



Teacher 's Guide

Supplementary Background Information
and Classroom Activities

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The Saguaro & the City

Teacher 's Guide

An Introduction :

Welcome to "The Saguaro & the City," an interactive exploration of land development and ecology issues in the Tucson Basin. Because of the fragile ecology of the Sonoran Desert, unique species and habitats, and water scarcity, land use development issues in this region are highly complex. Sensible and sustainable land management policy and practice will continue to be top priorities in Tucson for as long as people choose to inhabit this valley.

"The Saguaro & the City," sponsored by the University of Arizona, provides an extensive, in-depth introduction to desert ecology and development topics from a variety of local sources. Scientists, Tohono O'odham, conservationists, middle school students and government representatives all offer their perspectives on the best context for human activity and habitation within the delicate ecology of the Sonoran Desert. Use this teacher's guide to help you and your students get the most out of the CD-ROM as a classroom research tool and curricular supplement.

Organization of Teacher 's Guide

For your convenience, the background information on the CD-ROM is broken down into two main sections: Part I, "The Sonoran Backdrop," takes a close look at the composition of the Sonoran Desert as a whole, and explores some significant patterns of ecological change; Part II, "An Introduction to Land Use Policy," surveys the many agencies and organizations—both public and private—that play a role in Arizona land management, while illustrating some creative strategies for desert-compatible development. Each of these two main sections may be accessed through the table of contents either from the beginning, or by subject subheading on everything from buffelgrass to land easements.

At the conclusion of the informational sections are five in-depth student activities. Take some time to explore these activities in turn. Depending upon the needs of your classroom, it might be best to break some activities down into component exercises. Be creative. Activity guidelines are flexible, and ideas can be adapted to accommodate almost any learning conditions.

Following the student activities is a glossary of keywords found on the CD-ROM, and a list of books in the Tucson-Pima County library system that students and teachers can search for additional information. Remember: "The Saguaro & the City" is a valuable starting point for learning about development issues, but other perspectives not represented do exist. Use this CD-ROM as a springboard to propel your students into a greater range of knowledge and wisdom about ecology, policy, property rights, and development practices in their home community.

Part I :

The Sonoran Backdrop

In order to understand the complexity and significance of land management and development issues in the Tucson Basin, one must first learn to appreciate the many different aspects of our unique and fragile environment—the Sonoran Desert. This first section is offered to illuminate the many “parts of the whole” that make up our Sonoran backdrop.

Beginning with a broad view of Sonoran geography and climate, our focus will narrow to consider the desert’s smaller component communities, and the vital, threatened riparian habitats essential for life. From there, we will address new developments—natural and unnatural—that are changing the face of the desert and threatening the riparian areas so precious to desert life. Without question, the most significant variable in Sonoran ecology has been the impact of human settlement, and the environmental attitudes people have brought with them to the Sonoran Desert. Our chapter ends with a look at changing trends in human attitudes toward environmental development and preservation, thereby setting the stage for the extensive realm of land use policy and policy and policy makers which will be discussed in Part II.

What is the Sonoran Desert?

Sonoran Geography

In geologic terms, the Sonoran Desert is relatively young—about 10,000 years old. It covers approximately 120,000 square miles and spans most of central and Southern Arizona as well as parts of southwestern California, Baja, California, islands in the Sea of Cortez, and Sonora, Mexico.

• People unfamiliar with the Sonoran Desert often
• picture it as a low, hot, sandy environment. In
• fact, the diverse topographical features of the
• desert mean that it is home to a remarkable variety
• of habitats and species.

Sonoran Desert Seasons

• The technical definition of a desert is not determined
• by how much annual rainfall it receives,

Ecology and Ecosystems

Ecology is the study of natural systems, particularly the relationships of living organisms and with the non-living components of their environment. An ecosystem is a self-sustaining and self-regulating association of living and non-living things that interact together in a dynamic and complex system. Ecosystems may be as large as the entire planet, or as small as a decaying log. Although we tend to think of ecosystems on a grand scale, such as the Amazon Basin ecosystem or the Sonoran Desert ecosystem, an ecosystem is defined by the intricate relationship among its members and not by its size. In its most comprehensive focus, ecology is the study of ecosystems.

• but by the ratio of precipitation to evapotranspiration
• (the combination of evaporation and plant transpiration).
• In some deserts, such as Peru’s Atacama Desert, the
• evapotranspiration is greater than the precipitation.
• In the Sonoran Desert, spring and fall are generally
• seasons of drought. Most of the precipitation falls
• during the two “rainy” seasons: from December to
• March, frontal storms from the North Pacific
• occasionally bring widespread, gentle rain; from
• July to September, tropical “monsoons” from the
• Gulf of Mexico (and occasionally, in late summer,
• from the Sea of Cortez) bring localized, often
• violent, thunderstorms.

• During the rainy season, rainfall from the surrounding
• mountains runs off onto various stretches of the
• desert floor. The increased moisture in these runoff
• areas promotes greater plant diversity, allowing
• species that need more water, such as ragweed,
• to grow. During the rest of the year, humidity
• is generally very low. On cloudless days, when
• relative humidity is less than ten percent, solar
• radiation is extremely intense, drawing much of
• the life-giving water from plants. Many Sonoran
• Desert plant species are adapted to these harsh

conditions, and thrive with very little water in the dry, rocky slopes between the washes.

Temperature plays an important role in determining the vegetative composition of the Sonoran desert. Summer is a season of intense heat. While desert plants and animals are accustomed to the extreme temperatures of the summer months, extended periods of freezing temperatures during the winter can be devastating for Sonoran Desert plant life, especially cacti and other succulents. Because winters in the desert are generally mild (with much of the region being frost-free), many Sonoran plants are not adapted to survive freezing temperatures. Under normal conditions, however, these mild winters allow certain plants to continue their growth activity year-round. In addition to a dramatic seasonal temperature gradient, there is frequently great variation in temperature during a single day. Often, throughout the year, there is a 30-plus degree Fahrenheit temperature range during a twenty-four hour period.

Sonoran Regions and Communities: Parts of the Whole

Close to Home: The Arizona Upland

The Sonoran Desert region encompasses low desert, semi-arid grasslands, lush streams, and sub-alpine forests. In comparison with other deserts

Genetic Diversity

Anything that causes a reduction in the population of a species generally decreases its genetic diversity. Habitat loss reduces population size and thus removes some of the genetic variation from a population. Uncontrolled harvesting of wild plants or animals (poaching or clear cutting of trees, for example) can also have a negative impact on the abundance and genetic diversity of a species.

of the world, the Sonoran Desert is lush, supporting some 2500 species of plants. Such vegetative diversity – the result of physical factors such as

elevation, temperature and precipitation – creates an important link in the complicated energy pathways of the region. In an attempt to give order to the complex nature of the region, ecologists have designated various biogeographic subdivisions of the Sonoran Desert. The landscape around Tucson is dominated primarily by various cacti and desert shrubs and trees. This area is referred to as the Arizona Upland. The Arizona Upland "subdivision" stretches west from the Buck-

Community

A community is a group of interacting plant and animal species that occupies a particular place. Communities are often defined by the most abundant vegetation in the area, such as the saguaro-palo verde community found at the Arizona-Sonora Desert Museum, or nearby Saguaro National Park. When one considers the soil, climate, water, and other non-living (abiotic) factors along with the plants and animals that make up a community, the entire unit is called an ecosystem.

skin Mountains to the northwest of Phoenix, and extends nearly as far south as Altar, Sonora, Mexico. About 90 percent of the region is composed of slopes, broken ground, and sloping plains. The Arizona Upland region falls between the elevation of 2400 to 2800 feet and receives anywhere from less than three, up to approximately 12 inches of rain per year. Because parts of this region get more than the maximum eight inches of rain that define desert ecosystems, some scientists classify this portion of the Sonoran Desert as a subtropical thorn forest.

Life in the Saguaro-Palo Verde Community

Because saguaro cacti and palo verde trees are the most prominent plant life in the Arizona Upland region, it is referred to as a saguaro-palo verde community. The plants in the saguaro-palo verde community of the Sonoran Desert come in a greater variety of sizes and shapes than do plants in most other deserts. In addition to the towering saguaro cactus, there are several varieties of palo verde trees, including the blue palo verde and the foothills palo verde. Palo verdes, along with two other common spiny trees, the ironwood and the velvet mesquite, are legume trees, which produce highly nutritious seeds that provide food for birds

and rodents. Many other plants share the saguaro-palo verde community landscape, including barrel cacti, cholla, prickly pear, ocotillo, catclaw acacia, fairy-duster, creosote, jojoba, desert willow, yucca, bursage, and desert broom. The saguaro-palo verde community is also home to many animal species, such as the Gila woodpecker, wood rat, scorpion, desert brown spider, desert mule deer, rattlesnake, javelina, coyote, jackrabbit, and desert spiny lizard.

Riparian Areas: Critical Habitat

Ribbons of Life

Within the saguaro-palo verde community, there are other smaller ecological communities as well. Associated with each of these different communities are a variety of plants and animals. One of the most significant of these groups is the riparian area. Riparian areas are "vegetation, habitats, or ecosystems that are associated with bodies of water or are dependent on...surface or subsurface water drainage." In the desert, riparian areas have been called "ribbons of life"—providing shade, moisture, and cooler temperatures in an otherwise dry environment. The wetter conditions support a variety of plants that are unable to survive in the hot, dry desert surroundings. Riparian areas are critical wildlife habitat. It is estimated that 70 to 80 percent of Arizona's resident wildlife species depend on riparian areas for survival. It is also estimated that only 1 percent of the land area in Arizona is riparian.

