

**APPENDICES**.....

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## **Appendix A – Sonoran Desert Management Questions**

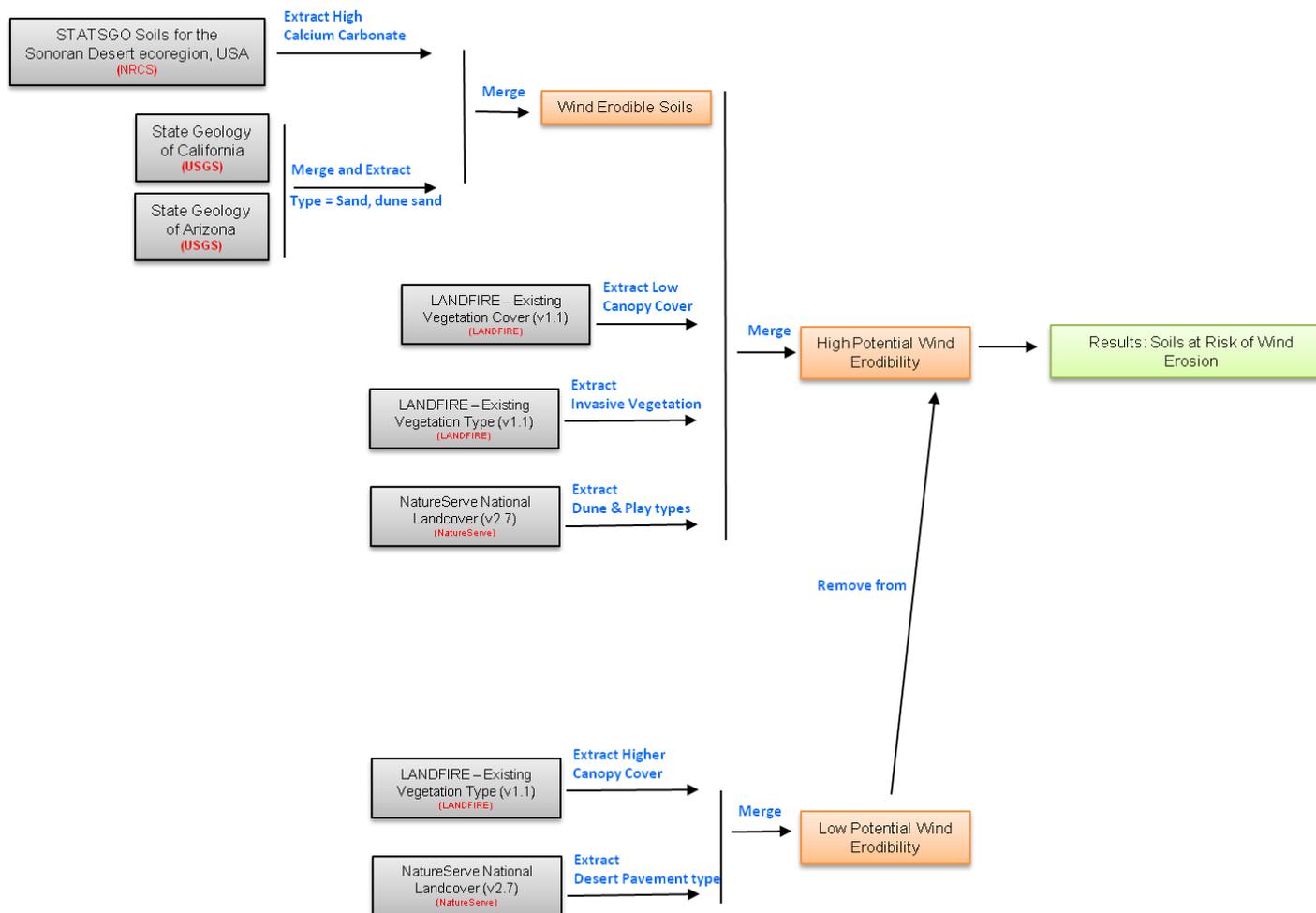
### **Organization of Appendix A**

The following sources and results are provided for each management question: a conceptual model and/or a Process Model and a description of the analytical process (including source data) for each management question and results in the form of maps and other supporting graphics. Access to a data portal to examine the results in greater detail is available at the BLM website: <http://www.blm.gov/wo/st/en/prog/more/climatechange.html>.

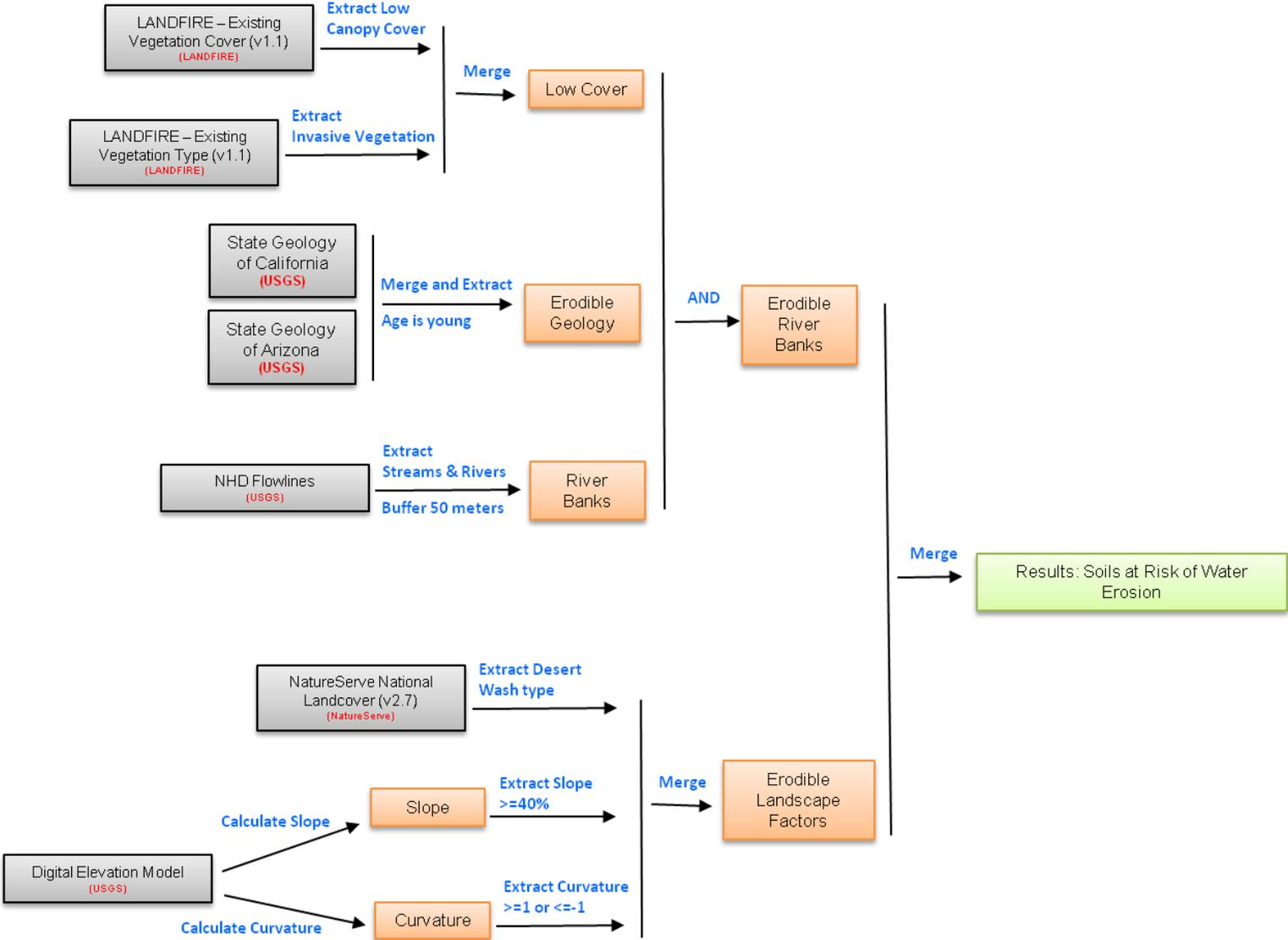
## A. Soils, Biological Crust, and Forage Management

MQ A1. Where are soils susceptible to wind and water erosion?

### Process Model: Wind Erosion

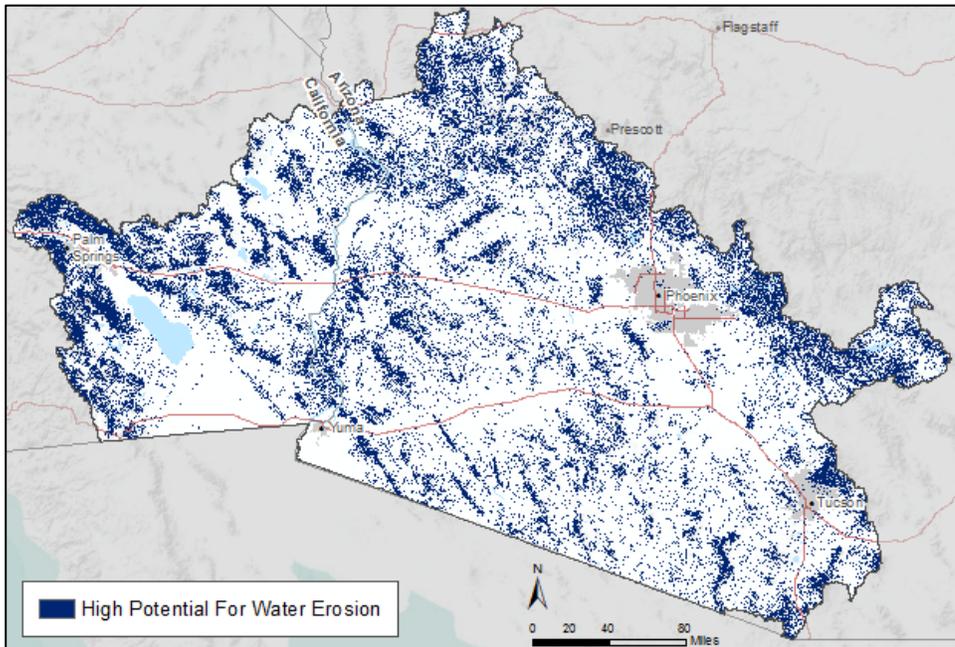
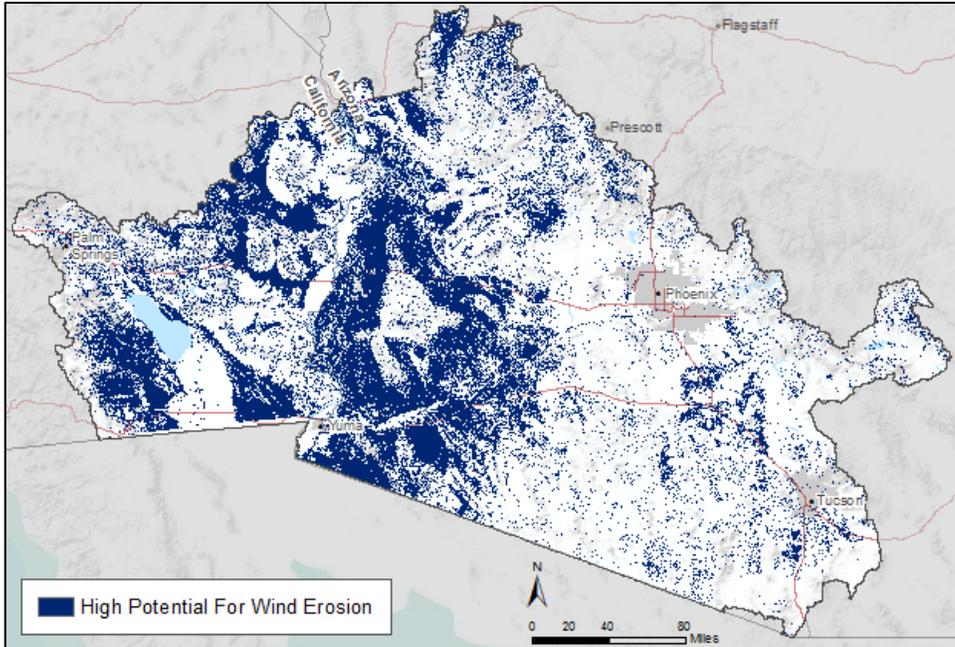


# Process Model: Water Erosion



# Results for Soils Susceptible to Wind and Water Erosion

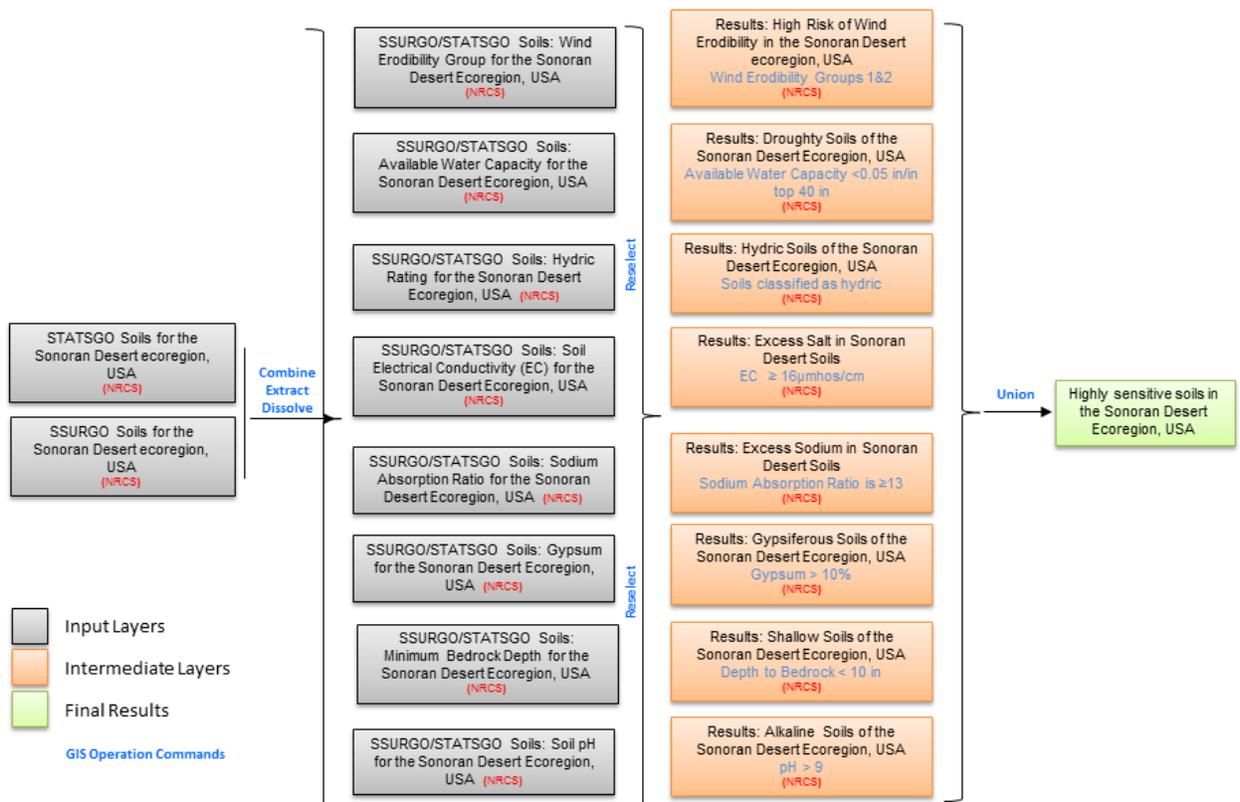
MQ A1. Where are soils susceptible to wind and water erosion?



## A. Soils, Biological Crust, and Forage Management

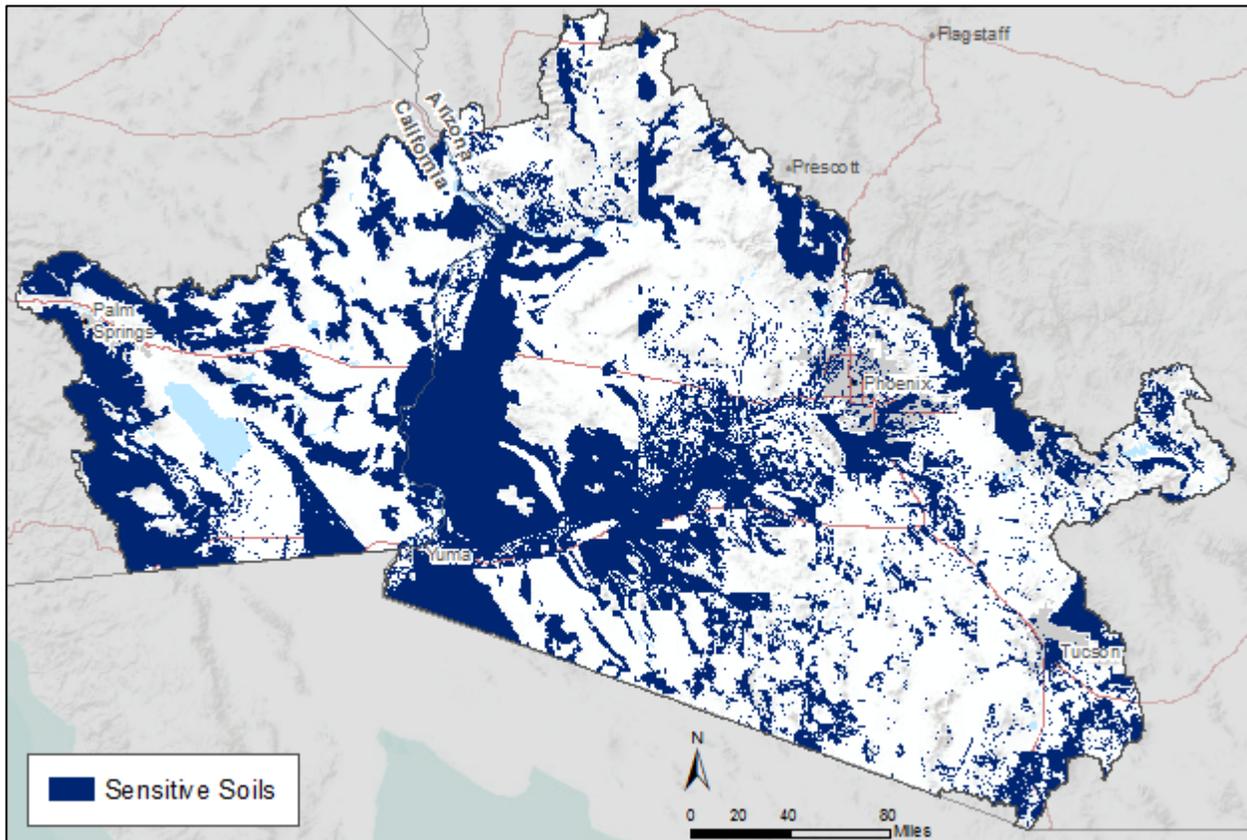
MQ A2. Where are sensitive soils (including saline, sodic, gypsiferous, shallow, low water holding capacity)?

### Process Model



## Results for Sensitive Soils All Types

MQ A2. Where are sensitive soils (including saline, sodic, gypsiferous, shallow, low water holding capacity)?



Note: Any individual soil type may be viewed individually as source data on date portal.

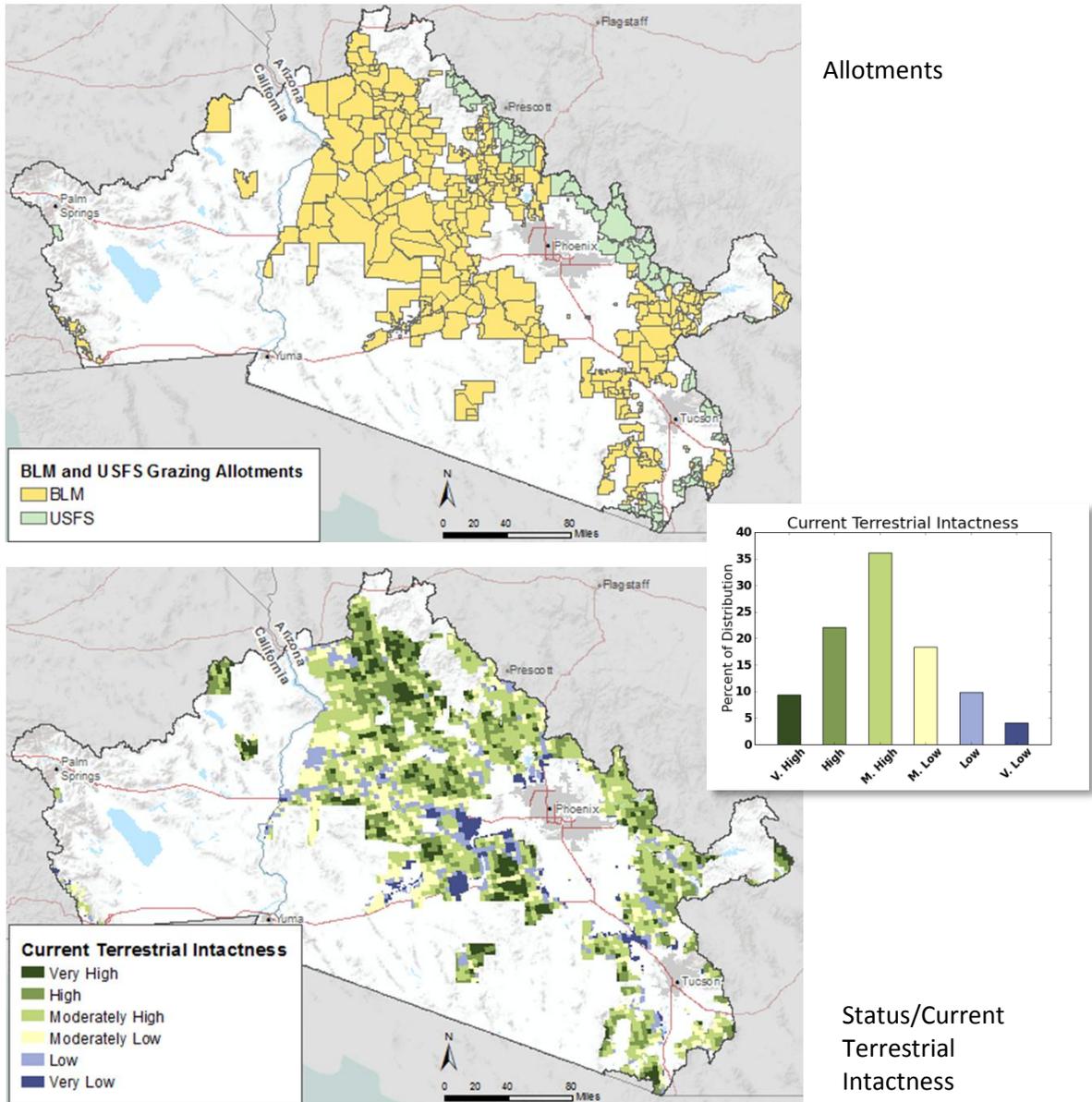
## A. Soils, Biological Crust, and Forage Management

MQ A3. Which HMAs and allotments may experience significant effects from change agents including climate change?

