University of Redlands

The Use of GIS in the Morongo Basin Regional Conservation Plan

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for the degree of Master of Science in Geographic Information Systems

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by
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Abstract

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The preservation of open space areas provides habitat protection for a number of plant and animal species, as well as places of natural beauty by redirecting future development to existing communities. The Morongo Basin Open Space Group (MBOSG) is ensuring the preservation of these areas, by developing a regional conservation plan for Morongo Basin that focuses on open space protection. Because of the basin's large geographic coverage area, the MBOSG has prioritized its conservation efforts. The group, however, needed a tool to help evaluate their priorities and effectively communicate other conservation information to the public. This project addressed these needs by developing an analysis tool and a series of online maps of the group's conservation themes and prioritized areas. The analysis tool aimed at helping conservation planners and other decision-makers to develop strategies and effectively allocate resources to the most appropriate places. The online maps served to enhance public access to important conservation material.

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List of Acronyms and Definitions

API	Application Programming Interface
APN	Assessor Parcel Number
BB	Base Buffer
BLM	Bureau of Land Management
CS	Community Separators
GIS	Geographic Information System
JTNP	Joshua Tree National Park
MCAGCC	Marine Corps Air Ground Combat Center
MDLT	Mojave Desert Land Trust
MGOSG	Morongo Basin Open Space Group
NAD	North American Datum
PB	Park Buffer
SDLC	System Development Life Cycle
SQL	Structured Query Language
TWC	The Wildlands Conservancy
USFS	United States Forest Service
UTM	Universal Transverse Mercator
VT	Views and Treasures
WH	Wildlife Habitat

Chapter 1 – Introduction

Human activity when unmanaged has the ability to drive other species into extinction making the area less inhabitable. It is apparent that human populations need space to grow and develop, however there needs to be a balance between human development and the preservation of some native habitats for other species to coexist. The adaptable nature of human populations makes it easier to regulate where these growth areas will occur and incorporating a conservation plan will ensure protection of the natural environment. A conservation plan is therefore designed to help better manage natural resources and sustain ecosystems as human populations and activities increase. This document focuses on a regional conservation plan developed for the Morongo Basin and discusses the methods used to present the information to the public.

The Morongo Basin lies south of the Mojave Desert in Southern California. It extends over a large geographic area and encompasses the boundaries of the Morongo Unified School District in San Bernardino County (Figure 1-1).

Figure 1-1: Project study area

This study area includes the cities of Morongo Valley, Yucca Valley, Joshua Tree, and Twentynine Palms. It also includes the communities of Landers, Flamingo Heights, and Wonder Valley, as well as parts of Joshua Tree National Park (JTNP), San Bernardino National Forest, and the United States Marine Corps Air Ground Combat Center (MCAGCC) more commonly known as the Twentynine Palms Marine Base (Morongo Basin Open Space Group, 2009c).

The Morongo Basin Open Space Group (MBOSG) is a collaboration of 22 local agencies and organizations working to protect open space within the basin. The group defines open space as land where natural processes may occur, that provides for ecological linkages and wildlife corridors, buffers between communities, around the national park, and around the military base (Figures 1-2 and 1-3). It also includes viewsheds and aesthetics, low-impact recreation opportunities, watershed and flood areas (Morongo Basin Open Space Group, 2009d).

Figure 1-2: Open space area within Morongo Basin

Figure 1-3: Wildlife habitat area within JTNP

The MBOSG developed a regional conservation plan to support the State of California in its mission to plan for economic growth and development within the region. The Morongo Basin regional conservation plan recognizes the direct correlation between economic growth and the consumption of natural resources, and gives high priority to preserving and protecting important natural resources in open space areas. Growth is directed to areas within the basin that have the least natural, historic, and cultural resource values. Part of the MBOSG's role in this planning project is to keep the local residents and stakeholders involved in decision-making. To help stimulate public interest toward the conservation plan, the MBOSG used a community-based process known as conservation priority setting to identify and characterize important conservation themes that were ranked by priority: low, medium, and high (Morongo Basin Open Space Group, 2009b). Using input from community workshops and the MBOSG, five conservation themes were identified; each theme was characterized by a collection of attributes (Morongo Basin Open Space Group, 2009a). Figure 1-4 displays these conservation themes and the related attributes.

Park Mission Buffer	MCAGCC Mission Buffer	Wildlife Connectivity & Habitat	Community Separators	Community Views & Treasures
<ul style="list-style-type: none"> • Location—Proximity to Park • Location—Linkage Design • Habitat Quality—Road Density • Habitat Quality—Riparian Habitat • Habitat Quality—Human Activity • Size of Parcel • Shape of Parcel Perimeter Contiguous with Park • Parcel Suitability for Development—Zoning Class • Adjacent Property Use and Plans—Zoning Class • Development Pressure—Existing Proposals • Species Preservation 	<ul style="list-style-type: none"> • Location—Proximity to Base • Size of Parcel • Current Land Use—Improvements • Development Potential—Ownership • Species Preservation • Location and Geography—Airspace/Air Corridors and Adjacency • Parcel Assessed Value 	<ul style="list-style-type: none"> • Linkage Design • Location & Proximity • Impediments to Connectivity • Threatened—Proposed Development, Energy Proposals • Streams • Barriers—Potential Crossings • Size of Parcels • Species Preservation 	<ul style="list-style-type: none"> • Visual Quality • Separates Communities • Proximity • Land Use—Current Zoning • Size of Parcel & Ownership • Length of Highway Frontage & Ownership 	<ul style="list-style-type: none"> • Iconic Places • Land Ownership • Dark Night Sky • Iconic Views • Ridgelines • Scenic Highway/Byway • Community Defined Scenic View Areas

Figure 1-4: Conservation themes with associated attributes

The five conservation themes: Park Mission Buffer, MCAGCC Mission Buffer, Wildlife Connectivity & Habitat, Community Separators, and Community Views & Treasures each represent important conservation planning goals for Morongo Basin. These themes consist of a number of attribute values that define important aspects of that theme, such as location or parcel suitability. The attribute values are assigned a conservation score for each theme within the parcel, and are recorded as A+, A, B, C, Neutral, and F.

1.1 Client

The primary client for this project was the Sonoran Institute, a nonprofit planning organization and collaborative partner of the MBOSG. Their mission is to “inspire and enable community decisions and public policies that respect the land and people of western North America” (Propst, 2009). Their role within the MBOSG was to address the main issue of public participation and information sharing of the conservation themes between the group members and the public. Dr. Stephanie Weigel, a regional planner for the Sonoran Institute, was the main contact for the project and her role was to provide data, as well as guidance on any specifications for the deliverables.

1.2 Problem Statement

The client encountered two main problems. First, they had no effective way to communicate conservation information with the public. Second, the client needed a tool to conduct further analysis on any set of prioritized parcels for conservation. Particularly, the client needed a complementary analysis that could help them answer: Where were the

coverage gaps in conservation values for selected parcels? Were there any redundancies in the types of parcels classified as high priority? Where were these areas? What were the represented conservation values?

1.3 Proposed Solution

Since there were two main issues to be addressed, two solutions were proposed in this study. The first proposed solution was to develop a Web GIS application that focused on usability. Users would have access to data layers relevant to the conservation priority values, conduct interactive data queries, and navigate throughout the map. The application would include topographic imagery to help users grasp where these priority areas were within the study region. To address the second need of the client, a modeling workflow, created in ArcGIS ModelBuilder, was designed to provide further analysis on the open space conservation themes for the parcel data.

1.3.1 Goals and Objectives

There were two main goals for this project. The first was to increase public participation in the Morongo Basin regional conservation plan by providing the information in an accessible and interactive format. The second was to develop a model, which represented the workflow geared towards evaluating the conservation priority settings conducted on the parcel data for Morongo Basin. Under these two main goals, there were a few objectives.

The first objective was to refine the file geodatabase provided by the client containing the GIS data needed for the Web application and the complementarity analysis. Other objectives specific to the Web application included identifying and incorporating the data layers or datasets to be used for visual display, and developing the functions needed for the application.

The objectives for the model included developing a set of GIS models to automate the workflow for the complementary analysis. Using the workflow, the client can review the coverage gaps and redundancies for the selected parcels in both table format and map display. The final objective was to demonstrate that both the Web GIS application and the complementarity analysis model were very useful for communicating and evaluating any conservation plans.

1.3.2 Scope

To satisfy the needs of the client, three major GIS components were developed and included in the project documentation: a GIS database, a Web GIS application, and a workflow model. The GIS database or geodatabase was configured and set up to store, organize, modify, and extract spatial data relevant to the study area and the conservation analysis. The Web GIS application was developed to present the conservation priority findings to the public and other audience members. The third GIS component, a workflow model, was developed to analyze the open space analysis conducted on the parcels. For both the Web application and the analysis model, help documents would be generated to help the client and other users, use the applications with ease and efficiency. The project documentation included metadata for the geodatabase, a user manual for the

Web GIS application, a summary report of the project with a PowerPoint presentation, and a DVD of the data and analysis performed.

Outside the scope of this project was installing software applications onto the client's machine that supported maximum system performance. Also excluded from the project scope were any configurations to the client's server network.

There were project constraints that affected the overall turnaround time assigned for prototype iterations. The first was system acquisition, which included proposal review, revisions, and acceptance. The second was development training, which included gaining proficiency in Adobe's Flex 4 programming language to customize the GIS applications.

1.3.3 Methods

To produce the major GIS components, there were several main steps to perform. Database design involved extracting the main feature class from the client's master geodatabase and normalizing the attribute table. In addition, data manipulation and data conversion was performed from the feature class to layer files. Adobe Flex 4 programming code was created for the Web GIS application and the user functions. The user needs and requirements determined the display content and performance of the Web GIS application. Finally, the analysis model was developed in ArcGIS ModelBuilder environment and customized with Python scripting.

1.4 Audience

The subject matter discussed in this report is of significance to a wide range of readers. A vast majority of these individuals is part of the MBOSG and includes the Bureau of Land Management (BLM), city council members, JTNP and MCAGCC officials, as well as the main client, the Sonoran Institute. Other interested readers include organizations interested in water management, local conservation groups, community service members, and those concerned with the use of GIS technology to increase public participation and interest in the Morongo Basin regional conservation plan.

The intended audience has varying levels of professional experience with GIS. As a result, the general tone of the report meets the needs of those with a basic understanding of GIS but unfamiliar with its processes and full capabilities.

1.5 Overview of the Rest of this Report

This report describes the approach to system design specifically intended to support the successful GIS operations in communicating geographic information for a regional conservation plan. Its purpose is to educate readers on the possibilities of GIS applications in conservation planning and to discuss the methods applied. The first chapter introduces the subject of conservation planning and the MBOSG. It also identifies the client for this project, the problem addressed, and the goals and objectives of the proposed GIS solution. Chapter 2 provides the background and literature review on the problems affecting communication in conservation planning and effective GIS applications for communicating information in a public forum. Chapters 3 and 4 examine the system and database design for the GIS applications. These chapters present information on the user needs and information products, as well as the data development

methods used. Chapter 5 deals with the implementation strategy applied. Chapter 6 looks at the obtained results and analysis and Chapter 7 completes the report with the conclusions and potential addenda to the work done.

Chapter 2 – Background and Literature Review

As stated in Chapter 1, a conservation plan is essential to help bring conceptual ideas for balancing urban growth and natural environment preservation to the forefront. The MBOSG has developed such a plan for Morongo Basin and has prioritized its conservation efforts. The group needs an effective method to evaluate the priority classifications of their efforts and publicize the information. This chapter provides a literature review on the role of GIS in conservation planning. It also discusses the application of complementarity analysis in validating these efforts. Chapter 2 will also address public participation and some of the issues associated with using traditional planning methods for communicating ideas in the decision making process, as well as discuss Web technology and Web GIS applications

2.1 The Role of GIS in Conservation Planning

Conservation relies heavily on knowing where things are within space. Whether the concern is biological, referring to the preservation of various species and their habitats, or mineral, referring to the management of natural resources, a key aspect in conserving or preserving an entity is first identifying where it is and the environment surrounding it. This spatial concept is what makes mapping such an important part of conservation planning. GIS has been widely recognized as an important tool in conservation planning because of its capabilities of handling spatial data (Phua and Minowa, 2005; Peng, 2001). It not only provides the tools to map non-spatial or attribute data about the entity or phenomena, but location information as well. GIS technology has been used for a variety of conservation projects. For example, identifying potential conservation priority areas in forest management by combining forest conservation priority maps with weighted distance analyses (Phua and Minowa, 2005), protecting large predator species by combining the animal movement with land use data (Laurence, 2001), and for planning potential conservation areas by using relationships between bird migration patterns and environmental factors (Mariuki et al., 1997). What should also be noted from these examples is that GIS not only can be used for its mapping capabilities but also for its analytic capabilities. In conservation planning there are several factors and considerations that apply to site selection, including proximity to other areas, size, soil type, and precipitation. These factors can all be stored in a GIS and analyzed to produce new information. In reference to the Mariuki et al. (1997) example, before a conservation site could be chosen, protected areas were extracted from the analysis and the unprotected areas were examined to determine if the preferred site size was available. Once the new sites were approved, they were further analyzed to identify areas of Kenyan bird clusters. Each step in the process involved the use of various analytic tools that were implemented with GIS technology.

2.2 Validating Conservation Efforts

Once the analysis for site selection has been completed, the prioritization of the conservation efforts should be evaluated. This helps planners discern whether the

priorities set for their conservation efforts proved successful in supporting the main goals of the project or if certain aspects of the conservation plan should be refined. One method that has become more commonly used and documented among researchers is gap analysis (Margules and Pressey, 2000; Phua and Minowa, 2005; Theobald et al., 2000). Gap analysis is often applied to identify unrepresented features within the ‘high priority’ category. When gaps in the coverage are identified, the unrepresented features can be more closely examined (Scott et al., 2003). Often these features are well represented in lower priority categories and can be identified using a second method called Complementarity. Complementarity looks at the degree to which an area contributes otherwise unrepresented features to an existing area (Margules and Pressey, 2000). For example, Table 2-1 illustrates how to identify a new site using the principle of Complementarity. There are four sites presented in this example: one, two, three, or four, to add to a priority list of areas to be protected. Previously protected sites were lacking in criteria A, B, C, and D. Using the principle of Complementarity, the best site to add to the protection list is site three because it offers the most value and diversity of the sites presented.