Within the saguaro-palo verde community, there are scattered riparian communities. Some are characterized by deciduous trees, such as cottonwoods and willows, that grow along the banks. The cottonwood-willow forests of the Sonoran Desert's riparian areas are one of the rarest and most threatened forest types in North America. These trees are important to migratory birds, nesting hawks, and large mammals.

One type of riparian area within the saguaro-palo verde community is the mesquite bosque, a

forest-like area in which numerous, large mesquite trees grow in the floodplains of major desert streams. Examples of bosques can be found along the Santa Cruz River, Gila River, San Pedro River, and along certain stretches of the Agua Caliente and Pantano Washes. Many mesquite bosques are threatened because of human activity, such as land clearing for cattle grazing and agriculture, cutting of trees for fuel, and groundwater pumping. Grasses such as vine-mesquite grass and careless

Niche

All species live in natural communities with various other plants and animals and have numerous interrelationships with these other species. Each species has its own role or niche in a community, and the loss of one species usually directly or indirectly affects other species in the same area. Because of the complex web of interrelationships, disturbing one species can have detrimental effects on entire communities. For example, if all the palo verde were destroyed in one location, it would reduce available nesting sites in the area and thus reduce the number of birds active in that area, which in turn could lead to an increase in the insect population on which the birds formerly fed. There would be less natural cover for small animals, which could decrease their numbers as they became easier prey. Thus, maintaining species diversity contributes to the health and stability of entire communities and

weed share the terrain with the mesquites, while raccoons, desert pocket mice, doves, and phainopepla also frequent these areas.

Another example is the ironwood community. Here, the diverse plant life—primarily ironwood, mesquite, palo verde, catclaw, and desert willow—attracts creatures such as the grey fox and the Harris hawk. Ironwood is by far the slowest growing desert tree, often taking over 100 years to reach a height of twenty feet. The least common (and most ecologically diverse) riparian area in the desert is the wetlands zone. Wetlands ponds and lakes draw various migratory birds and play host to numerous varieties of amphibians, fish, and mammals.

While Sonoran riparian areas vary much in description and character, they all share one thing in common—they are all essential to desert life. Riparian areas are our oases, providing water, dense foliage for shelter, and often abundant food

resources. In order to support wildlife species diversity, it is essential to preserve our remaining riparian areas.

Riparian Areas and People

Wild animals are not the only living creatures attracted to these areas. Humans are attracted to these lush environments also—to the cool, shady areas, and especially, to the water. The last two centuries of human settlement in the Southwest has brought with it livestock grazing, mining, farming, recreation and floodplain development. All of these practices have impacted riparian areas—often with devastating effects. Today, the vast majority of our riparian areas have been altered, damaged, or have completely disappeared. Upstream diversions such as dams often change the rate or course of water flow; impoundments and extensive groundwater pumping often lowers the level of water in the ground below. By some estimates, over 90% of the streams that flowed year round in the lower desert regions in Arizona have dried up during the last century. One notable casualty is the Santa Cruz River, which flowed near the San Xavier Mission as recently as the 1920's.

The preservation of Arizona's remaining riparian areas is important for many reasons. In addition to providing habitat for wildlife and water for humans, riparian areas perform numerous other valuable functions in the environment as well. Healthy riparian areas improve water quality, stabilize streambanks, and moderate floods. As they absorb water flows, riparian areas also recharge underground aquifers by letting water slowly percolate through the soil into the water table. Wa-

Fragmentation

Fragmentation of habitat occurs when large tracts of natural vegetation are removed, leaving only small habitat "islands," or when structures such as canals and highways limit animal movements. Habitat fragmentation creates populations that are isolated from each other, and thus reduces or eliminates their ability to reproduce. It also can lead to inbreeding, which results in reproduction without diversity. Generally, with larger populations come greater gene variations and better odds for long-term species survival.

ter is a vital resource all over the world—in the water-scarce Sonoran Desert, it can't be taken for granted.

Intruders in the Dust: Non-native Plants and Species

Species

A species is a group of organisms that can breed successfully and produce viable offspring with others of the same kind. Viable offspring are those able to reproduce successfully themselves once they reach maturity. Members of one species normally do not breed with members of another species. When organisms breed within their species, genes are exchanged, genetic diversity is maintained, and the species usually is able to adapt to changing evolutionary and environmental conditions. Thus species are not static: they evolve over time and are "discrete entities in time as well as space."* Members of a particular species generally resemble one another more closely than they resemble members of other groups.

*Niles Eldredge and Joel Cracraft, *Phylogenetic Patterns and the Evolutionary Process* (New York: Columbia

The Danger of Exotic Species

One significant threat to habitat integrity and species diversity in the Sonoran Desert has been the introduction of non-native species. An exotic (or introduced) species is a plant or animal accidentally or deliberately introduced to areas where it does not occur naturally. Because of the natural interrelationships already in place, exotics can wreak havoc in communities. Many plants, including tumbleweeds, tamarisk trees, and numerous grasses, have been transported into the Sonoran region. Very often, these species out-compete native species for precious water, light, and space and their success may cause native species numbers to decrease. Non-native animals have also "taken over" habitats which natives traditionally relied upon. Sometimes, exotic predators or disease organisms can wipe out entire populations of animals or plants when the native species cannot adapt to the new predator or disease. Whether by competition or predation, introduc-

tion of exotics usually results in a loss of native species diversity.

The Spread of Buffelgrass

Exotic species have often been introduced into areas for specific purposes, as food supplies, for example, or to curb insect infestations. The long-term effects of such introductions, however, have often been overlooked. Buffelgrass is one such species whose negative long-term effects were not anticipated. Buffelgrass was brought from Africa to the Sonoran desert in the 1940's by well-intentioned scientists to help prevent soil erosion and replace the native grasses destroyed by grazing cattle. This aggressive species grows where it is not wanted and thrives after a fire has destroyed everything else in the area. Unfortunately, buffelgrass grows back even stronger after fire, consuming precious water and nutrients. Some ranchers use bulldozers to clear the desert-destroying native wildlife and plant life and plant buffelgrass to feed their cattle. The continued cultivation of this monoculture in place of once thriving desert habitat is a serious problem for the Sonoran Desert. "Buffelgrass is the most pervasive threat to the diversity and stability of the Sonoran Desert," says Dr. Gary Nabhan, a well-known botanist and author.

The introduction of pecans to the Sonoran Desert in the 1920's brought in more than nuts and dollars. Because pecan groves depend on flood irrigation to grow, their need for water placed a strain on water supplies. Along with the pecan groves also came a host of new insect pests to the area, such as mosquitoes, who find flood irrigation waters prime breeding areas. More recently the incidental arrival of a species of mosquito from Africa, whose eggs readily survive many months in a dormant state in the absence of water, has become a serious nighttime nuisance for residents throughout Southern Arizona.

Cattle in the Sonoran Desert

Another introduced species that has affected the Sonoran Desert is cattle. Cattle grazing removes much of the plant cover that surrounds saguaros. Without the presence of low plant cover such as wheatgrass, burrobush, buckwheat, and bursage (often referred to as "nurse plants"), young saguaros are not protected during the many years

it takes them to become established in the desert (it takes approximately 14 years for a saguaro to grow to a height of six or seven inches). The decline of Saguaro populations in the presence of cattle grazing continues to be closely studied.

Not all exotic introduction is detrimental. According to extinction expert Ariel E. Lugo, sometimes the introduction of exotic species can help expand local biodiversity. "Exotics can provide food and fiber without causing ecological havoc....certain exotic trees grow well in highly degraded lands where they contribute to soil rehabilitation and reestablishment of native species."* This has been true with some Eucalyptus species used selectively in the Sonoran Desert.

*Ariel E. Lugo, "Removal of Exotic Organisms," Conservation Biology 4(4): 345, 1990.

Changing Attitudes: Forging a Public and Private Land Ethic

A Call to Change

A long-standing attitude towards open, undeveloped land is that it possesses no inherent value of its own. Many people believe that the only value of vacant land lies in what can be done with it, what type of structure can be erected upon it, or what natural resources can be extracted from it. In recent years, however, a new attitude has been gaining popularity. One description of this new attitude has been called a new "land ethic." Forty years ago, conservationist Aldo Leopold called for a new land ethic which values the land above and beyond its development potential.

"We abuse land because we regard it as a commodity belonging to us. When we see it as a community to which we belong, we may begin to use it with love and respect."

—Aldo Leopold

Congress Gets Involved: The National Environmental Policy Act

In response to public outcry during the late 1960's demanding increased protection for the environment, the United States Congress passed several far-reaching and innovative environmental laws. One of the most popular of these new laws was the National Environmental Policy Act of 1970, otherwise known as NEPA.

The Environmental Impact Statement is a product of the NEPA process. Through this process, federal agencies are required to forecast the environmental consequences of projects and their alternatives, and to make these forecasts available to the public. The basic concept underlying the NEPA process is simple: the federal government should know how a project will affect the environment before that project is approved. In addition, since decisions on what is an acceptable level of environmental damage involve difficult value judgments, the process requires that the government consult with members of the public. The result of this is much greater citizen and local government awareness and involvement than previously existed.

Environmental Action Groups

Thousands of environmental action groups exist today, addressing water contamination, public lands cattle grazing, wilderness conservation, wildlife protection, air quality, clean energy, and many other issues. Different environmental groups have different objectives and different methods of operation. Some of these groups are of strictly local orientation while others are national, or even internationally, affiliated. All groups try to educate the public on their specific concerns, though their tactics often vary. Some groups raise awareness by going door-to-door. Other groups lobby politicians or speak at city council meetings or public hearings. Sometimes groups express their concerns through rallies and protests. One of the oldest environmental groups still active today is the Sierra Club. Sierra Club chapters operate in different Arizona communities.

