizona Flood Warning System (AFWS) station. Summaries and graphics from automated stations are available at http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?azorga and from the AFWS station at http://data.afws.org/sui/siteDetail.aspx?dbNm=alert&statn_id=7230.

Landscape-scale Indicators: In 1988–1992, a team of scientists tested various indicators of ecosystem health that span a wide range of monument ecosystems, key processes, and trophic levels. The monument's Ecological Monitoring Program (EMP) was launched in 1993, and a series of monitoring protocols that were both quantifiable and logistically feasible to implement were developed for selected indicators. Air, water, and plant and animal communities have been monitored since the beginning of the EMP; soil and channel-morphology protocols were recently developed by the Sonoran Desert Network (SODN) and are now being implemented.

Rare and Sensitive Species: Rare and sensitive species are of special concern to resource managers, and their status is often closely monitored to inform management and comply with legal requirements. Monitoring of special-status species is often accomplished in cooperation with partners, and the areas surveyed may extend beyond monument boundaries. Sensitive species are monitored not only because they are of high concern to both managers and the public, but also because preserving native flora and fauna is core to the park's mission.

Stressors: Stressors are human-caused influences to natural systems and processes. Stressors may be global, such as the consequences of global climate change; regional, as is the case with groundwater overdrafts and encroaching agriculture or urban development; or local, such as visitor use impacts and illegal immigration.

Focal Resources: Focal resources are park resources that are of particular interest and value to the public, and/or that are specifically mentioned in park enabling legislation, planning documents, and other mandates. Many fundamental resources were identified in the monument's foundation plan and are of special interest to resource managers. Those not included as landscape-scale indicators or rare and sensitive species are presented here. With the designation of wilderness in 1978, and the recent rise of border-related human impacts, the monument is now developing protocols to monitor wilderness values.



ECOSYSTEM DRIVERS

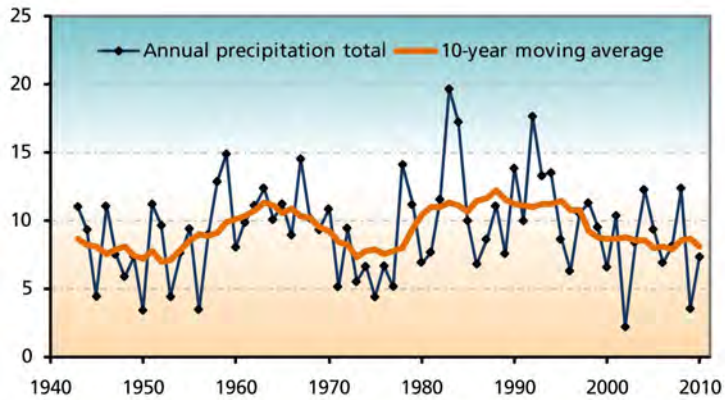
Climate

Annual Precipitation

Rainfall in the southwest deserts typically follows a cyclic pattern, with the region currently in a relative drought period. The annual precipitation total for 2009 was one of the lowest since recordkeeping began in 1943. At OPCNM, rainfall distribution follows an east–west gradient that also reflects the more mountainous eastern part of the park and the lower desert areas of the west.

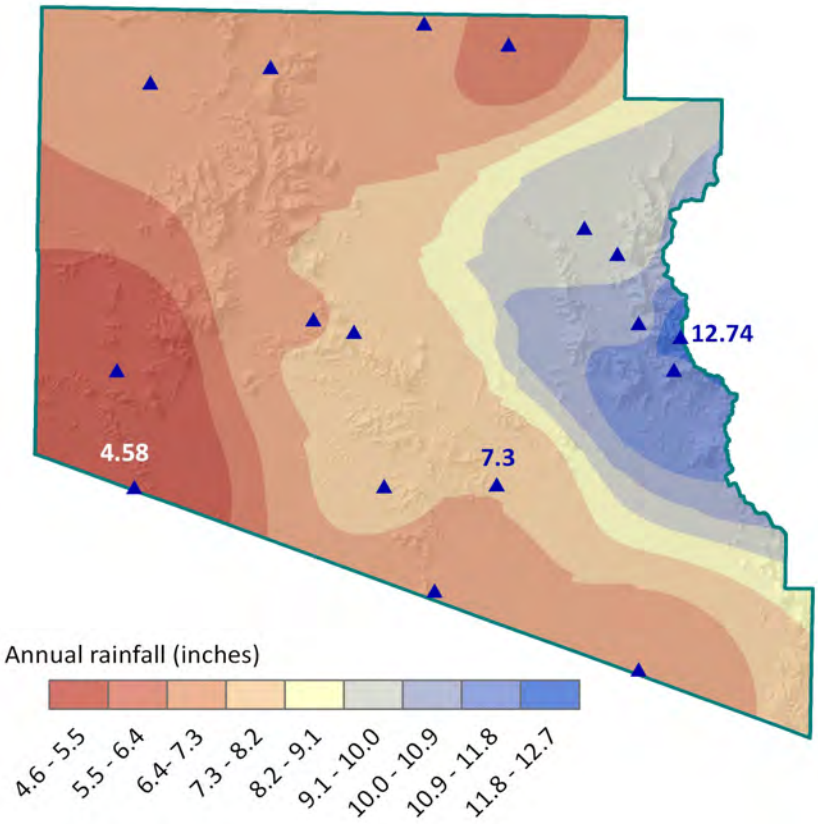
Winter rains tend to be widespread and westerly, while summer rains are much more localized and generally originate from the east and south. Summer storms are frequently no more than a mile or two in diameter and last for less than one hour. In addition, late September sometimes brings remnant effects of hurricanes that form off the Pacific coast of Mexico and can turn north towards Baja California and the Gulf of California, pushing moisture into the southwest deserts of the U.S. This extreme variability in rainfall can cause areas of verdant desert to be located adjacent to areas of drought.

Automated weather stations record rainfall and other weather parameters at 10 sites in the park, and eight rain gauges log data at other sites. Most of these stations are located near long-term wildlife and vegetation monitoring sites. They provide important information about the park's main ecosystem drivers.



Annual precipitation and 10-year moving average precipitation measured at OPCNM headquarters, 1943–2010.

Middle Bajada weather station before and after January 2010 precipitation events (top: 1/12/10, bottom: 3/13/10). Total January rainfall was 4.94".



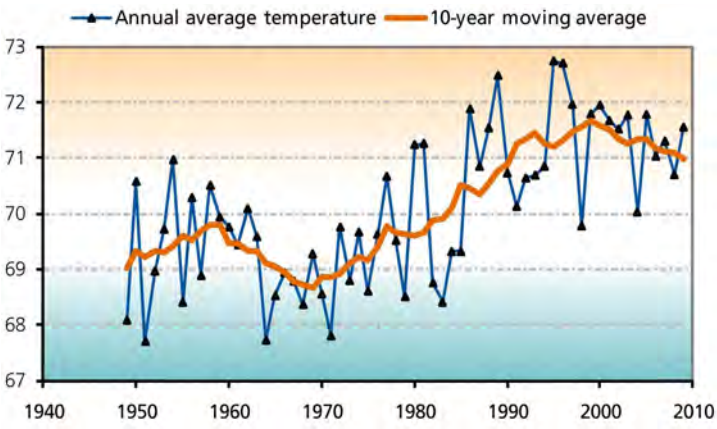
Interpolation of 2010 annual rainfall from 17 rain gauges. Annual totals ranged from a high of 12.74" at Mt. Ajo to a low of 4.58" at Quitobaquito (half of the Quitobaquito annual rainfall occurred in January). Monument headquarters received 7.3".

ECOSYSTEM DRIVERS

Climate

Average Annual Temperature

The average annual temperature for 2010 was 70.5°F, which was 0.4° higher than the long-term average for 1949–2010. Average temperatures increased by approximately 2°F betweeen1949 and 2010 and have varied widely from year to year. Increasing temperature is apparent during all seasons, and includes overnight lows and daily highs (not shown). Temperature is an important determinant of primary productivity and drought severity. Due to higher temperatures, the current drought is more severe than prior droughts of long duration in the 1950s and 1970s.

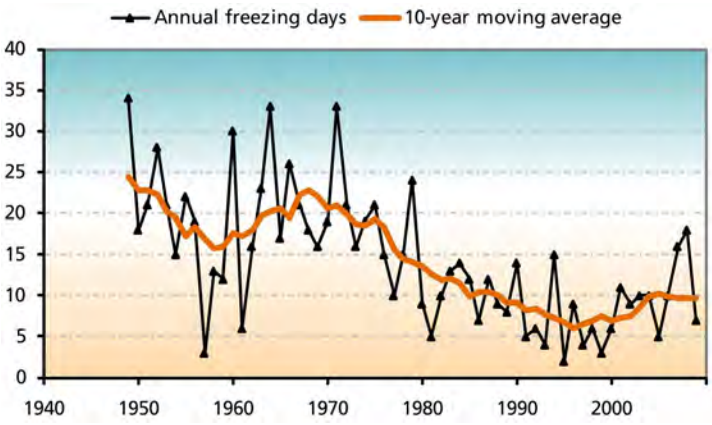


Annual average temperature and 10-year moving average measured at OPCNM headquarters, 1949–2010.

Climate

Days with Freezing Temperatures

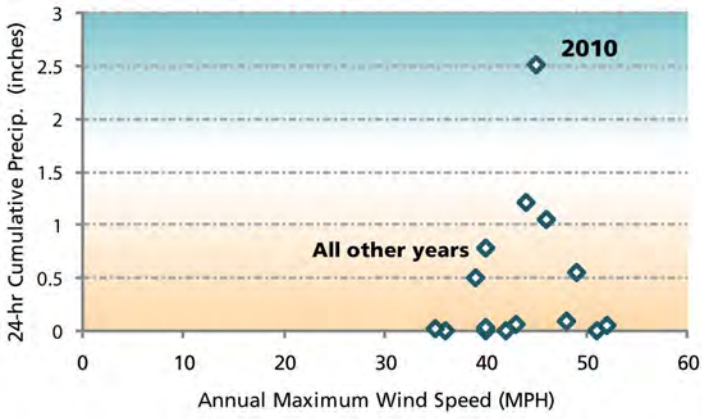
In 2010, there were two days with freezing temperatures—far fewer days than the annual average of 14.1 since record-keeping began in 1949. Freezing temperatures are a significant factor in the growth, phenology, and overwinter survival of plant and animal species. Several tropical plant species reach their northern distributional limit in or near the park and are intolerant of hard freezes. Because severe freezes also limit the spread of some exotic species, such as Africanized honeybees and buffelgrass, the reduced frequency of freezes has important implications for the management of exotic species at OPCNM.



Annual number of freezing days (minimum temperatures of 32° F or less) recorded at OPCNM headquarters since 1949.

Severe Weather

For severe weather events, the past year was noteworthy for the winter storm of January 21–22, 2010. Due to heavy rains and debris accumulation where washes cross the border, Lukeville, Arizona, was flooded for the second time since construction of the border pedestrian fence. Within view along Puerto Blanco Drive, 156 saguaros, 3 organ pipes, and 1 senita cactus fell over as a result of this storm. Except for one saguaro next to an off-road vehicle track, all were large specimens. A combination of high wind and wet soil was probably responsible for this blowdown event; higher gusts have been recorded in previous years when the soil was not as wet, without any blowdowns of this magnitude. Maximum wind speed at the nearby Senita Basin weather station reached 45 mph on January 21; in the previous 24 hours, 2.51 inches of rain had fallen.



