MEMORANDUM

Date: August 28, 2009

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **How Effectively will the County Mitigation Lands Include the Specific Habitats of Covered Species under the Multi-Species Conservation Plan?**

Background

One study released today dealt with the large issue of how well our open space acquisitions have included landscape types identified for the Sonoran Desert Conservation Plan. Another study showed how open space lands become "mitigation lands" which then qualify as conservation acreage under the Multi-Species Conservation Plan. Mitigation land is basically open space that is acquired, managed, monitored and legally protected. This study is smaller in scope and asks a narrower question:

> How effectively will the County's mitigation lands include the specific habitats of covered species under the Multi-Species Conservation Plan?

The purpose for this study is to provide the United States Fish and Wildlife Service with an analysis that identifies anticipated impacts to each of the covered species. Whereas this study has a focus on the acreage it will take to achieve our federal permit, the open space study examined the conservation needed to achieve the larger goals of the Sonoran Desert Conservation Plan – an effort that will require cooperation from other jurisdictions.

Conclusion

The Multi-Species Conservation Plan is a small subset of the overall Sonoran Desert Conservation Plan, limited by Pima County's land use authority. The chart on page 5 shows that on a species by species basis, we have already acquired enough potential mitigation land to cover the take of nearly every proposed covered species for the life of the permit. In this sense, we have been able to conserve faster than we have been able to negotiate with the Service for the plan.

The County's Science Team has asked that landscape which falls into the MSCP-area be protected, or mitigated upon impact, in addition to the habitat of specific species. Our total projected mitigation needs (species plus landscape types) for 30 years are 125,414 acres. We soon will have 71,000 acres of fee mitigation land. If the Service approves our proposal that we obtain credit for state leased lands we will have more than 102,000 acres of mitigation lands in the bank now and need only secure the conservation status of these lands and acquire some 20,000 acres of mitigation land during the next 30 years.

CHH

Habitat Mitigation in the Pima County Multiple Species Conservation Plan

By Julia Fonseca, Office of Conservation Science and Environmental Policy

Habitat, habitat, have to have a habitat.

You have to have a habitat to carry on.

--Bill Oliver, troubadour

This popular children's song makes the point that habitat is where species find the conditions needed for their survival. The concept of habitat is fundamental to the purposes of the federal **Endangered Species Act**, which are:

> "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth"…..

Habitat varies greatly from species to species; for instance a desert tortoise has very different needs than a semi-aquatic mud turtle. Tortoise habitat is not habitat for mud turtles! But not all aspects of habitat are so obvious. For example, the populations of tortoise in the Sonoran desert seem to prefer much rockier sites than populations in the Mojave desert of California, and no one really knows why. Biologists may spend years attempting to understand what constitutes habitat for a particular species.

Pima County is seeking to comply with the Endangered Species Act and reduce the need for future listings by increasing the amount of habitat that is protected from development in our region. As explained in the *Mitigation Lands* report, Pima County has primarily been purchasing and protecting land in the Conservation Lands System (CLS). Most of the acquisitions have been publically funded, but when rezonings occur in the CLS, developers have conserved a portion of the land within their area of ownership. The acres of CLS that are protected provides a fundamental "currency" or measure of how close we are to achieving the landscape-level biological goals of Sonoran Desert Conservation Plan. Though this landscape-level approach to conservation is critical, it does not measure how well the conservation plan is meeting the needs of a particular species.

Problem Statement and Purpose

This report summarizes species-by-species accounting of the potential, direct, habitat losses that could occur due to activities covered under Section 10(a) of the Endangered Species Act and which will be reported in the upcoming Pima County MSCP. To achieve the purposes of the Endangered Species Act, unavoidable habitat impacts need to be reduced or mitigated. Pima County's primary mitigation method is to protect land that is capable of providing the resources and habitat that protected or "covered" species need. Mitigation for the direct habitat losses represents the "floor" for how much mitigation Pima County will need to provide to replace habitat lost due to the covered activities.