Another environmental action group active in southern Arizona is the Rincon Institute. It is a community stewardship organization with the

purpose of protecting Saguaro National Park and adjoining lands through cooperative approaches that bring together diverse elements of the local community. The Rincon Institute also works with landowners and developers to protect desert streams and washes. In the future the Institute plans to be involved in long-term ecological monitoring and environmental education.

Environmental Protection in Arizona:

The Heritage Fund

In 1990 the Arizona Heritage Fund was established, yearly allocating \$20 million in state lottery funds to be divided evenly between the Arizona State Parks Department and Arizona Game and Fish Department. Almost \$9 million annually is directed towards conservation and enhancement of wildlife habitat throughout the state (Development and the Saguaro 1995).

Such wildlife habitat protection measures underpin several other important regional goals, and will promote multiple benefits for the community. Some of these benefits include: overall natural resource protection—including biodiversity and general environmental health; riparian area and water resource protection; erosion control; opportunities for active and passive recreation; and environmental education for the citizens of Arizona. (Development and the Saguaro 1995).

Part II : An Introduction to Land Use Policy

Throughout Arizona there is a broad spectrum of landownership. Some land parcels are owned by public entities, such as state universities, national parks, state parks, the department of transportation, or municipal governments. Other areas house individual residences, small businesses, utilities, or industries. Landowners use their properties in many different ways, for many different reasons. Without a system for determining land ownership and use, the result would be...complicated. Would you like to live next to a slaughterhouse? Would it be wise for an herbicide manufacturer to locate their factory beside a farm? Or imagine eating at a restaurant next to a landfill! We use land use planning to avoid such undesirable scenarios.

The system for governing multiple land uses statewide can be broken down into two general categories: Land Management, which addresses the management and maintenance of lands (such as parks or forests) already designated for specific purposes; and Land Use Planning, a multi-tiered process in which strategies for future land preservation and development are devised according to public and private concerns. In this section these categories will be described and their significance discussed in turn.

Managing for the Future

The Tucson metropolitan area, like many Southwestern cities, is experiencing rapid growth. Tucson's location between beautiful mountain ranges, its mild climate, and the unique Sonoran Desert landscape, combine to make it a desirable place to live. The challenge facing Tucson, and

cities like it, is how to continue to provide ample job opportunities and housing for the current and future residents without seriously damaging its fragile desert ecology, its cultural heritage, its clean air, and its pleasant lifestyle.

Many growth-related issues confronted by non-metropolitan regions of Arizona are similar to those faced in the urban areas. There are, however, some important differences. Many non-metropolitan regions lack the necessary infrastructure to support a large influx of population and lack the funds to meet the needs of development. Increased populations mean increased pollution, added stress to water supplies, and a possible change—often unintended or undesirable—in the character of small communities.

Growth management has arisen as a response to such problems, and stems from the conviction that a community's future can and should be directed. Managed growth helps communities meet the increased costs of services for new residents while addressing the need for preserving areas of natural and historical significance.

Planning and Zoning: Tools of the Trade

Planning and zoning has been the primary mechanism by which local government seeks to assure that the growth and development of the community will be suitable, planned, and prosperous. Planning and zoning involves establishing clear rules and guidelines defining appropriate uses of the land, administering those rules, and enforcing adherence with the established guidelines.

There are many interrelated factors involved in this process—the rights of property owners, differing views on the "common good," overlapping strata of public jurisdiction, and the physical composition of land parcels themselves—all of which makes land use planning a highly complex activity. Below is a list of several local agencies involved in planning and zoning decisions, along with some common strategies for land use planning.

A Delicate Balancing Act: Economic Growth and Environmental Protection

One of the greatest challenges facing urban areas is to allow for needed economic growth and expansion without destroying or irreparably damaging the natural environment. A typical goal of the local planning process is to allow the highest and best economic use of the land that is consistent with non-economic considerations such as environmental preservation and quality of life. This goal is typically met through a progressive, far-reaching, comprehensive plan and zoning process that will facilitate the desired growth while allowing for unique open space to be preserved.

Creative Solutions: Pima County's Comprehensive Plan

One side of a solution to this problem is Pima County's Comprehensive Plan. The Plan supports an integrated regional open space system composed of public parks and preserves, river parks, desert belts, natural and cultural landmarks, protected floodplains and wildlife habitat and subdivision linkages (Development and the Saguaro 1995).

Conservation of greenways (networks of parks, trails, waterways, scenic roads and bike paths), rivers and trails may result in reduced costs to local governments and other public agencies. By conserving a greenway corridor rather than permitting intensive development, local agencies may reduce costs for public services such as sewers, roads and school facilities. Establishing a greenway in an area prone to hazards, such as flooding, may decrease costs for potential damages. Greenways and associated vegetation can also help control water, air and noise pollution by natural means, resulting in potential decreased pollution control costs (Rivers, Trails and Conservation Assistance 1992). Greenways preserve the biological diversity of plant and animal species by maintaining the connections between ecosystems while providing refuge and safe migration routes.

The ribbons of green soften urban and suburban landscapes and improve the overall quality of life. Greenways can also help protect the quantity and quality of water by reducing flood damage and helping to recharge underground water supplies (MacDonald 1993).

Desert Belt Zoning

Another class of zoning techniques which preserves large areas of privately held open space are urban land containment programs. These programs rely on the zoning of an urban growth core and surrounding desert belt. Desert belts refer to an interconnected, regional open space network utilizing natural desert washes and floodplains. The intent of a desert belt is to create a "natural edge" to urban development as a transition to more rural development, and to provide wildlife and trails connections between public resource management units. The desert belt zoning has two goals: to eliminate development pressure from the desert belt; and to prevent speculation on the desert belt land (Nelson, 1986). Desert belt zoning has another advantage—the preservation of surrounding desert habitat makes urban areas more scenic and attractive to home buyers, thus raising the value of the developed land.

However, there are many communities in which desert belt zoning to allow for more open space and agricultural land preservation is not feasible. This is particularly true in areas where development pressure is high, and it is clear that the zoning restrictions would reduce the value of the land. Still, this type of zoning is gaining popularity, and for many reasons. Passive recreational uses such as picnicking, walking, jogging, horseback riding, and bird watching can easily be integrated into the open space of a well planned development. Wildlife areas may also serve as natural and aesthetic buffers between developments. (Burns et al. 1986)

Cluster Development

Another alternative to conventional zoning is an environmentally sensitive technique called cluster development. This type of zoning pro-

notes "clusters" of development with a variety of housing types on the unrestricted portion of a site at the same density that would be achieved under conventional zoning. Cluster ordinances rely on the underlying zoning density to determine development units, and require that a specific percentage of open space, usually 50 to 80 percent, be set aside in a contiguous tract. This open space may be held publicly or privately, but carries a deed restriction prohibiting further development.

Passive recreational uses such as picnicking, walking, jogging, horseback riding, and bird watching can easily be integrated into the open space of a well planned development. Wildlife areas may also serve as natural and aesthetic buffers between developments (Burns et al. 1986). There are several different classifications of open space:

*Cluster open space refers to open space, either natural or functional, provided to compensate for the lot size reductions from minimum lot size requirements or increases in overall gross density.

*Common open space refers to land area within a development, not individually owned or dedicated for public use, which is designed and intended for the common use or enjoyment of the residents of the development. Common open space may be either natural or functional open space.

*Natural open space refers to any area of land, essentially unimproved and not occupied by structures or man-made impervious surfaces, that is set aside, dedicated or reserved in perpetuity for public or private enjoyment as a preservation or conservation area.

*Public open space is open space owned by a public agency, such as a city department of parks and recreation, and maintained by the agency for the use and enjoyment of the general public.

Major Players in Arizona

The following is a list of a number of local, state, and federal agencies, as well as certain private organizations, that are directly involved in various aspects of land management in our state.

Local Land Management Agencies Responsible for Land Planning Issues

These generic examples are representative of cities, towns and counties throughout the state.

The city council or county board of supervisors has authority to appoint the membership of other bodies having planning and zoning power. The local government is also empowered to adopt the comprehensive land use plan and its subsequent amendments as public policy. The local government has further authority to enact zoning ordinances that give the force of law to land use policies outlined in the plan.

The planning commission has the power to approve the plan and its amendments for submission and recommendation to the local legislature. The commission has authorization to establish and administer regulation governing land subdivision.

The board of adjustment was formed to grant variances from zoning restrictions in those exceptional instances not anticipated in the plan where literal enforcement at a particular site would result in an uncommon hardship. The board also has authorization to administer special exceptions that would permit certain specified uses not ordinarily allowed in a zone.

County Land Management Agencies:

These examples are representative of Pima County. Similar organizations exist in counties throughout the state.

Pima County Parks and Recreation Department provides an integrated system of trails, natural resource parks, urban parks, recreational facilities, and program services to residents of Pima County.

Pima County Department of Transportation and Flood Control

State Land Management

Agencies

Arizona State Land Department

The mission of Arizona State Parks is to manage and preserve Arizona's natural, cultural and recreational resources for the benefit of the people.

The mission of the Arizona Game and Fish Department is to conserve, enhance, and restore Arizona's diverse wildlife resources and habitats through aggressive protection and management programs, and to provide wildlife resources and safe watercraft recreation for the enjoyment, appreciation, and use of present and future generations.

Federal Land Management

Agencies:

U.S. Department of Agriculture

The U.S. Forest Service (USFS) manages 11.5 million acres of multiple use lands in six national forests in Arizona. National forest lands are managed for timber, mining, grazing, recreation and wildlife. The Forest Service has the demanding responsibility of maintaining these lands for all these uses simultaneously, some of which have conflicting objectives. The primary goal of USFS is to maintain these lands as a public resource over the long haul.

The Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, provides technical assistance to ranchers and farmers. Their mission is to provide leadership and administrative services that help people conserve, improve and sustain our natural resources and environment. Natural Resources Conservation Districts exist throughout the state.

U.S. Department of the Interior

The Bureau of Indian Affairs (BIA) is responsible for administration of federal Indian programs. The BIA provides comprehensive assistance to tribes regarding their governments, welfare and natural resources.

The Bureau of Land Management (BLM) is the steward of 12.5 million acres of arid lands in Arizona. The BLM, pursuant to the Federal Lands Policy Management Act, manages these lands for multiple use and sustained yield. The primary uses of BLM lands are for mining, grazing, wildlife, recreation and agriculture.

The Bureau of Reclamation (BOR) manages water development projects, including the Central Arizona Project (CAP), all of the dams on the Colorado River, and several other dams that provide power, water and recreation.

The National Park Service (NPS) manages eighteen national parks, monuments and recreation areas in Arizona. The primary mission of NPS is the preservation of these lands for visitation and enjoyment of the American people.

The U.S. Fish and Wildlife Service (USFWS) is primarily concerned with preservation of threatened and endangered species, and with the impact of federal actions on all species of animals. They also provide technical assistance to federal land and water resource managers in relation to all species of fish and wildlife. In addition, USFWS manages approximately 1.5 million acres of game and wildlife refuges in Yuma and Mohave Counties.

Private Land Management

Organizations:

The Nature Conservancy is an international nonprofit conservation organization with local chapters in all 50 states. Its mission is to find, protect, and maintain the best remaining examples of plants, animals and natural communities by protecting the lands and water they need to survive. The Nature Conservancy owns and manages over 1200 preserves - the largest private system of nature preserves in the world. The Arizona chapter is one of the largest chapters in the nation with more than fifty habitat protection projects throughout the state. The Patagonia-Sonoita Creek Preserve, Ramsey Canyon Preserve, Aravaipa Canyon Preserve, and Muleshoe Ranch Cooperative Management Area are open to the public for nature study and hiking.

The Rincon Institute is a non-profit, conservation organization that helps to protect the sensitive ecosystems of Saguaro National Park and the adjoining Rincon Valley with community-based approaches that bring together diverse elements of the Tucson community. In cooperation with the Rocking K Ranch, other landowners in the Rincon Valley, federal and state agencies and a variety of other public and private organizations, the Rincon Institute is working to protect natural areas, carry out ecological research, provide environmental education, develop public trails, and protect native plants like the saguaro.

Conservation Easements: Options for Land Owners

Along with land ownership comes certain rights concerning what one can do on or with one's land. Some of the associated property rights that exist (as long as they don't conflict with zoning and other laws) are: the right to restrict access; to build structures; to subdivide the land; to farm or ranch; to harvest timber; and to extract minerals. In certain cases a landowner may find it beneficial to give up certain rights in the land while retaining ownership. For example, a landowner might want to give up the right to build on a specific portion of his or her property which is important wildlife habitat. Or a rancher who, because of rising property taxes, is faced with the reality of having to sell their ranch, might choose to give up the right to develop the property, thereby reducing the value of the land and the property tax and allowing them to continue ranching on the land. In order to relinquish particular rights, the landowner deeds an easement. The terms of each a document creating an easement spell out exactly what the landowner gives up, and exactly what he or she gets in return. Easements can be flexible tools for protecting land while leaving it in private ownership. Easements used in this way are called conservation easements.

Conservation easements provide numerous benefits:

- *Landowners retain title to their property and may continue to live on it, sell it, or pass it on to heirs, knowing that it will always be protected in accordance with their wishes.
- *Easements may eliminate or greatly reduce estate taxes, preventing the forced sale of properties. Easements can also provide landowners with income tax and property tax reductions by eliminating unwanted development value.
- *Easements are flexible, adapted to the particular needs of the landowner and the resources of the property.
- *Easements offer permanent protection, applying to all future landowners. A land trust or government agency ensures that restrictions are followed in perpetuity.

Conservation easements protect a variety of land types, including ranches, farms, riparian areas, forests, historic areas, wildlife habitats and scenic views. The different classifications of conservation easements are: forever wild; resource management; or limited development—depending on what they are intended to protect. A landowner generally donates the easement to a qualified conservation organization (such as the Rincon Institute) or government agency which ensures that the conditions of the easement are met over time. The holder of the easement assumes permanent responsibility for monitoring the property and enforcing its legal terms. This usually involves annual inspection of the property and ongoing contact with subsequent landowners.

The Continuing Challenge

Ideally, each of the approaches to land development listed above would be coordinated in common. Unfortunately, this is not always the case. Because of the fragmented nature of land development (decisions are made on a parcel-by-parcel basis), the large number of participants involved, the often competitive relationship between private (and to some extent public) par-

ties, and failures of communication and understanding, harmonious coordination has not always proved possible. The need for improvement in this area has long been understood. Over time, it is hoped that the refinement of public and private land use planning techniques will provide permanent solutions to Arizona's ongoing land development issues.

Nelson, Arthur C., 1986. Using Land Markets to Evaluate Urban Containment Programs, *Journal of the American Planning Association*. 55(2): 156-171.

MacDonald, Lynn. Greenways: Parks for the 21st Century. *Urban Forests*. June/July 1993.

Burns, J.M., W. W. Shaw, and K. Sternberg. Critical and Sensitive Wildlife Habitats in Tucson, Arizona. *Schools of Renewable and Natural Resources, University of Arizona, Tucson, AZ*. 1986.



Part III : Student Activities

Activity One :

The Desert Disc Tribune

Procedure for Classroom Lesson

The following list of questions can be answered by locating information provided in the "Saguaro and the City" CD-ROM. Each student is responsible for completing the attached "questions page." To answer the questions as thoroughly as possible, students need to collect information from various sections of the CD-ROM.

Once the students have had an opportunity to complete the questions, have them focus on a particular question, or combination of related questions, of particular interest to them. They are to assume the role of on-line reporters. Each student is given the assignment to write a short article for a fictitious newspaper called the Desert Disc Tribune. To avoid redundant coverage, appoint surplus reporters to editorial positions in which they are to write "op-ed" pieces based on the raw data collected in the question-and-answer phase.

Activity at a Glance :

In "Desert Disc Journalists," students use a series of questions to navigate the "Saguaro and the City" CD-ROM interface, sorting and collecting the information they need to write articles for an issue of the fictitious newspaper, the Desert Disc Tribune.

C D-ROM Section I: Saguaros and Ecology

1. What is the significance of riparian habitat in Arizona?
2. Which wildlife species are associated with riparian habitat?
3. From a historical perspective, how have riparian habitats changed in Arizona since the turn of the century, and what have been the primary causes of change?
4. Which land management agencies have focused efforts to preserve and/or restore riparian habitat?
5. What is biodiversity?
6. What is the significance of biodiversity?
7. Briefly describe some of the important stages in the life cycle of a saguaro cactus.
8. What factors influence saguaro regeneration?
9. How would you describe the "niche" that the saguaro occupies?
10. Which animal species rely on the saguaro for food, shelter, nesting, hunting, or other activities?
11. Which animal and plant species are active participants in the life cycle of the saguaro?
12. What are some of the threats to saguaros?
13. Are saguaros a protected species? If so, how are they protected?
14. Do saguaros have legal protection? If so, is it at the county, state, or federal level?

C D-ROM Section II: Land Policy and Development

16. In what ways can citizens become involved in policy-making decisions that affect saguaros or other species?
17. What are some techniques that non-governmental land management agencies utilize to minimize the impact of urban development and possibly even restore habitat?
18. What is land stewardship?
19. Who traditionally have been stewards of the land?
20. What are the principles of good land stewardship?
21. Describe some of the common approaches to developing land in the Tucson Basin?
22. What effects, both positive and negative, can development have on wildlife and natural systems?
23. How can we make land development more compatible with wildlife and natural systems?
24. What are some ways that habitat conservation can be integrated into human communities? What are some of the advantages of this integration?
25. What are some of the city, county and state governmental agencies with jurisdiction in residential development?
26. How do these agencies strike a balance between urban growth and habitat preservation?
27. What are some of the independent, private organizations responsible for monitoring the methods and effects of land development?

Activity Two : Wash Biological Investigation

Procedure for Classroom Lesson

Have the students read the section of the Background Information focusing on the Sonoran Desert, and in particular Sonoran Desert riparian habit. This can be a homework assignment, or can be done in class either individually or with different students reading sentences out loud. You may also want the students to view the portion of the CD-ROM under "Coronado Middle School," heading "Experiencing the Desert," subheading "Conducting local research projects."

Locate two washes/arroyos close enough to the school that can both be visited on the same day. The character of the wash is going to vary greatly depending on whether your school is located in a city or in a rural community. When locating the two washes look for one that is relatively pristine and another that has been reinforced, channelized or in some way altered by humans. Try to avoid choosing a concrete culvert devoid of vegetation, but if this is all you have to choose from it will suffice as long as there are some plants living there.

Inform the class that they will be going on a field trip to two different washes. Tell them that the class will be divided into five groups, with each group establishing a transect (cordoned off survey area) for study, so that there will be a total of five transects. Each group will be recording the different plant species and number of individuals of each species for their transect.

Each student should have a spiral notebook that is to be their field notebook. On the day of the field trip to the wash study sites the students are to spend the first 10-15 minutes at each site making an individual entry. Both entries should include day, date, time, weather conditions (especially water flow or evidence of water flow), wildlife observations (including animal behavior), and plant observations (especially flowering).

