

Slide 1



Slide 3



As we all know ...AZ's population is projected to grow significantly in coming decades. The complexity of issues facing wildlife in the County are compounded by the fact that neighboring counties to the south, north, and west also face unprecedented urban growth and development rates as part of the "Sun Corridor" within the context of North American economic development (Arizona State University 2009).

Slide 4

- POPULATION GROWTH
 - greater than 14 million by 2050 (Arizona Department of Transportation 2010a, US Census Bureau 2011)
- TRANSPORTATION INFRASTRUCTURE
 - BQAZ
- UTILITY INFRASTRUCTURE
 - alternative energy

= significant losses of wildlife habitat and connectivity in parts of the county that are as yet undeveloped.

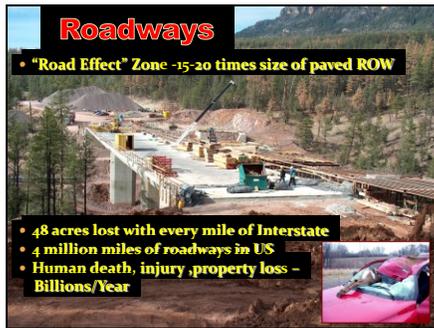
With many land use decisions made at a local level, the cumulative effects at a landscape or ecoregional level are oftent not adequately addressed or even understood, but the potential for loss of existing natural habitats is significant.

Slide 5



For example, AGFD calculated potential habitat loss of existing creosote-bursage and desert scrub in the Sonoran Desert as a result of predicted population growth for 2050 and current proposed solar developments to be as much as 31%.

Slide 6



The cumulative impacts of urban development and existing and future transportation networks will continue to fragment Az's landscape into smaller and smaller habitat patches.

In some places **human safety and property loss are issues**, simply because wildlife are trying to get across the road.

Slide 7



Cumulative impacts from all development/infrastructure need to be considered in planning in order to guide future development and meet conservation goals.

Slide 8

WILDLIFE ROAD MORTALITY ALONG WILDLIFE CORRIDORS IN THE TUCSON, AZ AREA

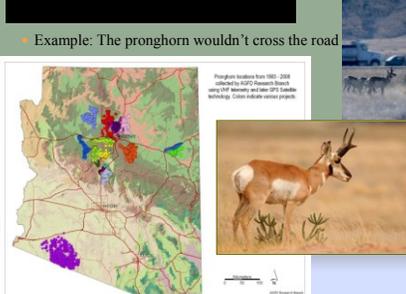
- 34 survey days
- 20 miles of roadway
- ~ 2,540 vertebrates found dead
 - Amphibians (55%)
 - Reptiles (26%)
 - Mammals (14%)
 - Birds (5%)



Wildlife research tells us the impacts are not just habitat loss...they also include direct loss of wildlife

Slide 9

• Example: The pronghorn wouldn't cross the road



Pronghorn studies from 1983-2009 indicate the USFS Research Station and USGS Research and Monitoring Technology Center conduct various projects.

We have a growing body of wildlife research that tells us fragmentation and habitat loss is already having effects on wildlife populations in AZ.

Data are a composite of VHF telemetry and GPS satellite data from multiple projects.

Slide 10

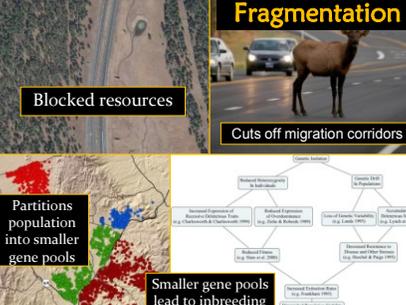
Fragmentation

Blocked resources

Cuts off migration corridors

Partitions population into smaller gene pools

Smaller gene pools lead to inbreeding



The flowchart diagram shows the following structure:

- Fragmentation (Overall Outcome)
 - Blocked Resources
 - Reduced Availability of Resources (e.g., Food, Water, Shelter)
 - Increased Mortality (e.g., Starvation, Dehydration)
 - Reduced Reproductive Success (e.g., Lower Fecundity)
 - Cuts off Migration Corridors
 - Isolated Populations (e.g., Small, Isolated)
 - Reduced Genetic Diversity (e.g., Inbreeding Depression)
 - Increased Extinction Risk (e.g., Local Extinction)
 - Partitions Population into Smaller Gene Pools
 - Smaller Gene Pools lead to Inbreeding
 - Reduced Genetic Diversity (e.g., Inbreeding Depression)
 - Increased Extinction Risk (e.g., Local Extinction)

Habitat loss and Fragmentation has 2 primary effects to wildlife:

- 1st - it can **reduce** the sizes of habitat patches so much that they can no longer support viable populations of some species
- 2nd - fragmentation can **isolate** remaining patches so that animals have a low chance of moving between patches making them more vulnerable to local and regional extinction.

Slide 11

Why conserve linkages?
Nature needs room to roam



Connectivity is the ability of a landscape to support natural levels of:

- Individual movement for needed resources (food, water, cover)
- Immigration or recolonization after local extinction; emigration to new habitats
- Seasonal migrations
- Gene flow (the ability to evolve; genetic variability)
- Population movement in response to changing climate or stochastic events
- Ecological processes and flows (e.g., disturbance, predator-prey interactions, pollination/seed dispersal, nutrient cycling)



Why nature needs room to roam...