Pima County has already acquired a great deal of Mitigation Land for the Section 10(a) permit. Analysis in this report will only consider Mitigation Lands already acquired, not the full suite of open space lands. To understand better the scope of protection offered under the larger Sonoran Desert Conservation, see *Progress Report: Measuring Effectiveness of Open Space Land Acquisitions.*

The Draft 5 MSCP used a CLS "currency" to measure the value of the Mitigation Lands as habitat. But the CLS currency does not demonstrate that sufficient acres of habitat are being protected for any given species. Fortunately, the team of scientists who contributed to the Sonoran Desert Conservation Plan have prioritized where habitat conservation and restoration should occur for individual species in Pima County. We used Priority Conservation Areas, which were defined by species experts, as a means of calculating habitat loss and mitigation. For species in which experts declined to identify their priorities (Sonoran desert tortoise and Tumamoc globeberry, we used models of potentially suitable habitat (see RECON Environmental Inc. 2000). Habitat maps and models are available to the public on the SDCP Mapguide site, along with the locations of acquired lands.

A new habitat impacts analysis is also needed because Pima County is proposing to provide Endangered Species compliance for only certain kinds of development, known as "covered activities". These are mainly discretionary, Board-approved developments in unincorporated Pima County (mainly rezonings) and capital improvement projects. Other sources of future habitat loss included existing platted subdivisions, lot split development, mining and other activities. Habitat losses from these activities will be estimated in the Environmental Impact Statement for the Pima County MSCP, but are beyond the scope of this report.

Nothing compels a local community to pursue a Section 10(a) permit, but in order for the permit to be issued, the community must identify anticipated impacts to each covered species. U. S. Fish and Wildlife (USFWS) considers the impacts in the context of all of the proposed avoidance, minimization and mitigation measures, previously described in the Multiple Species Conservation Plan.

Mitigation of Impacts to the Conservation Lands System (CLS)

Table 1 summarizes the landscape-level distribution of projected impacts to the CLS due to the urban growth that would be covered in the Pima County Multiple Species Conservation Plan (MSCP). Approximately 35,000 acres of growth would be covered under the permit, mostly rezonings that would be approved by the Pima County Board of Supervisors and future public structures such as roads and sewage treatment facilities. This is a subset of all potential development in Pima County. (See Appendix 1 for more information.)

Table 1. Impacts that are likely to occur from the Covered Activities

Relationship to CLS	CLS Category	Total Impacts (Ac.)
Inside CLS	Biological Core	9,007
	Special Species Management Area	347
	Multiple Use	12,965
	Important Riparian Area	2,350
	Agriculture	2
	CLS Total	24,671
Outside CLS		11,205
Total CLS + Outside CLS		35,877

The Pima County MSCP commits mitigation land at ratios that vary depending on what part of the CLS is impacted. This mechanism assures that Pima County compensates with many more acres than are actually impacted directly by the covered activities (Table 2).

Table 2. Projected mitigation needs

Relationship to CLS	CLS Category	CLS Mitigation Ratio	Total (Ac.)
Inside CLS	Biological Core	4	36,028
	Special Species Management Area	4	1,390
	Multiple Use	2	25,930
	Important Riparian Area	4	9,400
	Agriculture	0	0
	CLS Total		72,748
Outside CLS		4.7	52,666
Total (Inside CLS + Outside CLS)			125,414

Pima County has or will soon have approximately 71,000 acres of fee-owned Mitigation Land, and manages nearly 124,000 acres of State Trust lands. If USFWS grants partial credit for State Trust land, Pima County will have approximately 102,000 acres of mitigation credit in the CLS “currency”, enough for

more than 20 years of projected growth. Nearly all of the Mitigation Lands are located in the CLS, though some lie outside it, mainly those that lie just outside Pima County boundaries.

Mitigation of Habitat Impacts

The CLS "currency" does not tell us how any given animal or plant may be affected. This information is provided in Table 3, where the projected habitat losses caused by County activities covered under the Section 10(a) permit are compared to the habitat in the Mitigation Lands.

Covered species are the plants and animals for which we are seeking a Section 10(a) permit under the Endangered Species Act. Section 10(a) allows incidental harm to come to a species during the course of otherwise lawful activities. In this table, the harm is direct habitat loss. Habitat "take" or loss is presented in the column labeled "Total MSCP Take". Projected habitat losses range from zero to almost 20,000 acres. Habitat losses are highest for Tumamoc globeberry, Pima pineapple cactus and rufous-winged sparrow.

