Project Introduction

Modern planners are increasingly challenged with designing built landscapes which better harmonize with ecological systems and processes. Increasingly, environmental planning has attempted to minimize the impacts of growth and development on the natural landscape, particularly as it pertains to locations which may be environmentally sensitive. Fundamental to this process, thoroughly inventorying existing environmental conditions, mapping of relevant natural factors, and subsequent analysis of their relationships are all essential components can aid planners in making better informed land use decisions.

Project Goal

The goal of this analysis is to inventory and identify areas which exhibit environmentally sensitive characteristics and potential ecological importance. Once analyzed, these areas may be considered as candidate sites for conservation efforts and environmental protection as part of a green infrastructure plan.

Project Methodology

The study utilizes ArcGIS geospatial analysis software to perform a green infrastructure suitability analysis for the Santa Cruz Watershed in Arizona (USA). This analysis inventoried nine environmental factors and subsequently analyzed each factor based on potential measures of sensitivity for this region. The natural factors included:

- **Slope**: A natural factor of topography, slope is inventoried as percent slope. Steeply sloping areas were considered more sensitive as they are highly erodible.

- **Aspect**: A natural factor integral to microclimate evaluation, aspect is inventoried as the cardinal orientation of the slope. Areas with cooler microclimates (aspects of N and NE) were considered as more sensitive for this hot and arid region.

- **Hydrology**: A natural factor which inventoried the proximity to surface water/washes. This included major rivers, main streams, and primary tributaries located within the Santa Cruz Watershed. Areas within close proximity to these features were considered more sensitive for their flash flood, erosion, and cooler microclimate potential.

- **Hydric Soils**: A natural factor relating to the hydrologic characteristics of the soil. Hydric soils were inventoried as classes B, C, and D in the Santa Cruz Watershed. Soils with higher hydric characteristics (class D) were considered more sensitive.

- **Prime Farmland**: A natural factor relating to the agricultural potential of the soil. Soils with higher agricultural potential were considered more sensitive.

- **Vegetation Canopy Coverage**: A natural factor which inventories crown closure and vegetation density. Canopy coverage is inventoried as a percentage of an area which is covered with vegetation. Areas exhibiting high canopy coverage were considered more sensitive due to their potential for habitat provision and cooler microclimates.

- **Mammal Species Richness**: A natural factor inventoried as an indicator of biodiversity. Mammal species richness is expressed as a count of disparate species capable of potentially being present in a given area. Areas with higher potential species richness were considered more sensitive based on their positive contributions to regional biodiversity.

- **Impervious Surface**: A factor of the built environment and a measure of development intensity. Impervious surface is expressed as a percentage of impervious surface in a specified area. Less impervious areas were considered more sensitive as they represent predominantly natural areas.

- **Land Cover Type**: A natural factor which inventories vegetation and land use types. Land cover was utilized to determine the naturalness of a given area. Areas which were comprised of various vegetation types (as opposed to built land uses) were considered more sensitive.
The study was divided into a two-step process: 1) an inventory and sensitivity evaluation of the natural factors previously mentioned 2) followed by a weighted overlay analysis to generate composite sensitivity scores. The first step required compiling and categorizing inventory maps for each of the natural factors. The nine factors are then examined in relation to their ecological significance and potential environmental sensitivity for this region. Classifications were chosen according to the researcher’s best understanding of their importance in the greater ecological system. Following the process of classification, each factor was assigned a sensitivity score (1 = low sensitivity, of less importance; 2 = medium sensitivity, of moderate importance; 3 = high sensitivity, of greatest importance). Areas assigned sensitivity scores of 1 appear in green, scores of 2 appear in yellow and scores of 3 appear in red. The diagram below demonstrates the process of natural factor inventory and sensitivity scoring overlays.
**Study Area**