Cumulative 24-hour precipitation and annual maximum wind speed recorded at the Senita Basin weather station, 1994–2010.

LANDSCAPE-SCALE INDICATORS

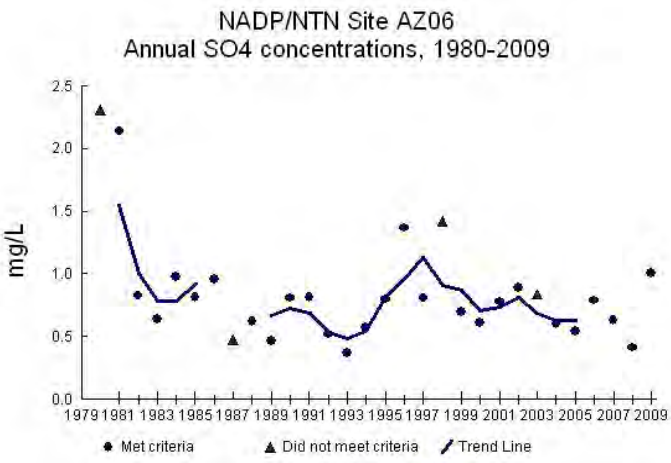
Air Quality

Deposition

To monitor atmospheric deposition at OPCNM, the Sonoran Desert Network (SODN) acquires, analyzes, and reports on air quality data from the web-based program archives of the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). The objective of deposition monitoring at the monument is to determine the seasonal and annual status and trends of nitrogen- and sulfur- containing ions.

Wet deposition occurs when air-pollutant emissions, such as sulfur dioxide (SO_2), nitrogen oxides (NOx) and ammonia (NH_3) from power plants, vehicles, agriculture, and other sources are transported and transformed in the atmosphere and deposited to ecosystems as sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4) compounds via rain or snow.

Sulfate concentrations in wet deposition have decreased since 1980, when copper mining and smelting were still active in Ajo, but no trends were seen in nitrate, sulfate, or ammonium concentrations in rain and snow from 1999 to 2009. According to the NPS Air Resources Division, sulfur conditions are good at OPCNM, but nitrogen conditions are rated as being of significant concern.



Annual sulfate concentrations in wet deposition, 1980–2009.

Air Quality

Visibility

Both local and distant air pollution sources affect air quality in OPCNM. The monument's air quality related values (AQRVs; resources that are potentially sensitive to air pollution) include vegetation, surface waters, soils, fish and wildlife, and visibility. At present, visibility has been identified as the most sensitive AQRV in the park. Although visibility is still superior to that in many parts of the country, it is often impaired by light-scattering pollutants (haze).

To monitor atmospheric deposition at OPCNM, SODN acquires, analyzes, and reports on air quality data from the web-based program archives of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The objective of visibility monitoring at OPCNM is to determine the seasonal and annual status and trends in concentrations of visibility-reducing pollutants.

Visibility includes not only how far we can see, but how well we can see, and is often expressed with an index of visual range and light extinction. Visibility impairment results largely from small particles in the atmosphere; small pollutant particles in the air scatter and absorb light, causing haze and reducing visibility. As light extinction increases, visibility decreases. For visibility trends, light extinction on the 20% clearest and haziest days is analyzed. From 1998 to 2008, no trend was detected for the 20% clearest days at OPCNM. Haziest days showed a non-statistically significant improving trend.

In 2008, ammonium sulfate (40.6%) and coarse mass (26%) were the major sources of haze-causing fine particulates at OPCNM. Ammonium sulfate comes mainly from coal-fired power plants and smelters; coarse mass consists of wind-blown dust. Other particles consisted of organic carbon (15%), fine soil (10%), sea salt (4.4%) and elemental carbon (4%). Organic carbon comes primarily from combustion of fossil fuels and vegetation.

Representative visibility conditions from automatic visibility camera operated at OPCNM, 1997–2004.

Since aerosol monitoring began at OPCNM in 2003, the highest concentrations of nitrate particles in the air occurred in winter 2008–2009. Peak concentrations of fine soil occurred in fall 2006 and spring 2007, coinciding with high $PM_{2.5}$ (particulate matter <2.5 micrometers) levels.

Surface Water Quality

Although the park has more than five dozen documented tinajas (rainfall-recharged ephemeral and intermittent bedrock catchments), perennial springs provide the only reliable year-round water source in OPCNM, supporting unique plant communities and many wildlife species. The Quitobaquito springs and pond have been the focus of resource monitoring projects for many years, including measurements of spring flow and water quality. Nearby Williams Spring has not been visited in several years due to security restrictions. At last observation, that spring supported wetlands vegetation but no surface water was present.

Dripping Springs is a small perennial spring contained within a cave in the Puerto Blanco Mountains. This important wildlife water source is located on a major illegal trafficking route and is intermittently subject to trash deposits and associated water quality impairment. Low water levels were documented in 2001–2003, possibly due to drought. USGS water quality testing in 2003 documented the presence of *E. coli* in the springs. Backcountry security restrictions have prevented regular water quantity or quality monitoring at the spring for the past six years.

Tinaja water levels and longevity are affected by the size and runoff characteristics of the watershed draining into the tinaja, volume of the catchments, amount of shade received, and permeability of the bedrock. Water quality of tinajas is highly variable, and is susceptible to contamination from human activities and atmospheric deposition of chemicals.

The NPS Water Resources Division has identified three water quality parameters and two physical parameters as "core" freshwater indicators for long-term aquatic monitoring. These measures were selected as the most fundamental parameters required for characterization of water quality of aquatic ecosystems, and are known to be related to both biological and physicochemical processes. The required measures include specific conductance, dissolved oxygen, pH, temperature, and flow rate or water level. Core parameters have been measured intermittently at Quitobaquito and selected tinajas since 1998; no large deviations from baseline data have been documented. An inventory of springs and tinajas will commence in 2011.

Quitobaquito Pond, circa 2006.

Core water quality parameters from selected site, 1998–2010.

Date	Time	Temp (C)	pH	Cond.	DO (mg/l)
Quitobaquito, SW Spring pool					
September 25, 1998	1030	27	7.59	1132	5.7
September 5, 2003	1030	27.2	7.58	1159	5.8
September 8, 2010	1000	27.5	7.59	1323	5.8
Quitobaquito, mid-channel pool					
September 25,1998	1050	27	8.06	1127	7.2
September 5, 2003	1045	27.8	7.98	1160	7.3
September 8, 2010	1000	27.1	8.21	1157	8.4
Quitobaquito, SE corner of pond					
September 24, 1998	1020	25	9.39	1415	4.3
September 8, 2010	945	24.8	9.54	1561	3.2
South Alamo, Jacuzzi tinajas					
September 3, 1998	1015	26	8.06	278	4.8
September 11, 2003	1540	29.9	9.96	226	14.5
September 18, 2010	1110	23.3	9.25	600	6.3
Wild Horse Tank					
September 7, 1998	1600	30	8.76	175	13.3
October 12, 2003	1040	23.5	9.16	276	11.7
September 19, 2010	1120	24.4	8.8	296	11.5
Dripping Springs					
September 5, 1998	1530	23	7.4	399	0.2
July 15, 2001	1140	21.7	6.58	849	0.9
September 20, 2010	0930	21.1	7.58	654	0.3

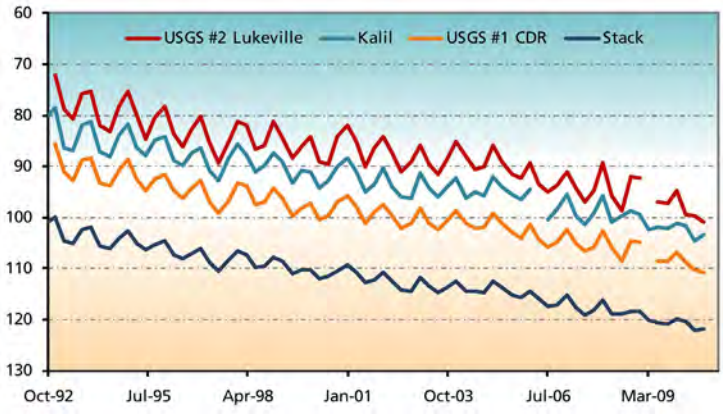
Intermittent tinaja in Bull Pasture, Ajo Mountains.

LANDSCAPE-SCALE INDICATORS

Groundwater

Depth to groundwater was monitored quarterly at 9 of 13 wells in the park. With the exception of three monitoring wells drilled by the USGS near the border in 1988, all are old ranch wells that still have water and access for measurement. Four of the 13 wells are no longer monitored due to collapse, going dry, or vandalism. These wells and their last observations of water include Pozo Salado (April 1989–collapsed), Hocker Well (April 1995–dry), Dowling Well (October 1993–collapsed), and Pozo Nuevo Well (October 2001–blocked by rocks).

The general trend for all wells in the core area of the park has been a slow but steady lowering of the water table. The four wells nearest Lukeville (Kalil, Stack, USGS #1, and USGS #2) have shown the greatest decline compared to their long-term averages and have been declining at a rate of approximately one foot per year (see table). These wells are near the populated agricultural zone of Sonoyta, Sonora, and prone to seasonal swings due to pumping and recovery. This drawdown along the border ultimately can affect groundwater further north and also may indirectly affect the springs that feed Quitobaquito. Remarkably, Bonita Well had water during all four quarters in 2009, and two quarters in 2010; this well was dry for much of 2006–2008.



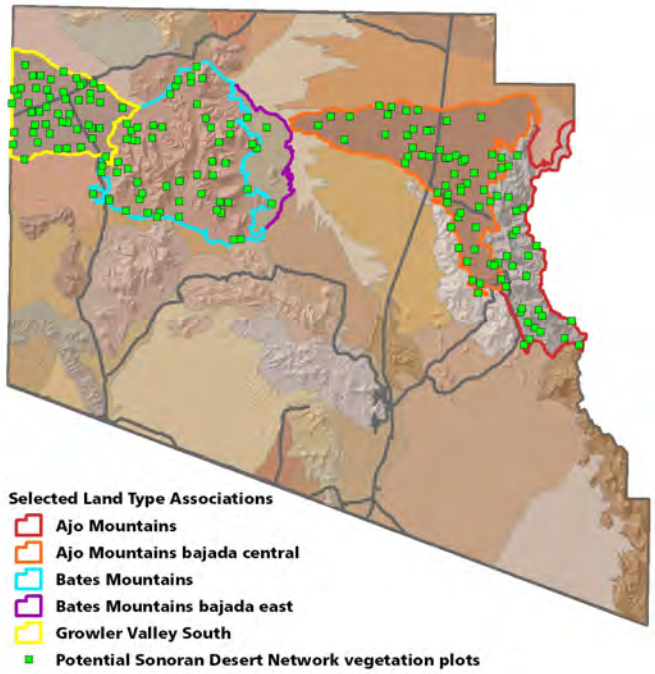
Depth to groundwater (feet) at four Lukeville-area wells since 1992.

Depth to groundwater (feet) at monitoring wells in OPCNM. An increasing depth indicates a declining water table.