Using the same habitat "currency" and the assumption of 25% credit, we calculated the acres of Mitigation Land that provide habitat for any given species. These are the same lands that we used earlier with the CLS currency. The column labeled Fee Title is the number of acres of Mitigation Land that provide habitat for a given species. The ratio of mitigation to losses is sometimes called a mitigation ratio. Table 1 shows that mitigation ratios of more than 1:1 habitat loss to habitat protection can be assured for most covered species, using only the Mitigation Lands owned by Pima County.

Current levels of County-owned Mitigation Lands might prove insufficient to compensate at a ratio of 1:1 for projected losses of habitat for two desert plants: Tumamoc Globeberry and Pima Pineapple Cactus. Both of these plants are found on gently sloping bajadas (piedmonts) of southern Arizona, where much new urban development and mining expansion has already occurred and is continuing to occur. If USFWS will consider partial credit for Pima County's management of State Trust land, then Pima County will have sufficient compensation to meet a 1:1 mitigation ratio for the impact of covered activities upon Tumamoc Globeberry, but we may not have quite enough for the Pima Pineapple Cactus. The slight deficit projected in Pima Pineapple Cactus mitigation can be resolved through acquisition or other means.

Mitigation ratios from 1:1 to over 100:1 can be provided for nearly all species. Additional information about methods used to estimate future habitat loss and mitigation needs in Draft 6 of the Pima County MSCP can be found in Appendix 2.

Table 3 Habitat Analysis		Pima County Mitigation Lands (Acres)			
Species	Total habitat take after 30 years	Fee Title	25% of State trust land acres	Total to date	Habitat Mitigation Ratio
Pima pineapple cactus	19,260	9,063	9,641	18,704	0.97
Needle-spined pineapple cactus	908	5,866	2,788	8,655	9
Huachuca water umbel	500	3,885	171	4,056	8
Tumamoc globeberry	19,521	13,449	7,817	21,266	1
Mexican long-tongued bat	5,979	32,498	11,975	44,473	7
Allen's big-eared bat	1	2,263	0	2,263	>100
Western red bat	170	17,818	3,032	20,850	>100
Southern yellow bat	126	7,553	823	8,377	66
Lesser long-nosed bat	16,353	52,468	26,830	79,298	5
California leaf-nosed bat	180	10,049	2,583	12,632	70
Pale Townsend's big-eared bat	1,591	18,994	7,179	26,173	16
Merriam's mouse	390	8,163	197	8,360	21
Burrowing owl	1,486	2,663	0	2,663	2
Cactus ferruginous pygmy-owl	7,908	27,882	13,912	41,795	5
Rufous-winged sparrow	19,747	26,005	11,232	37,237	2
Swainson's hawk	11,400	40,430	13,303	53,733	5
Western yellow-billed cuckoo	74	7,930	1,032	8,962	>100
Southwestern willow flycatcher	0	314	0	314	>100
Abert's towhee	600	9,838	378	10,216	17
Bell's vireo	143	7,396	528	7,924	55
Longfin dace	1	2,762	312	3,074	>100
Desert sucker	0	99	0	99	99
Sonora sucker	0	50	0	50	50
Gila chub	1	3,342	122	3,465	>100
Gila topminnow	1	4,161	319	4,480	>100
Chiricahua leopard frog	2	10,175	3,296	13,471	>100
Lowland leopard frog	7,753	26,707	12,003	38,710	5
Desert box turtle	909	5,554	20	5,574	6
Sonoran desert tortoise	9,490	33,134	13,573	46,707	5
Tucson shovel-nosed snake	81	1,175	0	1,175	14
Mexican garter snake	3,613	10,100	464	10,564	3
Giant spotted whiptail	4,586	6,275	1,132	7,407	2
Ground snake (valley form)	11	809	0	809	76

Uncertainties Related to Habitat Mitigation

While much habitat has been acquired for the species we propose to cover under the Pima County MSCP, there are uncertainties about how much mitigation will actually be needed. These unknowns can be grouped into two categories: uncertainty relating to what actual habitat *loss* will occur for any given species and uncertainty relating to habitat *mitigation* obligations under the Section 10(a) permit. Some of the most important factors which could affect projections of habitat *loss* under the Pima County MSCP are:

Population growth. Population projections were based on estimates by Arizona Department of Economic Security. If human population growth in Pima County does not reach the levels projected, then habitat loss will be decreased.