Slide 12

WHAT ARE WE DOING ABOUT IT?

- Wildlife Research
- Linkage Planning
- Design Guidelines
- Outreach
- Collaborative Planning & Implementation



AGFD effort to address issues are focusing on the following (bullets).

The effort has been successful so far with the help of many partners.

Slide 13



- SR 260 Crossing Structures, Fencing, and Automated Crosswalk Studies
- SR's 93 and 68 Bighorn Sheep Crossing Studies
- I-17 and SR 64 Elk and Deer Crossing Studies
- SR 89 Pronghorn Crossing Studies
- Mountain Lions in Prescott, Payson and Tucson Area Studies
- Cactus Ferruginous Pygmy-owl Crossing Studies
- Flat-tailed Horned Lizard Culvert Study
- Statewide Wildlife Linkages Assessment
- Sun Valley Wildlife Corridor Study
- Road K11 "Hot Spot" Definition Studies
- Camino de Manana
- SDCP Connectivity Areas

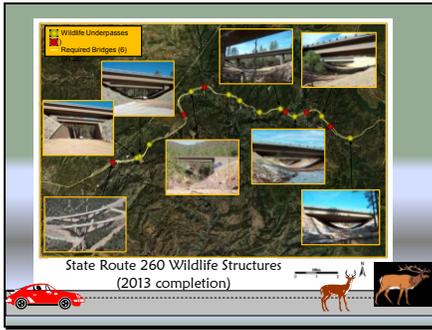
- Roadway Ecology
- Movement
- Habitat Use
- Mitigation Designs
- Roadkill Assessments



1st across the state, through collaboration with funding partners, we are conducting wildlife research to learn more about the issues....

We acknowledge funding through Federal Highway Administration, ADOT, Tonto National Forest, Arizona Desert Bighorn Sheep Society, Pima County Regional Transportation Authority

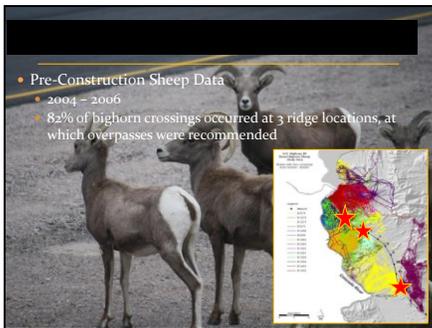
Slide 14



We are using wildlife research to answer many important questions such as:

- Where are there human/wildlife conflicts and safety issues?
- What wildlife species are impacted by development and how?
- Are impacts population level or more local in extent?
- Where is habitat fragmentation occurring?
- Where are the most critical places to conserve as linkages?
- What conservation and development designs can we recommend to avoid, minimize or mitigate impacts?

Slide 15



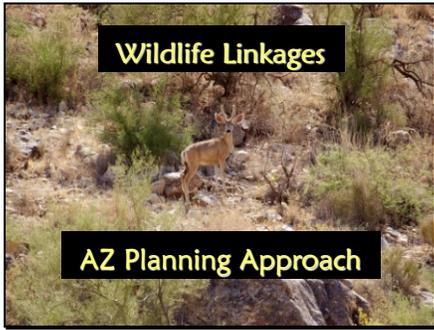
We are also learning solutions ...such as how to reconnect bighorn sheep habitat and populations in western AZ fragmented by US93 years ago.

Using the best science and data available the Department can recommend where and what kind of mitigation will provide maximum benefits to wildlife and provide the wisest expenditure of limited funding resources.

Slide 16

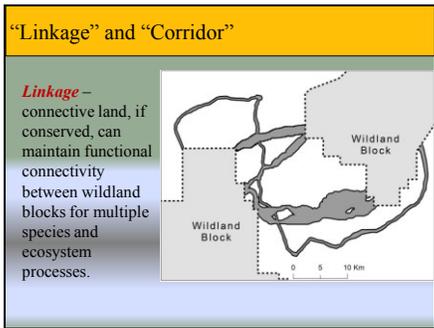


Slide 17



2nd we are planning solutions that will conserve wildlife habitats and populations for future generations, while recognizing the reality that AZ will continue to grow.

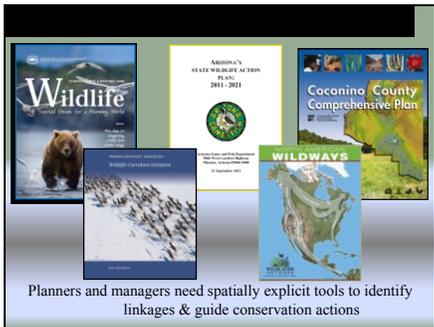
Slide 20



Wildlife Corridor = This term is often used interchangeably with "wildlife linkage" as we do in this report. Some biologists define the term "corridor" more narrowly to represent features such as canyons, ridgelines, riparian areas, and other landscape features that constrain or "funnel" wildlife movements in more restricted paths.