Well	Years	Average	2000	2010	2000 - 2010
Alamo	1987-2010	7.93	8.9	7.6	1.3
Bates	1987-2010	37.28	38.6	39.8	-1.2
Bonita	1987-2010	28.79	33.0	30.0	3.0
Corner	1987-2010	61.21	61.8	62.9	-1.1
Dowling	1983-1993	82.99			
Hocker	1977-1995	15.32			
Kalil	1977-2010	86.49	92.1	102.7	-10.7
Pozo Nuevo	1987-2001	43.95	47.4		
Pozo Salado	1987-1989	93.12			
Stack	1987-2010	109.21	111.0	121.0	-10.0
USGS #1 CDR	1993-2010	99.23	98.6	109.1	-10.6
USGS #2 Lukeville	1993-2010	87.47	86.8	98.7	-11.9
USGS #3 Salsola	1993-2010	96.27	95.4	96.3	-1.0

Terrestrial Vegetation and Soils

Vegetation monitoring at OPCNM resumed in 2010, as the NPS Sonoran Desert Network implemented new protocols for terrestrial vegetation and soils. Results for 2010 have not yet been processed and will be reported later. The sampling design at OPCNM will include 60 plots, with 12 plots sampled each year on a five-year rotation. Most of the plots will be new, but some were established in previous decades. Instead of a monument-wide approach, the plots will be distributed along an east–west belt transect that includes the Ajo Range, Valley of the Ajo, Bates Mountains, and Growler Valley. This design will capture a wide range of precipitation and soil texture gradients in the monument.



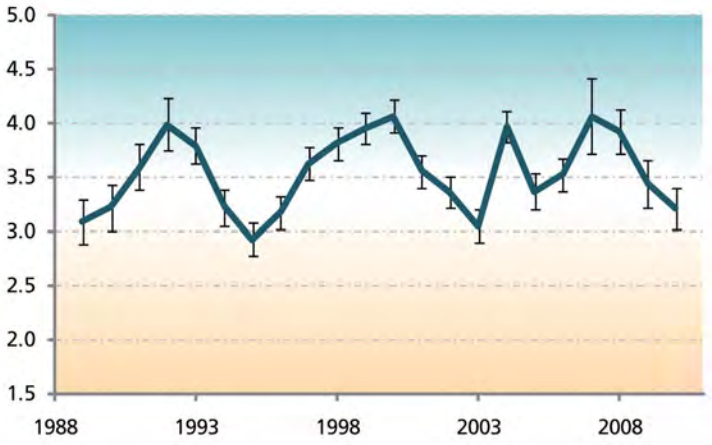
Diurnal Lizards

Lizards are among the most diverse, numerous, and conspicuous vertebrates in the monument. While most species are insectivores, some are herbivores or carnivores. Lizards serve as prey for larger vertebrates, such as roadrunners, raptors, owls, foxes, and snakes. They are much less mobile than birds and should respond to variation on a smaller spatial scale.

Lizards are sampled along permanent transects in both spring and summer at OPCNM. The transect design is observation-based distance sampling, 15 m wide and varying from 100 to 300 m long. Typically, 29 transects would be completed at 17 sites. Indicators reported here include species richness and relative abundance of selected species. In 2010, 20 transects were completed at 10 sites in spring and 21 transects at 11 sites in summer.

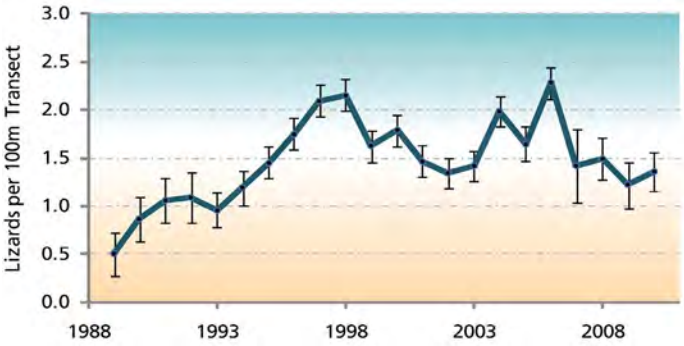
Annual sampling typically reveals 11, and as many as 13, species among all sites combined. Average species richness for a single site is 3.5 for spring and summer combined. Species richness appears to vary with the El Niño climate cycle, as some species recolonize individual study sites in response to abundant winter rains and disappear during dry periods. Species richness rebounded sharply in 2004, from a drought whose severity peaked in 2002.

Linear-trend analysis of relative abundance indicates that over the history of monitoring, small-bodied species, such as the side-blotched lizard, have been increasing, while large-bodied species, such as the western whiptail, have been declining. The small-bodied species at OPCNM are traditionally classified as r-strategists because they mature early, reproduce frequently, and are short-lived, compared to the larger-bodied species, or K-strategists. Small-bodied species are better adapted to unpredictable environmental variation and disturbance, much like weeds are in the plant kingdom.

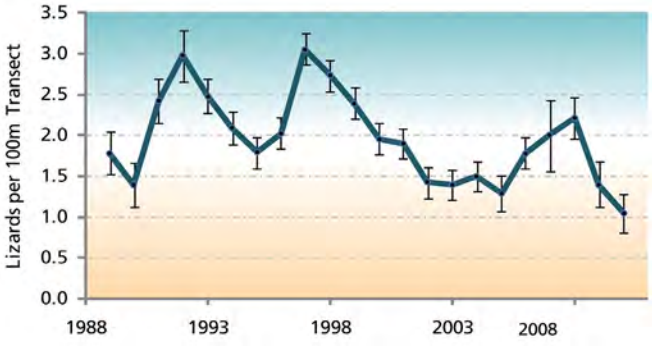


Average number of lizard species per site (adjusted mean and standard error), 1989–2010.

Side-blotched lizard (*Uta stansburiana*).



Average abundance of side-blotched lizard per site (adjusted mean and standard error), 1989–2010. This species is one of the small-bodied species with a trend of increasing abundance.



Average abundance of western whiptail lizard (*Aspedoscelis tigris*) per site (adjusted mean and standard error), 1989–2010. The western whiptail is one of the larger-bodied species with a trend of decreasing abundance.

Landbirds

Birds are the most taxonomically diverse vertebrate group in the monument, with about 280 species know to occur as residents or migrants; 76 of these species are confirmed as breeding. During 2010, 42 survey points were sampled on six transects at OPCNM. Two transects were in xeroriparian habitats and four were in upland (desert scrub) habitats. There were seven point count stations along each transect, and each point was surveyed twice in May.

During 2010, a total of 1,411 birds of 55 species were detected during monitoring. Bird abundance was higher in xeroriparian areas, with an average of 58 detections per station, compared to upland areas, with 20 detections per station. No new species were detected in the park in 2010.

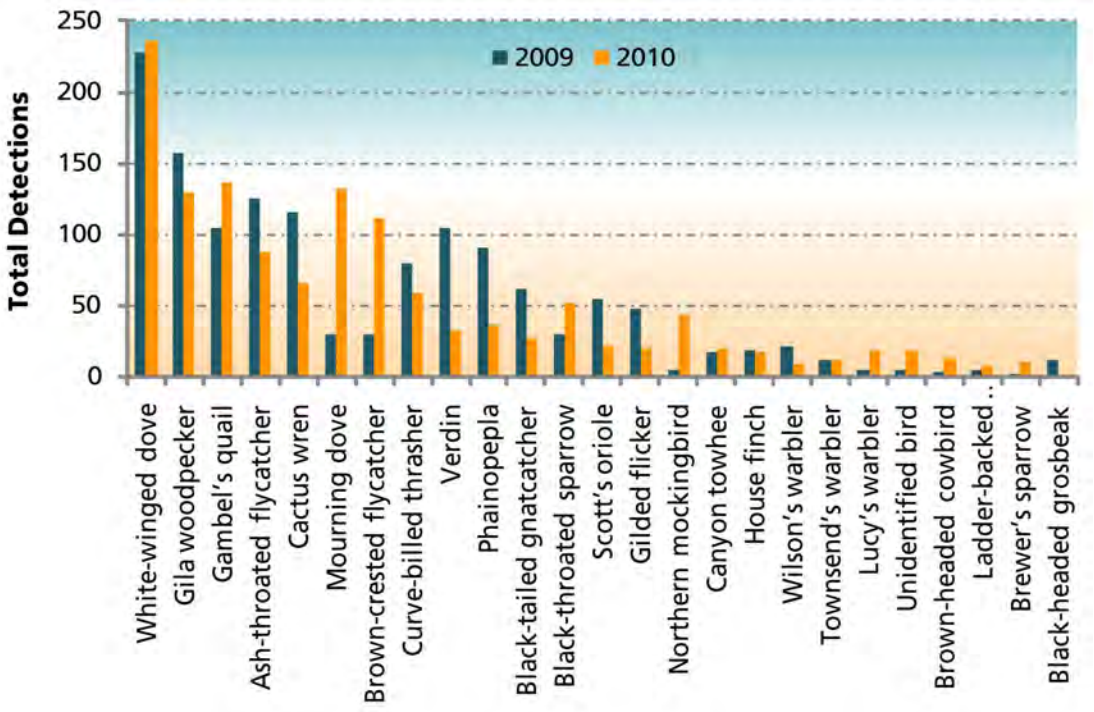
Previous bird monitoring efforts (1999–2004) sampled stations on three occasions over a longer period (February–May) and detected more wintering, migrant, and earlier-breeding species. These efforts also documented xeroriparian areas as having the highest species richness and abundance from late winter to summer, including wintering, migrant, and permanent-resident species. Upland areas, including the valley floor, were also important habitats for some wintering species (e.g. white-crowned and Brewer's sparrows), which sometimes occured at very high numbers.

The high aural detectability of white-winged doves likely biases these surveys in favor of detections for that species in late spring and early summer. Regardless, it is clear this migratory bird is an abundant spring-summer breeder. Its penchant for feeding on flowers and fruits of saguaro and organ pipe cacti make it an important influence in pollination and seed dispersal for these keystone plants.

USFWS/JIM RORABAUGH

Juvenile white-winged dove.

While white-winged doves remained the most commonly detected species in late spring–early summer, species breeding in late winter to mid-spring (phainopepla, Gambel's quail, mourning dove) had more overall detections.



Average number of birds detected at point count stations in each habitat type, 2009 and 2010 (25 most common species).

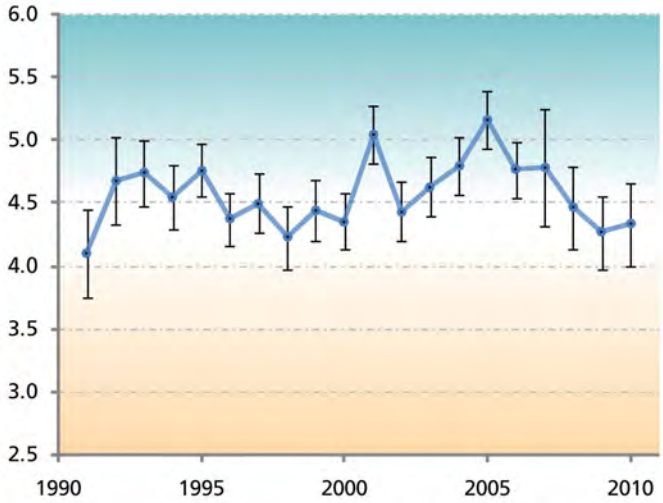
Nocturnal rodents

Nocturnal rodents are common in all OPCNM habitats, are easily captured and identified, occupy small home ranges and exhibit high fecundity, and respond quickly to changes in primary productivity and disturbance. Heteromyids, including kangaroo rats and pocket mice, constitute an important guild of granivores and are less dependent on environmental moisture than murids. Murids, including woodrats, cactus mice, and cotton rats, feed primarily on fruit and foliage, except for the grasshopper mouse, which is an insectivore that will sometimes prey on other rodents. Rodents constitute the prey base for many snakes, owls, and carnivorous mammals. They are also responsible for considerable excavation and mixing of soil layers (bioturbation), "predation" on plants and seeds, and the dispersal and caching of plant seeds.