Density of urban development: The projections we used were based on the "status quo" scenario for future land use discussed by the City-County Water Study Committee. This scenario had the highest land area requirements of the four scenarios studied by the Committee; in addition, the impacts in Pima County's permit area were higher than what we projected for the previous Draft 5 MSCP. If urban densities can be increased, then habitat impacts in the County's permit area would be lowered.

Development location: The pattern of development we used was based on many assumptions about where future growth will be located (Appendix 2). One of the more important assumptions used in the City-County water study that bears on habitat loss is the belief that areas of high socio-economic stress (which lie mainly in incorporated areas) will not grow as fast as other areas. If areas currently characterized as having high stress levels grow as rates similar to the rest of the County, then habitat impacts in the County's permit area would be lessened.

Location of covered activities: The MSCP covers only certain types of development within the permit area. If the definition of covered activities changes, or the assumptions used to spatially represent them change, then the pattern of habitat impacts could differ from the projection, and increase or decrease the habitat mitigation obligation.

Release of State Trust lands for development. The assumptions we used were similar to the City-County Water Study's with regard to the availability of State Trust lands for planned development. If the State Trust does not make available the Southlands and other areas for development, then habitat impacts will be shifted to private lands elsewhere in the region. Pima County's habitat mitigation obligations could increase for some species and decrease for others.

Habitat definitions. Because the science changes with time, the Science Technical Advisory Team has adopted a process for updating habitat definitions (Appendix 1).

It is not possible to predict in advance how these changes might affect calculations of habitat loss.

For habitat *mitigation*, there are five basic sources of uncertainty. Unlike the uncertainties of future growth, the uncertainties relating to mitigation must be resolved through negotiations between Pima County and U. S. Fish and Wildlife Service before the permit would be issued.

Habitat definitions. This is same source of uncertainty discussed above. It is not possible to predict in advance how these changes might affect calculations of habitat loss.

Annexation: We assumed no annexation will occur. Annexation will reduce Pima County's obligations for mitigation for all species. It is reasonable to believe that other local jurisdictions will annex a significant amount of the projected growth now included in the Pima County MSCP.

Credit for State Trust Land and other improvements to mitigation lands: The table addresses the uncertainty regarding whether USFWS will grant credit for Pima County's management of State Trust land by providing two scenarios: no credit and 25% credit. In the upcoming MSCP Pima County is proposing to achieve higher mitigation credit for all lands if condition improve. If a higher proportion of credit can be granted, then the mitigations ratios for nearly all species would improve.

Mitigation ratios. If the habitat mitigation ratio required by USFWS is greater than 1:1, then Pima County will either need to acquire more habitat, or not proceed with the Section 10(a) permit.

Opt-ins: If many land-owners in existing subdivisions were to opt into coverage under the County's permit, it would increase the habitat mitigation obligations of Pima County. Our model assumed some opt-ins, primarily from rezonings in the CLS which pre-dated the issuance of the permit.

CLS mitigation provides an important method to reduce uncertainties inherent in using the habitat "currency" to calculate species mitigation obligations. CLS mitigation assures that Pima County will purchase additional lands that will help connect the landscape in a meaningful way for a wide variety of species. Some of these lands may not be considered habitat for a given species today, but could become useful for habitat mitigation in the future either for a covered species or for some other species whose endangerment was not anticipated. In addition, mitigation land outside Pima County boundaries can also be used to offset habitat impacts.

Conclusions

The Sonoran Desert Conservation Plan provides two ways to measure habitat impacts due to growth in Pima County: the Conservation Lands System and species habitat maps. Impacts to the CLS reflect impacts to the "wholeness" of a biologically preferred reserve system, while the habitat maps are used to measure impacts to any given species.

These same measures can be used to calculate habitat mitigation obligations. Both measures have been used in the Pima County MSCP. With modest additional effort, Pima County seems likely to be able to mitigate for direct habitat loss to covered species caused by covered activities at mitigation ratios of from 1:1 to over 100:1. High species mitigation ratios and CLS mitigation ratios help address uncertainties about direct, indirect and cumulative impacts to species habitat and lack of certainty about where development will occur.

Pima County will monitor and report the actual losses due to covered types of developments, mainly by tracking the acreage of rezonings and other discretionary projects as approved by the Pima County Board of Supervisors. The species' impacts actually realized and actual mitigation will be compared on an annual basis. Monitoring data about where covered impacts are actually occurring will be made available to the public as well as USFWS. The location of Mitigation Lands is already available on the Pima County SDCP Mapguide site.