Table 2-1: Complementarity Matrix

	A	B	C	D
1	0	1	0	1
2	1	1	0	0
3	0	1	1	1
4	0	0	1	1

Although gap analysis and complementarity typically have been applied to biological diversity (Margules and Pressey, 2000; Scott et al., 1993), the concepts have been successfully applied to other areas of interests such as land use (Kauko, 2003) and preserving open space areas (Esbah, Deniz, and Cook, 2007). Kauko (2003) looked at residential property values and the effect or influence that the locations environment (both positive and negative) had on the price of these areas. He used different modeling analyzes to develop a ‘locational value’ matrix and complementarity, to select alternative locations to observe the effects of these attributes.

Esbah et al. (2007) used Gap analysis to identify and isolate open space patches to conduct further analyze on these areas.

2.3 Communicating Conservation Ideas

In planning, active public participation is encouraged during the decision making process to ensure that the main concerns of the affected community members and other stakeholders are acknowledged and taken into account in the final decisions of the development plan. Planners have often fallen short in obtaining the critique from a large participatory group of community members to guarantee that they have considered the

views affecting the majority of community members and not just a small subset of that community. One of the main obstacles attributed to this was the method used to communicate the necessary planning materials to the public. Conventionally, individual reviews, letter writing, news reporting, and public hearings, or planning council meetings have been used to create awareness and stimulate public interest about the development plan, but these methods have proven to restrict the level of public involvement and participation (Dragicevic and Belram, 2004; Peng, 2001; Shiffer, 1998).

The setting of a planning meeting can have an effect on the level of participation and future attendance of the meeting. Traditionally, the atmosphere for public participation has been perceived as uninviting and confrontational (Kingston, Carver, Evans, Turton, 2000). Often planning meetings or hearings involve arguments between planners and the community members on the proposed ideas. This environment can severely discourage public feedback from less vocal members, whose valid arguments may represent the views of the majority; instead, the opinions of more vocal members, whose criticisms may be relevant to a small minority, are dominant in the discussions and debates (Dragicevic and Belram, 2004; Kingston et al., 2000). It can also affect the attendance of these less vocal members if they feel like their voice would not be heard at these events.

The second major factor to limit public participation using the traditional methods is the level of public access to planning information. Planning maps may not always be available for public display due to technology failure or lack of infrastructure in the appointed meeting place. This lack of representational aids can provoke more confusion than understanding of the proposed ideas and cause the public to contribute less meaningful criticism towards the plan (Shiffer, 1998). Scheduling conflicts are also a concern, as planning meetings require individuals interested in the discussion to meet at specific dates and times, which may not be convenient for many community members with families and demanding jobs. In addition, the location of the meeting can lessen public turnout, especially for those without access to transport (Dragicevic and Belram, 2004; Kingston et al., 2000).

Having an effective tool to broadcast planning maps and other information to a large audience has been an important consideration for planners and decision makers. GIS has been recognized as an effective tool for mapping and analysis in conservation planning, however as a stand-alone system, accessibility to GIS data is limiting (Dragicevic and Belram, 2004; Peng, 2001). There is the financial overhead cost associated with hardware and software purchases, as well as privacy issues for personal data (primarily the disclosure of names with the associated address information). This has been addressed, however, by researchers such as Peng (2001) and Dragicevic and Belram (2004), who have successfully employed GIS technology to customize the information presented to the public and integrated this with the Internet or Web to increase accessibility to planning material.

Since the rapid expansion and development of the Web, many barriers associated with communicating thoughts, findings, and discussions are lessening. The idea that any desktop can be immediately linked with any others to share data, regardless of distance in location or difference in time, has been made possible with Web technology (Convis, Jr., 2001). This advancement in networking abilities is what makes the integration of Web technology with GIS increasingly popular among planning organizations (Dragicevic and Belram, 2004; Kingston et al., 2000; Peng, 2001). Planners can deliver

improved planning services to the community by providing a fast, highly accessible, and interactive application directly related to important community issues. The Web provides planners with the opportunity to share planning data with a much wider audience (Kingston et al., 2000). The public no longer needs to install costly proprietary software, or be faced with transportation or scheduling conflicts. Web GIS has been implemented across diverse fields from community planning (Al-Kodmany, 2000), data distribution (Hu, 1999), natural hazard management (Carrara, Cardinali, Guzzetti, & Reichenbach, 1999), and public participation (Kingston et al., 2000). It has also been applied to map data at different scales, from large-scale city planning data (Figure 2-1) to small-scale state data (Figure 2-2).

Figure 2-1: Concord Massachusetts WebGIS application for data distribution

Figure 2-2: Maryland Department of Transportation WebGIS application

Basic GIS functions for interactive map navigation (e.g. pan, zoom, query, and feature select) are common in Web GIS applications. The public is given the opportunity to explore the data and gain a better visual perspective from the interactive component of the application, sometimes far better than they would from the static printed map.

2.4 Summary

When used to its full potential, GIS can provide a full range of solutions, from management capabilities for mapping spatial data to conducting various types of analysis for planning. GIS can also be integrated with Web technology and used to reduce communication barriers between planners and the public. Overall, GIS can prove valuable to the MBOSG in providing an effective tool for their prioritization analysis as well as an effective means to communicate their conservation values and efforts.

Chapter 3 – Systems Analysis and Design

Implementing an effective GIS means building a system that can meet the needs of the client. This is achieved in part by conducting a requirements analysis, which identifies what the data requirements are and what the system requirements are to support the client's needs. Once these requirements are determined, a system can be designed. A project plan is another essential component to ensure that the resources are allocated accordingly and that the project remains on course for its expected completion date. This chapter is divided into five sections. The first provides a review of the problem statement. The second discusses the requirements analysis and includes an explanation of both the functional and non-functional requirements for project completion. Section 3 describes the system design, which will be followed by the project plan in Section 4. Chapter 3 concludes with an overall summary in the last section.

3.1 Problem Statement

There were two problems addressed in this project. First, the client needed a tool to help evaluate the priorities of their conservation efforts and determine whether priorities that were set on the parcel data provide a complete coverage on the five conservation themes. Second, the client needed an effective channel of communication between the MBOSG and the public on the five main themes and their attributes for the basin's regional conservation plan.

3.2 Requirements Analysis

This project focused on the development of two major components: a desktop complementarity tool and a Web GIS application. The tool was developed to allow the client or any other knowledgeable ArcGIS user to easily identify gaps in the conservation coverage for the five themes. It would also determine attribute redundancies in the parcel data, based on the combined result of the conservation themes. These combined results are the combinations of the priority categories for each theme in a parcel. For example, a parcel is ranked in the medium category for each of the five conservation themes; therefore, the combination observed is coded as MMMMM. The Web application simply needed to display the results of the conservation themes and their priority categories, to the public, in a clear and effective manner. In order to evaluate whether the applications presented to the client met their specific needs, a requirements analysis was conducted. This consisted of documenting use cases and information products descriptions, as well as conducting a public focus group to develop a list of requirements. This process was necessary to identify and evaluate the functional and nonfunctional requirements of the project.

3.2.1 Functional Requirements

The functional requirements describe the “what” of a project, more specifically, what are the functions that the application must perform. Table 3-1 summarizes these requirements for the complementarity tool. First, the client needed to add the parcel data to the tool,

and be allowed to select parcels of interest to be analyzed. The tool should then perform analysis on the input parcel data to identify any gap in coverage. In addition, the tool also needs to analyze the input parcel data to identify the redundancies in parcels that have similar conservation categories. Finally, this new information would be presented, both in a table format and map display.

Table 3-1: Functional requirements for the Complementarity tool

Requirement	Description
Accept user input	The model should allow the user to input the required feature class
Identify gaps	The model should analyze the parcel data to identify gaps in conservation coverage
Identify redundancies	The model should analyze the data to find parcels that share similar attribute values for the five priority categories
Show results	The model should generate a table of the included parcels and a map to display results

Table 3-2 summarizes the functional requirements for the Web GIS application. These requirements were developed by the client along with the input of a small public focus group (See appendix A for focus group summary). The users of the Web application needed control of map navigation such as panning around the map and zooming in and out. They also needed the ability to turn layers on and off, query on specific parcels, return attribute information on specific conservation themes, and print the area maps. Also needed was the ability to view the entire extent of the conservation themes while looking at a more detailed area.

Table 3-2: Functional requirements for the Web GIS application

Requirement	Description
Map navigation	Pan map in display window or zoom in or out of extent
Data query	Search for parcels by parcel id number or address location
Layer selection and display	Turn the conservation values layer on or off to display values
Map overview	Track user location and extent within the study area
Display attributes	Retrieve data on the conservation value for each parcel and return data in an information window
Print	Ability to print the map display from the application

3.2.2 Nonfunctional Requirements

Nonfunctional requirements focus on the “how” aspect of the project: how will the application perform these tasks? Table 3-3 summarizes the non-functional requirements for the complementarity tool and Web GIS application. These requirements included the usability, technical, operational, transitional, and legislative requirements that were developed from the use cases.

Table 3-3: Nonfunctional requirements for the system

Type	Requirement	Description
Usability	Efficiency	Users should be able to complete the tasks within a tolerable timeframe
	Effectiveness	Users should be able to perform tasks with completeness and accuracy
	Easy to use	Simple design
Technical	Visual Design	Visible font types, background color chosen to represent conservation theme, large symbols in map legend, and buttons are all clearly labeled for the Web application.
	Input Guidance	Descriptive tooltips for the Web application and help suggestions for the model
	ArcGIS Desktop 9.3 and ArcGIS Server 9.3	The maps used for Web display and the model application were created using ArcGIS Desktop 9.3 and the map services were created and published to ArcGIS Server 9.3.
	Third party software	The Web application framework was developed in Adobe Flash Builder 4 and requires the installation of Adobe Flash Player 10.1 or higher
	Web Browser	Internet explorer 8.0 or higher, Mozilla Firefox 3.6 or higher
	Data Storage	File geodatabase storage for model and Web application data
Operational	Automated processing	The complementarity tool needs to automate the process of analysis and data display
	Software Updates	Download Adobe software updates as required

Type	Requirement	Description
Transitional	Data Conversion	Data is projected to the Universal Transverse Mercator (UTM) coordinate system with a geographic projection of North American Datum of 1983 (NAD 83), Zone 11 North
	Testing	Tool testing and Web application testing
	Demonstration	Brief demonstrations on how to operate the manage the tool and Web application
	System Documentations	This includes a help document for the Web application, metadata for the complementarity tool, and a project report
Legislative	Privacy Protection	Removing owner names associated with parcel address

The usability requirements focused on efficiency, effectiveness, and ease of use. It was not imperative for the complementarity tool be extremely efficient since the process would not be performed frequently. It did however need to be effective and easy to use. To facilitate this, there were default values for the input and output path names and feature classes and the interface only displayed parameters that were necessary for the user to manipulate. The Web application needed to perform efficiently. Data retrieval and display were required within a tolerable timeframe (seconds). Additionally, it was important that the application be easy to use, to maximize user effectiveness in accomplishing tasks.

The technical requirements focused on the layout and minimum software specifications. In order to run the complementarity tool or create the maps for the Web application, the client needed ArcGIS Desktop 9.3 or higher, installed on the client's machine. Input guidance for the tool was made available by the tool help option. To create and publish the map services for the Web application, ArcGIS Server 9.3 or higher was required. The Web application framework was developed in Adobe's proprietary software, which required the installation of Adobe Flash Player 10.1 or higher for viewing purposes. In order to increase public accessibility, the Web application was made compatible with multiple Web browsers. It was tested on Internet Explorer 8.0 and Mozilla Firefox 3.6, however, the complete list of compatible Web browsers with the associated operating system can be found on Adobe's Website. The Web application needed to accommodate a wide range of public users from varying age groups and educational backgrounds. To facilitate this need, large font types, descriptive headings, descriptive tooltips, and logical design layout were incorporated into the application framework. A geodatabase was necessary to organize and store the data, as well as to develop the tool and manage the map services. Since the geodatabase needed to have a flexible storage capacity without the need for multiple editors, a file geodatabase was used.

There were two main operational requirements of the system. First was the automation of the complementarity tool. This tool allowed the client to set the initial parameters, retrieve the results table, and map display without additional involvement in

the model analysis process. The second operational requirement was software updates. This requirement, relevant for the Web application, will be based on Adobe's latest software updates. Additionally any updates to the parcel data attributes will be done through the file geodatabase editing mode.

The transitional requirements focused on data conversion, testing, demonstrations, and system documentations. These were included in the requirements to ensure that the client knows how to use and maintain the applications. Any new data layers created were converted to the UTM zone 11 north coordinate system to stay in compliance with the client's projection standards. Prior to delivery, there was extensive tool and Web application testing to ensure that the functional and non-functional requirements were met. Brief demonstrations on both applications were provided to the client along with the accompanying documentation. These documents include a DVD with all the necessary data, a help document for the Web application, and a complete project report.

The legislative requirement dealt with the protection of privacy. All owner names that were associated with the parcel data were removed from the geodatabase to maintain anonymity.

3.3 System Design

Two main factors were attributed to the system design: the system requirements and application users. These factors were used to determine the most optimal configuration of hardware, software, and network to ensure a successful implementation of the GIS. The application requirements consisted of functional and non-functional constraints that were determined from the requirements analysis. For this project, there were two categories of users: a GIS user and a public user. The GIS user was responsible for executing the analysis from the tool, as well as maintaining the map services for the Web application. The public user was granted access to the Web application to view map services and perform predefined data queries. Figure 3-1 illustrates the system architecture for the project.

Figure 3-1: System Architecture

The system architecture was composed of a file geodatabase that stored Morongo Basin’s parcel data and study area boundary. Data from the geodatabase was used in the complementarity tool. The tool development was done solely in ArcGIS ModelBuilder. The output of the tool produced summarized tables of attributes from the parcel data. This table could also be mapped for a visual display. The result of the analysis was made accessible to the GIS user through a desktop client or local machine.