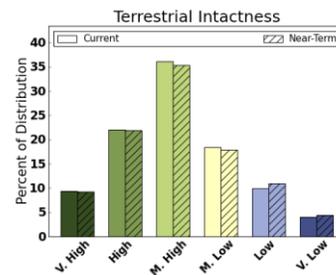
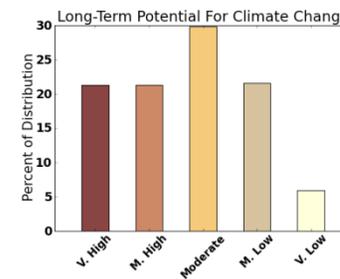
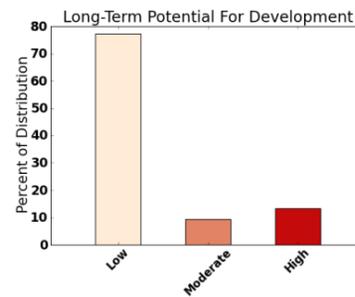
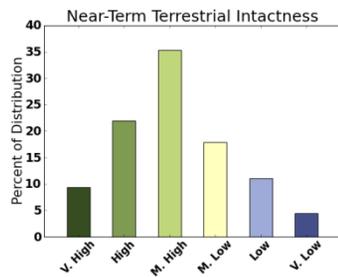
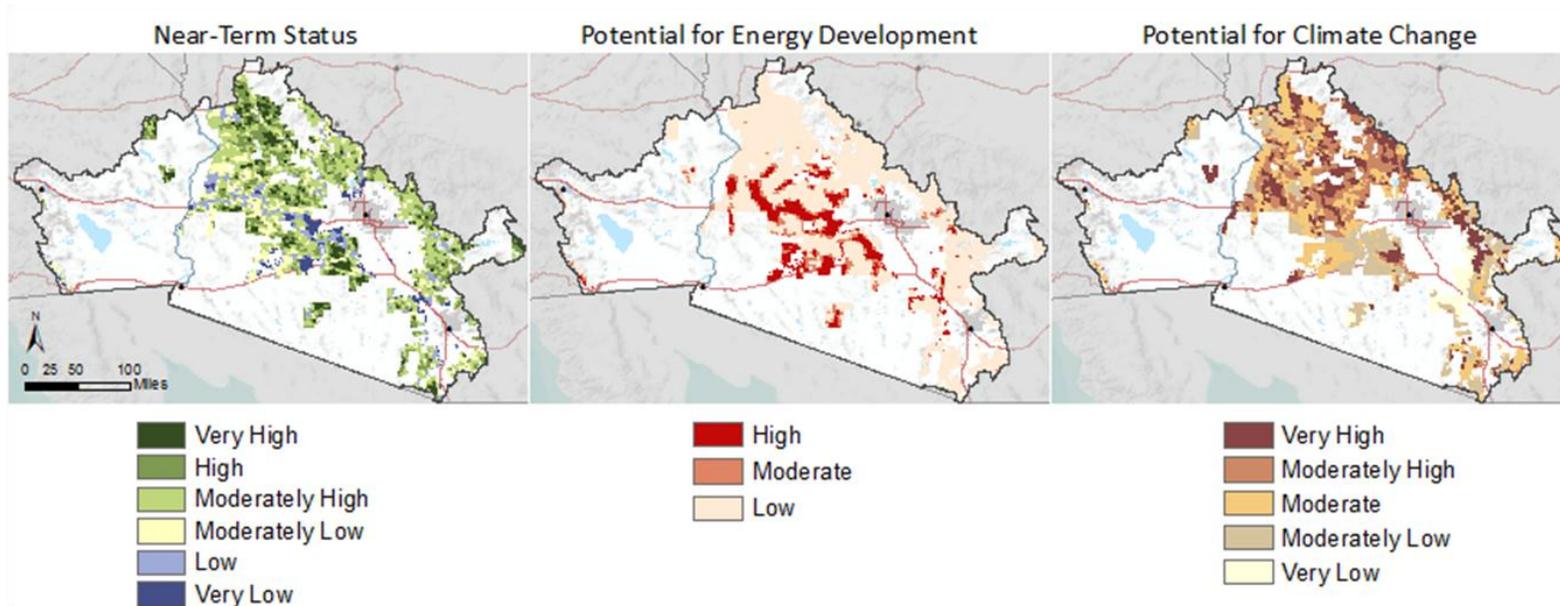
### Process Description

Grazing allotments and Wild Horse and Burro Herd Management Areas were intersected with the combined results of current and near-term terrestrial intactness and long-term potential for climate change and energy development (see Appendix E for logic models).

### Results



MQ A3. Which grazing allotments may experience significant effects from change agents including climate change?

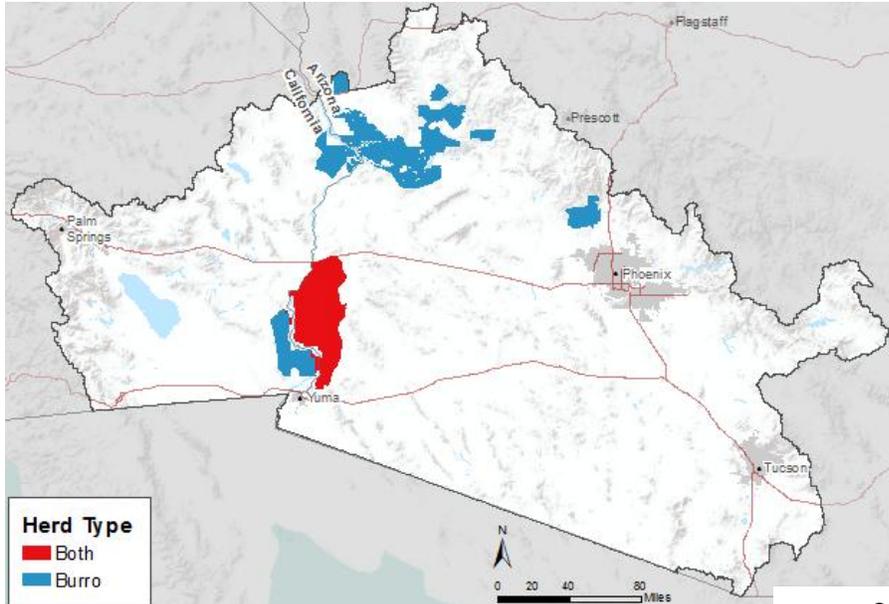


**Current & Near-term Intactness**

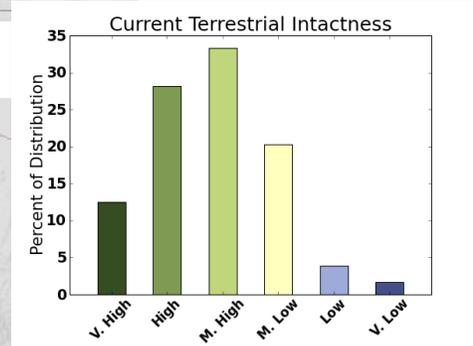
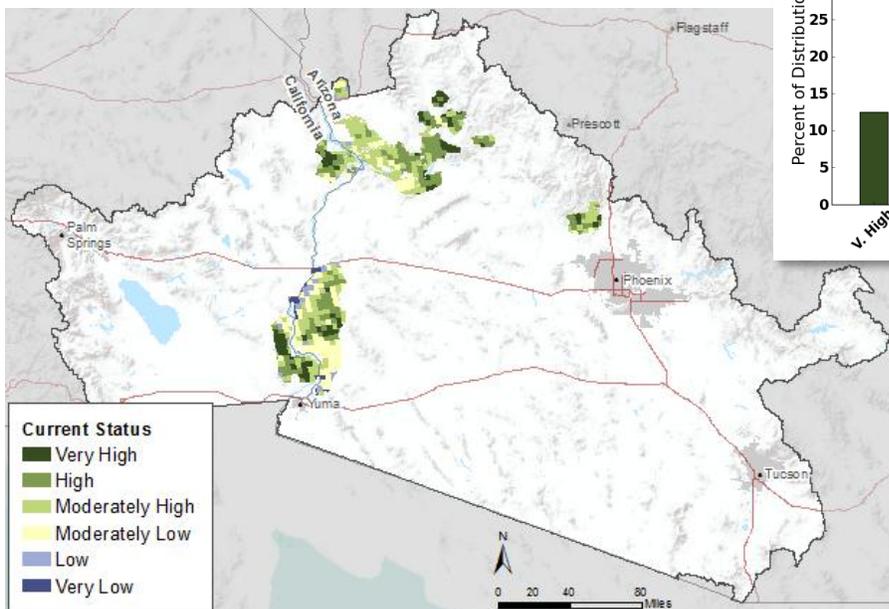
Current (solid color) and Near-term (cross-hatched) Intactness

MQ A3. Which Wild Horse and Burro Herd Management Areas may experience significant effects from change agents including climate change?

**Current Distribution and Status of Herd Management Areas (HMAs)**

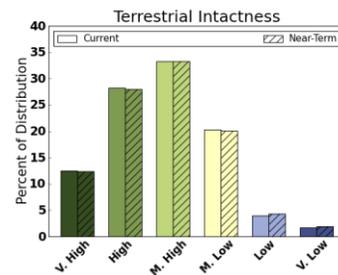
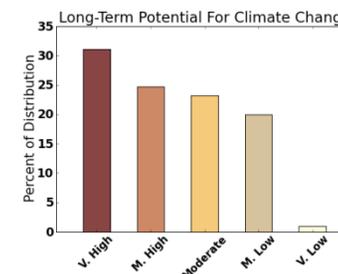
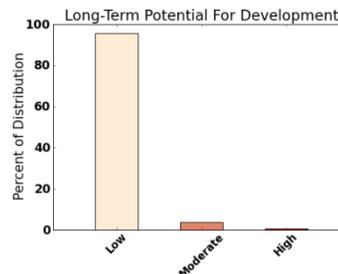
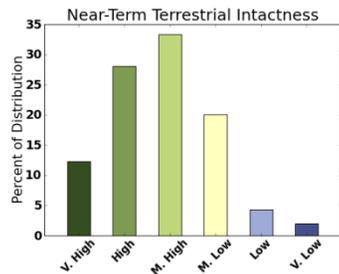
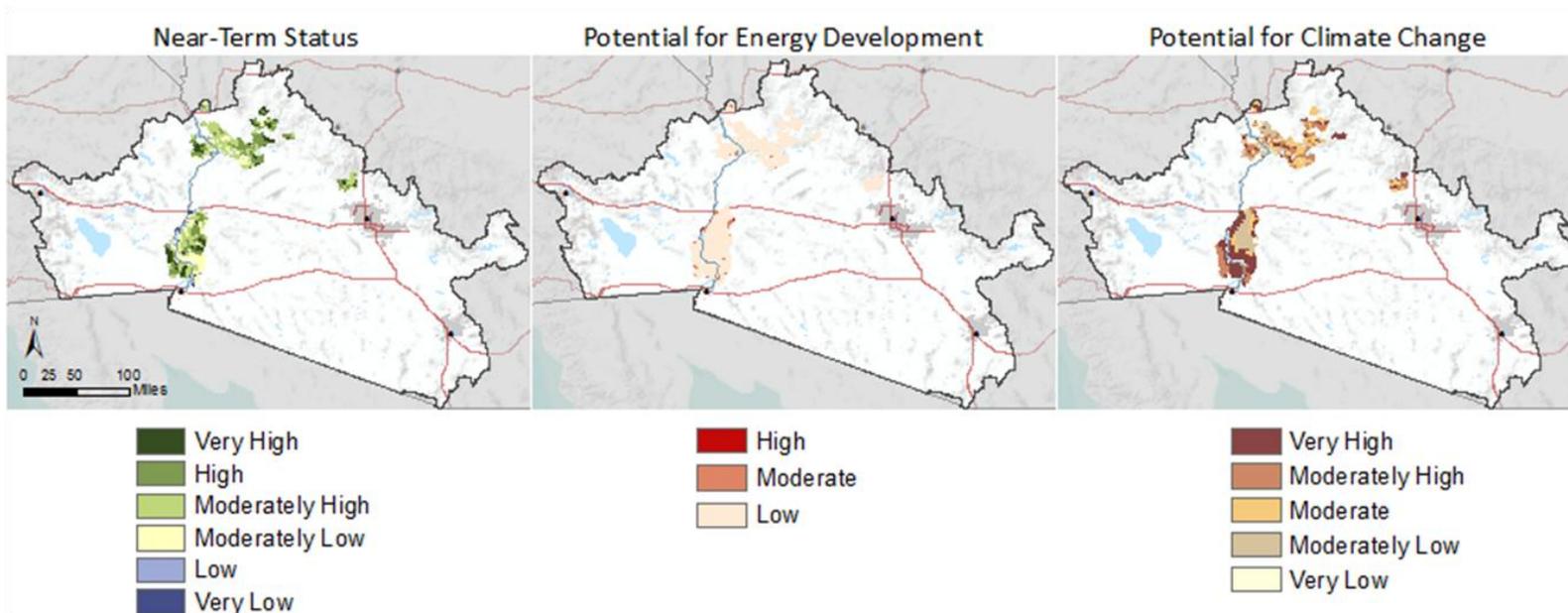


Herd Management Areas



Status/Current Terrestrial Intactness

MQ A3. Which Wild Horse and Burro Herd Management Areas may experience significant effects from change agents including climate change?



**Herd Management Areas  
Current & Near-term Intactness**

Current (solid color) and Near-term (cross-hatched) Intactness

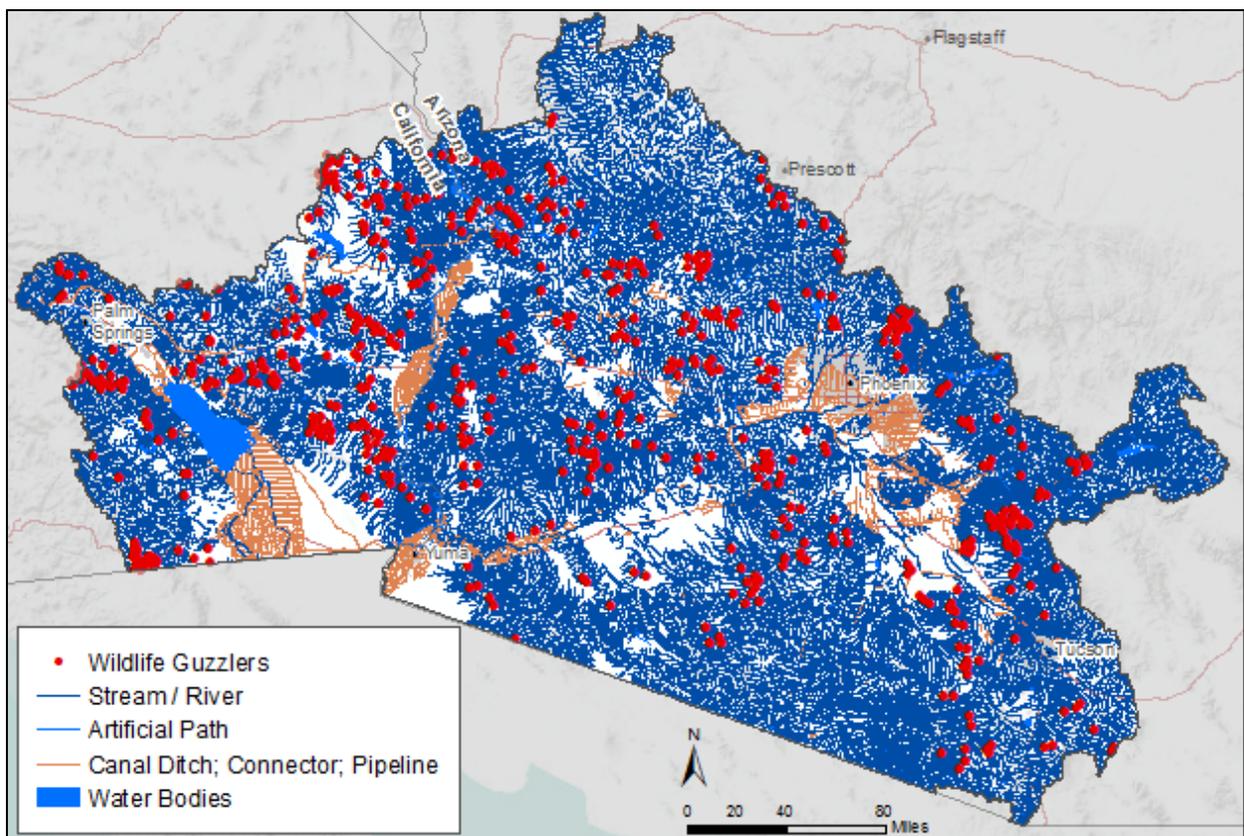
## B. Surface and Groundwater

MQ B1. Where are lotic and lentic surface waterbodies and livestock and wildlife watering tanks and artificial water bodies?

### Process Model or Description

Features from National Hydrography Dataset (USGS) Flowlines and Water Bodies datasets extracted. **Flowlines represent ephemeral, intermittent, and perennial stream channels.**

### Results



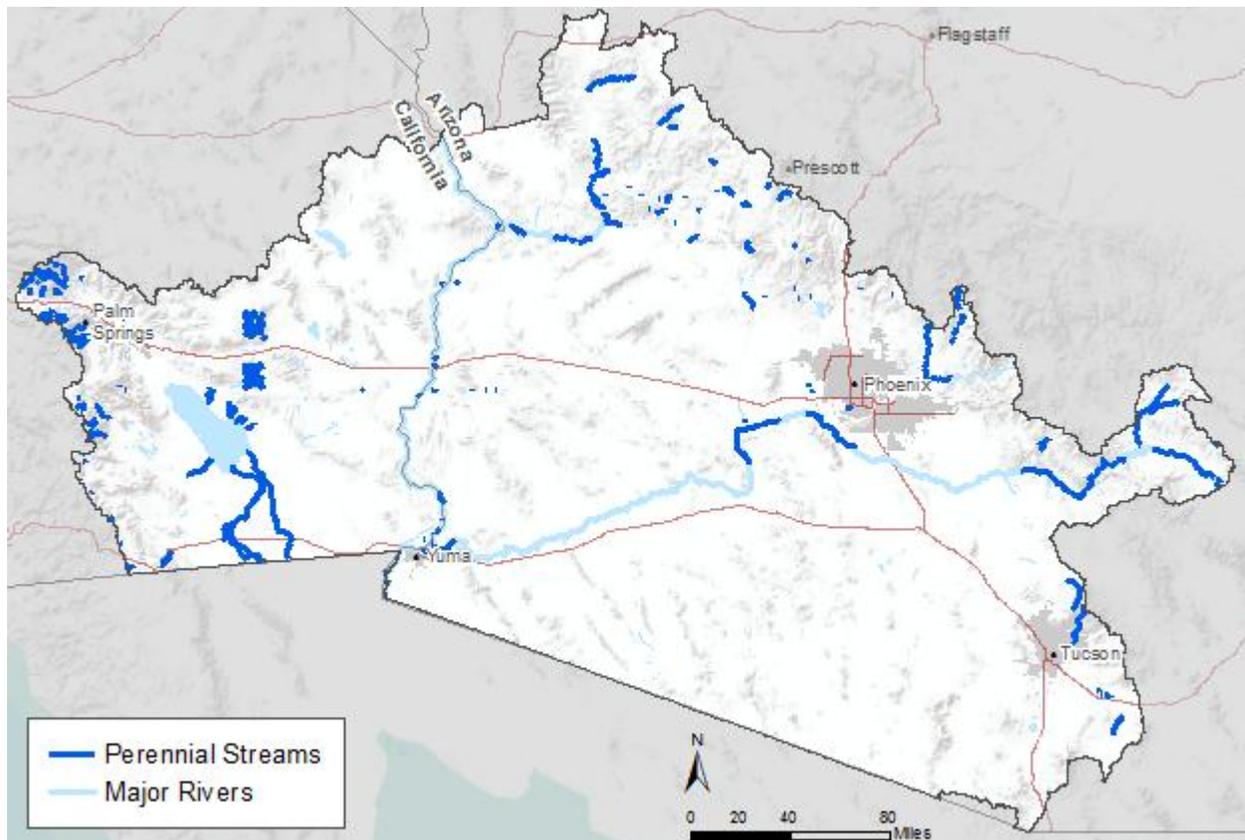
## B. Surface and Groundwater

MQ B2. Where are perennial streams and stream reaches?