The monitoring and tracking methods used in the MSCP should allow scientific understanding of habitat to improve, and measure results using the best science available. This is important because the location and quality of habitat will change with time, due to climate and other factors beyond the scope of local control. The scientific understanding of what constitutes habitat will also change with time as more research is conducted. The Science Technical Advisory Team has adopted standards for updating models of habitat and priority conservation areas. The "shifting sands" of what constitutes habitat will require that Pima County and USFWS formalize how habitat losses and habitat mitigation would be monitored in the MSCP.

Acknowledgments

This work would not have been possible without the support and insights provided by Pima County Geographic Information Systems, in particular the work of Cory Jones on habitat analyses and Mike List on the City-County land use model. Thanks also to Brian Powell for editing the report and Dale S. Turner for his advice. George Malesky illustrated the desert tortoise. Bill Singleton illustrated the Pima Pineapple Cactus.

Appendix 1.

Procedure for Future Updating of Covered Species Suitability Models and PCAs

Adopted by the Science Technical Advisory Team May 12, 2009

Throughout the development of the Pima County's Multiple Species Conservation Plan (MSCP) and the Sonoran Desert Conservation Plan (SDCP), STAT drew on the best available scientific information of proposed covered species for a variety of needs such as developing the CLS and prioritizing land acquisitions. As Pima County moves toward implementing the MSCP and related conservation measures, there will be a need to revisit the habitat models and PCAs as better information becomes available. The purpose of this memorandum is to recommend that the Science Technical Advisory Team (STAT) formalize the process for amending habitat models and PCAs.

Habitat models were developed by species experts during the development of the SCDP based on environmental features that were believed to control the distribution of potentially suitable habitat at the landscape level for a given species. Using these models, suitability was mapped by GIS analysts for the entirety of Pima County, without regard to political boundaries, though some areas were excluded from analysis due to biological factors identified by experts. Suitability was usually represented in GIS raster datasets as high, medium or low potentially suitable habitat. Habitat models make explicit assumptions about preferences of species for environmental features, and utilize more complete information about the variation of physical or biological characteristics over the landscape than would otherwise be available.

Priority Conservation Areas (PCAs) were defined by species experts to prioritize SDCP land acquisitions. PCAs are species-specific, but not all species have PCAs; where data to inform acquisition is lacking, experts declined to designate a priority. All PCAs are GIS polygons enclosing an area of significance; many represent an area encircling a smaller unit of potentially suitable habitat. PCAs were subdivided, if deemed appropriate by experts, using the following definitions developed:

PCA 1: Areas with populations which must be included in a reserve system (excluding the Tohono O'odham Nation);

PCA 2: Areas that would be of value to the reserve system;

PCA 3: Critical landscape linkages;

PCA 4: Areas with potential for habitat restoration or enhancement.

PCAs are based on local knowledge and integration of the differences between habitat conditions, threats, and species population distributions. PCA 1-3 should

represent a prioritization of the area of potentially suitable habitat for regional conservation and acquisition.

PCAs and habitat models were periodically adjusted by species experts assembled by County staff. These adjustments have been reviewed at STAT meetings and generally approved, but the process itself has not been reviewed and endorsed. Therefore, County staff requests approval of the following process:

Staff initiates a revision by soliciting and receiving input from at least two individuals with particular expertise in the distribution or habitat preferences of the species in question. Experts will be scientists who are engaged in inventory, research or monitoring of the taxon as it occurs in Pima County and the surrounding region. County staff would also solicit supporting documentation from amateur naturalists, consulting biologists, or scientists with particular knowledge of habitat preferences outside of Pima County.

Staff uses input from the experts to revise the habitat model parameters, limits of analysis, or the area or classification of the PCA. Staff obtains location or distribution information for the experts as appropriate. Staff prepares maps or other materials for review by the experts.

Staff presents revised models or PCAs based on the input of the experts at a meeting of the Science Technical Advisory Team or other appropriate advisory group. Notice of the meeting will be provided to interested parties.

The technical advisory group approves or recommends changes.

Staff replaces the preceding version of the model or PCA on official maps and uses the information in analyses, as appropriate.

