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USE OF GIS FOR NATURAL AND CULTURAL RESOURCE MANAGEMENT: A COMPUTERIZED RULE-BASED ACTIVITY PLANNING SYSTEM ON SAN NICOLAS ISLAND, POINT MUGU NAVAL AIR WEAPONS STATION

by

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A Thesis Submitted to the Faculty of the

SCHOOL OF RENEWABLE NATURAL RESOURCES

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE
WITH A MAJOR IN RENEWABLE NATURAL RESOURCES STUDIES

In the Graduate College

THE UNIVERSITY OF ARIZONA

1998

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ACKNOWLEDGMENTS

I would like to thank all the members of my thesis committee for their assistance in completing this study. Specifically, I wish to acknowledge the time, patience, and financial support provided by Dr. Phil Guertin in helping to guide my educational course here at The University of Arizona. I also would like to thank Barbara Ball and everyone else at the School of Renewable Natural Resources/ Advanced Resource Technology Group for giving me my first break into the world of GIS, even if it was digitizing countless contour maps. Additional thanks go to Mike Kunzmann and Tom Keeney for allowing me to visit Point Mugu and San Nicolas Island and for showing me around my study site, which was previously known only from computer screens. Thanks go to the students who took the time to complete the evaluation of the PM-CAPS prototype. Finally, I thank my family for their unwavering support and encouragement.

DEDICATION

I would like to dedicate this thesis to my wife, Suzanne, whom I met midway through the completion of my degree. If I had not taken the time to meet her, follow her to Thailand, and marry her, I would probably have graduated sooner, but my life would not be nearly as exciting or fulfilling.

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ABSTRACT

Managing natural and cultural resources on a Department of Defense (DoD) facility presents a difficult challenge. Many DoD facilities contain sensitive resources that are protected by a myriad of state and federal laws. Resource protection is complicated further since, while an important endeavor, it often is subjugated to the fulfillment of the military mission. The ability for resource managers to compare, analyze, and integrate complex resource data determines the speed and efficiency in which planning decisions are made. Geographic Information Systems (GIS) can help resource managers make informed accurate resource management decisions in an expedient manner. This project expanded a GIS database for San Nicolas Island (SNI), part of the Point Mugu Naval Air Weapons Station, CA, and created prototype computer application to assist in resource management. This application, the Point Mugu Computerized Activity Planning System (PM-CAPS), assists managers in selecting locations on SNI for military activities to occur while minimizing the negative impacts on sensitive cultural and natural resources.

I. INTRODUCTION

I.A. Problem Statement

The Department of Defense (DoD) is one of the largest federal land managers in the United States with approximately 25 million acres under its control. These lands, which generally have limited public access, often are in near pristine condition and contain vast natural and cultural resources. Historically, DoD has managed lands under its control almost exclusively towards the fulfillment of its military mission, with little regard towards the management and planning of the natural and cultural resources.

Over the last 25 years, DoD has invested increasing amounts of time and money towards its environmental program, particularly to ensure compliance with overarching laws such as NEPA and the Endangered Species Act. Currently, many DoD installations are in the process of gathering data on the resources within their boundaries in an attempt to inventory, assess, and manage these resources. Consolidating these disparate data into a common format that allows them to be compared, analyzed, visualized, and utilized for planning and management purposes poses a significant challenge at most military installations. The use of Geographic Information Systems (GIS) can facilitate data management significantly. This technology allows for development of a customized knowledge based system that can assist in planning of base activities while minimizing their impacts on sensitive natural and cultural resources.

This project expands the GIS developed for San Nicolas Island (SNI), associated with the Naval Air Warfare Center Weapons Division, Point Mugu, California, and

creates an application running on ArcView, a desktop GIS package (ESRI 1996). This customized application is called PM-CAPS (Point Mugu Computerized Activity Planning System). It is designed to assist with activity planning on SNI.

A GIS for SNI was already established prior to initiating this project, but did not contain complete data sets on basic island geographic characteristics, facilities, or resources. This project attempts to validate the existing data theme layers, augment the GIS with newly acquired data, and utilize the GIS to create additional layers from existing data. The culmination of the project is the development of PM-CAPS. PM-CAPS is a computer application that makes it easier for resource managers on SNI to control the timing and location of human activities in order to protect the resources, without unduly affecting the military mission of the facility. PM-CAPS compares spatial locations of resources to legal and political restrictions in order to inform the user of restrictions or required mitigation associated with certain activities proposed on SNI. This information includes variability in the restrictions based on temporal characteristics of the resources.

San Nicolas Island, one of the Channel Islands off the coast of Southern California, is an excellent location for the development of this project for a number of reasons. First, as an island, it is a relatively closed ecological system. This makes it easier to control the island's resources through management decisions than in a setting with more immigration and emmigration of species. Second, the resource managers for SNI and NAWS, Point Mugu hold favorable opinions of GIS and are committed to expanding its applications for more effective resource management. This attitude assists in attaining cooperation through all stages of project development and indicates a strong

likelihood that PM-CAPS will be utilized upon its completion. Third, SNI contains important legally protected natural and cultural resources. However, because of the island's size, the number of resources present and the number of restrictions that require consideration are of a manageable scope. Lastly, large amounts of data concerning SNI's geographic features, military facilities, and resources already existed in a digital format prior to beginning this project. Having this dataset available reduces the amount of time and effort required for additional data collection in the fulfillment of this project. It is important to note that, while resource management is a high priority on SNI, its dominant use is as a military facility and resource management is subordinate to the fulfillment of the military mission.

I.B. Objectives

The ultimate goal of this project is the development of a working prototype GIS application that will assist SNI resource managers in deciding what restrictions exist to various military activities in order to minimize their impact on sensitive resources on the island. This application is expected to serve as a tool that will reflect the priorities and resource planning decisions of the SNI Resource Manager in determining how best to abide by resource protection laws while minimizing the constraints placed on fulfilling the military mission at SNI.

The objectives involved with achieving this goal are:

1. Assess how military activity site planning is determined in regards to avoiding negative impacts on sensitive resources.

2. Determine how rules governing the site planning decision making process can be codified and automated into a computer application such that results are consistent with those made by the SNI Resource Manager.
3. Create a prototype application that demonstrates how the military activity site planning process can be augmented with a "user-friendly" and easily updatable system that provides spatial and management information concerning sensitive resources.

The prototype application will demonstrate how such a system can facilitate the activity siting decision-making process in regards to assessing the potential restrictions involved with impacting the protected resources on SNI. It allows the user to view the spatial extents of sensitive resources and their associated management policies and restrictions. It is expected that by quickly giving resource managers information regarding the locations and restrictions governing these sensitive resources via the GIS application , they will be better able to make fast, objective, and consistent decisions as to locating military activities on SNI.

I.C. Procedures

I.C.1. Create GIS Database

Data concerning SNI have been gathered from a number of sources and converted to GIS themes using ARC/INFO, a GIS software package (ESRI 1995), as part of an ongoing project that began in 1994. These include themes representing natural features,

such as elevation and geology maps, digitized from SNI General Development Maps (GDMs), and human created features, such as roads and buildings digitized from GDMs. GIS themes also have been developed from data on most of the plant, animal, and cultural resources found on SNI. The datasets for these themes usually contain additional attributional information for the features, such as facility numbers for the features in the building coverage and artifact assemblages associated with each site in the archaeology coverage.

Before significant data analysis could be performed or the application prototype constructed, it was necessary to develop the GIS data set to a sufficient level of completeness. Required datasets included themes representing basic landform features on SNI and for each natural or cultural resource to be included in the prototype. Many of the data were already available in various non-digital formats and had only to be converted to the appropriate format. For example, spatial extents for a theme's features often were digitized from hardcopy maps and their attributional information added to the GIS database.

Validation of the data was imperative since data collection and the actual construction of the coverages were done by many individuals associated with several different entities, such as students from The University of Arizona, NAWS, Point Mugu environmental division employees, and private environmental consulting firms contracted to NAWS, Point Mugu. The lack of thorough metadata records makes it difficult to assess the accuracy, precision, and validity of a given theme by simply visually displaying it. In some instances, there were conflicting data for the same feature. For example, the

shoreline of SNI was defined slightly differently in a number of maps; the most accurate data source needed to be determined in order to establish a single accepted definition for the shoreline feature. It was necessary to investigate, to the extent reasonably possible, how, when, and by whom the data were collected in order to determine how the data could be applied appropriately within this project.

Additional data were required to complete this project. There were gaps in many of the necessary datasets due to an absence of some needed themes and incompleteness or insufficient levels of precision or accuracy within existing themes. After validating the existing themes by comparing them to their original non-digital source data, it was possible to determine what further data needs existed. These needs then were addressed by supplementing the GIS dataset as necessary.

I.C.2. Evaluate and Classify Military Activities on SNI

As an active military installation, a wide range of human activities occur regularly on SNI that have an effect on the natural and cultural resources present. These activities include: a) actions specific to the military mission, such as missile firings; b) activities required for maintaining the installation itself, such as new road construction; and c) actions associated with the personnel on the island, such as beach fishing or other forms of recreation. Many of these activities have the potential to impact important resources to some degree.

In order to understand how the island's resources are managed and how to duplicate the procedure in a computer application, it was necessary first to identify and

categorize what human actions are likely to occur. Since all activities on SNI, both those directly in fulfillment of the military mission and those in support of the personnel on the island, are somewhat limited and regulated by SNI managers, they were identifiable through conversations with SNI personnel and by consulting the San Nicolas Island and Santa Cruz Island Site Manual (Dulka et. al. 1993). This manual was produced by the Naval Air Warfare Center Weapons Division of NAWS, Point Mugu and was designed, largely, to describe the resources on SNI and the scope of the military mission thereon.

After a listing of the commonly occurring activities on SNI was compiled, each activity was categorized based upon the nature of its impact. That is, by the type of effect the activity has on the area in which it occurs. For example, activities such as building construction, laying of below ground water lines, and setting utility poles could all be classified as sub-surface construction activities. This project, including the application prototype, uses these activity classes rather than individual activities themselves for purposes of determining impacts on protected resources.

I.C.3. Determine Restrictions On Activities

SNI is a Navy installation and is managed following the dominant use doctrine (Loomis 1993). Fulfillment of the military mission is the main priority and any regulation or policy that limits military actions, including those imposed for natural or cultural resource protection, is considered a constraint to the fulfillment of this mission. Land managed by the DoD is subject to overarching federal laws, such as the Endangered Species Act, but not to the many agency specific policies implemented by other federal

entities that manage large tracts of land (e.g. Bureau of Land Management). SNI is subject to California state regulations on its beach land below the median high water mark; a small portion of the entire island, but a significant one in terms of the number and relative sensitivity of the resources found there. A third source of resource management regulations affecting SNI are particular to the facility itself issued by the base commander and resource planner. These policy restrictions are imposed to reduce impacts to resources that are not legally covered by other means.

Some policies and regulations are well defined as to how they are to be implemented; they are relatively specific in stating the types of actions that are restricted in the management of certain resources. Other policies are more vague in that they state their intended results or goals, but leave the actual implementation to the discretion of the land manager. Restrictions applied towards implementing a policy can take many different forms. For example, prohibiting certain activities at all times and requiring consultation with the resource planner before an activity can occur are both types of restrictions. Ultimately, it is up to the SNI, Point Mugu base commander and resource managers to decide exactly how all resource management policies are defined, enacted, and enforced.

This step in the project required the identification of existing regulations that restrict any type of activity in an area where any managed resource occurs. It was necessary to determine what regulations, legal or strictly as a matter of policy, govern the managed resources on SNI and, specifically, how the previously defined activity classes

are thereby restricted. Attribute data regarding these restrictions was associated with the ARC/INFO coverages that define the spatial extents of managed resources on SNI.

I.C.4. Development of PM-CAPS

The culmination of this project was the development of the PM-CAPS application prototype that will assist in the planning of activities on SNI for the purpose of resource management. PM-CAPS is a queriable system operating through an ArcView for Windows ver. 3.0a interface that answers the operator's question of what restrictions exist for a specific activity class anywhere on the island. More specifically, it informs the user as to what protected resources exist in any given area and what the restrictions are towards one of the pre-defined activity classes. The PM-CAPS prototype application was created using Avenue programming language and internal customizing options within ArcView.

I.C.4.a. Develop Database for PM-CAPS Prototype

The PM-CAPS prototype functions by referencing information held in the database associated with the application. Before the application interface was developed, this database had to be designed and constructed. The application itself is a "rule-based" type system. Therefore, the structure of the database and the interrelation of the data within it are crucial for determining the performance of the application.

There were three primary considerations involved in the design of the database:

1. effective functionality of the PM-CAPS application
2. ability to be updated easily as information (e.g. legal restrictions or spatial extents of a resource) on SNI changes
3. ability to include additional managed resources into the application in an easy and seamless manner

The data are found in ARC/INFO thematic coverages and in a number of associated database (.dbf) files. The coverages contain little attribute information for the data themes and provide, primarily, the spatial extents of the theme and referencing information to the appropriate attribute tables. Storing the attribute information in separate data files makes it easier for information to be updated or added to the application at a later date. The attribute tables can be related to the coverages feature attribute tables within PM-CAPS.

I.D.4.b. Design PM-CAPS Prototype Interface

The PM-CAPS prototype is designed to be operated by someone with a basic working knowledge of Environmental Systems Research Institute (ESRI), Inc.'s ArcView software. However, it is not necessary for users to have a full understanding of how the data are manipulated by the application since this process is transparent to them. PM-CAPS utilizes a standard ArcView GUI with only a few modifications in the form of additional menu items, buttons, and tools.

Upon loading PM-CAPS, the user sees an SNI base map view. They can use standard ArcView functions to visualize or analyze the facility, resource, and other themes, or any of the associated data files in much the same manner as with any ArcView project. The PM-CAPS prototype has added functions that allow a unique type of analysis designed to assist a resource manager in making decisions in siting activities on SNI.

The user can use PM-CAPS to discover the restrictions that would apply to performing a certain activity in a certain location on the island. They would begin by defining the location to be considered using a cursor control device. From a list of available options, they then select the activity class that includes the specific activity to be considered. PM-CAPS will compare the selected location to the restrictions that have been defined for that area and display, in tabular form, a verbal description of what protected resources are present in the impact area and what the restrictions are to the specified activity class. It also will display the extent of the protected area for each applicable resource in order to assist the user in developing a new query or alternative site if they so desire.

I.C.5. Evaluation of PM-CAPS Prototype

After a working prototype of the PM-CAPS application was completed, an evaluation of it was performed. This evaluation was designed to assess whether the prototype is useable by someone with limited expertise in ArcView and to gather input as to how the application could be modified to increase its ease of use and efficiency in

delivering useful information to assist the user in the activity siting decision making process.

The evaluation was conducted using individuals with varying degrees of proficiency with ArcView, but no prior exposure to this project. Subjects were asked to utilize the PM-CAPS prototype to assist in the hypothetical siting of an activity on SNI: the type of task that the SNI Resource Manager will perform with the completed product. Each subject then completed a form that encouraged him to subjectively describe his experience using the prototype and evaluate certain aspects of its functionality and performance. These evaluations were reviewed as sources for possible improvements to the prototype.

I.D. Expected Results

This project will result in the creation of a prototype tool that can be used to manage the natural and cultural resources on SNI more effectively. The PM-CAPS prototype will demonstrate to the resource management decision makers at NAWS, Point Mugu that advanced GIS technology, such as this application, can lead to faster, objective, consistent decisions in regards to siting activities on a military facility in such a way as to minimize the negative impacts on sensitive resources. This project will deliver a working prototype in the expectation that further revisions will be completed after a testing and evaluation period by the SNI resource managers. However, these evaluations and revisions are beyond the scope of this particular project.

The delivered prototype, while not as robust as the final version of PM-CAPS, will have the same basic functionality of more advanced versions. During operation of the application, the user first will select which activity class they wish to use for their query. Next, they define the area where the proposed activity would occur. PM-CAPS will overlay the user defined area with the appropriate activity restriction theme and determine what theme on theme overlays occur. The application then will display the spatial extents of the affected features and a table containing any applicable restriction information.