### Process Model or Description

Features marked as perennial streams from National Hydrography Dataset (USGS) Flowlines. (Note: some features that may in fact be perennial were not marked as such, because of other labels, e.g., Artificial Path)

### Results



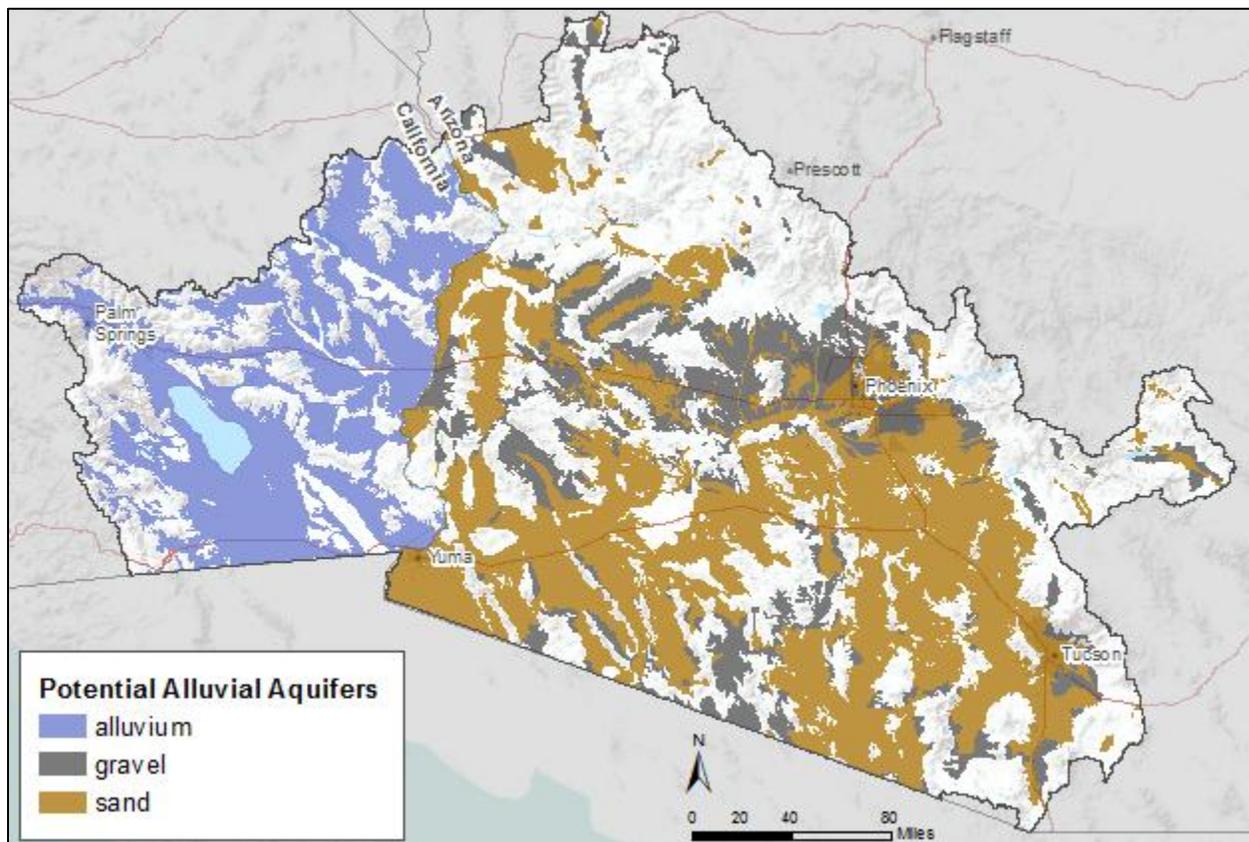
## B. Surface and Groundwater

MQ B3. Where are the alluvial aquifers and their recharge areas (if known)?

### Process Model or Description

Selected alluvium, sand, and gravel types from composite state geology dataset

### Results



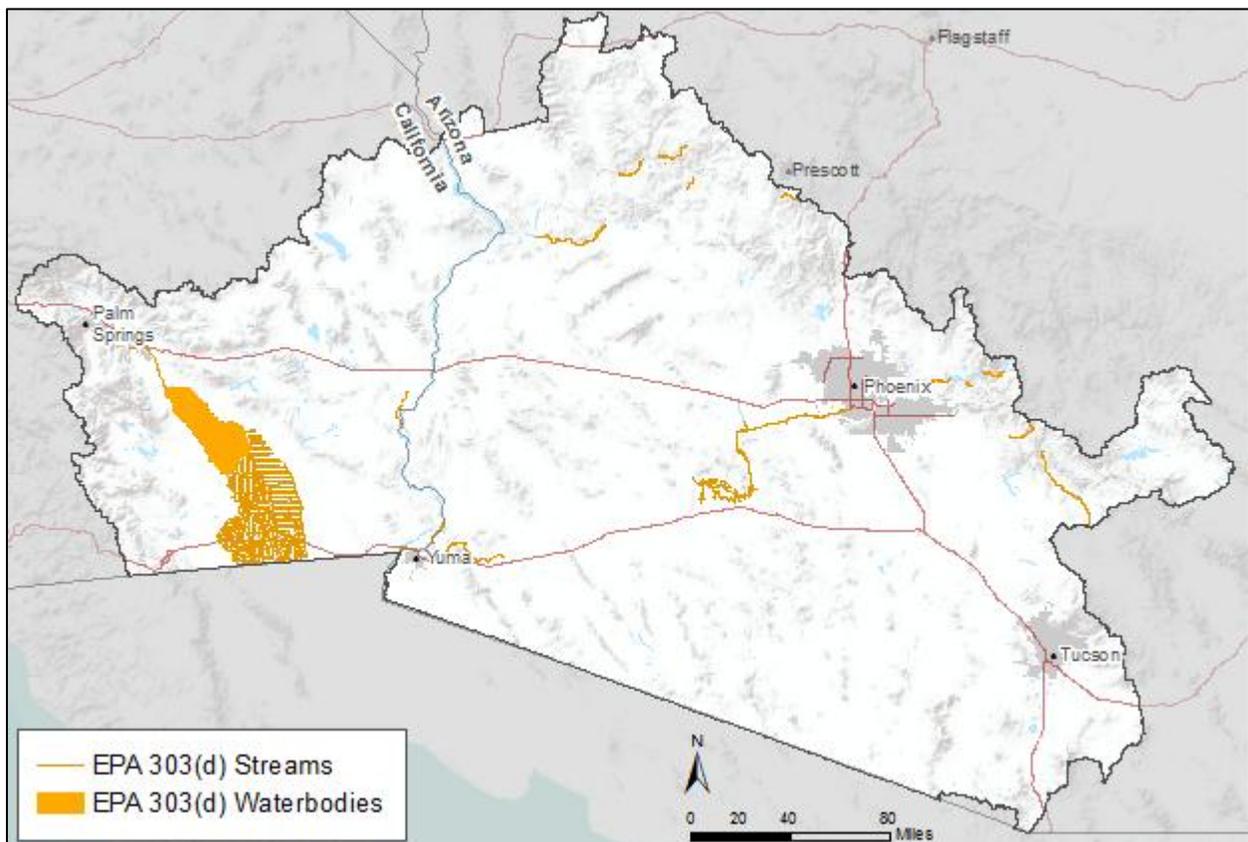
## B. Surface and Groundwater

MQ B4. Where are the aquatic systems listed in 303(d) with degraded water quality or low macroinvertebrate diversity?

### Process Model or Description

Features were identified in Environmental Protection Agency (EPA) 303(d) datasets. Explanation of 303(d) below from EPA website <http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/overview.cfm>: The term "303(d) list" refers to the list of impaired and threatened waters (stream and river segments, lakes) that the Clean Water Act requires all states to submit for EPA approval every two years on even-numbered years. The states identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards, and establish priorities for development of Total Maximum Daily Loads (TMDLs) based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors. States then provide a long-term plan for completing TMDLs within 8 to 13 years from first listing.

### Results for Aquatic Systems listed in Section 303(d)



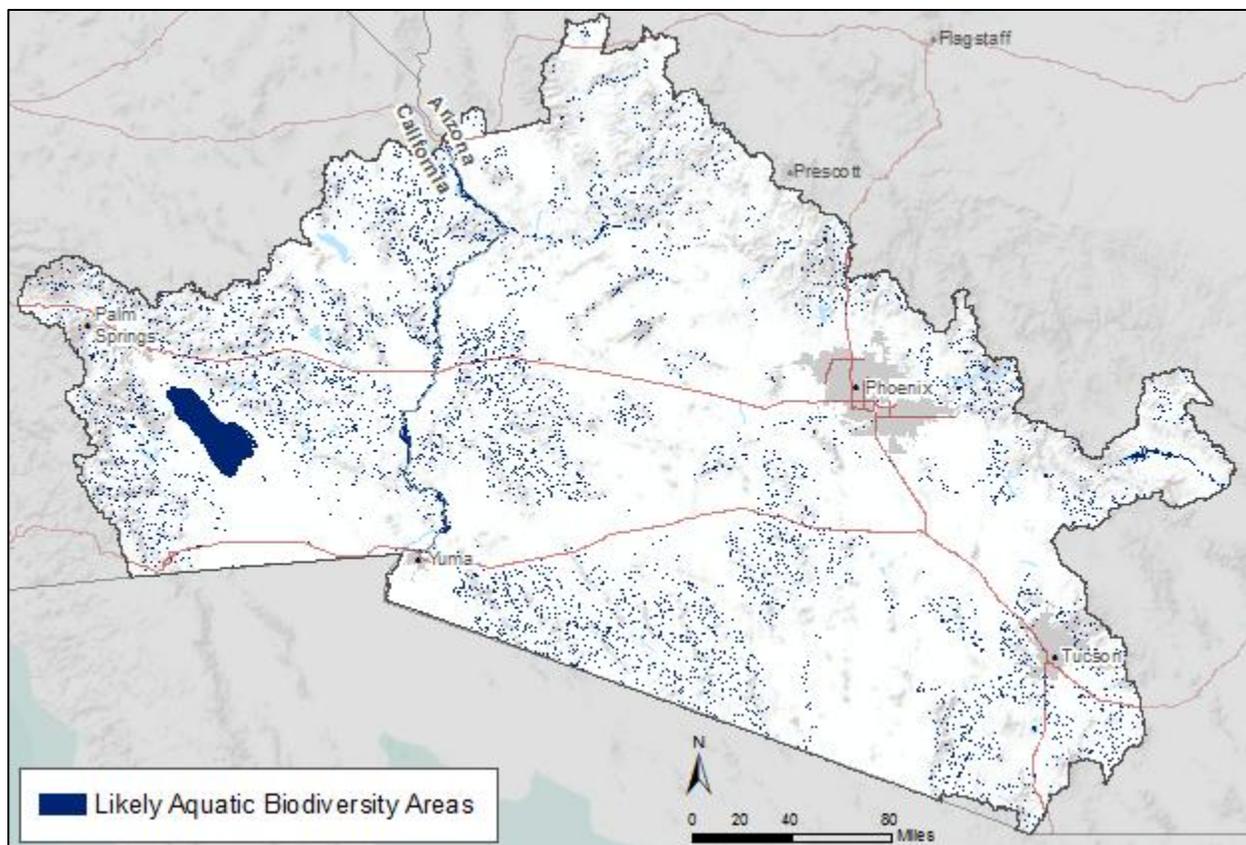
## B. Surface and Groundwater

MQ B6. What is the location/distribution of these aquatic biodiversity sites?

### Process Model or Description

40 meter buffers were selected around NHD flowlines, wetlands, and deep water habitats (USFWS) that fell within Nature Conservancy (TNC) Conservation Portfolio areas or Special Designations.

### Results



## B. Surface and Groundwater

MQ B7. What are seasonal discharge maxima and minima for the Colorado River and major tributaries at gaging stations?

### Process Model or Description

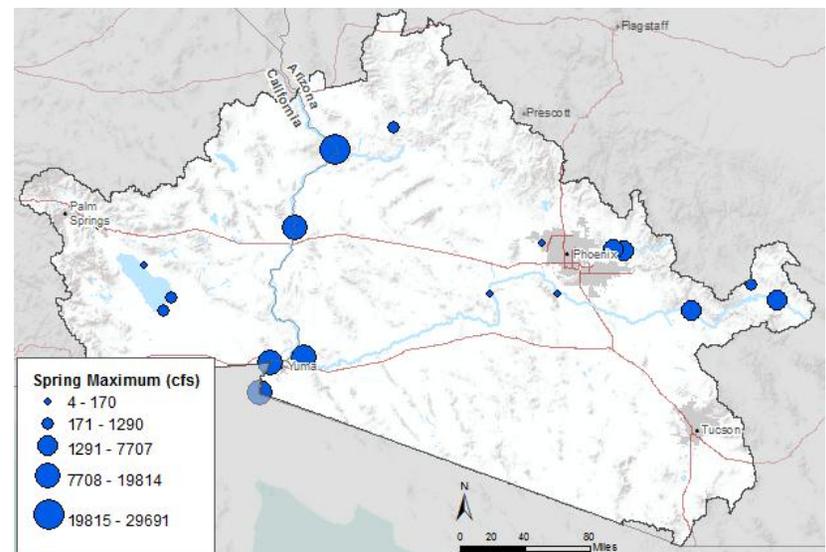
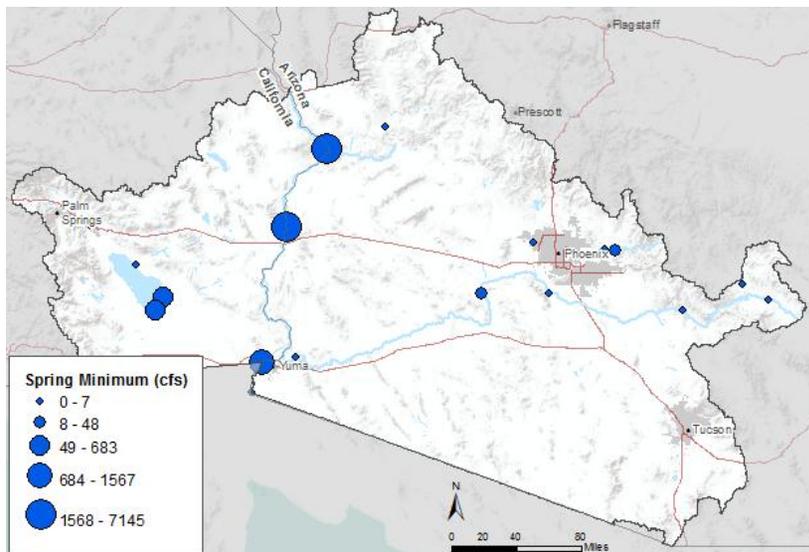
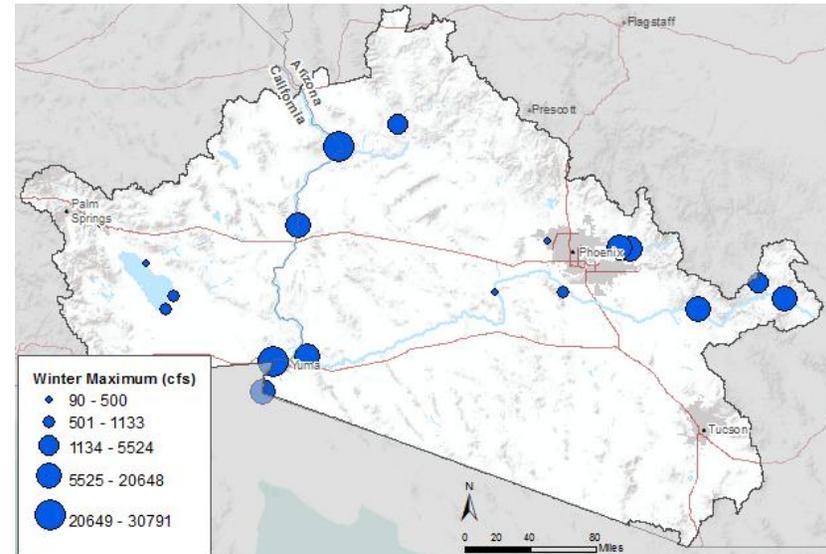
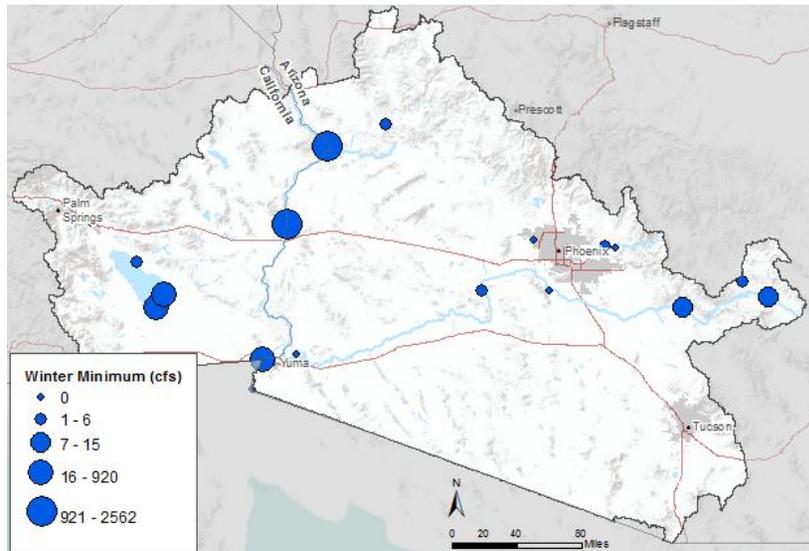
For each gaging station, daily summary statistics were obtained from USGS for the period of record of the station up to 9/30/2010. Daily statistics were partitioned into seasons and minimums and maximums calculated for each season.

Average seasonal maxima and minima for gaging stations on the lower Colorado River and major tributaries recording 12–100 years of records from various gaging stations through 9-30-2010 (Source: <http://waterdata.usgs.gov/nwis>). Figures in cubic feet/second rounded to the nearest cfs.

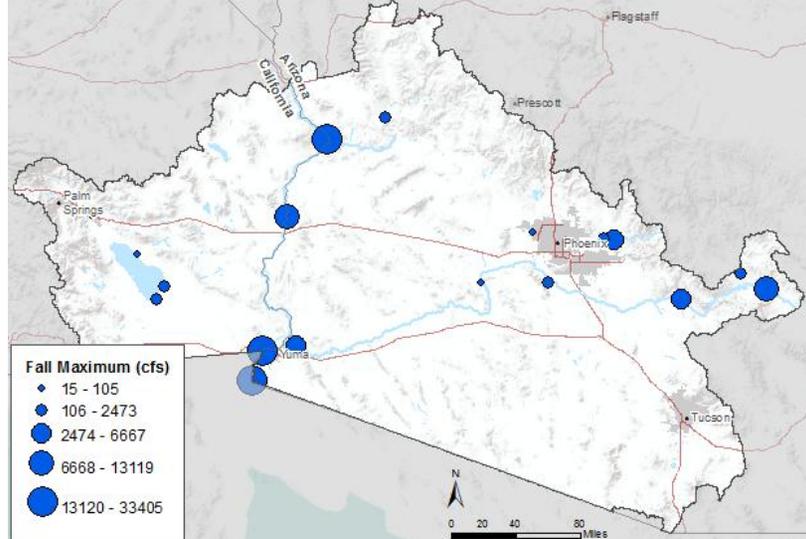
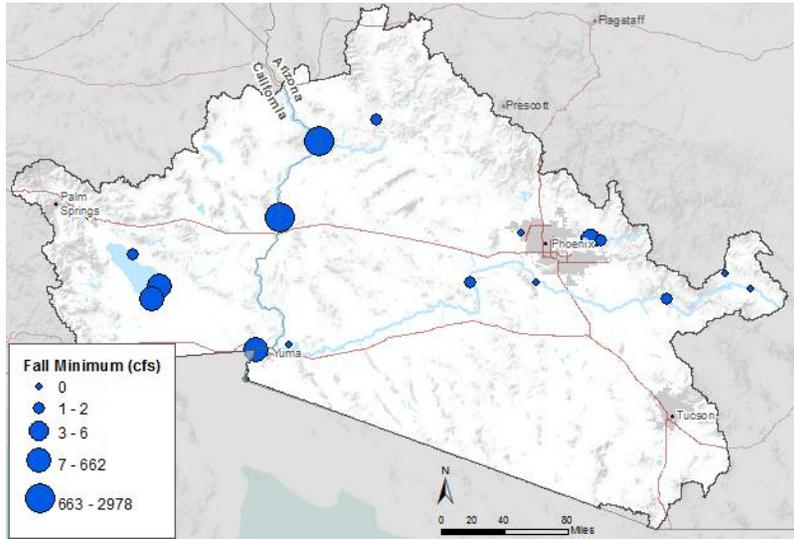
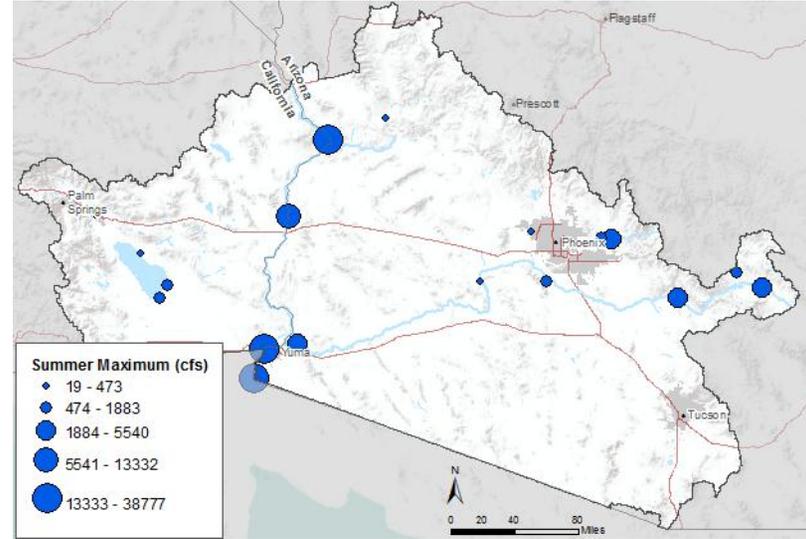
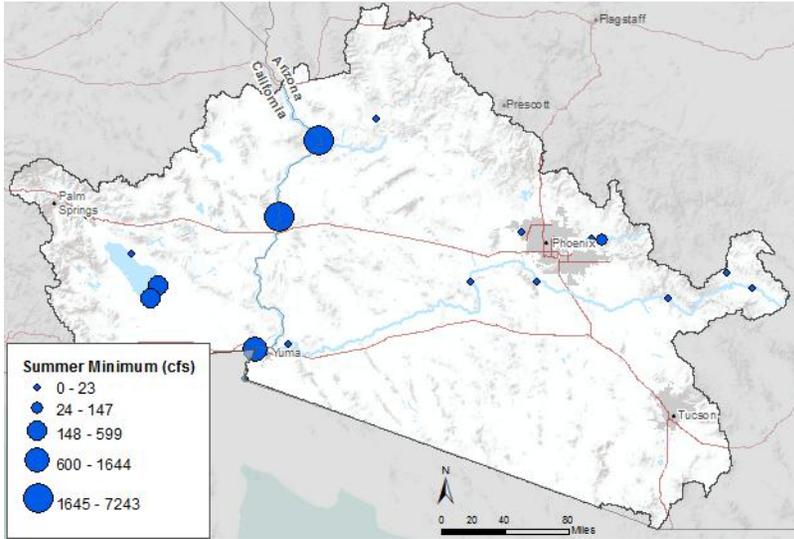
Gaging Station Location	SPMN	SPMX	SUMN	SUMX	FMN	FMX	WMN	WMX
COLORADO RIVER PARKER DAM, AZ-CA	7145	29691	7243	38777	2440	33405	2502	30791
WHITWATER RIVER AT INDIO CA	0	4	0	53	0	28	0	500
COLORADO RIVER PALO VERDE DAM, AZ	6149	17167	5763	13332	2978	13119	2562	18403
SALT CREEK NEAR MECCA	2	21	1	50	1	53	3	90
ALAMO RIVER NEAR NILAND CA	683	1290	599	1274	540	1201	389	1133
NEW RIVER NEAR WESTMORLAND CA	469	918	416	1049	414	973	392	932
AGUA FRIA RIVER AT EL MIRAGE, AZ	0	43	0	19	0	15	0	101
VERDE RIVER NEAR SCOTTSDALE, AZ	0	3950	16	1883	6	2473	6	17144
SALT RIVER STEWART MT DAM, AZ	48	7707	147	2638	1	4672	0	19554
GILA BEND CANAL AT GILLESPIE DAM, AZ.	36	170	23	130	1	105	2	171
SANTA CRUZ RIVER NEAR LAVEEN, AZ.	0	56	0	843	0	1081	0	1017
COLORADO RIVER AT NIB	1567	19814	1644	30509	662	28100	920	24144
GILA RIVER NEAR DOME, AZ.	0	13257	0	3344	0	6667	0	15691
SAN CARLOS RIVER NEAR PERIDOT, AZ.	0	477	0	747	0	1276	2	4655
GILA RIVER AT KELVIN, AZ.	7	3034	3	5540	1	5405	14	16062
GILA RIVER AT CALVA, AZ.	1	3039	0	3101	0	9044	15	13905
COLORADO RIVER NEAR SAN LUIS, AZ.	0	15359	0	25060	0	24945	0	20648

SPMN=spring minimum; SPMX=spring maximum; SUMN=summer minimum; SUMX=summer maximum; FMN=fall minimum; FMX=fall maximum; WMN=winter minimum; WMX=winter maximum.