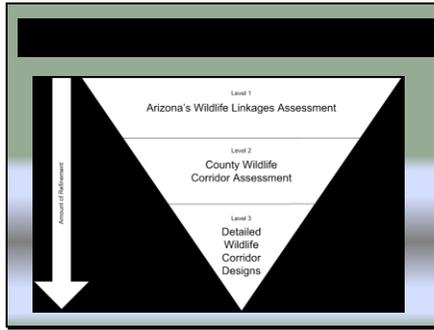
Linkage Design = a continuous swath or swaths of land that should - if conserved – maintain or restore the ability of wildlife (many species) to move between wildland blocks

Slide 22



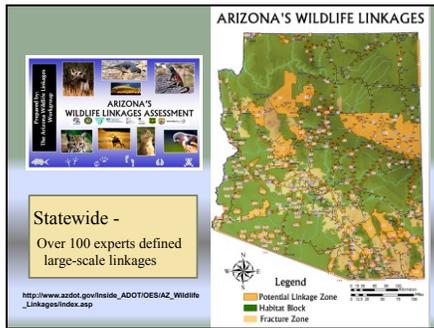
Identifying & conserving wildlife movement corridors or linkages is a growing priority for management agencies, municipal & county planners, transportation agencies, & NGOs

Slide 23



Statewide approach is to start with the broader landscape and work towards a local level with the goal of a linkage design that is implementable and balances the conservation investments required.

Slide 24



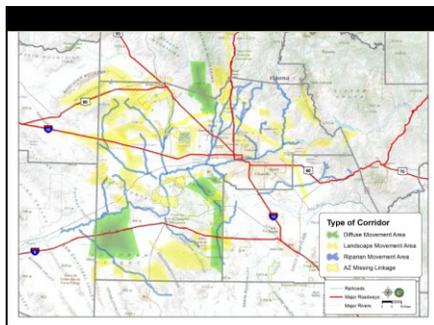
- Based on expert stakeholder workshop – biologists, land managers, planners, engineers, transportation officials

- Habitat blocks: important wildlife habitat expected to remain wild for at least 50 years, primarily federal land

- Large-scale movement areas delineated for further refinement in subsequent efforts.

- Descriptions: vegetation, species, ownership, threats, hydrology

Slide 25



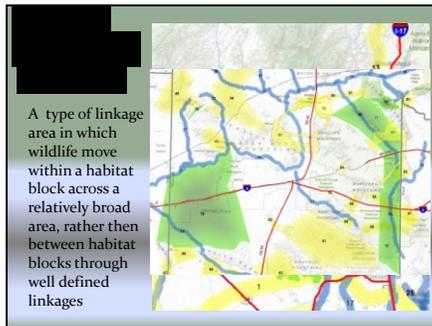
Stakeholder Workshop 2008: Diverse group of stakeholders with knowledge of different areas of Maricopa County, wildlife, as well as development pressures and conservation opportunities –produced hand-drawn then digitized linkage maps of the county

There are **81** Unique Wildlife Linkages:

- 7 Diffuse Movement Areas
- 46 Landscape Movement Areas
- 23 Riparian Movement Areas
- 5 AZ Missing Linkages

CAP is barrier but there are also linkage opportunities associated with ROW lands set aside as wildlife mitigation for project.

Slide 26

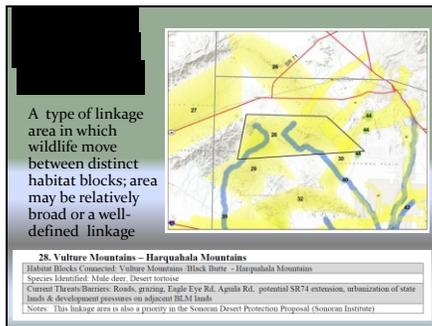


Represented by green shading and include:

Sentinel Plains
Rainbow Valley and Vekol Valley
Heiroglyphic , Buckhorn and Bradshaw Mountains NW of Lake Pleasant

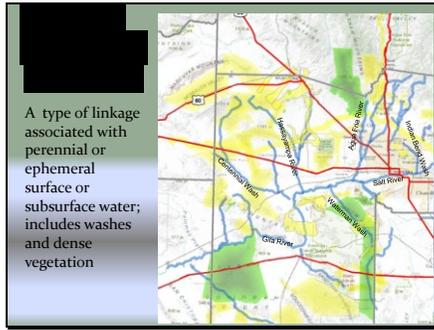
...and others

Slide 27



Represented by yellow shading..

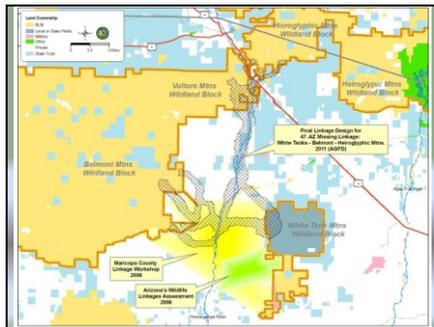
Slide 28



Riparian linkages facilitate movement of both terrestrial and aquatic wildlife species
They include: lakes, rivers, streams, and washes.