It is expected that use of the PM-CAPS prototype will lead the SNI resource managers to examine and refine the current process for activity siting. The restriction information that PM-CAPS gives the user is exactly what is programmed into it based on information provided by NAWS, Point Mugu resource managers during the design phase of the project. It could be considered a static knowledge retrieval system in the sense that it is designed to extract and display the applicable information from its database rather than possessing any deterministic capabilities of its own. For example, it could provide the legal restrictions to performing a certain type of an activity in an area where a particular resource is found only if that information has already been programmed into it. It is anticipated that use of PM-CAPS will lead to situations where the resource managers disagree with the responses provided by the application prototype. This should encourage a process of codification of the rules and restrictions that govern the sensitive resources on SNI.

II. LITERATURE REVIEW

Since the development of the first GIS, the Canadian Geographic Information System, CGIS, in 1964, GIS has gained support from a wide range of types of users. However, issues such as hardware and software expense, a lack of trained users, a lack of readily available data, and human reluctance to embrace new technology have confined the adoption of GIS to a limited number of technically and financially capable users and organizations (Ehler et al. 1995). This group is continually expanding as each of these limitations has been addressed through various means, but has resulted in a situation where there is a wide disparity in the complexity of GIS applications found from one user to another. The DoD was one of the earlier GIS users and continues to support new applications of the technology (Dilks and Finney 1994).

Since the inception of GIS, the technology has slowly established itself as a valuable tool for a variety of applications requiring the management of large amounts of spatially referenced data (Loh and Power 1993; Powers et al. 1994; Schmoldt and Rauscher 1996). The CGIS application was designed for agricultural landscape suitability analysis (Star and Estes 1990), and early GIS applications were applied most often to resource management purposes (Turk and Pineau 1994). Familiarity with GIS and advancements in technology have led users to expand the use of GIS to include other non-resource management applications , such as military ship routing (Dilks and Finney 1994). With further advancements in computer hardware and software, primarily in the

1980s, GIS expanded its role to include more complex data analysis and decision support functions (Ehler et al. 1995; Gorry and Morton 1971; Schmoldt and Rauscher 1996).

Government entities from the municipal level to large federal agencies were among the first, and continue to be among the most active, users. This is due largely to their ability to support the costs of establishing and maintaining the equipment, personnel, and data required to implement GIS successfully (Schmoldt and Rauscher 1996). Many facilities managed by the DoD have learned to embrace GIS technology, first as a resource management tool, then as an application for other landscape and data management purposes, and, more recently, as a decision support tool.

II.A. GIS for Natural and Cultural Resource Management

GIS has been applied effectively by a variety of users as a natural and cultural resource data management, visualization, and analysis tool. One of the strengths of GIS is its ability to standardize how data are collected, stored, and managed when large numbers of people are involved or when data come from disparate sources and formats. One example of this is in the County of Riverside, California, which uses GIS to normalize its biological survey data collection by requiring that its field personnel collect their data in a standard format and operate at the same scale by establishing common base maps (Luna and Egetter 1995). Another example is the John F. Kennedy Space Center, FL, which has integrated data gathered by various private contractors, U.S. Fish and Wildlife Service, National Park Service, and Meritt Island National Wildlife Refuge into a common GIS accessible by each of the concerned land managers (Duncan et al. 1994).

GIS data can be stored or manipulated using readily available relational database management system (RDBMS) software. This has increased the ease of functionality and user acceptance of GIS since DBMS applications have been in use for several years and have gained wide acceptance in the workplace (Arogyaswamy 1992).

Oftentimes, a spatial component can be integrated into existing databases containing data for features that possess such properties, but were established prior to adoption of GIS. The Miami Conservancy District integrated their established electronic database and hardcopy maps to establish a GIS database that provided greatly expanded speed, functionality, and capabilities without losing any information or usability (Allen Jr. 1997). Such transitions can occur nearly seamlessly with a low learning curve relative to the gains realized by GIS capability.

The data visualization capabilities of GIS are useful for several natural and cultural resource management applications. The concept of thematic mapping, described by Star and Estes (1990) as "..recording various layers of spatial data on a series of similar base maps..", has been an established cartographic technique since the late 18th century (Star and Estes 1990). Thematic mapping allows users to visualize spatial overlays of dissimilar data sets within common geographic boundaries. This ability to visualize any combination of thematic spatial data present in the user's database and, if desired, produce hard or soft copy cartographic products, has been utilized extensively by GIS users. Many GIS applications designed for natural or cultural resource planning and management purposes explicitly identify data visualization and/or cartographic

production among their primary goals (Swanson 1994; Copeland et al. 1994; Luna and Egetter 1995; Kish 1995).

The speed and ease in which data can be visualized using GIS, relative to other non-digital techniques, can result in better control, understanding, and analysis of the data. Maps can be produced showing only specific themes that the end user is currently interested in viewing or has access to view (Kish 1995; Luna and Egetter 1995). Also, GIS allows the display of data themes, such as wetlands, archaeological sites, buried pipe and cables, and sensitive plants and animals that are not typically overlaid in a single map (Kish 1995). Visualizing thematically dissimilar but spatially related themes can result in a greater understanding of the resources in an area and lead to new insights for additional analysis and research (Copeland et al. 1994; Duncan et al. 1994).

Simulations can be performed that allow users to visualize data under a variety of hypothetical conditions in order to answer "what if" type questions. If the data exist, visual comparison of the distribution of a theme at different temporal points can be an effective analysis technique. For example, Frye and Denning (1995) created maps showing various hydrological themes for the York Creek Watershed in Michigan for the years 1963, 1993, and 2020 (estimated) as a way to display potential future conditions. Pacific Lumber created displays of a forested area under various management options in order to demonstrate how natural vistas would be affected by each option (Lang 1997). GIS allows multiple variations of such queries to be performed and visualized more rapidly than possible using non-digital methods.

The computational and analytical abilities of GIS are utilized in many natural and cultural resource applications. Standard environmental models can be run for an area using spatially referenced data stored in a GIS. For example, the U.S. Environmental Protection Agency (EPA) has incorporated the HEC-1 and Universal Soil Loss Equation (USLE) models into watershed level GIS analyses (Fry and Denning 1995; James and Hewitt 1992). The data required as input for such models often are already present within the GIS database or can be derived easily from existing data through GIS analysis. Also, the ease in which the spatial extents or other model parameters can be modified allows for multiple iterations to be run relatively quickly using GIS. This allows the user to examine many potential scenarios with good control over the individual model parameters.

The analytical capabilities of GIS for resource management and planning extend beyond just applying established models to database information. New models specific to a project's location and interests also can be developed and run directly from a GIS application (Hasentab 1983; Duncan et al. 1994). Overlay analysis, that is the examination and assessment of layered thematic data within a discrete spatial extent, is another common data analysis technique. Often, this is done to determine or assess the relationships or interactions of various themes within the landscape of interest. For example, a study by the University of Idaho examined the relationship between various environmental factors, such as vegetation types, proximity to recent timber cutting, and edge area, and deer habitat selection (Chang et al. 1994). The EPA established a GIS database in order to determine the distribution, status, and trends of ecological resources

in the Louisianian Province of an estuary monitoring and assessment program (Bourgeois et al. 1997).

This type of analysis can be used for pattern recognition to identify commonalties as a way of predictive modeling. That is, by examining multiple themes in locations where an event of interest occurs, it is possible to identify certain patterns of conditions that seem to indicate an expected presence or absence of the event's occurrence. Statistical analyses can be done to assess the significance of these relationships. Other areas then can be examined, given that the proper data are available, to identify locations that possess the same characteristics indicating a likelihood that the event could potentially occur there. This technique has been applied successfully for uses as diverse as archaeological site location prediction (Calamia 1986; Hasentab 1983; Jacobson and Meacham 1998), species habitat selection (Chang et al. 1994; Duncan et al. 1994), and risk assessments (Hickey et al. 1997). Such applications can be immensely valuable to resource planners and managers by indicating areas that may require additional study or special protection.

II.B. DoD Use of GIS for Resource Management

Many DoD installations were early users of GIS technology, largely due to the monetary and technical resources available to them and a generally receptive attitude towards new technology (Dilks and Finney 1994). Use of GIS within the DoD has occurred largely on a site by site basis as opposed to any coordinated top-down approach (Dilks and Finney 1994). That is, rather than following a coordinated GIS

implementation plan originating from the Pentagon, individual facilities and sub-agencies (eg., the U.S. Army Corps of Engineers) discovered and integrated GIS into their worksites on their own. As GIS has become established in a larger number of sites, intra-facility and inter-agency cooperation and data sharing have become easier and more common.

As large numbers of DoD facilities began using GIS technology, the U.S. Army Construction Engineering Research Laboratories developed a GIS software package, the Geographic Resources Analysis Support System (GRASS), as a means of normalizing GIS data collection and management among different facilities and departments (Dilks and Finney 1994). Although this software is now utilized less frequently, as most users have transformed their data into more powerful and popular commercial package formats, its development is significant in that it represents the DoD's recognition of GIS as a viable long-term data management and processing tool.

Historically, GIS applications often were introduced to DoD facilities in the Public Works, Environmental Affairs, and Natural Resources divisions (Hughes 1996). However, as the benefits of GIS became recognized more widely, other divisions began their own application development, often resulting in better data integration throughout the facility (Foresman 1993; Dilks and Finney 1994; Kish 1995; Sherman 1995). GIS frequently was brought in by one of these divisions for very specific purposes or individual projects. For example, one of the first uses of GIS at Vandenberg Air Force Base, CA was the automation of the digging permit process for the Civil Engineering office (Kish 1995). However, with the success of this first application, the base planner

began an installation-wide GIS automation project, envisioning GIS as "... an integral part of day-to-day operations" for the plethora of divisions working on the base.

There often is an inherent conflict between the fulfillment of a DoD facility's military mission and environmental resource management (Rubenson et al. 1996). Various activities required for military purposes, such as troop maneuvering or range firing, have a significant impact on the landscape and planning for them seemingly is directly at odds with environmental preservation. Inter-division data sharing can lead to a greater emphasis on, and more effective, resource management, even when that is not the primary objective of the application. Military activities are, obviously, affected by the environmental conditions that exist where they occur. Having environmental data readily available when activity planning occurs and using them to determine locations where the activity can be successfully completed while minimizing the impact on the resources can result in better planning decisions, as well as increased environmental resource awareness and protection. For example, at Fort Knox, Kentucky, a U.S. Army base, a GIS application was created to help plan the placement of a tank firing range. While the safety of personnel and facilities was the main concern to military planners, by providing environmental and natural and cultural resource layers to the GIS, resource planners were able to influence the range placement in order to ensure sensitive resources were not in the shell impact area (Dilks and Finney 1994).

By making common data layers available to users throughout a facility, planners from several divisions can make more informed decisions that are both more effective for their specific application and provide better resource conservation. The previous example

of Fort Knox, where areas containing protected environmental, instead of just personnel and facility, resources were eliminated from consideration for locating the tank firing range, demonstrates how, using GIS, natural and cultural resource concerns can be incorporated without unduly hindering the military mission.

Importantly, through the use of GIS, environmental planning can assist in making military planning more effective. The Air Force Civil Engineering Support Agency used a wide range of environmental data in the construction of a GIS application designed to help solve the problem of bird strikes by Air Force aircraft, a problem responsible for the loss of several human lives and millions of dollars each year (Dilks and Finney 1994). A computerized model was developed which calculates the relative risk of a bird strike by integrating biological (including temporal) and geographic data into a GIS. Tabular and graphic outputs identify the relative risks associated with flying in different areas and altitudes, allowing flight planners to choose the safest times and routes. This application would not have been possible without access to data gathered by many different divisions at several Air Force facilities.

II.C. Use of GIS for Resource Management Decision Support

As GIS has become a more common and accepted resource management tool, the complexity of applications designed with it have increased dramatically as well. As stated earlier, many early applications were little more than data visualization or map making tools (Swanson 1994; Copeland et al. 1994; Luna and Egetter 1995; Kish 1995). The complexity of GIS applications has expanded, both conceptually and technically, as

the technology has advanced and become more widespread, and as spatially referenced data have become increasingly available for more themes and areas (Arogyaswamy 1992).

Since the 1980's there has been a proliferation of applications that are designed to perform more complex data analyses than could be managed by most individuals (Arogyaswamy 1992; Anjomani 1992; Ehler et al. 1995). These applications often are intended to assist the user in making complex land use planning or resource management decisions (Arogyaswamy 1992; Anjomani 1992). Resource planning and site planning are tasks that can be facilitated by the use of GIS. Ehler et al. (1995) stated that, using non-digital methods, site planning often results in poor decision making, due largely to a lack of consideration of all relevant information. GIS can provide decision makers with more efficient data organization and evaluation.

The development of object oriented programming languages has led to significantly enhanced resource decision making (Loh and Power, 1993) With relatively low level programming effort, compared to other models, object oriented programming allows separate components of a natural system to be evaluated in a more individualized manner. Besides possessing separate attribute data, each object in the system can be modeled with its own distinct behavior, more closely resembling the natural system. Loh and Power (1993) credit object oriented programming with the development of a new paradigm in environmental modeling where a natural system can be analyzed through a computer model without forcing a computer specific abstraction. This, in turn, assists the resource planner in his ability to make accurate decisions.

There is a wide range in the complexity of the GIS applications that are developed to provide decision support for resource planners. Although there is no standard definition for the term "decision support system" (DSS), first used by Gorry and Morton (1971), Arogyaswamy (1992) defines it as a system possessing 1) the ability to display and manipulate map images, 2) attribute data, and 3) hierarchical computational decision models. While the first two components are present in most applications that are defined by the developer as a DSS, many applications do not internally process data through a mathematical model are also referred to as a DSS (Frye and Denning 1995; Luna and Egetter 1995). Ehler et al. (1995) further refine the term to a "spatial decision support system" (SDSS) when a DSS is applied to spatially referenced data. For environmental applications, SDSS are likely to be object oriented.

Regardless of the semantics concerning the term DSS, there are many functionally different types of GIS applications that have been developed specifically to assist resource planners in their decision making. An application was developed using PC ARC/INFO software that contains several data layers for Alpine Township, MI, such as streams and erosion potential, at different temporal intervals, including predicted future conditions (Frye and Denning 1995). It was intended to allow planners and the general public to examine how various resources and other aspects of the area could overlap given current development patterns. This led local planners to change the zoning in several areas to try to prevent resource degradation. A more complex application used workstation ARC/INFO to estimate pollution levels for the Blackfoot River in Montana based on user defined land use patterns within the watershed (James and Hewitt 1992).

Conditions were recalculated and displayed graphically and in tables based on the user's input. The value of such applications is greater than just the direct responses that the user receives; they can be of substantial usefulness in identifying options, developing familiarity with the subject, and identifying needs for targeting more extensive data acquisition and analysis (Beardsley et al. 1997).

When attempting to determine an optimal solution to a land use problem or predict the outcome of certain planning choices, the use of GIS can assist resource planners in decision making in ways that other tools cannot (Anjomani 1992; Arogyaswamy 1992; Faber and Wallace 1996). Ehler et al. (1995) found that land use decision making suffered from poor data management and evaluation . These problems can be addressed effectively through the use of GIS and knowledge based techniques (Ehler et al. 1995; Schmoldt and Rauscher 1996). A well-constructed GIS is capable of analyzing considerably more data than a human. Therefore, more factors, such as environmental conditions, influencing factors, and sensitive resources, can be included in the decision making process (Arogyaswamy 1992; Frye and Denning 1995). Ehler et al. (1995) contend that, as more criteria are included in the evaluation, the accuracy of decisions made by humans decreases while the accuracy of an effective computer application should remain static.

The accuracy of GIS determined solutions is dependent on, not only the validity of the data, but also the quality of the evaluation rules that the application is provided (Schmoldt and Rauscher 1996). Any analytical models used must be accurate and applicable to the data. Schmoldt and Rauscher (1996) state that a computer application

used for decision support for natural resource management should, theoretically, provide the same answer as a human expert who evaluates the same data. The rules for determining the output are human determined. An effective GIS application can be used by a resource manager to evaluate large, thematically disparate data sets in order to make accurate, consistent planning decisions.

III. SITE DESCRIPTION

III.A. Location of San Nicolas Island, NAWS, Point Mugu

San Nicolas Island (SNI) is located approximately 105 kilometers south of the Naval Air Weapons Station (NAWS), Point Mugu and 170 kilometers southwest of Los Angeles, California (Figure III.A.). It is one of the eight Channel Islands. Management of the Channel Islands is complicated. Five of the islands are managed by the National Park Service, five have some degree of Navy usage, and one is predominantly managed by the Nature Conservancy, a private conservation organization (Dulka et al. 1993). Seven of the islands, including SNI, contain legally protected species, archaeological sites, or both.

