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# Storyline Development



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# Introduction: “You Are Here”

*The desert was our ocean....  
It is our geography that truly sets us apart.*

Rachel Sacco  
President and CEO, Experience Scottsdale

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As people enter the Desert Discovery Center, they are immediately introduced to the story of the McDowell Sonoran Preserve. In the face of urban expansion and encroachment, Scottsdale citizens recognized the pressing need to protect this part of the world for future generations. They began in 1990 by dedicating five square miles of the McDowell Mountains to the creation of the McDowell Sonoran Preserve. Today, the Preserve protects forty-seven square miles of Sonoran Desert habitat and serves as a vital wildlife corridor connecting the three-million-acre Tonto National Forest to the 21,000 acre McDowell Mountain Regional Park. Representing one quarter of the City of Scottsdale’s total land area, it stands as the largest urban preserve in America. It is, at once, a portal to the sixth most populous urban settlement in the United States and to the most biodiverse desert in North America.

For about 7,000 years humans have been drawn to this distinctive landscape which formed 2 billion years ago of sedimentary, igneous, and metamorphic rocks—from Precambrian outcroppings to more recent volcanic deposits left in the neighboring Superstition Mountains 15 to 20 million years ago. Since 5,000 BCE, we have altered this geologically diverse place with our petroglyphs, dwellings, canals, and trails.

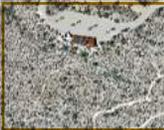
Perched on the edge of the Preserve, the Desert Discovery Center is ideally positioned to educate and inspire generations on the magnificence and vulnerability of the Sonoran Desert. At this crossroad between desert and city, scarcity and abundance, life optimizes opportunity and rewards resiliency; and as the Earth’s climate changes, the world looks towards this hot, arid ecosystem—home to millions—in preparation for the future.

## **Gesturally-Activated Split Screen Map**

A split-screen map tells the founding story of the Preserve and allows people to orient themselves in the McDowell Sonoran Preserve, the Sonoran Desert, the City of Scottsdale, and the greater Phoenix metropolitan area.



Site







**The Pod: Desert Time**



**City**



**Bajada**



**Saguaro Sundial**



**Mountain**

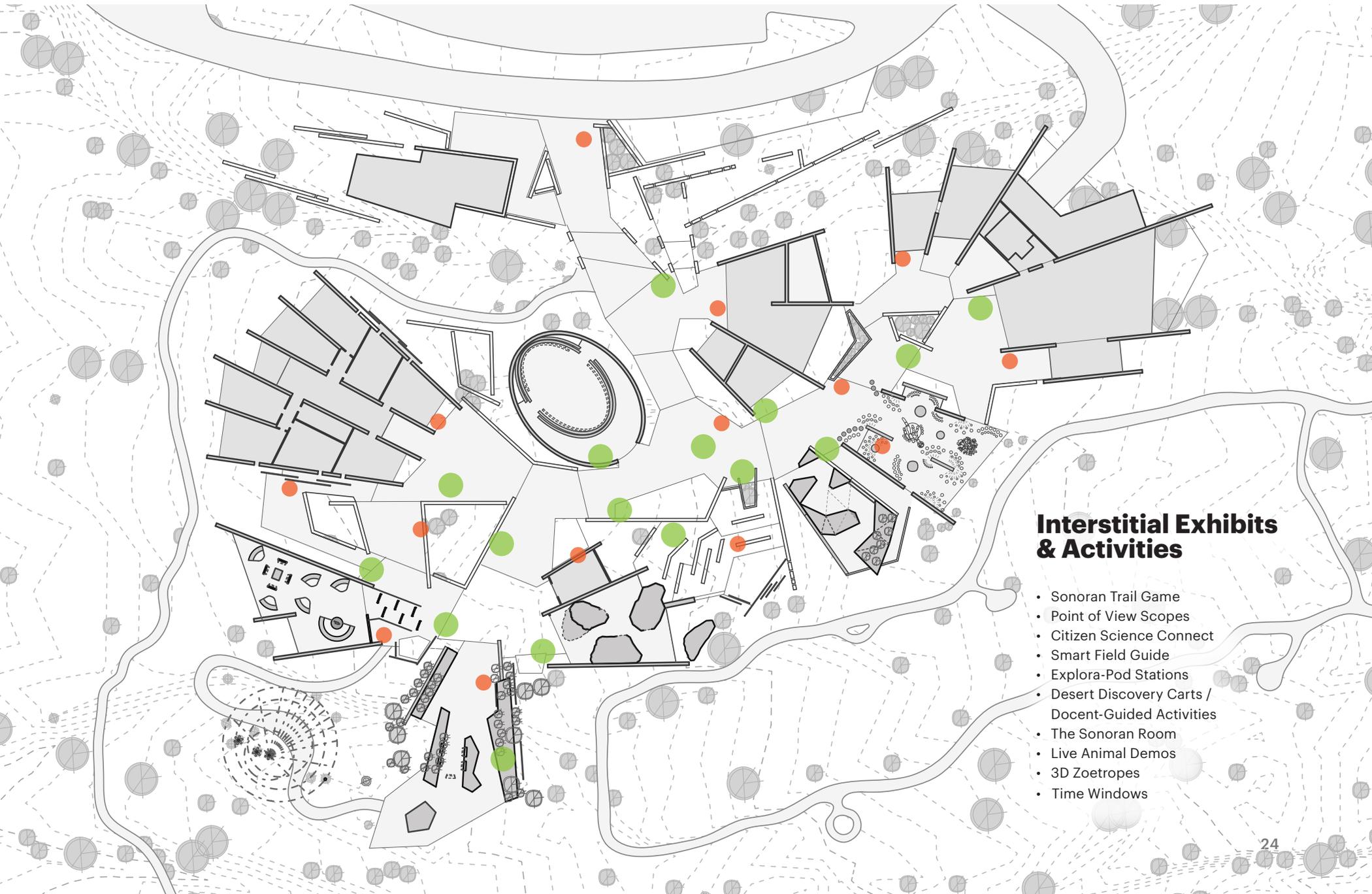


**Wash**



**Tom's Thumb**

## Keeping It Vibrant



### Interstitial Exhibits & Activities

- Sonoran Trail Game
- Point of View Scopes
- Citizen Science Connect
- Smart Field Guide
- Explora-Pod Stations
- Desert Discovery Carts / Docent-Guided Activities
- The Sonoran Room
- Live Animal Demos
- 3D Zoetropes
- Time Windows

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## Keeping It Vibrant

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Our understanding of the desert expands and deepens as more people turn to arid lands for answers to our most pressing sustainability questions and needs. The Desert Discovery Center is a place where people can keep up with exciting new research and begin to understand how this new knowledge impacts our lives. The Center's architecture encourages movement between interior and exterior spaces, as well as, views into the Preserve. These transition spaces will have interpretive experiences that call attention to how the Center's architecture and environmental design models sustainable desert living: Can the very sound of water cool us down? How does a cooling tower work? Is temperature or relative temperature more important to our comfort? What is the psychological benefit of nature? Visitor encounter guides and educators throughout the Center help people make connections between what they've learned in the exhibitions to what they see in the Preserve.

In addition to vibrant public programming, interpretive vehicles designed for changing content are placed throughout the Center, delivered through the Center app and/or kiosk stations. It is the Center's relationship and connection to stakeholders that will fuel its continual dynamism and relevancy. At the core of these experiences is the interaction among the Center's community of docents, scientists, environmentalists, cultural producers, locals and tourists.

### **Sonoran Trail Game**

As soon as people step into the Desert Discovery Center, they become intrepid explorers on the Sonoran Trail. Each character, either human or animal, starts out with a unique profile and special set of adaptations. At each physical exhibit players make choices of how they will manage resources, build cultures and form relationships with their natural surroundings, so that by the end of their visit they have created a full narrative of what it means to thrive in the desert. At each spot, players get "boons" or "curve balls"

depending on the environment. How prepared are they to withstand insect infestation or extreme heat? Do they know how to take advantage of the approaching storm or find shelter from a predator? Hints are given along the way, and people learn how desert plants, animals and people have solved the same problems. This branching decision game is not about winning; rather it is about experimenting and can be experienced multiple times to different results. It can be played on personal devices through the Desert Discovery Center app or be installed at kiosks.

### **P.O.V. Scopes**

Placed at strategic points around the Center, POV Scopes present a desert detail from the point-of-view of a local writer, artist, naturalist, member of the Salt River Pima-Maricopa Indian Community, Salt River Project worker, ASU scientist, or founding advocate for the McDowell Sonoran Preserve, etc. Stories are one way we make sense of the world, decide what to hold on to, and what to take care of. These view scopes allow people to compare

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## Keeping It Vibrant

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what they see with what locals see, which may be imparted in a myriad of ways: through writing, music, historical photographs, soundscape, spoken word, visual art, etc. These vignettes may also be sent home as a digital souvenir “postcard” through the Center app.

### **Desert Wisdoms Station [Give One, Get One]**

People can submit tips for living in the desert (eg. how to stay cool or harvest water on a hike), and receive a beautifully-designed keepsake card, inscribed with a desert wisdom, in return. From traditional ecological knowledge, to ways of repurposing everyday items, to tips on staying comfortable in a heat wave, each card celebrates local know-how and love of the desert. New public submissions are recorded to inspire new sets of Desert Wisdom cards for people to share and collect. Local artists may be commissioned to design special edition card sets.

### **Citizen Science Connect**

The Desert Discovery Center connects people to citizen science and conservation projects around the country. As people engage with topics in the interpretive spaces, they learn about active projects that offer them an opportunity to contribute meaningfully to scientific research. For example, upon learning about the nectar corridor, one might want to help report observations on hummingbird feedings or simply support a worthwhile cause. Through the Center app or a handheld device, people can bookmark projects they find interesting at the Center and follow-up on them when they get home.

People at the Center and hiking in the Preserve can also contribute to real time data collection. Using the Center app and working in collaboration with Arizona State University, people can record real time data on climate (temperature), phenology (vegetation), and animal behavior. Data is stored and displayed in real time to show seasonal, daily and annual comparisons over time.

### **Smart Field Guide**

The Smart Field Guide is both an app, and an on-site kiosk. People browse through a visual database of what they can expect to see in the Preserve. The information is organized in a variety of ways to anticipate different types of explorers: by time of day, habitat, trail, flora/fauna type, color, species health (lower risk, threatened, extinct), native or exotic, etc.

As an app, the Smart Field Guide provides maps of all the hiking trails in the Preserve, and allows hikers to share their hike with their social network and scientists at the Center. People can pick a trail that interests them and provide information on how their hike was, upload photos, share tips and experiences. Hikers can inform ASU scientists of interesting wildlife sightings from the trail, or perhaps post a photo and ask questions about what they’ve encountered. In turn, resident scientists can post questions to hikers. How many hummingbirds did you see today? Was there any erosion on the trail from last night’s

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## Keeping It Vibrant

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storm? They can also highlight interesting things to look out for, depending on the season, on the Center's "Today in the Preserve" digital board, along with Q & A's and real time observations from the trail.

### **Explora-Pod Stations**

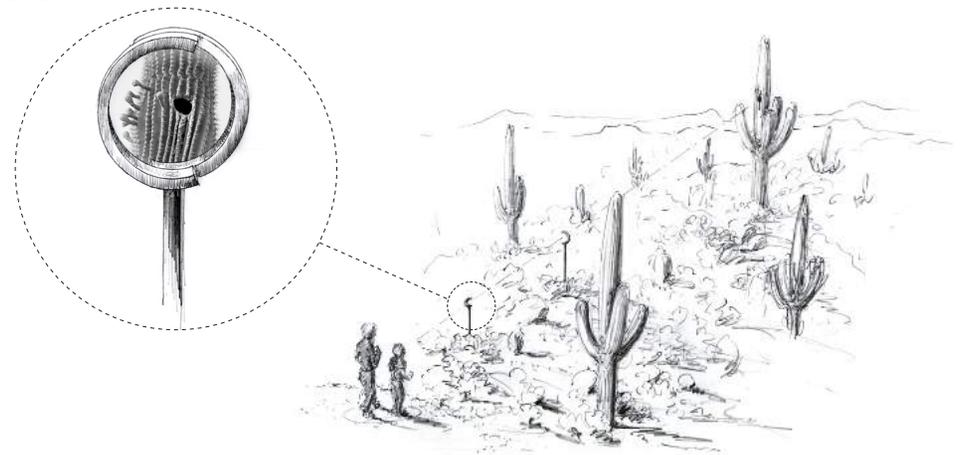
Explora-pods are stand-alone, updateable stations that apply the Desert Discovery Center's 4-Question approach to current scientific issues: 1) "What is this [organism/ place/phenomenon]?" 2) "What don't we see?" 3) "What can we learn from this?" and 4) What implications does this have for the future? These stations are ideal for immersive macro/micro, time-lapse, transportive and immersive experiences. Content is produced in collaboration with Center's community of leading environmentalists and arid land specialists (Arizona State University and The Nature Conservancy) to present exciting research throughout the Center as it emerges.

### **Live Animal Demonstrations & Workshops**

Against the stunning backdrop of the McDowell Mountains, people come face to face with iconic desert wildlife. Raptors take flight in demonstrations at the Sonoran Steps; people get a hands-on introduction to native birds (owls, hawks), mammals (kangaroo rats, foxes), reptiles (tortoises, snakes, lizards), and invertebrates (tarantulas, scorpions). Public programming at the Center starts with the premise, "You love what you know, and you protect what you love." At the Center, people get to know and learn how to better live with their desert co-habitants.

### **Desert Discovery Carts (Docent-Guided Activities)**

Desert Discovery Carts put science in motion throughout the Center as ASU- and Center-trained docents engage people in lively conversation about current conditions in the Preserve and things they see at the Center. Through hands-on activities at each Cart, docents can conduct demonstrations and



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## Keeping It Vibrant

*Imagine if the land around you were not only a source of refuge, inspiration, and pleasure, but were also the physical embodiment of your scriptures, your literature, your moral code, history and philosophy.*

From *A Great Aridness: Climate Change and the Future of the American Southwest*  
by William deBuys

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introduce an up-close perspective on the desert: an opportunity to handle a saguaro cross-section or examine a million-year old fossil or taste foods derived from desert plants.

The Carts can also serve as stops on children's scavenger hunts. Children get their first scavenger hunt card with admission. As they solve the riddles on each card, they can collect a special stamp and the next card at any Desert Discovery Cart until they collect all the cards and stamps. Each completed card is also a souvenir postcard.

### **The Sonoran Room**

The Sonoran Room opens its arms onto the Preserve, while engaging us in the question, "What is our story in the desert?" The desert can remind us of deep time and our place in it. It embodies our history as a people and our imagined tomorrows. It prompts nostalgia for past landscapes and delight in our own ingenuity. Stories help us recognize what is meaningful to us today... and perhaps what is important enough to us to invest towards our future.

It is a space that connects people of all backgrounds and generations through dialogues about living in the desert: from workshops with school groups, to international symposia on arid lands, "lab" demonstrations on green tech innovations, and multi-disciplinary events that explore ideas like Science and the Imagination, The Edge, and Green in the Desert. The Desert Discovery Center is a generator of ideas for arid environments, sharing and communicating what we've known and what we continually learn about living in the desert. Events at the Center are live-streamed to audiences around the world and stored in its accessible, online library. Public programs demonstrate how to forge cross-disciplinary approaches to address environmental issues in new and innovative ways.

The Sonoran Room also connects people to what roots us to the desert. Using the Sonoran Desert Jukebox, people choose from a pool of key words that best describes the desert to them. Based on these word tags, the Jukebox

database of poetry/ quotes that represent the region's multiple cultural influences, finds the best match for their key words. Each piece is coupled with a desert soundscape. The effect can be energizing or quiet, capture the feeling of the heavy heat or coolness of night, etc. People can submit their piece into the "jukebox" of experiences that get "played" environmentally—projected writing and soundscapes that subtly animate and give texture to the room. Each environmental piece gets played in the order of their submission.