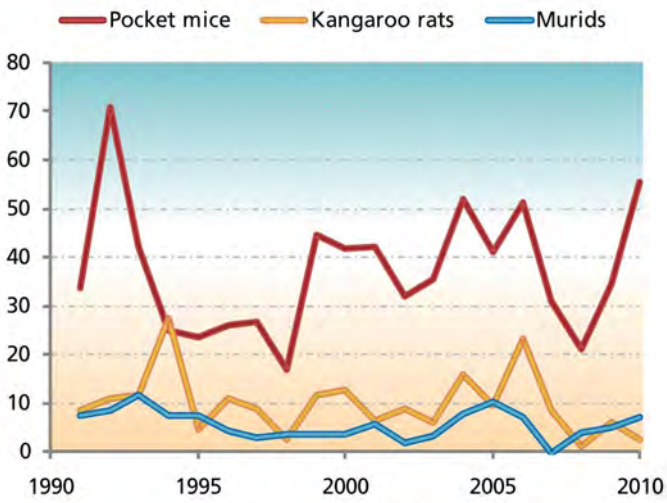
Annual monitoring typically samples 30 trapping grids (90 × 90 m, 49 traps per grid) at 16 sites for two consecutive nights. Most sites have two trap grids. Indicators reported here include species richness and relative abundance of major ecological species groupings. In 2010, 16 grids were sampled at nine sites.

Annual sampling typically reveals seven, and as many as 10, species among all sites combined. In 2010, average species richness per site was 4.3, which was slightly less than the long-term average of 4.57 for the period 1991–2010. Multi-year swings in species richness probably reflect local extinction and colonization of rare species in response to climate cycles, such as El Niño. Species richness has increased slightly over the history of monitoring, but the trend is not statistically significant. No species have been lost, nor have new species appeared, since regular monitoring began in 1991. Relative abundance of kangaroo rats has been below average for the past four years, whereas the smaller-bodied pocket mice are at their highest population level since 1992. Murids, including pack rats, are at their highest population level since 2004–2006.

Desert pocket mouse (*Chaetodipus penicillatus*), the most common rodent species in OPCNM.



Species richness and standard error of nocturnal rodent communities among monitoring sites, 1991–2010.



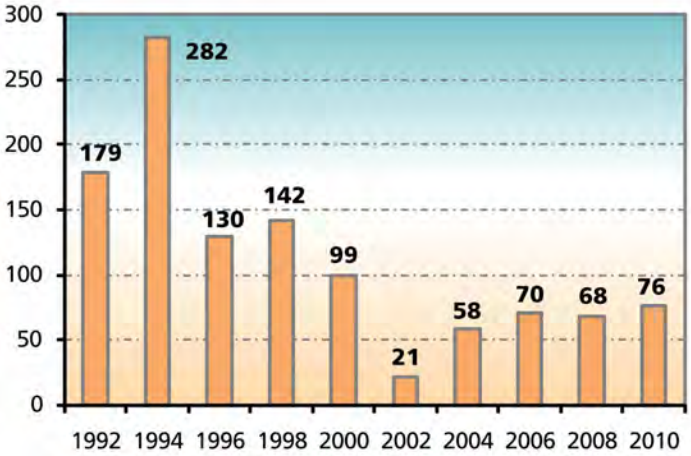
Relative abundance of three groups of rodent species among monitoring sites, 1991–2010.

Sonoran Pronghorn

In OPCNM, the endangered Sonoran pronghorn (*Antilocapra americana sonoriensis*) chiefly occurs west of Highway 85. The current range of this species in the United States occurs in OPCNM, Cabeza Prieta National Wildlife Refuge, and on lands managed by the Bureau of Land Management and Barry M. Goldwater Range. The Sonoran pronghorn also occurs in northwestern Sonora, Mexico. The Mexican and U.S. populations are physically separated by international boundary fences and Mexican Highway 2, which parallels the border through this region. Radio-telemetry data indicate that Sonoran pronghorn in the U.S. move upslope during the summer months. By midsummer, a substantial portion of the population may be in the monument or near its border, making OPCNM important habitat for the U.S. Sonoran pronghorn population during this critical time of the year. The monument also provides winter habitat for the pronghorn.

In 2010, Sonoran pronghorn continued to recover from the crisis year of 2002. In that year, the U.S. population was reduced to 21–25 animals due to the combined stresses of extreme drought and persistent human disturbance in the form of illegal immigration, smuggling, and associated interdiction activities. Rainfall in the area improved somewhat from 2003 through 2010, although it remained below long-term average values, and 2009 was another extreme drought year. This, combined with continuing border-related human activity, may have had adverse effects on pronghorn survival, inhibiting recovery from the 2002 low point.

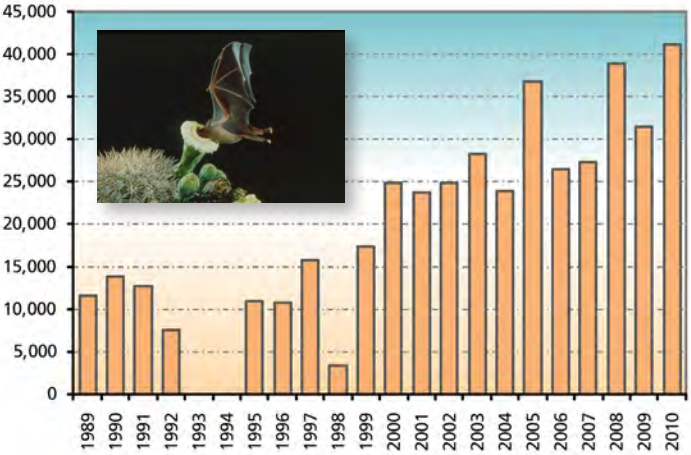
USFWS



Estimated U.S. population of Sonoran pronghorn. All estimates are derived from Arizona Game and Fish Department aerial surveys.

Lesser Long-nosed Bat

The largest known maternity colony of endangered lesser long-nosed bats (*Leptonycteris curasoae yerbabuenae*) in the U.S. is located in OPCNM. Discovered in 1969 in an abandoned mine, the colony averaged approximately 10,000–12,000 bats until the mid-1990s. Since then, the colony has gradually increased and its numbers now approach 40,000. Reasons for the increase are unclear, but likely include (1) a possible increase in the species' regional population; (2) immigration from other regional roosts that have been abandoned; and (3) widening of the south entrance to the mine, which occurred in 1997–1998, and may have facilitated use by larger numbers. Other, much smaller roosts of this species are also located in OPCNM. The monument's chief conservation actions have been monitoring the population and maintaining closure fences and signs at the roosts. In 2011, potential new roost sites will be created at other abandoned mine locations. Perhaps most important, the monument conserves several hundred square miles of rich foraging habitat, as this species feeds primarily on the flowers (nectar) and fruit of the saguaro and organ pipe cactus. By providing these abundant resources during the critical months when the young are born and raised, OPCNM is likely a major factor in maintaining this species in the Arizona–Sonora region.

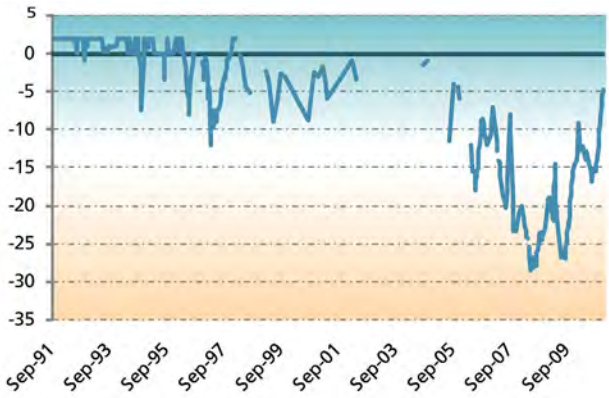


Average of June exit flight estimates of lesser long-nosed bats. The value for most years is the average of two June counts.

Quitobaquito Pupfish

The Quitobaquito pupfish (*Cyprinodon eremus*) population and its habitat at the Quitobaquito springs and pond remained fairly constant from 1962 to 2006, with the pond size at approximately 32,000 ft^2 and averaging 3 ft deep, and the pupfish population ranging between an estimated 8,000 to 15,000 or more. In 2006, the pond surface began falling in elevation and shrinking in total area. The situation became acute in 2007–2009, when it became clear that an unseen, large-scale leak was draining the pond. The pond essentially disappeared in midsummer 2008 and 2009, with surface area shrinking to less than 10,000 ft^2 of water, one to several inches deep. With exposed mudflats and shallow water conditions, American bulrush (*Shoenoplectus americana*) rapidly advanced into the former pond area, accelerating the loss of pond volume.

A partial renovation and sealing of one suspected leak in August 2009 repaired some but not all of the leakage, restoring the pond to about 60% of normal depth. A second effort near a large cottonwood in September 2010 restored the pond to about 80% of its normal depth, the highest level since 2005. The pond is currently reduced to approximately 75% of its surface area in 1962 (year of the previous major renovation), with the net loss now due mainly to encroachment by bulrush during the recent shallow-water events. For the interim, the system has been partially restored and stabilized and the pupfish population remains healthy. In addition, approximately 2,500 Quitobaquito pupfish are held in off-site refugia, at monument headquarters, the Arizona-Sonora Desert Museum, and Cabeza Prieta National Wildlife Refuge.



Quitobaquito Pond level (inches below overflow pipe), 1991–2010.

Acuña Cactus

Acuña cactus (*Echinomastus erectocentrus acuñensis*) is a small cactus, usually less than 30 cm (12 inches) tall. It grows in fewer than 10 areas in the central to northern Sonoran Desert in the U.S. and Mexico. One of these areas is located in the monument. Because the plant is rare and declining throughout its range, it has been designated as a candidate for listing under the Endangered Species Act. The NPS considers acuña cactus to be a species of management concern. The Desert Botanical Garden, in Phoenix, harbors seeds in a long-term storage environment for research and reintroduction.

Each year since 1988, permanently tagged acuña cactus plants located in six 20 × 50-m monitoring plots have been checked to determine how many survived and reproduced during the year. During the past 22 years, the number of plants greater than 25 mm (1 inch) tall in the six plots declined from 194 plants in 1992 to 37 plants in 2010. Additional detailed research is needed to (1) discover if the decline in the six monitoring plots represents the population as a whole, (2) identify the conditions needed for successful seedling recruitment, (3) determine why plants are dying, and (4) develop techniques to ensure continued presence of acuña cactus in OPCNM.

The number of plants taller than 25 mm (1 inch) in six monitoring plots declined from a high of 194 plants in 1992 to a low of 37 plants in 2010.