Many of these linkages are in developed landscapes; some remain in fairly natural states, others are highly developed for recreation and/or flood control. However they still provide important habitats and connectivity for migratory birds, reptiles and amphibians and other small mammal species.

Slide 29



This slide illustrates the Evolution of linkage design:

From a broad placeholder to a ¾ mile wide linkage that is the best biological recommendation for a suite of focal species.

We also have 5 linkage areas that have been modeled to a scale that is implementable at the local level. This graphic shows the planning and design progression for the White Tanks – Belmont – Heiroglyphic Mtns linkage. The final linkage design shown as crosshatch represents a multi-species design with a max width of 1 km.

Slide 30



CorridorDesign

Least-cost corridor GIS modeling

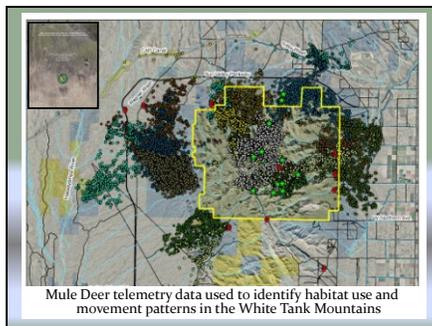
- Focal species approach assumes:
 - habitat suitability = landscape permeability
 - modeled species represent **many** species & processes
- Overlay multiple species' **corridors** to form a **linkage**

This is our basic approach: While we are interested in conserving ecological processes, we take a focal species approach

Species Represent: large area requirements, sensitivity to barriers, habitat specialists, limited dispersal “corridor dwellers”

The model finds the shortest, most direct path of permeable habitat for a species to move through to get from habitat patch to habitat patch.

Slide 31



Another critical step to designing a linkage plan for conservation is to start with the best data available...

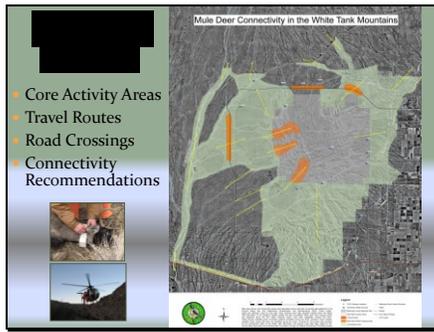
whether that is site specific research on wildlife habitat use,

research based data that defines wildlife habitat requirements to inform computer modeling,

or even local expert knowledge.

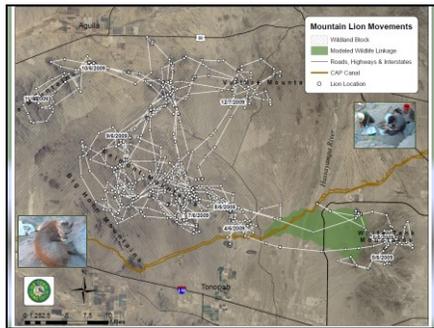
These combinations of data should be used to design a linkage that can be implemented and evaluated over time for effectiveness and adapted if necessary

Slide 32



Researcher's conceptual interpretation of the mule deer telemetry data and results.

Slide 33



White Tank Mountains mountain lion telemetry data for 1 lion collared in the White Tank Mtns.

Slide 34

How to Use the Connectivity Assessment

- Screening tool in early stages of land use planning
- Conversation starter
- "Roadmap" for Biological priorities & needs

Working *for* Connectivity not against development

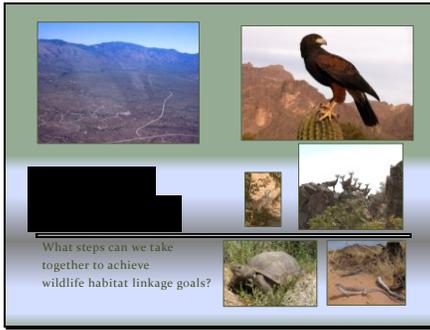
Linkage Plans are meant to start conversations. For example the plan does not include comprehensive information on wildlife and so planners should consider the plan a starting point for consultation with biologists from AGFD, USFWS, USFS and other land managers.

Product's value is to:

The goal is to keep common species common and strategically align conservation plans with development plans

- Alert local planners to connectivity goals
- Early ID of potential resource conflicts/concerns
- Identify areas of impact and opportunity
- Target further research
- Focus fine-scale GIS modeling

Slide 35



Section Break

Slide 36



Conservation design: clustering, gradient density, transferring development rights, density bonus

Don't forget transportation and stormwater management

Slide 37



Key message: Local efforts can contribute to statewide success.