## Results for Seasonal Max/Min at Various Gaging Stations on the Lower Colorado River and Tributaries



## Results for Seasonal Max/Min at Various Gaging Stations on the Lower Colorado River and Tributaries



<b>C. Ecological Systems Conservation Elements Management Questions</b>
<b>Sonoran Paloverde-Mixed Cacti Desert Scrub – go to Appendix B</b>
MQ C1. Where is existing Sonoran Palo Verde-Mixed Cacti Desert Shrubland and what is its status?
MQ C2. Where are vegetative communities vulnerable to change agents in the future?
MQ C3. What change agents have affected existing vegetative communities?
<b>Sonoran-Mojave Creosotebush-White Bursage Desert Scrub - go to Appendix B</b>
MQ C1. Where is existing Sonoran-Mojave Creosotebush-White Bursage Desert Scrub and what is its status?
MQ C2. Where are vegetative communities vulnerable to change agents in the future?
MQ C3. What change agents have affected existing vegetative communities?
<b>Riparian Vegetation - go to Appendix B</b>
MQ C1. Where is existing Riparian Vegetation and what is its status?
MQ C2. Where are vegetative communities vulnerable to change agents in the future?
MQ C3. What change agents have affected existing vegetative communities?

<b>D. Species Conservation Elements–Management Questions</b>
MQ D1. What is the most current distribution and status of available occupied habitat (and historic occupied habitat if available), seasonal and breeding habitat, and movement corridors (as applicable)?
MQ D6. What aquatic and terrestrial species CEs and movement corridors are vulnerable to change agents in the near-term horizon, 2025 (development, fire, invasive species) and long-term change horizon, 2060 (climate change)?
<b>Go to Appendix C for details on the wildlife species conservation elements listed below:</b>
<b>Bell’s Vireo</b>
<b>Desert Bighorn Sheep</b>
<b>Desert Tortoise (<i>Gopherus agassizii</i>)</b>
<b>Desert Tortoise (<i>G. morafkai</i>)</b>
<b>Golden Eagle</b>
<b>Le Conte’s Thrasher</b>
<b>Lowland Leopard Frog</b>
<b>Lucy’s Warbler</b>
<b>Mountain Lion</b>
<b>Mule Deer</b>
<b>SW Willow Flycatcher</b>

## D. Species Conservation Elements

MQ D4. Where are potential areas to restore connectivity?

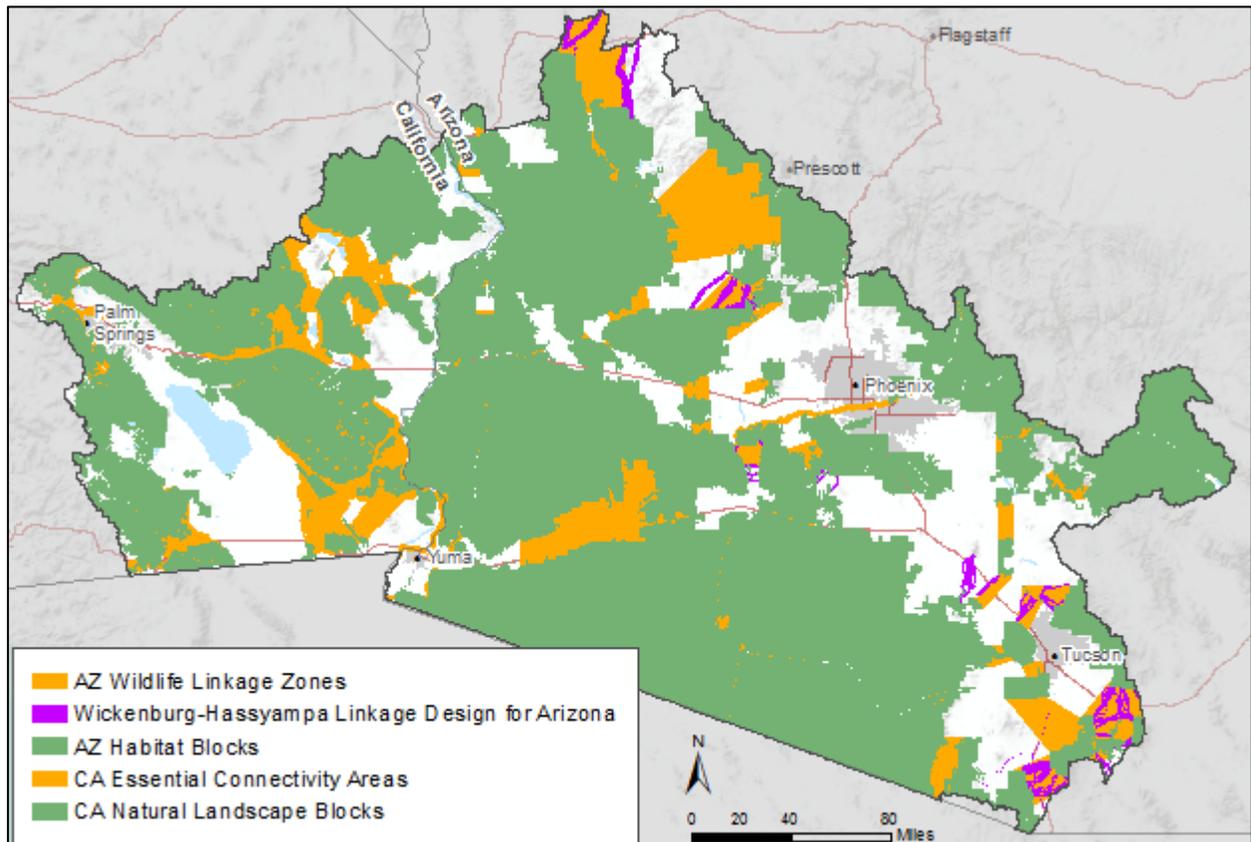
### Process Description

Data were compiled from CA essential connectivity analysis (see Spencer et al. 2010), and Arizona wildlife linkages and blocks (AZDOT 2006). See text Section 4.2.2.

AZDOT (Arizona Department of Transportation). 2006. Arizona's Wildlife Linkages Assessment. Arizona Department of Transportation and Arizona Game and Fish Department. Phoenix, Arizona

Spencer, W.D., P. Beier, K. Penrod, K. Winters, C. Paulman, H. Rustigian-Romsos, J. Strittholt, M. Parisi, and A. Pettler. 2010. California essential habitat connectivity project: A strategy for conserving a connected California. Prepared for the California Department of Transportation, California Fish and Game, and Federal Highway Administration. <http://www.dfg.ca.gov/habcon/connectivity/>.

### Results



## D. Species Conservation Elements

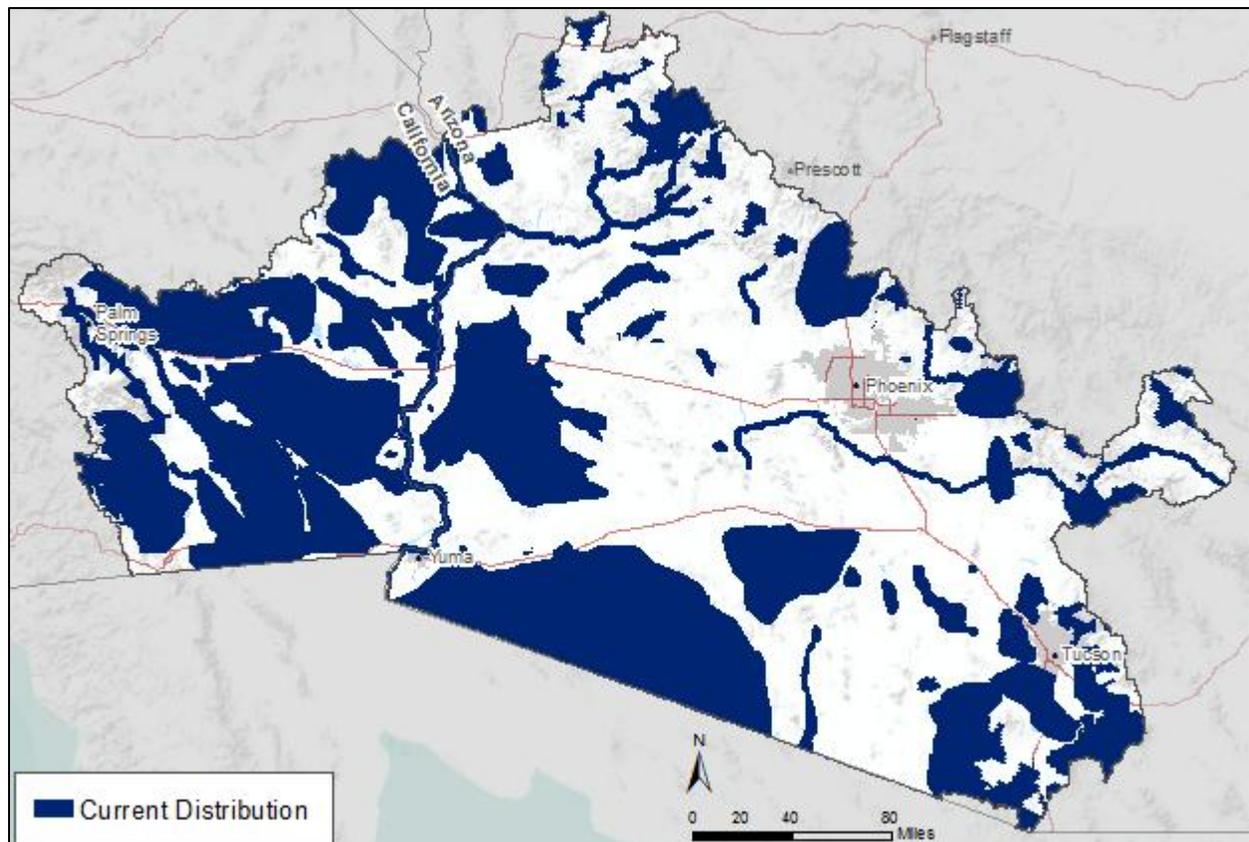
MQ D5. What is the location/distribution of terrestrial biodiversity sites and designated sites?

### Process Description

Terrestrial Biodiversity Sites are defined by TNC Terrestrial Conservation Portfolio areas plus Special Designations: combined CBI Protected Areas Database GAP 1 & 2, roadless areas (USFS), and conservation easements (NCED) with recent versions of wilderness areas and areas of critical environmental concern (BLM). Map also shows national historic and scenic trails, and wild and scenic rivers.

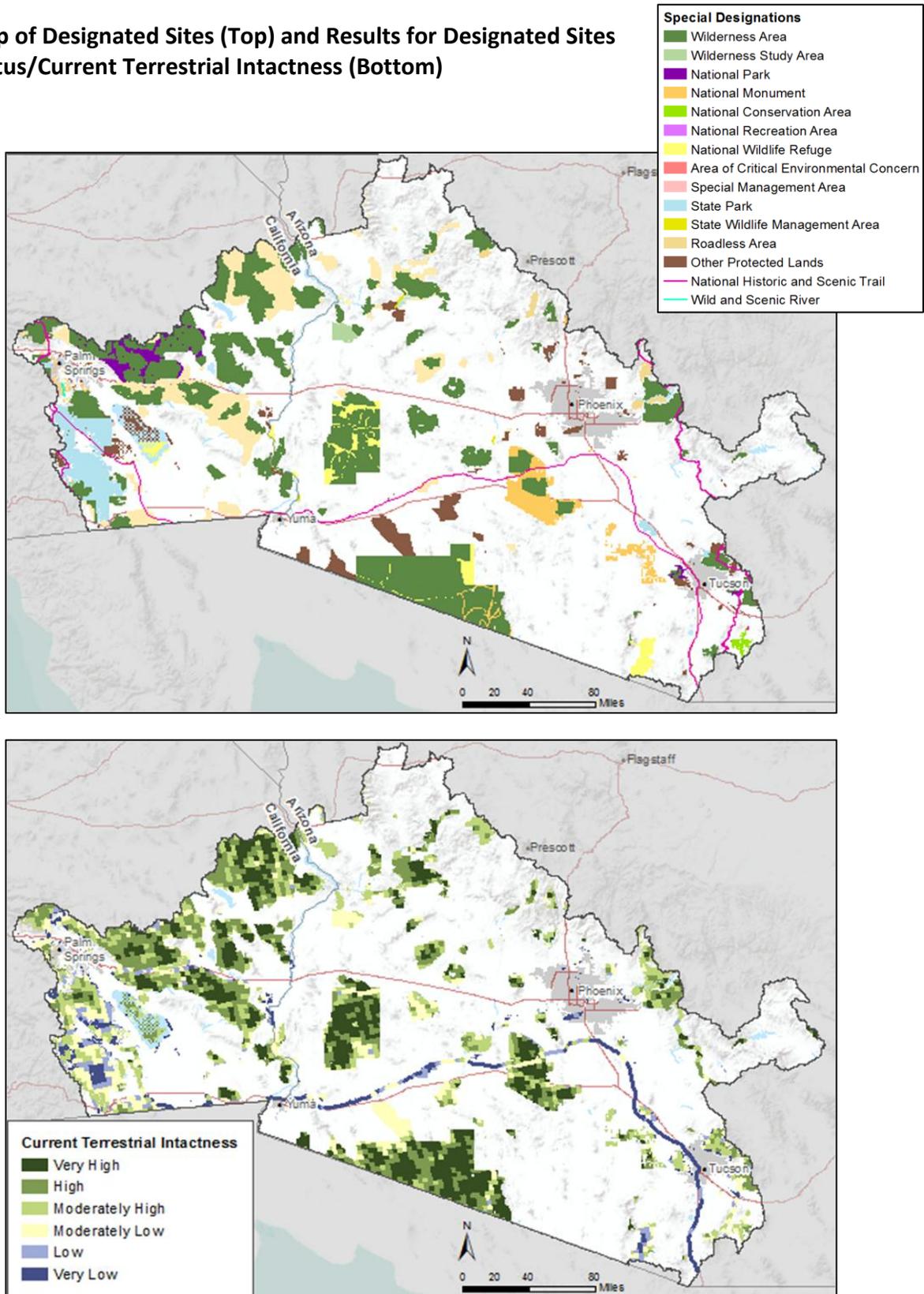
### Results

MQ D5. What is the location/distribution of terrestrial biodiversity sites?

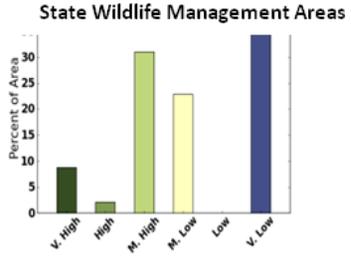
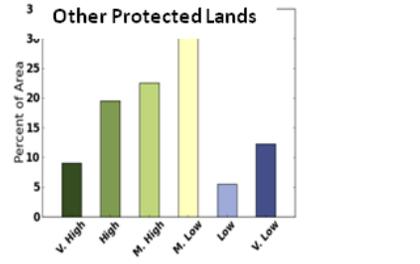
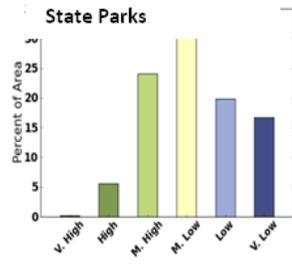
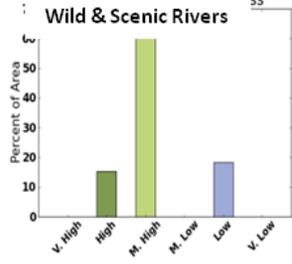
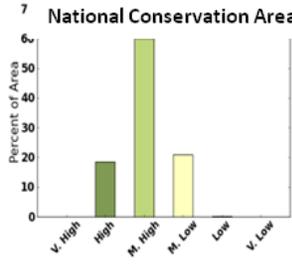
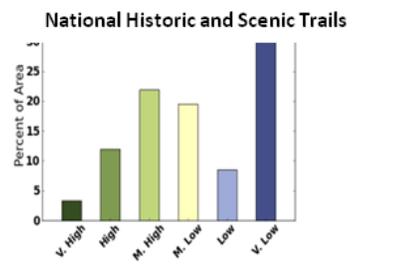
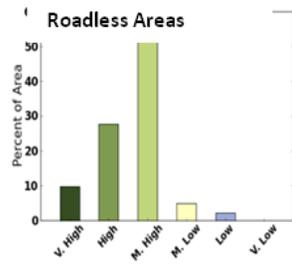
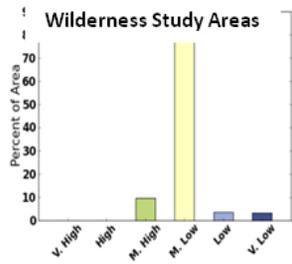
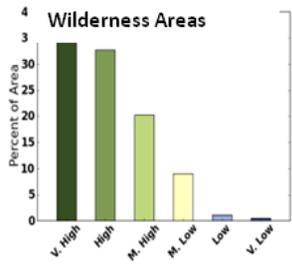
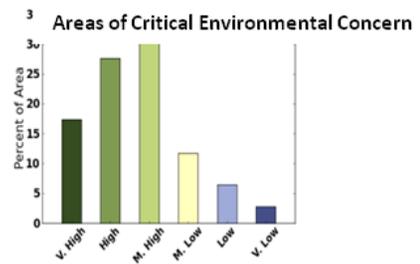
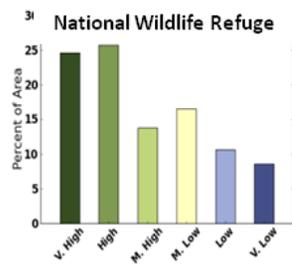
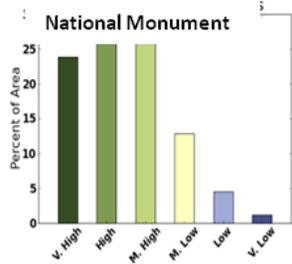
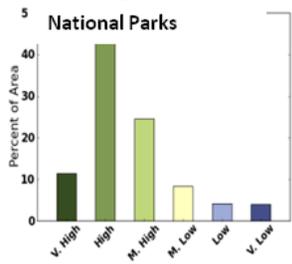


MQ D5. What is the location/distribution of designated sites?

**Map of Designated Sites (Top) and Results for Designated Sites Status/Current Terrestrial Intactness (Bottom)**



Histograms represent 6 classes of Current Terrestrial Intactness for each category of designated sites.



MQ D5. What is the location/distribution of designated sites?

Table 4-7. Total area (acres) of each status category for all designated protected lands in the Sonoran Desert Ecoregion.

Designation Category	Very High	High	Moderately High	Moderately Low	Low	Very Low	Total Area (acres)
Wilderness Area	1,812,561	1,632,927	1,011,143	451,464	55,862	21,933	4,985,890
Wilderness Study Area	0	0	6,620	55,984	2,525	2,272	67,401
National Park	19,819	83,040	42,873	14,441	7,178	6,979	174,330
National Monument	127,785	148,652	158,627	68,922	24,265	6,305	534,556
National Conservation Area	0	6,779	21,819	7,638	95	0	36,331
National Wildlife Refuge	91,295	95,602	51,145	61,499	39,637	31,834	371,012
Area of Critical Conservation Concern	257,951	409,293	503,740	174,291	95,838	41,669	1,482,782
State Park	1,151	35,434	152,845	212,951	126,418	105,968	634,767
State Wildlife Management Area	1,202	288	4,250	3,126	4	4,819	13,689
Roadless Area	11,564	32,957	65,350	5,908	2,526	0	118,305
Other Protected Lands	71,122	153,511	177,174	243,082	43,660	97,114	785,663
<b>Totals</b>	<b>2,394,450</b>	<b>2,598,483</b>	<b>2,195,586</b>	<b>1,299,306</b>	<b>398,008</b>	<b>318,893</b>	<b>9,204,726</b>
Designation Category	Very High	High	Moderately High	Moderately Low	Low	Very Low	Total Area (miles)
National Historic and Scenic Trail	28	97	179	160	69	282	815
Wild and Scenic River	0	1	6	0	2	0	9
<b>Totals</b>	<b>28</b>	<b>98</b>	<b>185</b>	<b>160</b>	<b>71</b>	<b>282</b>	<b>824</b>

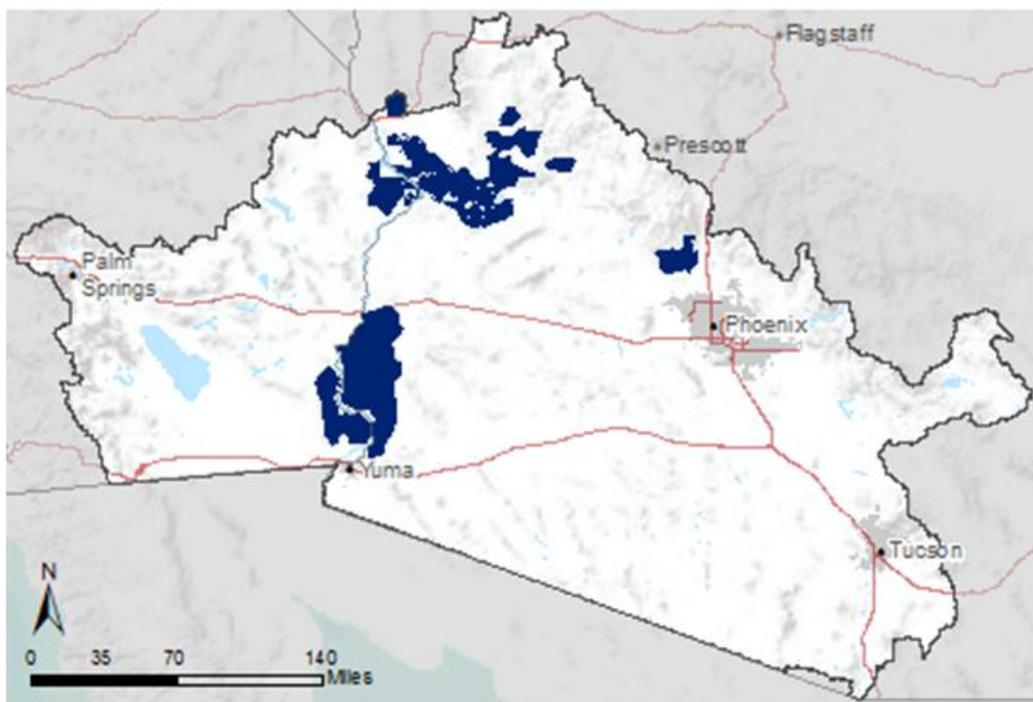
## D. Species Conservation Elements

MQ D7. Where are HMAs located?