Sonoyta Mud Turtle

The range of the Sonoyta mud turtle (*Kinosternon sonoriense longifemorale*) is restricted to the Quitobaquito springs of OPCNM and a sewage lagoon and few remaining pools of perennial water in the Rio Sonoyta drainage of northwestern Sonora, Mexico. It was recently discovered at Quitovac, Sonora, about 24 miles south of Sonoyta. Populations were once connected by more frequent and extensive flows in the Rio Sonoyta. The U.S. Fish and Wildlife Service (USFWS) has identified the Sonoyta mud turtle as a candidate for listing under the Endangered Species Act. Only a few hundred individuals remain of this subspecies. Loss and fragmentation of aquatic habitat from groundwater pumping and drought. Other concerns include potential wildfire, habitat contamination, and introduction of exotic species.

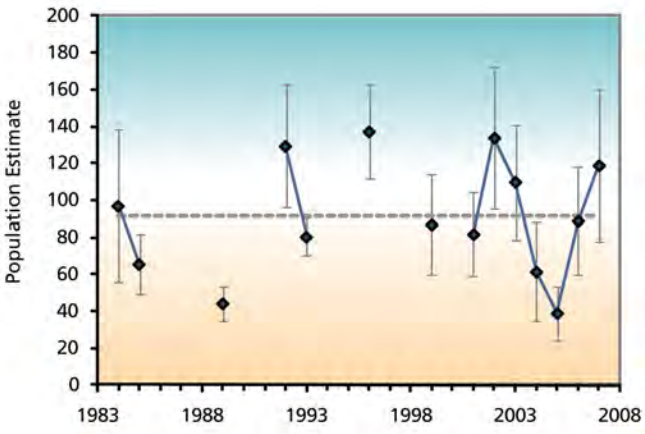
Researchers have studied the Quitobaquito population of the Sonoyta mud turtle since the 1950s. The NPS began regular annual monitoring in 2001, with assistance from the Arizona Game and Fish Department (AGFD) and USFWS. The Sonoyta mud turtle at Quitobaquito matures in seven years, and numbers of individuals (excluding young of the year) vary from 39 to 134 (average 91.1). The last census at Quitobaquito, completed in 2007, yielded an estimate of 119 turtles. A rapid decline in the water level at Quitobaquito Pond began in late summer 2007. Between fall 2007 and summer 2009, 81 mud turtles were evacuated from the pond to provide an assurance population in case of further water loss and to permit managers to repair a leak. Turtles were moved to the Arizona-Sonora Desert Museum and Phoenix Zoo. The AGFD assisted with arrangements, turtle capture, and transportation. Interestingly, efforts to capture turtles by hand revealed many turtles that had not been recaptured in years and were apparently trap-shy. This is good news, because it suggests that the population size may have been underestimated.

The multi-party Quitobaquito/Rio Sonoyta Working Group has drafted a Candidate Conservation Agreement to guide conservation of the aquatic ecosystem and sensitive species. Goals of the strategy include the protection of remaining wild populations and establishment of captive assurance populations of the Sonoyta mud turtle. To provide guidance on numbers of individuals needed to ensure survival, a population viability analysis was performed. Results indicated that a minimum assurance population of 8 small juveniles, 8 large juveniles, and 8 adult females (and a smaller number of males) is needed to maintain an extinction probability of zero for the captive population.

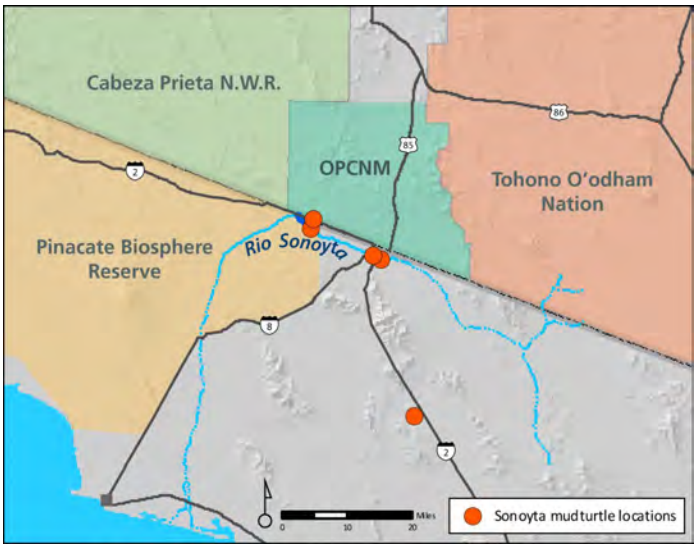
The current captive population of 29 juveniles, 24 adult males, and 28 adult females (total 69) could be adjusted to 10 hatchlings, 10, juveniles, 13 adult males, and 13 adult females (total 46) by releasing some juveniles and adults and collecting 10 hatchlings. Resource managers at OPCNM hope to adjust the assurance population and repatriate some captive turtles as soon as repairs to Quitobaquito Pond are completed.

AGFD

Juvenile Sonoyta mud turtle.



Population estimates and standard error for yearling and older turtles (carapace length ≥41 mm) at Quitobaquito, 1984–1987.



Sonoyta mud turtle locations in Arizona and Sonora.

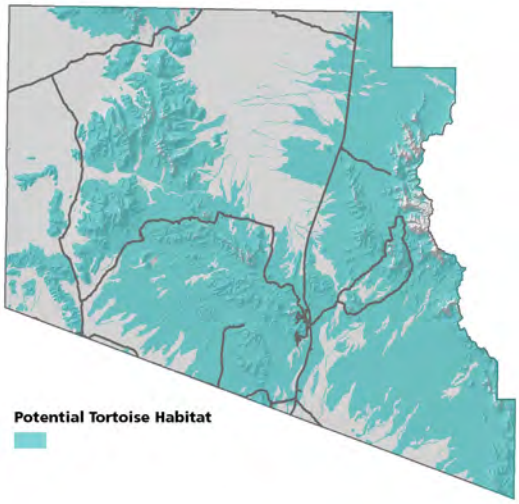
Sonoran Desert Tortoise

The desert tortoise (*Gopherus agassizi*) occupies much of the Mojave and Sonoran deserts and adjacent subtropical woodlands. In 2010, the Sonoran population of the desert tortoise was classified as a candidate for listing by the U. S. Fish and Wildlife Service. Major threats to the desert tortoise include habitat loss, drought, disease, and highway mortality.

Cooperators conducted 50 survey transects in 1995 and repeated 25 of those transects in 2005. Indicators reported here include live tortoises and scat. Habitat categories include hills and bajadas. Transects are grouped by east, central, and west regions in the monument. For the 25 repeated transects, 1995 and 2005 survey periods had very similar numbers of tortoise detections . However, the results also indicated that there may have been a significant shift in habitat distribution from hills to bajadas during that time period.

Number of Sonoran Desert tortoises found on 25 transects, 1995 and 2005.

		1995	2005
East	Hills	13	7
	Bajadas	10	15
Central	Hills	5	2
	Bajadas	1	2
West	Hills	3	2
	Bajadas	11	13



Cactus Ferruginous Pygmy-Owl

The USFWS listed the cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*) as an endangered species in Arizona in April 1997. The pygmy-owl was removed from the list in April 2006, but in 2007, conservation groups petitioned to have the pygmy-owl relisted. A final decision on that petition and status review is pending. OPCNM continues to consider the pygmy-owl a sensitive species, and one that is strongly associated with the Sonoran desert scrub cactus-forest plant communities for which the monument was established.

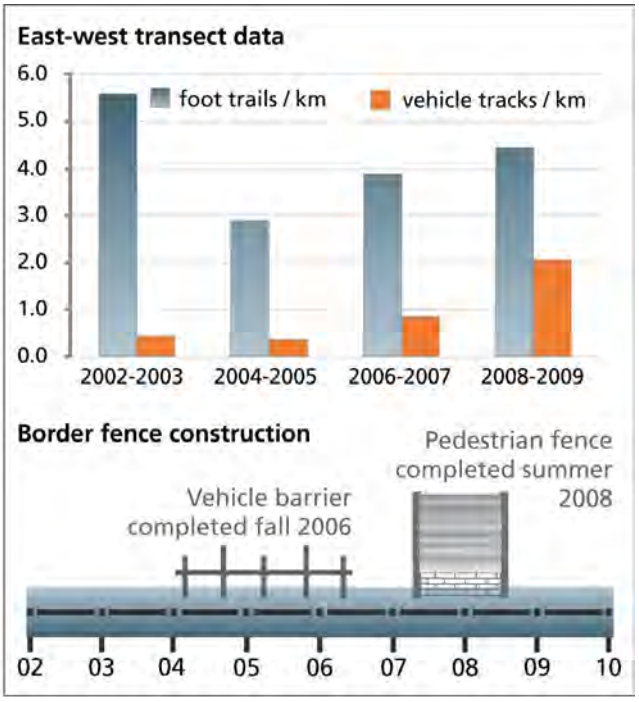
OPCNM is known to be one of the few locations in the United States where cactus ferruginous pygmy-owls may still be reliably found. Even here, they are uncommon to rare. Pygmy-owls generally occur in arborescent, middle-bajada Sonoran desert scrub associations with relatively dense, diverse shrub and tree components. Major xeroriparian associations are not part of all territories, but likely contribute to the high quality of others. In the monument's areas of high-quality habitat, pygmy-owls occur every year as resident breeders. Other areas of the monument are occupied less frequently, approximately every 1–3 years. Still other sites appear to be occupied rarely (e.g., once every 4–10 years). The monument's combination of sites that are occupied annually and erratically may be expected for a species at the edge of its range and/or at reduced population levels. Based on observed occupancy patterns, habitat use, and availability of suitable habitat, OPCNM is estimated to support 10–18 occupied territories each year.

Monument staff monitored the pygmy-owl from 1995 through 2005, at 8–10 territories annually. Since 2005, monitoring has been largely curtailed due to the combined influences of delisting, large increases in illegal border-related activities, and associated changing work priorities for NPS staff. However, visits to territories in the higher-quality habitat continue to indicate that they are still occupied annually.