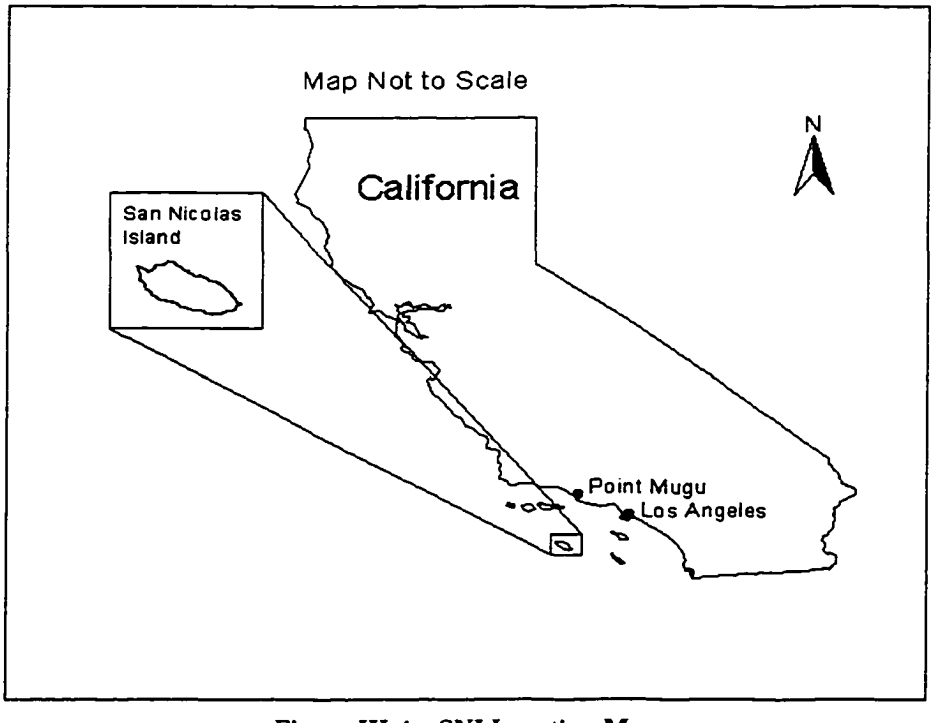


Figure III.A. SNI Location Map

Six of the islands are within the Sea Test Range (STR) of the Naval Air Warfare Center Weapons Division (NAWCWPNSDIV). The STR extends over 300 kilometers from the California coast and encompasses six of the Channel Islands. The NAWCWPNSDIV uses SNI largely as a range instrumentation test site (Dulka et al. 1993). The island is equipped with facilities supporting metric radar, telemetry, extended area test system optics, communications, microwave, missile launching, drone launching, surveillance radar, and target control. The main support facilities include an airport facility, housing, a power plant, a fuel farm, a reverse osmosis water system, and several public works facilities (Dulka et al. 1993).

San Nicolas Island is approximately 14.5 kilometers by 5.5 kilometers and is about 54.1 square kilometers in size. The island is relatively flat with very steep cliff faces averaging 153 meters descending to the ocean on the south side and more gradual slopes on the north. The majority of the interior of the island is part of a relatively flat plateau with a maximum elevation of 277 meters. Figure III.B., a relief map, illustrates the topology of SNI.

The vegetation found on the island is composed primarily of coarse grasses and shrubs. The only trees on SNI are recent introductions found in "Nicktown," the military residential compound. The interior of the island is highly eroded rolling mesa land with many rills and gullies. The island's western beach has large semi-transient sand dunes. The eastern edge has a large low sand spit extending eastward. Many natural springs occur across SNI. The water, though highly mineralized, is potable. Some of these

springs have mechanical pumps or wells installed over them, restricting natural access to the flows.

An extensive network of over 80 kilometers of paved and dirt roads provide access to most areas of the island. Several buildings and other facilities, including a 3,048 meter permanent bituminous paved runway and taxiway, are located across SNI. Approximately 200 military personnel and contractors live on the island at any one time (Dulka et al. 1993). Most living quarters, along with a mess hall, PX, and other residential facilities are located in Nicktown in the center of the north side of the island (Figure III.B.).

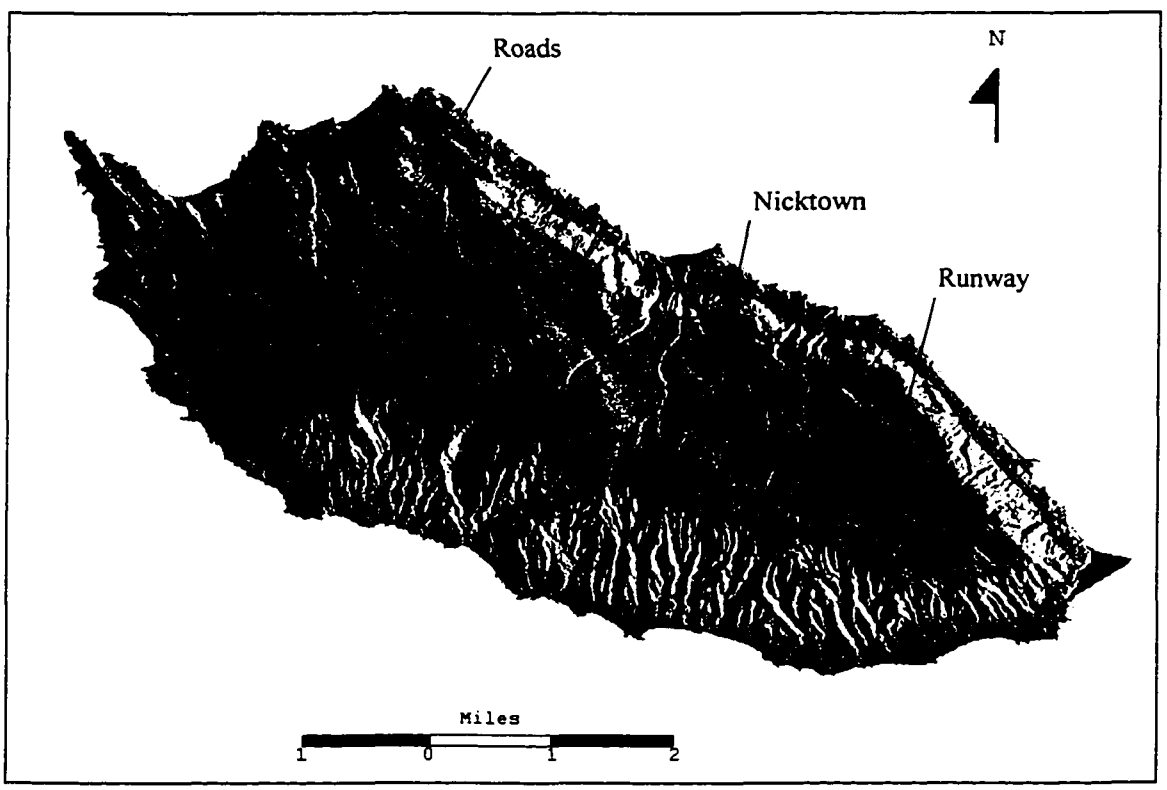


Figure III.B. Relief Map of San Nicolas Island

III.A.1. San Nicolas Island History

San Nicolas Island was discovered in 1543 by explorer Bartolome Ferrer. At this time, the Channel Islands were heavily populated by Native Americans of the Chumash tribe, possibly of Shoshonean stock (Dulka et al. 1993). These inhabitants of SNI, dubbed the "Nicolenos" by early white explorers, are estimated to have inhabited the island for at least 7,200 years (Schwartz 1997).

Almost all knowledge of the Nicolenos has been derived from the archaeological record, although some written accounts of other Channel Island Chumash were made by Spanish explorers in the mid 1500's. The Nicolenos survived on an almost entirely ocean based economy. Although some terrestrial vegetation was utilized for food, building, and craft materials, the majority of the material remains are of sea origin. Their diet was mainly comprised of sea mammals, fish, birds, and shellfish. These also provided the materials used for clothing, tools, such as fish hooks, and the heavy ornamentation worn by the Chumash. Archaeological evidence indicates trading amongst inhabitants of the Channel Islands and with the mainland. It is estimated that as many as 1,500 Nicolenos lived on the island at one time (Dulka et al. 1993).

Nicoleno habitation of SNI ended in the 1800's due to the lucrative sea otter pelt trade. Large numbers of the otters were found on the island, attracting hunters from Russia and the newly established United States. In 1811, a Boston trader landed about thirty Kodiak Indian sea otter hunters on SNI. When he returned a year later, he found that the Kodiak Indians had killed nearly all of the male Nicolenos. Within two decades, the otters were close to extinction and the trade was nearly over. In 1835, missionaries

from Los Angeles removed the remaining 20 or so inhabitants from the island, leaving SNI deserted (King 1990).

In 1857, private sheep ranching began on San Nicolas Island. By 1890, SNI's 4,047 hectares of grazing land were supporting over 30,000 sheep. By 1930, only 1,619 hectares of vegetation remained (Dulka et al. 1993). The Navy took possession of SNI in 1933 under presidential directive and assigned fifteen troops to live there and maintain a weather station. The last sheep were removed from the island ten years later.

The Army was given temporary administration of SNI in 1942 and used it as a gunnery and bombing range. After World War II, control of the island returned to the Navy. In 1947, SNI was incorporated into the Naval Air Weapons Station, Point Mugu. Millions of dollars of communications and missile tracking equipment were installed and approximately 200 troops were assigned to the island. Control of Pt. Mugu NAWS is maintained from the mainland base (Dulka et al. 1993).

III.A.2. Facilities and Military Mission of SNI

The facilities found on San Nicolas Island impact many sections of the island to various degrees. SNI's primary mission is to provide support for NAWCWPNSDIV, headquartered at NAWS, Pt. Mugu. Of the eight islands located within the NAWCWPNSDIV Sea Test Range, SNI has the most instrumentation, personnel, and utilization.

The Navy considers SNI an ideal site for many of its range functions due to its location. Southern California is home to several major Navy testing, communication, and

command installations. SNI also is outside of the reach of most interfering civilian activities. Hazardous weapons systems can be used and tested with less interference to operations and greater safety than on the mainland (Dulka et al. 1993).

San Nicolas Island Range Operations Department has five primary responsibilities in the fulfillment of its mission (Dulka et al. 1993):

1. Provide radar tracking, range surveillance, telemetering, optical instrumentation, and electronic trajectory measurement data.
2. Provide assigned communications support and services, including electronic data transmission.
3. Provide liaison with mainland technical organizations and personnel to obtain technical assistance for the Offshore Islands.
4. Provide geophysical data to support NAWCWPNSDIV range users, primarily weather information.
5. Provide operational support for special projects and special studies, including contracted missile launchings and guidance.

Seven technical Operational Support sections exist under the SNI Range Operations Department to meet these responsibilities (Dulka et al. 1993):

1. Range Communication Section: operates and maintains communications systems, transmitters, and receiver facilities.
2. Geophysics Section: provides weather information on the STR through upper air soundings, meteorological rockets, and surface instrumentation and observations.

3. Surveillance Section: provides air and surface range surveillance systems in support of range safety. Provides hazard area control during operations.
4. Ordnance and Launching Section: maintains and operates ordnance storage and launching facilities. Provides ordnance transportation and storage, and operational control of impact and ordnance disposal areas.
5. Telemetry Section: operates and maintains antenna sensors and other telemetry equipment. Provides real-time telemetry data for range users.
6. Metric Radars Section: operates, maintains, and calibrates electronics trajectory data, collection radars, and real-time data handling and recording systems.
7. Santa Cruz Section: overseas STR facilities on Santa Cruz Island.

Roads, instrumentation, public works, and other support facilities are located across most areas of the island, with the steep southern cliffs and some of the sandy beaches being the few sections of SNI lacking direct visible human activity. Of the over 80.5 kilometers of roads on the island, over 48 kilometers are paved (Dulka et al. 1993). The instrumentation facilities include three metric radars, eight telemetry antennas, a frequency monitoring station, three surveillance radars, meteorological measurement systems, range communication systems, ordnance and launching facilities, and other support sites and equipment.

The Ordnance and Launch Section facilities are confined to the western third of SNI. This section provides facilities for missile assembly, explosive storage, aircraft loading, and surface launching of missiles and targets. The facilities consist of two

launch areas, each equipped with a control system blockhouse and multiple launching pads. Each launch site has a 45 degree horizontal flight corridor extending out to the ocean, within which all missiles must remain. This is to control and minimize the land area exposed to missile fly-overs (Dulka et al. 1993).

The Public Works Division on SNI is responsible for maintaining much of the infrastructure necessary for continuing operation of the installation. Among their primary responsibilities are the provision of roads, water, sewage, and electricity. The majority of SNI's water supply is pumped from several wells, catchments, and springs to a number of above and below ground storage tanks where it supplies nearby buildings. Two reverse osmosis desalination units augment the fresh water supply (Dulka et al. 1993).

Wastewater and sanitary sewage is not removed from the island. Approximately 40 septic tanks and leachfields are found on the island. There also is a wastewater treatment facility consisting of three concrete lined aeration ponds, a chlorination well, and a conic surcharge pond. The chlorinated effluent is pumped from the surcharge pond and disposed of by spraying. Over 1,371 linear meters of sewer lines are used (Dulka et al. 1993).

Electricity on SNI is generated by five diesel generators located near Nicktown. Fuel is held in a 37,879 liter above ground tank. Power is distributed throughout the island by three feeders and a combination of above and below ground lines (Dulka et al. 1993).

Another significant source of impact on the island is the airfield, located in the eastern portion of SNI. The airfield, with a 3,048 meter runway and taxiway, also has a

ground controlled approach facility, hazardous waste facility, and several other support buildings. The airfield is used for scheduled daily flights from the mainland and can accommodate all sizes of aircraft, including supersonic planes (Dulka et al. 1993).

III.B. Resource Inventory of San Nicolas Island

A wide array of natural and cultural resources exist on San Nicolas Island. Many of the plant and animal species found on SNI are morphologically different from mainland populations and those on other Channel Islands due to their long-term isolation. Some have diverged to the degree that they are categorized as separate species or subspecies (Dulka et al. 1993). The archaeological resources on SNI also are significant in their uniqueness and richness. A number of federal and state laws regulate the activities that can occur where many of these resources are found. These regulations are augmented by further restrictions imposed by the resource managers of NAWS, Point Mugu and SNI. The PM-CAPS prototype takes into account most of the sensitive resources on the island.

III.B.1. Cultural Resources

Over 500 archaeological sites have been identified and recorded on SNI (Dulka et al. 1993). However, it can be difficult to delineate precise site boundaries because of the heavy utilization of most of the island and site migration due to alluvial and erosional activities. With an estimated maximum population of up to 1,500 Chumash (Dulka et al. 1993), it is likely that human activities occurred across the entire island. The Chumash

culture dominated an area of about 16,835 square kilometers on the mainland, as well as the Channel Islands for close to 7,000 years until the arrival of Europeans in1542 (Grant 1965; King 1990).

Unfortunately, little information on the culture exists outside of the archaeological record for the time preceding the first Spanish settlement. Grant (1965) claims that there is no culture in California that was as important as the Chumash, but about which so little is known. Each remaining site holds the potential to expand the amount of information and understanding held on the Chumash.

San Nicolas Island has a high concentration of varied and complex sites containing potentially valuable information and artifacts. Different categories of archaeological sites have been defined by the various archaeologists who have worked on the island since the early 1900s (Dulka et al. 1993). Sites are categorized by the type of activity or activities that occurred there, based on material remains. Approximately ten buried midden sites, fifty cobble processing sites, ten campsites, fifteen hearth sites, ninety lithic scatters, one cave site, twenty five abalone processing sites, and 180 multiple use sites have been recorded.