### Process Description

Data on BLM Wild Horse and Burro Herd Management Areas (HMAs) obtained from BLM.

### Results for Wild Horse and Burro Herd Management Areas



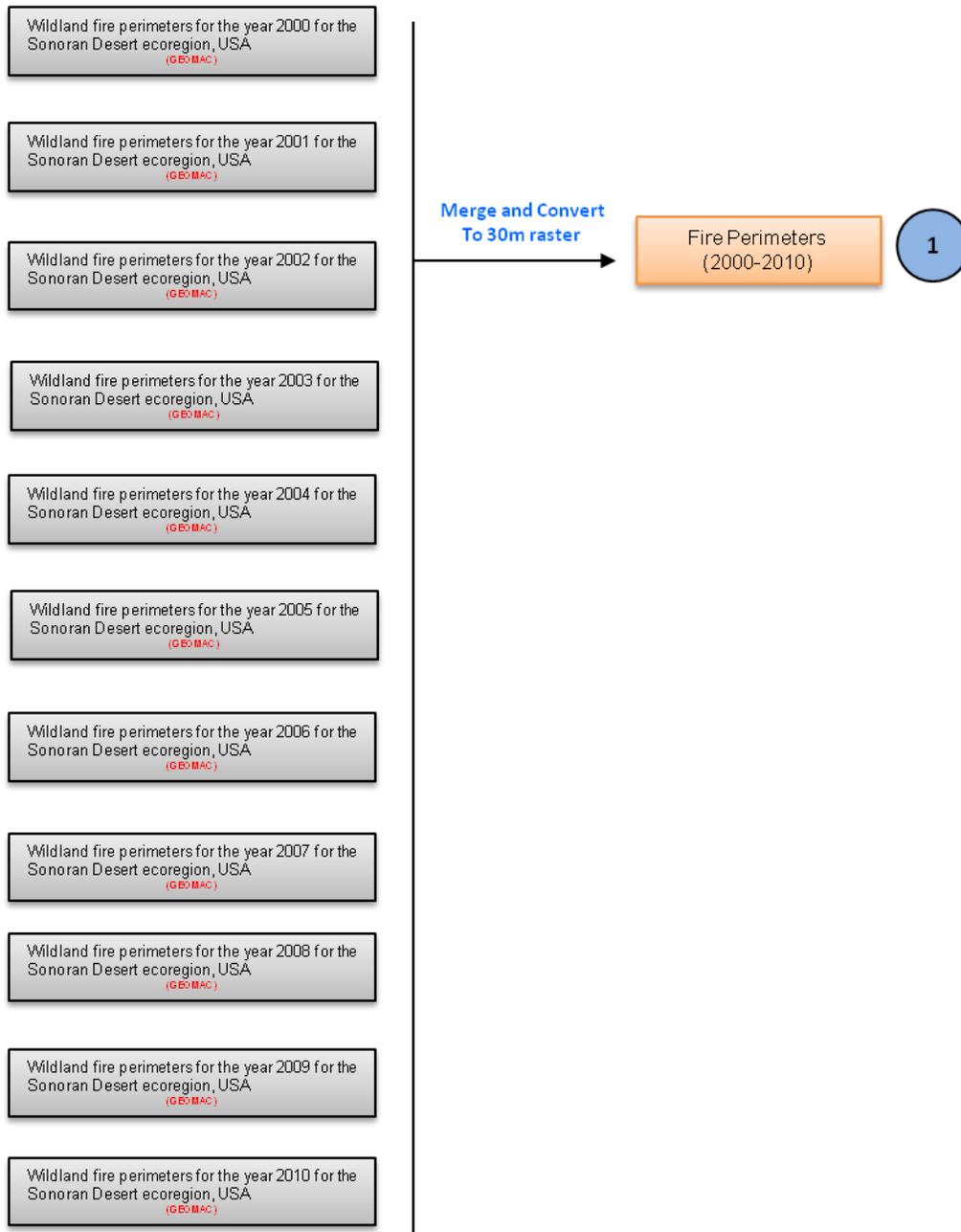
 Current Distribution

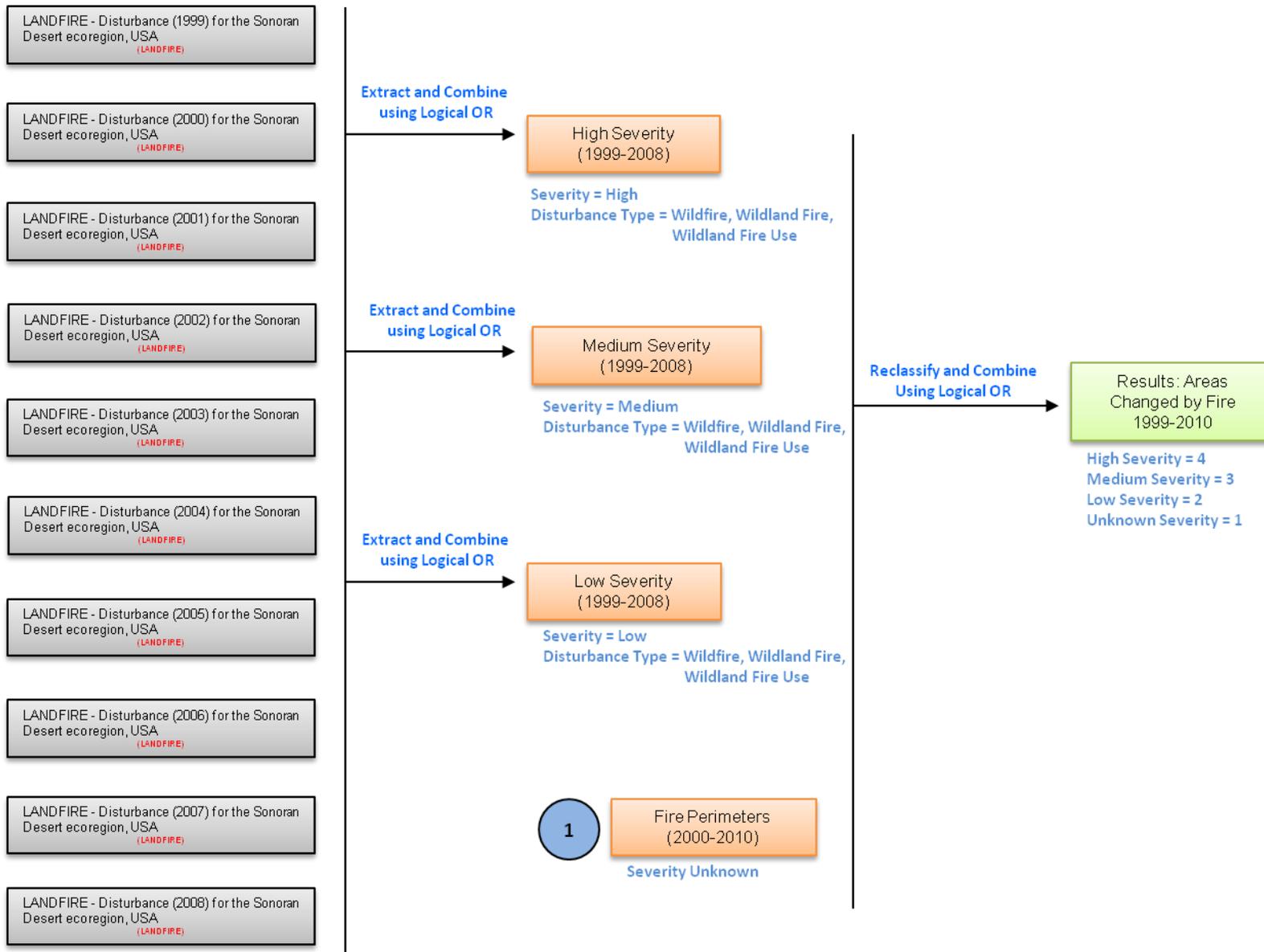
## E. Wildfire

MQ E1. Where are areas that have been changed by wildfire between 1999 and 2009?

### Process Model or Description

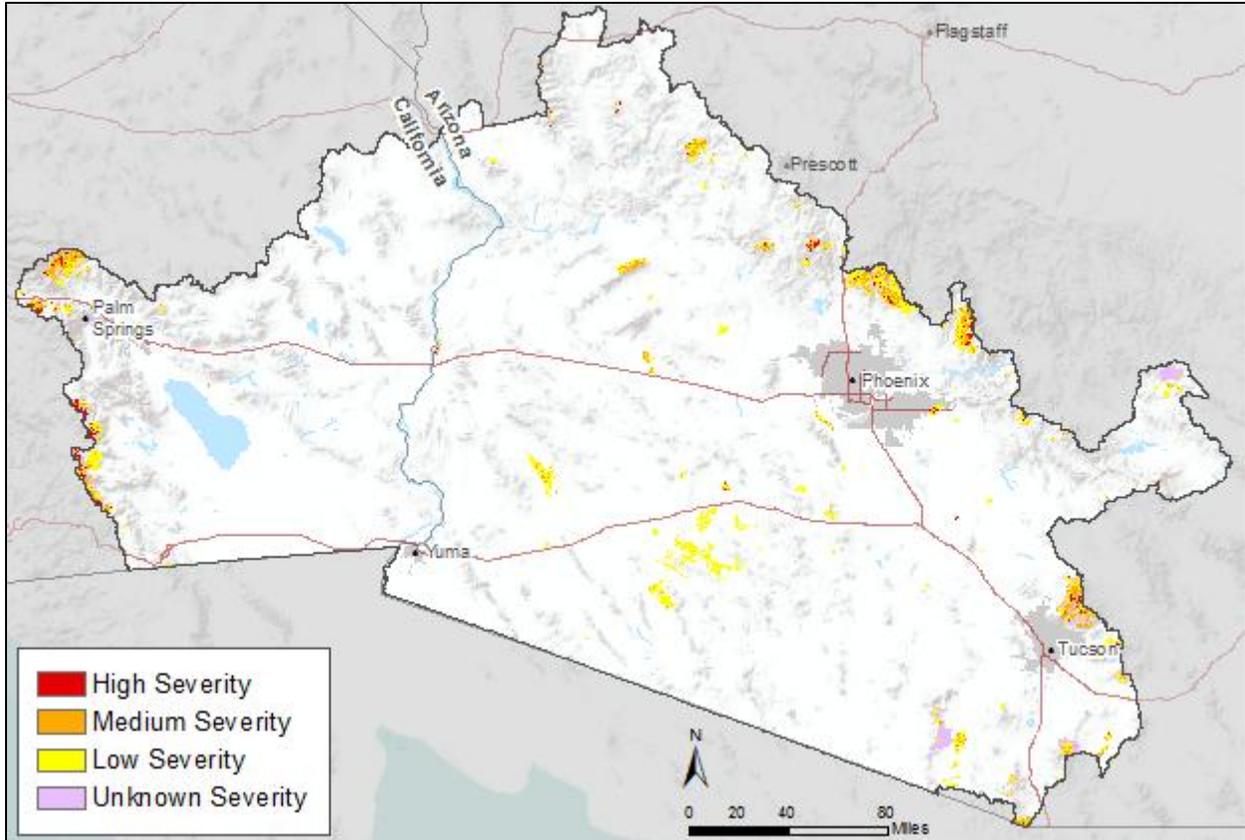
Merged fire perimeters from USGS for 2000–2010 with fire severity data obtained from LANDFIRE Disturbance datasets (1999–2008).





## Results

MQ E1. Where are areas that have been changed by wildfire between 1999 and 2009?



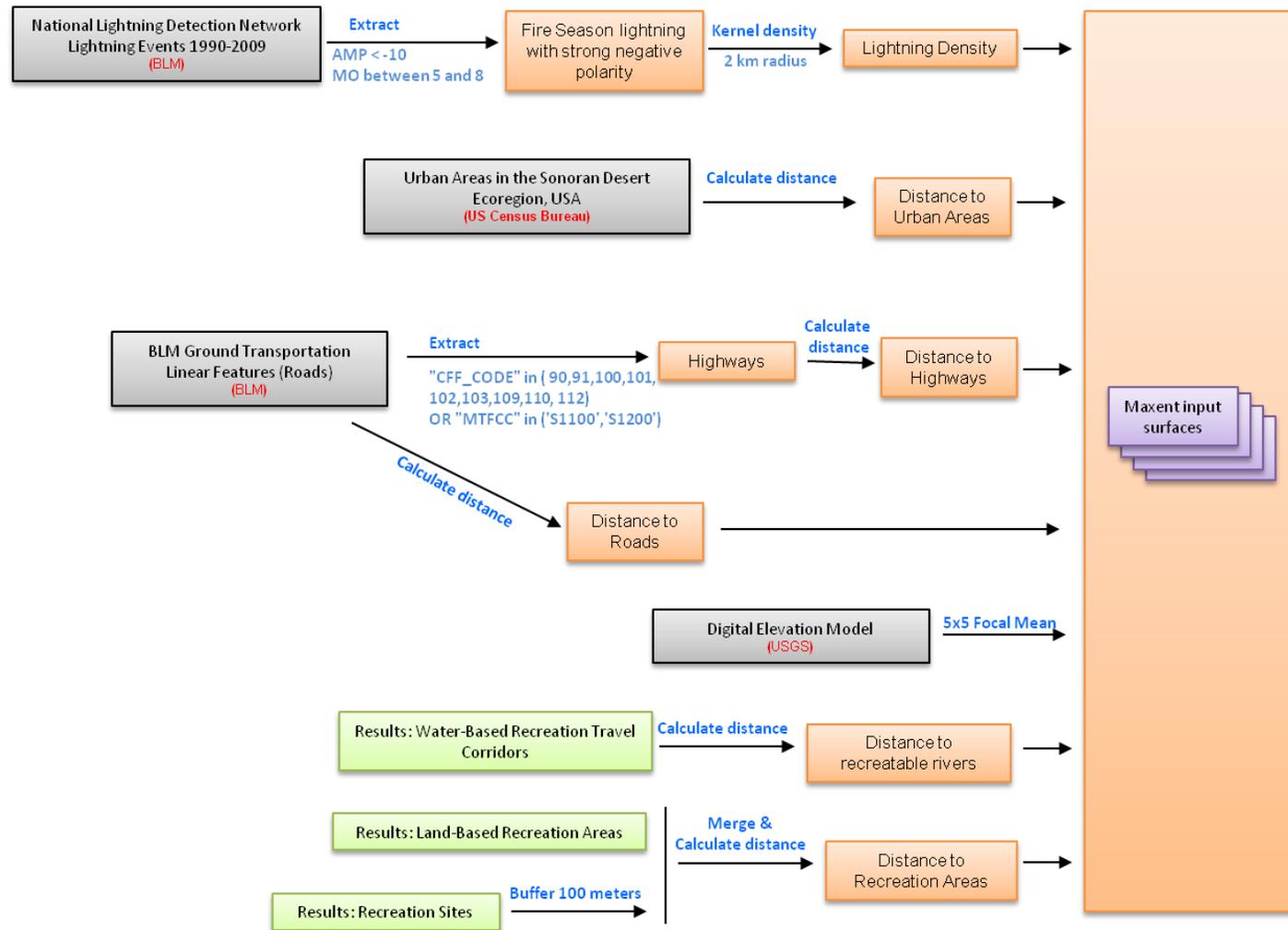
## E. Wildfire

MQ E2. Where are areas with potential to change from wildfire?

### Process Model or Description

See process model for development of MaxEnt model based on current climate (PRISM) and landscape factors. Projected near-term (2015–2030) and long-term (2045–2060) results using this same model with near-term and long-term climate parameters obtained from RegCM3 regional climate model based on ECHAM5 boundary conditions. Other landscape factors were not changed for future projections. Calculated difference between near-term and long-term areas of high potential for fire occurrence compared to current areas of high potential.

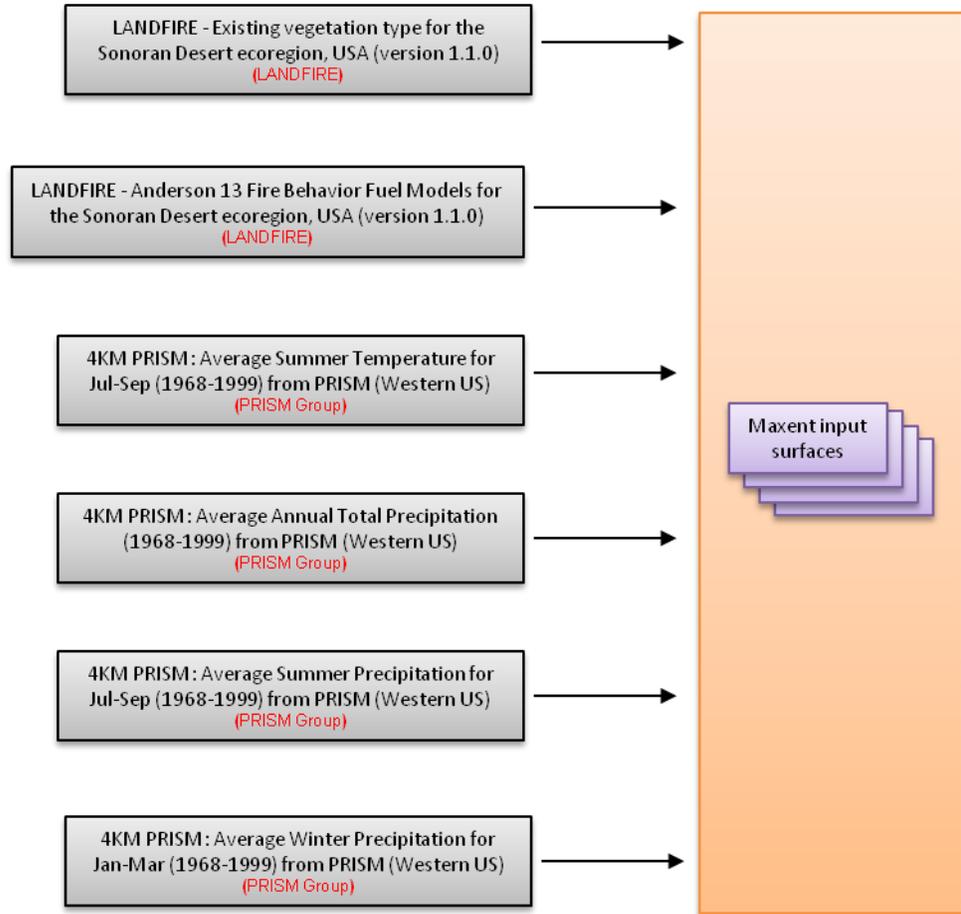
## Input Surface Creation



MQ E2. Where are areas with potential to change from wildfire?