Border-related Impacts

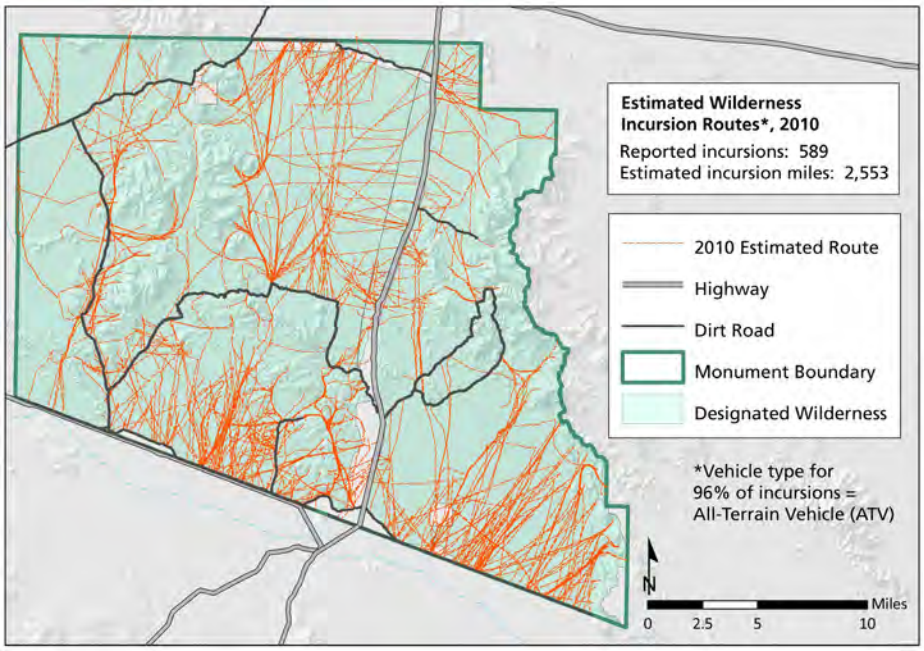
Today, the effects of the U.S./Mexico border situation are found throughout OPCNM. While impacts on park resources are common and sometimes severe, many parts of the monument are still relatively undisturbed and representative of the pristine Sonoran Desert wilderness that OPCNM is intended to conserve. Nonetheless, illegal border-related activities influence every aspect of park operations. The creation of thousands of miles of unauthorized roads and trails, associated damage to soils and vegetation, interruption of natural ecological processes, disturbance to wildlife movements, recurring vandalism and theft at cultural-resource sites, and an abundance of trash are some examples of issues facing the park. In response, OPCNM managers are working to understand the extent and nature of these impacts, and are collecting baseline data on un-impacted areas to facilitate ongoing and long-range restoration plans. Examples of border-related projects include:

- East/west transects surveyed to document trends in the distribution of illegal trails and vehicle routes
- Development and use of a rapid-assessment tool for illegal roads and trails
- Remote-imagery sensing of illegal roads and trails
- Opportunistic restoration of impacted habitats
- Remote-camera and soundscape monitoring of border activities
- Assessment of the effects of border activities on threatened and endangered species
- Wilderness Minimum Requirements analyses of border-related actions (e.g., abandonded vehicle removal)
- Implementation of a collaborative, USGS-led project to assess soil and vegetation vulnerability and recoverability



Monitoring results from east-west transects compared with border fence infrastructure.

- Trash monitoring and clean-up
- Channel-geomorphology monitoring at sites where hydrology has been influenced by border infrastructure
- Cultural-resource condition surveys and stabilization
- Training of agents and contractors about issues related to wilderness and natural and cultural resources



Estimated routes of reported off-road incursions within OPCNM during 2010.

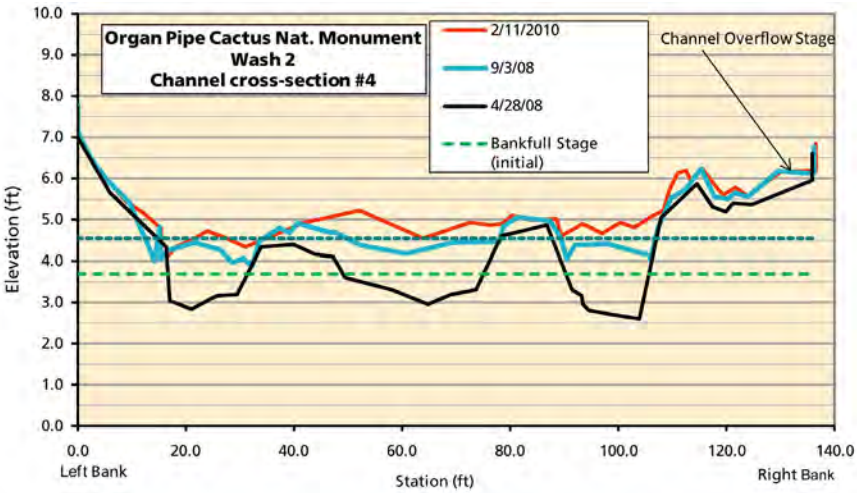
Pedestrian Fence Impacts to Surface Hydrology

In spring 2008, the Department of Homeland Security (DHS) constructed a five-mile section of pedestrian barrier fence along the monument's south boundary, adjacent to the U.S./Mexico border. Due to concerns that the fence, made of steel mesh and grate, could disrupt overland water and debris flow at wash crossings during flood events, six permanent monitoring sites measuring cross-section elevation were installed at major wash channels along the fence in April 2008. Four cross-sections at each wash were measured before fence construction and post-construction in 2008, 2009, and 2010 (see table and chart).

A major monsoon storm event in July 2008 caused flooding at the Lukeville port of entry (POE), debris piles at the pedestrian fence, road damage, and downstream scouring. Cross-section measurements in fall 2008 showed increased sedimentation and washbed elevation after this event. Measurements in 2009 and 2010 showed a continuing trend of decreased capacity for channel flow in proximity to the pedestrian fence, with the long-term potential for channel realignment and effects to riparian vegetation. In January 2010, a winter storm event again caused flooding at the Lukeville POE, as well as border-road damage.

Estimated discharge for cross-sections closest to fence, 2008–2010. Graph for wash #2 shown below.

Wash #	Pre-Fence Overflow (cfs), 2008	2009 Overflow (cfs)	2010 Overflow (cfs)	Discharge Percent Change
1	544	434	361	-34%
2	1698	821	698	-59%
3	2487	2239	2224	-11%
4	949	426	300	-68%
5	459	544	533	+16%
6	398	280	177	-56%

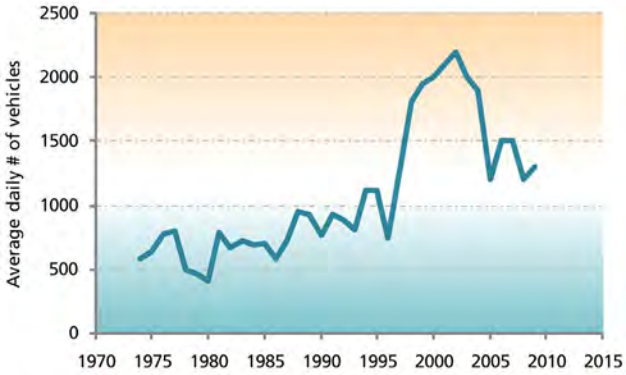


Debris flow at pedestrian fence after major precipitation event in January 2010.

Highway 85

The Arizona Department of Transportation reports average annual daily traffic (AADT) on its website. The time series reported here is based on the segment of Highway 85 between Why, Arizona, and Puerto Blanco Drive. AADT was last reported for 2008, and was based on one 48-hour, short-term coverage count collected during the year and then adjusted (factored) for seasonal and daily variation. Numbers are bi-directional volumes and have been rounded according to recommendations by the American Association of State Highway and Transportation Officials.

Despite wide variation between years, traffic volume has increased over the period of record, roughly doubling since the 1970s. Highway 85 has long been recognized as a major cause of wildlife mortality and chronic disturbance of adjacent habitats. Traffic volume is likely to remain high and will probably increase due to rapid development of Rocky Point, Sonora. Expansion of the Lukeville POE to 24 hours of operation is also a real possibility. Relevant information about highway traffic can help park managers understand impacts to wildlife



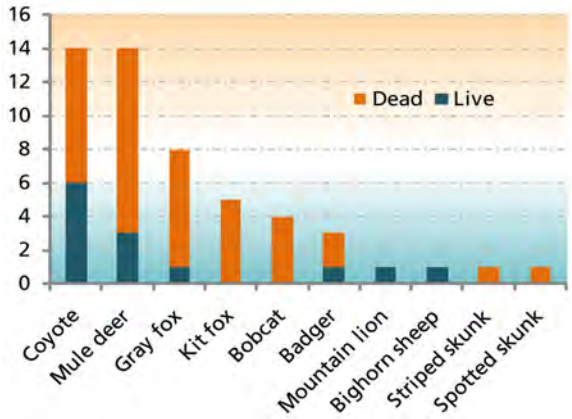
Annual vehicular traffic on Highway 85 between Why and Lukeville, Arizona.

Highway Impacts to Wildlife

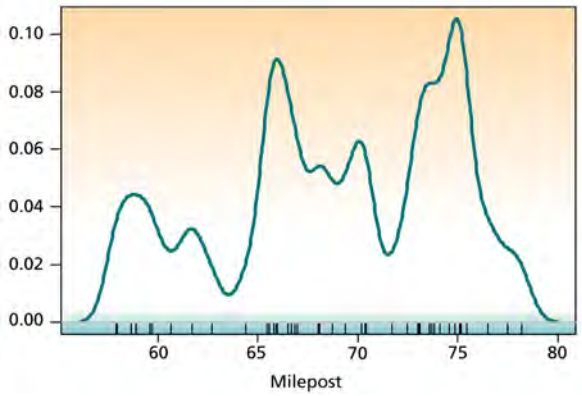
Within OPCNM, large mammals tend to have large home ranges and movement corridors that are bisected by the highway. Road surveys provide a means of assessing the presence of large animal species in the monument and identifying important movement corridors. The results of a pilot study conducted in FY2010 have been combined with other recent data to improve understanding of wildlife interactions with Highway 85.

A total of 52 animals representing 10 species were recorded, with the coyote and mule deer being the most commonly identified. Coyotes and other carnivores may be drawn to the road by the opportunity to scavenge roadkill. Analysis of these data reveals three zones of high wildlife use along Highway 85. From north to south, the three zones include (1) Gunsight Hills to the Kuakach Wash system, (2) Alamo Wash to Cherioni Wash, and (3) Chuckwalla Hills to the Visitor Center. Common features of these three zones include major xeroriparian corridors and nearby hills. At the visitor center, there is an open water source that may be attracting wildlife.

Roadkilled bobcat on Highway 85 with visitor center in background.



Carnivores and ungulates recorded along Highway 85. Actual numbers may be higher.

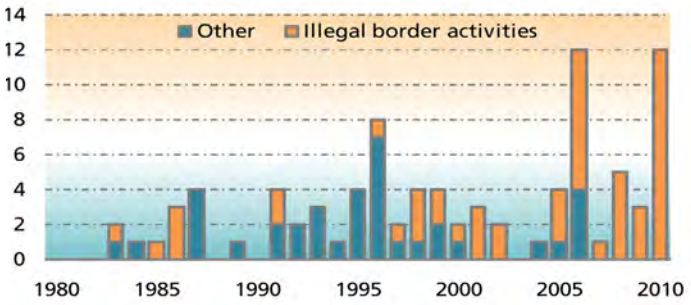


Average density of carnivore and ungulate observations along Highway 85, based on 52 records. Kernel method was used for smoothing.

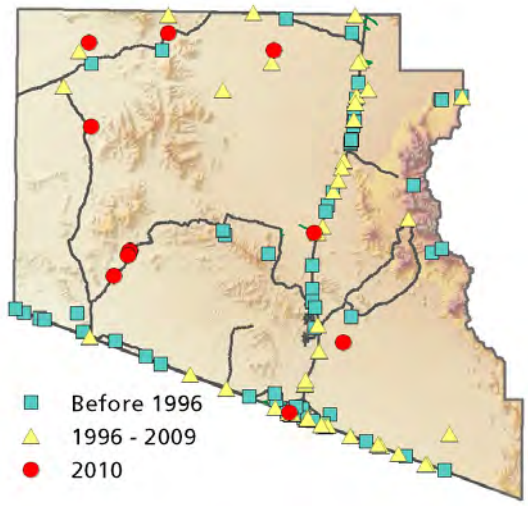
Fire

Wildland fires are rare in the Sonoran Desert, even though lightning strikes are common during summer thunderstorms. Lightning-caused fires in OPCNM are usually small (less than one acre) and almost never detected or recorded. In 2010, no lightning-caused fires were discovered in the park.