The material culture left by the Chumash includes utilitarian items such as sea grass textiles, fish lines, and baskets, stone bowls and other vessels, and shell fish hooks (Dulka et al. 1993). Non-utilitarian craftwork, declared by antiquities experts to be of exceptional workmanship and distinct originality, such as shell beads and other ornamentations, bone and wood carvings, and stone vessels have also been recovered (Dulka et al. 1993). Several exceptional examples of petroglyphs and pictographs

depicting local sea life also are found on SNI. Looting of archaeological sites, particularly grave sites, occurred on SNI from the time the natives were removed from the island until the military restricted access (Grant 1965).

Cultural resources on SNI are protected by a combination of state and federal laws. The sites and the artifacts on them are covered by the Antiquities Act of 1906 and the National Historic Preservation Act of 1966, last amended in 1991 (Dulka et al., 1993; Schwartz 1996). Under the National Environmental Policy Act of 1969, the Commander of NAWS, Point Mugu is responsible for local protection, care, and control of all archaeological sites in his jurisdiction (Dulka et al. 1993). It is illegal to disturb any of these sites, collect any artifacts, or remove material from any site on SNI. The Resource Manager for NAWS, Point Mugu has applied through the California State Historic Preservation Office to have SNI as a whole declared eligible for listing on the National Register as a district (Martz 1996). Such a listing would require a determination of potential effect on the cultural resources for any activity proposed on SNI.

III.B.2. Wildlife Resources

San Nicolas Island has several legally protected resident species (Dulka et al. 1993). The island also is utilized seasonally as a nesting or feeding site and as a stopover by other bird species. Four species of marine mammals also are found on SNI beaches. Two terrestrial mammals, three lizard species, and one gastropod also exist on the island (Dulka et al. 1993). These species are protected by a number of California and federal laws. Every sensitive species whose spatial extents have been studied has been included in the PM-CAPS prototype (see Table III.A.)

Three bird species, the rock wren, the horned lark, and the house finch have endemic Channel Island races occurring on SNI, but are not legally protected species (Dulka et al. 1993). Two other birds, Brandt's Cormorant and the Western Gull, are found seasonally on the western portion of the island. Brown Pelicans and Snowy Plovers roost and nest on SNI beaches. Other bird species occasionally seen on SNI include the Black Oystercatcher, the Double Crested Cormorant, the Pelagic Cormorant, and miscellaneous Laridae species, including Heermann's Gull, California Gull, Glaucus-winged Gull, royal Tern, and elegant Tern.

Three species of pinnipeds utilize SNI beaches year round. Approximately 25,000 California Sea Lions, 15,000 Northern Elephant Seals, and 1,500 Harbor Seals use the island's beaches annually for birthing and rearing their pups (Dulka et al. 1993). Each species is present all year, but has its population fluctuate significantly during breeding and non-breeding times. Each of the three species has a breeding season different than the other two. The Southern Sea Otter, a federal and California listed endangered species, also is found on SNI beaches. However, NAWS, Point Mugu is required only to do an informal consultation with the US Fish and Wildlife Service before conducting an activity with potential impact on the otter because the SNI population is a translocated experimental population (Keeney 1997).

Various parts of SNI are managed to reduce negative impacts on sensitive species that are found there. The southern shores of the island, except for the missile launch area, have restricted access year round to minimize disturbance of the sea lion's, elephant seal's, harbor seal's, and sea otter's breeding areas and nesting areas for Brandt's

Cormorant, Western Gulls, and Snowy Plovers. Other beach areas on the western and northern sides of SNI are closed seasonally during Elephant Seal breeding, and Snowy Plover and Brandt's Cormorant nesting seasons. One northern beach area is close year round to protect the Harbor Seals (Dulka et al. 1993).

Other species utilize areas on SNI that are not included in these restriction zones. Proposed activities that could potentially adversely impact sensitive species are decided on a case by case basis by SNI resource managers. PM-CAPS attempts to identify the spatial extents of each sensitive species on the island and determine the types of activities that are restricted in the areas where they occur. The island night lizard is unique in its treatment by the PM-CAPS prototype. This lizard is a federally listed threatened species and is found to utilize the entire island rather than just specific portions of SNI. An earlier study rated the distribution of the night lizard as "low, medium, or high" across all of SNI. The application prototype provides restriction information for areas that are rated as medium or high utilization by the species.

III.B.3. Plant Resources

San Nicolas Island contains approximately 230 different recognized plant species. Eighteen of these are endemic to the Channel Islands. Twelve have some standing or designation under either California or Federal law (see Table III.B.) Also of concern to resource managers on SNI are several unwanted invasive plant species (see Table III.C.) These species have been introduced to the island either intentionally or by accident (Dulka et al. 1993). Additional spread across SNI is considered undesirable and activities

that could lead to further distribution are judged on a case by case basis by resource managers.

Table III.A. Sensitive Animals and Protecting Regulations

Species	Law
Black Oystercatcher	MBTA
Brandt's Cormorant	MBTA
Brown Pelican	ESA-CE
Double Crested Cormorant	MBTA
Island Fox	ESA-CT
miscellaneous Laridae, (gulls and terns)	MBTA
Island Night Lizard (Xantusia riversiana)	ESA-FT,CT
Pelagic Cormorant	MBTA
Snowy Plover	ESA-FT,CS
San Nicolas Island Snail (Micrarionia feralis)	N
Western Gull	MBTA
Southern Sea Otter habitat	ESA-I
Harbor Seal	MMPA
California Sea Lion	MMPA
Elephant Seal	MMPA

Laws

MBTA: Migratory Bird Treaty Act (protects eggs, nest, and chicks)
MMPA: Marine Mammal Protection Act (prevents lethal take)
ESA: Endangered Species Act
FE: Federally endangered species
FT: Federally threatened species
CE: California endangered species
CT: California threatened species
CS: California sensitive species
I : FE and CE species, but island has only a translocated experimental population that is not covered by ESA, only informal consent with USFWS is required
N: No legal protection

Table III.B. Sensitive Plants and ESA Designation

Species	Fed[1]	CA[2]
Aphanisma blitoides	C2	none
Artemisia nesiotica	none	none
Astragalus traskiae	C2	CR
Atriplex pacifica	C2	none
Calystegia macrostegia ssp. Amplissima	C2	none
Cryptantha traskiae	C1	none
Dithyrea maritima	C2	CT
Dudleya virens	C2	none
Eriogonum grande var. timorum	C2	CE
Eschscholzia ramosa	C3c	none
Hemizonia clementina	none	none
Hordeum intercedens	none	none
Jepsonia malvaefolia	C2	none
Lepidium, oblongum	none	none
Lomatium insulare	C2	none
Nassella cernua	none	none
Nassella lepida	none	none
Nassella pulchra	none	none
Orobanche parishii subs. Brachyloba	C1	C1
Achnatherum diegoensis 92-93	none	none
Trifolium microdon	none	none
Trifolium palmeri	none	none

Plants with legal protection are covered by the Endangered Species Act (ESA)
none: indicates plant is not covered by the ESA
1 = Federal Legal Classification
C1: Category 1 candidate; enough data to support listing
C2: Category 2 candidate; threat/distribution data are insufficient to support listing
C3c: Too widespread and/or not threatened
2 = State Legal Classification
CE: Endangered
CT: Threatened
CR: Rare

Table III.C. Non-native plant species on SNI

Species
Foeniculum vulgare
Lobularia maritima
Tragapon porrifolius
Aeonium sp.
Asparagus officinalis
Chrysanthemum coronarium
Cortaderia atacamensis
Cotyledon orbiculata
Cynara cardunculus
Diptatherum miliaceum
Eriogonum cinereum/ E. fasculatum
Oxalis pes-caprai
Phalaris aquatica

These plants are invasive non-native species and are not legally protected

IV. PROCEDURES

The culmination of this project is the development of the Point Mugu Computerized Activity Planning System (PM-CAPS) prototype, a GIS application. This application is designed to assist in planning military activities on SNI to minimize their impact on sensitive resources. The GIS database used by PM-CAPS was created using ARC/INFO version 7.1 (ESRI 1997). ArcView version 3.0a (ESRI 1996) was used for the user interface for the application

PM-CAPS operates as a customized ArcView project that contains additional newly created features not found in the standard interface, while still retaining standard ArcView functionality. These features allow the user to manipulate and analyze the database for specific resource management purposes. The application is designed to help resource managers on SNI decide where to site various activities in order to minimize their impact on sensitive resources.

The activity planning function of the PM-CAPS prototype starts with the user manipulating one of the new tools to define an area on SNI where they propose siting an activity. They then select the type of activity from one of four pre-defined activity classes. These activity classes were determined from discussions with resource managers at SNI concerning the types of activities that are likely to occur on the island. They encompass activities performed in direct support of the military mission on the island and those performed for other reasons, such as recreation by island personnel. This information was used to develop four activity classes that are intended to encompass the

full range of likely occurring activities. Activities are categorized based on the similarity of their impacts on protected resources. The four activity classes are:

1. Walk-over. This consists of human foot traffic over an area.
2. Fly-over. Any aircraft or missile traveling below 500 feet (152 meters) is considered a fly-over. Items above this altitude are not considered to pose a significant impact risk to island resources.
3. Surface construction. This consists of the construction of any permanent or semi-permanent structure that does not require significant sub-surface construction (e.g. constructing a paved road or a cement launch pad.)
4. Sub-surface construction. This consists of any activity that has a significant sub-surface impact (e.g. digging and placing underground utility lines.)

Once the user selects one of the activity classes, the application determines which sensitive resources are found in the proposed area and creates a new table. This table supplies information that is useful in deciding whether or not the area is appropriate for the proposed activity, such as the laws that protect the resource, temporal or seasonal information when the resource is protected differently (e.g. breeding season), and more specific resource policy or required mitigation.

Before the prototype application could be programmed, the database that it uses had to be prepared. This process consisted of creating the GIS database, gathering and structuring the restriction information into a collection of associated data tables, and integrating the entire dataset into the PM-CAPS prototype.

IV.A. Development of GIS Database

The process of developing a GIS database for the purpose of resource management had begun for NAWS, Point Mugu prior to the conception of the PM-CAPS application. Many themes already existed as ARC/INFO coverages and could be incorporated immediately into the application. However, many of the data necessary for the application existed in non-digital formats or were in a condition not directly usable by the PM-CAPS prototype and had to be created or modified from their original format or structure. In all, almost seventy coverages representing sensitive resources or physical and cultural features on SNI are used in the PM-CAPS prototype.

The themes representing the sensitive resources on SNI all had been developed prior to the PM-CAPS project. These coverages were developed and maintained by the Advanced Resource Technology Group at The University of Arizona. The coverages were digitized from hardcopy maps; the data on the maps were collected by several different individuals associated with NAWS, Point Mugu.

The extents of the archaeological sites were digitized from areas hand-drawn on SNI general development maps by private consultants hired by SNI (Dulka et al. 1983). The consultant's work underwent further updating and validation by Schwartz, the NAWS, Point Mugu Senior Archaeologist.

The plant resources on the island have been studied and mapped by several individuals employed and contracted by SNI. Most of the hardcopy maps digitized for the GIS database were supplied by Smith, the SNI Senior Resource Manager, and by Junak and Halvorson of the U.S.G.S. Cooperative Park Studies Unit, The University of

Arizona (Junak et al. 1995 a and 1995 b). G. Smith also provided the data used for delineating the invasive "weed" species on SNI.

The sensitive animal species on SNI, including the bird species, have been studied and monitored by both employees and other consultants in a number of projects. Some, such as the Snowy Plover, have been examined and mapped since 1989. The hardcopy maps produced by each study were digitized, leading to an extensive collection of spatial data for many of the species. The majority of hardcopy maps digitized and integrated into SNI's GIS database were provided by G. Smith and S. Schwartz of NAWS, Point Mugu, and Gerry McChesney of the U.S.G.S., Biological Resources Division. In the PM-CAPS project, for species that had more than one digital map, all of the existing coverages were combined to produce a single map showing the species' maximum recognized spatial extents.

It is important to note that PM-CAPS is not the sole, or even the primary, purpose for having a GIS database for SNI; the database is expanded, used, and managed by individuals not directly related to the PM-CAPS project. The development of the PM-CAPS prototype necessitated slight modifications of some of the themes from their original structure and storing them in a separate location. However, care was taken to minimize the extent to which the modified themes diverged from their original condition.

IV.A.1. Digitize Hardcopy Maps

At the outset of this project, no electronic maps existed as accepted standards to delineate the spatial extents, topography, or many of the other physical features of SNI.

There was, however, a series of thirty-six general development maps (GDMs) available. A number of island features were manually digitized from these maps by several individuals employed by The Advanced Resource Technology Group at The University of Arizona. Coverages digitized from the GDMs that were used in the development of the PM-CAPS prototype include :

Point Coverages:

1. Over 1500 spot elevations

Line Coverages:

1. Road network. Paved, dirt, and relic roads and the SNI airfield runway were digitized as they appeared on the GDMs.
2. Cultural features such as culverts and fences.
3. SNI footprint. The GDMs are supposed to represent the median high water line.
4. Contour intervals. All 5 foot contours and selected 1 foot intervals were digitized.

Polygon Coverages:

1. Buildings and other structures. Buildings, water tanks, and other surface constructions such as concrete pads were digitized from the GDMs.

IV.A.2. Validate and Correct Coverages

After a standard SNI footprint coverage was digitized from the GDMs, it was necessary to reconcile other coverages to the same spatial extents. This was not required

for any of the coverages that also originated from the GDMs, but for some of the themes created from other data sources. Approximately ten coverages representing the spatial extents of animal species found on beach areas of SNI were clipped to conform to the extents of the footprint coverage. The original animal coverages were derived from various other sources prior to the conception of the PM-CAPS project.

Global positioning system (GPS) equipment was used to validate some of the coverages used in this project. A mobile GPS unit was mounted on a vehicle that drove the center line of much of the road network on SNI. Data were collected using a GPS Workhorse eight-channel receiver , and GeoLink Encore version 4.1.b software, both manufactured by Geo Research, Inc. An established base station exists on SNI allowing code transmission post processing to be done using GrafNav software by Premier Inc. The results of this process have a level of precision, on average, to within three meters when the equipment is mounted on a moving vehicle.

These data were used to create an ARC/INFO coverage. Overlaying the road coverage developed using GPS with the coverage digitized from the GDMs revealed a few discrepancies. It was assumed that the GPS derived theme was more accurate and, consequently, the project road coverage was corrected accordingly.

Additional validation and updating of the coverages used by PM-CAPS are likely to continue on an ongoing basis. For example, the themes representing archaeological sites on SNI are part of an independent project that is using GPS to validate and correct site boundaries. Also, coverages that depict the spatial extents of several animal species are likely to change since monitoring of many of these species is an ongoing process. The

PM-CAPS prototype is designed to allow seamless integration of additional or modified coverages.

IV.A.3. Modify Coverages

Several of the resource themes in the GIS dataset required some degree of manipulation besides error corrections before they could be used in the prototype application. Since construction of the GIS database for SNI began over three years before the development of the PM-CAPS application, several of the coverages could not be integrated directly into the prototype. The spatial extents or database structure of many coverages required varying degrees of modification in order to make them useable by the prototype.

At the beginning of this project, two coverages existed that contained spatial extents of the thirteen invasive "weed" species on SNI. The individual species were separated as ARC/INFO regions within the coverages. However, the PM-CAPS prototype is not able to manipulate individual regions within a coverage, so a separate coverage for each "weed" species was extracted.

Similarly, four coverages existed that contained archaeological site features. Sites were differentiated based on the types of activities occurring on them as inferred by the archaeologists that recorded them. However, there is not a significant difference in the way that resource managers at NAWS, Point Mugu manage different types of sites. Therefore, the features in the four coverages were organized into only two coverages that are used by the prototype: sites that have received California State Historic Preservation

Office (SHPO) numbers, and Chinese Abalone processing sites, which had not received SHPO site numbers at the time the prototype was developed.

The themes for two plant species, *Trifolium microdon* and *Trifolium palmeri*, existed only as point coverages. This is a result of how the initial surveys for the species were conducted. Points are not an effective management unit since, digitally, they do not possess any area. After consulting with resource managers, it was decided to create polygon topology from the points by buffering each point by 500 feet (approximately 152 meters.)