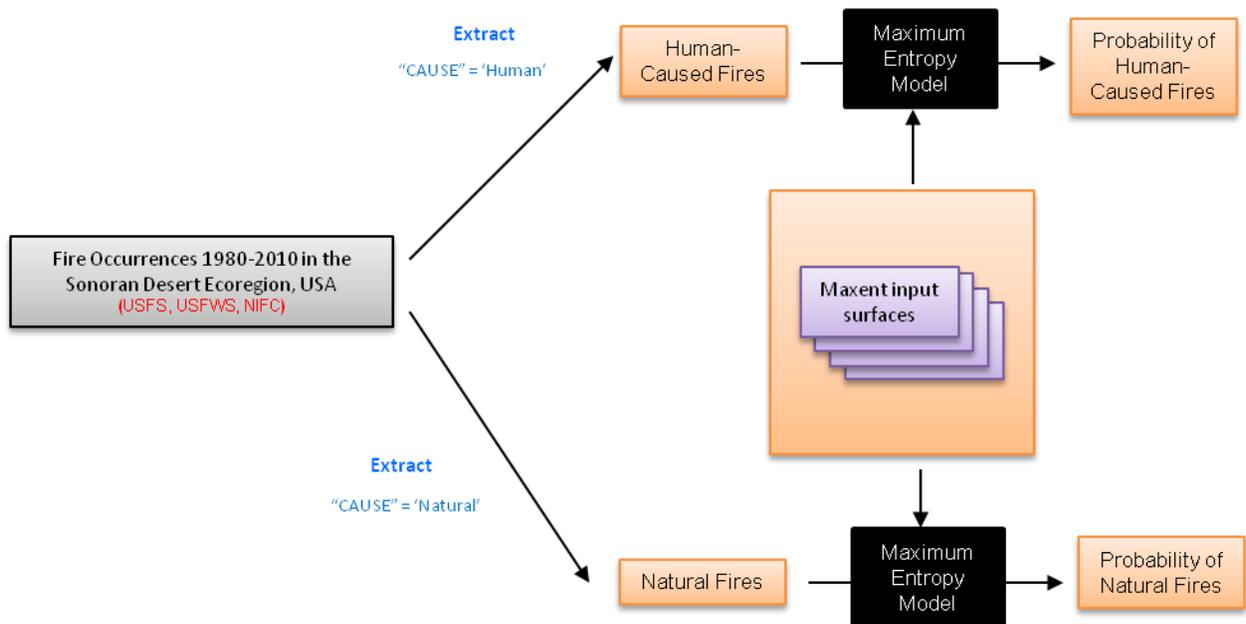
**Process Model Part 2**

Input Surface Creation (continued)

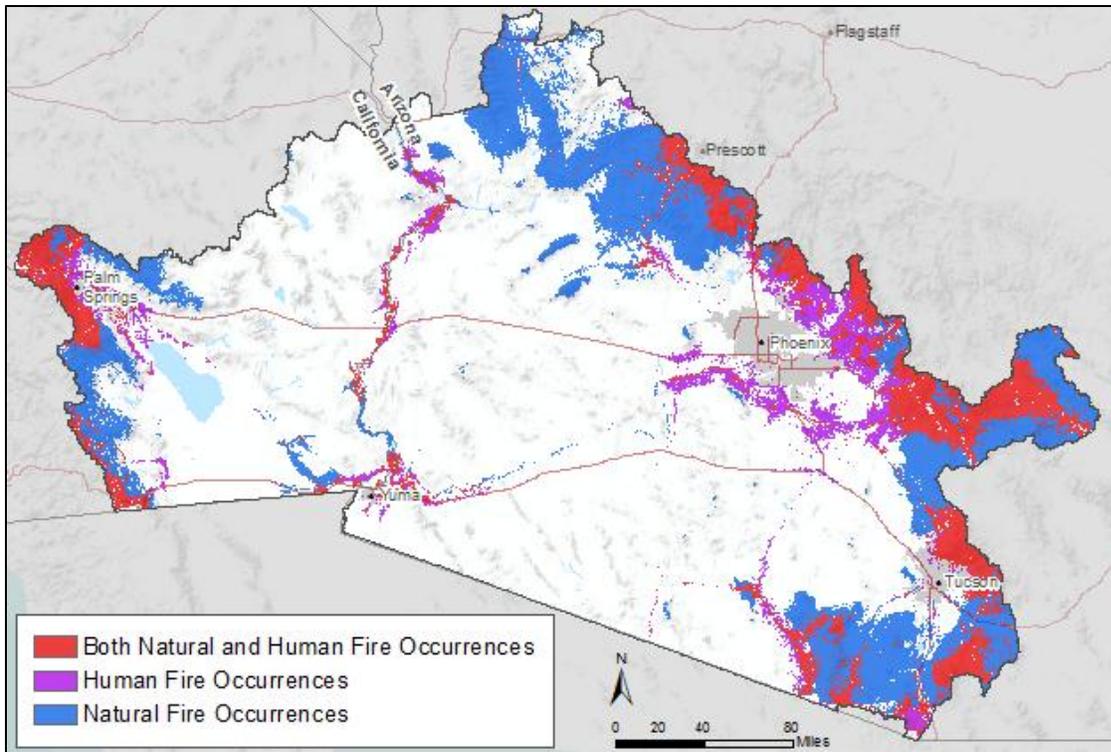
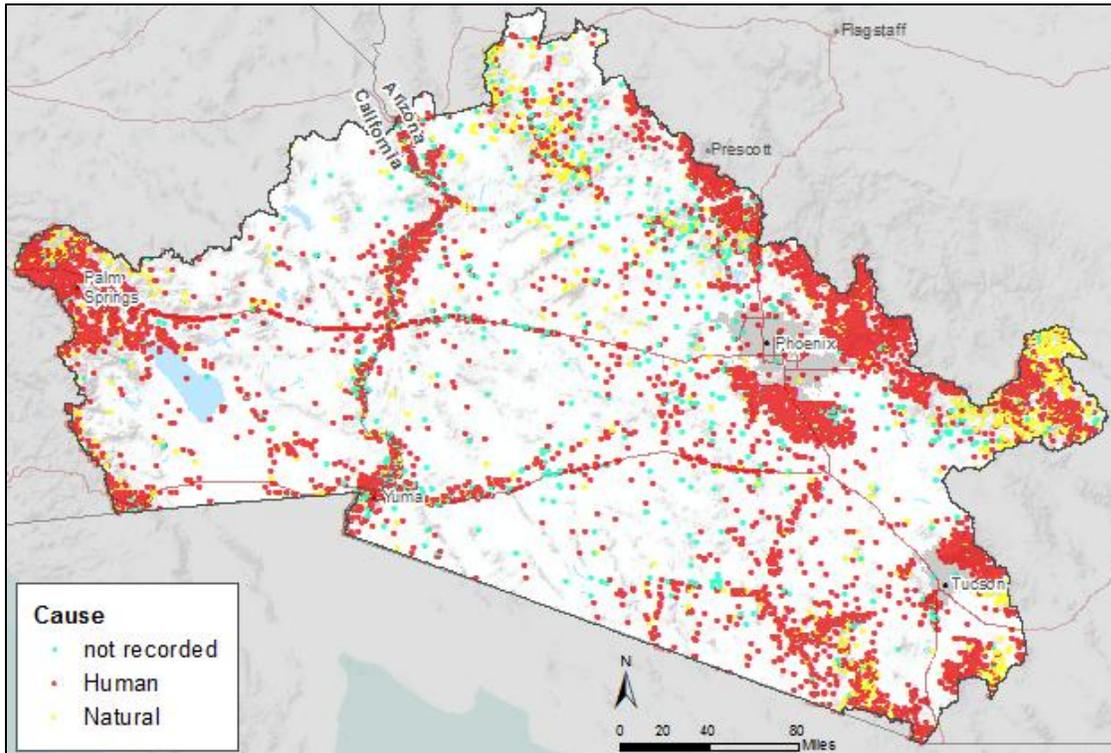


MQ E2. Where are areas with potential to change from wildfire?

**Process Model Part 3**

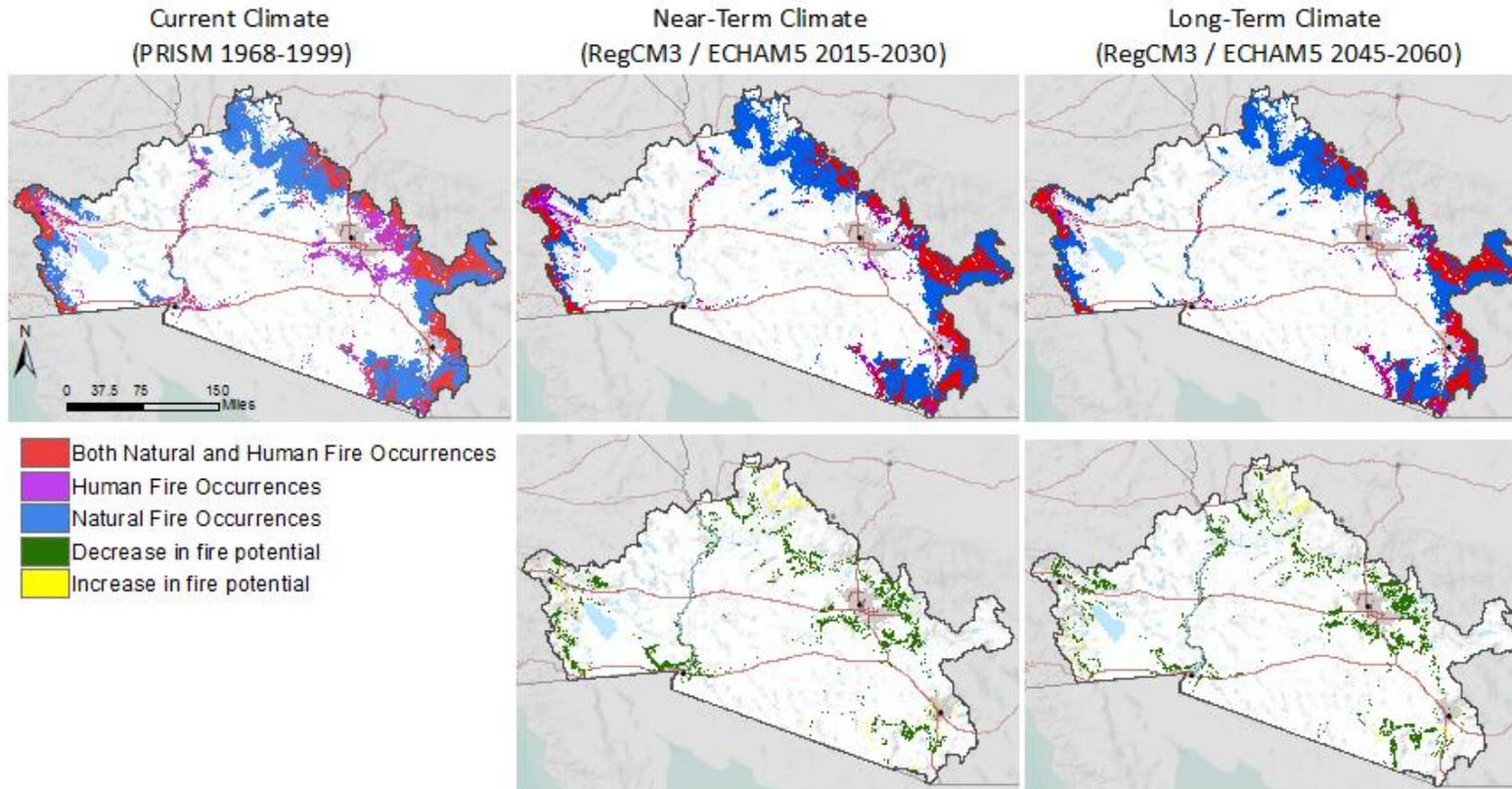


## Results for Areas with Potential to Change from Wildfire



MQ E2. Where are areas with potential to change from wildfire?

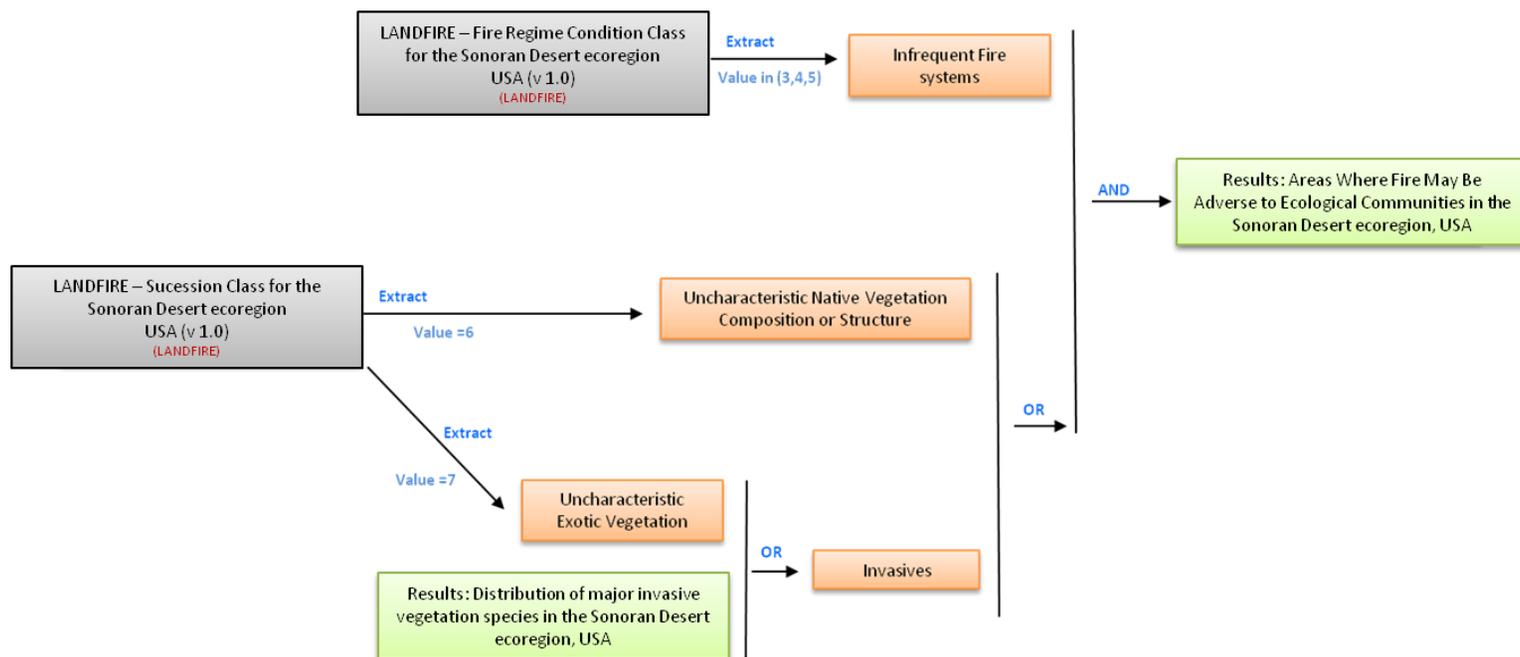
Projected near-term (2015–2030) and long-term (2045–2060) results using this same model with near-term and long-term climate parameters obtained from RegCM3 regional climate model based on ECHAM5 boundary conditions.



## E. Wildfire

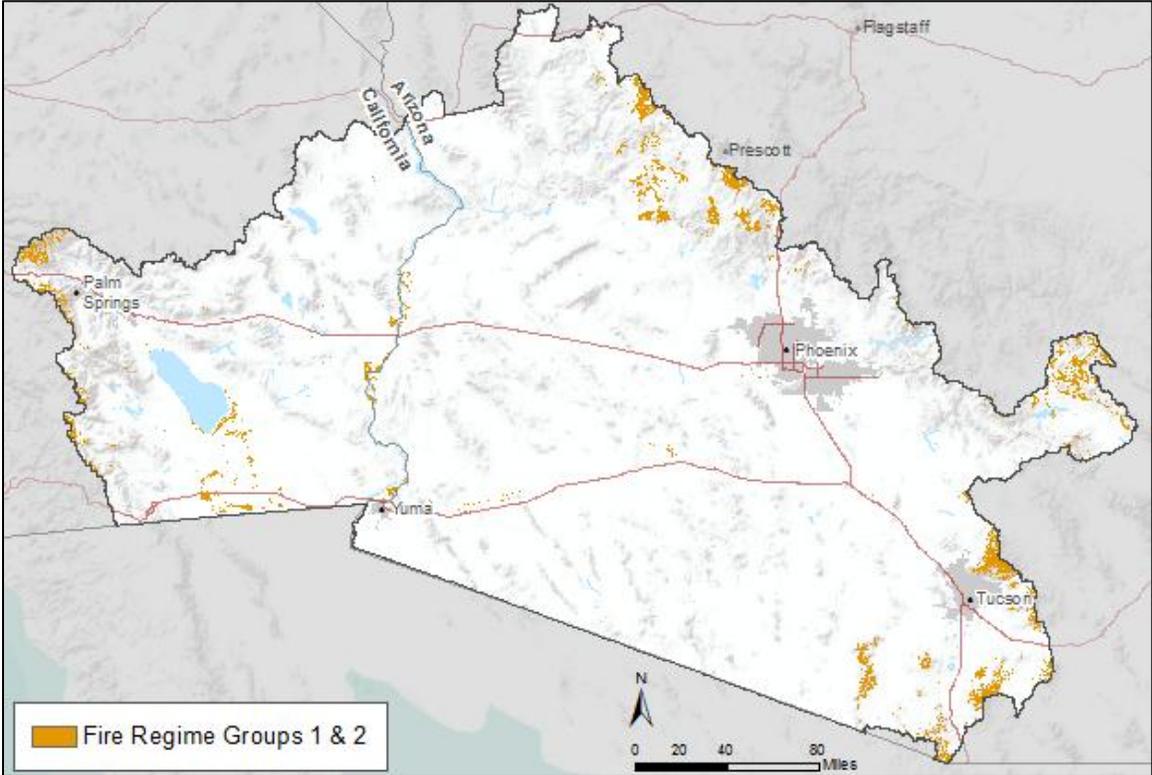
MQ E3. Where are fire-adapted communities?

### Process Model or Description



MQ E3. Where are fire-adapted communities?

## Results



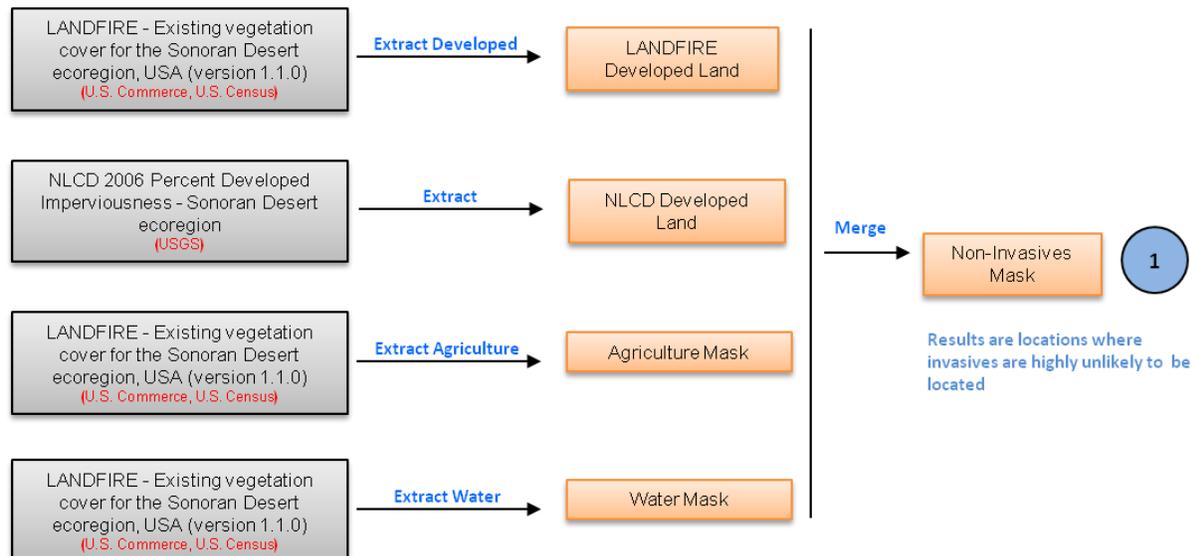
## F. Invasive Species

MQ F1. Where are areas dominated by tamarisk, invasive grasses, and Sahara mustard, and where are quagga, zebra mussel, and Asiatic clam present?

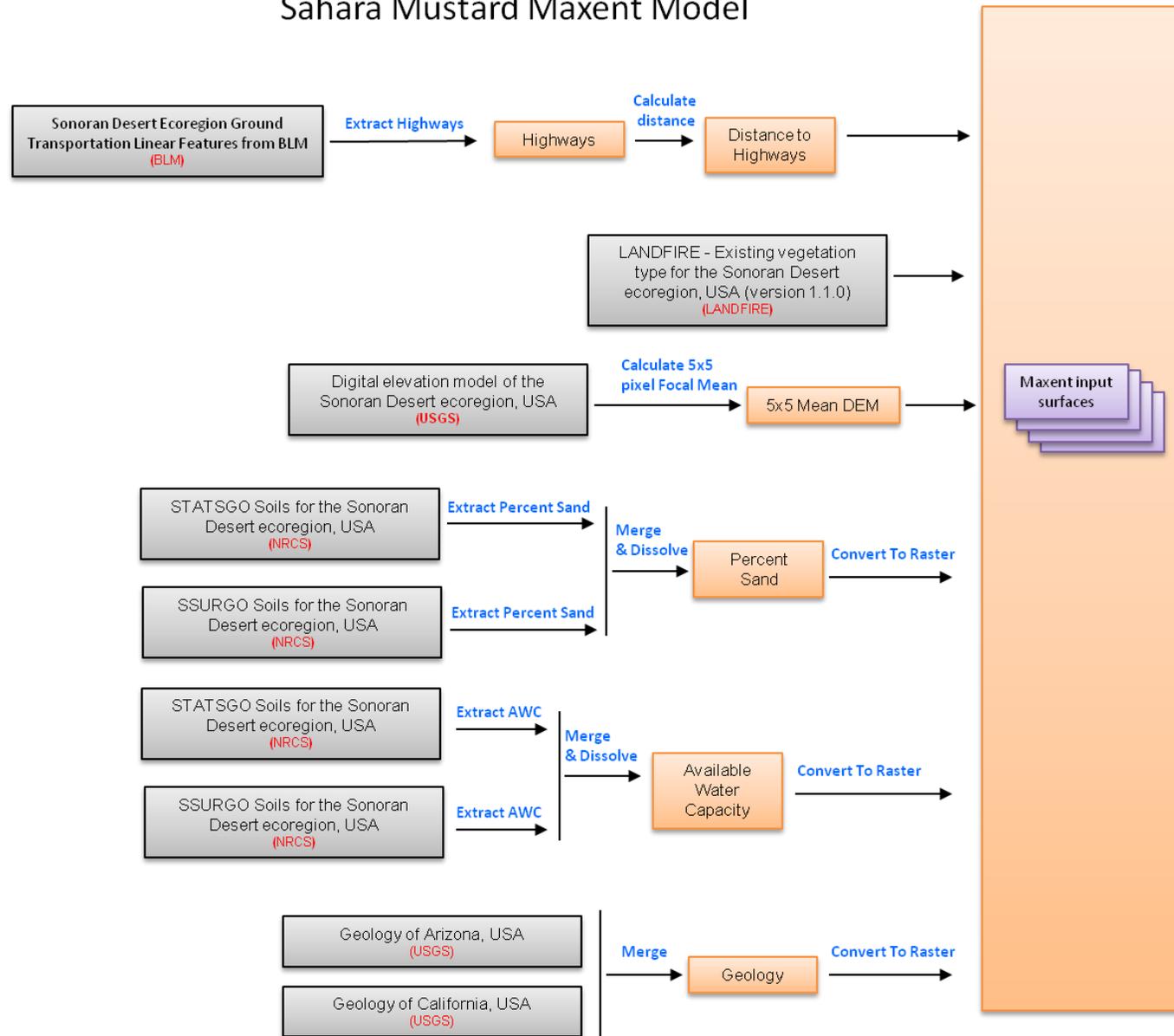
### Process Model or Description

See process model for vegetation invasives. Aquatic invasives are simply selected from the USGS Nonindigenous Aquatic Species database (<http://nas.er.usgs.gov/>)