Fires ignited by people are much more common. Before the late 1990s, most fires in OPCNM occurred along roadsides or the U.S./Mexico border, especially near agricultural fields. Most fires were unintentionally caused by motor-vehicle accidents, tossed cigarettes, campfires, or agricultural activities in Mexico. By comparison, the 12 fires that occurred in the park during the first nine months of 2010 were intentionally started by drug smugglers and migrants. All fires were less than one acre in size.



Number of known fires and their causes, 1980–2010.



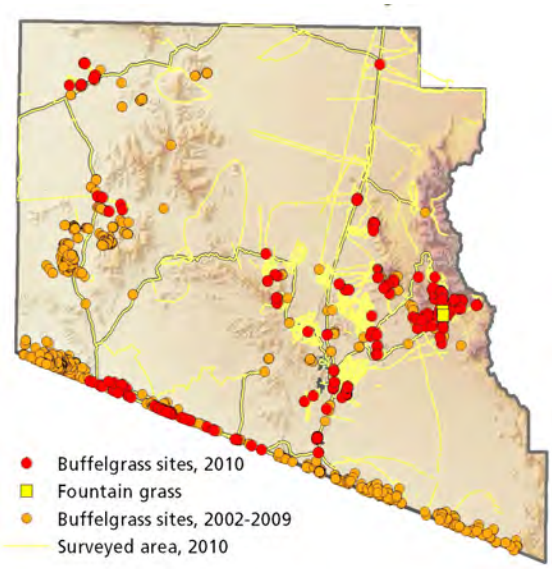
The number of backcountry ignitions has also risen since the late 1990s. The remoteness of these fires increases the risk that they will become large, similar to the large fires (several hundred thousand acres) on Cabeza Prieta National Wildlife Refuge and the Barry M. Goldwater Range that occurred in the mid-2000s.

Non-native Invasive Plants

Non-native invasive plants are species that are not native to OPCNM and its immediate vicinity whose introduction does or is likely to cause economic or environmental harm or harm to human health. Sixty-seven non-native plant species have been documented in OPCNM; nine of these arrived after 2004. One non-native species, herb sophia (*Descurainia sophia*), arrived in 2010, along with three or four others that represent re-infestations of species previously extirpated. Most of the non-native species that arrived after 2004 were agricultural weeds brought in during work occurring along Highway 85.

A number of non-native species are actively managed in the park. Receiving the highest management priority are species with small, localized populations, especially if they are capable of invading wildlands. These species include spotted knapweed (*Centaurea melitensis*), Indian hedgemustard (*Sisymbrium orientale*), tall tumblemustard (*Sisymbrium* cf. *altissimum*), arugula (*Eruca vesicaria* ssp. *sativa*), stinknet (*Oncosiphon piluliferum*), and mouse barley (*Hordeum murinum*). Because infestations of these species are small (<1 acre), they are frequently eliminated with a small amount of effort.

Requiring the most management effort are well-established invasive plants that are known to have significant ecological impacts. Foremost among these are buffelgrass (*Pennisetum ciliare*) and fountain grass (*Pennisetum setaceum*). A large population of fountain grass was discovered in the backcountry in 2008, and eradication efforts have been successful to date. Buffelgrass has been



managed in OPCNM since 1994, and many populations have been eradicated by hand-pulling. In recent years, however, buffelgrass has been increasingly found in remote, mountainous areas where control is more difficult. The buffelgrass invasion is proceeding more rapidly than our current ability to manage it, and additional resources are needed to control it.

STRESSORS

Visitor Use

Visitor-use statistics are reported by the NPS Public Use Statistics Office. Although methods for estimation have changed over the years, visitor statistics provide a crude but useful index of potential disturbance to park resources, as well as an indicator of public response to perceived border-related issues. A key traffic counter has been broken since January 2010, so total recreational visits may be underestimated by several tens of thousands. Neverthleless, visitor use at OPCNM has increased in recent years and has exceeded 300,000 annual visits for the period 2006-209. Peak visitation occurs from January to April, and in 2009, visitation peaked at 61,832 visits in April, compared to a low of 9,460 visits in August. Numbers of overnight stays and backcountry permits have declined since the 1990s.

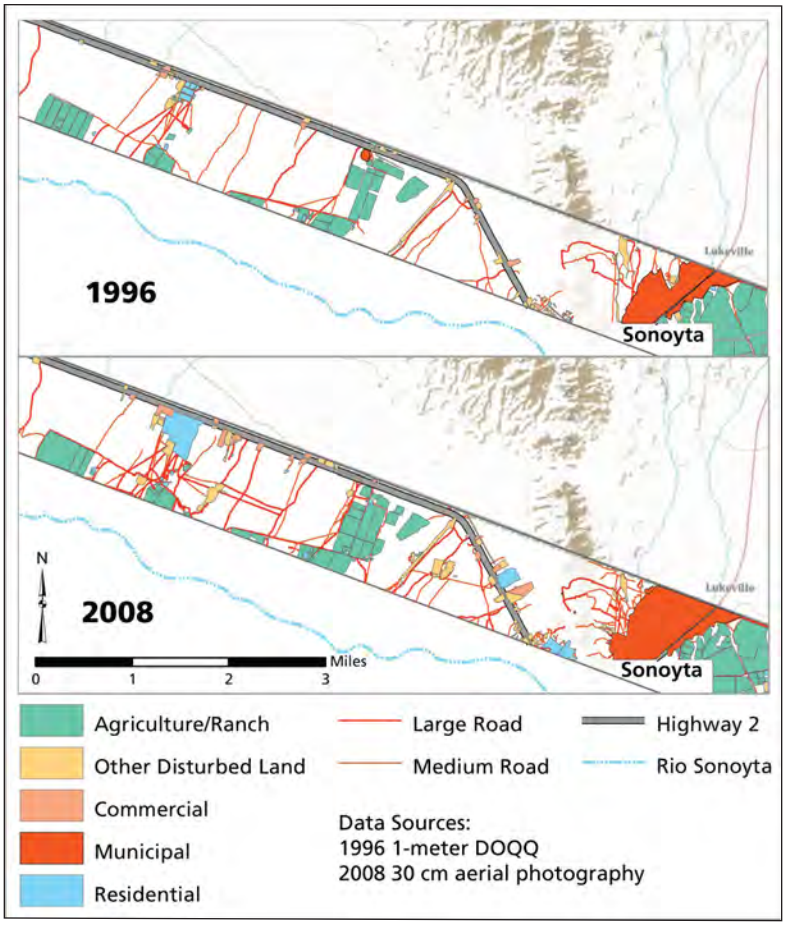
NPS Public Use Statistics Office:
http://www.nature.nps.gov/socialscience/stats.cfm

Recreational visits and overnight stays, 1979–2010.

Adjacent Land Use Trends

In the U.S., OPCNM shares boundaries with the USFWS, BLM, and Tohono O'odham Nation. Although trespass livestock enter the park from these lands, activities in these rural and undeveloped areas are less significan stressors than land use trends in Sonora, Mexico. Agricultural development and associated groundwater depletion, along with the effects of other agricultural practices in the Rio Sonoyta Valley, were early concerns for resource managers. Since the 1980s, both rural and urban development in the Sonoyta area have increased rapidly; potential impacts include wind-blown trash, woodcutting, livestock trespass, non-native plant spread, altered wildfire frequency, and fragmentation of wildlife habitat and corridors. From 1988 to 2004, OPCNM staff took biennial, panoramic, repeat photos from eight border hilltop locations to document land-use trends. The most notable observation was the rapid increase in urbanization and rural development along Higway 2, west of Sonoyta. Due to border safety concerns, photopoint visits have become less frequent in recent years.

In 2010, OPCNM staff categorized and digitized land use occurring within one mile of the border as depicted in aerial photographs taken in 1996 and 2008. Within the 12-year span, rural dwellings, roads, truck stops, and land clearing all increased along Highway 2. The northwest municipal zone of Sonoyta also grew significantly, and some expansion of irrigated agricultural fields was noted west of Sonoyta. These developments further stress the Rio Sonoyta Valley aquifer and decrease the viability of the permanent river reach that supports populations of Quitobaquito pupfish and Sonoyta mud turtles. Active construction for the Highway 2 expansion project was also visible in 2008, as many large fill and/or gravel pits were established in previously undeveloped rural lands.



Land-use classification for a portion of the OPCNM borderlands. For this map, inactive agricultural fields, active agricultural fields, and ranching-related land use were grouped. "Other disturbed land" included bladed areas and gravel/fill pits excavated for highway construction.

FOCAL RESOURCES

Prehistoric Cultural Resources*

There remains much to discover about OPCNM's archeological record. Prehistoric artifacts indicate that human cultures have inhabited the OPCNM area for thousands of years. Not surprisingly, in the Sonoran Desert, archeological sites are frequently associated with scarce and scattered sources of water. Prehistoric populations moved seasonally, spending winters in the mountains near springs. During the summer they gathered food, such as cactus fruit and mesquite beans, and practiced ak-chin monsoon floodwater farming on the plains, growing crops of maize, squash, and beans. At present, less than 8% of the park has been intensively surveyed for cultural resources, though the park adds to this total every year. During 2009 and 2010, 820 additional acres were intensively surveyed. New and important sites continue to be discovered during these surveys. Baseline inventories and monitoring results will help park managers to develop vital sign measures that assess the condition of prehistoric cultural resource sites over time.

Bedrock mortar and pestle.

Historic Cultural Resources*

Important historic sites occur throughout OPCNM. These sites are primarily related to early mining and cattle ranching. The period of significance for most historic structures is between the 1850s and early 1900s, sometimes extending to the 1930s and 1940s. The monument contains numerous abandoned gold, silver, and copper mines, including examples of early deep-shaft silver mines, such as the Victoria mine (nearly 400 ft deep). Other mine features in the park include glory holes, tunnels, adits, ore-cart runouts, leaching vats, and thousands of prospect pits. Ruins include the infrastructure associated with mining camps, such as mining supply stores; blacksmith's shops; miners' outdoor kitchens and quarters with structures of ocotillo, cactus ribs, and adobe; cisterns; and dynamite storage bunkers. The remains of a rare arrastra, a machine that used burros and grinding stones to process ore during the eighteenth and nineteenth centuries, is located at Bates Well, a former ranch headquarters.

Multiple features remain of early cattle ranches, including ranch houses, cowboy line camps, tack barns, bunkhouses, chicken coops, hay barns, windmills, charcos, represos, pipelines, canals, terraced fields, berms, wells, fences and trigger gates, cattle chutes, corrals, stock troughs, sandwich-style corrals, and historic wagon roads and horse trails.

An intensive archeological survey has been performed at the Bates Well Ranch headquarters; all other historic sites are in need of such surveys. During 2010 and 2011, OPCNM and its partners conducted two Ruins Preservation Field Schools during which considerable historic structure stabilization and rehabilitation work was performed. Several historic buildings, including the Gachado line camp house, an historic adobe structure, the Armenta house and adjoining jacal, the Bates Well main ranch house, hay barn, bunkhouse, sandwich-style corral fences and portions of several other features underwent emergency stabilization work. Such work has contributed greatly to the continued conservation of these important resources.

"Lost Cabin" historic mining structure.

* Although the term "vital sign" is typically used in reference to natural resources, cultural resources are included in this report for several reasons. Our mission includes the preservation of both natural and cultural resources, culture has shaped and been shaped by the natural landscape, and management policies require that we consider both natural and cultural resources in the planning process.