Data within the geodatabase were also used to create a map service. This map service, along with other ArcGIS online services and a Flex API (application programming interface), were stored in ArcGIS server 9.3. These three components were served onto the Web and distributed to the public user through thin Web clients or Web browsers. The geodatabase, tool, and map documents were all created in ArcGIS Desktop 9.3. This system architecture was chosen because it most suited the client’s needs with its ability to ensure platform-independence and its accessibility over the Web to its end users. It also accommodated limited client-side processing, provided high quality graphical display, and allowed the management of restrictive client-side resources.

3.4 Project Plan

The project plan followed a staged approach for the system development lifecycle (SDLC). Individual components of the project were built and tested separately in an effort to identify any potential errors in the design. Each component was submitted for review and the design was revised accordingly.

3.4.1 Original Plan

The initial project plan (Table 3-4) provided a breakdown of the major phases with the projected completion time assigned to each task. There were five project phases: define, plan, execute, monitor, and close. Each phase was comprised of tasks “T” and milestones “M”. The initial scope involved the development of two application deliverables, a geodatabase and a Web GIS application. The geodatabase was designed for storage, and it contained all data relevant to the Morongo Basin regional conservation plan. The Web application served as a public access portal to conservation data for the plan.

Table 3-4: Initial Project Plan

Phase	Task	Start	End	Duration (days)
1	Define	1/26/2010	3/18/2010	24
T	Project Selection	1/26/2010	1/28/2010	3
T	Project Approval	1/29/2010	2/2/2010	5
T	Develop a Project Proposal	2/3/2010	2/25/2010	22
M	Present Project Proposal to Client	3/18/2010	3/18/2010	-
2	Plan	4/6/2010	5/19/2010	43
T	Data Collection	4/6/2010	4/15/2010	22
T	Assess User Needs	4/7/2010	4/12/2010	6
T	Develop Information Products	4/14/2010	4/30/2010	16
T	Assess User Requirements	5/5/2010	5/19/2010	15
3	Execute	5/20/2010	9/30/2010	103
T	Develop Geodatabase	5/20/2010	5/30/2010	11
T	Create/Update Metadata	5/20/2010	6/15/2010	12
M	Submit Database Design for Review	6/2/2010	6/2/2010	-
T	Develop Web Application	6/25/2010	9/30/2010	98
4	Monitor	10/1/2010	11/29/2010	50
T	Test Design/ Functions	10/1/2010	10/10/2010	10
M	Design Release to Client	10/12/2010	10/12/2010	-
T	Revisions	10/14/2010	10/25/2010	12
T	Test Design/ Functions	10/26/2010	10/30/2010	5
M	Design Release to Client	11/3/2010	11/3/2010	-
T	Revisions	11/5/2010	11/14/2010	9
T	Finalize Application Deliverables	11/15/2010	11/29/2010	14
T	Finalize Project Documentation	10/2/2010	11/29/2010	49

Phase	Task	Start	End	Duration (days)
5	Close	12/1/2010	12/15/2010	15
M	Present Project	12/1/2010	12/1/2010	-
T	Deliver Project Solution to Client	12/2/2010	12/15/2010	13

3.4.2 Revised Plan

As the project progressed, the initial scope was expanded to include an analytic component. The desktop tool was added to enhance the GIS capabilities of the overall project. The new deliverable caused a rippling effect in the delay time for each phase starting with the completion of the planning phase as new information products, user needs, and system requirements needed to be developed. The additional component also required that the client resubmit updated parcel data to include attributes that were needed for the tool's analysis. This new data was then preprocessed to ensure completeness. The next significant delay was experienced in the execution phase as the feature classes within the geodatabase needed to be reprocessed, the map service republished, and the Complementarity tool developed. The Monitor phase was also extended past its expected completion date, due to testing procedures for the new deliverable. Although there were significant time delays in many of the phases, the overall project completion date was not significantly altered.

3.5 Summary

This chapter discussed the systems analysis and design for the applications and explained the project plan. It also addressed the additional component that was added and its impact on the progression of the project. Conducting the requirements analysis proved crucial in ensuring that the applications supported the user's needs and the overall project goals. The result from the requirements analysis was also necessary to develop an effective system design. Having a flexible project plan was crucial to redistribute resources to other phases of the project to ensure minimal delay for project completion.

Chapter 4 – Database Design

This chapter discusses the database design chosen for the project. It begins by explaining the conceptual and logical data models. This is followed by a description of the data sources and data preparation procedures. This chapter concludes with an overall summary.

4.1 Conceptual Data Model

The conceptual model looks at an abstraction of real world entities and identifies the features, their attributes, and the relationship between them. Figure 4-1 demonstrates the structure of the conceptual model for the project.

Figure 4-1: The conceptual data model

The client wanted a map or a series of maps of the Morongo Basin parcels. These parcels were classified by conservation themes: Base Buffer, Park Buffer, Wildlife Habitat, Community Separators, and Community Views and Treasures, all of which shared a similar structure. Each parcel was classified by all five conservation themes.

4.2 Logical Data Model

The next step in the design process was to develop a logical data model. A file geodatabase was chosen for this project because of its capacity to store large amounts of data, multiple feature classes, and tables. In comparison, a personal geodatabase cannot support the storage capacity for any of the feature classes since it is limited to two gigabytes of storage, and its performance deteriorates after 500 megabytes. The large

storage capability of the file geodatabase provides the client with the ability to add more datasets for future study areas.

The logical data model of this project contained two datasets: one for the Web application and the other for the Complementarity tool. It also included the associated feature classes and tables. Figure 4-2 shows the logical data structure for the Web application.

Figure 4-2: Logical data model for the Web application

There are eight feature classes in the Web dataset, five of which represent the conservation themes. The Combined feature class contained all the high category values for the five conservation themes. The MB_USD and the MB_Parcels feature class were both part of the MB_Dataset_Topology. A topology was set up to ensure data quality, as well as merge the behavior between feature classes which shared the same geometry. The MB_Parcels feature class contained each conservation theme in an attribute field, and these fields were dissolved to create the feature classes for the conservation themes. Converting these feature classes to layer files further reduced the overall size of the feature classes while maintaining the symbology. A priority domain was also created for the MB_Parcels feature class, to reduce user input error for future changes in the data.

Figure 4-3 illustrates the logical data structure for the model application. The analysis dataset contained one primary feature class: the Analysis_Parcels. Once the model was run, it returned two feature classes. These feature classes were categorized

based on their protected status (protected or non-protected). In addition to these two feature classes, the model returned three analysis tables.

Figure 4-3: Logical data model for the analysis model

The NonProtected_Report and Protected_Report were summary tables of the total number of parcels for each conservation theme. The third table, NonProtected_Stats, was an analysis table of features within the conservation theme. The priority field for each of the reports contains textual values (high, medium, and low), while the count fields display short numeric values indicating how many parcels fall into that priority category based on a particular conservation theme. The statistics table contained two fields: CS_B_P_VT_WH and the Frequency field. The first represents a concatenation of the priority categories for the conservation themes in each parcel. The latter represents how many parcels within the given feature class had a similar combination. Table 4.1 summarizes the attribute information in these three analysis tables.

Table 4-1: Attribute descriptions for analysis tables

Table	Attribute	Description
Protected_Report / NonProtected_Report	Priority	Conservation category of a parcel (high, medium, and low)
	COUNT_CS	Community Separators
	COUNT_BB	Base Buffer
	COUNT_PB	Park Buffer
	COUNT_VT	Community Views and Treasures
	COUNT_WH	Wildlife Habitat
Protected_Statistics	CS_B_P_VT_WH	Combined conservation themes
	Frequency	Number of parcels that contained the same CS_P_B_VT_WH values

4.3 Data Sources

The Morongo Basin parcels data, used in both the Web application and the analysis model, were provided by the client. The parcels, along with other MB data, were delivered in a file geodatabase and projected in Universal Transverse Mercator (UTM). The client also provided metadata for the parcel attributes and data processes that were used to populate the fields. For the Web application, additional data layers were created from the original parcel data to improve the application's performance. Other data sources for this application included street and aerial imagery from the ArcGIS online resource center, as well as a geocode service to support the address finder functionality in the Web application.

4.4 Data Scrubbing and Loading

There were two feature classes extracted from the geodatabase provided by the client: the study area boundary (MB_USD) and MB_Parcels. There were few data preparations necessary for the MB_USD feature class. Fields that were not required for identification, redundant, or left unpopulated were deleted to reduce the feature class size. The MB_Parcels was more closely examined. Since owner names were to be kept anonymous, this information was removed from the feature class. Additionally, fields that were not used in either the model analysis or the Web application were removed from the MB_Parcels feature class. For example, the address field was removed because it was based on the owner's address, not the actual parcel location. Fields were also renamed to improve clarity as to their function and contents. For example, the conservation theme's fields were renamed so that the client would know which theme they were analyzing. To do this, the feature class was exported to Microsoft Excel, the field names changed, then imported to the new geodatabase as a database table. The new feature class for the parcels was created and the schema and data from the database table copied. The parcels' ID or

assessor parcel number (APN) was used as a unique identifier for each parcel. Not all parcels had this unique ID already provided. As a result, a unique APN was assigned for these parcels, starting from 000000001 to 0000000193.

4.5 Summary

This chapter focused on the design of the file geodatabase used for the project. The conceptual model was used to identify the features, the attributes, and the relationship between them. The logical data model looked at the physical design of the geodatabase and the types of values that were represented in the feature classes. It discussed the use of a domain to reduce the likelihood of errors with data entry. The MB_USD and the MB_Parcels were the two main feature classes used in the project; all others were derived from MB_Parcels. Data sources consisted primarily of the client and ESRI. Finally, data scrubbing and loading provided an outline of the data preparation methods used to prepare the data for the applications.

Chapter 5 – Implementation

This project focused on developing two GIS components: a Web application and a desktop tool. Chapter 5 describes the implementation process for each component in six sections. The first section describes the project workspace and the portability of the GIS system. It looks at the methods used to support successful system transfer between different user environments. Section 2 describes the Complementarity tool created in this project and specifically outlines the steps taken, as well as the specific geoprocessing tools and scripts used in its development. Section 3 addresses the second component, the Web GIS application, and highlights some of the key software used in its implementation process. This included ArcGIS Server software and Adobe Flash Builder 4, used for the Flex API. Sections 4 and 5 describe the documentation and metadata included for both the desktop tool and Web application. Chapter 5 concludes with an overall summary of the key elements of the tool and Web application.

5.1 Project Workspace and Portability

The first step in the implementation process was to create a project workspace. This was a project folder located on the C:\ drive, where all data and the tool were stored (Figure 5-1). There were two subfolders contained within the MB project folder. The first, Tool folder, contained the Complementarity tool. This tool consisted of three submodels that focus on Gap analysis and Redundancy analysis. The map document and layer files used for the Web application were stored in the second subfolder, the Web_mxd folder. The project workspace also contained the file geodatabase (Morongo_Basin.gdb) used to organize, manage, and store the feature classes for both applications, as well as the output results of the Complementarity tool. Also included in the MB folder was a text file (Template.csv) which contained the schema and data for a table that was used in the Gap Analysis submodels.

Figure 5-1: Structure of project workspace

It was important that the project workspace and its contents be transferable between different user environments. To allow this, relative path names were used to save the data locations. This made sharing the tools, map documents, and other data between user environments easier.

5.2 Complementarity Tool

To automate the process of the Complementarity tool in the GIS, three submodels were created and stored in a custom ArcGIS toolbox (Figure 5-2). All submodels were developed using ESRI's ArcGIS ModelBuilder and composed of a series of geoprocessing tools.

Figure 5-2: Custom Toolbox for the Complementarity Tool

When necessary, Python scripts were used to extend the functionality of these tools. The script was embedded within the code block section of the system tool to customize the results when the model was run. Figure 5-3 shows this method used in the Calculate Field tool.

Figure 5-3: Python 9.3 script written in the geoprocessing tool

The five conservation themes in the parcels feature class were labeled PriorCls_BB, PriorCls_CS, PriorCls_PB, PriorCls_VT, and PriorCls_WH. The attributes of these themes were the priority categories (high, medium, and low) and were recorded as text values. Text values could not be used to rank the overall importance of a parcel statistically. This meant that the system did not distinguish parcels that received an 'H' (high) value as more important than a parcel that received an 'L' (low) value. In order to provide this distinction, the text values were given a numeric weight. The weight for this system was based on the priority importance. Therefore, an 'H' value was assigned a larger number than an 'M' (medium) or 'L' value. Likewise, an 'M' value was assigned a larger number or numeric weight than an 'L' value. The Python script was used to reclassify the attributes of each conservation theme from a text to a numeric value. This ensured that further tabular analyses could be conducted on the parcels while maintaining the importance of their priority category.

5.2.1 Gap Analysis

The Gap Analysis model was designed to summarize the coverage area of the five conservation themes for the selected parcels. Two versions of the model were developed: a single status Gap Analysis model, and a multiple status Gap Analysis model. The status refers to whether the parcel was already protected or non-protected. Once the input

parameters were entered, the model would begin the analysis process. An outline of the procedure is provided in Figure 5-4.

Figure 5-4: Methodology for the Gap Analysis model

The first step in the process was to convert the attributes of each conservation theme from textual form (high, medium, and low) to a numeric value. To do this, five new fields were added to the attribute table using the Add Field tool. This also ensured that the original attribute information was not lost or altered when the analysis was performed. These fields were labeled with similar headings as the conservation themes they represented. For example, a field called VT will be added to represent the conservation theme that each parcel gets for PriorCls_VT, or more descriptively named community views and treasures. Figure 5-5 represents a sample of the reclassified fields with the respective field names and cumulative total.