In making its determination as to whether or not to initiate a review of a species, Pima County staff will be particularly interested in habitat models that are refined for more localized areas of the County, such as happened with the City of Tucson and Town of Marana HCP. In this review process, Pima County staff will determine the method(s) used to develop models.

Neither County staff nor STAT recommend revisions to the CLS in any future review of species' habitat or PCA. The habitat suitability models of priority vulnerable species were also used, along with many other inputs, for developing a biological reserve design for the entirety of Pima County (RECON 2000; RECON 2001). It would be incorrect to base revision of the Conservation Lands System upon new habitat suitability models alone. The Science Technical Advisory Team re-iterates its recommendation that any revision of the Conservation Lands System be based upon a similarly comprehensive review of available biological data, including fine-filter and

coarse-filter information as well as review of the principles of reserve design by a similarly constituted advisory body.

Literature Cited

RECON Environmental Inc. 2000. Priority Vulnerable Species: Habitat Data Analysis. Report to the Pima County Board of Supervisors for the Sonoran Desert Conservation Plan, Tucson, AZ.

RECON Environmental Inc. 2001. Reserve Design Process Update. Report to the Pima County Board of Supervisors for the Sonoran Desert Conservation Plan, Tucson, AZ.

Appendix 2. Habitat Impact Analysis Methods
By Julia Fonseca, Cory Jones, Mike List, Mark Probstfeld, and Sherry Ruther, Pima County.

Overview: Urban growth projections use land to absorb an increasing human population. The growth projection scenario used for estimating habitat impacts was developed by a public-private team of planners and engineers during the City-County Water Study, then modified for this study to assess a shorter and variegated time horizon. Then the impacts within the permit area from the growth model were combined with the impacts from future Capital Improvement Program projects for the 30-year term of the Multiple Species Conservation Plan (MSCP). This combined result was then intersected with species habitats to measure habitat impacts. Figure A summarizes the methods used.

The resulting impacts are a projection of where covered activities might occur. Actual measurements of covered activities will be tracked using rezonings and Certificates of Inclusion on an annual basis.

Urban Growth Projection: The projection of urban growth we used for habitat impacts was consistent with what was called the "status quo" growth scenario in the City-County Water Study (Stantec 2009). The defining characteristic of the "status quo" growth scenario is that new growth in the suburbs occurs at 2500 people per square mile, a relatively low metropolitan population density that is consistent with current patterns of growth in the Tucson area. If the region is able to achieve higher urban densities (ie, requiring higher densities in planned communities and/or implementing transit oriented development), then the predicted habitat impacts would be fewer than represented here. More information is available about the development of the "status quo" growth scenario in Stantec (2009).

For our purposes, assumptions were needed to predict population growth at ten-year increments, and to differentiate covered activities from other impacts in the permit area. Because of the changes in covered activities, we departed from methods described in Fonseca et al. (2009), which were the basis for habitat impacts in the Draft 5 MSCP.

We obtained population projections from the Arizona Department of Economic Security (2008) for the years 2020, 2030, and 2040. These projections were used in conjuntion with an urban form classification developed for the City-County Water Study. This GIS layer divides eastern Pima County into four urban form units (urban core, core suburbs, expanding suburbs, and exurbs) and many sub-units (eg, exurbs - lot split low density) . Each urban form unit dictates a unique population density, ranging from 4500 people per square mile in the urban core to 300 people per square mile in portions of the exurbs. The urban form boundaries were drawn using elements of the Pima County Comprehensive Plan and the City of Tucson General Plan in conjunction with data on current population density as well as subdivision and annexation history. The urban form layer was overlain with the past ten years of

residential building permits, and the resulting ratios of permits by urban form were applied to the population projections. In this fashion, land absorption was "spread around" at varying population densities based on dynamics particular to eastern Pima County.

A definition of the current built environment per the Pima Association of Government's latest land use model (2008) was used as the starting point for adding new urban growth. This is different than the Draft 5 MSCP calculation for the 2008 built environment, which was based solely on Pima County data. Road rights-of-way (ROW) were not included in the built environment.