Slide 38

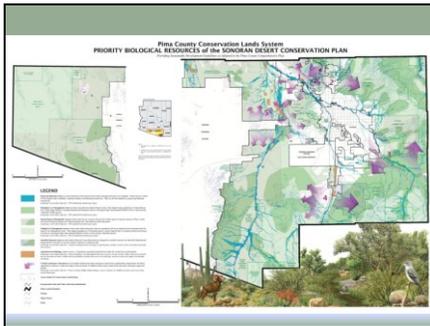


In order to build communities that align development plans with wildlife habitat needs **we need linkages to be included in land use plans.**

Align plans between jurisdictions

Align plans at multiple scales – statewide, regional, county, local
Use plans to prioritize acquisition of OSP (Peoria example)

Slide 39



For example, Pima County has adopted the Conservation Lands System as part of their county comprehensive plan and it is their tool to maintain landscape permeability (identified as natural resource areas AND wildlife corridors, Or *Critical Landscape Connections*) through the use of the site analysis process and guidelines...both of which are applied during the rezoning process (not an ordinance). The rezoning process is a negotiation . Where the county has CLS priorities it uses guidelines to identify what mitigation ratios must result from negotiation of the site development. The government grants higher land use intensity in exchange for meeting CLS goals...but a developer’s fallback is using original zoning. Board of Supervisors has lots of flexibility to customize results on site specific basis to achieve landscape goals.

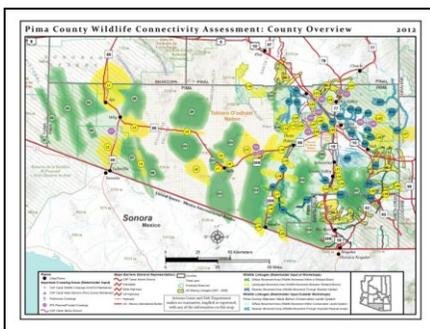
When a developer applies for rezoning the Pima County application requires identification of whether a site falls within or adjacent to the connections and requires a Biological Impact Report in the site analysis process. The applicant must explain how the proposed development plan maintains, contributes to or enhances landscape connectivity.

Pima County transportation mitigation and OS Funding:

\$45 Million for wildlife mitigation within RTA bond (1/2 cent sales tax passed in 2006) which funds transportation infrastructure. Using Sonoran Desert Conservation Plan, Pima County was able to resolve conflict and in short it paved the way for a successful bond passage. The \$45 million mitigation money managed by TRA works in conjunction with a 2004 Regional OS acquisition program \$175 million. In short...the organizing framework is the CLS which guides working partners.

Although wildlife linkages were addressed as an important issue in the Sonoran Desert Conservation Plan (1998) and through the Maeveen Marie Behan Conservation Lands System (2001), a comprehensive knowledge of wildlife movement throughout the entirety of Pima County was not available until the Pima County Connectivity Assessment was completed in 2012.

Slide 40

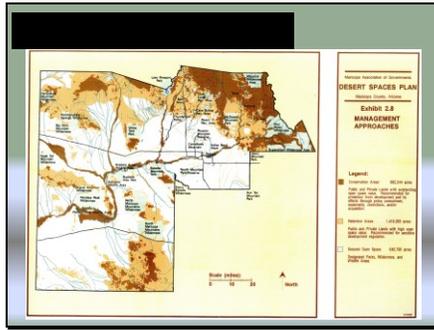


The county overview map from The Pima Wildlife Connectivity Assessment: Report on Stakeholder Input.

The assessment offers additional site specific information on wildlife habitat connectivity needs and the county plans to use it as additional site specific information, complimentary to the CLS, during the rezoning process.

Other counties with completed connectivity assessments include: Coconino, Yavapai, La Paz, Pinal, Apache, Navajo, Santa Cruz, and Yuma

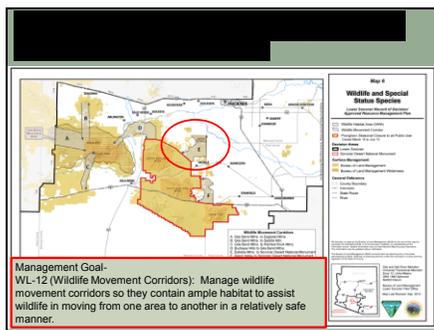
Slide 41



The Desert Spaces Plan has a goal to “provide opportunities for **inter-jurisdictional cooperation to develop a regional open space system that builds on existing efforts** of the public and private sectors”. The system is described as a “network of protected open space” with parks, preserves and trails as the foundation. **Conceptually it recognizes that open space linkages that allow wildlife to move freely between larger preserves.** Plan objectives include **sustainable habitats and identify a measure of success as the extent to which populations of native plants and animals remain viable...**linkages are critical to that success.

The Maricopa linkages could be used to update the current plan and refine areas most critical to meeting the stated goals relating to wildlife. From a biological perspective... linkages should be considered a priority for open space acquisition initiatives in order to protect the ecological functions and values of existing conservation investments.

Slide 42



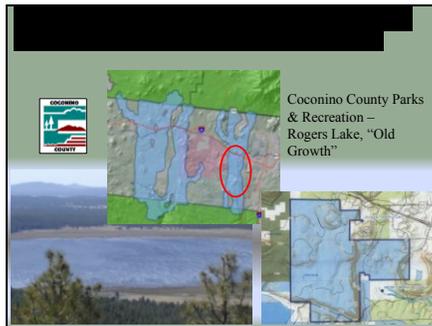
Cities, towns and counties can help contribute to statewide and regional goals by aligning community and infrastructure development plans with regional habitat management plans such as the BLM’s Lower Sonoran Resource Mgmt Plan.