BB	CS	PB	WH	VT	Total
1	1	1	1	1	5
1	1	1	1	1	5
1	1	1	1	1	5
1	1	1	1	1	5
1	1	1	1	1	5
1	1	1	1	1	5
1	1	1	1	1	5
1	100	1	1	10	113
1	100	10	1	10	122
1	1	1	1	1	5
1	10	1	1	1	14
1	10	1	1	1	14

Figure 5-5: Five reclassified fields with total

Once the new fields were added, they were calculated using the Calculate Field tool. For each of the conservation themes, if the attribute value was H (high), the numeric value assigned was 100; M (medium), the numeric value assigned was 10; and L (low) values, was returned as 1. Using multiples of ten guaranteed a clear distinction between the value categories. No two parcels would have the same cumulative score without having the same number of highs, mediums, and lows for the five conservation themes. This distinction was important for selecting parcels of interest. Parcels could now be selected within a value range.

When the reclassification was complete for the five new fields, a sixth field was added and labeled Total. This field was populated with the sum of the numeric values from the individual parcel. This allowed the user to target specific categories of parcels by selecting them within the range from 5 to 500. For example, if the intent is to evaluate parcels that contain at least three high values, an SQL expression can be entered, such as Total > 299, which would return only those parcels meeting that criteria.

The next step in the model process was separating the parcels into two feature classes by their protected status. To accomplish this, the model also used SQL expressions. It was important to separate these parcels to identify the conservation coverage of each category of parcels independently. This step in the analysis would help determine how much more of the overall study area would be protected or ignored depending on the selection query. Once these parcels were separated, the model created two new feature classes to display the results. The attributes of these feature class were also summarized and presented in table form. The Summary Statistics tool was used to calculate the total number of parcels for each priority category represented (Figure 5-6). The tool performed a count of the numeric values in the reclassified fields. The corresponding priority class field was used as a case field to calculate the statistics for each unique value of H, M, and L.

Figure 5-6: Summary Statistics tool

Finally, the statistics fields were combined using the Join tool and exported to a table for display. Appendices B and C illustrate the ModelBuilder structure for both versions of the Gap Analysis model.

5.2.2 Redundancy Analysis

As shown in Figure 5-7, the redundancy analysis model summarizes the attributes of the input feature class.

Figure 5-7: Methodology for the Redundancy Analysis model

In this step, the Summary Statistics tool was used to categorize the parcels by their collective results of the conservation values. For example, if a parcel received three highs and two lows from the conservation themes, the tool selected all parcels that received the exact results and tallied those parcels. The results of this model could be used to create new feature classes of each combination of results. In doing so, users can identify the parcels that are of similar value for the conservation purpose (See Appendix D for ModelBuilder process).

5.3 Web GIS Application

The second major component in this project was the development of the Web GIS application. First, a map document was created (MB.mxd) to organize, label, and manipulate the data (Figure 5-8).

Figure 5-8: Project map document (MB.mxd)

As Figure 5-8 illustrates, each conservation theme was represented as an individual layer: ‘BB’ for Base Buffer, ‘CS’ for Community Separators, ‘PB’ for Park Buffer, ‘VT’ for Community Views and Treasures, and ‘WH’ for Wildlife Habitat. To achieve this, the features in the parcels layer were dissolved based on the five conservation fields. The new feature classes were symbolized and ranked from high to low (H, M, and L). To reduce overall size and maintain symbology, the feature classes were converted to layer files. Layer symbology was kept to a minimum by using simple, solid color patterns. The outlines were removed to reduce the drawing time for the Web application and to make it easier to identify patterns between different categories at a small scale. A Combined layer was also developed. This represented the overall number of high values received for each parcel. This layer was created by first selecting all parcels that belonged to a particular category; for example, selecting all parcels that received no high values. Once these parcels were selected, they were exported into a new feature class. The feature was dissolved and symbolized. When all six categories were created in this same manner, they were merged to form the Combined layer. This layer was also converted to a layer file to improve overall file size and rendering time for the application. Scale dependencies were set for each layer; a minimum scale bound the large-scaled layer (Parcels layer). This meant that the Parcels layer would not be visible if the user zoomed out to an extent greater than 1:24,000. Maximum scales bound the other layers, which were considered small-scale layers. This meant that the layers would not display once the user zoomed in to an extent on the map smaller than 1:1,000. The projected coordinate system used for all layers was Universal Transverse Mercator (UTM) zone 11 north. The geographic coordinate system used was the North American Datum of 1983 (NAD 1983).

5.3.1 Publishing a Map Service Using ArcCatalog

Once the map document was saved, it was used to create a map service in ArcGIS Server. The simple structure of the server wizard made the process of creating and configuring

the map service relatively simple. ArcGIS Services Directory was used to manage the MB map service (Figure 5-9). Since the layers needed to be turned on or off based on the user input, the data in the service was not cached or tiled so that it could be accessed from the server on demand or dynamically.

Figure 5-9: Project map service

5.3.2 Developing the Flex API

A Rich Internet Application (RIA) was created on top of the ArcGIS Server through a Flex API. RIA is simply an application that marries the functionality of a desktop with the freedom from platform dependence, via the Web framework. The RIA for this project was based on the client-side technology supported by the Adobe Flex framework. The MB map service, which was created in the ArcGIS Server, was added to the Flex application. The Street and Aerial Imagery from ArcGIS resource center were also included in this application. The extent of the map display was set to reflect the spatial position of the study area and the initial extent of the application displays at a large scale to enable faster rendering of the query results.

5.3.3 Color and Fonts

Choosing an appropriate color palette for the application and its components was an important part of the design process. Color was used to group similar elements together, highlight important information, and provide visual appeal. As a formatting tool, color was used to improve the structure of the elements within the application and aid users in identifying which groups of elements were related or functionally similar. Red hues were applied to highlight essential information and draw the user's attention to particular areas on the screen. This type of color implementation was observed when the search function was executed to inform the user whether the application was successful or unsuccessful in retrieving the results. To provide visual appeal to the Web application, the color theme was selected based on its connotation and its association to the overall context of the project. A green hue was chosen for the application's background, along with a lighter desaturated foreground color. This green hue was chosen because it is often associated with the natural environment and harmony, both important aspects of a conservation plan.

A black font was used to provide a high visual contrast with the background. The minimum font size applied in the application was 12-pt. A slightly larger 13-pt bold font was used to highlight the section headings. Two fonts were used in the application: Georgia and Verdana. The Georgia font was used for the title heading, while the Verdana was used for all other text within the application.

5.3.4 Organization and Layout

The layout the application was kept simple with three main elements (Figure 5-10). The first element, identified in Figure 5-10 as 1, was the title area. This consisted of the application title, project logos, and textual links to external functions such as printing the map or accessing the help document. The second element, identified as 2, was the main navigation area. This included the application's main functions for searching and querying. The third element, 3, was the main map display, which consisted of the three map services and navigation functions. Elements and their contents were positioned in order of importance from top to bottom and left to right.

Figure 5-10: Web application design

Border containers were used to enhance groups and separate sections within each element. For example, within the second element, a border container was applied to separate the overview map display from the above functions. It was also used to group similar objects within the section, such as navigation buttons.

5.3.5 Functions

The Web application supported three major functions: searching, navigation, and querying. These functions were scripted using a combination of sample codes provided by the ESRI Resource Center and customized code. Appendix E includes the scripts for these functions. The search function identified and zoomed to the exact parcel location or geographic area within Morongo Basin. It helps the user isolate an area of interest or a particular parcel of interest. It used two different services to access the parcel location: the MB map service, and an address geocode service. To locate the parcels using the MB map service, the function matched the user input to the attributes in the APN field of the Parcels layer. The parcel could also be located using the geocode service; the function matched the user input with several fields, street name, city, and state. Since the user input was not required for the street name field, it allowed the option of a greater search radius returned or extent of parcels in the map display.

The navigation functions were linked to the map display (Figure 5-11). It controlled the extent of visible parcels within the display area.

Figure 5-11: Navigation functions

Buttons were used to give the user more control of the navigation experience. The user has the ability to zoom in to a more detailed extent, zoom out, or pan through the map to other areas of interest. Once the button was pressed, the function was activated and remained in this way until the button was depressed or another navigation function was selected. It used an event change handler to switch between navigation tools.

The third major function for the Web application was querying. There were two querying functions provided. The first queried the MB map service to return the layer symbology for the five conservation values and the combined layer. It was accessed through radio buttons (Figure 5-12).

Figure 5-12: Radio buttons to access the conservation layers

The second function queried the Parcels layer within the MB map service and returned specific attributes based on the conservation value selected. It was activated once the display extent was less than 24,000 meters and a radio button was pressed. This extent was determined by the scale dependency set on the Parcels layer.

Other secondary functions added included the Print Map, About, and a Help function. The Print Map function was included to provide a secondary means to view and share the conservation layers. The About and Help functions were incorporated into the application's design to provide clarity on its contents and how to appropriately manipulate the available user functions.

5.4 Documentation

Important and useful information is provided in the help section of the model to reduce user frustration. This information is displayed when the tool help button is clicked. The ArcGIS Toolbox Documentation editor tool was used to help add this information. For

each sub-model (gap analysis and redundancy analysis), short explanations of the expected input parameters and output fields were provided. A short summary of the complementarity analysis model's function was also provided. The help files developed for the models are available for viewing and can be edited or updated by the client. In addition to the model's help, a help document was created for the Web application, which combined textual and graphical images to help users improve their navigation skills and interpret the results of their queries.

5.5 Metadata

The metadata for this project was created using the FDGC metadata editor tool in ArcCatalog. Metadata was developed or revised to reflect its use in the Complementarity Analysis model and Web GIS application. The Sonoran Institute provided metadata documentation for some of the attributes of the parcel layer, which included the grading schema and tally for each of the conservation values. This was provided in a hardcopy table format. The data layers required metadata to be developed.

5.6 Summary

Procedures used to develop the two major components for the project were discussed in this chapter. First, the project workspace was configured and tested to determine accessibility and portability. This chapter looked at the creation of the Complementarity tool. This tool was composed of three sub-models that used several geoprocessing tools, along with Python 9.3 scripts, to extend the processing tool's functionality and provide custom results. The second component discussed was the Web application. This used a Flex API to provide the users with a Rich Internet Application to support their needs.

Chapter 6 – Results and Analysis

This chapter provides a discussion of the interface and outputs of the Complementarity tool and the Web GIS application. One of the primary goals of the project was to develop a tool that could analyze the Morongo Basin parcel data and the five conservation themes developed for the basin's regional conservation plan. The results from this analysis help evaluate the coverage areas of the themes, as well as highlight some attribute similarities among selected parcels. This goal was accomplished through the development of three ModelBuilder tools (the Gap Analysis single status and multiple statuses models, and the Redundancy Analysis model) that were customized with Python scripts in ArcGIS. The results of these tools could be visualized in a desktop environment using ArcGIS software (ArcMap or ArcCatalog).

The second primary goal was to develop an easy-to-use application that could provide the public with information on the conservation themes. This was geared toward expanding the level of communication between the MBOSG and the public on the priorities of their conservation efforts. To accomplish this goal, a Web GIS application was developed in a Flex API framework. The output of this application could be viewed in a Web browser equipped with Flash player 10.0 or higher.

6.1 Model Interface

Since three models were developed to handle different aspects of the analysis, three different interfaces were produced. The first two (Figures 6-1 and 6-2), show the Gap Analysis model interface used to evaluate the coverage areas for the five conservation themes. By selecting the input feature class, applying the SQL expression or expressions, and output names, the model produces one or two output feature classes, as well as one or two output reports or tables. All fields require user input.

Figure 6-1: Gap Analysis model interface for single status

Figure 6-2: Gap Analysis model interface for the multiple statuses

The third interface design (Figure 6-3) shows the Redundancy Analysis model. This model takes the input feature class, which can consist of the original input or output feature classes of the Gap Analysis models, and returns a summary table with attribute results.

Figure 6-3: Redundancy Analysis model interface

6.2 Model Scenario and Results

These models can be used independently or together to perform analyses on the basin's parcel data using different scenarios. This section discusses how the models are used to address different questions and how to interpret the analysis results. The feature classes created depend on the parameters entered by the user, which in turn affect the results. These parameters are based on the structure of the client's data, as well as achieved results.

The basin's parcel data are divided into two status categories: protected and non-protected. It was important to understand the differences in these categories to determine which parcels were of interest. As noted by the client, not all private lands were considered non-protected. Likewise, not all public lands were protected. A parcel is considered protected if it meets any one of the current requirements listed below:

- Private lands in conservation status (The Wildlife Conservancy, and the Mojave Desert Land Trust)
- Bureau Land Management (BLM) Multiple Use Classes Controlled and Limited
- Big Morongo Canyon Preserve
- US Forest Service (USFS)
- San Geronio Wilderness (BLM, USFS)
- Local Parks and Protected Space

Parcels that did not meet these requirements were considered non-protected.

6.2.1 Finding the Gaps in Conservation Coverage

For this scenario, the GIS user wants to identify which conservation theme is poorly represented in the parcel data to improve its overall coverage. The Gap Analysis model can be used to identify which conservation theme is the least or worst represented of the protected or non-protected parcels. The process for executing this model is straightforward; the user selects the feature class for input, specifies the parcels of interest

using the SQL expressions, and enters the output names. Figure 6-4 shows the model interface with all the user input.

Figure 6-4: Gap Analysis model with user input

The model selects the parcels based on the parameters and returns two feature classes and two associated tables with the results. Figure 6-5 displays all protected parcels for the five conservation themes. As indicated in the attribute table of the feature class, there were 743 parcels represented in this category. Analysis_Parcels is the input feature class used in the model, and it contains all the parcels for Morongo Basin. MB_USD is the study area boundary for this project. These layers have been included in the sample map display for reference information. Mapping the selected protected parcels allows the user to identify whether the parcels are clustered together or dispersed throughout the study area, as well as observe their geographic locations.

Figure 6-5: Protected parcels feature class

Figure 6-6 depicts the summarized result of the themes for the protected feature class. For the conservation theme, Community Separators (COUNT_CS), 178 parcels scored high, 411 parcels scored medium, and 154 parcels scored low. The values for other fields were interpreted in a similar way. The user can use these results to identify gaps in coverage. From this analysis, the Base Buffer theme (COUNT_BB) showed a major gap in coverage. Over 80% of the parcels within this theme are categorized as low priority, meaning that once resources are allocated for priority areas, only a small percentage of parcels from this theme would be considered first.