### **Changing Exhibitions**

In addition to public programming, the Center will host a range of changing exhibitions and programs that give audiences access to works by leading research institutions and cultural producers, and that highlight the unique experiences of life in this desert and in other drylands around the world.

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# The Pod: Desert Time

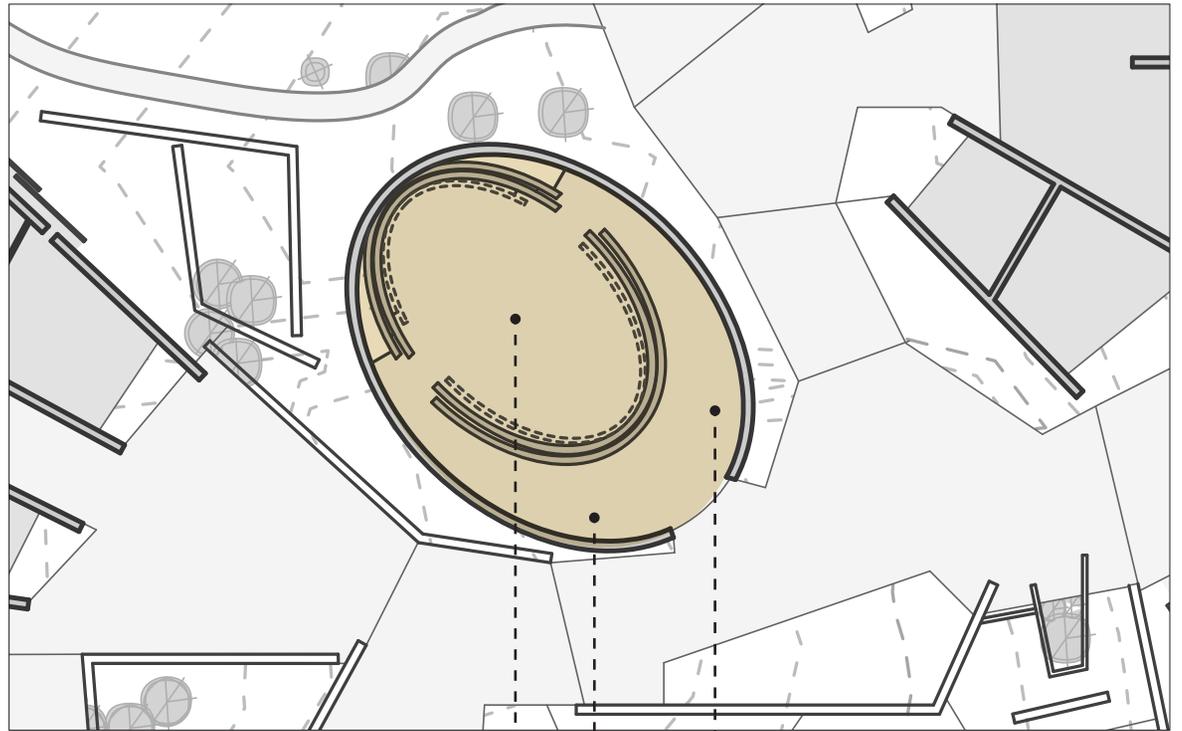


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*It is real desert people who lift their faces  
upward with the first signs of moisture.  
They know how to inhale properly.  
Recognizing the aroma of creosote in the distance.  
Relieved the cycle is beginning again.*

From "Proclamation"  
by Ofelia Zepeda

# The Pod: Desert Time



**Desert Time Experience**

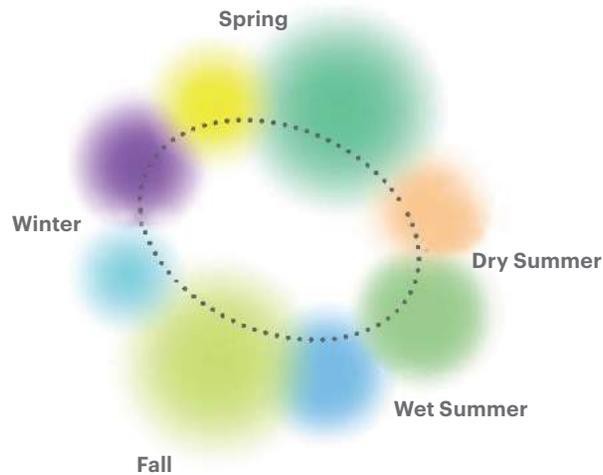
**Aroma Corridor**

**Sound Corridor**

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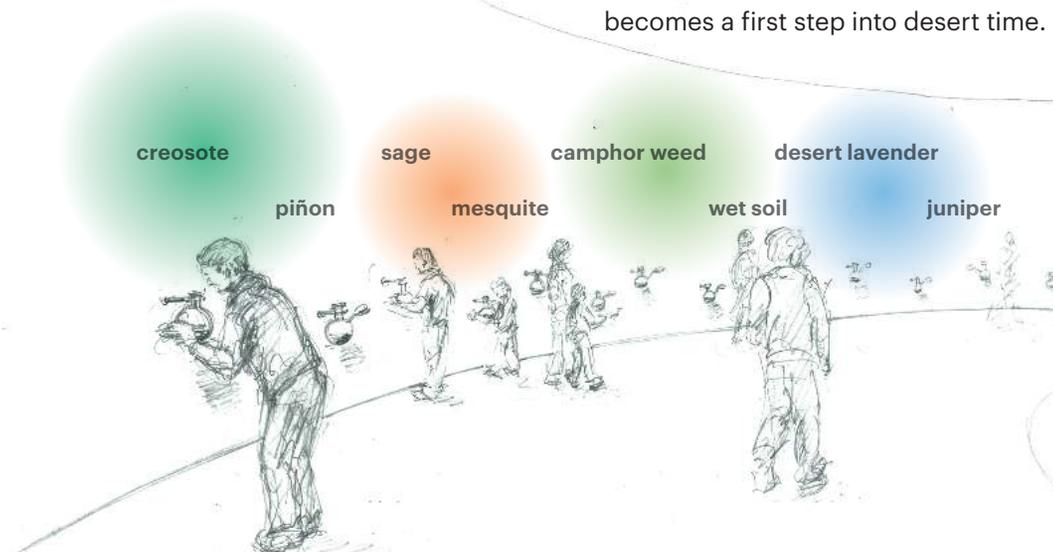
# The Pod: Desert Time

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For the uninitiated, the desert may seem a barren, lifeless place. A first immersion dispels this stereotype in a vivid, 8-12 minute experience that reveals the short and long rhythms of life in desert. The truth is, life is everywhere here. If we tune our senses to the desert, it will open its hidden worlds to us. In Desert Time we learn how to look at the desert, and we are invited into its unseen spaces.

The approach to the Pod follows a long, curving wall. Along the wall are “aroma stations”—containers of concentrated aromatic oils with atomizers - where people can experience distinctive scents of the desert; eg. creosote, sage, camphor weed, wet soil, juniper, piñon, mesquite, desert lavender. The scents occur in the same sequence that they occur throughout a desert year, so the procession to the theater becomes a first step into desert time.



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## The Pod: Desert Time

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When people arrive in the cool space of the Pod, they may take a seat on a comfortable bench or a floor cushion. Audio is delivered through binaural headphones which provide rich sounds with a vivid sense of location, movement, and a highly realistic three-dimensional effect.

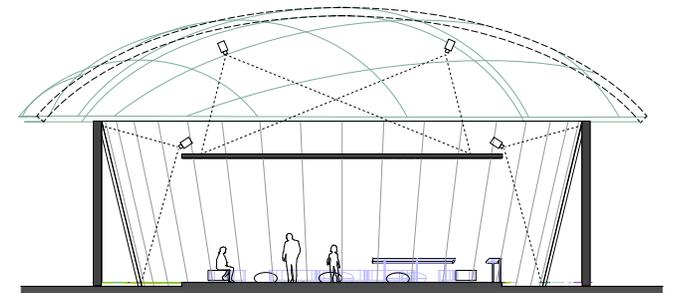
Desert Time is visually organized into three “rings” of video presentation. The primary level presents desert life at larger-than-life scale. Above, images indicate the passage of time—the sun rises over the mountain range, dramatic weather events signal seasonal changes, and stars move across the night sky. Below, the desert floor completes the immersive experience. Temperature readings tell us how cold the desert has become at night. The video opens with a quick time-lapse of the year and then slows down. We go through the seasons again, this time zooming in, going in, sometimes taking on the perspective of an animal inside its burrow. We look out onto the desert scrub, realizing as we

zoom in that a rattlesnake has camouflaged itself in the sand. An elf owl feeds her young in their saguaro home. The sounds of the desert are experienced three-dimensionally, and people become aware of the snake at their feet or the pollinating bees behind them.

The desert’s five seasons are marked by the rhythms of: drought and flood, dormancy and activity, celestial bodies, migrations, monsoons, desert blooms. People experience desert time as the drama unfolds at the primary level—the spadefoot toad spends nine months buried in the sand, only to resurface when powerful summer monsoons drench the ground. The desert is full of their loud proclamations. Birds announce the storm’s end by marking territories with their song. Flowers paint the horizon with their pollen-filled blooms.

Through high-definition, multi-scaled visuals and three-dimensional audio, people experience a desert drama timed with the seasons and made extraordinary by the adaptations that make life here possible.

As people exit, they experience the distinctive aural prints of the desert. In-between timed screenings, the Desert Time Pod can provide a simple environmental immersion experience that people enjoy at their own pace.





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## The Pod: Desert Time



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# **Bajada: Biodiversity and Connectivity**



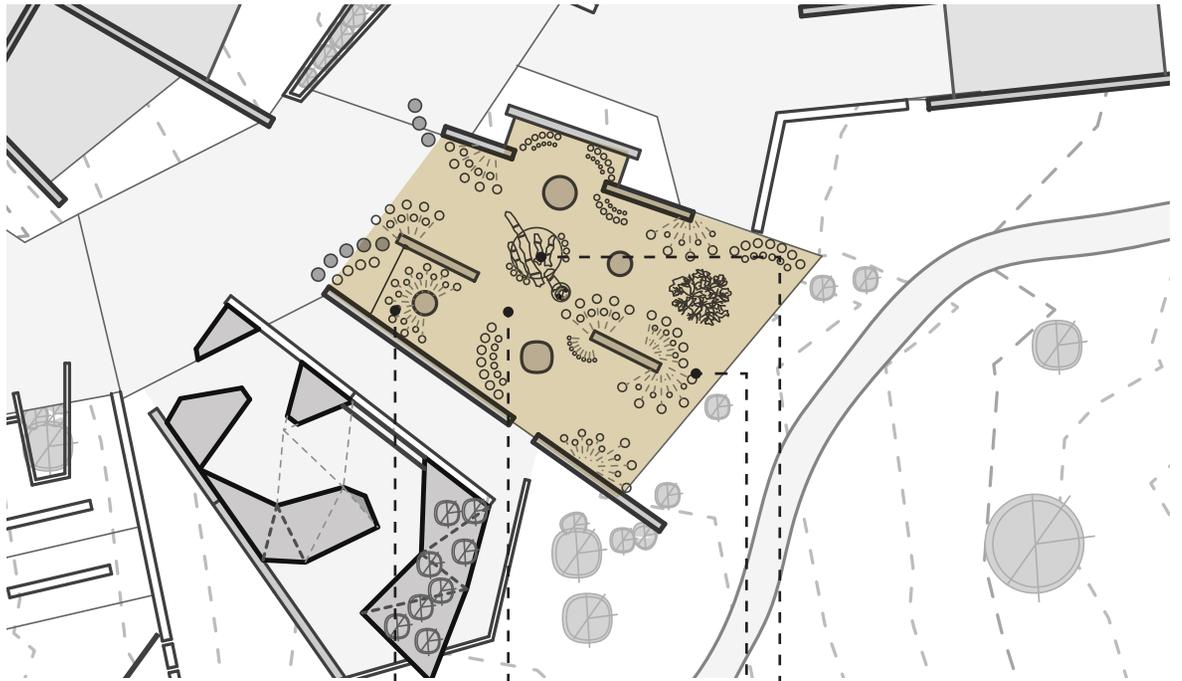
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*Small mice scurry along moist sand.  
Pack rats tremble in the brush.  
Rabbits freeze, pretend to be invisible.  
Mourning doves do not coo.*

*All understand balance and  
the desert is thankful you are here.*

From "Harris's Hawk"  
by M.E. Wakamatsu

# Bajada: Biodiversity and Connectivity



**Fly the Nectar Corridor**

**Web of Life**

**Build an Ecosystem**

**Desert Voyage Windows**

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## **Bajada: Biodiversity and Connectivity**

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### **What is this place?**

The McDowell Sonoran Preserve is a part of the Sonoran Desert—the most biodiverse desert in North America, which supports 60 mammal species, 350 bird species, 20 amphibian species, over 100 reptile species, 30 native fish species, over 1000 native bee species, and more than 2,000 native plant species. The entire Sonoran Desert encompasses more than 100,000 square miles of southwestern Arizona, southeastern California, northwestern Sonora and most of the Baja Peninsula. Ecosystems thousands of miles apart, including ours in the McDowell Sonoran Preserve, are connected by the Sonoran Desert Nectar Corridor, which fuels the migration of pollinators with flowers that bloom in seasonal sequence. Throughout time, people have also blazed trails through here. Millions have called it home.

### **What don't we see?**

The bands of green across the McDowell Mountain foothills signal where water is and used to be. Upon closer inspection, there

is life in these crevices, in the numerous microhabitats created in between rocks, and in their deep and water-absorbent soils. Storms in the McDowell Mountains discharge water onto the rocky slopes, and bring down rich debris to the bottom of the McDowell Mountains, creating bajadas or coalesced alluvial fans that support a rich diversity of plants. While much of the Sonoran Desert lies at fairly low elevation, this region is punctuated by mountain ranges; their gradients of elevation and moisture support a large array of biotic communities. From microbes in the soil, to plants, animals, and people, the desert is teeming with life.

### **What can we learn from living in the desert?**

Once life takes root, it adapts to the desert's extreme environment to not only survive, but thrive. Specialized adaptations may end up requiring the very heat and drought conditions that non-native life forms find burdensome; and the desert environment becomes necessary, as much as the species inhabiting

it, to maintain the community's structure. Over thousands of years of evolution, desert flora and fauna have come to rely on each other in specific, mutually-beneficial ways. We all depend on this multi-layered and interconnected system. Biodiversity is part of our life-support system. It has not only ecological, economic, spiritual, cultural, and aesthetic importance, but gives our system greater resiliency.

### **What future do we want to create?**

Interdependence among organisms and their environments creates conditions we need for survival: clean air and water, crop pollination, pest control, climate regulation, nutrient rich soils, and a diversity of plants and creatures. Biodiversity gives us greater resiliency, and a future in which we can adapt to changes and harsh environments.