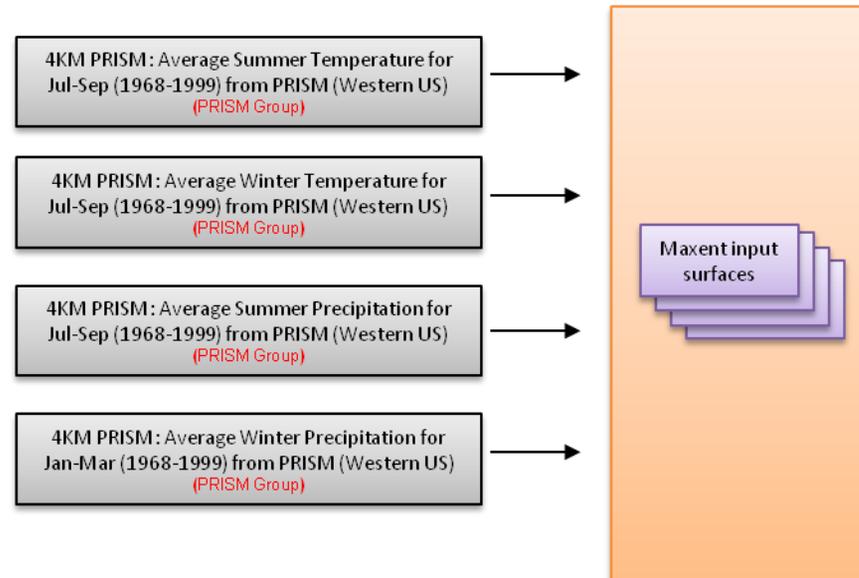
#### Mask Creation

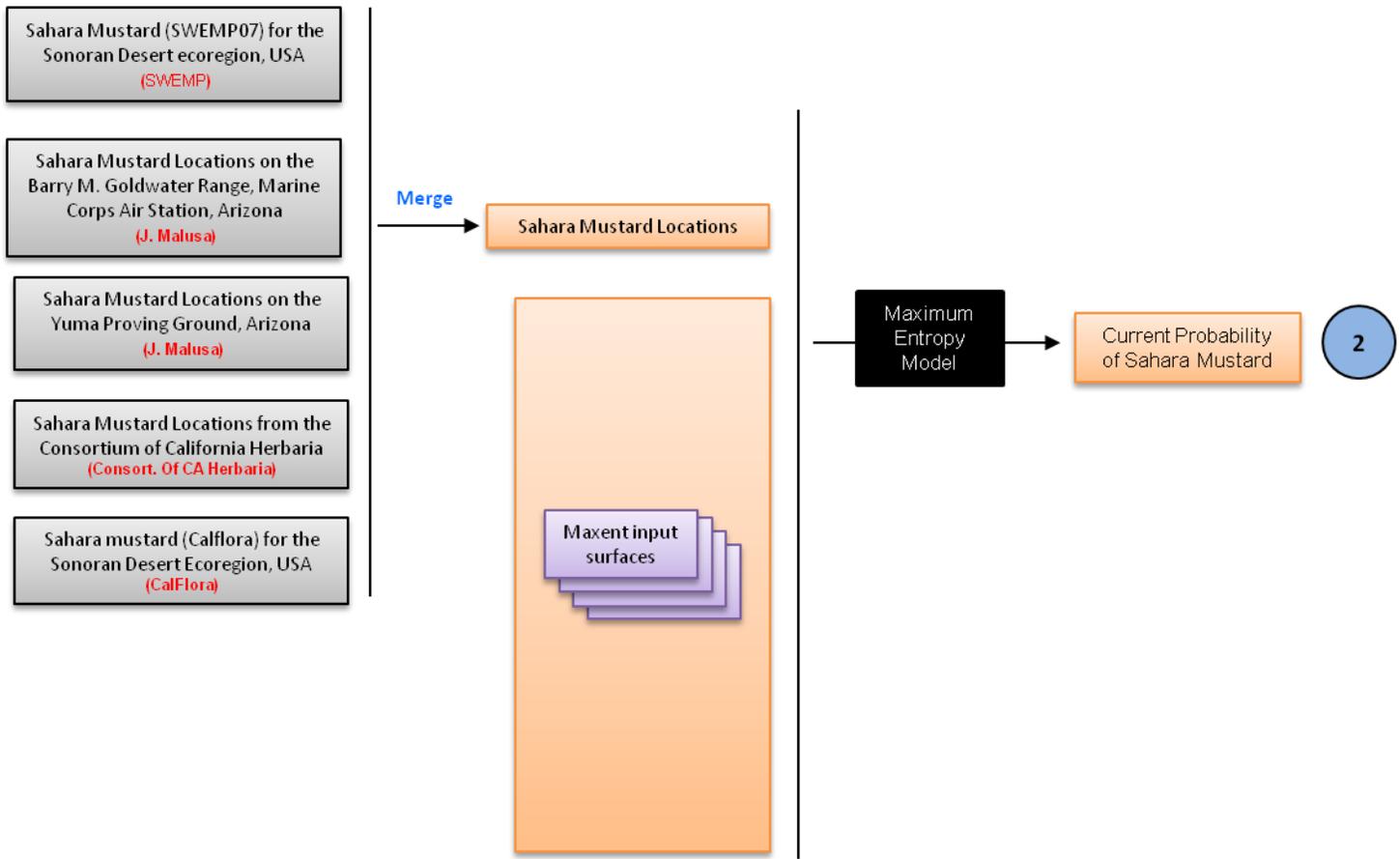


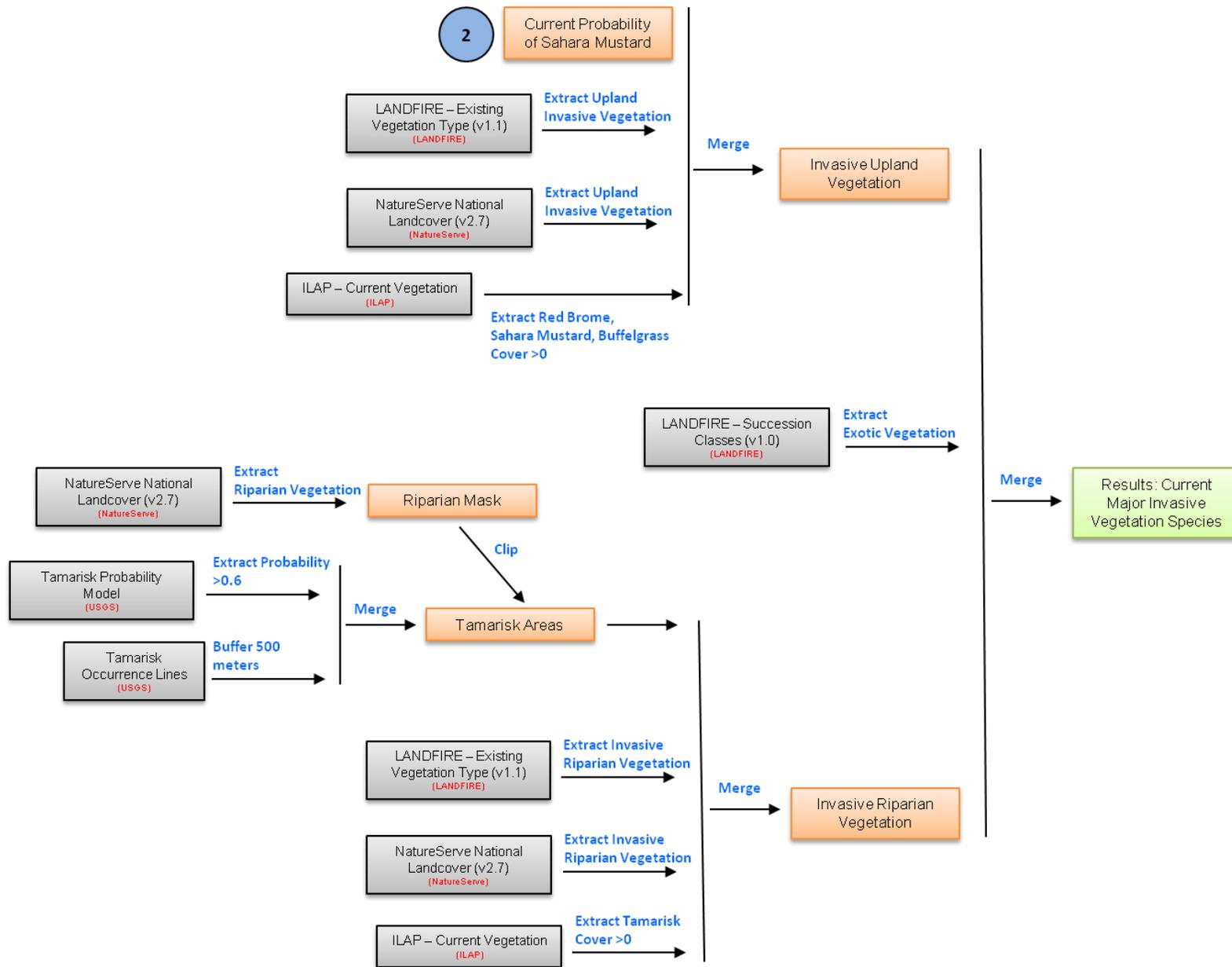
# Sahara Mustard Maxent Model



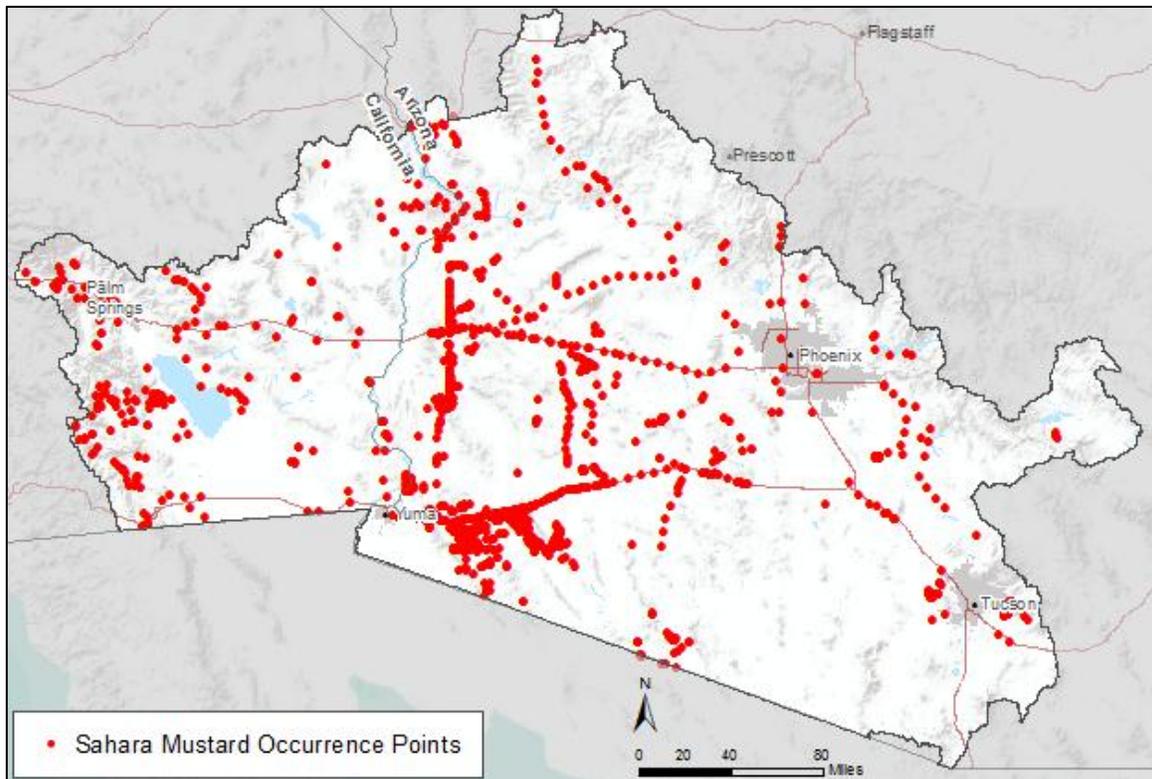
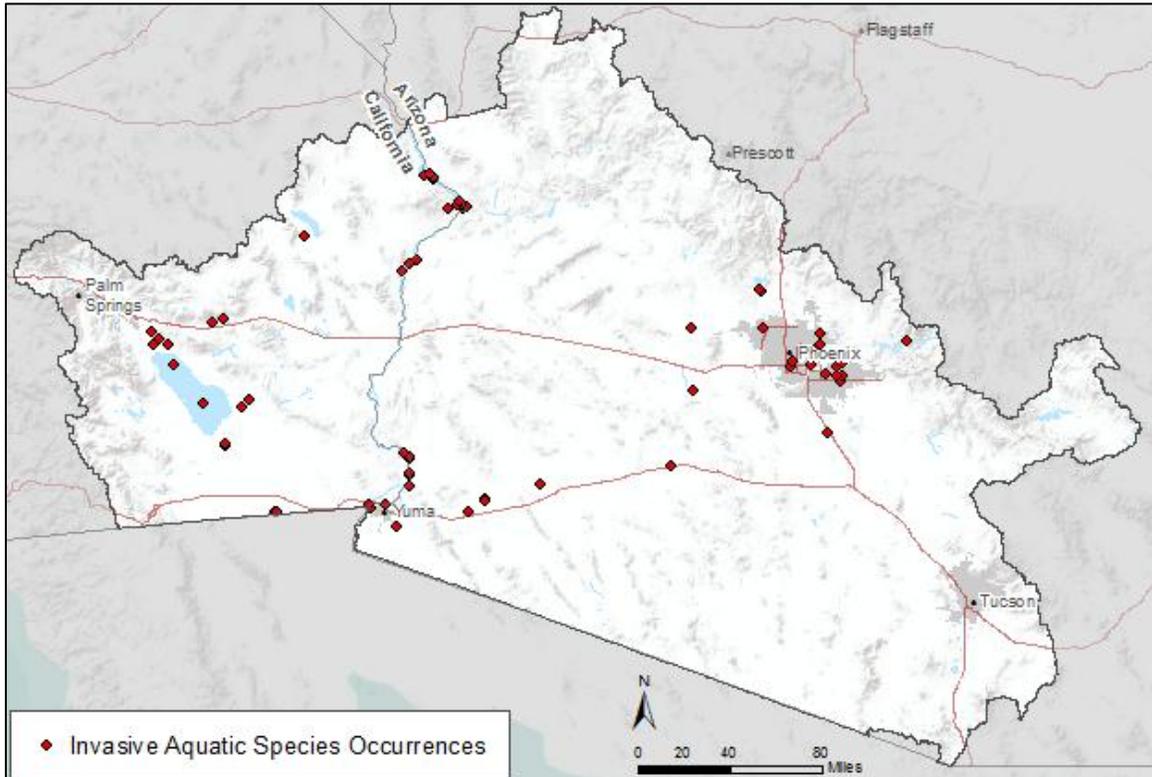
## Sahara Mustard Maxent Model – Current Climate

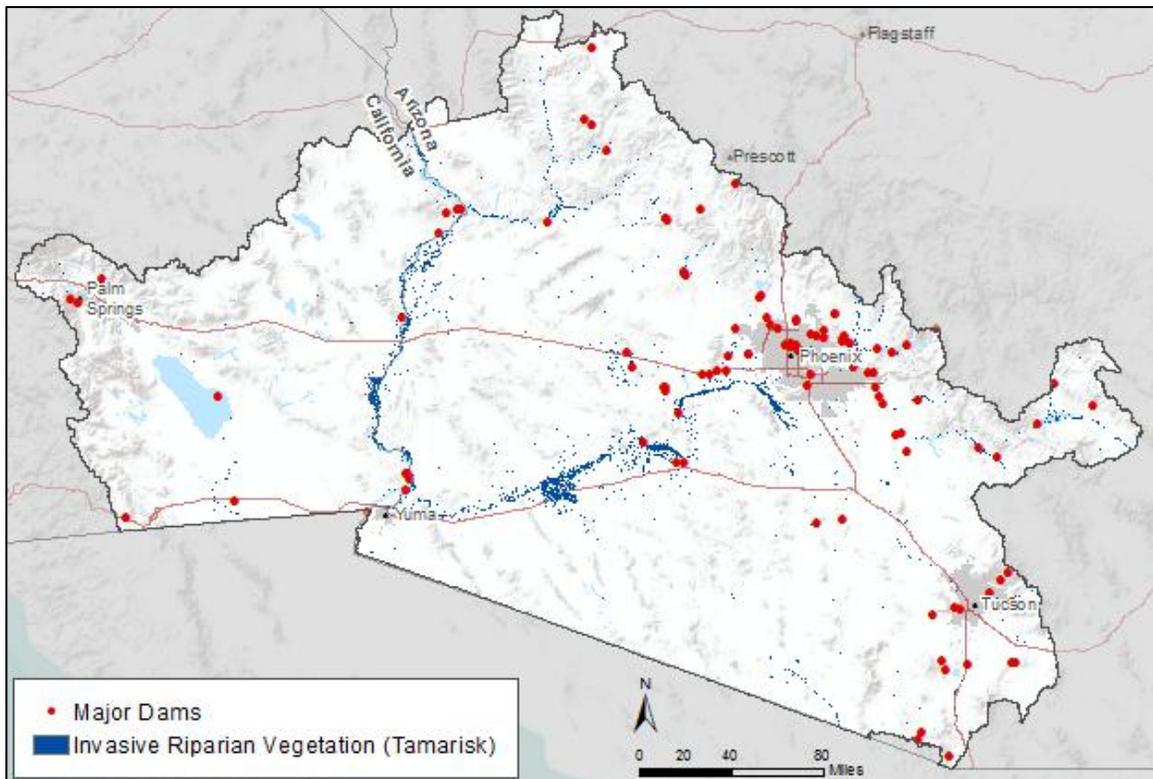
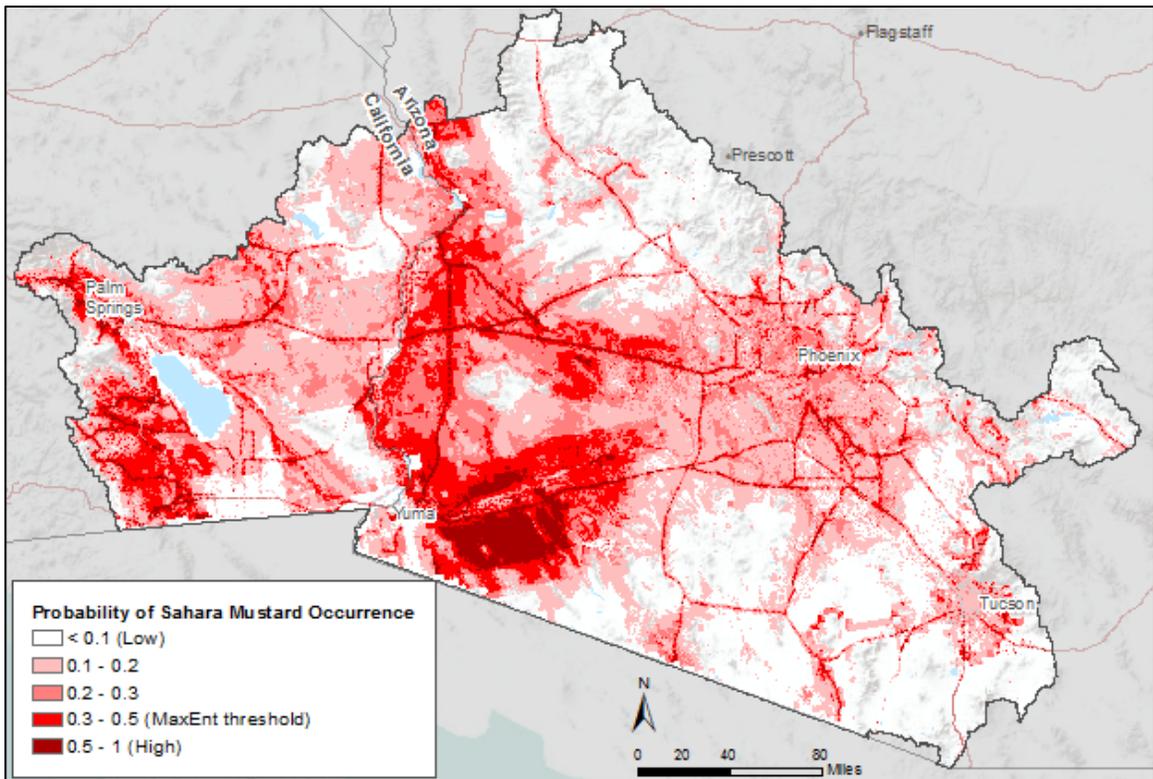


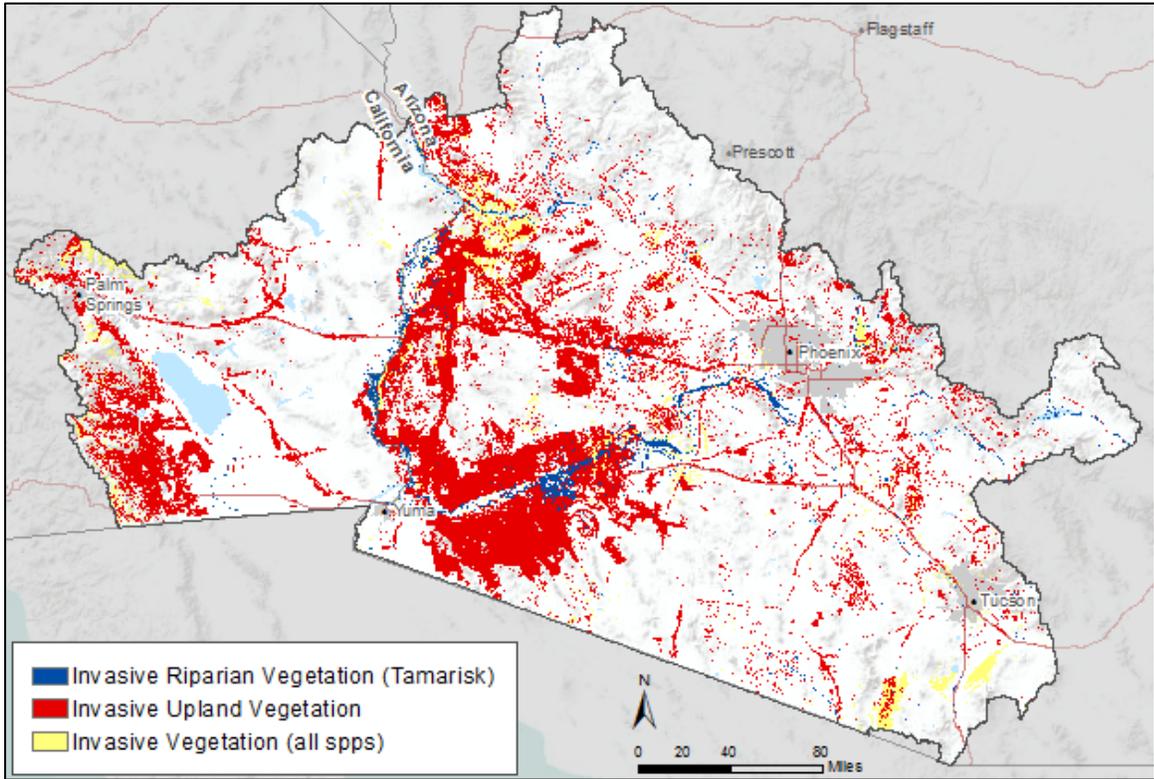




## Results for Aquatic, Upland, and Riparian Invasive Species





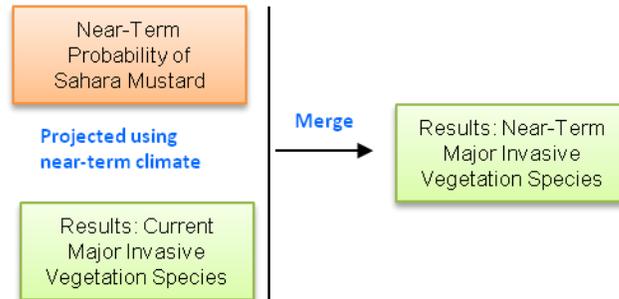


## F. Invasive Species

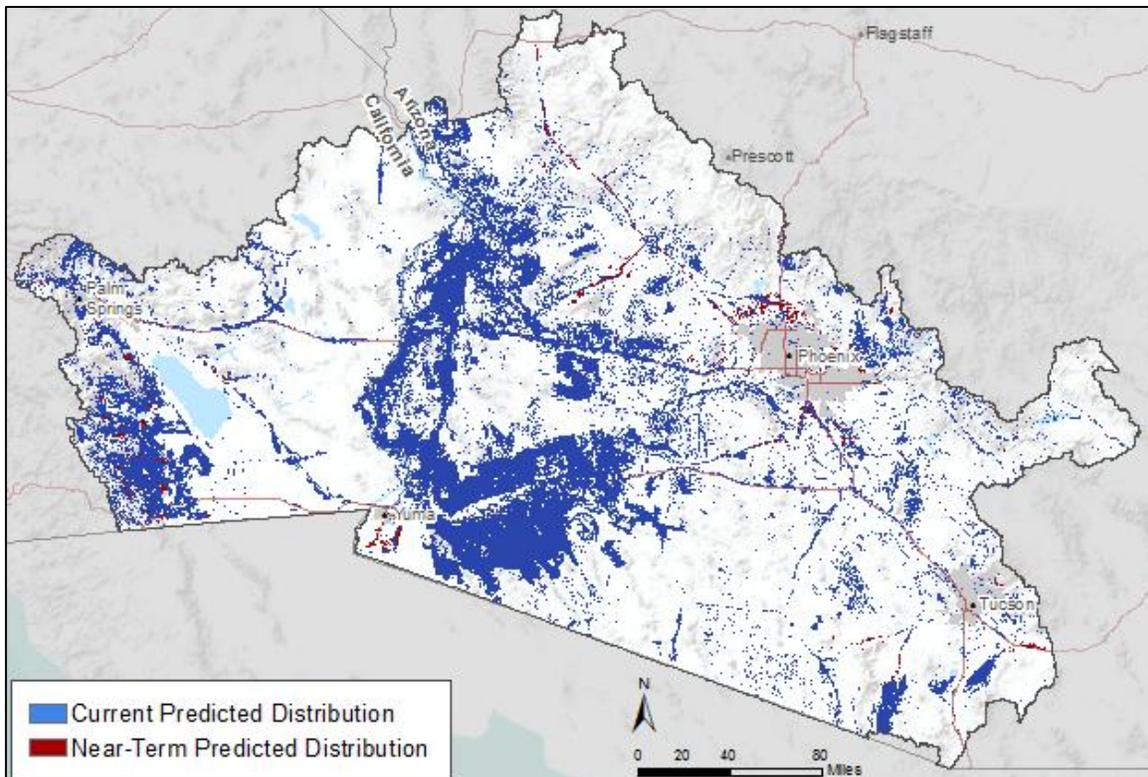
MQ F2. Where are areas of potential future encroachment from this invasive species?