Attributes of Protected_Report							
OBJECTID *	Priority	COUNT_CS	COUNT_BB	COUNT_WH	COUNT_PB	COUNT_VT	
1	H	178	78	300	167	179	
2	M	411	63	284	365	315	
3	L	154	602	159	211	249	

Record: 1 Show: All Selected Records (0 out of 3 Selected)

Figure 6-6: Protected parcels table

The non-protected parcel results are shown in Figures 6-7 and 6-8.

Figure 6-7: Non-protected parcels feature class

There were 62,723 parcels represented in this analysis for the non-protected data. This accounted for 99% of the parcels within the study area.

Attributes of NonProtected_Report							
	OBJECTID *	Priority	COUNT_CS	COUNT_BB	COUNT_WH	COUNT_PB	COUNT_VT
	1	H	1398	2680	1060	1237	1840
	2	M	9700	10770	13207	10079	12074
	3	L	51625	49273	48456	51407	48809

Figure 6-8: Non-protected parcels table

From these results in Figure 6-8, all themes showed a significantly high number of parcels in the low priority category. Among the lowest were the Park Buffer theme (COUNT_PB) and the Community Separators theme (COUNT_CS), which both showed over 80% of their parcels in this category.

6.2.2 Optimizing the Coverage Area for Allocating Resources

In this scenario, the user needs to find the best way to allocate resources to protect the top 100 parcels, and ensure that there is minimal gap in coverage. For this scenario, the top 100 parcels are assumed to have at least three high priority categories for the conservation themes. The first step is to isolate those parcels using the Gap Analysis

model for the single status. Figure 6-9 shows the Gap Analysis model used in addition to the user input.

Figure 6-9: Gap Analysis model interface with user input

Once the model is run, the user can visualize the parcels of interest (Figure 6-10).

Figure 6-10: Non-Protected parcels with at least 3 high priority categories

The gaps within this selection can be observed in Figure 6-11. Null values refer to 0 values within the priority category.

The dialog box titled "Attributes of NonProtected_Report_300" displays a table with the following data:

	OBJECTID *	Priority	COUNT_CS	COUNT_BB	COUNT_WH	COUNT_PB	COUNT_VT
	1	H	95	46	206	240	189
	2	M	108	55	30	5	24
	3	L	42	144	9	<Null>	32

Below the table, the "Record:" field shows "1" with navigation buttons. The "Show:" field has "All" and "Selected" options. The "Records (0 out of 3 Selected)" dropdown is set to "All".

Figure 6-11: Summary report of Non-Protected parcels

From this analysis, the Base Buffer theme (COUNT_BB) showed the most significant gap in coverage. Since this theme is not very well represented by these parcels, it is important that the parcels be more thoroughly observed to minimize this gap. The Redundancy Analysis model allows the user to identify the different combinations of the themes represented by the parcels, as well as the total number of parcels in that group. Figure 6-12 shows the Redundancy Analysis model interface with user input.

The "Redundancy Analysis" dialog box shows the following input fields:

- Input Feature Class:** C:\MB\Morongo_Basin.gdb\Analysis_Dataset\NonProtected_300
- Output Table:** C:\MB\Morongo_Basin.gdb\NonProtected_Stats_300

At the bottom, there are buttons for "OK", "Cancel", "Environments...", and "Show Help >>".

Figure 6-12: Redundancy Analysis model interface with user input

The result of this model process is shown in Figure 6-13. As the table illustrates, the two highest frequencies of combined results focused on protecting the same conservation themes (Park Buffer, Community Views and Treasures, and the Wildlife Habitat). If these two highest categories were selected (indicated with the arrows), it would account

for over 80 of the 100 parcels and would be biased to those three themes. The user can achieve complementarity by selecting different combinations of conservation themes to ensure that all five themes are considered.

OBJECTID *	CS_B_P_VT_WH	FREQUENCY
1	HHHHH	1
2	HHHHM	3
3	HHHLH	1
4	HHHLM	1
5	HHHMH	1
6	HLHHH	17
7	HLHHL	1
8	HLHHM	15
9	HLHLH	13
10	HLHMH	8
11	MLMHH	3
12	HMHHH	5
13	HMHHL	8
14	HMHHM	11
15	HMHMH	5
16	HMMHH	2
17	LHHLH	3
18	LHHMH	2
19	LLHHH	26
20	LMHHH	11
21	MHHHH	12
22	MHHLH	14
23	MHHMH	8
24	MLHHH	61
25	MMHHH	13

Record: 1 Show: All

Figure 6-13: Statistical table of Non-Protected parcels

6.3 Model Testing and Issues

The two models were executed numerous times to test for errors in the process. This stage was also used as the test plan for the application. Errors found in the initial tests of the submodels were corrected in the final version. The main issue experienced was the population of the fields in the output table for the Gap Analysis model. Initially these

fields were joined to each other using their common Priority field, which often misrepresented the actual results. For example, while joining the values of COUNT_PB to COUNT_VT, if COUNT_VT only returned values in the high and medium categories and was used as the main join field, it would omit all low values for the COUNT_PB as well. To correct this, a template table was created to include all priority classes and to ensure that all features were represented in the final output.

6.4 Web Application Interface

The startup interface for the Web GIS application is presented in Figure 6-14.

Figure 6-14: Web GIS application interface

The application's functions were placed in order of importance from top to bottom in the left panel. The layers or conservation themes, outlined in the blue box, were placed at the top of the application. These layers are controlled by radio buttons, which function like switches to turn layers on or off in the main map display. It is operated by clicking on a different layer name or the actual button. The second function, highlighted by the orange box, shows the interface for the search function. A default address was placed in the fields to be used as a guide for the Web user. The third component in the panel,

highlighted by the yellow box, shows an overview map of the basin's parcels, as well as a color legend of the values. This legend and mini map display are directly linked to the conservation layers and change to reflect the layer chosen. All functions that controlled the look and feel of the main map display were placed within that container. These functions include the navigation toolbar, the imagery layer slider, and the layer transparency slider. The transparency slider controls how opaque the conservation layers appear in the map display. The three hyperlinks for the print function, about, and help document were placed at the top right side of the screen and underlined to indicate that they are active links.

6.5 Web Application Scenario and Results

Different scenarios can be applied to the Web GIS application to retrieve important parcel information on the basin's conservation plan. Developers can use the site to identify prime low priority areas to construct new housing complexes. Realtors can also use the site to identify areas that are prone to heavy wildlife traffic to adjust housing values and market these neighborhoods appropriately. This section will provide a discussion on a general application of use, and illustrate how the Web GIS application was successful in retrieving the results and guiding the user through the process.

In order to provide constructive criticism on planning decisions, the public needs to know what is going on in the community. Residents are interested in being able to identify an area within the basin and obtain a quick overview of the concerns of development and its impact on the natural environment, wildlife habitats, or cultural values. The Web GIS application can be used to facilitate these needs. The navigation functions of this Web application are flexible to allow the user to interact with the application through non-structured methods to access the necessary information. For example, accessing a parcel location either by using the interface for the search function or by using navigation buttons.

Once the application is loaded in the browser, the user can begin by selecting a conservation theme of interest. Tool tips are provided to give the user more descriptive messages about the themes or process (Figure 6-15). To access a tool tip, hover the cursor over the text.

Figure 6-15: Tool tips the Web application

Once the theme is selected, the user can locate a community of interest or particular parcel. The parcels can be accessed by using the parcel APN number or address location. Once the function is executed, a message window appears on the screen to let the user know whether the request was successfully executed (Figure 6-16).

Figure 6-16: Indicators for the search function

A symbol maker (illustrated by the blue arrow) will also highlight the parcel that was requested in the map display. If the exact location of a parcel is not known, or if the user wishes to explore the area, the navigation toolbar can be used. Clicking on the button activates the function and allows the user to target specific areas of interest. It creates a red extent box to let the user know the new extent that would be visible in the display (Figure 6-17).

Figure 6-17: Map navigation function

The navigation tool can be deactivated by clicking on the button to deselect it. This is illustrated by the orange arrow above. On the overview map, a gray box represents the extent of the main map display and reflects the parcels that the user sees (Figure 6-18).

Figure 6-18: Overview map of main map extent

This extent is updated as the user makes changes to the main map display. The layer opacity can also be adjusted to show or hide the underlying street or aerial imagery. To access attribute information for the conservation theme, the user moves the cursor over the parcel of interest. An information window appears to display the results (Figure 6-19), featuring the parcel identification or APN number as the title of the window box, and listing the attributes for the parcel within its contents. The information viewed in the window refers to the attributes, which make up the conservation theme and the score that this attribute received in order for theme to be categorized. To close the window or access the attributes for a different parcel, the user can simply move the cursor to the new location.

Figure 6-19: Information window with attributes for Community Separators

Users can also identify which priority category a parcel belongs to by looking at the overview map legend. Beneath the mini map display is a small color legend of the categories (Figure 6-20).

Figure 6-20: Legend for priority categories.

More detailed layer attribute information is provided in the hyperlink button labeled Help. Clicking on this link takes the user to another Web browser, which contains a .pdf

file of the help document. Here the user can find information on what each attribute value represents, as well as navigation tips for the site.

6.6 Web Application Testing and Issues

All functions for the Web GIS application were performed many times and monitored by the FlashBuilder debugging tool to ensure that any errors in the code were identified and corrected. This was an important process for the testing phase of the application. During this phase, many coding errors were fixed and interface modifications applied. The Web GIS application was tested using different browser resolutions to find the most optimal dimensions for the interface display. This was necessary to ensure that the user's browser resolution did not exclude any significant portions of the interface design. This issue was corrected by adjusting the dimensions of the application to meet the standard browser resolution of 1024 x 768.

Another issue faced was changing the map projection for the Web application. ESRI's Street and Aerial imagery were supplied in the Web Mercator projection and the client's data in the MB map service were in UTM. Several attempts were made to re-project the base imagery to the UTM coordinate system; however due to time constraints, it was left unresolved. All map services within this project default to project in Web Mercator.

6.7 Web Application Performance

Because of the dynamic nature of the application, it was necessary to find ways to improve performance and wait time for data retrieval. Layer files were used because of their smaller size to make display time and rendering of the conservation layers symbology shorter. The attribute limit for immediate display was set to 500 because this was the largest number of attributes that can be returned at once before the server speed diminishes. The attributes were also cached on the user's machine to allow the user to return to the previous parcel without having to wait for the browser to request the attributes from the server again. The maximum number of attributes that could be cached on the machine was 1000.

6.8 Summary

This chapter discussed the interface designs and application scenarios for the Complementarity tool and Web GIS application. It also presented the issues faced during the testing phase of each project component, as well as the developed solutions. Each scenario was used to demonstrate how the application executed a process and the results that were observed. The Gap Analysis and Redundancy Analysis models could be used independently or as a set to analysis the Morongo Basin parcel data. These submodels returned feature classes and tables that could be viewed in the ArcGIS desktop environment. The Web application scenario demonstrated how a user could manipulate the application to retrieve information on the conservation themes and visual cues of the system.

Chapter 7 – Conclusions and Future Work

This chapter concludes the report on the use of GIS in the Morongo Basin regional conservation plan. It provides a summary of the project, as well as some possible ideas for future implementation. The final section of the chapter provides future students with some considerations when pursuing GIS projects.

7.1 Conclusions

This project was designed to meet the needs of the client and the MBOSG. First, the client needed a tool that would help analyze prioritized parcels for conservation. The main interest was to discover gaps in conservation coverage, as well as redundancies in selected parcels. As a result, the complementarity tool produces summarized statistical reports to aid in their analysis, as well as feature classes to help visualize these results. Data queries can be modified by the user to reflect parcels of interest in the model outputs.

The client also required that the models be easy to use, effective, and support automated processing. The simple design interface, as well as the supplemental guidelines in the help document, made the two models (Gap Analysis model and Redundancy Analysis model) easy to use. The effectiveness of both models was tested rigorously and proven successful in ensuring that the user tasks were executed with completeness and accuracy. In addition, the models also supported automated processing of the data by using custom Python scripts and other geoprocessing tools in the ModelBuilder application. Overall, both models developed for the client were successful in meeting the critical functional and non-functional requirements.

Second, the MBOSG needed to communicate their conservation findings to the public. It was important that the information presented by the application be highly accessible and usable. Usability was described in terms of the application's efficiency, effectiveness, and ease of use. To address this need, a Web GIS application was developed. This application supported the group's accessibility concerns by providing the user with the convenience of accessing the conservation data over the Internet via Web browsers. It also supported cross-platform compatibility and could be used with most Windows, Mac, and Linux operating systems, since it functions within the web browser window. The efficiency of the system depends on the user's Internet or Web connection. However, initial testing results have shown the average wait time for retrieving and loading data from the server ranges between three to nine seconds. The Web application design was also found to be successful overall in effectively handling the user's function requests with great accuracy and completeness. In addition, the simple design of the application, coupled with the use of descriptive tool tips, make navigation and operating this application simple. Overall, this Web GIS application, like the analysis models, was successful in fulfilling the client's functional and non-functional requirements for the system.

7.2 Future Works

This project can be used as an initial building block for future projects. Provided in the following sections are some possible extensions that could be of value to the MBOSG and the planning community.

7.2.1 Enhancing the Complementarity Tool

The models developed in this project identified gaps in complementarity for the conservation themes and redundancies in attributes at the parcel level. One extension to this work done would be to expand the scope of analysis to a city or community level and examine the data at that scale. This would be useful in identifying the complementarity of conservation themes between communities and creating a rank order for targeting or allocating resources.

7.2.2 Expanding the Analysis of the Redundancy Model

In the interest of the client, the Redundancy model that was developed for this project focused on the high priority category for the conservation themes. The analysis isolated parcels that contained at least one high priority category. This could be expanded to include other priority categories such as medium and/or low to analyze different groupings of the data. An example could be isolating parcels that have at least one medium category for the five conservation themes.