Management Goal-
WL-12 (Wildlife Movement Corridors):
Manage wildlife movement corridors so they contain ample habitat to assist wildlife in moving from one area to another in a relatively safe manner.

Management Actions-

- Include roadway/highway designs across linkages that facilitate movement & reduce mortality
- Retrofitting existing roads when maintaining/expanding with structures to restore connectivity
- Protecting wash corridors
- Limiting road densities within linkages to 3 miles of road/section

Slide 43



Linkage plans can also be used to inform/prioritize future acquisitions of open space or important habitat areas (“Old Growth”).

For example in Coconino County P&R and the City of Flagstaff are using stakeholder input and linkage plans to prioritize ASLD parcels for future acquisition within the context of the Flagstaff Area Regional Land Use Plan and open space element. Shown here is the Peaks to Rim linkage area which overlaps with Rogers Lake ASLD parcels purchased by P&R in 2010.

Slide 44



So not only do we need linkages included in land use plans...we also need them addressed in infrastructure plans.

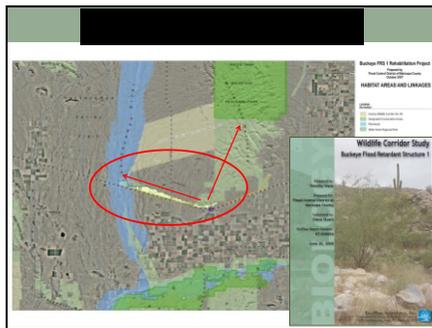
Slide 45



The keys to our success to mitigate transportation corridors across wildlife habitat linkages will be:

- Early ID in planning process
- Choosing alignments that avoid/minimize habitat loss and fragmentation
- Engineering roadway designs that mitigate the barrier effects

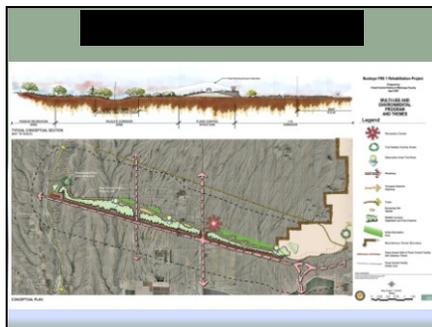
Slide 46



For Example the Maricopa County Flood Control District has chosen an alternative to rehabilitate the Buckeye FRS 1 Dam south of the White Tanks in such a way as to enhance the area as a wildlife corridor. This contributes to our overall goals for the White Tanks.

They will use soft structural design strategies to enhance vegetation and push multi-use trails to the edge of the corridor to minimize disturbance to wildlife. They will also work with transportation on roadway crossing structure designs that facilitate mule deer movement through the area.

Slide 47



They will use soft structural design strategies to enhance vegetation and push multi-use trails to the edge of the corridor to minimize disturbance to wildlife. They will also work with transportation on roadway crossings designs that facilitate mule deer movement through the area.

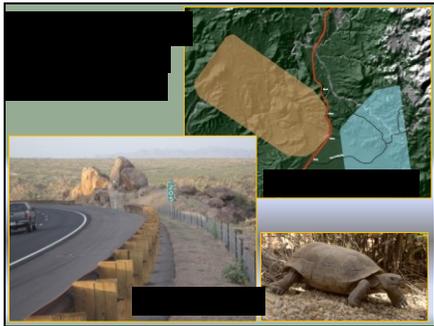
Area Drainage Master Plans and various river course Master Plans are also opportunities to plan for linkages.

Slide 48



Modify existing barriers within linkages to meet wildlife needs.
Example is the CAP canal...this has been done before and proven to work.

Slide 49



Plan mitigation costs into projects.

For example...Along SR 87 near Sunflower, a 1-mile stretch of fine mesh fencing was installed to prevent Desert tortoise, a species protected under the Endangered Species Act, from accessing the highway in an effort to reduce roadway mortality and population effects to that species (Photographs: Arizona Game and Fish Department).

Slide 50



AGFD has produced several guidelines to help inform on how to address wildlife needs in project or development planning and implementation.

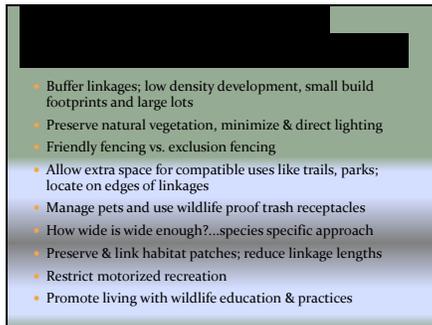
Slide 51



This slide is animated...to see go to slideshow view
Wildlife have a variety of requirements and by planning corridors for the species with the greatest space requirements you accommodate most if not all species in your planning area.
Plan to include important habitat features into linkages...

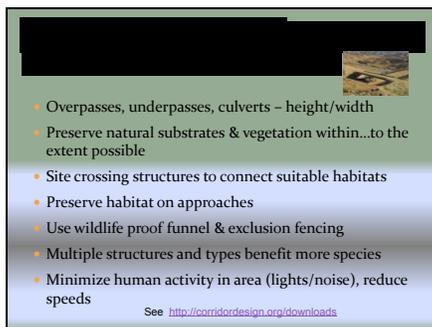
Fine scale versus broadscale planning; mountain ridges, washes, canyons VERSUS caves, mine shafts, large trees/saguaros or snags.