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## Bajada: Biodiversity and Connectivity

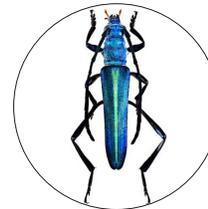
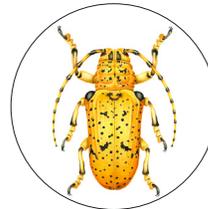
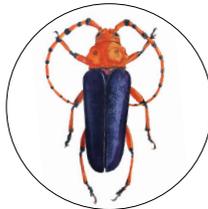
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### Interpretive Experiences

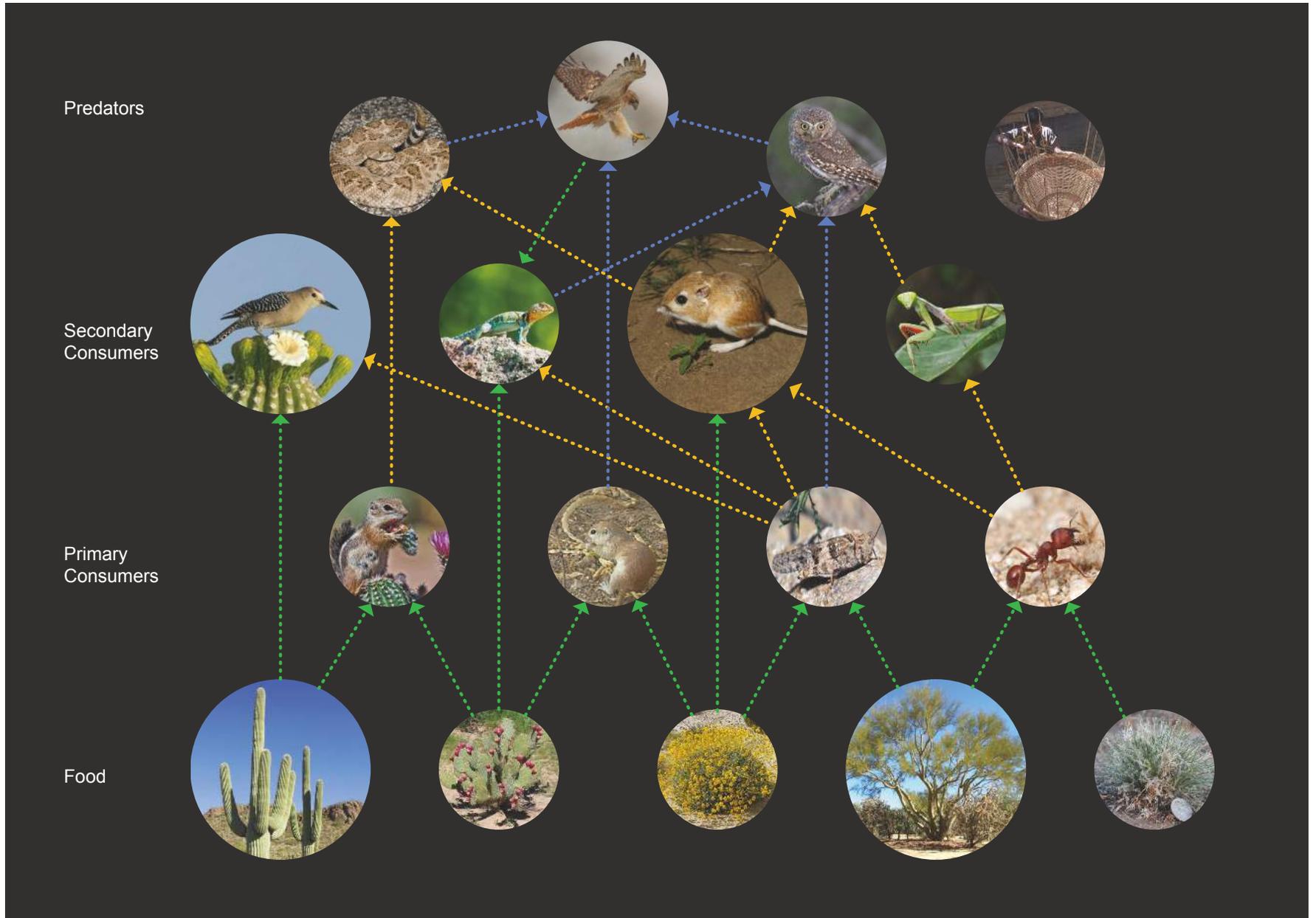
#### 1. Web of Life

People walk into a space that is active and teeming with life. It is a biotic representation of the landscape just outside the window—hundreds of species of flora and fauna that call the McDowell Sonoran Preserve home. Handsome sculptures and illustrations of desert microbes, flora and fauna float, crawl, and slither around floating pedestals of natural rock. Selected sculptures are animated by sound and projection, and nocturnal organisms inhabit darkened, cool spaces. All are connected by ribbons of LED lights; and as people touch particular sculptures, they light up to reveal the “invisible” connections between organisms.

Engaging with the biota, people discover the many types of ecological interactions (symbiosis, mutualism, commensalism, parasitism, etc.) that support the desert ecosystem. Humans are intricately connected in this web of life as well, and are represented by artifacts relating to food, medicine, ritual, clean air and water, etc. to show how we benefit from (and impact) these relationships. As our climate and habitats change, so does our web. Threatened, endangered, and extinct species are represented as ghosted sculptures to raise the issue of species loss and its potential impact to our ecosystem and our way of life. The ripple effect of extinction can be depicted through a scene played out in augmented reality.



# Bajada: Biodiversity and Connectivity



## Bajada: Biodiversity and Connectivity

Pollinators



Nurse Plants



Seed Dispersers



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## Bajada: Biodiversity and Connectivity

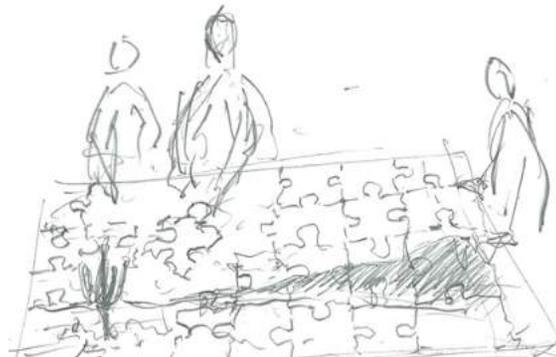
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### 2. Fly the Nectar Corridor

This multi-player game invites participants to become pollinators (eg. birds, bats, bees) on their annual migration across the Sonoran Desert. The goal is to discover and pollinate the kinds of flowers that attract their chosen creature by recognizing shape, color, nectar, pollen, and perfume. Along the way they encounter challenges that range from shifting climate patterns affecting the timing of floral blooms to the late hatching of insects. The pollinators travel through the unique biomes of the Sonoran Desert, from cold conifer forests to hot dry deserts that run right up to the ocean in a beautifully rendered environment. Players will explore the migratory seasons and paths of the desert's pollinators and how changes to the nectar corridor impact food crops and other species. The game is played on a projected surface that curves from the floor to ceiling to create an immersive feel.

### 3. Build an Ecosystem

Participants are challenged to create an interdependent ecosystem that will flourish in the Sonoran Desert. They manipulate physical playing pieces on top of a digital table to create an environment and then view the resulting flourish of life through augmented reality. This multi-player experience presents requires collaboration to determine what lifeforms (from soil microbes to flora and fauna) are required to create a diverse and resilient ecosystem within unique challenges



relating to climate change or human activity. The game can potentially integrate the tradition of Native American storytelling (with the permission of the Salt River Pima Maricopa Indian Community) to highlight relationships between different animals, plants and humans and their importance to the health of the natural world.

### 4. Desert Voyage Windows

Desert Voyage Windows offer views onto different parts of the Preserve, the Sonoran Desert, and deserts around the world over a 24-hour period, and over the course of a year. While the McDowell Sonoran Preserve is part of Sonoran Desert, one of the most biodiverse deserts in the world, it has its own unique character. Side-by-side views of different desert regions demonstrate the range of landscapes and life forms encompassed by the term "desert."

## Bajada: Biodiversity and Connectivity



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# Mountains: Source & Inspiration

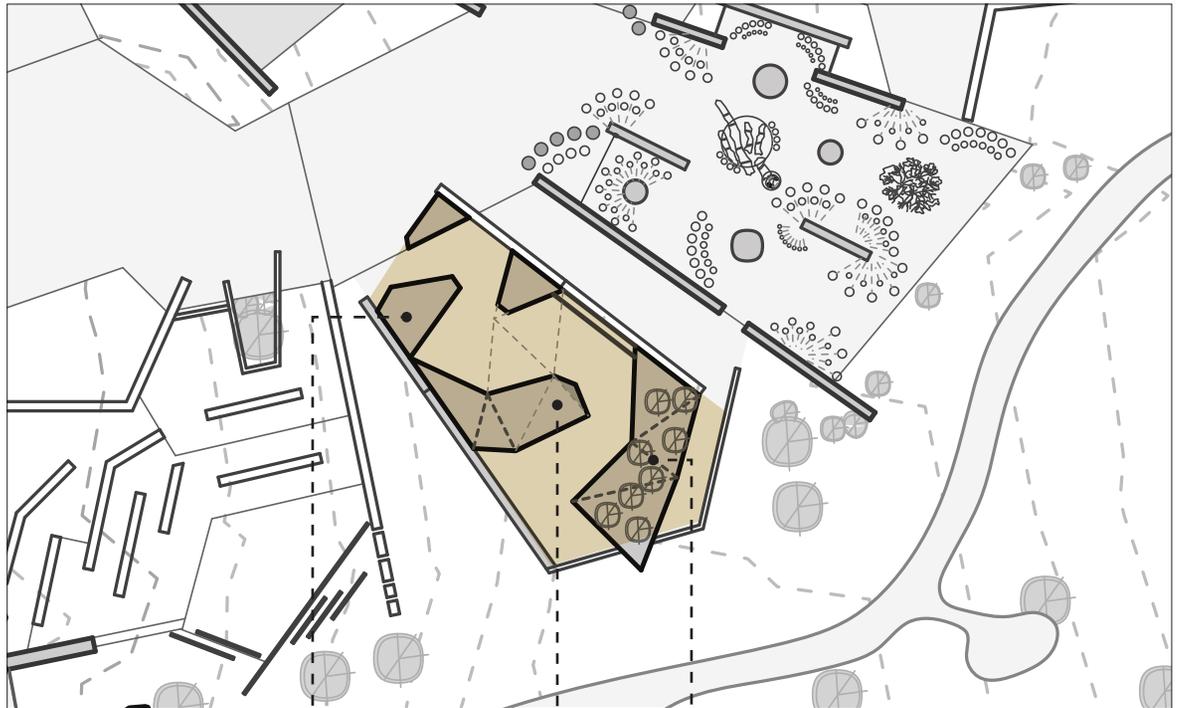


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*We must come to them with music  
so they are generous with the summer rains  
that appear to start their journey from their peaks.  
We must come to them with song  
so they will be generous  
with the winter snow that settles there.*

From "Music Mountains"  
by Ofelia Zepeda

# Mountains: Source & Inspiration



## Mountain

## Forest

## Soil

350,000 Acre-Feet of Water  
Erosion Tables  
"Fire is Always About Water"  
What is Your Watershed?

Magnification Room: Soil Crust,  
Desert Pavement, Rock Varnish,  
Geoglyphs & Petroglyphs  
Plant Strategies  
Plant-Speak  
Burrowing Down  
Minerals & Mining

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## Mountains: Source & Inspiration

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### What is this place?

The McDowell Mountains anchor our view here onto the Preserve; and we are drawn to their beauty and majesty as generations were before us. We have named their peaks, used their rock faces to calculate the solstices, marked and cut trails to navigate through them, sung songs to remind ourselves of our relationship with them, and drilled into them for their ancient stores of minerals and water. We seek refuge from the heat under the cool shade of their pines, and respite on their rivers and lakes. However, we also owe the very character of our desert—from its unique geological formations to its biodiverse inhabitants—to this mountain-valley topography; and we depend on its ecological systems for the very water, soil, and minerals that make life and industry in the desert possible.

### What don't we see?

Many of the world's deserts, including the Sonoran Desert, occur in a zone around 30 degrees North and South - near the Tropics

of Cancer and Capricorn—products of the largescale forces of air, water, and earth. The great air and ocean currents create a region here of high pressure and descending hot dry air that is additionally impacted by the “rain shadow effect,” in which moisture-carrying air is blocked to the west by mountain ranges. The mountains give rise to the forest habitats and watersheds that help capture, store, and filter what little rain the region does get, and release it to the desert lands below.

### What can we learn from living in the desert?

A desert is defined by aridity, but it is not completely absent of water. We depend on distant topographical features, ecological processes and weather events for the water we do get. Life here is optimally adapted to this very particular environment; in fact, drought is just as critical to the function of this ecosystem as the rain. Many desert adaptations are based on beneficial connections between species and synchrony with the seasons. However, if adaptations

cannot keep up with the pace of climate change, these connections run the risk of “de-linking” and even this highly adaptive ecosystem may not be able to sustain itself.

### What future do we want to create?

How far is that ripple going to go? Understanding that natural systems like watersheds are so critical to life in the desert encourages us to embrace a systems approach to our future. In the words of Shane Anton of the Salt River Pima-Maricopa Indian Community, “If we take care of the land, the land can take care of us.” Seemingly unrelated habitats and biotic communities may show connections that reach back to us. If we look beyond our silos, we can broaden our thinking and understanding in service of more sustainable outcomes.

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## Mountains: Source & Inspiration

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### Interpretive Experiences

Members of the Salt River Pima-Maricopa Indian Community describe the natural world as three spheres that need to be in balance with one another—that which is above, on the ground, and below the surface. Against the backdrop of the McDowell Mountains, people move through these spheres (represented by Mountain, Forest, and Soil) to explore the life that supports and is supported by these ecosystems, including our own.

#### Mountains: What is above

People begin their journey high above the Earth. An arresting video of the “Breathing Earth” shows the arctic ice cap retreating and advancing over time, much like the rhythm of a living, breathing organism. The video zooms into the Western Hemisphere and an explanation of the natural forces and geography that led to the formation of the Sonoran Desert. Zooming into the Basin and Range Province, people learn that much of the region is punctuated by mountain ranges and is therefore host to many climates and biomes. Climbing 1,000 feet is equivalent to a 3.5°F drop in temperature, or to driving north 300 miles. These gradients of elevation and moisture help establish a great array of biotic communities in the Sonoran Dessert.

The American Southwest has experienced a 25% to 40% drop in rainfall over the past 50 years. When rain does fall, more of it falls on mountains because air travelling over land is forced up and over them. Rising air cools, creating condensation and rain. This now cooler and drier air then flows down the other side of the mountain, and like water, flows down into the desert washes.

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## Mountains: Source & Inspiration

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### Forests: What is on top of the ground

From the mountain top, people then enter a forest. In these regions, moisture tends to stick around for longer periods of time due to low temperatures and evaporation rates.

### 350,000 Acre-Foot of Water

A conifer tree installation demonstrates how watersheds in the Tonto National Forest produce an average of 350,000 acre-feet of water each year. Like sponges, forest vegetation and soils absorb melted snow and rainfall. The lower half of a conifer seems to break through the pavilion ceiling; and people engage up-close with its rootball. There is life among the roots, which exhibition techniques such as Pepper's ghost can animate here. People see how the spongy forest floor helps store and filter water underground until it is slowly released as springs, and flows into our streams and rivers. Without these "sponges", water would just hit desert rock, and there would be no permanent rivers. We need rain to fall in a gradual and consistent manner so our soil can absorb and store the water in the ground.

Conifers retain their needles throughout the winter. Their dark green needles help absorb heat and begin photosynthesis as soon as temperatures rise above freezing. Their stomata are positioned underneath a waxy cuticle to prevent water loss. When heavy snowfall accumulates, their conical shape helps to shed snow and prevent branches from breaking off. To combat cold temperatures, conifers produce resins that act like antifreeze. When the needles fall off, these chemicals leach into the soil creating a toxic environment for competing plant life.

### Erosion Tables

Water erosion leads to topsoil and subsoil loss. Degraded lands are less able to hold onto water, which can worsen flooding. They contribute to increased pollution and sedimentation in streams and rivers. A set of erosion tables allow people to simulate and compare the effects of water runoff with different types of soil (i.e. spongy vs. hard), at different rates and volumes of water flow (slow steady rain vs monsoon storm), at different

angles of descent (mountain slopes) and with varying types of channels (washes). People can compare their erosion scenarios with real views of bajadas, washes, and city floods; and see how conditions in the distant mountains and forests impact life in the valley.

### "Fire is Always About Water"

Traditional ecological knowledge teaches us that you need fire to bring back the water. Cultural burns (or "controlled burns") have been used for generations to thin out forests. You need to be able to see through the trees, to see through the forest to the next world. It is a concept of openness that is both spiritual and physical. Less dense forests allow water to seep more easily into the ground. They also help hold off the natural succession of meadows to forest and support greater biodiversity.

Under normal circumstances, fire is a common occurrence in dry areas. Mature trees would survive the blaze, but young trees and ground cover would burn quickly,

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## Mountains: Source & Inspiration

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recycling their nutrients back into the soil. Working in tandem, these disturbances keep the forest young and healthy. Forests that are overgrown (due to forest management policies of fire suppression) and dehydrated (due to climate change) are susceptible to uncontrollable fires. When an overgrown forest burns, it sends debris and ash downstream, decreasing the overall water quality.