Activity at a Glance :

In this investigation, students conduct comparative field research in two different washes. In their activities, they will:

1. demonstrate a working knowledge of biological field research techniques;
2. identify at least six species of native Sonoran Desert plants;
3. distinguish between native Sonoran Desert plants and exotic plants;
4. compare two different washes focusing on species composition and general health of riparian community;
5. explain the basic characteristics of riparian communities.

Materials:

- field guides(birds, plants, mammals)
- measuring tape
- stakes
- durable string
- sledge hammer

Designate five groups of students. When the class arrives at the first wash site each group establishes their transect. Two of the transects should be located in the bottom of the wash; the third transect should ascend one bank of the wash; the fourth transect should ascend the opposite bank; and the fifth and final transect should be located along the flat area above the wash banks.

To set up the transects each group will need two stakes and a 30' length of durable string. If the wash is densely vegetated each group should select a place to establish the transect that's fairly representative of the overall plant species composition. If the wash is sparsely vegetated each group should select a place that has the most vegetation. After the specific location has been selected, each group needs to drive the first stake into the ground and tie one end of the string to it. Now they need to run 30' of string to the desired location of the other stake, drive in the second stake and tie the string to it, making sure that the string is taut and straight between the two stakes. The students need to be reminded that the purpose of the transects is to survey the plant life present, so they need to make sure not to trample the plants when they are moving around the transect doing the work.

When they initiate their investigations the groups should get an overview of the different plant species existing along their transect. They should keep in mind that in surveying the plants along the transect line, the actual line represents a vertical plane, continuing infinitely skyward. So, if there is a tree branch overhead that intersects that plane it should be recorded in the survey. Each student should devote a page in their field notebook to recording the information from each of their transect surveys. Initially they should list the name of each different plant species in their transect, leaving space to the right of the name for tallying the number of individuals of each different species. The procedure for surveying the transects is to start at one of the stakes and proceed methodically along the string to the other stake. Each and every plant, or part of a plant, that falls along the string is to be counted and recorded.

When the students arrive at the second wash site they should spend the first 10-15 minutes making their individual entry in the field notebook. When that is completed they should begin establishing the transects following the same procedure for the first transect. The students should devote another page in their field notebook to recording the information from the second transect.

Once both transects have been completed, the students are to process the raw data they collected. For each transect they should average what percentage each plant species constitutes of the total number of plants counted.

Each group should submit a clear, complete copy of the data they collected for both transects. These are to be posted in the classroom so that all students have access to all the data collected. Using the cumulative class data each student should calculate for each wash

site what percentage individual plant species constitute of the total number of plants counted among all five transects. Additionally, have students use the questions below to hypothesize about the significance of their findings.

Research Interpretation

Questions:

1. How would you describe the character of the vegetative composition of your transects? Do different species tend to cluster in different areas? If so, what factors might have contributed to the plant distributions in your transects (possible factors might be: placement of water drainage; exposure to sunlight; relationship(s) to other plants in the area, etc.)?

2. Using your field guide, compile a list of all the plants in your transect. Are all of your plants native species? If there are any exotics, where did those species originate? Speculate on possible explanations that would have brought the exotic species to your transect.

3. Compare the plant compositions of your two washes. How has the adulteration of human hands affected the growth and variety of plants. Compare your sites using a chart. Offer some possible conclusions to explain your findings.

Activity Three : Land Management Agency Research Project

Procedure for Classroom Lesson

While the students are viewing "Saguaro and the City," ask them to list the various land management agencies which are represented or referred to. Divide the class into pairs and ask each pair to choose an agency from their list to research and report on. If there is too much duplication among the class, or if certain pairs aren't interested in reporting on the agencies from the CD-ROM, then give them the choice of reporting on the following agencies:

- Bureau of Land Management
- USDA Forest Service
- Arizona State Parks
- The Nature Conservancy

Encourage students to conduct thorough research before beginning to write their reports. Various avenues of research include: gathering information from books and periodicals at a library; visiting actual national parks, state parks, national forests, or Nature Conservancy preserves; and interviewing employees of the particular agency. It may be interesting to have a large Arizona state map in the classroom on which students can designate the areas of jurisdiction of each agency.

Activity at a Glance :

In this activity, students will:

1. gain and in-depth understanding of one land management agency;
2. utilize research skills to search out and acquire information;
3. present a summary of their research and practice their public speaking by giving a report to the class .

Specific points that every student will want to include in their report include:

- 1) the mission of the agency;
- 2) the agency's level of jurisdiction (county, state, federal);
- 3) the public or private funding of the agency;
- 4) the year of their founding;
- 5) the amount of land they're responsible for in Arizona; their responsibility for conducting research, and if so, what kind.

After students have completed writing their reports, they are next to prepare oral classroom presentations. Have students who conducted research on the same agency meet to discuss and corroborate their individual findings. Groups of students targeting the same agency will want to divide the responsibility for the oral presentation so that each member of the group participates in the presentation. For example, one student may want to report on the agency's mission, with another student reporting on the amount of land the agency is responsible for within the state, and yet another student covering the research the agency conducts. If there are individual students who are the only ones that reported on a particular agency, they will need to work on the oral presentations alone. Allow each group 15 minutes for the oral presentation.

Activity Four: Gold Valley Role Play: Riparian Protection vs. Housing Development

Procedure for Classroom Lesson

Photocopy and distribute a copy of the "Background Information on Honeyflower Canyon" to every student, and read it with your class. Inform the students that land use decisions affecting wildlife have become a familiar issue where housing developments are concerned. Tell the students that the Honeyflower scenario is based upon real circumstances. For this activity, the class will be conducting a town council meeting focusing on an upcoming bond election.

Tell the students that the mock town council meeting they will be having is very similar to meetings held in towns throughout Arizona and the United States. Meetings of the town council are held for the purpose of gathering and disseminating information, inviting public opinion, and ultimately making policy decisions on issues pertaining to the town.

In this activity, some students will assume the role of different people present at the council meeting because they are involved in, or concerned about, the upcoming bond election. It is everyone's responsibility to read their "character role play card," give some thought to the beliefs, opinions and concerns of the character described, and to represent this person as accurately as possible. In many respects this mock town council meeting is similar to a dramatic presentation; every student will have to put themselves in the place of someone who may have a very different way of thinking from themselves. Encourage the students to have fun staying in character with, and acting out, the part of a different person. You can even suggest that the students dress in character for the actual council meeting.

Activity at a Glance:

In this role-play activity, students debate the different sides of a land development scenario based on actual events. Students adopt the parts of different residents of the community of Gold Valley—town council members, scientists, farmers, retirees and community activists. At stake is a proposed development in a sensitive riparian area in Honeyflower Canyon. In this activity, students will:

- 1) describe the importance of land-use planning;
- 2) identify various governmental agencies and special interest groups involved in land-use decision-making;
- 3) understand the processes involved in making decisions regarding land-use planning;
- 4) explain the challenges of making a decision which has positive and negative implications for both humans and wildlife.

Background Information on Honeyflower Canyon

Through Honeyflower Canyon flows a perennial stream which supports riparian habitat including deciduous trees, diverse species of birds, desert tortoise, bobcat, striped skunk, javelina and mule deer. Indian petroglyphs (images chipped into stone) attest to the fact that this reliable source of water, in otherwise arid surroundings, has long attracted humans. The perennial flow of Honeyflower Creek is a rare occurrence in the Sonoran Desert, making this habitat unique and valuable.

Honeyflower Canyon is located within the rapidly growing town of Gold Valley. The canyon originates in the Tortilla Mountains and runs south for about four miles to join Arroyo Grande. The canyon itself, as well as substantial amounts of land on both sides, is owned by Silvestre Partners, Inc. This development company is building a 44 acre residential development, called Honeyflower Estates, on the west side of the canyon. The lot nearest Honeyflower is 250 feet from the centerline of the canyon. Up to 128 lots have been approved for single-family homes: this includes the proposed Honeyflower Ridge development on the east side of the canyon.

Many Gold Valley citizens and others are opposed to the development of Honeyflower Canyon. Some base their opposition on the uniqueness, beauty and importance of the free-flowing stream and the healthy riparian habitat it supports. Others focus attention on the fact that in comparison with other similar communities, Gold Valley is seriously lacking open space and parks.

A political action committee, Neighbors for Parks, Open Space and Trails, has been formed to work for the passage of a \$14 million bond issue. \$3.1 million of the bond money is designated to buy 51 acres, or 36 lots, from Silvestre Partners, Inc. for a protective wildlife corridor and buffer to Honeyflower Canyon. Environmentalists have sought an 800-foot-wide corridor from the centerline of the canyon. This is a much wider no-build zone than the development company's plans had called for.

The general obligation bonds would be repaid by a secondary property tax on homeowners—the first such tax in Gold Valley. If all bonds are approved, the first year tax would be \$1.06 per \$100 assessed valuation. For the owner of a home valued at \$131,000, the secondary tax to pay off the bonds would be \$9.26 per month.

Activity Procedures Continued:

Make a copy of the "character role play cards." Cut out the individual cards and distribute them to different students. Ask the students to read the character description to themselves. Allow the class a period of time to think about their characters and to write some guidelines for their beliefs and opinions.

These guidelines are meant to be brief, and serve to focus the student's understanding of the character they are acting out. Once the students have had time to contemplate their character's position, allow 15 minutes for each character to develop a 3 minute presentation to be made to the town council. During this 15 minute time period the town council reviews the issue and develops a question for each person.

Gold Valley Town Council— Meeting Procedure

The town council of the community of Gold Valley, Arizona is meeting to hear testimony from town citizens and invited specialists regarding the current Honeyflower Estates development and the proposed Honeyflower Ridge development.