Slide 52



See also reference list provided by AGFD for workshop

Slide 53



There are many resources to use for recommendations:

See also:

<http://corridordesign.org/downloads>

http://www.azdot.gov/Highways/Roadway_Engineering/Roadside_Development/HwyBLM_USFS.asp

Slide 54



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AZ Examples

- White Tank – Belmont – Heiroglyphic Mountains Linkage
- Pima County – Town of Oro Valley

"Your yard is starting to mess with my livingroom."

Following our 2 examples of collaborative planning and implementation. Both examples are efforts underway to conserve linkages on the fringes of Arizona's 2 biggest metro areas...Tucson and Phoenix.

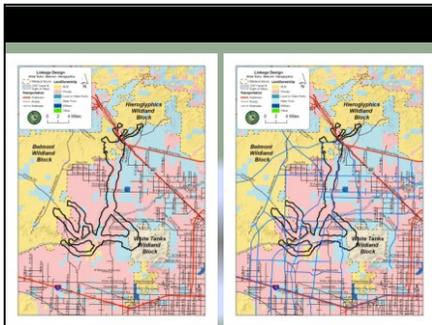
Slide 55



We know the solutions for wildlife are complex and will take commitment and cost money. But we also know the benefits are significant to AZ communities.

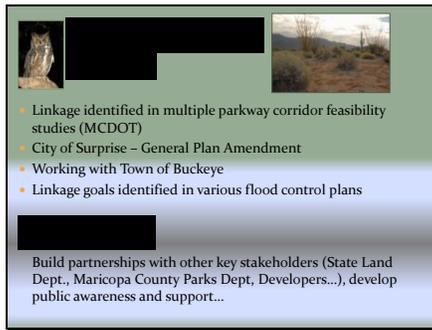
The White Tank – Belmont – Heiroglyphic Mtns linkage will be extremely complex as the majority of land ownership is private and state. The purpose of the linkage is to preserve the biological diversity of the White Tank Mtns. Proposed development will surround the mountain.

Slide 56



These two slide illustrate the difference between existing roads and the future road network which will include several parkways, freeways and possibly an interstate highway. Each of these roadways will need to be mitigated to preserve wildlife movement through the corridor.

Slide 57

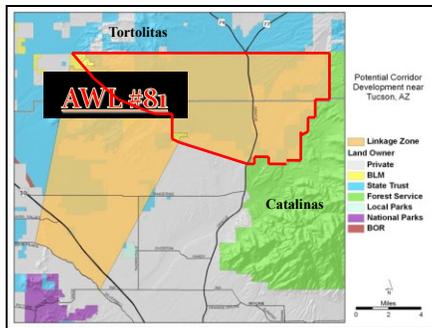


- Linkage identified in multiple parkway corridor feasibility studies (MCDOT)
- City of Surprise – General Plan Amendment
- Working with Town of Buckeye
- Linkage goals identified in various flood control plans

Build partnerships with other key stakeholders (State Land Dept., Maricopa County Parks Dept, Developers...), develop public awareness and support...

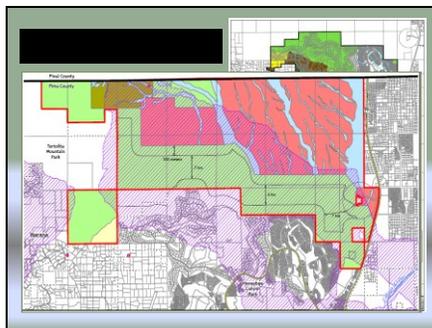
Our success for preserving populations of species such as mule deer, mtn. lion, desert tortoise and others in the White Tank Mountains will depend on conservation of swaths of upland desert habitat between the White Tanks and the Belmont/Bighorn Mtns/Vulture/Heiroyglyphic Mountains and the Hassayampa River corridor. Washes are not the only habitat requirement. We have another AZ example of such an effort.

Slide 58



AZ Missing Linkage – Santa Catalina – Tortolita ...potential success story that is unfolding in Pima county

Slide 59

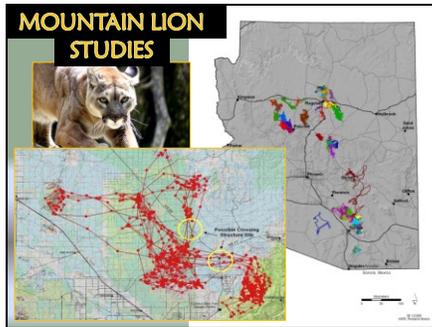


Earlier I shared the Pima County CLS.. The Town of Oro Valley added more site specific details and created an ESLO that implements the General Plans open space and natural resource conservation goals. Their ESL Conservation System uses maps to ID location of major and minor wildlife linkages and other conservation categories. In short, the ESLO limits development within major linkages to “essential infrastructure” and it promotes greater density in exchange for open space offsets.