Forests of the American West account for 20%-40% of total U.S. carbon sequestration. In the last decade, more than a quarter of the forests in Salt River Project's watershed have been destroyed by fire. If present trends continue, these forests may become a source of increased atmospheric carbon dioxide rather than a carbon sink.

The Nature Conservancy will provide people with the opportunity to have a 360° virtual reality experience of the forest and learn about fire and restoring forest health.

### **What is Your Watershed?**

People can enter their home city into the interactive Global Forest Watch Water map to identify and see the current risks to their watershed. The disappearance of rivers like the Gila is due to watershed damage from generations of beaver trapping (beaver dams slowed the flow of water), mining and deforestation, livestock overgrazing and floods and ecological damage. As of 2004, 35% of Arizona's natural perennial rivers had been altered or lost. We stand to lose at least seven rivers in our lifetime. Since the watershed is often far away from our cities, this essential component of living in the desert is easily forgotten.

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## Mountains: Source & Inspiration

*[The soil] is the most vital place on Earth for human existence.*

E.O. Wilson

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### Soil: What is below

Continuing down along the mountain, people exit outdoor to a 12-foot tall, sloped planter installation. As people walk around the downward sloping planter, they can explore a cross-section of the desert floor, and discover how the flora and fauna of these drylands take advantage of spaces below the surface.

### Magnification Room

People enter a small room under the desert floor, and discover that they are now even smaller than a harvester ant. Everything here is scaled up, and they can now see the microscopic world of organisms that support all life in the desert. A digital sandbox of the desert floor invites tactile play. As people disturb the “soil,” a system of projectors and sensors expose the tiny life forms—from lichens to cyanobacteria. A digital clock counts down the time it takes for soil crust, desert pavement, and rock varnish to form.

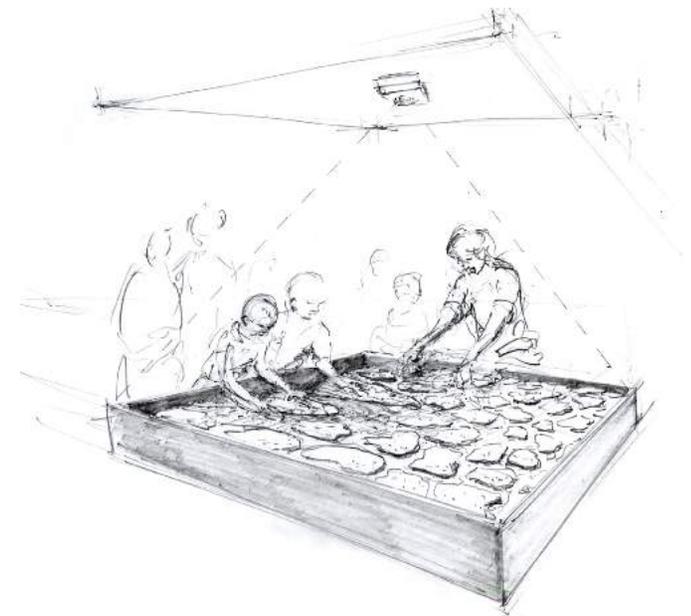
### Soil Crust

Plant life in the desert (and therefore life up the food chain) depends on the tiniest of organisms to create the conditions they need for growth in this hot, arid land. Cyanobacteria (one of the oldest known life forms), algae, lichen, mosses and liverworts form communities of living crusts on desert soils. They protect and contribute nutrients and organic matter to desert soils, improve native plant health, and block invasive species. Soil crust is key in reducing erosion, increasing water retention, and increasing soil fertility.

Although they are so very small, their communities can be seen by its dark color on the soil surface. While they have no roots to absorb water and cannot regulate their temperature in the extreme heat, they have developed their own “sunscreen” to withstand the sun’s damaging rays. They are tough against temperature extremes and ultraviolet radiation, and have even survived nuclear tests in the desert; however, they cannot survive the compression of a hiker’s boot.

### Desert Pavement

As the term 'pavement' implies, desert pavement is a stretch of desert that is paved and flat like street pavement, seemingly man-made. Pavement is found in the driest parts of the Sonoran Desert, and samples have been dated from thousands to tens of thousands



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## Mountains: Source & Inspiration

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of years old. Pavement formation is such an exceedingly slow-forming process that researchers can only come up with theories on how it develops. Desert life benefits from its ability to sequester nutrients and moisture and to become the habitat for microbes and plants. Compression from human activity such as driving is likely to cause permanent damage, since their extremely slow formation makes recovery improbable.

### **Rock Varnish**

Rock varnish gives desert pavement its dark complexion. Its color and sheen are the respiratory byproduct of microbe colonies, which protects the microbes from damaging solar radiation. Varnish forms very slowly. If rock surfaces resist weathering, varnish coatings can become increasingly thick and dark with time, and provide geologists with a tool dating alluvial fan deposits. In some cases, they may have been accumulating for many tens of thousands to over 100,000 years.

### **Geoglyphs and Petroglyphs**

A “zoom-out” monitor tells the story of how ancient inhabitants of the Sonoran Desert used varnished, desert pavements as canvases for gigantic artwork. By removing the dark varnished stones and exposing the underlying light-colored soil, they created fantastic images of human figures, animals, and abstract forms. The largest one yet discovered is a human figure nearly the length of a football field, about seventy-five miles west of Phoenix. Similarly, petroglyphs on boulders were created by chipping away the surface of the dark varnish to expose the lighter-colored rock beneath. A visual storytelling can begin with a close up of desert pavement and end with aerial images of these large-scale pieces of art. Locations will not be revealed as they are kept secret for their protection.

### **Plant Strategies**

Unlike in other biomes, where plants compete for light, plants in the desert compete for water. Here people can see and appreciate a plant’s entire morphology—from root tip

to spiny needle. The structure of the planter also helps present how elevation and north-south orientation supports different types of vegetative communities, depending on their adaptations to the cold, stress tolerance and growth strategies. People see that the desert’s extreme environment has produced a diverse portfolio of solutions: from extensive shallow roots to deep tap roots, from dormancy to fast life-cycles, from drought evasion to drought resistance, and the role of nurse plants.

The planter will feature iconic desert plants such as: creosote, cacti, mesquite, jumping cholla, foothill palo verde, ocotillo, limberbush, jojoba, and desert globemallow. The interpretative approach is a combination of the informational, anecdotal, artistic, and whimsical—helpful hints and local knowledge are offered amongst the many ways in which desert flora contribute to the ecosystem (eg. “Place a comb between you and the cholla branch to help release a prickly hitchhiker;” or “If you get lost, look for barrel cactus, they tend to always lean south.”)

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## Mountains: Source & Inspiration

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### Plant-Speak

There is some evidence that plants “speak” to each other through chemical signaling via their root systems. Research experiments have shown that unstressed plants were able to receive and pass on information through their roots from nearby drought-exposed plants. In response to these signals, the unstressed plants closed their stomata in preparation for possible exposure to future stress.

As humans change the environment, how will plants adapt to cope with the stress of change? While vegetative communities may move up in elevation in response to warmer and drier conditions, human interventions (eg. fire, livestock grazing, introduction of exotic plants) can often determine the kind of plants that ultimately take root.

### Burrowing Down

Among the network of plant roots are displays of seeds stored by animals, burrows, and live insects. The desert underground is used by desert animals for nutritional sustenance,

shade and security. A “residential complex” of model burrows demonstrates the housing strategies of desert animals such as: the tarantula (silk-lined), kangaroo rat (multiple exits), desert tortoise (opening does not face the summer sun), woodrat (cholla-protected middens, inhabited over many generations), and harvester ant (nest of tunnels and galleries). (Any representation of mammals will be done as media or “evidence” of their presence.)

### Minerals and Mining

This area’s geological history made it mineral-rich. As mountains pushed up and volcanoes erupted, igneous rock rose up and brought their veins of rich mineral deposits with them. For over a hundred years, people have burrowed into the earth in search of these minerals: copper, silver, and gold. Mining is one of the most land-intensive industries. Thousands of miles of shafts and tunnels were excavated, hillsides denuded, streams diverted, water tables polluted and vegetation communities irrevocably changed. From

minute soil nematodes to people, a complex web of producers, prey, and predators affect the non-living components of the desert ecosystem.

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## Mountains: Source & Inspiration



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# Tom's Thumb: Deep Time

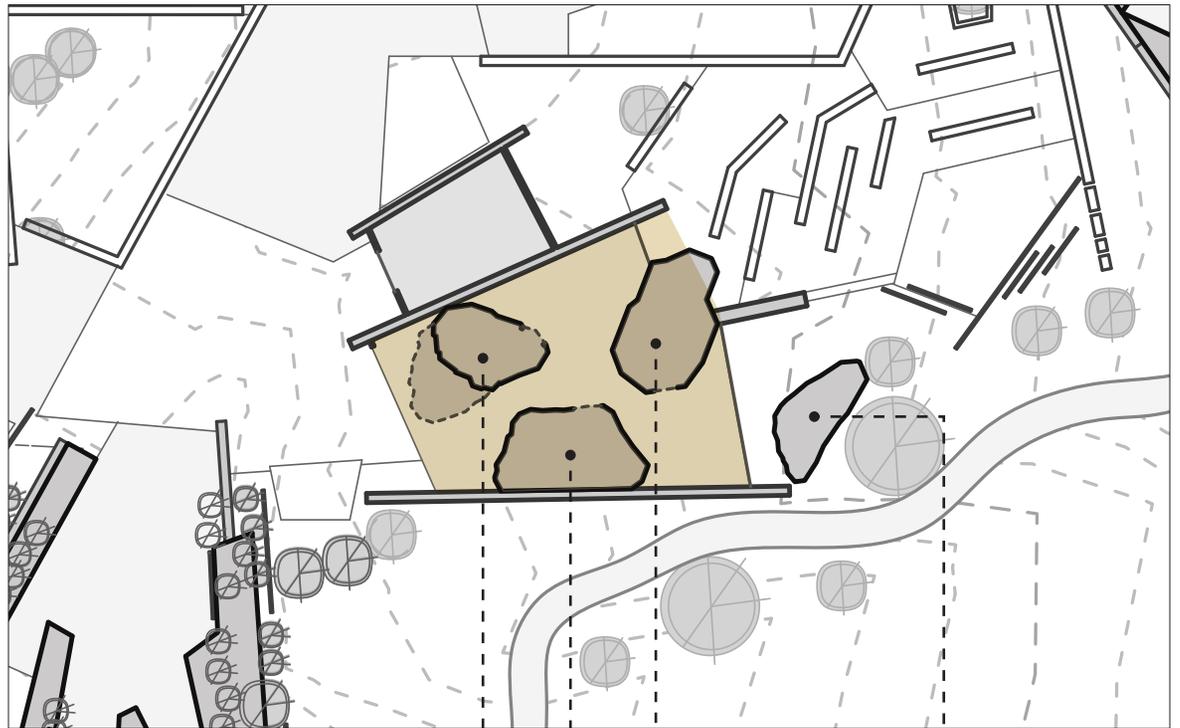


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*Desert having been ocean  
Remembers water, misses it,  
Hugs it and kisses it when it visits,  
Steals a little when it tries to leave,  
Prickly pear and ocotillo and mesquite  
A little fatter, a little wider, a little greener,  
These plants having been coral and puffer fish  
And green seaweed in their ocean lives.  
In this place now, one can still see  
This place **then**,  
Every grain of sand once having been  
A point of light in the crest of a wave.*

From "The Thirst of Things"  
by Alberto Rios

# Tom's Thumb: Deep Time



**Proterozoic (1,800-542 mya)**  
**Paleozoic (541-252 mya)**

**Cenozoic**  
**(66 mya-today)**

**Mesozoic**  
**(252-66 mya)**

**Views from the**  
**Anthropocene**

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## Tom's Thumb: Deep Time

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### **What is this place?**

It took eons to create this landscape—the physical remains of shallow seas, desert dunes and lava flows. Almost every rock type and geologic age can be found in Arizona, especially in the Basin and Range Province. The iconic rock formations that define this northeastern area of the McDowell Sonoran Preserve are composed of 1.4 billion year old coarse-grained granite that weathers readily into unusual, spheroidal shapes. Tom's Thumb, the landmark granite spire that rises in the distance, began as magma beneath the earth's surface that pushed up and transformed into granite. Exposed to the elements, it was dramatically rounded by erosion. The majority of the McDowell Mountains are composed of erosion resistant quartzite, meta-volcanic rock formed about 1.7 billion years ago. Roughly one-third of the mountain slopes here are exposed bedrock, and the rest are thin soil over bedrock. This soil retains limited amounts of water, and large rainfalls rapidly carve out local drainage channels.

Over in the nearby Superstition Mountains, we see geologically young (15 - 25 million years old) volcanic deposits.

### **What don't we see?**

Continents drift, collide and re-form. Rivers and oceans appear and disappear. Land masses, oceans, the climate, our atmosphere, and all life have co-evolved on this planet in a complex, interwoven web. As climates and habitats change, plants and animals adapt, migrate or become extinct.

### **What can we learn from living in the desert?**

This land's deep history challenges our notion of permanence. These geological forces helped create a tremendous array of topography and environments—a wide range of lifezones that support a remarkable diversity of organisms. By zooming out in time, we can get a better perspective on these ecological relationships. For example, recent arrivals are often perceived as invasive and non-native species, but the vegetation we think of as

“native” to this desert actually migrated here from the sub-tropics 10,000 years ago. From this perspective, everything is “non-native.” Geological, biological, and anthropological evolution are continuous processes. While change isn't inherently “good” or “bad”, it can impact specific species—or whole communities—negatively or positively.

### **What future do we want to create?**

The planet's carbon and nitrogen cycles, ocean chemistry, and biodiversity are products of millions of years of slow evolution. However, human activities have started to have a significant global impact on earth's geology and ecosystems. Our activities (eg. population growth, the creation and use of plastics, etc.) have become geological forces as significant as deep-time processes. How can we take responsibility and action for the future of the planet and its inhabitants?

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## Tom's Thumb: Deep Time

*Sometimes the one still point in the center of the landscape is moving*

"Desert Tortoise" by Wendy Burk

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## Interpretive Experiences

### **A Sea That Became a Desert**

The space is inhabited by a rockscape of the McDowell Sonoran Preserve. Three 20 foot-tall "rock" formations line a winding path and frame a view of Tom's Thumb and the McDowell Mountain Range. The trail is transformed by augmented reality, guiding people through deep time from the Proterozoic to the Paleozoic, Mesozoic and Cenozoic Eras: using a handheld tablet, people first experience the land rising around them, shallow seas washing over them, then the gradual lowering of water levels until they reach dry land. The first sounds heard on earth, such as the effect of wind in trees or grasses, waves at the ocean or lakeshore, or movement of the earth can be heard. Real fossils and/or artifacts mark the transition of geological periods in protective cases, and people will have opportunities to handle rock samples.

People enter "time boulders" along the way. The interiors are inviting and qualitatively different from the rocks on the exterior

trail. Inside, people unlock an animated story of geological events when they touch the rock strata of a particular period; and help bring the space to life by contributing their own era-specific fossil rubbings/drawings to the organisms living in the space. People first encounter the Proterozoic Eon (1,800-542 mya) when then rocks in this area were formed and single-cell / simple multicellular organisms emerged; and the and Paleozoic Era (541-252 mya) when Arizona was covered by a shallow sea.

On the rock walls people touch and examine fossils and replicas of organisms that inhabited this watery environment: trilobites, brachiopods, primitive fish, coastal plant life, and what was once the most diverse population of sharks in the world. As people enter the Mesozoic Era (252-66 mya), geological forces elevate the topography of Arizona's southwestern region and the water level lowers as club mosses, ferns, dinosaurs, and marine reptiles appear.