Ecological planning is often prepared at a different scope than traditional planning. Study areas are not constrained by jurisdictional or other political boundaries, but rather, tend to be based on natural ecosystem geography. This study chose to focus on the Santa Cruz Watershed in southeastern Arizona (USA). Falling within five counties, the ecological planning effort can be more comprehensive as a whole than it would on an individual county basis. The map below illustrates the study area in relation to the State of Arizona and the nation of Mexico. It is important to note that a comprehensive evaluation of this watershed would also incorporate data from the Mexican side of the border. However, time constraint and inconsistencies in data availability made this unfeasible for the purposes of this report.
Overview
Topography is a natural factor demonstrating landscape elevation variation. From stream beds to mountain cliffs, topography and elevation dictate flora and fauna populations. Certain types of species prefer or can only survive at certain elevations, for as elevation changes so too does the local ecology. Soils and erosion potential are greatly influenced by an aspect of topography known as slope. Typically understood as a measure of rise over run, higher slopes tend to demonstrate an increased potential for erodibility. Operations that reshape slope using heavy equipment, deforestation operations or drainage alteration can exacerbate this soil instability. Soil composition, degree of slope, vegetative cover and land use indicators can be used to estimate slope stability. Landslides are a very real and dangerous threat resulting from failure to account for issues of slope and soil stability. Most municipalities have guidelines regarding development on slopes greater than 3% and most built uses cannot exceed 15% to reduce danger. Additionally, slope impacts the hydrologic cycle through influencing groundwater retention. Greater slopes increase stormwater runoff, reducing the amount of water that seeps into the aquifer, while simultaneously increasing potential for soil erosion. (Marsh, 1998; Chapter 4)

Analysis
The study addressed topography through an examination of slope. Based on United States Geological Survey (USGS) digital elevation model (DEM) data, slope is expressed as a percent of slope. The inventory map demonstrates slope distribution as a percent slope. Sensitivity scores assigned higher sensitivity to locations with greater slope. Based on industry standards for construction, areas with 0% to 3% slope (typically the range for buildings and structures) were considered least sensitive (score 1). Development is restricted, but certain types are permitted on sites with 4% to 15% slope. These areas were assigned medium sensitivity (score 2). Development is not recommended in areas with greater than 15% slope, which was assigned highest sensitivity (score 3). Protection of areas with higher slopes, and de-emphasizing areas with lower slope more suitable for development, allows for a mutually beneficial plan for ecological protection.
Santa Cruz Watershed Environmental Analysis

Slope Map

Legend

Greater Slope (High, 400.106)

Less Slope (Low, 0)

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS Seamless Data Server
Santa Cruz Watershed Environmental Analysis
Slope Sensitivity Map

Legend
- 0 - 3% Slope, Low Sensitivity (Score: 1)
- 3 - 15% Slope, Medium Sensitivity (Score: 2)
- >15% Slope, High Sensitivity (Score: 3)

Santa Cruz Watershed (US Side): Topography Inventory

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS Seamless Data Server
Overview
Aspect is a measure of solar path based on the topography of the landscape. Typically a good indicator of microclimate over a large area, aspect identifies cardinal direction of sun exposure for a particular location. In general, microclimate identifies subtle differences in ground-level temperatures based on a variety of variables, such as sun exposure, wind direction and shade potential. On a small-scale numerous ecological indicators are impacted by aspect, including vegetation, hydrology and soil. Vegetation is greatly dependent upon solar exposure, with different flora preferring varying microclimates of sun, shade and temperature. Hydrology and soil are likewise influenced by solar exposure. Ultraviolet light produced by the sun impacts bacterial load, evaporation and temperature of water bodies, particularly those sources above ground. Soils are similarly impacted by exposure to sun. Areas of denuded earth, particularly where previous vegetation existed, can become dried out through exposed to direct sunlight (particularly when exposure was limited my canopy in its natural state) further adding to issues of erosion and other ground instability. In terms of the built environment, planning for temperature control and landscaping as well as ideal orientation for solar panels and passive lighting/heating are greatly impacted by solar path. Impervious surfaces, particularly dark asphalts, can greatly increase temperature in a microclimate environment. A more detailed examination of microclimate might incorporate other variables such as wind direction, micro-hydrology, impervious surface percentage or shade and shadow modeling. (Marsh, 1998; Chapter 15)