Approximately fifteen of the sixty resources included in the PM-CAPS prototype had more than one coverage in the original GIS dataset. For many of the resources, this was a result of different coverages representing different temporal monitoring periods; each coverage contained the spatial extents for a particular species as recorded for a specific monitoring interval. It was decided that the application prototype would use only one coverage for each plant or animal species. Rather than using only one of the existing coverages for a particular species and discarding the data contained in additional coverages, it was determined that the coverage used by PM-CAPS would combine the full spatial extents contained in all of the themes relating to each species. A five step process was used for each species with multiple coverages:

1. Combine the full spatial extents for the species held in all of its themes. This was done by using the UNION command in ARC/INFO. This combines all of the features for the species in each theme resulting in a single polygon coverage.

2. Create a temporary integer field called TEMP in the polygon attribute table using the ADDITEM command.
3. In ArcEdit, SELECT all polygons with an area > 0 and CALC TEMP = 1. This excludes the universal polygon created by ARC/INFO.
4. Eliminate artificial polygon borders by using the DISSOLVE command in ARC/INFO using the TEMP field. This eliminates any arcs that are used by more than one feature simultaneously.
5. Eliminate any unnecessary fields in the .pat, including the TEMP field, using the DROPITEM command.

IV.A.4. Create Viewshed Coverages

For eight bird and marine mammal species on SNI (see Table III.D.), restrictions exist not only in areas where the species occur, but also in areas that are visible to them. These species are sensitive to certain types of activities within their viewsheds, which can disrupt their activities such as breeding and nesting for bird species. Some types of activities within pinniped viewsheds can interfere with breeding, pupping, and nursing. If the animals are startled or frightened, a stampede from the shore to the water can be instigated causing immature animals to be crushed, abandoned, or attacked by other adults. Restrictions to activities within these viewsheds are limited to specific times of the year for each species and usually apply during nesting season for birds and when pinnipeds are breeding or "hauling out."

The eight species with protected viewsheds are:

1. Elephant Seal
2. Harbor Seal
3. California Sea Lion
4. Snowy Plover
5. Black Oystercatcher
6. Brandt's Cormorant
7. Western Gull
8. Miscellaneous Laridae (e.g. various terns and gulls)

Viewshed coverages for these species were included in the PM-CAPS prototype and had to be created during the GIS database development segment of the project. For each of the eight species, a viewshed was developed that resulted in a polygon coverage depicting the areas on SNI that are within a mile and visible from the areas where the species occurs. ARC/INFO allows viewsheds to be calculated using a digital elevation model (DEM) and either a polygon coverage or a grid.

The DEM was created in ARC/INFO using topographic data digitized from GDMs of SNI. Contours were digitized at five foot intervals for the entire island and at one foot intervals on portions of the island that have large topographic variability. Over 1500 spot elevations were also taken from the GDMs and incorporated into the DEM. All "no data" areas were assigned a value of 0.

An eleven step process was used within ARC/INFO to create a viewshed theme for each species:

1. Create a separate theme for each individual polygon feature within the original species coverage. This was done in ArcEdit by SELECTing each polygon individually (with the exception of the universal polygon) and saving it as a separate coverage.
2. Rasterize each single polygon theme to create a grid. This was accomplished using the POLYGRID command. It was decided arbitrarily to use a cell size of 100 square feet.
3. Create a point coverage consisting of all the center points of the grid cells. This was done with the GRIDPOINT command.
4. Perform the visibility analysis using the VISIBILITY command with the point coverage and specifying a grid output and selecting the FREQUENCY option. This creates a grid with a numeric field in the feature attribute table whose value is the number of times each cell in the grid is in view from one of the point features. The spatial extents of the output grid are the same as for the DEM.
5. Add all of the output visibility grids generated for a species to create a single grid.
6. Create a new binary field in this grid named "visible" using the ADDITEM command. If the frequency for a cell is greater than 0, CALC the value in the "visible" field to equal 1.
7. Vectorize the grid for each species using the GRIDPOLY command to create a polygon coverage.

8. It was determined that it is irrelevant whether or not offshore areas are visible in regards to specifying use restriction in the PM-CAPS prototype. Therefore, offshore areas were eliminated from each species' visibility polygon coverage using the CLIP command and the shoreline coverage.
9. It was assumed that species are not sensitive to activities that occur more than one mile away from them. Therefore, a new polygon coverage was created that included a one mile buffer around each polygon feature in the original species location polygon coverage. This was accomplished with the BUFFER command.
10. The new buffered coverage was used to CLIP the visibility polygon coverage for each species, resulting in a polygon coverage that includes only areas that are within one mile of species locations.
11. During the vectorization process, separate polygon features were defined based on the value of the "frequency" field. The DISSOLVE command was used to merge adjacent polygon features that have the same "visible" field values.

The time necessary to complete this process for a single species varies greatly and is determined by the size and number of polygon features in the original species location coverage. Processing was done on several PCs with 120 to 200 MHz processors using the Windows NT operating system and ARC/INFO version 7. Scripts were written in Arc Macro Language (AML), the imbedded programming language of ARC/INFO, in order to automate almost every step of the process. With the use of AML scripts, total processing

time to complete a polygon visibility viewshed coverage ranged from, approximately, six to forty eight hours.

IV.B. Develop Lookup Tables

The information that the PM-CAPS prototype retrieves from the database and delivers to the user is held in a series of related lookup tables (LUTs). These LUTs contain the restriction information the user sees when proposing an activity in a specific area on SNI. When the user performs an activity analysis, the application creates a table that describes the sensitive resources found in the proposed area and the restrictions that apply to performing the specified activity in that location. The LUTs are in dBASE (.dbf) format, which can be read easily by ArcView and opened as ArcView tables. All LUTs are listed in Appendix A.

IV.B.1. Determine Information Required for LUTs

Before designing the LUTs, it was necessary to determine the types of information that the PM-CAPS prototype is intended to provide to the user about the sensitive resources on SNI. A series of conversations with resource managers at NAWS, Point Mugu resulted in a preliminary understanding of the types of queries that they expect to pose to the prototype application. This anecdotal information was examined and three general types of questions were extracted as being desirable for the prototype:

1. What sensitive resources exist in a particular area?

2. What regulations or laws protect these resources?
3. What restrictions exist to different types of activities in areas where a sensitive resource occurs?
4. What additional information might the user need about a resource in order to make an informed decision (e.g. temporal variations for a restriction)?

IV.B.2. Determine Table Structure and Establish the LUTs

In designing the table structure for the LUTs, it was desirable to try to make the tables simple, logical, and easily changed or updated. One of the main goals for the PM-CAPS prototype was to allow it to be modified or expanded relatively easily as information changed or was added. For example, restriction policies for a resource may change or additional sensitive resources may be added to the application.

A total of fifteen LUTs were created to store the information about the 59 resources used by the prototype application. The first table consists of three fields:

1. the full name of the resource
2. the name of the ARC/INFO coverage that defines the spatial extents of the resource
3. the designated "Res_ID" number for the resource. This is a unique numeric identification number for each resource that is used to relate data held in other tables to the resource.

The other fourteen LUTs are comprised of paired tables that provide the rest of the data for each resource used by the application. These seven pairs contain the following information about each resource included in the prototype application:

1. resource type. This describes what the resource is (i.e. plant, animal, cultural resource, etc.)
2. protecting laws. This lists the law(s), if any, that cover each resource and its Endangered Species Act designation when applicable
3. additional notes. These notes include information such as the time of year when certain bird species are nesting, or that certain plant species are considered invasive weeds.
4. restrictions, if any, of each resource to fly-over activities
5. restrictions, if any, of each resource to walk-over activities
6. restrictions, if any, of each resource to surface construction activities
7. restrictions, if any, of each resource to sub-surface construction activities

Each pair of tables supplies a specific type of information (e.g. laws that protect the resource) and consists of a "relate" table and a "definition" table. Each "relate" table contains two fields: 1) "Res_ID", and 2) a numeric field that provides a code for the applicable data. Each "definition" table also contains two fields: 1) the numeric codes established in the "relate" table, and 2) a corresponding character field that contains the actual information.

For example, in the pair of tables that provides information on the laws protecting each resource, the "relate" table lists the "Res_ID" number of each resource and a corresponding number from one to twenty. The "definition" table lists the numbers one to twenty and a corresponding definition for each number. For example, the number 8 corresponds to the text: "Marine Mammal Protection Act." Six animal species on SNI are covered by this law and, therefore, have the number 8 in the "relate" table.

The prototype application can be used to create a new table within ArcView that contains resource information specific to a type of activity proposed for a specific location. Such a table contains the text fields from the appropriate tables since it is unreasonable to expect the user to be able to interpret the numeric codes. In order to provide this information, the tables must be related via commonly held key fields (Figure IV.A.).

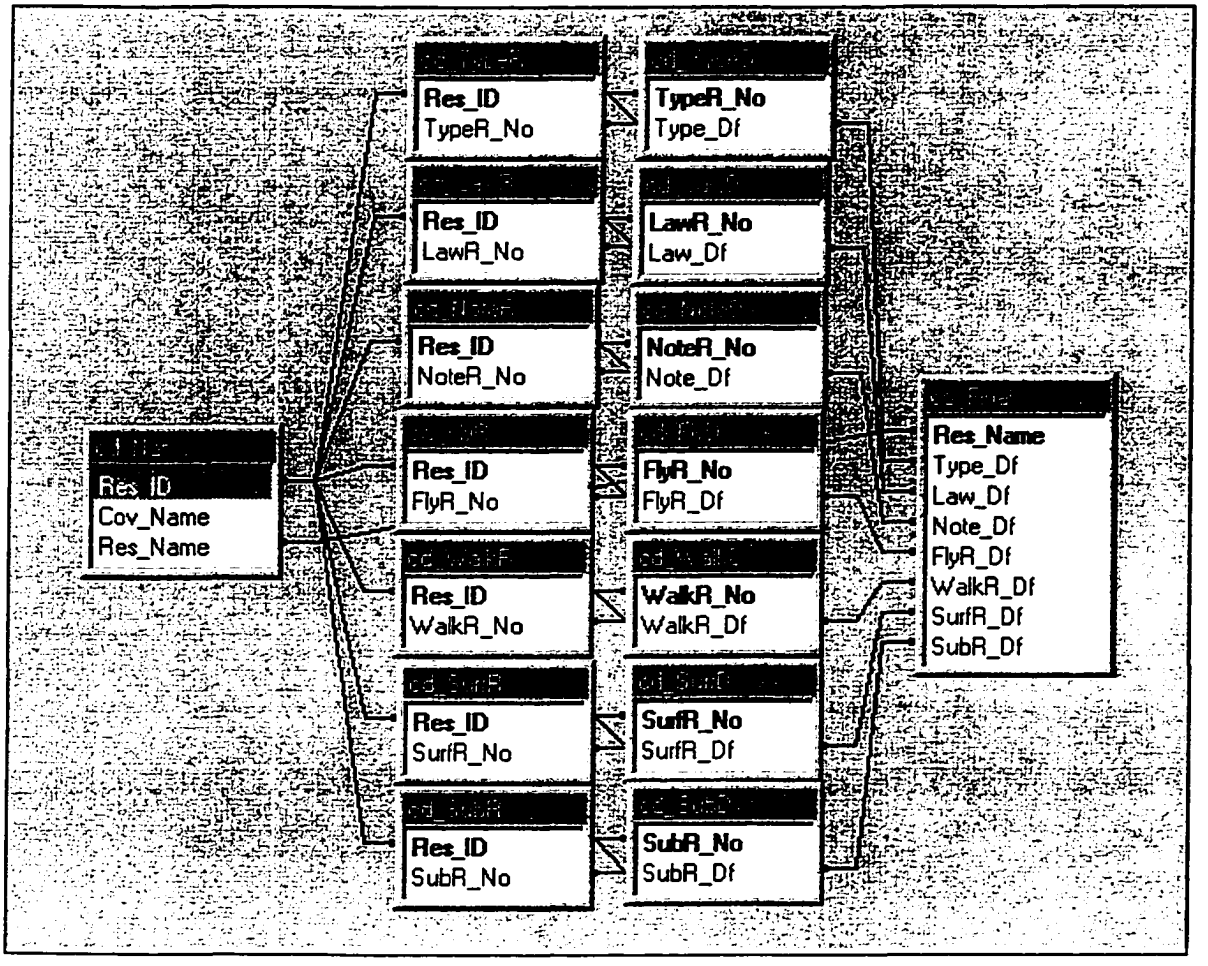


Figure IV.A. Relationship of LUTs

IV.B.3. Collect Data to Populate LUTs

The data used to populate the LUTs were derived from a number of different sources. As described previously, spatial extents for the sensitive resources on SNI have been compiled in the GIS database managed by the Advanced Resource Technology Group at The University of Arizona. This information was collected by several contractors and employees of NAWS, Point Mugu.

The regulations covering the biological resources were determined from personal interviews with resource planners at NAWS, Point Mugu (Keeney 1996; Keeney 1997; Schwartz 1997) and from independent research. Legal status of the plant resources were collected from two sensitive plant study reports published by the U.S. Geological Survey Cooperative Park Studies Unit at The University of Arizona (Junak et al. 1995a and 1995b) Personal interviews with Martz (1996), an archaeological consultant contracted to SNI, and Schwartz (1997), a senior archaeologist at NAWS, Point Mugu, provided information regarding the legal restrictions governing cultural resources on SNI.

Entering this information into the LUTs for integration into the PM-CAPS prototype was a simple process since the data were, relatively, accessible. However, the information regarding the specific restrictions that apply to each of the activity classes for the sensitive resources on SNI was more difficult to obtain. These rules are largely a matter of SNI and NAWS, Point Mugu policy and are not listed in any single source.

The process of gathering this information involved going through the list of sensitive resources one-by-one and determining, as well as possible, what restrictions apply to performing each of the four previously defined activity classes in an area where the resource exists. The restrictions used in the prototype PM-CAPS application were derived by the application developer, not by the actual resource managers of SNI, from a number of sources. It was not feasible to present the managers with a list of the 59 resources and four activity classes used in the prototype and request that they make 236 policy determinations.

One of the goals for the PM-CAPS prototype is to encourage the development of a codified set of policies regarding restricting activities on SNI where sensitive resources occur. The initial prototype is not expected to contain the final set of rules governing military activities, but, rather, to serve as a starting point for resource managers in precipitating an evaluation of such regulations. Therefore, the restrictions, as they are entered in the first version of the PM-CAPS prototype, should be regarded as educated estimates of how activities should be restricted rather than as a definitive rules as defined by the appropriate resource managers of SNI.

After the restriction information was collected, it was organized into a condition where it could be entered into the LUTs. The structure of the LUTs allows the use of one-to-many relationships; this condition was utilized to reduce the complexity and size of the tables. Many of the resources have identical responses within a LUT (e.g. within the LUT for restrictions to the walk over activity class, several species have the restriction of "Activity is restricted during the nesting season; consult SNI Resource Manager"). Wherever possible, similar entries in a table were worded in such a way that a single record could be related to several resources.

IV.C. PM-CAPS Prototype Application

The PM-CAPS prototype was created using ArcView version 3.0a, a desktop GIS software package by ESRI. The out-of-the-box interface was modified using the software's customization options and through the development and implementation of several scripts written in Avenue programming language, as well as modifications of

existing scripts integrated into the software. ArcView allows simple modifications, such as adding a new tool button to a document's GUI or deleting an existing one, through a user-friendly menu driven interface. Avenue is an object oriented language inherent to ArcView that allows a developer to change the GUI and operation of the software considerably. All Avenue scripts created for this project are listed in Appendix B.

The primary goal for the PM-CAPS project is to create an application that provides rapid, consistent, and accurate information in a way that the resource managers for SNI consider superior to standard methods of military activity planning and decision making. This first prototype is intended to serve as a starting point in a continuing dialogue between these resource managers and the staff at the Advanced Resource Technology Group of The University of Arizona.

The prototype application is intended to be useable by individuals with a basic familiarity with ArcView after only about 15 minutes of training with the specifics of PM-CAPS. This training can be done by an experienced user or via written instructions. More advanced ArcView users will be able to use their knowledge of the software to do more advanced data visualization and manipulation inherent in ArcView, but will not necessarily have an advantage over a less experienced user in performing PM-CAPS specific operations.

IV.C.1. Starting the PM-CAPS Prototype

The PM-CAPS prototype is a standard ArcView project (.apr) file. In order to use it, the user must open the file from ArcView. Opening the PM-CAPS file automatically

executes a start-up script written specifically for the application. This performs a number of operations to initialize the user session.