Desert Bighorn Sheep

In 1994 and 2006, the Arizona Game and Fish Department and NPS cooperated on helicopter surveys to determine the distribution, size, and composition of the desert bighorn sheep population in OPCNM. For both surveys, all potential bighorn sheep habitat was divided into blocks and flown at 50–100' elevation with two observers.

The number of bighorn sheep observed yielded an overall population estimate of 28 sheep for the surveyed portion of the monument in 2006. With a 95% confidence interval, based on the variability of surveys measured during previous studies in southwestern Arizona, the population range of sheep was calculated to be 21–43. Because of the mobility of bighorn sheep and the known variability of survey results, population sizes for individual blocks or mountain ranges were not estimated. However, it was apparent that most sheep were in the Ajo and Bates mountains.

Many fewer bighorn sheep were seen during the 2006 survey than on the survey conducted in 1994. Seventeen sheep were found in the same area where 59 sheep were recorded 12 years previously. The decline in numbers was consistent across all survey blocks. No sheep were seen in some apparently suitable habitat, such as the Puerto Blanco Mountains, Diaz Peak, and the Sierra de Santa Rosa. It is possible that low numbers of sheep were in these mountains and were simply missed on the survey. In the case of the southern tip of the Growler Mountains, the habitat within the monument is only a small percentage of the total habitat in those mountains, and sheep easily move on and off the monument portion. A similar situation exists for the Ajo, Diaz Peak, and Santa Rosa blocks, where habitat exists but was not surveyed on the adjoining Tohono O'odham Reservation. However, the majority of habitat is on the monument side, and it is unlikely that sheep were on the reservation in any large numbers at the time of the survey.

The lack of other large animals seen on the survey was also notable. Although the survey targeted bighorn sheep, other species were recorded whenever they were observed. On the 2006 survey, no mule or white-tailed deer, and only eight javelina, were seen in the same areas where 41 mule deer, 20 white-tailed deer, and 66 javelina were observed in 1994.

Several factors may have contributed to the low numbers of bighorn and other wildlife, including disease—especially those transmitted by domestic livestock; drought, as it impacts forage and water supplies; and predation. Although most of southwestern Arizona has not experienced a similar decline in bighorn populations during the past 12 years, areas north of OPCNM, around the Sauceda, Sand Tank, and Maricopa mountains, have shown similar declines. In order to monitor bighorn sheep population trends, the monument will continue to support aerial surveys, ideally every 5 years.

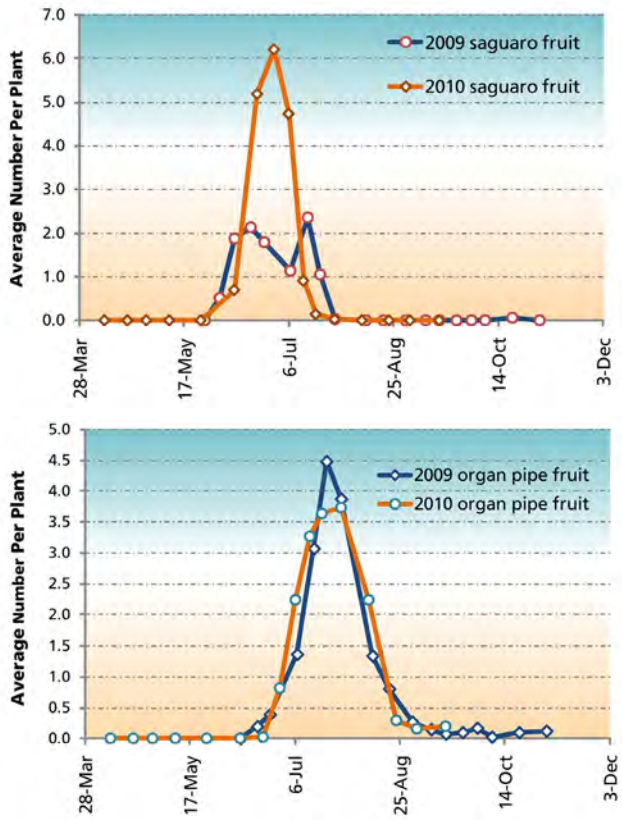
Results of aerial bighorn sheep surveys, 1994 and 2006.

Block Number	Block Name	1994 - # Observed	2006 - # Observed
1	North Ajo Mountains	12	6
2	South Ajo Mountains	10	4
3	Diaz Peak	6	0
4	Sierra de Santa Rosa	0	0
5	Diablo Mountains	0	0
7	East Bates Mountains	9	0
8	West Bates Mountains	8	6
9	Puerto Blanco Mountains	0	0
11	Growler Mountains	2	0
12	Cipriano Hills	12	1
13	Quitobaquito Hills	0	--
	Total	**59**	**17**

Columnar Cactus Phenology

OPCNM was established in part to preserve its unique stands of columnar cacti. These species are also important resources for wildlife, including the endangered lesser long-nosed bat. In 2009, a phenology plot was established near monument headquarters to record flower and fruit counts in a mixed stand of organ pipe and saguaro cacti at approximately 10-day intervals. In 2010, productivity was slightly less for the organ pipes and much greater for the saguaros when compared to 2009. Timing of flowering between years was similar, except that the peak of organ pipe flowering occurred approximately two weeks later in 2010 than in 2009.

Organ pipe cactus (*Stenocereus thurberi*) and flowers.



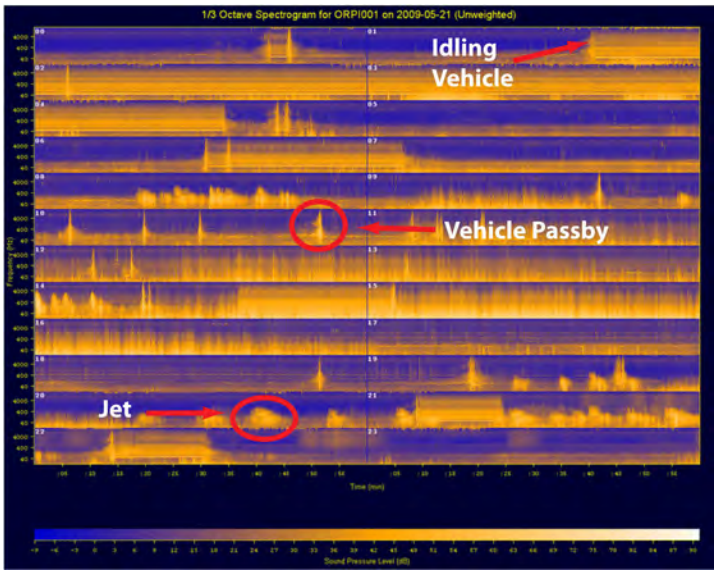
Saguaro and organ pipe fruit production, 2009–2010.

Wilderness Soundscapes

Ninety-five percent of OPCNM is designated wilderness. Natural soundscapes are a fundamental wilderness value, important both for wilderness experience and ecosystem function. Human activities, such as vehicular traffic, generator use, and aircraft overflights, impact park soundscapes and are expected to increase with growing border-related activity and infrastructure.

The NPS began preliminary acoustical monitoring at OPCNM in 2009, and is in the process of developing a regular monitoring protocol. Three sites were selected for the preliminary study, including an operations facility used by the DHS at Bates Well and two proposed surveillance tower sites. Results of this study indicated that generator noise was audible 100% of the time at Bates Well, inhibiting natural ambient calculation. At the two proposed tower sites, road vehicle noise was audible 11.9% and 19.9% of the time, and aircraft noise was audible 5.2% and 5.9% of the time.

Artificial noise is a special concern for recovery of the endangered Sonoran pronghorn. This normally shy animal is reluctant to approach roads and other areas where human activity is present, thus preventing the population from utilizing key parts of its former home range. Acoustic monitoring will allow managers to better understand habitat use by Sonoran pronghorn and better manage noise in key habitat areas.



A spectrogram produced from 1-second sound pressure level data collected in May 2009 on the western boundary of OPCNM.

Conclusion

Organ Pipe Cactus National Monument preserves an expansive, diverse and vibrant area within the Sonoran Desert region of North America. The monument's desert-adapted plants and animals have evolved unique life strategies that enable them to survive in such an extreme environment. Most native desert species continue to thrive here, though some are unquestionably struggling. This vital signs report provides insights into the monument's overall ecological health as well as the stressors that influence it.

Unquestionably, the most difficult issue faced by managers of OPCNM is the ongoing U.S./Mexico border situation. In recent years, every aspect of the park's management has been affected by border-related issues. In response, today we are implementing numerous border-related projects involving targeted research, monitoring, education, resource management, and restoration. Through this significant effort we hope to document the effects of border issues and facilitate the development of creative and effective management options to minimize future impacts and repair degraded resources.

Management of the park's other resources is similarly challenging. The Sonoran pronghorn, for example, is a critically endangered, desert-adapted subspecies of the North American pronghorn. The U.S. population of Sonoran pronghorn nearly became extinct in 2002; since then, the park has worked closely with numerous cooperators to recover the species. To date, these efforts have resulted in the successful establishment of a semi-captive breeding population and the subsequent release of captive-bred individuals into the wild. This work continues, and it is our hope that these pronghorn will once again thrive in our beautiful Sonoran Desert.

Another recent resource management challenge has involved the stabilization and recovery of Quitobaquito, a spring and pond system that represents the only habitat in the U.S. for the endangered Quitobaquito pupfish. Although we are not yet where we want to be, our new, more comprehensive understanding of this system has allowed us to design and implement management actions that have ultimately regained much of the pupfish's lost habitat. Our accomplishments here, in recovering this system, have truly been rewarding.

During 2010, record high numbers of the endangered lesser long-nosed bat were documented roosting in the park. During 2011, park managers hope to open new potential roosting habitats at various abandoned mine features by refitting the entrances with bat-friendly closures. Infestations by non-native invasive plant species continue to be of concern—especially because access to locations where infestations had previously been managed has been challenging in recent years, while at the same time, the frequency of ground disturbances, which can facilitate invasive species expansion, has increased. In response, park managers are currently preparing to implement an expanded and prolonged invasive exotic plant monitoring and management program.

Determining the effects of climate change on monument resources is yet another area to which the park is dedicating considerable effort. Our long-term monitoring program already measures diverse ecological and environmental parameters. We continue to refine this program, periodically adding new "vital signs" and refocusing our sampling efforts in order to better comprehend such new and developing issues as climate change and border issues. The insights that these data provide are vital to our understanding of biological patterns and the general health of the Sonoran Desert ecosystem.

Long-term, scientific monitoring is the key to documenting and understanding resource conditions and ecological health. Park staff will continue to strive to monitor the effects of stressors on such disparate parameters as threatened and endangered species, ecological processes, wilderness values, and cultural resources. Several vital signs show that OPCNM's ecological system is being stressed by forces acting at scales beyond the park's boundary. In light of these challenges, park managers are working with diverse and specialized counterparts to develop and implement research and monitoring programs using both established and newly developed technologies. Partnerships between park staff and federal, state, and private cooperators are helping to successfully address many of the park's complex issues. Ultimately, such partnerships help to form the basis for effective stewardship of Organ Pipe Cactus National Monument's resources.

Lee Baiza

Superintendent, Organ Pipe Cactus National Monument

Thank you for reading this report. Please send comments to Superintendent Lee Baiza, 10 Organ Pipe Drive, Ajo, Arizona 85321.