### Process Model or Description

Process model for vegetation (below) is an extension of Process Model for MQ F1. MQF2 was not done for aquatic invasives due to insufficient future projection data.



### Results for Current and Near-Term Distribution of Invasive Species



## G. Future Development

MQ G1. Where are areas of planned development? – go to **Appendix E**

MQ G2. Where are areas of planned development, including renewable energy and where are potential conflicts with conservation elements? – go to **Appendix E**

MQ G3. Where are areas of potential development (e.g., under lease), including renewable energy sites and transmission corridors and where are potential conflicts with CEs? – go to **Appendix E**

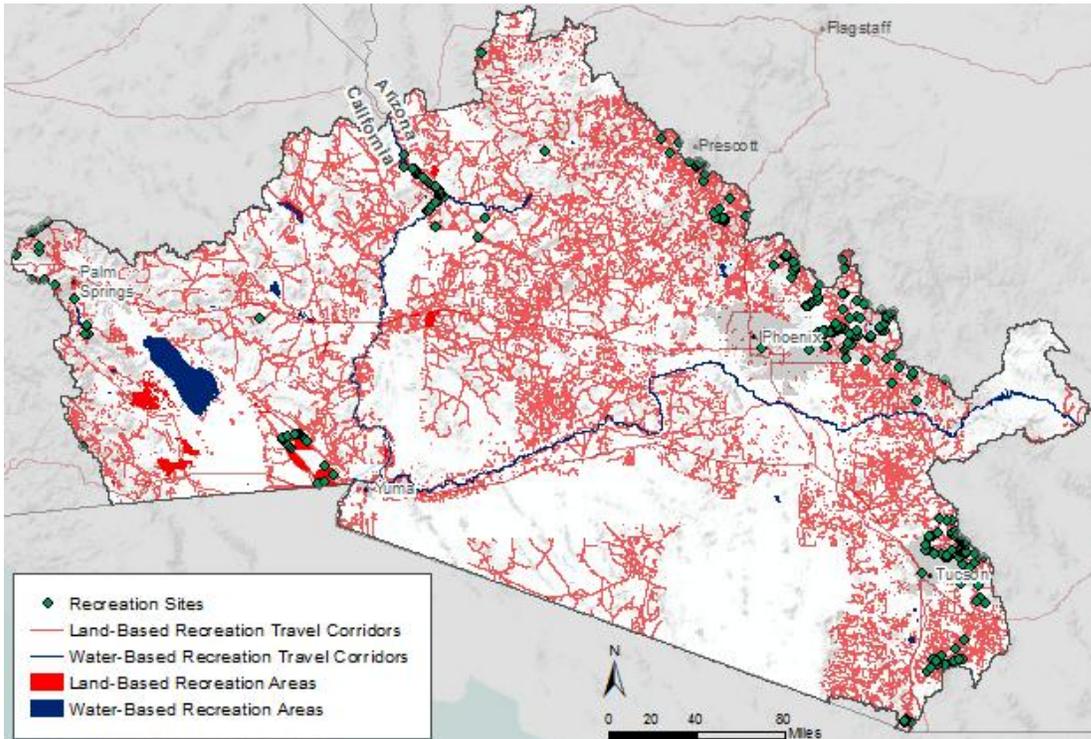
## H. Resource Use

MQ H1. Where are high-use recreation sites, developments, roads, infrastructure or areas of intensive recreation use located (including boating)?

## Process Model or Description

Recreation sites were compiled from USFS and BLM data. We compiled land-based recreation areas (open OHV areas) from BLM and water-based recreation areas by selecting larger water bodies from NHD (>1 square kilometer). Land-based travel corridors were extracted from BLM ground transportation linear features dataset within federal and state lands in Conservation Biology Institute protected areas database (excluding DOD lands). Water-based travel corridors were compiled by selecting rivers from NHD flowlines that were listed on BLM rivers website.

## Results for High-Use Recreation



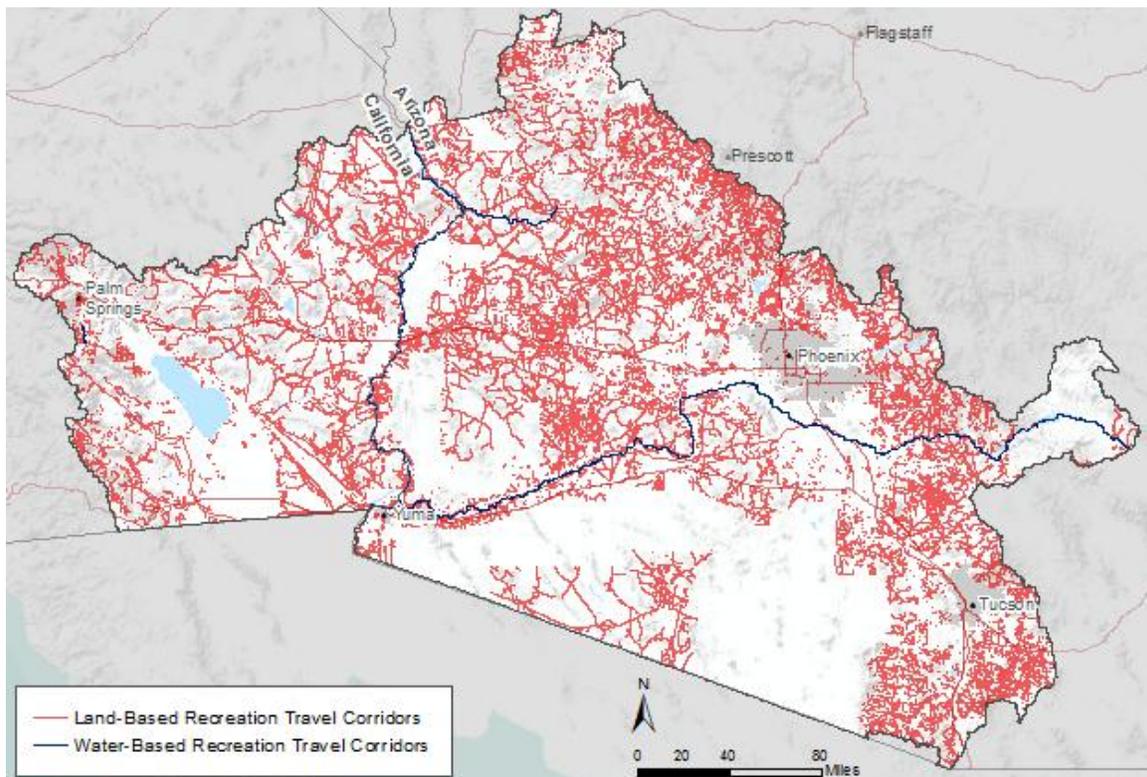
## H. Resource Use

MQ H2. Where are areas of concentrated recreation travel (OHV and other travel) located?

### Process Model or Description

Land-based travel corridors were compiled from BLM ground transportation linear features dataset within federal and state lands in Conservation Biology Institute protected areas database (excluding DOD lands). Water-based travel corridors were extracted by selecting rivers from NHD flowlines that were listed on BLM rivers website.

### Results for Areas of Concentrated Recreation Travel



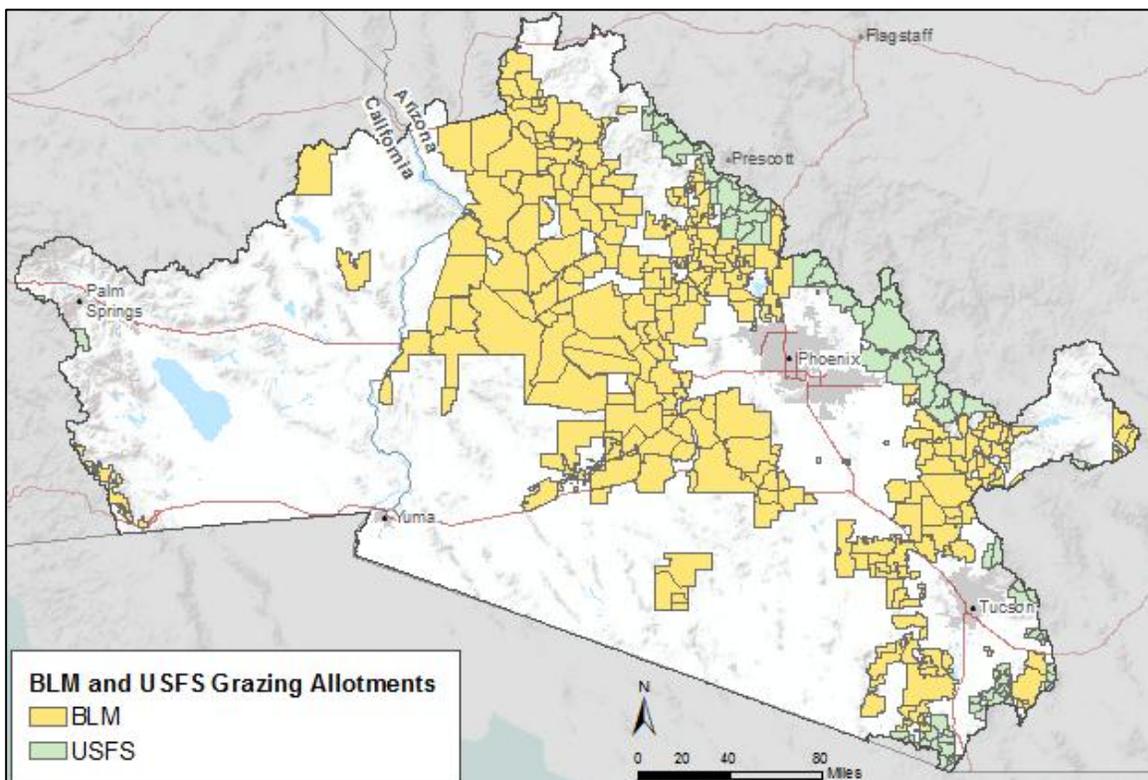
## H. Resource Use

MQ H4. Where are allotments and type of allotment?

### Process Model or Description

Grazing allotments were compiled from USFS and BLM datasets.

### Results for Location of Grazing Allotments



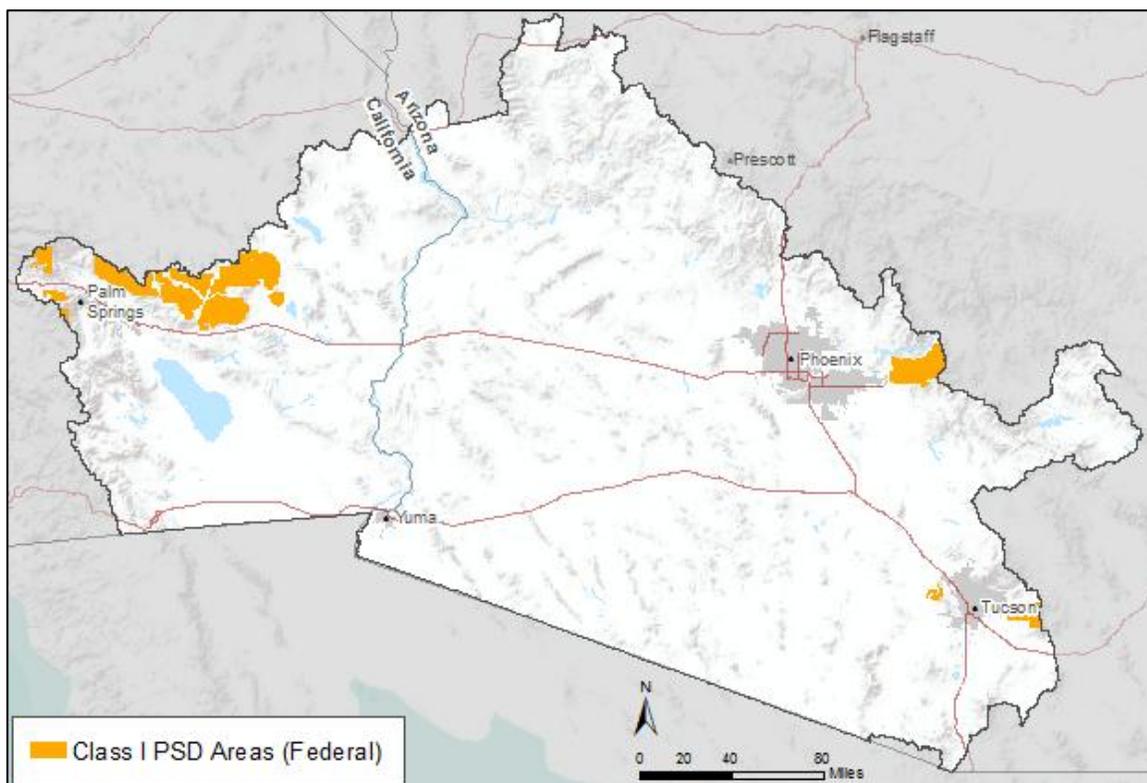
## I. Air Quality

MQ I3. Where are the Class I PSD areas?

### Process Model or Description

Federal Class I PSD areas selected from CBI protected areas database using authoritative list of areas (all national parks and some wilderness areas) from EPA.

### Results for Class I PSD Air Quality Areas



## J. Climate Change

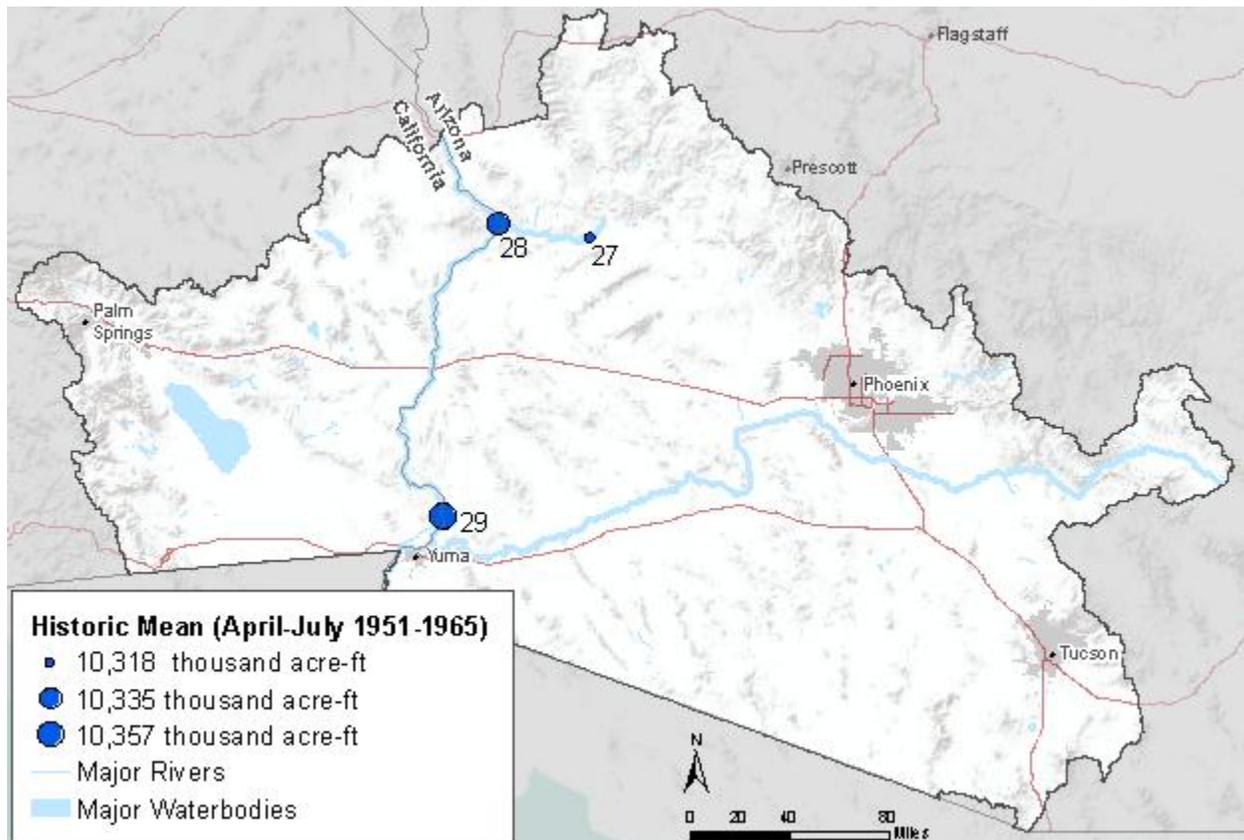
MQ J1. Where/how will the distribution of dominant native and invasive plant species be vulnerable to or have potential to change from climate change in 2060? – **see MQ C2 for each plant community**

MQ J3. Where are areas of species conservation elements distribute change between 2010 and 2060? – **see MQ D6 for each species**

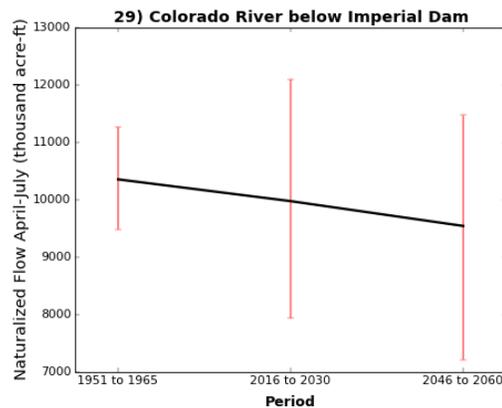
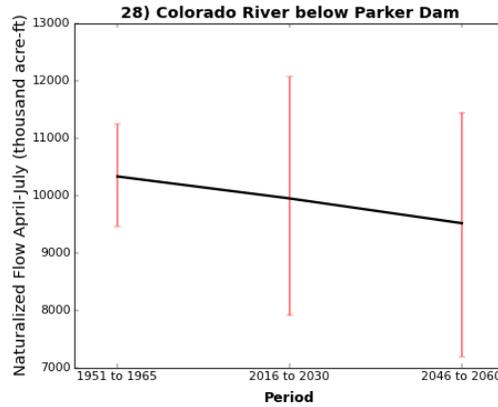
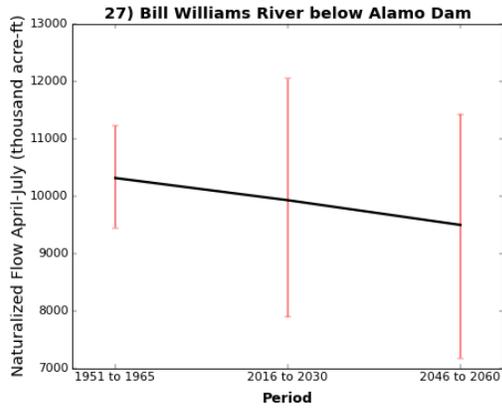
MQ J4. Where are aquatic/riparian areas with potential to change from climate change? – **see MQ C2 for riparian vegetation and results below for future discharge**

## Results for Aquatic Areas with Potential to Change from Climate Change

Map below: Historic stream flow data (April–July 1951–1065) from 12 gaging stations on the Colorado River and major tributaries in the Colorado Plateau.



Graphs show alteration in flow at 3 gaging stations pictured above from historical period (1951) through current period and projected to mid-21<sup>st</sup> century (2060, Bureau of Reclamation data, BOR 2012). Graph numbers correspond to gaging station locations on previous map.



BOR (Bureau of Reclamation). 2012. Colorado River Basin water supply and demand study. Technical report B: Water Supply Assessment. Prepared by Colorado River Basin Water Supply and Demand Study Team, U.S. Bureau of Reclamation.