The Arroyo Grande subdivision is not in the town limits. However, the Town of Oro Valley General Plan and Arroyo

Grande Special Area Policies have been developed to incorporate a wildlife corridor, (green area with blue hashmarks), into the future development plan for Arroyo Grande subdivision; in support of the ESLO. A modeled linkage design was used to locate the corridor and an artist created a conceptual design. There are several other policies such as the use of buffers and fencing guidelines that support the ESL.

Slide 60



Wildlife Research and linkage modeling were used not only to design the linkage but also to develop the biologically best recommendations for where to mitigate roadway barriers along SR77 where it crosses the linkage.

Slide 61



This conceptual rendition illustrates very well what could work as a viable wildlife linkage through and urban landscape.

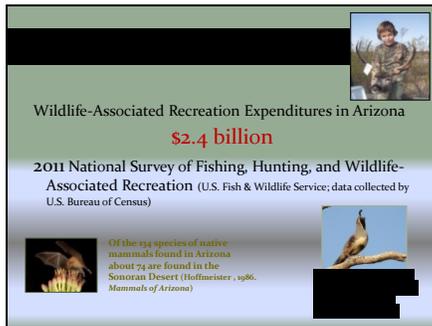
Slide 62



- Development Regulations & Guidelines
 - Preservation of natural vegetation, washes, OS
 - Minimize edge effects
 - Promote living with wildlife strategies
 - Density bonus
- Collaboration
- Mitigation
 - Crossing structures
 - Habitat enhancement
 - Water development
- Wildlife Research, Monitoring and Adaptive Management
- General Land Use Plans
 - Environmental goals or elements
- Land Conservation
 - Acquisition & easements
 - Transferring development rights
 - Purchase of development rights
- Funding Strategies
 - Open Space Programs and Tax Initiatives & Bonds
 - Land Trusts

The previous 2 examples illustrate the complexity and commitment it will take to preserve linkages. But we also know the benefits are significant to AZ communities.

Slide 63



Wildlife-Associated Recreation Expenditures in Arizona
\$2.4 billion

2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Fish & Wildlife Service; data collected by U.S. Bureau of Census)

Of the 134 species of native mammals found in Arizona about 74 are found in the Sonoran Desert (Hoffmeister, 1986, *Mammals of Arizona*)

According to a 2011 national survey the total Economic impact of wildlife related recreation in AZ was worth ~2.4 billion dollars (preliminary findings 2011 Nat Survey of Fishing, Hunting, and Wildlife-Associated Recreation-Arizona)

Fishing, hunting and wildlife watching expenditures

In 2011... 78% of respondents said they wildlife watch around the home and 47% away from home; 61% of the expenditures are associated with fishing and hunting; 39% with wildlife-watching.

2.1 billion in 2006
56% is Equipment related
35% trip related
9% is other

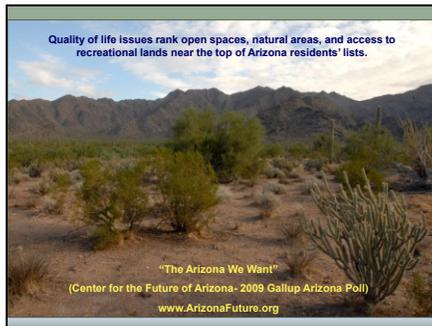
Slide 64

Fishing and Hunting	Wildlife Recreation
• \$409.1 Expenditures	• \$368 Expenditures
• \$515 Total Impact	• \$690 Total Impact
• \$103 Salaries/Wages	• \$193 Salaries/Wages
• 5,382 Jobs	• 6603 Jobs
• \$21.1 State Tax Revenues	• \$4.8 State Tax Revenues

Silberman J., 2004 Southwick Associates, 2003

Fishing, hunting and wildlife recreation type activities like bird watching and wildlife photography provide a significant economic benefit to local, state and national economies. Resident and nonresident expenditures.

Slide 65



“The Arizona We Want” (Center for the Future of Arizona- 2009 Gallup Arizona Poll)

Created Citizen’s agenda for AZ with 8 overarching goals including – protection of Arizona’s natural environment, water supplies and open space

Aesthetics & natural environment were the second most important influence over Arizonans sense of place

21% of respondents believed Implementing policies that balance pop growth with preserving open space and recreational opportunities was a best use of tax dollars and/or private sector funding....Second only to water mgmt policies...

In short, we believe the biological and ecological resources of Arizona are worth conserving for future generations.

Slide 66



- Habitat fragmentation & loss is impacting wildlife
- Conserving corridors & linkages can mitigate
- Wildlife research can inform design
- Collaboration & Partnerships = solutions
- Local plans can support statewide goals
- Work for connectivity not against development
- Plan for ecosystems not individuals; common species common
- Wildlife are a valuable resource for Arizona

Slide 67

Arizona Wildlife Linkages Workgroup



Maricopa Workshop Sponsors:
Arizona Game and Fish Department, Arizona Department of Transportation, Arizona State University Global Institute of Sustainability, Flood Control District of Maricopa County (workshop host), Maricopa County Department of Transportation, Maricopa County (Board of Supervisors, Andy Kunasek), Northern Arizona University, Sonoran Institute