7.2.3 Scenario Building Tool

Another valuable extension to this project would be to include a scenario building tool in the Web application. This would give the public an opportunity to see how implementing potential ideas would affect their community by creating possible outcomes from the conservation data. By setting the variables for the conservation themes, the user could develop alternative priority areas and visualize the impact of these changes on their environment. Stimulating creative ways of thinking can be useful during the decision making process in gathering different perspectives on the same problem and raising awareness to potential issues.

7.2.4 Online Editing

In order for the Web application to reflect the changes in the conservation plan during the planning process, the map document must be edited and saved, and the map service restarted. An online editing tool for the planner could make updating selective parcels a faster and easier process, without the potential service downtime.

7.2.5 Public Communication

While it is useful to provide online access to planning maps and other materials, public participation could be even more effective by providing the means for the public to communicate their thoughts without being restricted to a specific time and place. Enhancing the Web application to include a feedback mechanism or instant messaging

component would be a useful extension to the project. This could be as simple as allowing the user to flag or mark certain areas in the application and provide instant feedback to the planners on their thoughts and concerns.

7.3 Considerations for Students

To successfully implement a GIS based project, students need to become familiar with the hardware and software requirements, the people involved such as the client and/ or audience of the GIS, as well as the current business processes. Understanding these three factors ensures that the implementation costs are kept to a minimum as stages in the project's development progresses. It also ensures that the GIS developed will be useful for the particular application.

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Appendix A. Focus Group Summary

Conservation Priorities Setting Online
Focus Group Summary

May 7, 2010, 10 – 11:30 AM,

Rattlesnake Room, Joshua Tree

Morongo Basin Open Space Group

National Park Headquarters, 29 Palms, CA

Participants: Donna Thomas, Victoria Fuller, Laraine Turk, Marlana Brown, Larry Briggs, Anne Beattie, Eva Montville, Alan Rasmussen, Jeff Lane

Facilitators: Renee King, Stephanie Weigel

The Morongo Basin Open Space Group is working on a regional plan for conservation and open space in the Morongo Basin. As a part of that work, planning partners and community members have been involved in Conservation Priorities Setting around five community identified conservation themes:

- National Park Mission Buffer
- Marine Base Mission Buffer
- Wildlife Connectivity & Habitat
- Community Separators
- Community Views & Treasures

Maps have been developed for each of these themes in our project area, representing each of the 65,000+ parcels as High, Moderate or Low priority. In order to facilitate access to these maps and to the data underlying the maps, an online mapping application is envisioned. The purpose of this Focus Group was to evaluate sample websites for their functionality and utility in conveying information to interested stakeholders and decision makers in the Morongo Basin.

Renee King is a graduate student at the University of Redlands in the MS GIS program. Renee has chosen the project of creating an online mapping application for MBOSG as her program project. Renee's email address is Renee_King@spatial.redlands.edu.

To start, we asked some questions about the backgrounds of our participants:

Q: What is your relationship with your computer?

A: Answers included computer literate, novice, professional, friendly, straightforward – expect my computer to respond logically. Three of the participants are Mac users.

Q: Have you heard of “GIS” or Geographic Information Systems?

A: Several of the participants had heard of GIS, others had not.

Test Drives.

We took several mapping websites out for a “test drive” to get feedback on what participants liked or did not like about them. The “driving” was done by different participants in the focus group, not by the facilitators. The website links and the feedback we got on them are below. For each of the sites we tried to do such things as:

- Zoom in and out from maps
- Navigate around map
- Turn layers on and off
- Get information about a specific location.

During the test drives we talked about what data layers and functionality we would like to see included in a Morongo Basin mapping application. Over the course of the session, these included:

Data Layers suggested for inclusion in our mapping application:

- Wildlife corridors
- Would like to have access to information about specific animals or plants that are found in each corridor/area
- Boundaries of Base, Park
- Boundaries of BLM lands
- Boundaries of BLM ACEC, including Big Morongo Canyon Preserve
- Electric lines – undergrounded vs. on poles
- Parcel boundaries
- Terrain
- Flood channels – FEMA information for county, Yucca Valley and 29 Palms
- Ownership information – federal, state, private, local government
- Current vacant parcels
- Fault zones

Functionality suggested for inclusion in our mapping application:

- In addition to being able to Zoom In and Out using + or , zoom using a selection box
- Ability to add a comment or send an email
- KISS – Keep It Simple, Silly
- Need to balance level of complexity for a range of users
- Include introductory text (short blurbs) to explain what the website contains
- Ability to search by parcel number (APN) or address

- Don't let boxes obscure information, e.g. have a transparent legend
- Make sure to design interface to accommodate the screen size of laptops
- Split window – map in one side and support information (Table of Contents) in another. Provide the ability to change the width of either window.
- Don't include market value of a parcel, but do include assessor's value
- Want to be able to print screen as it is

Names suggested for website:

- www.viewmorongobasin.com, www.yourmorongobasin.com

1. THE CITY PROJECT – MONUMENTS

<http://www.mapsportal.org/thecityproject/monuments/>

Positive features of this website:

- Ability to zoom in and out by clicking on map
- Ability to hover over object and get information
- Pictures of monuments linked to location
- Call-out windows with link to additional information, i.e. shorter version and longer version
- Toggle between Map View and Satellite Imagery View
- Information provided about the right amount – not too much

Suggested improvements or changes:

- When you hover cursor over object, want the information to stay on the screen, not disappear
- Don't have boxes with additional information overlay other information
- Fit opening page completely on screen, so don't need to scroll down
- Add explanatory text (short blurbs) to explain what the website contains

2. DISTRICT OF NORTH VANCOUVER (click on Applications, then Projects to open site)

<http://www.geoweb.dnv.org/>

Positive features of this website:

- “Find” function—being able to search by address or parcel number
- Full screen launch option

Suggested improvements or changes:

- Found this site confusing, too busy, complex, difficult to navigate
- Legend information doesn't provide range of data – what does “high” mean in terms of crime rate?
- Pull down menus were not titled intuitively what does “Layers” or “Toolbox” mean? Think of names such as Themes that are more meaningful to users.

3. COLUMBIA COUNTY, GEORGIA

<http://gis.columbiacountyga.gov/>

Positive features of this website:

- Short paragraphs providing explanatory information
- Parcel find function
- Legend—click and it appears
- Split window—liked that arrangement and the ability to change the width of the windows
- This site was deemed clean, pleasing, easy to navigate and find information
- Liked the way the parcels were defined—easy to see

Suggested improvements or changes:

- Users liked the prearranged “Themes” (e.g. Planning and Zoning, Public Safety) but the pull down menu located at the bottom of the page was deemed poorly placed – put it in a more prominent location AND explain the themes on the website so users know they are there.
- Link to other information such as the Zillow website for recent information on sales
- Some of the symbols at the top of the page are not intuitive (e.g. the circle with the I inside – GIS jargon—need to make tools intuitively obvious)
- Rather than use the information button and clicking, use the hover option to show what the parcel information underlying is.

4. PARKINFO.ORG

<http://www.parkinfo.org/>

Positive features of this website:

- Like the “What are you Looking For” approach – intuitive, easy to use and clear choices
- Two windows with information in one and map in the other
- Drag zoom in option with box

Suggested improvements or changes:

- Don’t waste space at top of page with “Parkinfo.org” – use for mapping application
- Call out boxes deemed annoying
- Not clear what areas in green were—need to clarify whether these were government or private lands [Note: this data is from the California Protected Lands Database that includes both public and private lands in conservation. See <http://www.calands.org/> for more information]

5. AMHERST MASSACHUSETTS GIS VIEWER

<http://gis.amherstma.gov/apps/Conservation.aspx>

Due to technical difficulties near the end of the meeting we did not have time to peruse this website in detail.

Readers of this meeting summary are invited to submit feedback on the Amherst site or any other online mapping sites to Stephanie and Renee (email addresses below). Please include feedback on what you like or don’t like, in addition to the URL address of the site you are providing feedback about.

Thanks to all who participated! We look forward to working with Renee as she moves forward with this project.

Stephanie Weigel sweigel@sonoraninstitute.org 760-367-5567

Renee King Renee_King@spatial.redlands.edu

Appendix B. Gap Analysis Model (single status)

This is the complete ModelBuilder diagram for the Gap Analysis single status model. It is divided into 4 letter diagrams below.

Diagram A

Diagram B

Diagram C

Diagram D

Appendix C. Gap Analysis Model (multiple statuses)

This is the complete ModelBuilder diagram for the Gap Analysis single status model. It is divided into 5 letter diagrams below.

Diagram A

Diagram B

Diagram C

Diagram E

Appendix D. Redundancy Analysis Model

Appendix E. Web GIS Application Script

```
<?xml version="1.0" encoding="utf-8"?>
<s:Application xmlns:fx="http://ns.adobe.com/mxml/2009"
    xmlns:s="library://ns.adobe.com/flex/spark"
    xmlns:mx="library://ns.adobe.com/flex/mx"
    xmlns:esri="http://www.esri.com/2008/ags"
    xmlns:layers="com.esri.ags.layers.*" height="768" width="1024" >

    <s:layout>
        <s:VerticalLayout gap="5" horizontalAlign="center" paddingTop="10"
            paddingLeft="10" paddingBottom="10" paddingRight="10"/>
    </s:layout>

    <s:states>
        <s:State name="CombinedLegend"/>
        <s:State name="IndividualLegend"/>
    </s:states>

    <fx:Style source="YourMorongoBasin.css"/>

    <fx:Script>
        <![CDATA[
            import com.esri.ags.FeatureSet;
            import com.esri.ags.Graphic;
            import com.esri.ags.SpatialReference;
            import com.esri.ags.events.ExtentEvent;
            import com.esri.ags.events.GraphicEvent;
            import com.esri.ags.events.LayerEvent;
            import com.esri.ags.geometry.Extent;
            import com.esri.ags.geometry.MapPoint;
            import com.esri.ags.geometry.Polygon;
            import com.esri.ags.layers.TiledMapServiceLayer;
            import com.esri.ags.tasks.supportClasses.AddressCandidate;
            import com.esri.ags.tools.NavigationTool;
            import com.esri.ags.utils.WebMercatorUtil;

            import mx.controls.Alert;
            import mx.core.IFlexDisplayObject;
            import mx.effects.effectClasses.ActionEffectInstance;
            import mx.events.CloseEvent;
            import mx.events.FlexEvent;
            import mx.events.ListEvent;
            import mx.graphics.BitmapFillMode;
            import mx.logging.LogEventLevel;
            import mx.managers.PopUpManager;
```

```

import mx.printing.FlexPrintJob;
import mx.printing.FlexPrintJobScaleType;
import mx.rpc.AsyncResponder;
import mx.rpc.events.FaultEvent;

import spark.events.IndexChangeEvent;

private function doQuery():void
{
    queryTask.execute(query, new AsyncResponder(onResult,
onFault));
    function onResult(featureSet:FeatureSet, token:Object =
null):void
    {
        // clear the graphics layer
        myGraphicsLayer.clear();

        if (featureSet.features.length == 0)
        {
            myInfo.htmlText = "<b><font
color='#FF0000'>Parcel not found</b></font>";
            Alert.show("No Parcel found with that
APN/ID. Please try again.");
        }
        else
        {
            var unionExtent:Extent;

            var
myFirstGraphic:Graphic = featureSet.features[0];
            unionExtent =
Polygon(myFirstGraphic.geometry).extent;

            for each (var myGraphic:Graphic in
featureSet.features)
            {
                myGraphicsLayer.add(myGraphic);
                myGraphic.symbol = graphic3;

                unionExtent =
unionExtent.union(Polygon(myGraphic.geometry).e
xtent);
            }

            myInfo.htmlText = "<b><font color='#FF0000'>
Parcel found</b><br>";
            myMap.extent = unionExtent;

```

```

    }
}
function onFault(info:Object, token:Object = null):void
{
    myInfo.htmlText = "<b>Failure</b>" +
    info.toString();
    Alert.show(info.toString());
}
}
private function doFind():void
{
    var myAddress:Object = {
        Address: address.text,
        City: city.text,
        State: state.text
    };
    // Use outFields to get back extra information
    // The exact fields available depends on the specific
    Locator used.
    var myOutFields:Array = [ "Loc_name" ];
    locateTask.addressToLocations(myAddress, myOutFields,
    new AsyncResponder(onResult, onFault));
    function onResult(candidates:Array, token:Object =
    null):void
    {
        // clear the graphics layer
        myGraphicsLayer.clear();

        if (candidates.length > 0)
        {
            var addressCandidate:AddressCandidate =
            candidates[0];
            var myGraphic:Graphic = new Graphic();
            trace(addressCandidate.location);
            myGraphic.geometry =
            WebMercatorUtil.geographicToWebMercat
            or(addressCandidate.location);
            trace(myGraphic.geometry);
            myGraphic.symbol = mySymbol;
            myGraphic.toolTip =
            addressCandidate.address.toString();
            myGraphic.id = "graphic";
            myGraphicsLayer.add(myGraphic);
            myMap.centerAt(myGraphic.geometry as
            MapPoint);
        }
    }
}

```

```

// Zoom to an appropriate level
// Note: your tile levels and LOC_NAME
might differ...
if
(addressCandidate.attributes.Loc_name.sear
ch("RoofTop") > 0)
{
    myMap.scale = 10000;
}
else if
(addressCandidate.attributes.Loc_name.sear
ch("Address") > 0)
{
    myMap.scale = 10000;
}
else if
(addressCandidate.attributes.Loc_name.sear
ch("Street") > 0)
{
    myMap.scale = 15000;
}
else if
(addressCandidate.attributes.Loc_name.sear
ch("City") > 0)
{
    myMap.scale = 150000;
}
myInfo.htmlText = "<b><font color='#FF0000'>
Found:</b><br/>" +
addressCandidate.address.toString(); // formatted
address
}
else
{
    myInfo.htmlText = "<b><font
color='#FF0000'>Found nothing </b></font>";
    Alert.show("Sorry, couldn't find a
location for this address"
        + "\nAddress: " + address.text
        + "\nCity: " + city.text
        + "\nState: " + state.text);
}
}