Analysis
The study addressed microclimate through the incorporation of an aspect map derived from digital elevation model (DEM) obtained through the USGS Seamless Data Server. Inventory information was organized by cardinal direction (N, NE, E, SE, S, SW, W, NW). Sensitivity scores were then based on preferred solar orientation. Our research determined locations facing south tended to receive more direct sunlight. Studies of mountainous areas in semi-arid climates (similar to those found in Arizona), have demonstrated south-facing slopes result in greater surface heating, higher rates of soil moisture evaporation and greater plant transpiration. The difference in soil moisture often results in north-facing slopes having higher percentages of vegetative ground cover. Given the sun’s angle of rotation and exposure, locations facing east receive greater sun exposure in the morning and less at night. Related thermal temperature is lower in the morning than it is at night. The study thus categorizes north facing slopes as higher sensitivity in order to protect locations with higher rates of vegetation and soil moisture content. East facing slopes were of secondary importance, south and west facing slopes of least importance. As such, highest sensitivity was assigned to locations facing North and Northeast (score 3). Medium sensitivity was assigned to locations facing East and Northwest (score 2). Low sensitivity was assigned to all other cardinal directions; West, Southwest, South and Southeast, (score 1). (Marsh, 1998; Chapter 15)
Santa Cruz Watershed Environmental Analysis

Aspect & Microclimate Inventory

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS Seamless Data Server

Santa Cruz Watershed (US Side):
Topography Inventory

Sensitivity Scoring
- W, SW, S, SE; Low Sensitivity, Score 1
- E, NW; Medium Sensitivity, Score 2
- N, NE; High Sensitivity, Score 3
Hydrology is perhaps the most critical natural factor in the arid climate of the desert southwest. Its impact on soil type, vegetation, biodiversity, microclimate and the built environment is immense. Habitat, flora and fauna depend on access to water for basic survival. Microclimates are greatly influenced soil and surface moisture. Protection of critical riparian habitats is of utmost importance when determining natural ecosystem sensitivity. Contamination of waterways resulting from human behaviour should be avoided at all costs. Water pollution from run-off is usually defined as either “point source” or “non-point source.” Point source contamination occurs through direct contact between a human land use and a waterway (such as from a pipe or industrial use). Non-point source pollution results from land use practices not directly linked to a water source (such as groundwater contamination from fertilizers or pesticides used in an agricultural operation). (Daniels, 2003; Chapter 4) Creating buffer zones between these types of uses and sensitive hydrologic areas should be encouraged when possible. Hydrologic sites can also potentially impact the built environment. Development within riparian areas is often restricted to minimize flooding threat. Stream restoration and risk management is an ongoing process as waterways continually change over time. As such, floodplain mapping must be constantly updated, and development checked to ensure no significant impact on riparian areas occurs. (Marsh, 1998; Chapter 10) The critical wildlife corridors are thus ideal for preservation as construction can be very limited for other uses.

Analysis
The study addressed hydrology by incorporating an analysis of major rivers, main stems and primary tributaries of the Santa Cruz Watershed. An inventory map demonstrating these riparian areas was created using information from the UAiR website. Sensitivity scores were based on distance buffers drawn around identified hydrologic features. A standard 100 foot buffer was drawn around riparian areas. These locations were assigned highest sensitivity (score of 3). (Marsh, 1998; Chapter 20) Medium sensitivity was assigned to areas buffered 200 and 300 feet from surface water sources. Low sensitivity was thus assigned to all areas greater than 300 feet from surface water sources.
Santa Cruz Watershed Environmental Analysis

**Major Rivers, Main Stem & Primary Tributaries**

**Hydrological Inventory**
- Major Rivers, Main Stem, & Primary Tributaries
- Santa Cruz Watershed

State of Arizona (United States): The Santa Cruz Watershed Five Counties in Context

Map by Yancy Lucas
Data Source: UAIR

Santa Cruz Watershed (US Side): Hydrology Inventory
Santa Cruz Watershed Environmental Analysis

Major Rivers, Main Stem, & Primary Tributaries Sensitivity Map

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source: UAIR

Sensitivity Scoring (Distance to Surface Water)

- Greater than 300 feet (90 meters); Low Sensitivity, Score 1
- 300 foot (90 meter) Buffer; Medium Sensitivity, Score 2
- 100 foot (30 meter) Buffer; High Sensitivity, Score 3