Constraints to future land absorption were as chosen by the City-County Water Study Committee. For this model we stipulated that urban growth would not occur:

- in the existing built environment, except non-mapped infill in the urban core/core suburbs,
- in areas of greater than 25% slope,
- in areas of existing mines/quarries,
- in areas of floodways,
- on federal or tribal lands except BLM disposable land outside CLS,
- in existing or proposed preserves of any kind,
- on Tucson Water municipal lands and wellfields,
- on active landfills,
- on golf courses,
- within road rights-of-way,
- in public parks
- in cemeteries
- in DM/TIA approach and departure corridors.

Most land absorption occurred in the suburbs, which were divided into four urban form sub-units. The City-County study recognized both planned and unplanned residential suburban development. (Stantec 2009). Planned development was defined using information from Comprehensive Plan Amendments, State Trust discussions, and other GIS data. Planned development included unbuilt *and* partially built communities. At 2020, State Trust Land was only released within planned communities. In the subsequent timeframes, State Trust Land was released to development throughout the rest of the suburbs, but not in any of the exurbs.

Suitability for future development was developed in consultation with the City-County Water Study, and in consideration of recent trends in development. Suitability was assumed to improve with proximity to:

- Existing, committed, and planned road and transit infrastructure,
- Existing potable water infrastructure,

- Top single-site employers,
- Existing sewage conveyance and treatment infrastructure,
- Recent (2003-2008) building permits and house sales,
- Current built environment,
- Municipal parks and selected trailheads,
- High-performing school districts
- Areas not deemed “high stress”.

Note, these variables were weighted in terms of influence through a match pairs comparison exercise (ie, Analytical Heirarchy Process) completed by the team of engineers and planners.

Population is “absorbed” by the most suitable 30-meter cell (equivalent to approximately 1/5 acre). The cell size was determined by the slope grid used for urban growth constraints. The cells with the highest devlopment suitability scores were iteratively chosen until each population projection per urban form unit per timeframe was satisfied. The 2020 land absorption projections were added to the existing built environment to yield a new development constraint, and so on through the next timeframes.

Covered Development

Covered activities is the subset of projected urban growth used for our habitat impact analysis. As defined in the MSCP, covered activities are primarily rezonings and other land use activities that are subjected to discretionary approval by the Pima County Board of Supervisors, plus any opt-in parcels. In reality, these will be measured using Certificates of Inclusion recorded on an annual basis. To represent where the potential rate of these, we estimated the maximum potential annual acreage of rezonings based on previous years to be approximately 1100 acres per year, creating a ceiling of ~33,000 acres for a projection of covered activities. The cells of projected urban growth within planned communities within the City-County model in the permit area were selected to represent the potential location of covered activities. Growth that occurred in planned communities represented the bulk of covered activities in this model. We added that to the cells of growth that landed in areas that were rezoned between 2002 and 2009.

Capital Improvements Program

Staff reviewed all capital improvements projects identified by contributing departments of Pima County. Projects which would likely be completed before the MSCP permit is issued were deleted, as were projects believed to cause no new ground disturbances. All road projects are considered covered activities, but repaving and other projects confined to existing built rights-of-way were not modeled. Only projects in the permit area and outside the built environment were used. An estimated 1800 acres of potential impacts was identified in the GIS representation for capital improvements.

Habitat Losses

Habitat losses were modeled using the sum of covered development activities and capital projects, intersected with each of the species' habitats. We assumed that nearly all of the capital improvement projects would be completed in the first 20 years. For covered development, the assumptions about the availability of State Trust land results in "filling" the rezonings and planned communities mostly in the first 20 years.

Habitats were defined using all Priority Conservation Areas 1 through 4 defined by experts (EPG 2001). Two species, the desert tortoise and Tumamoc globeberry, do not have PCAs. We used habitat suitability models for these species. The desert tortoise model used was the "bedrock plus" model developed by Julia Fonseca with review by the Marana Technical Biological Team and others. The Tumamoc globeberry model used was the potentially suitable habitat model developed by RECON and others during the Sonoran Desert Conservation Plan.

Occurrences of talus snails and the Arkenstone Pseudoscorpion are too localized to model. Desert pupfish is not modeled because it does not occur in Pima County. It may be reintroduced, but no habitat take is possible until that time.

Habitat Mitigation

We used a projection of mitigation lands that Pima County expects to acquire with existing funding plus existing mitigation lands, previously described in the *Mitigation Lands* report. Lands located outside Pima County were analyzed, but in nearly all cases, PCAs or habitat models do not extend into these areas at the present time. Pima County owns ~1700 acres of Mitigation Land, and manages ~9600 acres outside Pima County boundaries.