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## Tom's Thumb: Deep Time

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In the final boulder, people enter the Cenozoic Era (66 mya-today) to witness the sea's departure from this part of the world. Between 20 and 40 million years ago, numerous volcanoes were active in the Sonoran Desert. The tectonic activity, coupled with intense heat from below, placed tremendous stress on the crusts underlying the Sonoran Desert, causing the horizontal and vertical movements that produced its characteristic Basin and Range topography. This steep topographic relief creates relatively cool and moist summits containing lifezones more characteristic of Canada than those of the valley bottoms below. We are now in the age of mammals and birds. Camels, horses, mastodons, and rodents roam this dry terrain amongst a wide variety of habitats; and most recently, humans arrive, leaving their dart points on the land.

### Views from the Anthropocene

Viewfinders at the end of the time trail offer a series of interpretations of the Sonoran Desert in the far future. What kind of pressures are our deserts (and their communities) under in the Anthropocene?

This landscape has changed before, and will likely change again. Based on various possible environmental, technological and cultural scenarios, artists (eg. writers, visual artists, composers, etc.) create a series of future visions for the desert. The visions address: our hopes for life in the Sonoran Desert moving forward; how we might create a future where people and nature thrive together; the key challenges that are connected to nature and people.

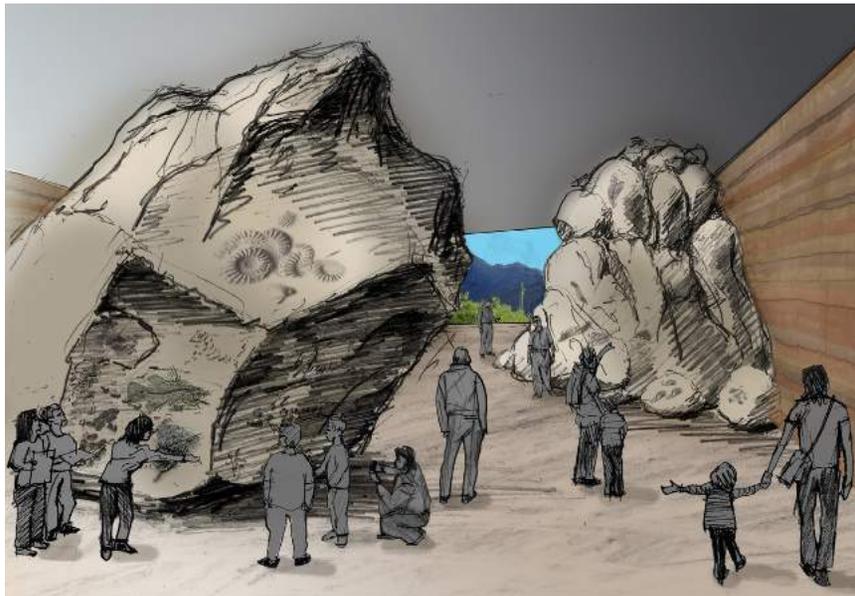


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## Tom's Thumb: Deep Time



## Tom's Thumb: Deep Time



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# The Wash: Water in the Desert

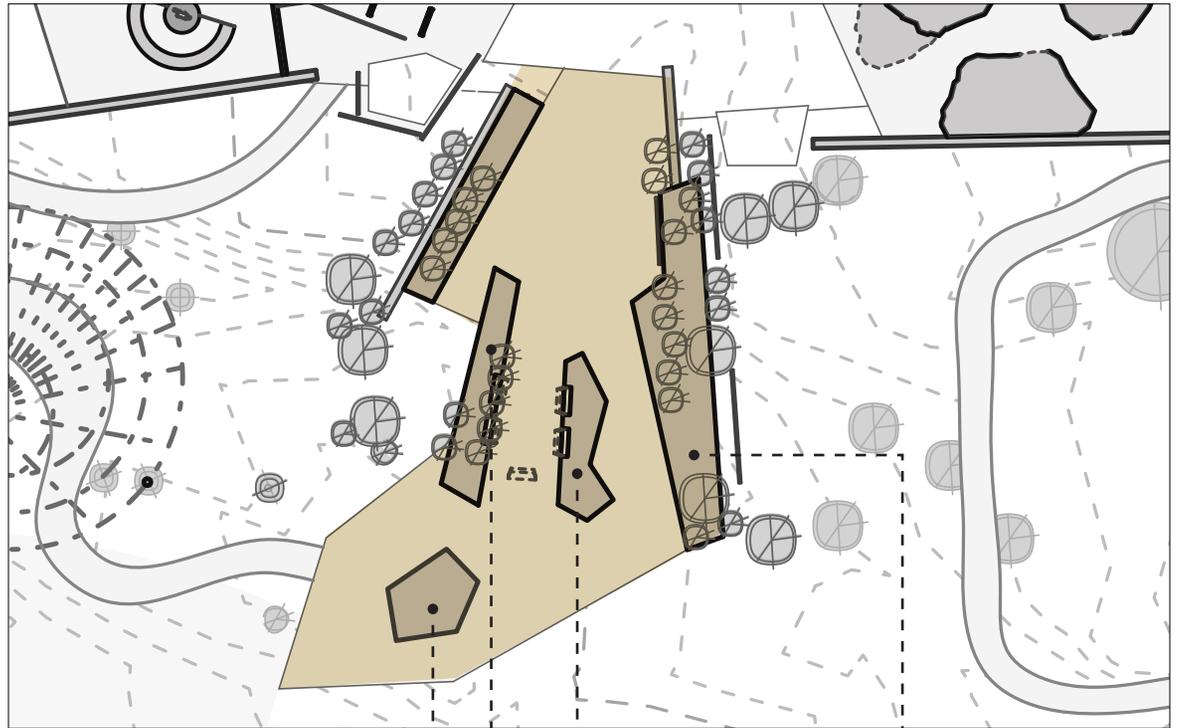
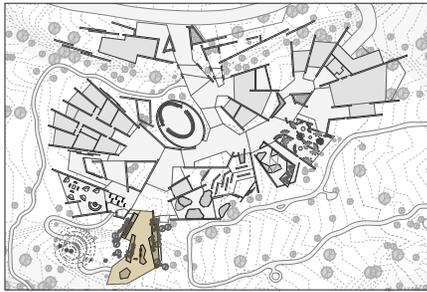


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*The Sonoran Desert is a place  
“where plants exist between  
hell and high water.”*

Frank Lloyd Wright

# The Wash: Water in The Desert



**After the Rains**  
Stormwater Map  
Ephemeral Pool  
Create Your Desert Avatar  
Living Animal Enclosures

**Flood!**

**Dry Wash**

**Night Watch**

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## The Wash: Water in The Desert

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### **What is this place?**

Looking out, we know that water once flowed here... again and again, perhaps even thousands of years ago... to create this vital wash habitat. We see signs of water everywhere in the landforms and life forms that live here. From the highest point in the desert, water finds the path of least resistance and erodes the rock away to create channels down to the basin. In the desert, water continues along easy paths in the landscape, creating capillaries that carry water and nutrients to the desert's inhabitants.

### **What don't we see?**

Drought. Flood. Drought for many months again. Flood. This is the rhythm of the desert. Every living thing needs water to live, and washes bring it to them. During the wet, rainy season, you might witness a feast of water finding its path from the mountains. During dry times, the "stream" is a lush, deep-rooted green impression. It's different here from the sparsely-vegetated desert floor. Cool air comes off the mountains and sits along the

wash; and its vegetation-lined banks create a travel corridor and a nutrient-rich home for opportunistic animals.

### **What can we learn from living in the desert?**

Part of living in the desert is letting the washes and desert systems do their work. In the arid West, desert wash habitats are important to wildlife populations and the establishment of plant communities. Nothing may happen for years, then with a major flood event, a large cohort of plant species is started. Once they get through the first critical year or two, many species can tolerate severe drought, waiting quietly until it rains again to grow or set seed. Washes generally support higher structural plant diversity and this habitat richness supports a greater diversity and density of wildlife than other desert scrub habitats. Wash habitats are particularly important to birdlife, providing food, cover, perches and nesting sites. Where there is water, there is life.

### **What future do we want to create?**

Frank Lloyd Wright described the Sonoran Desert as a place "where plants exist between hell and high water." Desert species know how to live in a land of diametrically opposed conditions: drought and flood. They know to wait, to hold onto the rain that does fall, and to take advantage of the opportunities that arise. Our future in the desert will depend on how well we can apply these lessons to our own communities. Years ago, people anticipated the seasonal rains and strategically diverted runoff to irrigate crops in the desert (ie. flash cropping). Today's massive water management systems are not divorced from these natural desert systems either, channeling storm water to the washes and rivers. Along the way, our pollutants and trash are carried into these vital habitats, and pumped back into underground aquifers.

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## The Wash: Water in The Desert

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### Interpretive Experiences

People who live in the desert generally follow crepuscular rhythms, especially in the summer. A walk in the desert is best at the end of the day right before the sun sets or just as the sun rises. The Wash takes people through a drought/rainy season experience, populated with live animal enclosures, and culminates in a walk through a real wash on overlook platforms.

#### Dry Wash

People enter the wash during the dry season. The wash banks contain seeds that seem to glow in the soil. They are waiting for the moisture and temperature to be just right. Many desert plants and animals do not necessarily attempt to reproduce every year, but they wait until sufficient rain has fallen to make the investment of energy worthwhile. Until then, they may lie dormant in the ground for many years. In the Wash pavilion people can discover some of these animals hidden in the crevasses, burrows and nests below ground.

#### Night Watch

The light is dim and the surroundings convey the wash at night...but this place is very much alive. Flowers glow with an incandescent color. Sundown brings relief from the desert heat, and nocturnal creatures emerge from their hiding places in search of food and water. People pick up a clue card that describes the wildlife that animates the desert from dusk to night. As

one McDowell Mountain Regional Park tour guide warns, "Everything in the Sonoran Desert either sticks, stings, bites or eats meat. There are quite a few things you don't want to touch, and in the dark it's harder to discern between safe and scary."

Upon entering the night nook, Audio Spotlight directional speakers bring the room to life with the distinctive sounds of nocturnal life. Can you guess who is here? Perhaps it is a rattlesnake making its way across the path; a gila monster hunting for prey; bats heading for the nectar of saguaro flowers; cactus pygmy owls or nighthawks calling from their perches; a mother bobcat walking through the vegetation with her kittens; or a javelina foraging for prickly pear fruits and roots. The audio track alternates between audio alone and audio with the sources of the sound revealed—sculptures "invisible" before light up in synchrony with the sound clues. Stations allow people to "see" like a bat (echolocation) or like a snake (infrared detection).

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## The Wash: Water in The Desert

*He had waited until the flowing washes slowed to a trickle before venturing out... Because creosote and other plants released their pungent scents in the air after a rain, the smell of his dry coat would be negligible.*

From *B'añ Ce:gig Ban—My Name is Coyote*  
by Angelo Jaoquin, Jr.

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### **Flood!**

From the nighttime wash, people approach a video “tunnel” and hear the distant sound of a flash flood (much like the sound of rolling thunder). Despite low annual average rainfall, intense localized storms can drop a year’s worth of precipitation within a few minutes. Sheets of water wash across the land, filling washes and riverbeds in minutes, the flow carries along sand, rocks, nutrients, and plants, carving new stream channels and eroding stream banks.

People are warned on the dangers of going into a wash during a rainstorm—a thunderstorm can create a flash flood very quickly and carry away everything in its path. Generations of people have learned to respect its power and live with periodic floods. A high-definition, time-lapse video of a gradually growing stream appears on both sides of a tunnel-like space. People experience a ferocious, fast-moving wall of water rushing through the wash after a monsoon. Visuals

continue onto the floor, and react to people’s locations to create a feeling of actually standing in the flood. As major flows often reach the desert at nightfall, it is an event most people will never experience in real life.

### **After Rain**

What happens after the rains? There are many signs of life people can learn to identify in the wash: dens, tracks, songs, etc. When monsoon water comes rushing down, little nooks and crannies are created in the walls of the wash. Here, animals like bobcats, coyotes, packrats, mice, and javelinas can dig farther into the soft soil to create caves and dens. For most of the year, Ironwood trees are a metallic gray with grayish leaves, but in spring, after soaking in the winter rains, they display cloaks of tiny purple flowers. Even after its death, remnants of the Ironwood tree can remain standing for a thousand years. Trees along washes provide food, or perches and homes for birds, who fill the air with their songs. From large-scale zoetropes that reveal the activities that created

the holes and animal tracks in the banks, Pima stories like that of the hummingbird who brought rain back to the people, to actual footage of secret watering holes in the Preserve, to ambient songbird audiotracks and “Who is singing now?” ID stations, the wash comes alive.

The wash is not only a home, but a corridor for traveling wildlife—a likely reason why, over a thousand years ago, the Huhugam used these washes as paths; and after a flood relics of human presence may be found in these passageways—Huhugam pottery shards, dart points, and petroglyphs. The locations of these petroglyphs are kept secret for their protection. They are rooted in places held sacred by the Huhugam, and connect our current and future generations to the spirit of this desert home. What kind of artifacts from the city are collecting in today’s desert washes?

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## The Wash: Water in The Desert

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### **Water Finds a Way: Stormwater Map**

Stormwater flows over the desert and either seeps into the ground or is channeled into small washes, eventually emptying into the rivers. In natural desert areas, stormwater follows these natural watercourses. However, cities were built over desert's natural drainageways, using systems of gutters, streets, and networks of underground storm drains, culverts, and washes to channel untreated rainwater into rivers, washes, and basins. Otherwise, our cities would experience serious flooding with almost every rainfall.

Posing the question, "Where does your stormwater go?" the map shows how the desert's major drainageways (washes, rivers, etc.) are connected to the stormwater management system of the cities of Scottsdale and Phoenix. People learn how cities attempt to do the work of natural drainage systems. They all ultimately conduct stormwater to the Salt, Agua Fria, and Gila Rivers. This water is not sent to a treatment plant, so all the pollutants and debris from our streets and storm drains go directly to our washes and

rivers. How do city pollutants affect wildlife dependent on temporary pools of storm water?

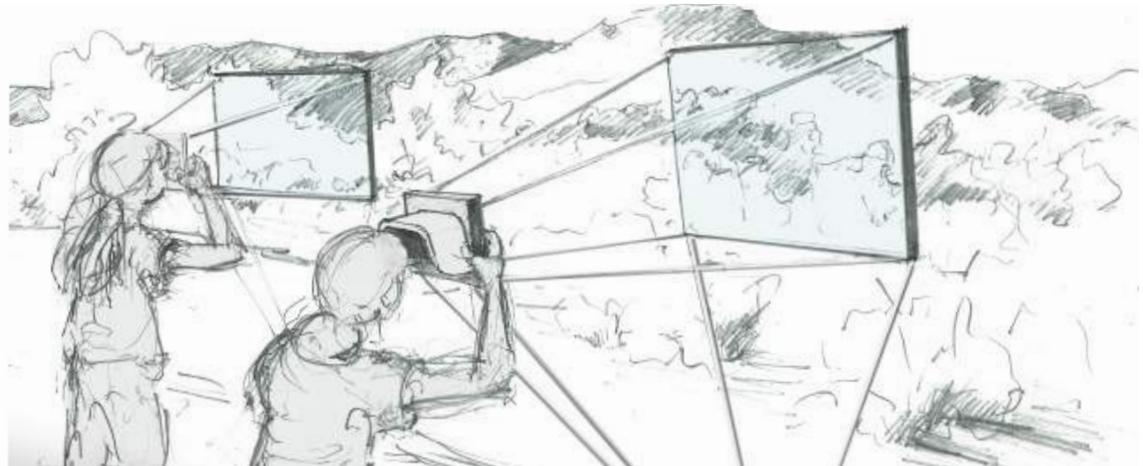
### **Time Windows**

Time Windows offer time-lapse views of the Preserve over a 24-hour period, and over the course of a year. After the rains, the desert seems to wake up almost instantly. Time Windows looking out onto the wash capture this phenomenon through time-lapse video superimposed on the real view. The Sonoran

Desert's two rainy seasons, one from December-March and the other from July-September, are on full display within a few minutes.