I. (30 min.) Presentations - Each individual has 3 minutes to present their opinion on the Honeyflower Canyon development and the upcoming bond election. The town council will be responsible for timing the presentations and making sure that presenters stay within the allotted time.

II. (20 min.) Questions - The town council may ask questions of the various individuals first. When the council members are through, they may ask each group if they have any questions for either the town council or others attending the meeting.

III. (10 min.) Final Presentations - Each individual has 1 minute to make a final presentation. At this time individuals may suggest new ideas or solutions to some of the issues.

IV. Vote - Everyone in the class casts their vote in the bond election.

V. Vote Tabulation - All votes are carefully counted.

Character Role Play Cards

- 1) Hector or Lucinda Valenzuela, Realtor (Town Council member)
You started your real estate business in Gold Valley six years ago, and have served on the town council for two years. Your business is not involved in developing this property. You have some questions regarding the credibility of the developer, but are generally pro-development.
- 2) Matt or Mary Wilder, Golf Course Superintendent (Town Council member)
You have lived in Gold Valley since 1992 and have served on the town council for four years. In general, you think the bonds would be beneficial for the town. However, you feel that the bond proposal doesn't hold Gold Valley officials accountable for how the bond money would be spent.
- 3) James or Betsy Bennett, member of Gold Valley Neighborhood Coalition
You are retired and live in a retirement community. You are an avid bird-watcher and have recorded 53 different bird species along Honeyflower

Canyon. You believe that the value of Honeyflower Canyon as wildlife habitat cannot be overestimated. You helped write an environmental report on the canyon which was presented to town planners.

4) Nathan or Nancy Thompson, president of Neighbors for Parks, Open Space and Trails

You moved from a big city to Gold Valley twenty-three years ago. You were instrumental in drafting the bond proposal and advocating its passage. You are concerned with the explosive growth of the town, and believe it is crucial to set aside unique natural areas before they are developed.

5) Ignacio or Gloria Lopez, resident

You are a 73 year-old "old timer" living on land adjacent to the proposed development. The land you occupy was once a ranch, and has been in the family for four generations. You keep honeybees and raise chickens out back, and your garden covers a half acre. You appreciate the rural beauty of the town and are worried about how fast it's changing.

6) Harvey or Gladys Stein, banker (Town Council member)

As a banker you are in the business of financing new home loans. You are former president of the Gold Valley chamber of commerce. Some of your hobbies are art collecting, bird-watching and golfing.

7) Steve or Stephanie Taylor, merchant (Town Council member)

You own a furniture store. You see this new development as an opportunity to sell furniture to new home owners. You can also see the value of allowing the 51 acre buffer to be left in a natural and undeveloped condition.

8) Richard or Melanie Hewson, farmer (Town Council member)

You own and operate a large farm on the edge of town and along Honeyflower Canyon, downstream from the proposed development. You rely upon water from the stream to irrigate your crops. You have been interested in the possibility of buying some of the land from Silvestre Partners, Inc. to add to your family's agricultural operations. You have a keen interest in the environment, making efforts to employ agricultural practices that benefit wildlife and minimize damage to other natural resources. You wonder how the development will affect the quantity and quality of water flowing in the canyon.

9) Chip or Sally Davis, U.S. Fish and Wildlife Service biologist

You've been studying the breeding behavior of desert tortoises in Honeyflower Canyon. Desert tortoises are a threatened species and you believe that development too close to the canyon will negatively impact the desert tortoises.

10) George or Cornelia Cornwall, land owner

You are a retired business person. You would like to sell your land, move to Florida, and relax on the beach. You want cash, but your asking price is very reasonable. You own 70 acres of prime wild land south of town. You are an active member of several civic organizations.

Activity Five : Housing Survey: Are you a Satisfied Citizen?

Procedure for Classroom Lesson:

Inform the students that this is an individual research project which will involve the development and administration of surveys focused on specific aspects of people's living situations. Each student will be responsible for approaching the general public in a public meeting place (a mall or park, for example) and asking them to answer a brief set of questions.

Initiate a class discussion by asking the students to brainstorm general factors which are part of anybody's home or neighborhood. These different factors should be listed on the chalk board. When the discussion is over a final, comprehensive list should be created and saved. Topics from the list below should be included in the comprehensive list if they don't already exist there.

- *housing type (i.e., apartment or house; owned or rented, etc.)
- *location/neighborhood
- *utilities
- *trash & recycling services
- *education (nearby schools and community centers, etc.)
- *safety
- *recreation
- *flood control
- *public transportation & road access
- *wildlife
- *shopping
- *landscaping

Activity at a Glance:

In this activity, students conduct surveys of the general public to assess their satisfaction of their housing and living environments—in other words, the final effects (good and bad) of land use management decisions.

Once the list of topics is compiled, have students begin formulating appropriate survey questions. Advise students that questions must be written as objectively as possible, without bias—they should take care to avoid leading their interviewees into certain kinds of responses. Remind students also that questions must be phrased in such a way that answers are quantifiable mathematically. Potential question types are:

Graded questions: An example of a graded question might be On a scale of one to five, with five being strongly dissatisfied and one being very pleased, how would you rate your satisfaction with the access to bike paths from your home? These questions are very flexible, and allow respondents to shade the enthusiasm of their answers.

Yes/No questions. These types of questions can be especially useful in breaking down respondents into different categories, and in combination with other questions. For example, the questions Do you own your own home? and ...how would you rate your satisfaction with the access to bike paths from your home? might reveal this student interpretation: Only 15% of homeowners respond that they are very pleased with their access to bike paths, while 60% of renters are very pleased with bike path access.

Raise the possibility with students of using a few personal target questions to help refine their interpretations. Questions along these lines might include: On a scale of one to five, how would you rate the importance of environmental preservation? or, If you had to choose a political label for yourself, which would you feel more comfortable with: liberal or conservative? Encourage students always to be polite, and to inform their respondents that the survey is anonymous.

Once students have gathered a sufficient number of responses (as many as possible, within reasonable limits), have them interpret their data as a class. Have them identify which topics garnered a high percentage of favorable assessments, and which topics were regarded with greater dissatisfaction. What may be inferred about the success and/or failure of land use policy in these areas? Initiate a discussion about what types of practical land use policy solutions might be employed to improve people's satisfaction in those areas.

Cross-curricular

Extension:

Because these surveys are conducted in public meeting places, they do not represent a random sampling of the population and thus include a significant bias (not everyone goes to malls, for example). Consider approaching a mathematics teacher in another class with this project. It may be possible to coordinate this project with a unit on statistics in a math class; or consider having a math teacher visit your class with a mini-presentation on the mathematical tools of statisticians (i.e., random number generation, means, medians, standard deviations, and confidence percentages, etc.)

Appendix I :

Glossary

amenities - things that increase the comfort, value, attractiveness, or pleasantness of something else.

arachnids - animals such as spiders, mites, scorpions, ticks, and other invertebrates (having no backbone) that typically have a body composed of two parts and three or four pairs of appendages. Arachnids, a subgroup of Arthropods, consist of about 60,000 species.

Arizona Game & Fish Department - state agency whose mission is to conserve, enhance and restore Arizona's diverse wildlife resources and habitats through protection and management programs and ensure wildlife resources and safe watercraft recreation.

Arizona Walnut (*Juglans major*) - growing along rivers and streams, walnut trees provide an important food resource for squirrels and other mammals and for people, though it's a lot of work cracking their tough nuts. In fall, walnut leaves provide a welcome splash of color as they turn brilliant yellow.

arthropods - invertebrate (having no backbone) animals such as arachnids, insects, and crustaceans (lobsters, crabs, etc.) that have an external skeleton and jointed appendages. There are about 875,000 species of arthropods, and they can be found in nearly all habitats.

bajada - the long, gentle lower slopes of desert mountains that are composed of debris that is deposited when water rushing down the mountains slows in speed as it reaches the desert floor.

Barrel Cactus (*Ferocactus wislizenii*) - you can't cut it open and drink from it, but a barrel

cactus does store water in its thick, succulent stem. That stored water allows it to grow and produce brilliant orange or yellow flowers even during dry years.

Beaver (*Castor canadensis*) - rare today, beaver once thrived in Arizona's waterways. By building dams, they slowed the flow of rivers and creeks, allowing more water to seep into the ground and nourish springs and marshes. Reintroduction programs are returning them, slowly, to some of their old haunts.

biological community - all the animals and plants that live and interact within a given area.

biologist - an individual who studies biology, the science of life.

biotic factors - the interactions between organisms in a habitat that can potentially affect them; for example, competition and pollination.

birds of prey - birds that feed mostly or solely on flesh gathered by hunting or by scavenging dead animals.

Black-tailed Jackrabbit (*Lepus californicus*) - a common plant-eater throughout the arid West, the jackrabbit is tempting prey to coyotes, foxes, eagles, and other predators. Jackrabbits respond to this hunting pressure by having lots of young-they can bear up to four litters a year.

blade & scrape - a term used when developers use heavy equipment to scrape an entire area clean of vegetation (in contrast to the selective clearing of building pads.)

Bobcat (*Felis rufus*) - only a little larger than most housecats, but bearing a distinctive short or "bobbed" tail, bobcats are widespread throughout North America. They prey

mainly on rabbits, but also eat rodents, quail, and other small animals.

brood - the offspring of an animal; usually refers to all the young hatched or born at the same time, as with birds.

building codes/ordinances - state and local laws that define building structure, safety and placement requirements to which building own-

ers, contractors, architects and others must adhere. Also used to protect open space in and surrounding residential and commercial developments.