```

```

function onFault(info:Object, token:Object = null):void
{
    myInfo.htmlText = "<b>Failure</b>" +
    info.toString();
    Alert.show("Failure: \n" + info.toString());
}
}
private function doPrint(myFlexPrintJobScaleType:String):void
{
    // Create an instance of the FlexPrintJob class.
    var myPrintJob:FlexPrintJob = new FlexPrintJob();

    // Start the print job.
    if (myPrintJob.start())
    {
        try
        {
            // hide the zoom slider so it won't be printed
            myMap.zoomSliderVisible = false;

            // Add the panel to print.
            myPrintJob.addObject(myPanel,
            myFlexPrintJobScaleType);

            // turn the zoom slider back on
            myMap.zoomSliderVisible = true;
        }
        catch (error:Error)
        {
            Alert.show(error.toString());
        }
        // Send the job to the printer.
        myPrintJob.send();
    }
}
protected function
theGraphicAddHandler(event:GraphicEvent):void
{
    event.graphic.addEventListener(MouseEvent.MOUSE_OVER,
    onMouseOverHandler);
    event.graphic.addEventListener(MouseEvent.MOUSE_OUT,
    onMouseOutHandler);
}
private function onMouseOverHandler(event:MouseEvent):void
{
    var gr:Graphic = Graphic(event.target);

```

```

gr.symbol = mouseOverSymbol;
if (OC.selected)
{
    myTextArea.htmlText = "<b>Community
Separator: </b>" + gr.attributes.PriorCls_CS + "\n"
    + "<b>Wildlife Habitat: </b>" +
    gr.attributes.PriorCls_WH + "\n"
    + "<b>Park Buffer: </b>" +
    gr.attributes.PriorCls_PB + "\n"
    + "<b>Views Treasures: </b>" +
    gr.attributes.PriorCls_VT + "\n"
    + "<b>Base Buffer: </b>" +
    gr.attributes.PriorCls_BB + "\n"
    + "\n" + "\n" + "\n" + "\n" + "\n" + "\n"
+ "\n" + "<font color='#0b3c6a'>See Help Document for more
information</font>";
    myMap.infoWindow.label = gr.attributes.APN;
}
else if (BB.selected)
{
    myTextArea.htmlText = "<b>Proximity: </b>" +
    gr.attributes.Proximity_BB + "\n"
    + "<b>Size: </b>" + gr.attributes.Size_BB
    + "\n"
    + "<b>Landuse: </b>" +
    gr.attributes.Landuse_BB + "\n"
    + "<b>Development: </b>" +
    gr.attributes.Development_BB + "\n"
    + "<b>Species: </b>" +
    gr.attributes.Species_BB + "\n"
    + "<b>Geography: </b>" +
    gr.attributes.Geog_BB + "\n"
    + "<b>Assessment: </b>" +
    gr.attributes.Assessment_BB + "\n"
    + "\n" + "\n" + "\n" + "\n" + "\n" +
"<font color='#0b3c6a'>See Help Document for more
information</font>";
    myMap.infoWindow.label = gr.attributes.APN;
}
else if (CS.selected)
{
    myTextArea.htmlText = "<b>Visual Quality:
</b>" + gr.attributes.Visual_Quality_CS + "\n"
    + "<b>Separator: </b>" +
gr.attributes.Separator_CS + "\n"

```

```

        + "<b>Proximity: </b>" +
        gr.attributes.Proximity_CS + "\n"
        + "<b>Landuse: </b>" +
        gr.attributes.Landuse_CS + "\n"
        + "<b>Size: </b>" + gr.attributes.Size_CS
        + "\n"
        + "<b>Highway Frontage: </b>" +
        gr.attributes.HwyFrontage_CS + "\n"
        + "\n" + "\n" + "\n" + "\n" + "\n" + "\n"
+ "<font color='#3d5f7e'>See Help Document for more
information</font>";
        myMap.infoWindow.label = gr.attributes.APN;
    }
else if (PB.selected)
{
    myTextArea.htmlText = "<b>Proximity:</b>" +
    gr.attributes.Proximity_PB + "\n"
    + "<b>Connectivity: </b>" +
    gr.attributes.Connectivity_PB + "\n"
    + "<b>Road Density: </b>" +
    gr.attributes.RdDensity_PB + "\n"
    + "<b>Riparian: </b>" +
    gr.attributes.Riparian_PB + "\n"
    + "<b>Human Activity: </b>" +
    gr.attributes.HumAct_PB + "\n"
    + "<b>Contiguous:</b>" +
    gr.attributes.Contiguous_PB + "\n"
    + "<b>Landuse: </b>" +
    gr.attributes.Landuse_PB + "\n"
    + "<b>Adjacent Landuse: </b>" +
    gr.attributes.AdjLanduse_PB + "\n"
    + "<b>Development: </b>" +
    gr.attributes.Permit_PB + "\n"
    + "<b>Species: </b>" + gr.attributes.Species_PB +
    "\n"
    + "<b>Size: </b>" + gr.attributes.Size_PB + "\n"
    + "\n" + "<font color='#0b3c6a'>See Help
Document for more information</font>";
    myMap.infoWindow.label = gr.attributes.APN;
}
else if (VT.selected)
{
    myTextArea.htmlText = "<b>Iconic: </b>" +
    gr.attributes.Iconic_VT + "\n"
    + "<b>Land Ownership: </b>" +
    gr.attributes.LndOwn_VT + "\n"

```



```

+ "<b>Linkage: </b>" + gr.attributes.Linkage_VT
+ "\n"
+ "<b>Iconic View: </b>" +
gr.attributes.IcView_VT + "\n"
+ "<b>Ridgeline: </b>" +
gr.attributes.Ridgeline_VT + "\n"
+ "<b>Scenic Highway: </b>" +
gr.attributes.ScHwy_VT + "\n"
+ "<b>Community View: </b>" +
gr.attributes.ComView_VT + "\n"
+ "\n" + "\n" + "\n" + "\n" + "\n" +
"<font color='#0b3c6a'>See Help Document for more
information</font>";
myMap.infoWindow.label = gr.attributes.APN;
}
else if (WH.selected)
{
myTextArea.htmlText = "<b>Linkage: </b>" +
gr.attributes.Linkage_WH + "\n"
+ "<b>Proximity: </b>" +
gr.attributes.Proximity_WH + "\n"
+ "<b>Imped: </b>" + gr.attributes.Imped_WH +
"\n"
+ "<b>Threat: </b>" + gr.attributes.Threat_WH +
"\n"
+ "<b>Stream: </b>" + gr.attributes.Stream_WH
+ "\n"
+ "<b>Barrier: </b>" + gr.attributes.Barrier_WH
+ "\n"
+ "<b>Size: </b>" + gr.attributes.Size_WH + "\n"
+ "<b>Species: </b>" + gr.attributes.Species_WH
+ "\n"
+ "\n" + "\n" + "\n" + "\n" + "<font
color='#0b3c6a'>See Help Document for more
information</font>";
myMap.infoWindow.label = gr.attributes.APN;
}
myMap.infoWindow.closeButtonVisible = false;
myMap.infoWindow.show(myMap.toMapFromStage(event
.stageX, event.stageY));
}

private function onMouseOutHandler(event:MouseEvent):void
{
var gr:Graphic = Graphic(event.target);
gr.symbol = defaultsym;

```

```

        myMap.infoWindow.hide();
    }

```

protected function

```

linkbutton1_clickHandler(event:MouseEvent):void
{
    navigateToURL(new URLRequest( "Help_Doc.pdf"),
    "_blank");
}

```

protected function

```

myMap_extentChangeHandler(event:ExtentEvent):void
{
    // set the overview map extent
    ovExt.geometry = myMap.extent;
    ovGraphicsLayer.refresh();
}

```

```

protected function About_click(evt:MouseEvent):void {
    PopUpManager.addPopUp(AboutWindow, this, true);
    PopUpManager.centerPopUp(AboutWindow);
}

```

```

protected function AboutWindow_close(evt:CloseEvent):void {
    PopUpManager.removePopUp(evt.currentTarget as
    IFlexDisplayObject);
}

```

private function

```

Navigate_changeHandler(event:IndexChangeEvent):void
{

```

```

    switch (Navigate.selectedItem)
    {
        case "Zoom In":
        {

```

```

navTool.activate(NavigationTool.ZOOM_IN);
            break;
        }

```

```

        case "Zoom Out":
        {

```

```

navTool.activate(NavigationTool.ZOOM_OUT);
            break;
        }

```

```

        case "Pan":
        {
            navTool.activate(NavigationTool.PAN);
            break;
        }
    }
}

```

```

        }
        default:
        {
            navTool.deactivate();
            break;
        }
    }
}
private function toPercent(value:Number):String
{
    return value + "%";
}

]]>
</fx:Script>

<fx:Declarations>
    <esri:QueryTask id="queryTask"
        showBusyCursor="true"
        useAMF="false"
        url="http://gis664-
08/ArcGIS/rest/services/MB/MapServer/1"/>

    <esri:Query id="query"
        where="APN='{parcelAPN.text}'"
        returnGeometry="true"

        outSpatialReference="{ myMap.spatialReference }"/>

    <!-- Place non-visual elements (e.g., services, value objects) here -->
    <!--<esri:Extent id="initialExtent" xmin="-12991400" ymin="4026437"
    xmax="-12881636" ymax="4075127">
    <esri:SpatialReference wkid="102100"/>
    </esri:Extent-->
    <esri:Extent id="initialExtent" xmin="-12921728" ymin="4050790"
    xmax="-12918298" ymax="4052312">
    <esri:SpatialReference wkid="102100"/>
    </esri:Extent>
    <esri:Extent id="OverviewMapExtent" xmin="-13005000"
    ymin="4026437" xmax="-12875000" ymax="4075127">
        <esri:SpatialReference wkid="102100"/>
    </esri:Extent>
    <esri:Locator id="locateTask"
url="http://tasks.arcgisonline.com/ArcGIS/rest/services/Locators/TA_Address_NA/Geoc
odeServer"/>
    <esri:SimpleMarkerSymbol id="mySymbol"

```

```

        alpha="0.5"
        color="red"
        size="19"
        style="circle">
    <esri:SimpleLineSymbol width=".1"/>
</esri:SimpleMarkerSymbol>
<!--***** -->
<esri:SimpleFillSymbol id="graphic3"
        alpha=".9"
        color="red"
        style="backwarddiagonal">

</esri:SimpleFillSymbol>
<esri:SimpleFillSymbol id="mouseOverSymbol" alpha="0.5">
    <esri:SimpleLineSymbol width="0" color="0xFF0000"/>
</esri:SimpleFillSymbol>
<esri:SimpleFillSymbol id="defaultsym" alpha="0.2">
    <esri:SimpleLineSymbol width="0" color="black"/>
</esri:SimpleFillSymbol>
<!--*****-->
<s:TitleWindow id="AboutWindow"
    title="About"
    width="400"
    visible="true"
    close="AboutWindow_close(event);">
<s:RichText top="10" width="100%" textAlign="left">
    <s:content>
        <s:p>
            This Online Mapping Application enables viewing
            of Geographic Information Systems (GIS) Mapping
            Data covering all of the Morongo Basin. The
            Morongo Basin Open Space Group (MBOSG) is
            working with local planning partners to make
            "basin-wise" choices about how the region grows.
            The key dataset includes parcel data from the
            communities of Morongo Valley, Joshua Tree,
            Twentynine Palms, Yucca Valley, Landers,
            Flamingo Heights, and Wonder Valley. This dataset
            has been compiled from various sources including
            State and Local Agencies. Up to date Parcels data
            has been provided by the Sonoran Institute. Digital
            Aerial and Street Imagery is provided by ESRI.
        </s:p>
        <s:p>
            This application displays map services with basic
            layers, functionalities, and search options. Basic

```

```

        functionality includes map zooming, panning, and
        map printing. Detailed information on a particular
        parcel will be provided through popup information
        window by hovering over the feature with the
        mouse. Searching by address or parcel ID or APN
        number is available.
    </s:p>
    </s:content>
    </s:RichText>
</s:TitleWindow>
<esri:NavigationTool id="navTool" map="{myMap}"/>

<mx:TraceTarget includeCategory="true"
                includeLevel="true"
                includeTime="true"
                level="{LogEventLevel.DEBUG}"/>
</fx:Declarations>
<!--layout container for the application title, logos, and background image-->
<s:BorderContainer width="100%" height="60" textAlign="left"
backgroundAlpha="0.0" borderVisible="false">
    <s:layout>
<s:HorizontalLayout horizontalAlign="center" paddingLeft="5" gap="5"/>
    </s:layout>
    <mx:Image source="logo.jpg" height="60" width="164">
        <mx:filters>
            <s:DropShadowFilter distance="2" alpha="0.7" blurX="6"
            blurY="6" color="#000000" angle="45"/>
        </mx:filters>
    </mx:Image>
    <mx:Image source="institute2.jpg" width="59" height="60">
        <mx:filters>
            <s:DropShadowFilter distance="2" alpha="0.7" blurX="6"
            blurY="6" color="#000000" angle="45"/>
        </mx:filters>
    </mx:Image>
    <s:RichText id="myTitle" paddingTop="1" left="10" height="65"
minWidth="500" fontFamily="Georgia" textAlign="center" kerning="on"
trackingLeft="5" width="557">
        <s:content>
            <s:p fontSize="28" fontWeight="bold" >Preserving
            California's Morongo Basin</s:p>
        </s:content>
        <s:filters>
            <s:DropShadowFilter id="dropShadow" alpha="0.45"
            blurX="6" blurY="6" distance="2" color="#000000"
            angle="90" />
        </s:filters>
    </s:RichText>
</s:BorderContainer>