### **Ephemeral Pool (Seasonal Rain Pond)**

After the rains, ephemeral pools appear in places once arid and dry. In the desert, organisms must often wait, know how hold onto what rain does fall, and get down to business when opportunities do arise. Here, people have a chance to see these adaptive



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## The Wash: Water in The Desert

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strategies at work. Fairy shrimp eggs can withstand long periods of desiccation and can remain as encased embryos—dehydrated and inactive in the dried mud of pools for years and sometimes decades. Spadefoot toads can spend weeks underground, coming to the surface at night time after a heavy rain so that they can feed. They do not automatically attempt to reproduce every year, but stay dormant underground until sufficient rain has fallen to make the investment of energy worthwhile.

### **Create Your Desert Avatar**

In this digital game, people learn about the many unique adaptations of desert animals, and create their own desert avatar by combining traits into a super desert creature. Users might choose: an external skeleton to reduce moisture loss (beetle), an expandable tail to store food reserves (Gila Monster), the ability to reabsorb water from one's own waste (Roadrunner), the power to lower one's body temperature (Turkey Vulture), the ability

to convert seeds into water (Kangaroo Rat), digestive systems that can process sharp objects like cactus spines (Jackrabbits), or the strength to dig extreme depths to escape the heat (Hairy Scorpion).

Users can compare how their avatar will fare in competitions against humans or other users' avatars in various desert challenges. At the end of the game, users can use their avatars as a personal profile, print out as paper cut-out/sticker or past on their social media accounts.

### **Live Animal Enclosures**

Collaborating with the Phoenix Herpetological Society, the Wash gives people an opportunity to observe desert reptiles, invertebrates and insects. Animal-friendly enclosures transition from indoor to outdoor spaces. Trained Scottsdale Community College students and guides answer people's questions about resident tortoises, snakes (Rattlesnakes, Kings, Red Racers), Gila monsters, lizards, scorpions, and tarantulas.

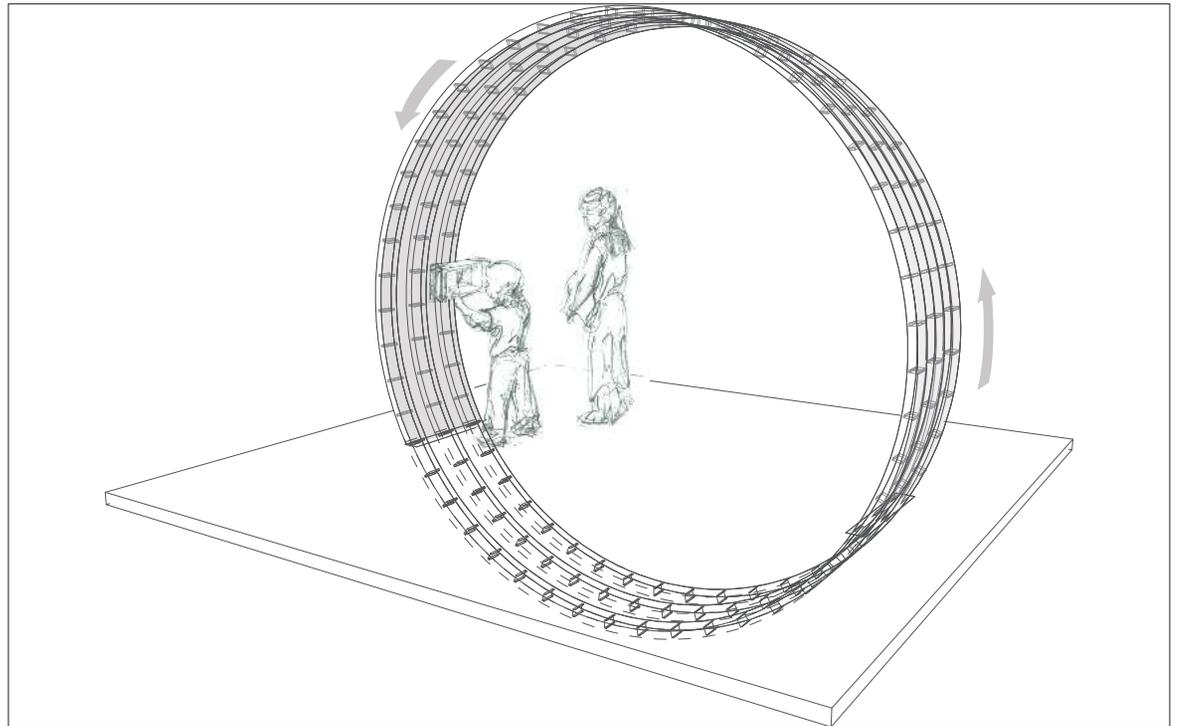
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# The Wash: Water in The Desert

## Zoetropes



Three-dimensional zoetropes



Large-scale, three-dimensional zoetropes animate slices of desert life.

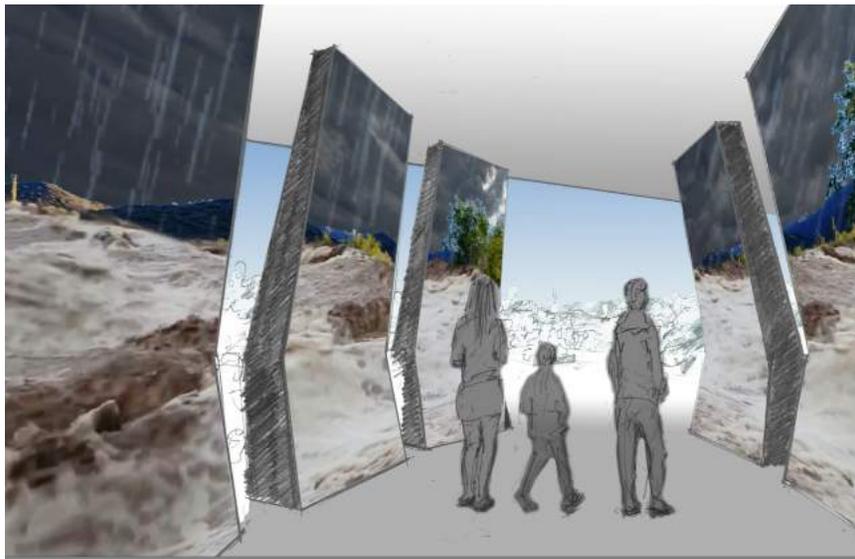
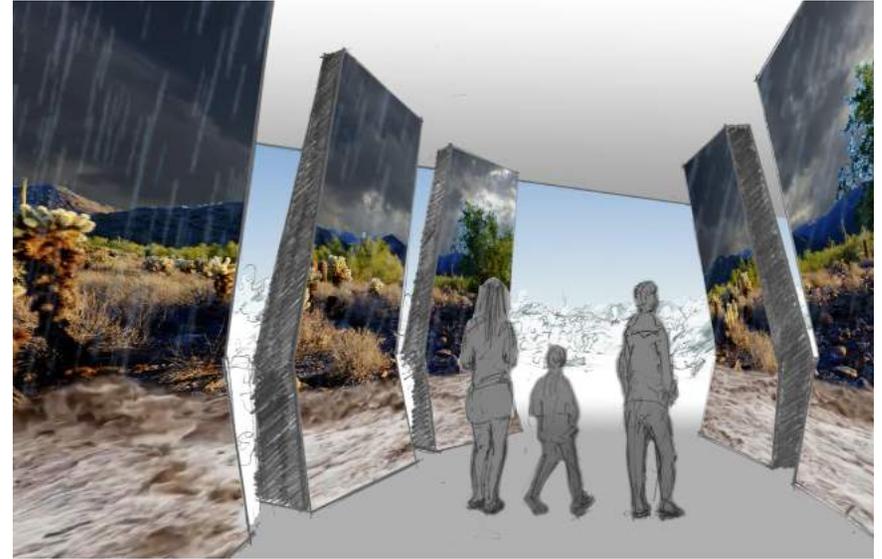
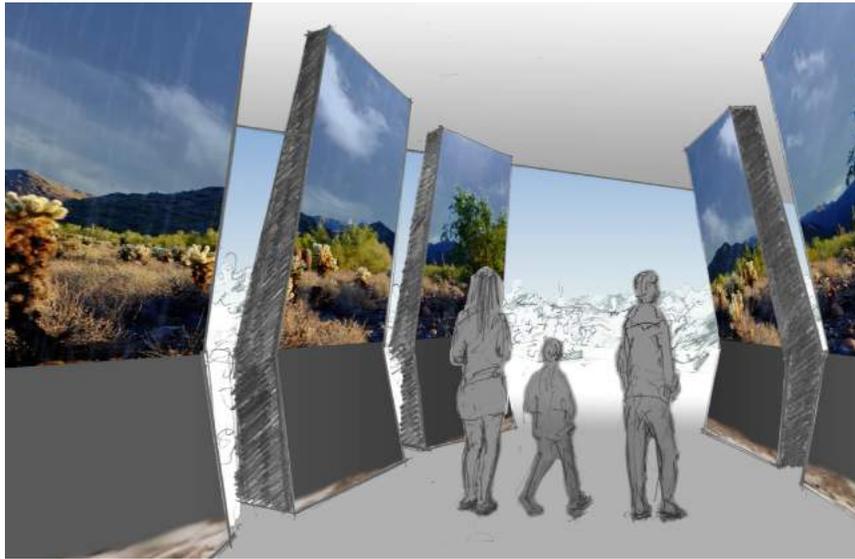
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## The Wash: Water in The Desert Flood!

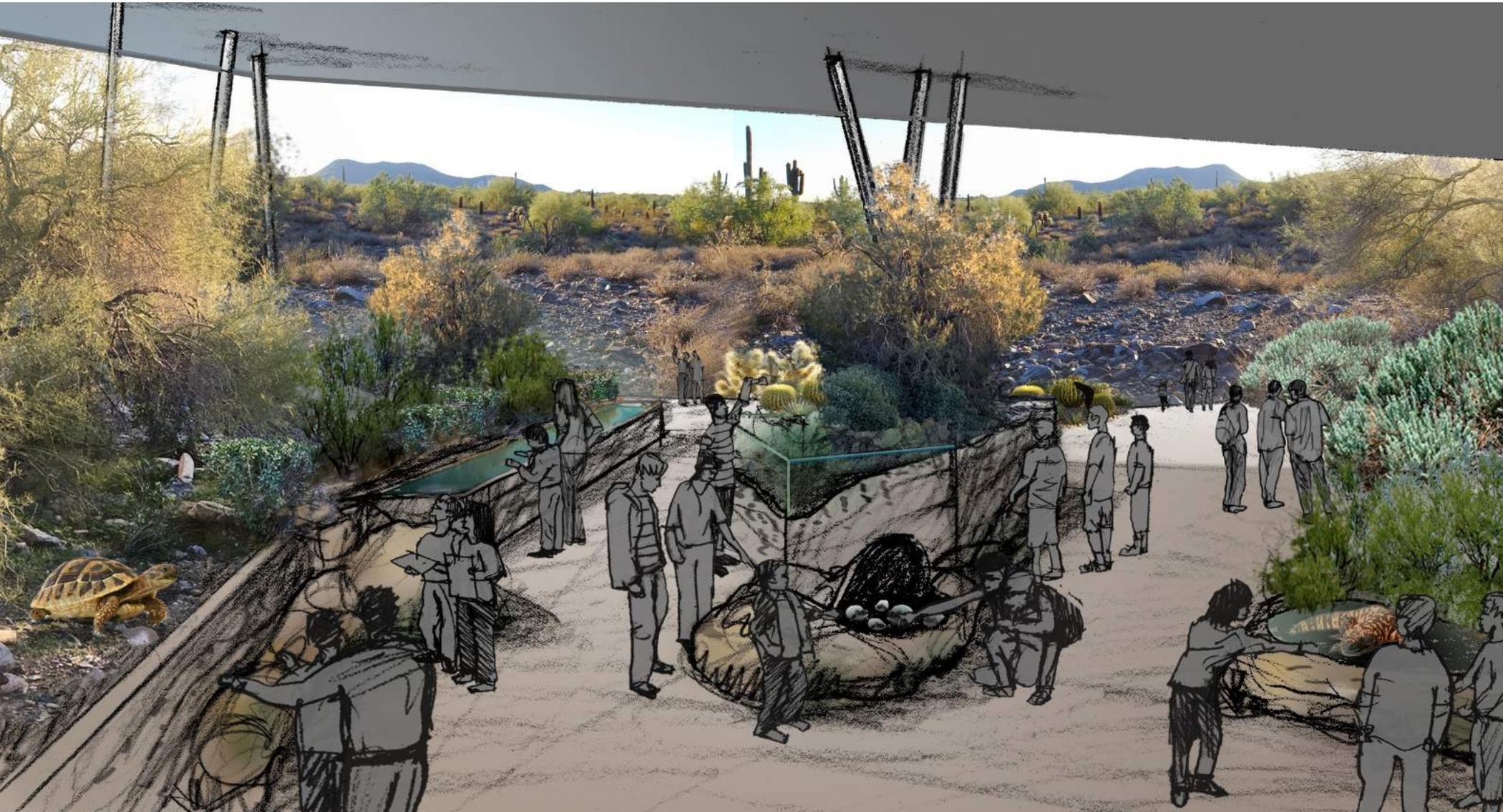


# The Wash: Water in The Desert

## Flood!



# The Wash: Water in The Desert



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# Saguaro Sundial

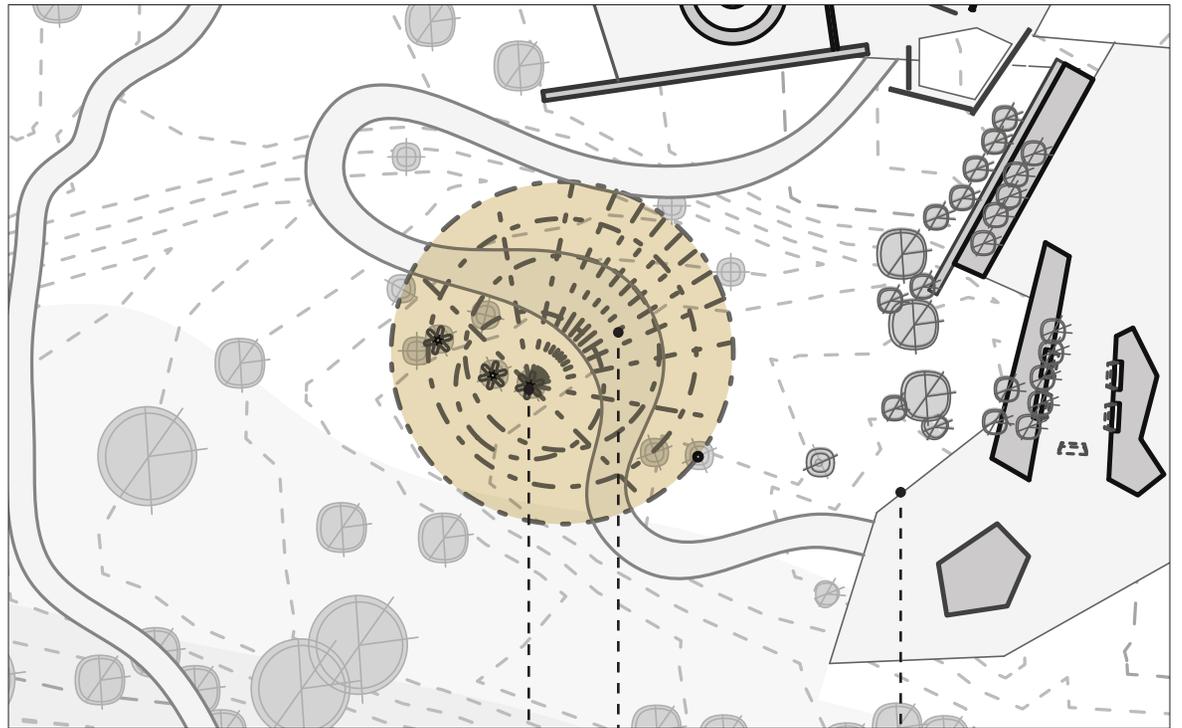
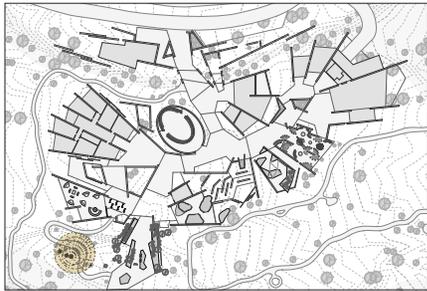


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*If it takes you a hundred years  
to grow your first arm  
for how long do you feel  
the sensation of  
craving something new?*

From "Questions for a Saguaro"  
by Alison Hawthorne Deming

# Saguaro Sundial



**Saguaro Sundial**

**Saguaro Outlook**

**Saguaro See and Touch Trail**

Listen to a Saguaro  
Saguaro Mysteries  
Spirit of the Sonoran Desert

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## Saguaro Sundial

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### What is this place?