Cardon Cactus (*Pachocereus pringlei*) - the largest members of the cactus family are more susceptible to cold than to heat. Even larger than saguaros, cardons are restricted to the warmer desert regions of northwestern Mexico. The sweet fruits they produce are an important food source for animals and native peoples.

Catclaw Acacia (*Acacia greggii*) - like many desert trees and shrubs, the catclaw has tiny leaves that limit loss of water and exposure to the burning sun. In spring its sweet flowers attract numerous insects, but larger plant-eaters are deterred by its many ferociously curved spines.

cholla (*Opuntia* sp.) - there are many different species of this cactus; many with descriptive names such as teddy bear, pencil, jumping, and staghorn. All species of cholla are similar in that they have branching arms comprised of many joints. Birds such as curve-billed thrashers and cactus wrens build their nests amongst the spiny arms of chollas.

conservation - the wise use and systematic protection and maintenance of natural resources, including plants, wildlife, water, air, land and others.

conservation easement - a legal contract that permanently restricts the type and intensity of future land use while allowing landowners to retain ownership of their property.

contiguous corridors - corridors or pathways which connect areas of natural vegetation; often a wash or riparian drainage.

cooperative hunting - a system by which animals of the same species hunt collectively and share in the kill.

corridors of habitat - routes that species use to move from one region or habitat to another.

Coyote (*Canis latrans*) - a most adaptable

predator, the coyote is found not only in remote deserts, but also on the edges of towns and cities, where garbage and fruits from backyard gardens may form part of its diet. Its colorful howls are an integral part of any nighttime outing in the desert.

Creosotebush (*Larrea tridentata*) - abundant in the most arid parts of the Southwest, creosote is able to weather heat and drought with the help of spreading roots that excel at finding scarce water, as well as oily resins that coat its leaves, protecting them against drought and plant-eating animals.

degraded - the state of a thing or object that has been broken down, decomposed, consumed, or reduced to a lower level of existence either naturally or because of human intervention.

Desert Broom (*Baccharis sarothroides*) - often seen along the edges of roads and in other disturbed areas, desert broom bears tiny white flowers and, in fall, fuzzy white seeds. But it is best recognized by its bushy growth form-its stiff, brilliant green stems hold enough chlorophyll that it doesn't need leaves to produce food.

desert landscape - the naturally occurring land formations and plant life of a desert region, which in the Southwest consists of scattered thorny shrubs and bushes, cacti and little or no ground cover.

developer - an individual or company that acquires land for the purpose of building residential and/or commercial projects upon it.

development - the act of making structural changes to land, which often includes constructing buildings or roadways; also, the land and improvements on it after the development process.

diversity - possessing variety or differences.

dominance interaction - relationship between the dominant and submissive animals in an environment.

drainage - the land area contributing runoff to a stream or other body of water and generally defined in terms of acres or square miles.

ecological viability - the ability of a given ecosystem, habitat, or area to continue to exist in a balanced state on a long-term basis.

economic incentives - monetary or financial benefits offered by an individual or group to another individual or group to encourage or prompt some action.

Engelmann Prickly Pear (*Opuntia engelmannii*) - common throughout the Sonoran Desert and adjacent grasslands, prickly pear cactus put on a show each spring with their bright yellow flowers. Those that are pollinated become deep red-purple fruits that serve as an important food source for many animals-and for people, too.

environmental ethic - a belief or system of values in which moral consideration is given not only to other humans but to other living things and to the environment.

exotic species - an animal or plant newly brought into an area; also called introduced or non-native species.

fauna - all of the animal species, collectively that live in an area.

flood hazard - an area that has factors which have the potential to cause flood conditions, such as poor drainage.

Foothills Palo Verde (*Cercidium microphyllum*) - with its green trunk and twigs, the distinctive-looking palo verde tree can continue producing food even after its tiny leaves have fallen off in times of drought. In spring it is covered with pale yellow flowers, a feast both for the eyes and for the many insects drawn to their sweet nectar.

forage - the act of searching for and obtaining food, also the food found.

fragmentation - in a natural environment, the loss of habitat and fracturing of habitat into smaller areas which are broken up by human habitation, farming, clearing of forests, or other means.

Fremont Cottonwood (*Populus fremontii*) - not really a desert plant at all, the cottonwood tree thrives only where water is abundant. It lines

the banks of some desert rivers and springs, providing welcome shade for people, as well as food and shelter for myriad birds, reptiles, rodents, insects, and other animals.

Gambel's Quail (*Callipepla gambelii*) - noisy and conspicuous ground dwellers, Gambel's quail are especially common in the desert after wet winters, when thick vegetation protects their eggs and young from predators. It also ensures large populations of the insects that, along with plant seeds, serve as food.

genetic isolation - lack of interbreeding between groups of a population or between different populations due to geographic isolation.

germination - the process whereby the embryo inside a seed bursts through the seed casing and a root emerges.

Gila Woodpecker (*Melanerpes uropygialis*) - large, black and white barred, "zebra-backed" birds common amongst the saguaros and mesquites. Their nests are self-constructed cavities, usually in saguaros or large trees. Once the birds have left, the nest cavity provides nesting sites for many other birds.

Gray Fox (*Urocyon cinereoargenteus*) - these small, gray foxes with reddish sides and bushy tails occupy a range of elevations from desert canyons to evergreen forests. They are primarily active at night, feeding mainly on rodents, but also young birds, eggs, reptiles and berries.

ground cover - plants that grow low to the ground and help prevent soil erosion and water evaporation and provide a habitat for small animals and insects.

groundwater - water beneath the surface of the ground that is in a saturated zone.

habitat - the surroundings, or environment, in which a plant or animal lives

habitat conservation - the attempt to preserve and maintain a given natural biological community in its natural state to the best degree possible.

Harris' Hawk (*Parabuteo unicinctus*) - usually seen in small groups, the Harris' Hawk is unique among birds of prey in its sociability. Two to five family members often roost together on saguaros and hunt together, too, greatly increasing their chances of catching rabbits and other prey.

independent (third party) - an individual not affiliated, aligned or employed by a given group.

infrastructure - the basic foundation, services, or facilities of an organization, company, or other group. Utilities and services provided to communities such as electricity, water and sewers.

insects - any of the more than 800,000 species of invertebrate animals in the subgroup Arthropod. Insects typically have three main body parts and three pairs of legs.

interchange of population - when a species or population moves out of an area and another one moves in because of a change to the environment, such as a change in food supply or intrusion by humans.

interconnectedness - the concept that all things, living and nonliving, have a direct or indirect effect on each other.

Ironwood (*Olneyi tesota*) - extremely slow-growing and long-lived, ironwood trees put on one of the desert's loveliest floral displays, sprouting myriad pale purple flowers in late spring. Because their tough wood is ideal for carving, firewood, and charcoal, large specimens have unfortunately become rare.

Javelina (*Tayassu tajacu*) - often called wild pigs, javelinas in fact belong to their own mammal family, the peccaries. Usually encountered in small groups, they are willing to live fairly close to humans, even foraging for roots and fruits in gardens on the edges of desert cities.

Jojoba (*Simmondsia chinensis*) - these woody, evergreen shrubs with thick, leathery leaves dot dry, rocky hillsides from 1000 to 5000 feet. The fruit contains liquid wax which is used as a supplement in lotions and cosmetics.

land use policy - rules and regulations that control the rate and level at which development is allowed to occur.

legislation - laws or rules which have been created by elected officials at the state or federal level in contrast to guidelines created by appointed officials.

legislative council - a body of elected individuals who make laws for a given area, such as a county, city, tribe, or state.

life cycle - the natural progression of an organism from birth through growth, reproduction and death.

long-term viability - ability to survive, function, or exist over an extended period of time.

marketing value - an amenity (such as proximity to a natural environment) that adds monetary value to a home or property.

Mesquite (*Prosopis velutina*) - among the most important food plants in the Sonoran Desert, the widespread mesquite tree produces a bumper crop of sugar- and protein-rich pods each summer. They are relished by deer, javelina, coyotes, and rodents and they are an important food for native desert people, too.

monsoon season - the time of year in the Southwest characterized by heavy rains and/or winds; in Arizona, typically from July through early September.

mortality - death; the number of deaths in a given location or time.

Mountain Lion (*Felis concolor*) - rarely seen, this large predator haunts Arizona's mountains and canyons, occasionally descending into the desert. By preying on deer and other plant-eaters, it helps maintain the balance of nature, ensuring that plants are not eaten more quickly than they can grow back.

Mule Deer (*Odocoileus hemionus*) - both white-tailed and mule deer live in Arizona. Mule deer prefer more open areas, including desert

washes and grasslands, where they can see potential predators at a distance. Their large ears, attuned to faint noises, account for their common name.

National Park Service - a federal agency created in 1916 to manage all US national parks and protect and preserve them as natural areas because of their special wildlife, scenery, historical importance and recreational possibilities.

native species - plant and animal species that live naturally in an area; excludes those transplanted or introduced from locations outside that area.

native wildlife species - wild animal species that naturally occur and live in a given habitat.

natural environment - a habitat, usually with little human disturbance, that exhibits its naturally occurring plant and animal life in a healthy, self-sustaining community.

natural vegetation - plant life that has been relatively undisturbed by human activities.

neighborhood association - a group comprised of residents of a given neighborhood whose purpose generally is to work on improvements, safety and sense of community.

neighborhood coalitions - different neighborhood groups or associations that band together in order to work on a specific common goal.

Nonprofit Organization - a group that is formed to serve a need or address a problem and whose members may not profit financially from its activities.

nutrient storage - holding of substances required by an organism for energy until the organism needs the nutrients.