First, the start-up script creates a view document titled Base Map (Figure IV.B.). This view contains the themes representing the shoreline of SNI, the road network of the island, and each of the 59 sensitive resources. This view is maximized to fill the entire screen in order to make it as easily readable to the viewer as possible.

The resource themes are grouped within the table of contents by their type (e.g. animals, plants, and cultural resource themes are all grouped with other such themes.) The shoreline, roads, and all the viewshed themes have a pre-defined legend that is loaded into the table of contents. The shoreline is a black line and the roads are defined by red lines. All viewsheds are polygon themes and, due to their nature, have polygons that cover the island in its entirety; all areas are designated as being either visible to the species or not visible. The legend for these themes uses a single color for visible areas while areas that are not visible to the species are transparent.

After creating the Base Map view, the start-up script loads all of the LUTs into the project. These tables are .dbf files stored in a certain location on the operating computer. ArcView loads each LUT as an independent table document into the project.

Once these tables are loaded into the PM-CAPS application, they are joined together to allow the data within them to be analyzed. First, each of the "relate" and "definition" tables described earlier are joined to each other and a new table is created within the application is created that contains all of the data from each pair of tables. Next, through an iterative process, each of the new tables created from a pair of LUTs is joined to the

"Name" table. This results in a single table that contains all of the data held in each LUT associated with the application. This table then is used to add the attribute data, previously held in the series of LUTs, to the feature attribute table of each sensitive resource theme.

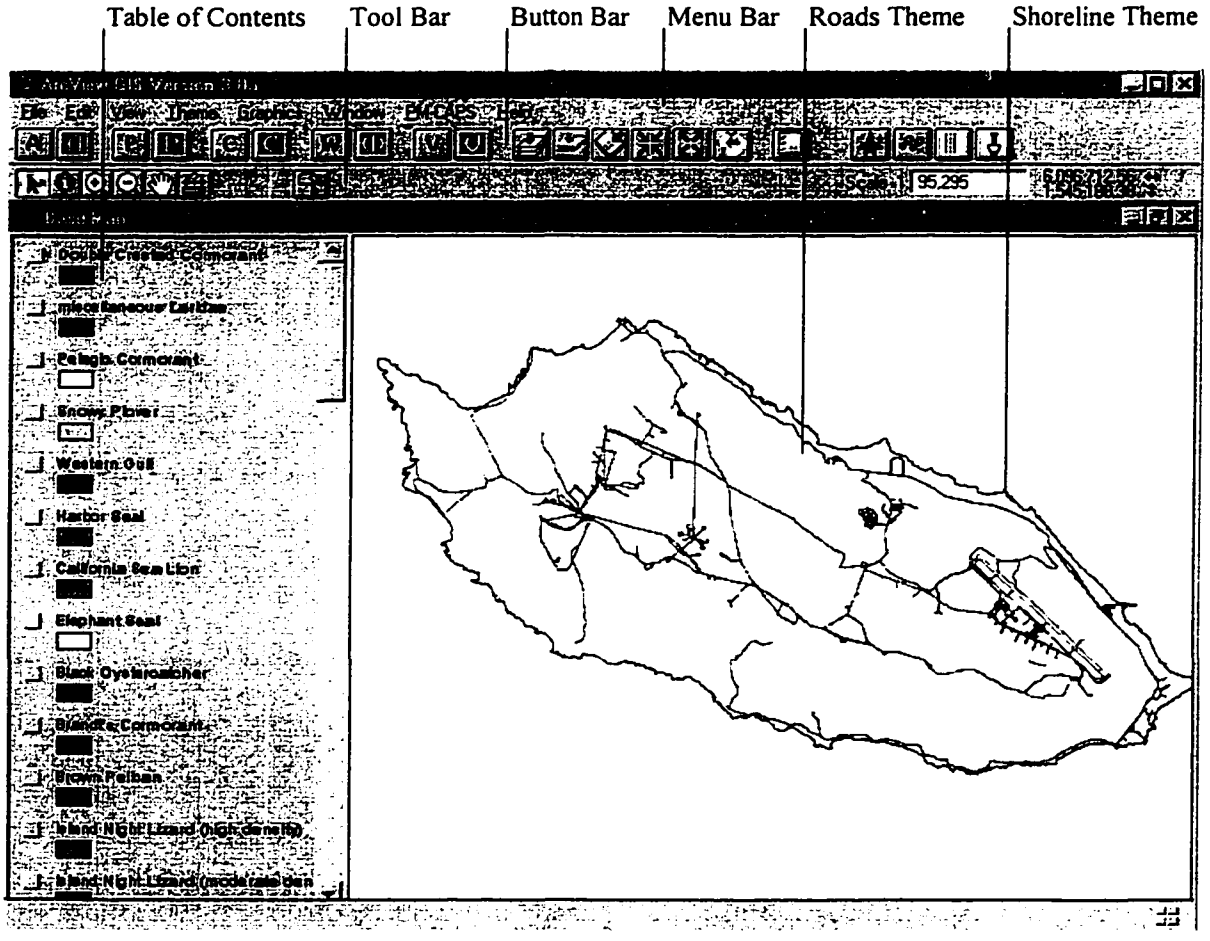


Figure IV.B. Base Map View Document

This process could be simplified considerably by joining all of the LUTs and expanding the resources' feature attribute tables outside of ArcView. This way, the application would need only to load the themes and a single LUT at start-up. However, the process used by the PM-CAPS prototype, while slower and more complicated, allows for the application to be modified or updated quickly and easily. This is particularly relevant if such changes are to be performed on site by a SNI resource manager rather than at The University of Arizona by an application developer.

The entire database structure could be modified relatively easily by creating new LUTs that provide additional information. Once the new LUT(s) is established, only minor modifications to the start-up script are required to allow full integration of the new data into the application. Also, if, at some future time, the regulations governing one of the resources change, any user with access to the application could open the appropriate LUT specific to the information that required changing and make the modification. Similarly, adding a new resource to the application only requires the user to add a new record to each of the LUTs and fill in the appropriate information. Changing the spatial extents of a resource already in use is done by removing the old coverage from the view and loading the new theme. Once the feature attribute table of the new theme has the key field that identifies the resource added to it, all of the data held in the LUTs are automatically referenced correctly.

The entire start-up procedure takes approximately 90 seconds when run on a PC with a Pentium 150 MMX processor. In order to assure the user that the process is running properly, a status index bar shows the continuing progress of each step of the process.

Upon completion of the start-up script, PM-CAPS displays an information message box that alerts the user that the application is ready for operation (Figure IV.C.).

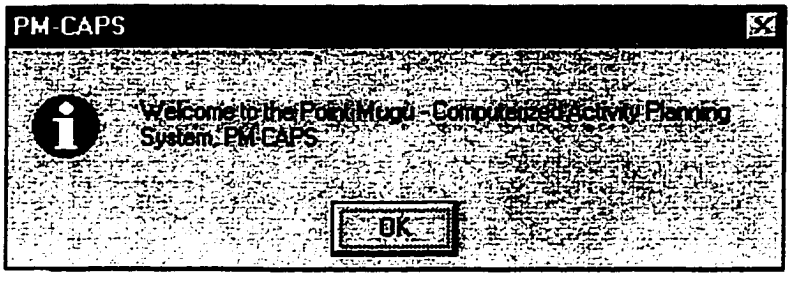


Figure IV.C. PM-CAPS Welcome Message Box

IV.C.2. Modifications to the Standard ArcView Interface

Changes were made to the standard ArcView GUI within the view and table document types in order to facilitate the operation of the PM-CAPS prototype. These modifications consist of the removal of some tools and buttons and the additions of others. All new features activate original Avenue scripts developed for the application. Also, the "Save" and "Save As" scripts, which are activated by either a menu selection or depressing a button, have been modified somewhat. In addition to the start-up script described earlier, a shut-down script also was created that runs automatically when closing the PM-CAPS project or upon the termination of the ArcView program.

Each of the new button and tool features added to the view and table document classes can be selected from a new drop-down menu, as well as from its corresponding button. This is consistent with other tools and buttons in the standard ArcView GUI. Also, moving the cursor over any of the new buttons or the new tool (without depressing

it) will display a short description of the feature in the status bar at the bottom of the GUI. This too conforms to standard ArcView operation.

IV.C.2.a. Modifications to the Table Document

In the table documents, only one change was made from the standard GUI. A new button was created and is found at the far right of the button bar when a table document is open (Figure IV.D.). When depressed, this button opens the Base Map view if it is currently closed and makes it the active document.

Figure IV.D. Activate Base Map View Button

IV.C.2.b. Modifications to the View Document

The majority of the modifications made to the GUI for the PM-CAPS application are found in the view document class. First, several tools and buttons were removed from the standard GUI. This was done to reduce the amount of visual clutter the user sees when a view document is active and to minimize user confusion if they are not extremely proficient with ArcView. The items removed were not deemed as being indispensable to the operation of PM-CAPS. However, no items were deleted from the menu bar, so the features removed from the tool and button bars can still be activated by selecting them from the appropriate menu.

Seven tools were removed from the view GUI. The removed tools are:

1. Vertex Edit
2. Select Feature (with Polygon)
3. Hot Link
4. Area of Interest
5. Label
6. Text
7. Draw Point/ Feature Pull-down Tool Menu

The one additional tool added to the view document GUI is the "Create Activity Area" tool (Figure IV.E.). This assists the user in creating a shapefile consisting of one or more polygons that are meant to represent an area to be considered for possible military activity. New themes created with this tool can be used for activity analyses by the PM-CAPS prototype.

Figure IV.E. "Create Activity Area" Tool Button

When first selecting the "Create Activity Area" tool, the user is prompted to name the shapefile that will be created. By default, the theme will be named "impact#", where the number is a sequential counter starting at one and advancing by one for each new

shapefile created. Next, the user sees two message boxes that instruct them on how to use the tool (Figures IV.F. and IV.G.).

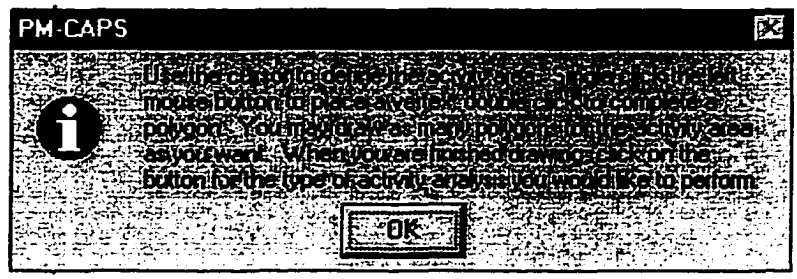


Figure IV.F. "Create Activity Area" Instruction Message Box 1

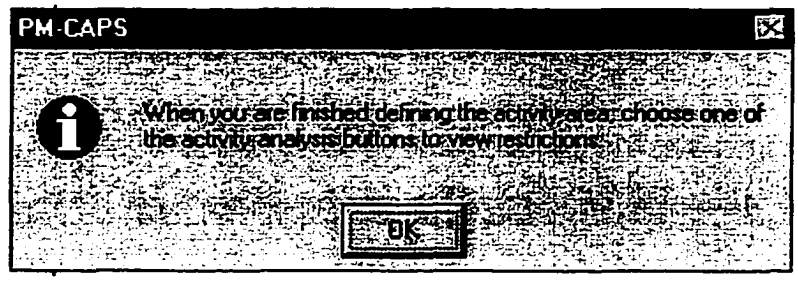


Figure IV.G. "Create Activity Area" Instruction Message Box 2

To use the tool, the user moves the cursor using the computer's mouse. Single clicking the left mouse button creates a vertex at the coordinates of the cursor. Double clicking the left mouse button indicates the final vertex for a polygon has been placed and the polygon is closed. The user can define as many polygons for the same shapefile as they desire. The tool remains active until the user either selects a different tool from the view GUI or they select one of the four activity analysis buttons. (The activity analysis buttons are described later in this section.)

Ten buttons also were removed from the view document GUI. The removed buttons are:

1. Save Project
2. Add Theme
3. Theme Properties
4. Edit Legend
5. Open Theme Table
6. Find
7. Locate Address
8. Query Builder
9. Select Features Using Graphic
10. Help

Several new buttons were added to the view document class that allow the user to perform operations specific to the PM-CAPS prototype. The first ten are grouped into five pairs, each bearing a single letter (Figure IV.H.). These turn the displays on or off for all resource themes in the view of the same type. The five types of themes are animals, plants, cultural resources (i.e. archaeological sites), "weeds" (i.e. unwanted plant species), and viewsheds. All sensitive resources currently integrated into the prototype are included into one of these categories.

Figure IV.H. Theme Display On/Off Buttons

Four other new buttons are located at the far right side of the button bar. These are the activity analysis buttons. There is one button for each of the four activity classes defined for the PM-CAPS prototype. They are, in the order from left to right, :fly-over, walk-over, surface construction, sub-surface construction (Figure IV.I.).

Figure IV.I. Activity Analysis Buttons

When one of these buttons is selected, the application creates a pull-down menu that prompts the user to select the theme they want to use for the analysis. The pull-down menu will list any themes created using the "Create Activity Area" tool. The menu also will list any themes added to the view via other means (e.g. using the "Add Theme" menu option.) Therefore, themes depicting potential activity areas can be created by other methods or on other machines and brought into the PM-CAPS prototype for analysis.

Once the user selects a theme to be used for an activity analysis, the application does a theme-on-theme overlay of the activity area and each of the sensitive resource themes. Next, it will create a new table of each of the resources that is present within the activity area. The fields included in this table contain:

1. names of impacted resources (if any)

2. laws protecting the impacted resources
3. any additional information regarding the resource (e.g. months that the species breeds)
4. restrictions that apply to performing the specified type of activity in an area where the species occurs

IV.C.2.c. Other PM-CAPS Modifications

The "Project.Save", "Project.SaveAs", and "Project.Close" scripts associated with the PM-CAPS prototype are modified from their standard ArcView form. Since the PM-CAPS application is an ArcView project, running the standard "Project.Save" script after making any changes would overwrite the original program (e.g. deleting themes from the Base Map view, creating new tables, or changing any project scripts.) It is not desirable for a user of the application to be able to save any changes that they make during the course of an operating session. The modified scripts are titled the same as the original scripts, but with "c_" preceding the original script name. For example, the modified "Project.Save" script is titled "c_Project.Save."

The "c_Project.Save" script is run by selecting it from the "File" pull-down menu or clicking on the "Save Project" button. In the PM-CAPS prototype, a modified script is run that creates a message box informing the user that saving the project is not allowed and prompting them to perform a "Save As" procedure instead (Figure IV.J.).

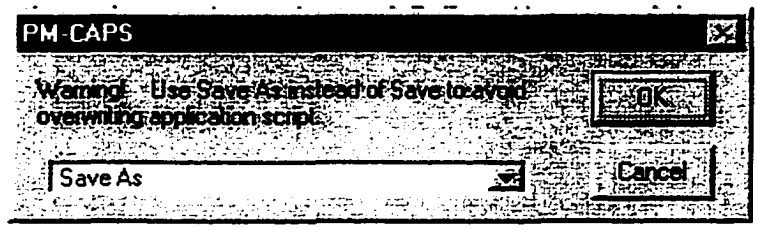


Figure IV.J. "Project.Save" Script Message Box

The "c_Project.SaveAs" script also has been modified slightly from the standard "Project.Save" script for the application. It will not allow the user to save the project by the name "pm_caps.apr" as this would overwrite the application file. If the user specifies this name, they receive an error message box informing them that the project cannot be saved by this name and prompting them to try again (Figure IV.K).

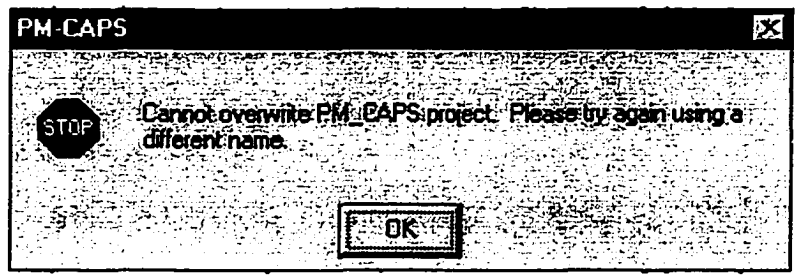


Figure IV.K. "Project.Save_As" Script Message Box

The "c_Project.Close" script is run by selecting the "Close Project" option from the "File" pull-down menu in the project document. The original "Project.Close" script allows the user to save any changes under the starting file name. The modified "c_Project.Close" script runs the "c_Project.SaveAs" script instead, thereby preventing a rewriting of the original PM-CAPS application file.