This is where the saguaros (*Carnegiea gigantea*) live. A 24-foot saguaro towers over this part of the Preserve—standing sentinel on this landscape for nearly a century, it may continue to do so for another hundred years. It is the view that most people associate with the American West, but these iconic plants grow only in the Sonoran Desert, within that frost-free zone between sea level and 4,000 feet (or higher on warm south facing slopes).

### What don't we see?

The saguaro is a keystone species—a centerpiece of extended ecological connections. A single saguaro can provide sustenance, protection, shade, raw material to a host of organisms in its range: bacteria, insects, birds, bats, cold- and warm-blooded animals, and people. Its flowers open only at night, attracting nocturnal bats and early morning bird pollinators. (This behavior is shifting more towards day pollination, however, due to the higher bird population in the northern Sonoran Desert versus the

subtropics where the saguaro originated.) Its body hosts a variety of birds, who excavate nests inside its pulpy flesh. At times this flesh can provide water to thirsty animals, or food for bacteria. In death, the saguaro is an oasis for insects and other arthropods, providing food, moisture, and shade.

### What can we learn from living in the desert?

In a harsh desert environment, it becomes clear how important adaptation and ecological connections are to the health of an ecosystem. In Arizona, saguaros are increasingly pollinated by birds rather than bats. One result of this is that the nocturnal saguaro flowers have begun to stay open into the morning hours, when birds are active. It is a dance between species that helps them thrive in this setting. By following one species' extensive connections we can see how the loss of one can have a ripple effect on other species and even the environment itself.

### What future do we want to create?

The saguaro is not only an iconic symbol of the Sonoran Desert, but an elegant example of how intricately connected life is on earth. As we think about our future in the desert, and our connection to these landscapes, the saguaro is a reminder that change never occurs in isolation.

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## Saguaro Sundial

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### Interpretive Experiences

#### Saguaro Sundial

A walkway leads people to a stand of large saguaros within the Center footprint. As the path arcs around a particularly tall specimen, lines of declination are inlaid in the path surface, marking the hours from sunrise to sunset. Visitors are walking through a giant sundial, for which the saguaro acts as the gnomon. The installation is inspired by the Huhugham’s sunwatch stations and their use of the sun’s movements to measure time. While sundials mark hours in a day, sunwatch stations mark annual solstices—the sun would come up and cast a shadow, or illuminate a rock with light, to hit a mark when the solstices arrive. With both, people are witnessing the rotation of the earth.

Near the cactus is a structure of cutouts, precision-angled so that, at the appropriate time of day, a shadow appears in the shape of an animal interacting with the cactus: bats, wrens, tortoises, squirrels. In addition to the shadow image, hour lines are accompanied by a line of simple text describing the interaction. As people walk along the sundial, a narrative is composed that depicts “the life of a saguaro” and the many organisms that depend on it.

Stimulated by the fading sunlight, its flowers first open in the early evening. By midnight, they are fully open, attracting night-feeding bats and early morning bees. By noon, in the heavy heat of the day, the flowers close again. Owls sleep in their nests, and hawks

# Saguaro Sundial



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## Saguaro Sundial

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perch atop its tall limbs, scanning for prey. As saguaros fruit, people harvest them using long poles to knock them down from their tall perches to make wine, jelly and candy; while animals like the iguana and kit fox wait patiently for them to fall to the ground. Each fruit contains about 2,000 tiny black seeds. Often looking for respite from the heat, foragers might find shade under the branches of a desert tree. Their droppings deposit the next generation of seeds exactly where they need to be—under a nurse plant. As the saguaro continues to grow, its much older nurse tree may die.

Many sundials bear a motto to reflect the sentiments of its maker (eg. “Time brings all things”). The Center may consider having a motto contest that reflects life in the McDowell Sonoran Preserve.

### **Saguaro Lookout**

An elevated lookout point gives people a rare opportunity to “rise up” and look at a mature saguaro at the crown level.

### **Saguaro See and Touch Trail**

As people reach the end of the sundial, the walkway u-turns, and the second path looks at why this plant is so resilient here, and why it has become synonymous with the American desert and desert living. Outdoor-friendly interpretive stations and interactives allow people to touch both real items and reproductions. Topics of exploration: Morphology - eg. a cross-section of the saguaro’s pulpy body, expandable vertical ribs, waxy skin and downward pointing spines, extensive but shallow root system, callous scar tissue.

**Morphology:** eg. a cross-section of the saguaro’s pulpy body, expandable vertical ribs, waxy skin and downward pointing spines, extensive but shallow root system, callous scar tissue;

**Growth rate:** from 1 to 1.5 inches in the first eight years, to flower-production at 35 years, the appearance of branches at 50 to 70 years, and arms at around 100 years. At 125 years, a saguaro is generally considered an adult.

**Reproduction:** from flower to fruit to seeds. In late April through early June, the tops of the saguaro’s trunk and arms sprout large white flowers. To develop into fruits, the flowers must be pollinated when they open at night and before they close the following noon. While a saguaro can produce some 40 million seeds during its lifetime, only a few will survive to become a seedling and grow into adulthood.

### **Spirit of the Sonoran Desert**

How a native plant sustains the spirit of people living in the desert:

**Marking history in the desert:** This plant—which only grows in the Sonoran Desert and can live up to 200 years—was chosen to hold the history of the Akimel O’odham (“River People”). They annotated oral histories by using an Oos:hikbina (O’odham for “stick cuts upon”), also known as a “calendar/talking stick”, made from a dried rib of the saguaro. The recorder and keeper of the Oos:hikbina etched dots, small notches, V-shaped cuts, and deep straight lines across the stick to

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## Saguaro Sundial

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represent years, and symbols were often painted with natural pigments of blue soot and red clay to document historical events. [This story/display is fully contingent on approval by members of the Salt River Pima-Maricopa Indian Community.]

**Building in the desert:** The strong, woody ribs of the saguaro were used to construct homes of the Huhugham; tools, fences, splints.

**Breaking bread in the desert:** Foods made from the saguaro bring people together as family and community: ceremonial wine, jelly, and candies from the fruit; cakes, oil, and a peanut-butter like paste from its seeds.

**Connection to the desert:** The saguaro has become a symbol of this place in the literary and visual arts, ritual, and music. Viewscopes point towards various points around the Preserve, and are connected by a digital code to a selection of music, poetry or personal memories.

### Listen to a Saguaro

Using acoustic sensors, people can listen to the internal movement of air through a saguaro. Pores open to capture carbon dioxide, and in so doing lose water. Roots take up water from the ground, which goes up through a series of tubes (the xylem). Pit membranes (two-way valves) connect these thousands of tiny tubes. The drier the soil, the more tension builds up in the xylem until an air bubble is pulled in through the membrane and creates a popping sound. For some plants, these embolisms are deadly (as with human blood vessels) because the gas bubbles interrupt the flow of water. Plant hydraulics might be the piece of the puzzle that tells us which species are going to live and which are going to die with climate change.

### Saguaro Mysteries

People are introduced to the current mystery of how saguaros carry out photosynthesis when they have lost multiple genes connected to photosynthesis. ASU scientists are exploring this very question.

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# Saguaro Sundial



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# City: On “The Edge”

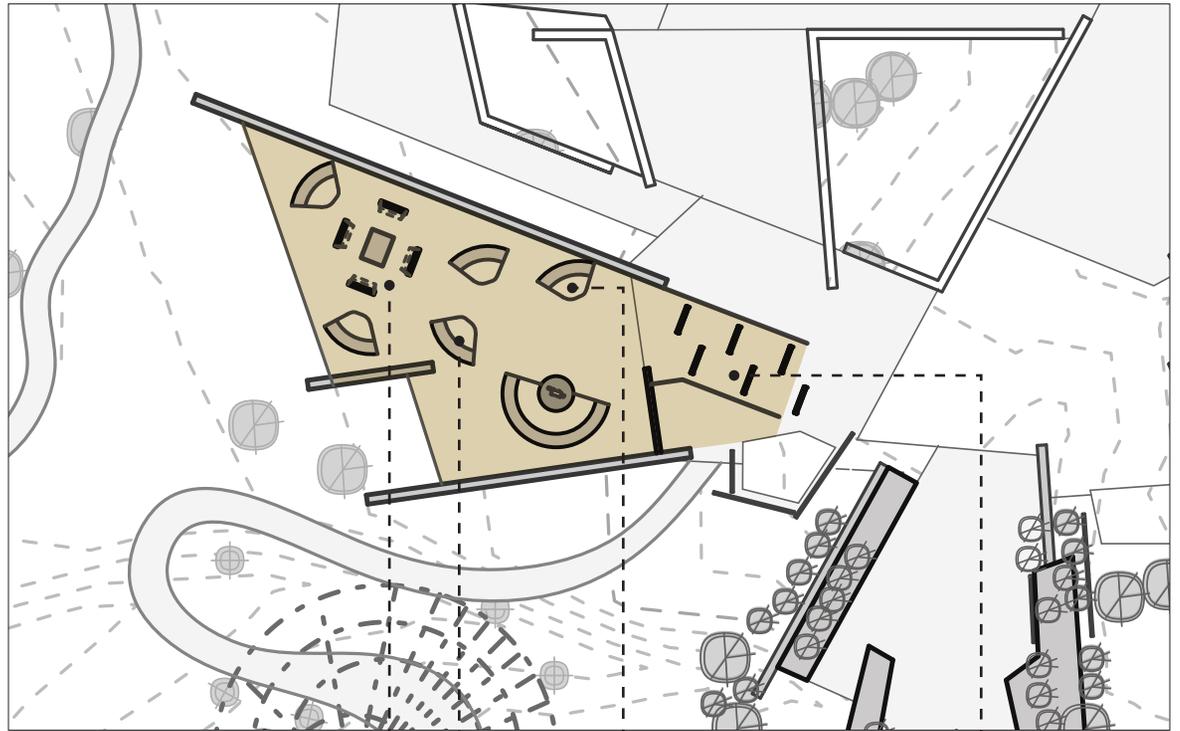
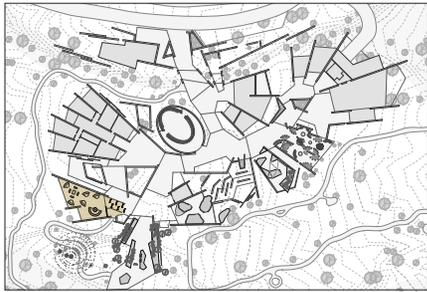


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*Having barely escaped death today  
you cannot judge too harshly  
the opportunistic forager  
seizing warblers from feeders and nests  
traveling downhill or in danger flying  
a few seconds as a bronze gloss  
you must be prudent if one races  
slow motion in front of your moving car  
only to dart into brush  
for the next thing you know  
the lamp is lit and the eyeglasses await  
the roadrunner as the reader*

From "The Roadrunner"  
by Jane Miller

# City: On "The Edge"



**A View to the Future**  
Tomorrow Block by Block  
Desert Cities Around the World  
Global Conversations  
Biomimicry Station

**Oasis**

**A Changing Landscape**  
Huhugham Canals  
In One Generation

**The Edge**

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## City: On “The Edge”

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### What is this place?

Sometimes the city “edge” feels like a line in the sand—a perimeter around the oasis we built. Like all life in the desert, we seek refuge from the heat and relief from our thirst. From the first people who reclaimed the desert, we learned to channel the rivers and irrigate our fields. Within this hot, arid environment, we found its green, riparian edges. When that began to run out, we dug into the ground to find ancient water sources, and when we feared that would not last, we recycled it. We are a city in the desert, a community of over a million, but perhaps the city’s edges aren’t the hard borders we think they are. The city is, in fact, in the desert and the desert is in the city.

### What don’t we see?

The Valley has expanded its footprint in the desert quickly—from 17 square miles in the mid-1950s to 517.9 square miles today—to become one of the largest urban settlements in the United States. Although man-made, it is a habitat within the Sonoran Desert ecosystem, and as such, shares a stake in the Desert’s

ecological future. Drawn to this valley’s beautiful but often hostile setting, people turned to technology to create a more livable environment. Canals, dams, and hydraulic pumps allow us to access water when and where we need it. Air-conditioning helps us cope with the extreme heat. Cars and paved streets permit us to travel great distances comfortably. With each innovation, “the desert” and its ecological systems seem farther and farther away... but they are all right here and so are our footprints on them: heat, water-scarcity, pollution, invasive species, as well as stewardship.

### What can we learn from living in the desert?

Desert flora and fauna have successfully evolved with the Sonoran Desert over thousands of years. The combination of heat, aridity, seasonality, and geology unique to this place has given rise to a slowly evolving, dynamic, equilibrium, based on specialized biological adaptations and symbiotic relationships. People migrated here much

later than their non-human desert neighbors, and as they did they found remarkable ways to adapt to the harsh environment. Through observation, ecological knowledge, and cultural innovation, generations of people have found ways to live with the desert overtime. Technological advances enabled us to not only live with the land but to change it, and test the boundaries of what is possible in the desert... before it becomes something other than the desert that drew us here. Has the optical illusion of the city’s hard edges begun to weaken? Do we feel the desert in the city yet?

### What future do we want to create?

When asked for his thoughts on sacred places in the desert, Shane Anton of the Salt River Pima-Maricopa Indian Community replied, “Anything of cultural significance

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## City: On “The Edge”

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begins with the people; if it’s important to them it is sacred.” This may be equally true of a church in a small town or a mountain peak in the McDowells. The tomorrow we want to create must begin by asking, “What is important to us?” As we move forward to identify and address these needs in the 21st century, we are reminded of the history and ecology of this place, the interconnectedness of all things and the implications of our actions on the future. As the earth’s climate becomes warmer and drier, much of the world will turn into desert. If we can learn how to live sustainably here, other parts of the world can benefit from our knowledge and learn to adapt to new conditions. While the word “Preserve” makes us think of the past—it may, in fact, hold our future.



*McDowell Sonoran Land Trust and the City of Scottsdale took thousands of people on hikes into what would become the Preserve in order to create awareness of what would be protected, and why. Courtesy of Joan Fudala, 1995.*

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## City: On “The Edge”

*One’s options in this world are as vast as the horizon.... Yet we must choose each step we take with utmost caution, for the footprints we leave behind are as important as the path we will follow.*

From *Dance of the Chupacabras*  
by Lori R. Lopez

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### Interpretive Experiences

People explore the idea of the city as desert habitat. It is hot and arid. It has microhabitats that support a diversity of lifeforms that are deeply inter-connected, channels that move water, and corridors for migrating wildlife. It adapts to changes and evolves over time. The City presents the tangible and intangible human footprint: made-made forms, shifting landscapes, and the meanings we’ve imparted on our past and future here.

#### The Edge

Often the city and the desert are spoken of as opposing conditions: developed vs. undeveloped, unprotected vs. protected. The entrance into the City challenges this idea of a hard city-desert “edge”. A series of visually-arresting, aerial images line the entryway as paired scrim. The scrim are positioned to seem visually unbroken, but upon approach, people find they can “walk through” the illusion.

Each set of scrim illustrates the city’s connection to the larger desert ecosystem, through: 1) water flow; 2) heat; and 3) native and exotic species ranges. As people cross the threshold, they consider such questions as: How far does our water travel and how long does it take to reach us? What is hot? How far do we typically go by foot or by car? How do these answers compare to cities on the coast, mountains, or plains?