Santa Cruz Watershed (US Side):
Hydrology Inventory
Overview
From the hydrologic permeability of soil types (amount and speed of water infiltrating the aquifer) to issues of erosion related to higher concentrations of impervious surface, soils are impacted by every other natural factor in this study. Soil composition and texture influences vegetation type, flooding, groundwater recharge, potential for contamination and a host of other variables. (Marsh, 1998; Chapter 5) Soil erodibility is a prime concern in the preservation of sensitive areas, and as such, locations with higher potential to erode require greater care and attention. Development often greatly impacts the erodibility potential of soil. As vegetation is removed, the roots systems that hold sensitive soils in place are also compromised. Several equations can be utilized to estimate soil erodibility based on human and natural factors. The revised universal soil loss equation (RUSLE) estimates erosion potential based on a determined erodibility factor by soil type, a rainfall indicator for the geographic region, slope analysis of the target area, vegetation cover and land conservation practices. (Randolph, 2004; Chapter 12) In terms of soil conservation, denuding areas of vegetation or altering the hydrologic cycle in a manner that significantly impacts flow speed or load should be avoided.

Analysis
The study examined two soil factors to determine the most sensitive areas for preservation, hydric soil group and prime farmland soils. Hydric Soil Group is a natural factor relating to the hydrologic characteristics of a soil type based on composition and texture. Hydric soils were inventoried as classes B, C, and D in the Santa Cruz Watershed. Higher sensitivity was given to soils with greater potential for erosion. As such, class B received a score of 1, class C received a score of 2 and class D hydric soil group received a score of three (highest sensitivity.)

The second soil factor, prime farmland, relates to the agricultural potential of soil. Soils were divided into two distinct groups, “prime farmland” and “not prime farmland.” Higher sensitivity was given to prime farmland areas, as these locations demonstrate higher potential for vegetation (and higher potential to be utilized for agricultural uses). As prime farmland consisted of only two classes, “not prime farmland” received a sensitivity score of 1 and “prime farmland” received a sensitivity score of 3.
Santa Cruz Watershed Environmental Analysis

Hydric Soils Group

Santa Cruz Watershed Environmental Analysis

Hydric Soils Group

Santa Cruz Watershed (US Side):
Soils Inventory

Soil Classification

- Hydric Soil Group B
- Hydric Soil Group C
- Hydric Soil Group D

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source: UAIR
Santa Cruz Watershed Environmental Analysis
Hydric Group Sensitivity

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source: UAIR

Sensitivity Scoring

- Green: Hydric Group B; Low Sensitivity, Score 1
- Yellow: Hydric Group C; Medium Sensitivity, Score 2
- Red: Hydric Group D; High Sensitivity, Score 3

Santa Cruz Watershed (US Side):
Soils Inventory
Santa Cruz Watershed Environmental Analysis

Prime Farmland

Santa Cruz Watershed (US Side): Soils Inventory

Soil Designation
- Not Prime Farmland
- Prime Farmland

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source: UAIR
Santa Cruz Watershed Environmental Analysis

Prime Farmland Sensitivity

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source: UAIR

Santa Cruz Watershed (US Side):
Soils Inventory

Sensitivity Scoring
- Red: Not Prime Farmland; Low Sensitivity, Score 1
- Green: Prime Farmland; High Sensitivity, Score 3
Overview
Vegetation is a natural factor intimately linked to numerous others discussed in this work. Most native wildlife is dependent, in some way or another, upon access to adequate vegetation both in terms of diet and habitat. Vegetation also impacts levels of oxygen, carbon dioxide and pollutants in the air. Soil erodibility potential and slope protection are likewise significantly impacted by vegetation abundance and diversity. In general, microclimate is heavily influenced by vegetation, from wind break protection to lower thermal temperature and higher soil moisture content. Certain specific species of flora can function as indicator species, demonstrating the relative health of a particular forest. Virgin forest stands have significantly decreased in the United States since the early 17th century. Much of these areas have since been repopulated with agricultural operations. However, the ecological benefits of such land uses are significantly reduced when compared with the virgin forest state. Indeed, the age of a forest greatly influences biodiversity within it. Old growth stands have significantly greater species diversity than newer foresets. Protection of the remaining old growth areas should be of paramount importance in green infrastructure planning. Since vegetation is to intimately associated with other natural factors, even subtle alterations in composition, size and shape can have significant impacts on the ecology of an area. (Marsh, 1998; Chapter 18) Canopy coverage is often used as an indicator of forest health and vitality. Areas with higher percentage of dense growth tend to also support larger populations of fauna.