```

```

        <s:GlowFilter id="glow" blurX="12" blurY="12"
        color="#88AEF7" quality="2" strength="1"/>
    </s:filters>
</s:RichText>
<s:Group>
    <s:layout>
        <s:HorizontalLayout horizontalAlign="center"/>
    </s:layout>
    <mx:LinkButton label="Print Map" enabled="true"
    click="doPrint(FlexPrintJobScaleType.SHOW_ALL);"
    skin="skins.JustALabel" width="77" paddingLeft="0"
    textDecoration="underline" />
    <mx:VRule height="21" width="1" chromeColor="#010101"/>
    <mx:LinkButton label="About" enabled="true"
    click="About_click(event)" skin="skins.JustALabel" width="55"
    paddingLeft="0" textDecoration="underline"/>
    <mx:VRule height="21" width="1" chromeColor="#010101"/>
    <mx:LinkButton label="Help" enabled="true"
    click="linkbutton1_clickHandler(event)" skin="skins.JustALabel"
    width="47" paddingLeft="0" textDecoration="underline"/>
</s:Group>
</s:BorderContainer>
<s:HGroup width="100%" height="100%" gap="5">
    <!--this container sets the boundaries for the conservation themes-->
    <s:BorderContainer width="250" height="100%" >
        <s:layout >
            <s:VerticalLayout/>
        </s:layout>
        <s:RichText text="Conservation Theme" fontWeight="bold"
        fontSize="13" width="100%" paddingTop="8"
        tooltip="Click on text below to select a conservation theme"
        textAlign="center" paddingRight="10" paddingLeft="10"/>
        <s:Group width="100%" minHeight="170">
            <s:layout>
                <s:VerticalLayout gap="10" paddingTop="5"
                paddingLeft="10" paddingRight="10"/>
            </s:layout>
            <s:RadioButton id="OC" label="Combined Themes"
            enabled="true" selected="true" width="100%"
            tooltip="Overall high values for all categories"
            click="currentState='CombinedLegend'" />
            <s:RadioButton id="BB" label="Base Buffer"
            enabled="true" click="currentState='IndividualLegend'"
            tooltip="Priority conservation for MCAGCC buffer" />
            <s:RadioButton id="CS" label="Community Separators"
            enabled="true" click="currentState='IndividualLegend'"

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        toolTip="Priority Conservation for community
        separators"/>
        <s:RadioButton id="PB" label="Park Buffer"
        enabled="true" click="currentState='IndividualLegend'"
        toolTip="Priority conservation for Joshua Tree National
        Park buffer"/>
        <s:RadioButton id="VT" label="Views Treasures"
        enabled="true" click="currentState='IndividualLegend'"
        toolTip="Priority conservation for community views and
        treasures" width="100%"/>
        <s:RadioButton id="WH" label="Wildlife Habitat"
        enabled="true" click="currentState='IndividualLegend'"
        toolTip="Priority conservation for wildlife habitat"/>
    </s:Group>
    <mx:HRule width="100%" height="2"/>
    <s:BorderContainer width="100%" minHeight="260"
    borderVisible="false" backgroundAlpha="0.0">
<!--setting the layout of all the contents within the navigation tab-->
        <s:layout>
            <s:VerticalLayout/>
        </s:layout>
        <s:RichText width="100%" text="Find Location by Parcel ID or
        Address" fontWeight="bold" fontSize="13" paddingLeft="10"
        paddingRight="10" textAlign="center"/>
        <mx:Form width="100%" height="100%"
        paddingRight="2" paddingLeft="2" paddingTop="5"
        paddingBottom="5">
            <mx:FormItem label="Parcel" height="56"
            width="100%" toolTip="Please enter the nine digit
            parcel ID or APN number" paddingLeft="2">
                <s:TextInput id="parcelAPN" text="" />
                <s:Button label="Find Parcel" click="doQuery()"
                toolTip="Click on button to find parcel"/>
            </mx:FormItem>
            <mx:FormItem label="Street" width="100%"
            toolTip="Enter Street number and name"
            paddingLeft="2">
                <s:TextInput id="address" text="57175
                Crestview Dr"/>
            </mx:FormItem>
            <mx:FormItem label="City" width="100%"
            toolTip="Enter City name" paddingLeft="2">
                <s:TextInput id="city" text="Yucca
                Valley"/>
            </mx:FormItem>

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```

        <mx:FormItem label="State" width="100%"
        tooltip="Enter abbreviated State name"
        paddingLeft="2">
            <s:TextInput id="state" text="CA"/>
        </mx:FormItem>
        <mx:FormItem>
            <s:Button label="Find Address" click="doFind()"
            tooltip="Click button to find address"/>
        </mx:FormItem>
    </mx:Form>
    <mx:Text id="myInfo" color="black" textAlign="center"
    width="100%"/>
</s:BorderContainer >
<mx:HRule width="100%" height="2"/>
<s:RichText paddingLeft="15" text="Overview Map"
fontWeight="bold" fontSize="13" tooltip="Shows the overview
of the selected conservation theme" textAlign="center"
width="100%"/>
<!--overview map container with components-->
<s:BorderContainer width="100%" height="100%"
                    borderVisible="false"
                    backgroundAlpha="0.0">
<esri:Map id="overviewMap" extent="{OverviewMapExtent}"
                    scrollWheelZoomEnabled="false"
                    scaleBarVisible="false"
                    zoomSliderVisible="false"
                    doubleClickEnabled="false"
                    doubleClickZoomEnabled="false"
                    logoVisible="false"
                    openHandCursorVisible="false"
                    panEnabled="false"
                    height="120" width="228" left="10">

        <!--this script calls the base buffer layer-->
        <esri:ArcGISDynamicMapServiceLayer visible="{ OC.selected}"
            url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
            <esri:visibleLayers>
                <s:ArrayCollection>
                    <fx:Number>2</fx:Number>
                </s:ArrayCollection>
            </esri:visibleLayers>
        </esri:ArcGISDynamicMapServiceLayer>
        <esri:ArcGISDynamicMapServiceLayer visible="{ BB.selected}"
            url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
            <esri:visibleLayers>
                <s:ArrayCollection>

```



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        <fx:Number>3</fx:Number>
      </s:ArrayCollection>
    </esri:visibleLayers>
  </esri:ArcGISDynamicMapServiceLayer>
  <!--this scrip calls the communtiy separator layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{ CS.selected }"
  url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
  <esri:visibleLayers>
    <s:ArrayCollection>
      <fx:Number>4</fx:Number>
    </s:ArrayCollection>
  </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
  <!--this script calls the park buffer layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{ PB.selected }"
  url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
  <esri:visibleLayers>
    <s:ArrayCollection>
      <fx:Number>5</fx:Number>
    </s:ArrayCollection>
  </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
  <!--this script call the community views and
treasures layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{ VT.selected }"
  url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
  <esri:visibleLayers>
    <s:ArrayCollection>
      <fx:Number>6</fx:Number>
    </s:ArrayCollection>
  </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
  <!--this script calls the wildlife corridors layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{ WH.selected }"
  url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
  <esri:visibleLayers>
    <s:ArrayCollection>
      <fx:Number>7</fx:Number>
    </s:ArrayCollection>
  </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
  <!--gray box symbol/graphic for the overview map-->
  <esri:GraphicsLayer id="ovGraphicsLayer" >
    <esri:Graphic id="ovExt"/>
  </esri:GraphicsLayer>
</esri:Map>

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        <mx:Image source="CLegend.jpg" horizontalAlign="center"
        x="28" y="124" height="25" includeIn="CombinedLegend"
        width="195"/>
        <s:RichText text="Conservation High Value" x="43" y="106"
        includeIn="CombinedLegend"/>
    <s:HGroup gap="19" minHeight="100" left="36" height="19"
    horizontalAlign="left" y="142" width="190"
    includeIn="CombinedLegend">
        <s:RichText text="0" verticalAlign="middle" height="20"
        width="15"/>
        <s:RichText text="1" verticalAlign="middle" height="20"
        width="15"/>
        <s:RichText text="2" verticalAlign="middle" height="20"
        width="15"/>
        <s:RichText text="3" verticalAlign="middle" height="20"
        width="15"/>
        <s:RichText text="4" verticalAlign="middle" height="20"
        width="15"/>
        <s:RichText text="5" verticalAlign="middle" height="20"
        width="15"/>
    </s:HGroup>
    <mx:Image source="ILegend.jpg" horizontalAlign="center"
    height="21" includeIn="IndividualLegend" width="100%" x="2"
    y="120"/>
    <s:RichText text="Conservation Priority"
    includeIn="IndividualLegend" x="58" y="104"/>
    <s:HGroup gap="8" height="19" left="58" y="145" width="154"
    includeIn="IndividualLegend">
        <s:RichText text="Low" verticalAlign="middle" width="32"/>
        <s:RichText text="Medium" verticalAlign="middle"
        width="54"/>
        <s:RichText text="High" verticalAlign="middle"
        width="34"/>
    </s:HGroup>
    </s:BorderContainer>
</s:BorderContainer>
<!--this container sets the boundaries for the map display-->
<s:BorderContainer width="100%" height="100%" id="myPanel"
borderVisible="false">

    <esri:Map id="myMap" extent="{initialExtent}"
    extentChange="myMap_extentChangeHandler(event)"
    height="100%" zoomSliderVisible="false"
    panEnabled="false" doubleClickEnabled="false">
        <esri:infoWindowContent>
            <mx:TextArea id="myTextArea" paddingLeft="5"

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dropShadowVisible="true"
width="250" height="230"/>
</esri:infoWindowContent>
<esri:ArcGISTiledMapServiceLayer
url="http://services.arcgisonline.com/ArcGIS/rest/services/World_Street_
Map/MapServer"/>
<esri:ArcGISTiledMapServiceLayer alpha="{lvrSlider.value}"
url="http://services.arcgisonline.com/ArcGIS/rest/services/World_Imager
y/MapServer"/>
<esri:GraphicsLayer id="myGraphicsLayer"/>
<!--individual layers-->
<!--this script calls the community separators layer-->
<esri:FeatureLayer
graphicAdd="theGraphicAddHandler(event)"
mode="onDemand"
onDemandCacheSize="1000"
outFields="*"
symbol="{defaultsym}"
url="http://gis664-
08/ArcGIS/rest/services/MB/MapServer/1"/>
<!--this script calls the combined high values layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{OC.selected}"
alpha="{1 - hSlider.value / 100}"
url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
<esri:visibleLayers>
<s:ArrayCollection>
<fx:Number>2</fx:Number>
</s:ArrayCollection>
</esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
<!--this script calls the base buffer layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{BB.selected}"
alpha="{1 - hSlider.value / 100}"
url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
<esri:visibleLayers>
<s:ArrayCollection>
<fx:Number>3</fx:Number>
</s:ArrayCollection>
</esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
<!--this calls the community separators layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{CS.selected}"
alpha="{1 - hSlider.value / 100}"
url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
<esri:visibleLayers>
<s:ArrayCollection>

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        <fx:Number>4</fx:Number>
    </s:ArrayCollection>
</esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
<!--this script calls the park buffer layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{PB.selected}"
    alpha="{1 - hSlider.value / 100}"
    url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
    <esri:visibleLayers>
        <s:ArrayCollection>
            <fx:Number>5</fx:Number>
        </s:ArrayCollection>
    </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
<!--this script call the community views and treasures layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{VT.selected}"
    alpha="{1 - hSlider.value / 100}"
    url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
    <esri:visibleLayers>
        <s:ArrayCollection>
            <fx:Number>6</fx:Number>
        </s:ArrayCollection>
    </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
<!--this script calls the wildlife corridors layer-->
<esri:ArcGISDynamicMapServiceLayer visible="{WH.selected}"
    alpha="{1 - hSlider.value / 100}"
    url="http://gis664-08/ArcGIS/rest/services/MB/MapServer">
    <esri:visibleLayers>
        <s:ArrayCollection>
            <fx:Number>7</fx:Number>
        </s:ArrayCollection>
    </esri:visibleLayers>
</esri:ArcGISDynamicMapServiceLayer>
</esri:Map>
<mx:HBox right="10" top="10" backgroundColor="0x000000"
    verticalAlign="bottom" alpha="0.7" height="20">
    <mx:Label text="Streets" color="0xFFFFFFFF"
        fontWeight="bold" />
    <mx:HSlider id="lyrSlider" minimum="0" maximum="1"
        value=".4" liveDragging="true" />
    <mx:Label text="Aerial" color="0xFFFFFFFF"
        fontWeight="bold" />
</mx:HBox>
<mx:VBox right="20" top="40" backgroundColor="0x000000"
    verticalAlign="top" alpha="0.7"

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        width="240" horizontalGap="0" verticalGap="0"
        height="49" horizontalAlign="center" cornerRadius="15">
        <mx:Label text="Layer Transparency" textAlign="center"
        color="0xFFFFFFFF" fontWeight="bold" width="100%"
        height="18"/>
        <s:HGroup height="15" width="196"
        horizontalAlign="left">
            <s:RichText text="0%" width="115"
            fontWeight="bold" verticalAlign="bottom"
            height="15" color="#B5B5B5" />
            <s:RichText text="100%" width="84"
            fontWeight="bold" verticalAlign="bottom"
            height="15" color="#B5B5B5" textAlign="right" />
        </s:HGroup>
        <mx:HSlider styleName="horizontalSlider" id="hSlider"
        minimum="0" maximum="100" value="40"
        snapInterval="1" liveDragging="true"
        dataTipFormatFunction="toPercent"
        allowTrackClick="true" height="8" width="163"/>
    </mx:VBox>
    <s:ButtonBar id="Navigate"
    change="Navigate_changeHandler(event)" height="40" top="10"
    left="10" fontWeight="bold">
        <s:toolTip>Click to select or deselect tool</s:toolTip>
        <s:ArrayList>
            <fx:String>Zoom In</fx:String>
            <fx:String>Zoom Out</fx:String>
            <fx:String>Pan</fx:String>
        </s:ArrayList>
    </s:ButtonBar>
    <mx:Image width="141" source="uor_logo.gif" x="506" y="642"
    height="31">
        <mx:filters>
            <s:DropShadowFilter distance="3" alpha="0.7"
            blurX="6" blurY="6" color="#000000"
            angle="45"/>
        </mx:filters>
    </mx:Image>
</s:BorderContainer>
</s:HGroup>
</s:Application>

```