Likewise, the Conservation Lands System categories generally do not extend into these areas.

References:

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Figure A. Schematic representation of the methods used to calculate habitat loss and habitat mitigation (illustration by Mike List)

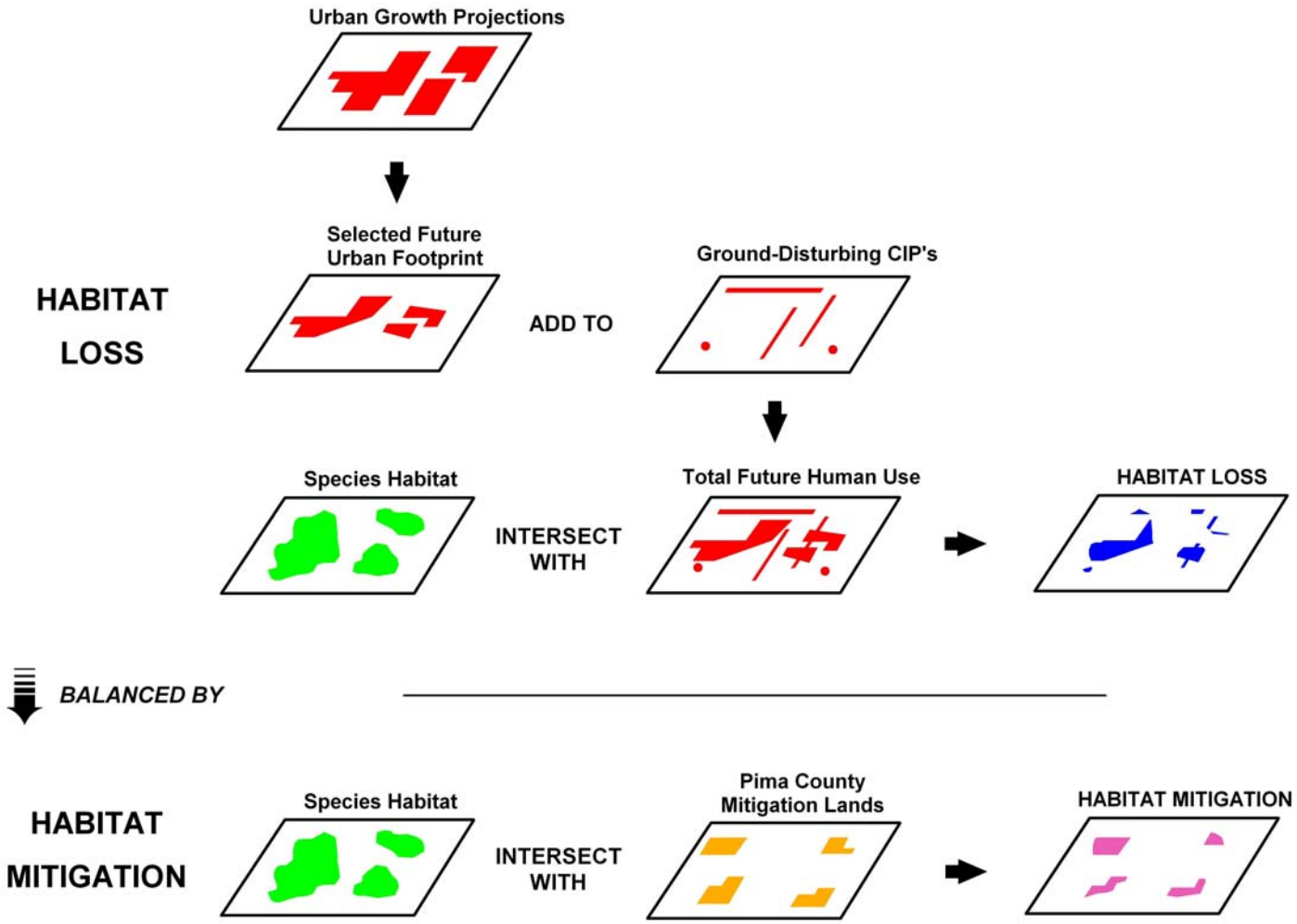

Figure B. Schematic representation of the methods used to calculate CLS impacts and mitigation (illustration by Mike List)