Analysis
The study addressed vegetation through an inventory of vegetative canopy coverage. Expressed as a percentage of coverage from 0% to 100%, canopy coverage gives a good sense of the overall flora abundance for a location. Sensitivity scores were based on a statistical analysis of the data. Breaks were determined according to the quantile method in order to demonstrate the spread of data. Sites with higher percentages of canopy coverage were assigned higher sensitivity scores as follows. Areas with no canopy coverage were assigned low sensitivity (score 1). Areas with 1 to 43% canopy coverage were assigned medium sensitivity (score 2). Locations with 44% or greater vegetative canopy coverage were assigned high sensitivity (score 3).
Santa Cruz Watershed Environmental Analysis

Vegetative Canopy Coverage

Percentage of Vegetative Canopy Coverage

100% Vegetative Canopy Coverage

0% Vegetative Canopy Coverage

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS Seamless Server
Santa Cruz Watershed Environmental Analysis

Vegetative Canopy Coverage Sensitivity

Sensitivity Scoring

- **0% Canopy Coverage; Low Sensitivity, Score 1**
- **1 - 43% Canopy Coverage; Medium Sensitivity, Score 2**
- **44%+ Canopy Coverage; High Sensitivity, Score 3**

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source: USGS Seamless Server
Overview
Biodiversity is a measure of faunal species abundance and variation. As the built environment continues to consume previously undeveloped areas, the natural environments required for perpetuation of native species decrease. Biodiversity of native species depends on abundant distribution of these areas, known as habitats. Identification of the most critical habitat locations can allow informed decisions for future planning. When identifying locations for habitat conservation, some basic principles should be kept in mind. Commonly understood as a system of patches, buffers and linkages; geographic shape, orientation and area of plots to be preserved is of utmost importance. Generally, locations (referred to as patches) should be as large as possible, incorporating ample buffer zones between conserved lands and built environments. Many species, particularly those that are native, avoid coming into close contact with human development. Buffer zones can assist in separating natural and human environments. Linking patches with wildlife corridors promotes movement of species, critical to the perpetuation of genetically diverse populations. (Randolph, 2004; Chapter 17)

Analysis
The study addressed biodiversity as a function of mammal species richness. Utilizing GAP mammal species richness maps produced by the USGS, we created an inventory of species distribution for the Santa Cruz Watershed. Richness was demonstrated as a range of unique mammal species per 30 meters. Classification breaks were included in the USGS data and have not been altered. Sensitivity breaks were based on an weighted equal interval scenario, with high sensitivity including four break groups (as opposed to three break groups used for low and medium sensitivity). The weighted scenario gives special consideration to areas with greater species richness, the focus of the biodiversity analysis.
Santa Cruz Watershed Environmental Analysis

Mammal Species Richness

Species Count (per 30 meters)

- Fewer than 8 Species
- 8 - 14 Species
- 15 - 21 Species
- 22 - 28 Species
- 29 - 35 Species
- 36 - 42 Species
- 43 - 49 Species
- 50 - 56 Species
- 57 - 63 Species
- 64 - 70 Species

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS GAP Server
Santa Cruz Watershed Environmental Analysis

Mammal Species Richness Sensitivity Map

State of Arizona (United States):
The Santa Cruz Watershed Five Counties in Context

Map by Yancy Lucas
Data Source: USGS GAP Server

Sensitivity Scoring
- 0 - 21 Species; Low Sensitivity, Score 1
- 22 - 42 Species; Medium Sensitivity, Score 2
- 43 - 70 Species; High Sensitivity, Score 3

Santa Cruz Watershed (US Side): Biodiversity Inventory
Land Cover & Impervious Surface