IV.C.3. Example Analysis With PM-CAPS Prototype

As mentioned previously, the PM-CAPS prototype is intended to allow the user to determine what restrictions exist to performing a certain type of military activity in a user-defined area on SNI. Below is an example of how such an analysis could be performed.

The hypothetical scenario used in this example is that the resource manager wants to fly military aircraft at an elevation of 500 ft. in a north-westerly direction straight from the SNI airport runway. After loading the PM-CAPS prototype, the potential restrictions for this activity are determined via the following steps:

1. Zoom in tighter to the proposed activity area using the standard ArcView "Zoom In" tool (Figure IV.L.).

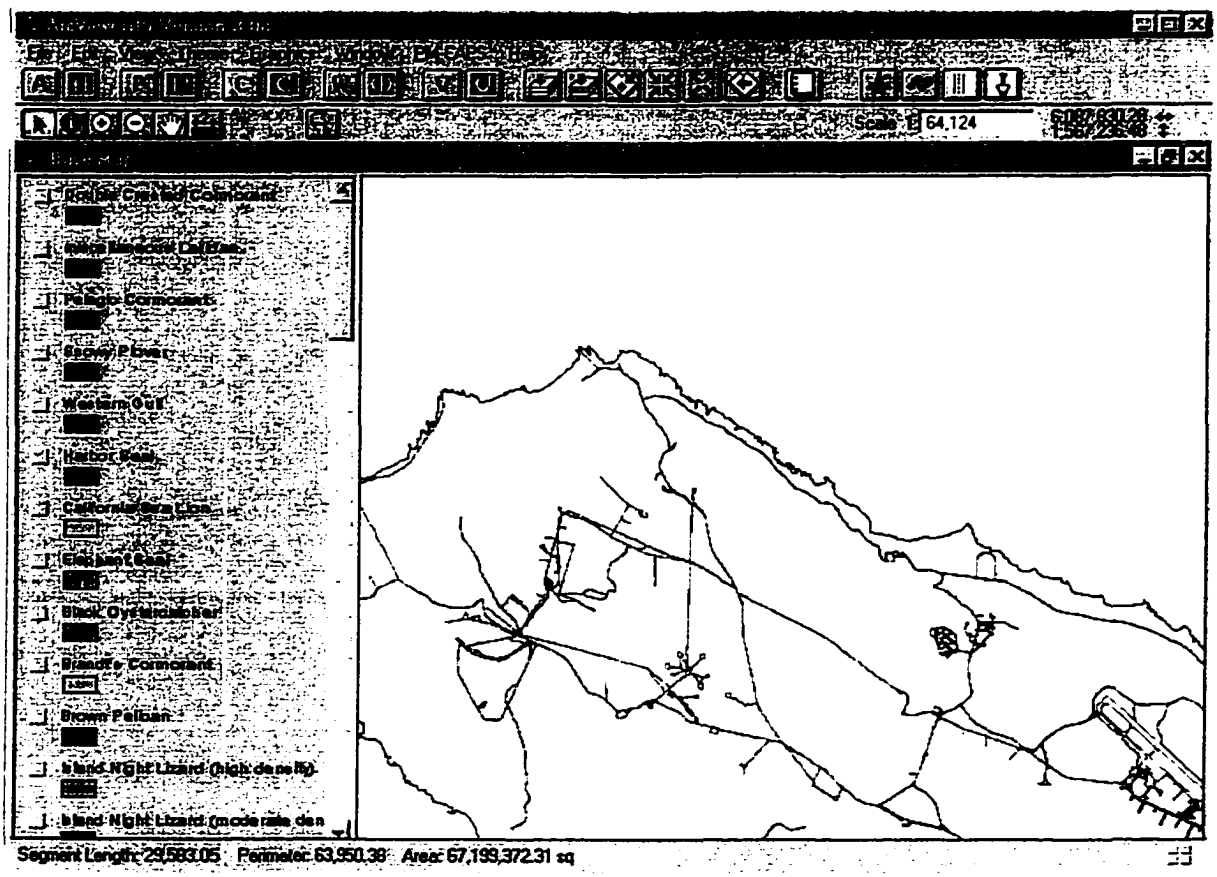


Figure IV.L. Example: Zoom In

2. Define the area for the proposed activity (Figure IV.M.). This is done with the "Create Activity Area" tool. The resulting shapefile is named "Impact1.shp" by default.

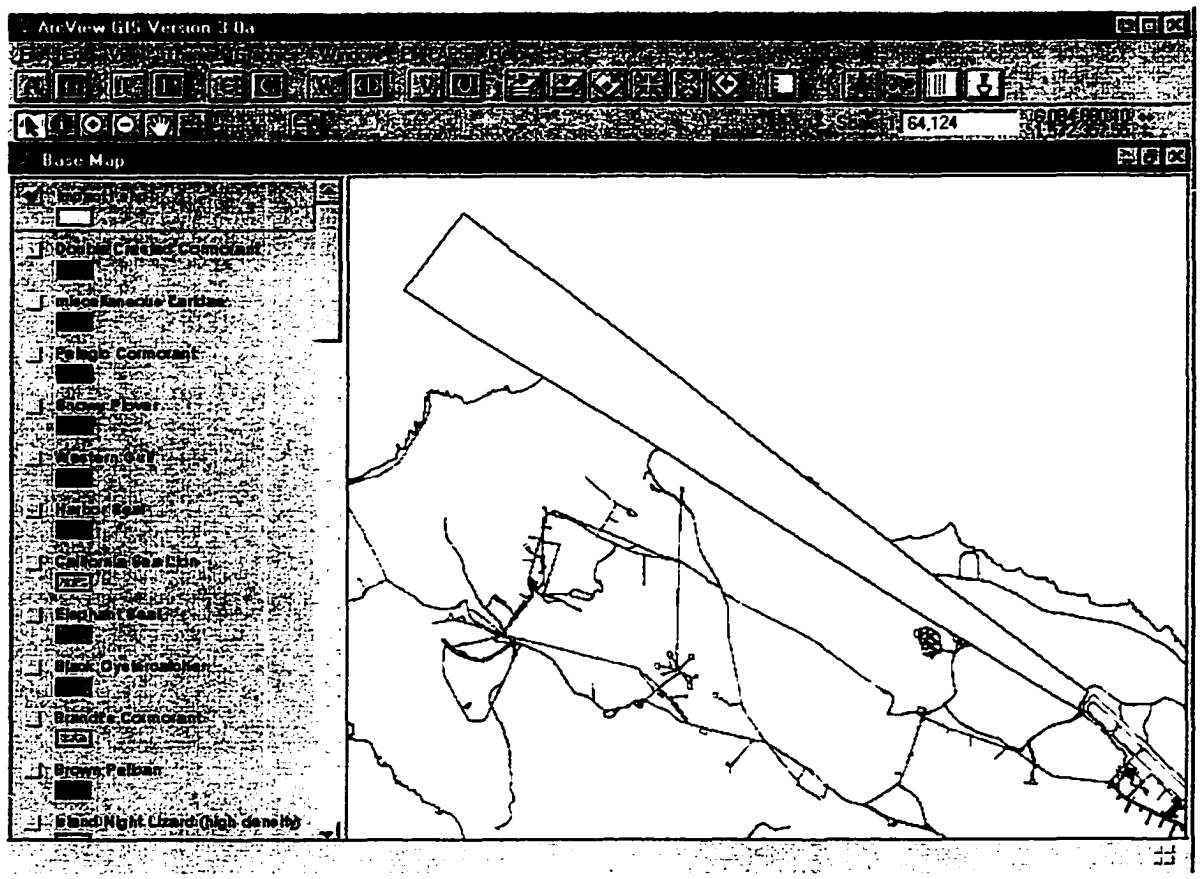


Figure IV.M. Example: Create Activity Area

3. Depress the "Fly-over Activity Analysis" button and select "Impact1.shp" as the theme to be used as the activity area (Figure IV.N.).

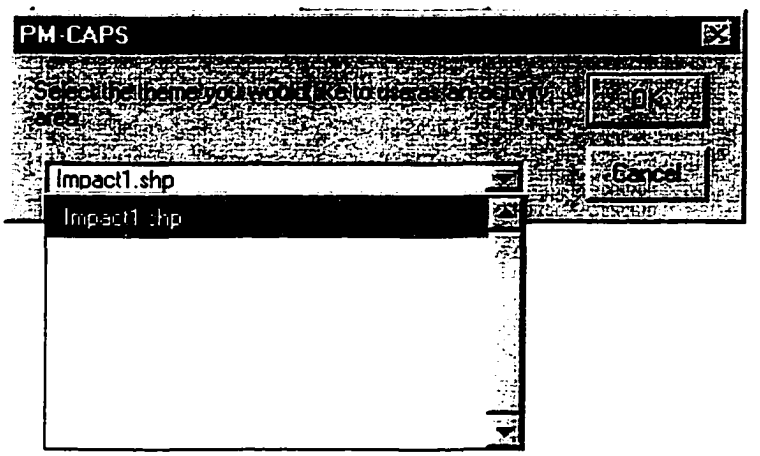
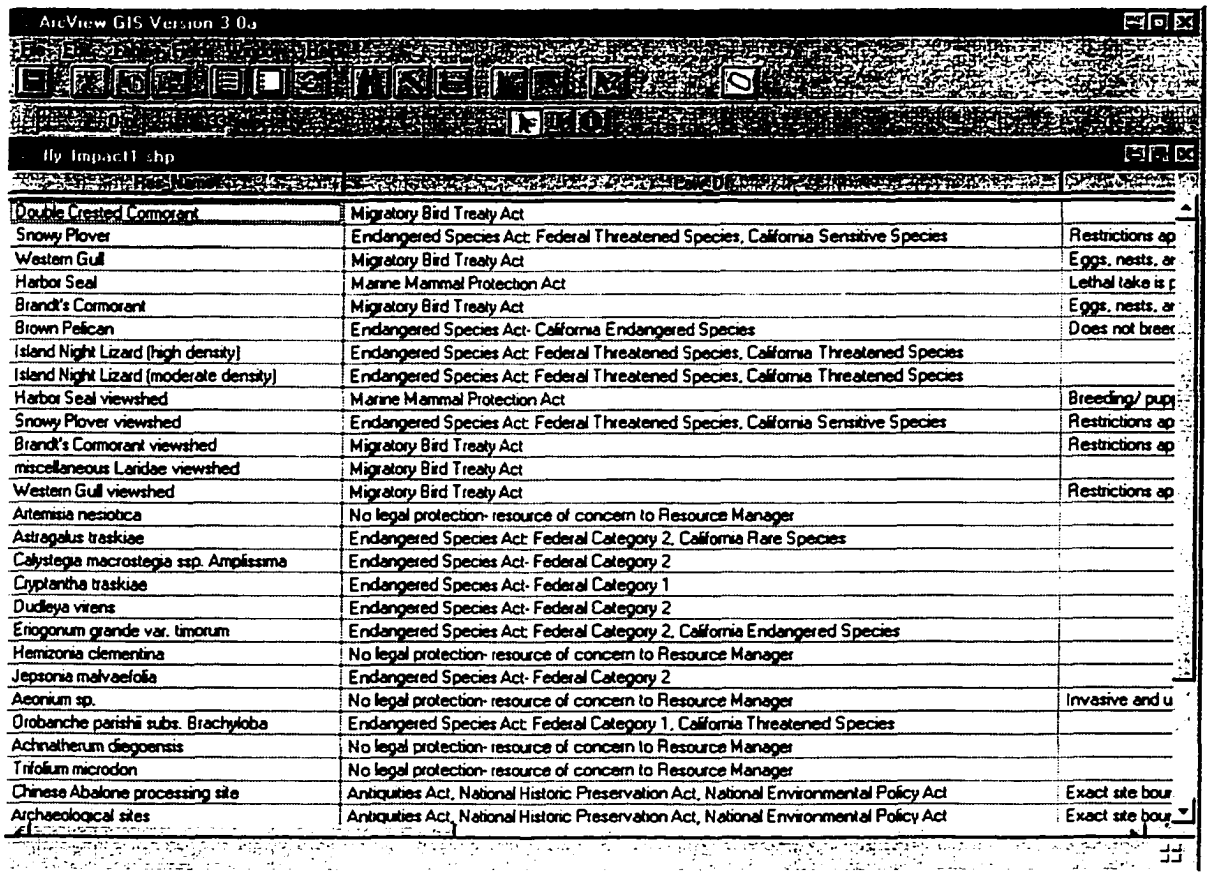


Figure IV.N. Example: Select "Impact1.shp" for Analysis

This will create and activate a new table automatically named "fly_Imapct1.shp" (Figure IV.O.). The table reveals that 31 resources are found within the proposed activity area. However, of these species, only six of the resources have restrictions to fly-over activities: Brandt's Cormorant, Brown Pelican, Double Crested Cormorant, Harbor Seal, Snowy Plover, and Western Gull.



Double Crested Cormorant	Migratory Bird Treaty Act	
Snowy Plover	Endangered Species Act: Federal Threatened Species, California Sensitive Species	Restrictions ap
Western Gull	Migratory Bird Treaty Act	Eggs, nests, ar
Harbor Seal	Marine Mammal Protection Act	Lethal take is p
Brandt's Cormorant	Migratory Bird Treaty Act	Eggs, nests, ar
Brown Pelican	Endangered Species Act- California Endangered Species	Does not breed
Island Night Lizard (high density)	Endangered Species Act: Federal Threatened Species, California Threatened Species	
Island Night Lizard (moderate density)	Endangered Species Act: Federal Threatened Species, California Threatened Species	
Harbor Seal viewshed	Marine Mammal Protection Act	Breeding/ pup
Snowy Plover viewshed	Endangered Species Act: Federal Threatened Species, California Sensitive Species	Restrictions ap
Brandt's Cormorant viewshed	Migratory Bird Treaty Act	Restrictions ap
miscellaneous Laridae viewshed	Migratory Bird Treaty Act	
Western Gull viewshed	Migratory Bird Treaty Act	Restrictions ap
Artemisia nesiotica	No legal protection- resource of concern to Resource Manager	
Astragalus traskiae	Endangered Species Act: Federal Category 2, California Rare Species	
Calystegia macrostegia ssp. Amplissima	Endangered Species Act- Federal Category 2	
Cryptantha traskiae	Endangered Species Act- Federal Category 1	
Dudleya virens	Endangered Species Act- Federal Category 2	
Eriogonum grande var. timorum	Endangered Species Act: Federal Category 2, California Endangered Species	
Hemizonia clementina	No legal protection- resource of concern to Resource Manager	
Jepsonia malvaefolia	Endangered Species Act- Federal Category 2	
Aeonium sp.	No legal protection- resource of concern to Resource Manager	Invasive and u
Orobanche parishii subs. Brachyloba	Endangered Species Act: Federal Category 1, California Threatened Species	
Achnatherum diegoensis	No legal protection- resource of concern to Resource Manager	
Trifolium microdon	No legal protection- resource of concern to Resource Manager	
Chinese Abalone processing site	Antiquities Act, National Historic Preservation Act, National Environmental Policy Act	Exact site bour
Archaeological sites	Antiquities Act, National Historic Preservation Act, National Environmental Policy Act	Exact site bour

Figure IV.O. Example: fly_Impact1.shp Table

4. Return to the "Base Map" view with the "Activate Base Map View" button and turn on the display for each of these six species by selecting them in the view's table of contents. The "Impact1.shp" theme is dragged manually below these six themes so that the species polygons will be displayed on top of the activity area (Figure IV.P.). The individual polygons that are overlaid by "Impact1.shp" are active due to the theme-on-theme overlay process and, therefore, are displayed in bright yellow.