Ocotillo (*Fouquieria splendens*) - not a cactus, despite its spiny appearance, the ocotillo deals with drought by sprouting water-using leaves only after a rain. During dry periods it continues to grow, much more slowly, by producing food within the green parts of its woody stems.

open space - areas next to or surrounded by developed sites that are allowed to remain natural and undeveloped, or which have been restored to a near-natural state and are for general public use.

ordinances - laws or rules created by local governments.

Phainopepla (*Phainopepla nitens*) - the male birds are shiny black with a distinct crest and have red eyes. Phainopeplas feed on insects and berries. When mistletoe berries are ripe this is their preferred food and they will aggressively defend clumps of mistletoe.

Pima County Board of Supervisors - a group of five elected officials, each of whom is chosen by the people of his or her district in Pima County to represent them. The term is four years.

planning & zoning department - government office that reviews and acts on land use requests and land development plans and determines how certain land can be used; for example, zoning land for residential versus commercial use.

policy - a definite method, procedure, or plan usually of a government agency, designed to achieve given goals and/or determine present and future decisions.

pollination - the transfer of pollen via wind, bees, other insects, birds, bats, mammals, or in some cases by hand, from the male structure of a plant's flower to the female structure of the same or different plants of the same species.

preservation - protecting something from harm, destruction, or injury.

prey base - the number of prey available to a given species in its environment.

private property rights - as a property owner, things you are legally entitled to do or not do with your property or which you can allow others to do or not do; for example, trespassing.

property taxes - monies individuals or companies are legally obligated to pay to the government which are based on a percentage of the value

of their real estate holdings.

regeneration - the process by which something is renewed, reformed, restructured, revitalized, or recreated.

restoration - the act of bringing something back to the condition it was in previously.

Rincon Institute - a nonprofit conservation organization that helps protect the sensitive ecosystems of Saguaro National Park and the adjacent Rincon Valley.

Rincon Valley - low-lying area around the Rincon Mountains to the east of Tucson near Saguaro National Park East.

riparian community - the collective plant and animal life that lives and interacts on the banks of a waterway including the surrounding area.

riparian drainage - the area of land, on the banks of and surrounding a natural watercourse where runoff of excess water occurs both on the surface and below the ground.

riparian habitat ordinance - regulation designed to protect, preserve and maintain the long-term viability of a riparian area.

Saguaro Cactus (*Carnegiea gigantea*) - best-known symbol of the Sonoran Desert, this giant cactus can grow as tall as fifty feet during a lifespan that may span two centuries. Its fleshy stalk and arms store water during storms, then use it during dry spells that can last for years.

Saguaro National Park - a federally maintained park divided into two sections, one East and one West of Tucson, which preserves saguaro cacti and other Sonoran Desert plant and animal life.

Scorpions - these relatively large arachnids are nocturnal creatures, feeding on insects which are killed or subdued by venom injected through the stinger.

sensitive areas - natural areas susceptible to damage or harm due to an outside force, effect, or intrusion.

Soil Conservation Service - a federal agency whose mission is to protect the land and soil against erosion and to maintain and promote its fertility. Reorganized into the Natural Resource Conservation Service in 1994.

Sonora - a state in Northwestern Mexico bordering on the U.S. and the Gulf of California.

Sonoran Arthropod Studies Institute (SASI) - a nonprofit science and environmental education organization that conducts research on and provides information about Sonoran desert arthropods and their relationships with plants, other animals, and humans.

Sonoran Desert - a dry (about 8-10 inches of precipitation per year) area that encompasses the southwestern part of Arizona, the extreme part of Southern California and Northwestern Mexico.

Sonoran habitat - a desert environment characterized by little rainfall and diverse land formations, including mountains, valleys, mesas, riparian areas, sandy and rocky soils and washes.

Sonoran vegetation - plant life native to the Sonoran Desert region of Southwestern Arizona and Northwestern Mexico; for example, saguaro and other cacti, mesquite and palo verde.

species - animals or plants that have distinctive characteristics, behaviors and habitat and that breed with one another in natural conditions and produce viable offspring.

species diversity - ratio of the number of species in a given community and the number of individuals in each species.

spring(s) - a natural water source that comes up through the ground from a single point(s) within a restricted area.

stream channel - a drainage cut or formed into the earth which carries runoff water from precipitation.

structural diversity - variety in a community due to the number of different layers that make it up; for example, layers of vegetation can

include ground cover, low-growing shrubs, trees such as the palo verde and columnar cacti such as the saguaro.

Teddy Bear Cholla (*Opuntia bigelovii*) - a cholla's fearsome spines help deter plant-eating animals, but they are also important in sheltering the plant's tissues from harsh sun and drying winds. Many birds like to build their nests in chollas because of the protection the spines offer from potential predators.

Tohono O'odham - means the Desert People or the Papago people; a population of native people living in the Southwestern U.S. and Northern Sonora, Mexico.

transplanted - removed from one area or situation and placed in another, as is done with plants.

United States Geological Survey - the nation's primary earth-science information and research agency, a bureau (division) of the U.S. Department of the Interior.

urbanization - the process by which an area becomes developed and populated by humans replacing the natural community of plants and animals.

urban development - the growth of a city area characterized by an increase in population, construction or renovation of buildings and/or work in parks or other public lands.

urban matrix - an area in which the elements of a city make up the dominant environment.

urban planners - individuals who plan the use of land for residential, commercial, industrial and transportation development in an urban setting.

wash - a natural, low-lying watercourse in which water flows only after heavy rainfall and remains dry the rest of the time.

watercourse - a natural or human-made channel through which water flows; example, a

stream, river, or canal.

White-throated Woodrat (Packrat) (*Neotoma albigula*) - notorious for their habit of collecting items left around campsites, woodrats - also known as packrats - build large protective shelters of sticks and cactus joints. They spend most of their time in burrows under these shelters, where they are shielded from heat, drought, and predators.

wildlife - mammals, birds, fish, reptiles and amphibians that have not been domesticated.

Appendix II : Additional Information Sources

The Following titles are available at local branch libraries in the Tucson-Pima County system.

Land Use Planning, Policy, and Development :

State of Arizona. Department of Commerce. Planning and Zoning Handbook. Phoenix: n.p., n.d.

State of Arizona. Department of Commerce, Community Development Program. Arizona Planning and Zoning Handbook. Phoenix: n.p., 1996.

State of Arizona. Department of Water Resources. Arizona Riparian Protection Program Legislative Report. Phoenix: n.p., 1994.

City of Tucson. Tucson Zoning Guide. Tallahassee: Municipal Code Corp., 1987.

City of Tucson. Department of Planning. City of Tucson Development Standards. Tucson: n.p., 1996

City of Tucson. Tucson General Plan: Land Use Policies. Tucson, n.p., 1996.

College of Agriculture, University of Arizona. An Environmental Study Area Plan for Tumamoc Hill. Tucson: U of Arizona, 1974.

Final Environmental Impact Statement, San Xavier Development Project: a Feature of the Southern Arizona Water Rights Settlement Act, October 1989. Boulder City, NV: The Region, 1989.

The Western Network. Water in the West: Western Water Flows to the Cities. Santa Fe: Western Network; Washington: Island Press, 1985.

Brachen, Paul. Arizona Tomorrow: A Precursor of Post-Industrial America. Study by the Hudson Institute. Croton-on-Hudson, NY: The Hudson Institute, 1979.

Kaiser, Edward J., David R. Goodschalk, and F. Stuard Chapin. Urban Land Use Planning. 4th ed. Chicago: U of Illinois, 1990.

Sonoran Natural History :

Alcock, John. Sonoran Desert Spring. Chicago: U of Chicago, 1985.

Alcock, John. Sonoran Desert Summer. Tucson: U of Arizona, 1990.

Bash, Barbara. Desert Giant: The World of the Saguaro Cactus. San Francisco: Sierra Club; Boston: Little, Brown, 1989.

Bowden, Charles: The Sonoran Desert. New York: H. N. Abrams, 1992.

Durbier, Roger. The Sonoran Desert: Its Geography, Economy, and People. Tucson: U of Arizona, 1968.

Olin, George. House in the Sun: A Natural History of the Sonoran Desert. Tucson: Southwest Parks and Monuments Assoc., 1994.

Sutton, Ann & Myron. The Life of the Desert. New York: McGraw-Hill, 1966.

Tohono O'odham History

Nakhan, Gary Paul. The Desert Smells Like Rain: A Naturalist in Papago Indian Country.

Erickson, Winston P. Sharing the Desert: The Tohono O'odham in History. Tucson: U of Arizona, 1994.

Field Guides:

Benson, Lyman. The Cacti of Arizona. 3rd ed. Tucson: U of Arizona P, 1969.

Eppelle, Anne Orth. A Field Guide to the Plants of Arizona. Helena: Skyhouse Publishing, 1995.

Turner, Raymond M., Jamie E. Bowers and Tony L. Burgess. Sonoran Desert Plants: An Ecological Atlas. Tucson: U of Arizona, 1995.

VanDyke Leake, Dorothy, John Benjamin Leake, Marcollette Leake Roeder. Desert and Mountain Plants of the Southwest. Norman, OK and London: U of Oklahoma P, 1993.

Werner, Floyd and Carl Olson. Learning About and Living with Insects of the Southwest. Tucson: Fisher Books, 1994.

Additional Perspectives on Development Issues, History, and the Southwest:

Abbey, Edward and Philip Hyde. Slickrock: Endangered Canyons of the Southwest. New York: Sierra Club; Scribner's, 1971.

Leopold, Aldo. A Sand County Almanac, and Sketches Here and There. New York: Oxford UP, 1949.

Reisner, Marc P. Cadillac Desert. New York: Viking, 1986.

Stegner, Wallace. Where the Bluebird Sings to the Lemonade Springs. New York: Random House, 1992.