Overview

Land cover is used to identify the primary use for a particular location in terms of the natural and built environments. Classification can be determined by human impact on the natural landscape (such as developed or agricultural uses), or ecosystem driven (such as forest or wetland areas). Understanding the interaction between human activity and natural systems can greatly influence the effectiveness of preservation and conservation strategies. Relatively new paradigms in the field of urban planning, such as New Urbanism, emphasize the importance of directing growth and development towards areas of existing infrastructure. Infill projects can revitalize locations that have experienced or may be experiencing economic decline, as well as protected “greenfield” development. The resulting clustered development is a significant shift away from more traditional suburban fringe growth (often referred to as urban sprawl). (Daniels, 2003; Chapter 18) The built environment can impact natural ecosystems in a number of ways. Sprawl development tends to rely heavily on street and highway infrastructure, a by-product of which is a substantial increase in impervious surface area. Impervious surfaces can impact hydrologic cycles and microclimate, and if uncontrolled, contamination and soil erosion. Stormwater moves more quickly across impervious surfaces, increasing the potential for erosion as well as collection and distribution of contaminants into water supplies. Radiant heat reflected off of impervious surfaces can significantly impact microclimate environments by raising thermal temperature. Increasing density in urban design and providing adequate transit alternatives can mitigate these issues through de-emphasizing single-user automobile transportation. (Randolph, 2004; Chapter 6)

Analysis

The study utilized land cover classifications as defined by the United States Geological Survey (USGS). As previously noted, land cover classes incorporate both natural and built environments. Sensitivity scores were based on the ecological importance of defined classes. Developed and industrial areas were determined to be low sensitivity (score 1) as the natural environment has already been compromised or altered by human activity. Note, barren land is a classification given to areas with active and historic mining operations in this region. Often these uses contribute to significant contamination, and as such, have been assigned a low sensitivity. Lower intensity developed areas, agricultural areas and shrub/scrub areas were assigned medium sensitivity. The first two broad categories represent areas that have been significantly altered by human activity, but which still retain some elements of natural open space of interest to our study. Shrub/scrub was included in this class as it constituted a significant portion of the study area (resulting in target areas too broad to be effective for this study). Highest sensitivity was assigned to undeveloped, natural areas not categorized as shrub/scrub.

Impervious surface was demonstrated as a percentage of ground cover as identified by the USGS. Sensitivity scores were based on a statistical examination of the impervious surface cover data. The quantile method was utilized to determine break points. Locations with greater than 20% impervious surface coverage were determined to be lowest sensitivity (score 1), areas with 0 - 20% impervious surface coverage were assigned medium sensitivity (score 2) and areas with 0% impervious surface coverage were assigned high sensitivity (score 3).
Santa Cruz Watershed Environmental Analysis
Land Cover Inventory

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS Seamless Data Server

Legend

Land Cover Type
- Shrub/Scrub
- Developed (High)
- Developed (Medium)
- Developed (Low)
- Developed (Open Space)
- Woody Wetlands
- Emergent Herbaceous Wetlands
- Evergreen Forest
- Deciduous Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water

Pasture/Hay
Cultivated Crops
Barren Land

Miles
5 10 20 30 40 50
Santa Cruz Watershed Environmental Analysis
Land Cover Sensitivity

Sensitivity Scoring
- Developed, Low Intensity; Developed, Medium Intensity; Developed, High Intensity; Barren Land; Low Sensitivity, Score 1
- Developed, Open Space; Shrub/Scrub; Pasture/Hay; Cultivated Crops; Medium Sensitivity, Score 2
- Open Water; Deciduous Forest; Evergreen Forest; Mixed Forest; Grassland/Herbaceous; Woody Wetlands; Emergent Herbaceous Wetlands; High Sensitivity, Score 3
Santa Cruz Watershed Environmental Analysis
Impervious Surface Coverage

Percentage of Impervious Surface Coverage

100% Impervious Surface Coverage

0% Impervious Surface Coverage

Santa Cruz Watershed (US Side):
Land Use Inventory

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Source:
USGS Seamless Server
Santa Cruz Watershed Environmental Analysis
Impervious Surface Sensitivity

Sensitivity Scoring
- Greater than 20% Impervious Surface; Low Sensitivity, Score 1
- 1% - 20% Impervious Surface; Medium Sensitivity, Score 2
- 0% Impervious Surface; High Sensitivity, Score 3

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context
Map by Yancy Lucas
Data Source:
USGS Seamless Server

Santa Cruz Watershed (US Side):
Land Use Inventory
Santa Cruz Watershed Environmental Analysis
Green Infrastructure Assessment

Final Composite Analysis

Overview
Overlaying sensitivity scores from the nine natural factors resulted in the following composite sensitivity analyses. Two outputs are provided: 1) a sensitivity analysis in which each factor was give equal weighting and 2) a follow-up assessment which placed additional emphasis on habitat factors specifically identified. Sensitivity scores were then extracted to derive proposed Green Infrastructure (GI) areas. GI areas are depicted in green for each analysis. Final GI designations were determined according to the statistical uniqueness of the composite sensitivity scores.