#### “Oasis”

After passing through the Edge, people encounter Oasis. We are the designers of our habitats. As flora and fauna evolved ways of adapting to desert heat and aridity, so did people. By turning to our cultural toolbox, we learned to shift the odds more in our favor. The Roosevelt Dam was built in 1911, creating the largest artificial lake in the world. President Theodore Roosevelt predicted that such great works would turn central Arizona into “one of the richest agricultural areas in the world.” It seemed that a lifestyle of sunshine, citrus trees and grass was possible here after all.

In 1935, the “Valley of the Sun” slogan was coined by a local advertising agency for the Phoenix Chamber of Commerce. The introduction of the air-conditioner made this transformation complete, and in tandem with a post-war home construction boom, the city’s population increased 311% by the 1950s. The potential to expand the city grid seemed infinite. Comfort and convenience were achieved through technology; and

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## City: On “The Edge”

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affordable home construction and political will helped propel the Valley’s image as a twentieth-century American oasis. Decades of exponential growth also raised, however, environmental concerns. Public awareness around ecological issues spurred movements to protect and conserve our natural resources. The creation of the McDowell Sonoran Preserve was one such movement, preserving the land for future generations while also framing the desert ecosystem as a vital asset.

Against this backdrop of urban growth is the reality that water is a limited resource; and technological adaptations and complex choices have been, and continue to be, made to live here. This story is told through a series of vivid and charming vignettes based on the idea of home—the private “oases” we’ve built in the desert—alongside the hard numbers of water availability and population growth. Using local residential forms: from adobe houses to bungalows, mid-century pre-fabricated homes to retirement communities and townhouses, intimate and evocative

installations (animated by sound, holograms, scents, etc.) are attached to first-person accounts of life in the Valley. For example, the memory of family road trips in the dead of the night before air-conditioning, sleeping on the porch with hanging wet sheets, growing citrus in the backyard, childhood summers in the swimming pool, and “lawns” made of glued-down pea gravel. The installation depicts human adaption to the desert environment through a visual history of urbanization: the policies and technological adaptations (eg. air-conditioning, automobiles, hydraulic pumps) that made growth possible on the one hand, and our responses to an increasingly man-made environment over time, on the other. Period house models depict both original forms and green modifications.

The overall effect will show how local wisdom can find its way back over time in new forms, and how cultural shifts can spark new innovations. What will a “green” Scottsdale home be like in the future? The result captures both our nostalgia for the past and our hope

for the future, providing slices of time that invite conversation.

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## City: On “The Edge”

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*Where there's a river,  
that tastes of direction.*

*Where there's an orchard,  
that says survival.*

*Where there's a desert,  
that changes everything,  
as if earth hadn't wanted  
to fill only her own need.*

“Desert” by Patricia Hooper

### **A Changing Landscape**

As people examine each house, they unlock and reveal the larger ecological and cultural context of each “oasis.” We have lived on earth for 200,000 years; but we have altered the planet more since 1950 than in our whole prior existence. Since 1950, the Phoenix metropolitan area has expanded by over 500

square miles and increased its population by 1.4 million. We are more, and consume more than ever. In the American Southwest, the consumption story is essentially about water. Generations have sought water security, again and again, in the desert, from the Huhugam canal builders to the Phoenician hydraulic masters; and we gained it (for a time) through technological achievement and political will power. We are no longer solely dependent on where we live for the things we need. The Colorado Arizona Project waters travel more than 300 miles through mountains, over plateaus, and across deserts to reach our city faucets. How many Colorado Rivers do we need to maintain our current rate of growth? What kinds of individual actions and policy measures can make a difference? What is the larger environmental context for our Oasis? While each house is at first blush self-contained, it is a habitat nested within larger systems: the city, the web of desert life, the water cycle, etc. Over time, we have been in dialogue with these systems.



**1915**



**1962**



**1994**

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## City: On “The Edge”

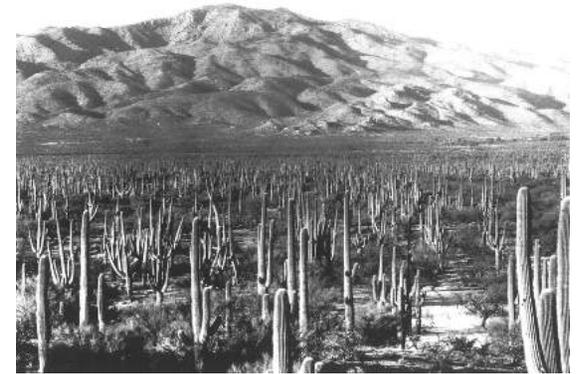
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### Reclaiming the Desert

Like all life forms in the Sonoran Desert, people also followed the water. They settled at the convergence of six rivers—the Salt, Gila, San Pedro, Santa Cruz, Verde, Agua Fria. From CE 1 until 1450, the Huhugam reclaimed and farmed these desert lands for cotton, corn, agave, squash and beans. Famously known for engineering “the largest prehistoric irrigation system in North America”, their canal systems (at least 1000 miles in the Salt River Valley alone) brought water to over 100,000 acres of farmland, which in turn produced enough food for tens of thousands of people and served their villages along the banks of flowing rivers. They also devised structures and techniques for sustaining crops and communities on alluvial fans, far from springs or permanently flowing water.

There is evidence that this region has experienced climate change before. Over time, large numbers of climate refugees migrated out of the drought-stricken Four Corners

region towards the Huhugam’s settlements in the late 13th century, perhaps propelling the Huhugam to move into less dispersed and more centralized communities. They became increasingly more urban. However, while they found security in these urban centers, population growth and a narrowing diet led to a decline of able-bodied workers. They could not maintain or scale down the extensive and sophisticated hydraulic system around which this lifestyle was built. It is speculated that they were forced to abandon their cities and return to a more sustainable way of life in the desert. Subsequent generations of the Akimel O’odham (“River People”) adapted their irrigation culture to riparian habitats, while the Tohono O’odham (“Desert People”) practiced flash flood farming technique that required precise timing with the annual Sonoran monsoons.



1935



1960



1998

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## City: On “The Edge”

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### “In One Generation...”

The Salt River Pima-Maricopa Indian Community has described its relationship to the land as one of respect for future generations, to whom the land belongs. It is a concept echoed by influential environmentalist Wendell Berry, “...the world is not given by his fathers, but borrowed from his children.”

Desert “memoryscapes” – a landscape diorama, desert object, or photograph associated with personal stories of ecological change witnessed over a generation and our responses to them – show the meaningful connections we make with our environment over time. We can see how the region has changed over the decades, and the notable acceleration of this change in recent years. Soundscapes recorded in the desert over a span of forty years can describe urbanization through sound and visual spectrographs—a story from the desert’s point of view. The phenomenal expansion of the urban streetscapes, the falling water line in Lake Mead, and other changes to the landscape are

documented through individual testimonials, photos and other personal memorabilia.

The Center can continually update the stories presented here with crowd sourced content. Is the City looking more like the desert? Are wildlife corridors intersecting with roadways? Where are birds singing the loudest? What was the Preserve like when it was first created? The style of presentation relates to the stories and may be as diverse as the storytellers. Various forms of storytelling are possible: oral history, visual art, music, soundscape audio, poetry, etc.

The rate of change is also connected to the idea that the desert can operate on time scales different from our own. It is not inconceivable that the saguaro we passed on our hike will outlive us by a hundred years. The watershed ensures the life of our rivers through its slow release of water. Without them, the waters come down too quickly for the system to sustain us. Time is important in the desert; unappreciated, we run the risk

of uncoupling the ecological synchrony that underpins the whole system.

Man’s relationship to desert time can be presented through a “time-lapse” photo series of people with the same desert landmark. A young child stands by a tall saguaro in her yard; in the next photo, she has visibly matured, but the saguaro is seemingly unchanged. As we share this home in the desert, our ripple on the land may seem short-lived, but in desert time, it has a long-term impact.

By 2050, a projected 66% of the world’s human population will be living in cities. How does urban development alter the desert ecosystem; and how are we, in turn, altered by these changes? Over time, there will be fewer animals living in the wild because there will be less wild to live in. Cityscapes are fast-changing and varied, creating both negative pressures for many species, but also opportunities for a few. Those that adapt to the city will be different from their brethren in

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## City: On “The Edge”

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the wild... that is, more “urban.”

### **A View to the Future**

#### **Tomorrow, Block by Block**

Tomorrow, Block by Block demonstrates how individual decisions can have a collective impact, and how policies can change/influence individual behaviors. Players work together to ensure sustainability for a virtual city. Users sit at a large digital table with wooden building blocks that allow them to design a city block (building up and out) using augmented reality. They can choose to apply architectural and landscaping principles found in many desert cities and/or green strategies, such as: narrow streets with building overhangs, courtyards, tree-lined avenues, xeriscaping, or technologies like solar panels, light rail, green building materials, water harvesting techniques, etc.

Players respond to various challenges as they build (increased temperatures, flooding, population growth, etc.) and select policy options. Users see how their urban planning strategies (dense centers versus sprawl,

public transit versus automobiles) and policy decisions (agricultural, industrial, or residential developments) impact daily conditions and periodic challenges of drought, flooding, and high temperatures. Users can see how others have “voted” on these policies and how it changes available options. They get a “health and happiness” index to see if their designs are impacting the human and non-human city dwellers favorably. In addition, they can see how urban and transportation infrastructures impact natural infrastructures (based on the current research conducted by The Nature Conservancy).

The game can be updated to introduce real policy ideas being considered by local municipalities and environmentalists. Players can compare their city block designs to the rest of the city, and discover the least and most popular strategies among all users. At the end of the session, users can add their block to the evolving desert city. How does the newly-designed city compare to other desert cities?

### **Deserts Around the World and Their Cities**

A visual tour of desert cities around the world explores their differences and similarities to cities in the Valley. It shows how other cities have responded to similar issues and challenges, and the cultural changes and technological solutions they have invested in.

### **Biomimicry Station**

The Sonoran Desert has the greatest diversity of plant growth forms—architectural strategies for dealing with heat and drought—of any desert in the world. This habitat richness leads to high biodiversity, as well as, a potential source of ideas for today’s sustainability challenges. Indian Bend Wash is an example of how the citizens of Scottsdale chose to work with nature’s design rather than oppose it by engineering concrete channels to mitigate flooding.

Since plants are rooted to a single spot on the earth, they need to be able to withstand weather changes over time. Desert plants

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## City: On “The Edge”

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may serve as particularly helpful guides as we attempt to adapt to a hotter and drier planet. We'll have the best chance to learn from them if we protect the habitats where they are found.

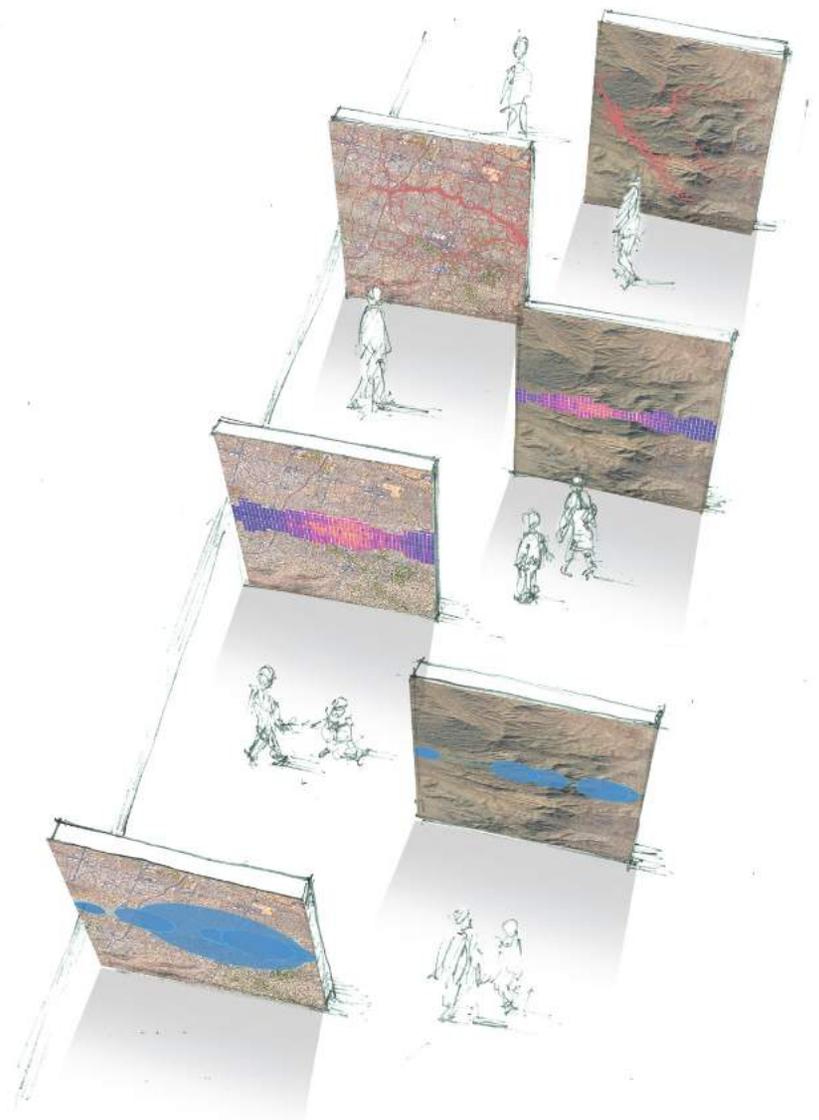
Through a digital biomimicry game, people match desert plant adaptations to problems scientists and engineers are currently attempting to solve. For example, saguaro stomata open and close to collect carbon dioxide, but as the pores open, the cactus loses water. Because of this, the stomata are closed in the daytime and open during the night. In Doha, the Minister of Municipal Affairs & Agriculture Building, mimics the skin of the saguaro: hundreds of smart shades open and close depending on the intensity of the sun, thereby saving precious energy.

### **The Desert We Call Home: Global Conversations**

Climate change affects the world, which is becoming more arid overall. The global interchange is two-way: what we can learn from cities and cultures in other arid regions and what we can teach places that will become more arid in the decades ahead. Phoenix was built in one of the hottest and driest places on the planet, and as such, it is ideally positioned to deal with climate change.

Through its educational partnerships with Scottsdale K-12 schools, the Desert Discovery Center works with students to explore how people live in deserts around the world and create a video database of global conversations. Facilitated by the Center, student questions are posed to citizens of other deserts, who can videotape or Skype in their answers. A virtual exchange program may be established between two schools for a longer-term relationship, as part of a designed curriculum.

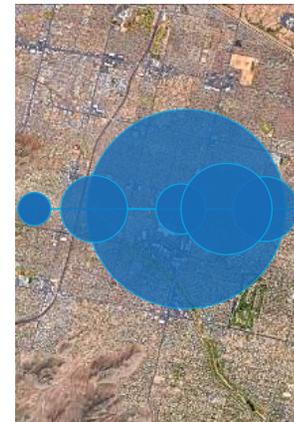
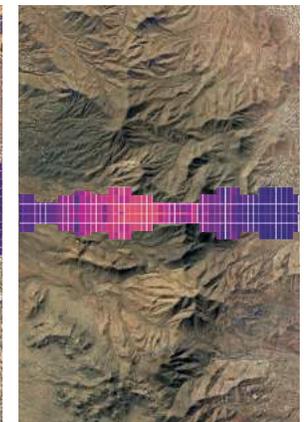
# City: On "The Edge"



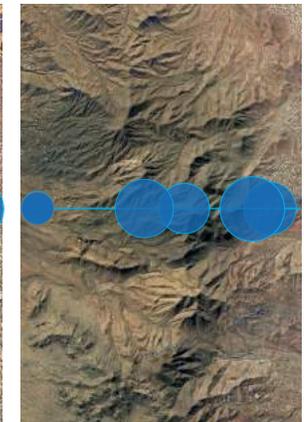
ANIMAL TRACKING



HEAT MAP



DISTANCE OF WATER



# City: On "The Edge"