For the final green infrastructure composite assessment, the nine sensitivity maps were overlaid and evaluated using a weighted sum calculation. Two scenarios are presented; the first titled “Composite Scenario” weighted all nine factors equally. The second, titled “Habitat Scenario” emphasized hydric soils and the hydrology factors as the driving inputs of the analysis. The habitat scenario weights water and soil higher as these factors have been identified as being integrally tied into all of the other examined natural factors. Higher composite scores represent locations of greater sensitivity, and thus, received higher priority for conservation. Areas appearing in red have been identified as highest sensitivity, green areas demonstrate lowest sensitivity. The resulting data was then evaluated, and classified into distinct categories: 1) not recommended for green infrastructure, or 2) proposed green infrastructure, which appear in green in the final green infrastructure selection maps. Areas designated as proposed green infrastructure were comprised of composite sensitivity scores greater than or equal to the first positive standard deviation of the dataset. This criterion was chosen to ensure that proposed green infrastructure areas exhibited sensitivity scores that were statistically unique among this analysis. Note the Habitat Weight resulted in larger, more contiguous areas of proposed GI. This was encouraging as successful habitat conservation is most effective when sizable and largely contiguous natural areas are preserved.

Future Analysis
Future analysis would perform a gap analysis to identify proposed areas of GI which are not currently preserved through federal, state, municipal or private land conservation. These areas represent protection gaps in conservation coverage and could then be targeted as potential areas for expanding current conservation efforts. These areas could be prioritized further by calculating the average sensitivity score within each region, thus allowing for the most sensitive areas to be targeted first.
Santa Cruz Watershed Environmental Analysis
Final Sensitivity Inventory
Composite Scenario

Santa Cruz Watershed Environmental Analysis
Final Sensitivity Inventory
Composite Scenario

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Sources:
UAIR, USGS Seamless Data Server, USGS Gap Server

Sensitivity Scoring

Low Composite Score (Min. 9) - Less Desirable

High Composite Score (Max. 26) - More Desirable

Santa Cruz Watershed (US Side):
Final Sensitivity Inventory
Santa Cruz Watershed Environmental Analysis
Green Infrastructure Selections
Composite Scenario

Legend

- Not Proposed Green Infrastructure (Score 0),
  Wt. Sum Score (0 - 19)
- Proposed Green Infrastructure (Score 1),
  Wt. Sum Score (19 - 26)

State of Arizona (United States):
The Santa Cruz Watershed
Five Counties in Context

Map by Yancy Lucas
Data Sources:
UAIR, USGS Seamless
Data Server, USGS Gap
Server
Habitat Weight

The Habitat Weight Scenario multiplies by 2, sums for Hydric Soils and Hydrology Overlays, to identify critical indicators for wildlife and vegetation in an arid climate.

Legend

Low Composite Score (Min. 11) - Less Desirable

High Composite Score (Max. 31) - More Desirable
Santa Cruz Watershed Environmental Analysis
Green Infrastructure Selections
Habitat Scenario

Legend
- Not Proposed Green Infrastructure (Score 0), Wt. Sum Score (0 - 22)
- Proposed Green Infrastructure (Score 1), Wt. Sum Score (23 - 31)

Santa Cruz Watershed (US Side): Final Sensitivity Inventory
Works Cited


United States Geological Survey (USGS) Seamless Data Warehouse. Made available by the U.S. Department of the Interior; found online at http://seamless.usgs.gov/

University of Arizona Institutional Repository (UAiR). Arizona Geospatial Data and Maps section. *The University of Arizona Libraries*; found online at http://uair.arizona.edu/item/292543