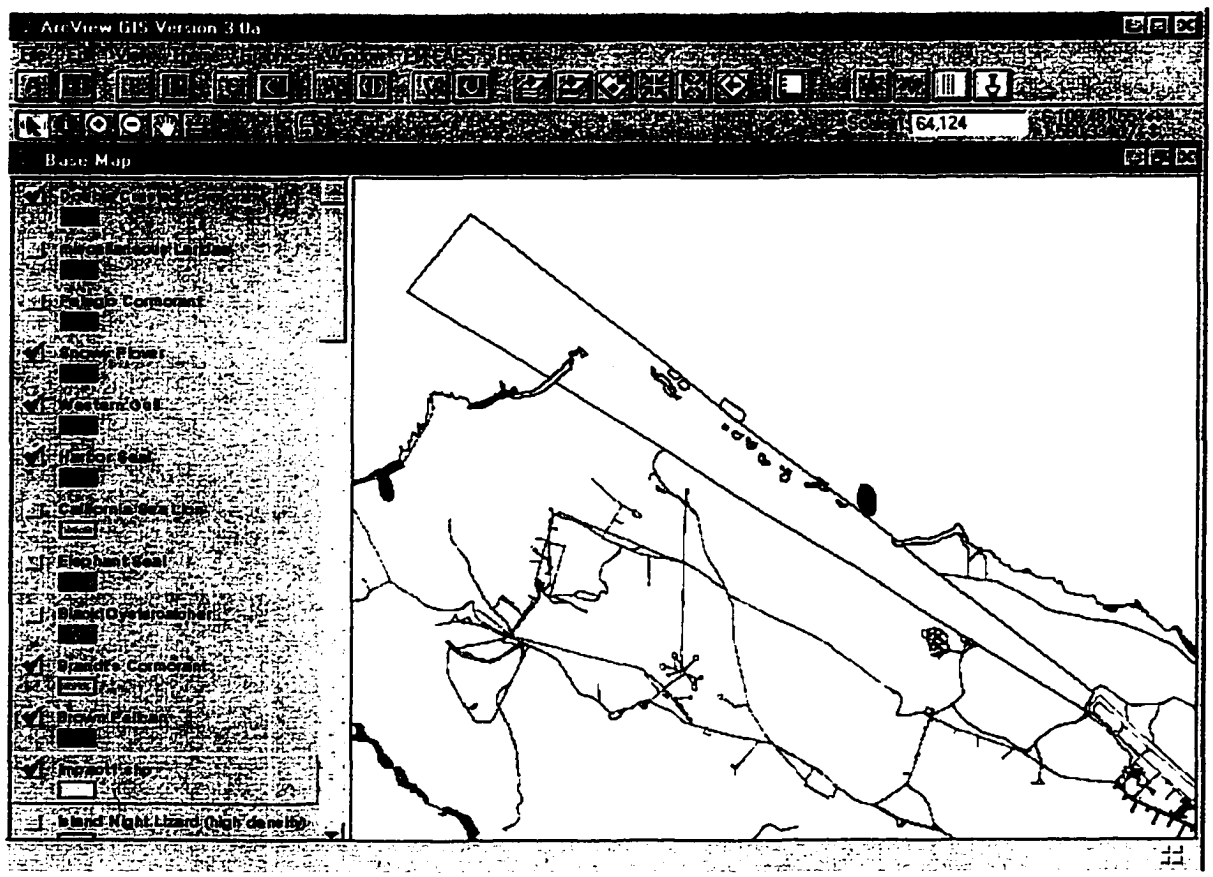


Figure IV.P. Example: Turn On Display for Restricted Species

Reviewing the Base Map suggests that angling the flight corridor slightly more southerly and making it more narrow should avoid any areas where these impacted species are found.

5. Use the "Create Activity Area" tool to define a new proposed flight path, "Impact2.shp", by using the previous suggestions in order to try to avoid the impacted species (Figure IV.Q.).

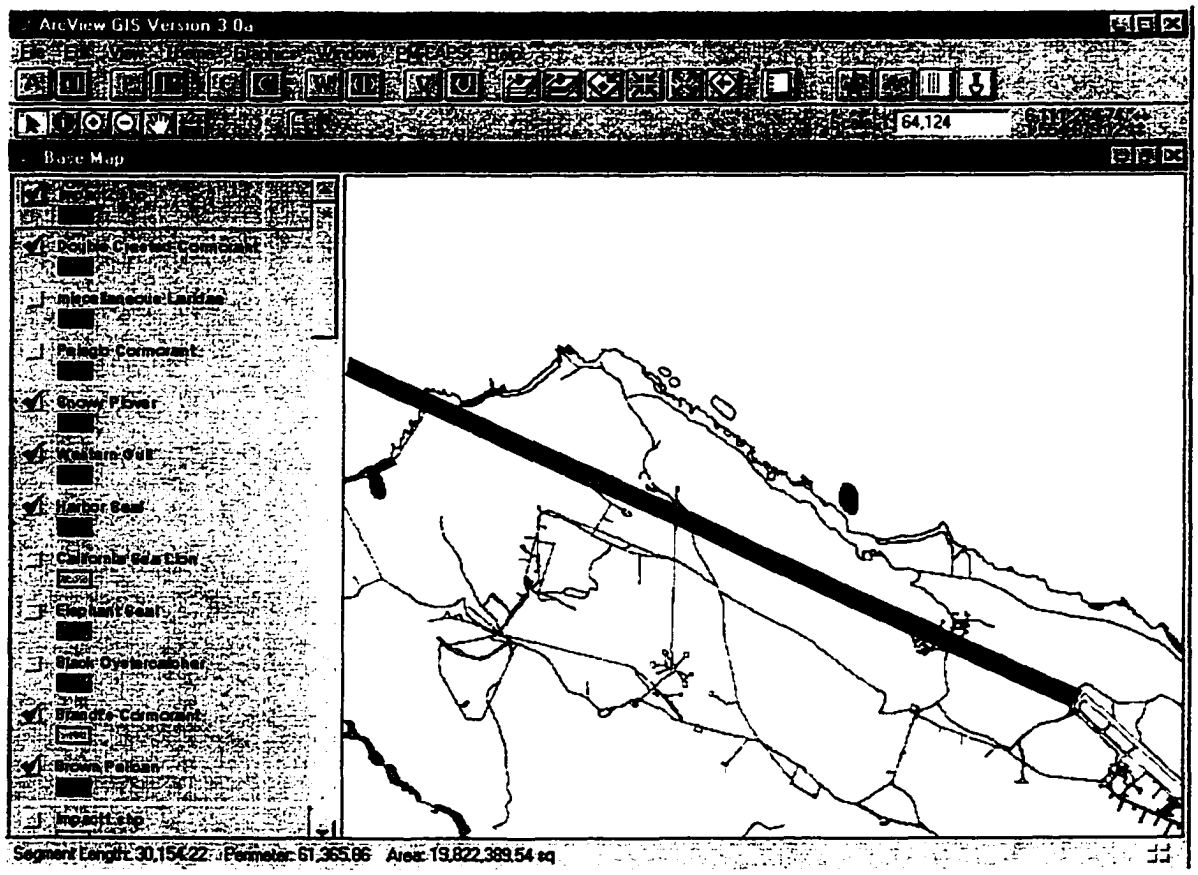


Figure IV.Q. Example: Define New Flight Path

6. Perform a fly-over activity analysis by depressing the "Fly-over Activity Analysis" button. This will create a new table named "fly_Impact2.shp" (Figure IV.R.).

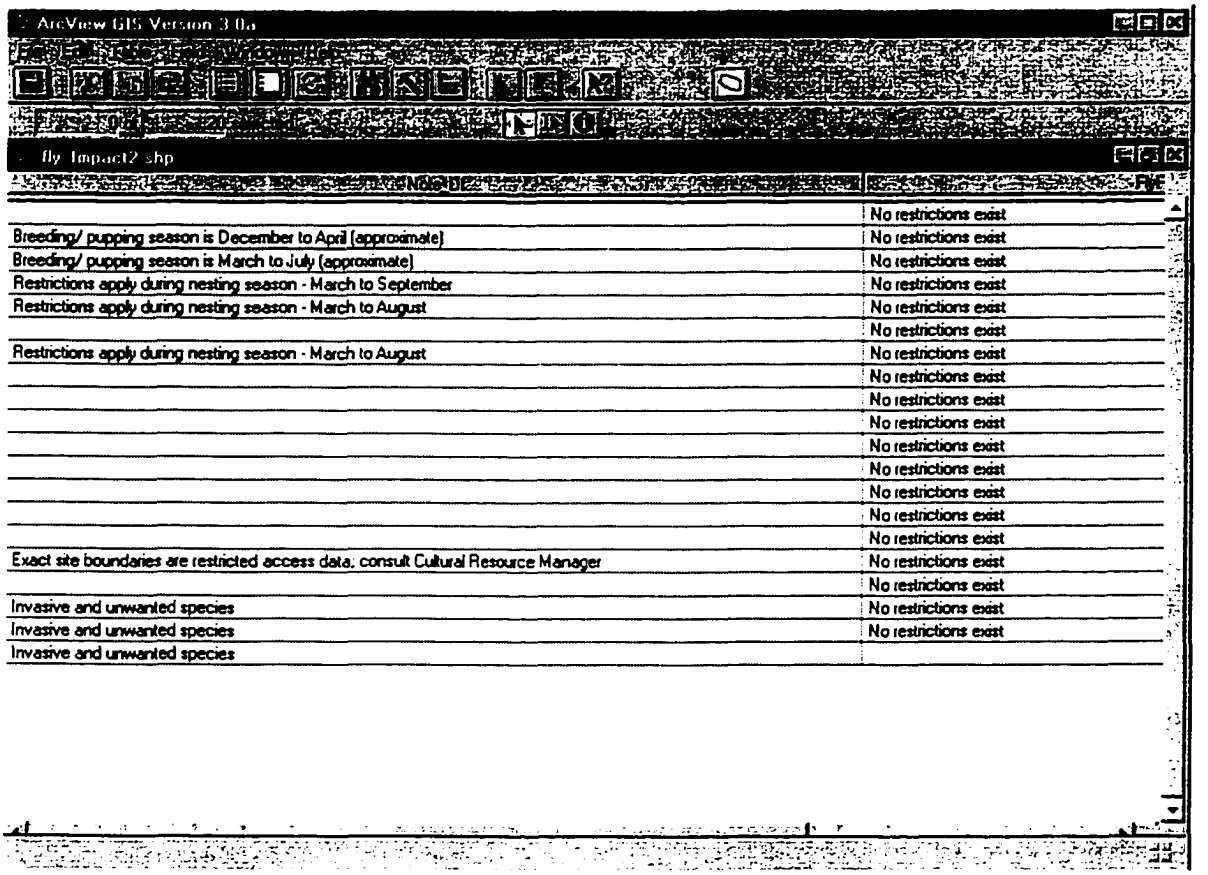


Figure IV.R. Example: "fly_Impact2.shp" Table

Reviewing the "fly_Impact2.shp" table reveals that, even though 21 resources are present within the second proposed activity area, none of them creates any restrictions to fly-over activities. Therefore, performing the proposed activity in the flight path defined in "Impact2.shp" appears to be acceptable. It is assumed that the SNI Resource Manager would approve the activity.

This example simulates a plausible scenario for using the PM-CAPS prototype application. It appears to demonstrate that the application can be used to assist in the planning of a military activity in an fast, efficient, and effective manner.

V. RESULTS

V.A. Evaluation of PM-CAPS Prototype

After the programming and development of the PM-CAPS prototype was completed, an evaluation simulating SNI resource managers use of the application was conducted. It was not possible, at this time, to have NAWS, Point Mugu resource managers participate in the evaluation due to difficulty in arranging travel plans. Therefore, eight students enrolled at The University of Arizona, who were associated with the Advanced Resource Technology Group, were recruited to perform the evaluation.

There were three main purposes to conducting the evaluation:

1. General troubleshooting and an attempt to find possible programming bugs
2. Determine if the prototype achieves the goals of the project
3. Receive user feedback indicating user-perceived design flaws or other comments indicating areas of further consideration or modification

The evaluation was not intended to provide wholly objective, quantifiable results. Rather, it was expected to generate subjective user feedback concerning the usability and efficacy of the prototype, leading to possible modifications to the application before it was delivered to NAWS, Point Mugu personnel.

V.A.1. Evaluation Procedure

Participants in the evaluation were selected in an attempt to represent the SNI resource managers in regards to certain qualifications. The student participants were all associated with the School of Renewable Natural Resources at The University of Arizona, indicating that they had some familiarity with resource management theory and techniques. Also, all had a moderate level of proficiency with ArcView.

The evaluation procedure was intended to simulate the process of introducing an SNI resource manager to the PM-CAPS prototype. The evaluations were conducted one at a time with no interaction among the participants prior to the evaluation. The application developer provided instructions to each evaluator and was present during the course of the evaluation. The developer answered questions from the subjects concerning operation of the application and provided other assistance when the user appeared to be having difficulty. While this assistance clearly dilutes the objectivity of the process, it is consistent with how SNI personnel will be trained to use the application.

The first step in the evaluation was to provide each participant with a two page handout explaining the purpose and procedure of the evaluation (see Appendix C.1.) The handout provides a brief description of the location and military mission of SNI and of the purpose and goals of the PM-CAPS prototype. It then describes the new ArcView features added to the interface and how they operate. Finally, the handout encourages the user to familiarize himself with the data and operation of the prototype and then asks him to use the application to perform a simple task: find a site for a military activity of his choosing where there are no resources present that prohibit the activity.

There was no time limit as to how long each subject had to experiment with the prototype and complete the activity siting task. When a participant indicated that they were finished, they were given a second handout: the PM-CAPS Evaluation Form (see Appendix C.2.) This handout is a subjective questionnaire that encourages the subject to describe their opinions regarding the ease of use and effectiveness of each of the new buttons and tools and the instructions explaining their operation. It also asks about the ability of the user to perform the activity siting task with the prototype. The respondent is prompted to include any additional comments they may have regarding the application and any suggestions for further changes or additions.

Each evaluator was given as much time as they desired to operate the application and complete the questionnaire. Individuals took anywhere from ten to thirty minutes to complete the entire procedure.

V.A.2. Results of PM-CAPS Prototype User Evaluation

The user evaluation forms provided several comments and suggestions that were of assistance to the application designer. Project coordinators reviewed the responses and, as a result, some modifications were made to the application. First, several features that had been removed from the view document GUI were restored. These consisted of the "Identify" tool and six button features:

1. Zoom to Full Extent
2. Zoom to Active Themes

3. Zoom to Selected
4. Zoom In
5. Zoom Out
6. Zoom to Previous Extent

These were features that still could be utilized from the menu bar, but whose button was removed in an attempt to simplify the interface. Maintaining their tool or button was not considered crucial by the application developer, but was requested by one or more evaluator.

Changes based on evaluator comments were made to the help information appearing in the status bar of the view or document GUI. Several subjects expressed having difficulty in identifying how the new tools and buttons in the view GUI operated. Therefore, the help information was changed from simply listing the name of the tool or button under the cursor, to a more complete help line that provides a brief description of what the feature does and how it is intended to be used.

Finally, the evaluation forms emphasize the need for detailed instructions on how the PM-CAPS prototype operates. Many of the users expressed, both in the written evaluations and verbally during the evaluation procedure, a level of confusion as to how features perform. They also had difficulty determining the expected procedure for conducting the activity site planning task. It is believed that longer and more complete written instructions would alleviate these problems. Clearly, the one page of instructions that was provided in the first handout was insufficient.

VI. CONCLUSIONS

VI.A. Fulfillment of Objectives

Determining the success of the PM-CAPS prototype development project is difficult at this time. The true test will be whether or not the prototype, and its eventual refined iterations, is accepted by NAWS, Point Mugu resource managers and integrated into their decision making process on a sustained basis. At the time of this publication, the application has not been delivered to the facility. Therefore, judging how well the project has accomplished its goals up to this point is done by comparing how well the principle objectives set forth earlier in this document have been met thus far.

VI.A.1. Assess Current Military Activity Site Planning Procedures

This assessment was done specifically in regards to avoiding negative impacts on sensitive resources occurring on SNI. This was accomplished by interviewing resource managers at NAWS, Point Mugu and questioning them on the methodologies currently in use.

In summary, resource managers evaluate the appropriateness of performing proposed activities in certain parts of the island by comparing the proposed area to a series of maps indicating where sensitive resources are found. When there is an overlay, the resource manager makes a determination as to what, if any, restrictions apply. This information was used to help design the PM-CAPS prototype by making the application replicate the

current methodology as much as possible. The theme-on-theme overlay that occurs during an activity analysis within the prototype is intended to simulate this process.

VI.A.2. Determine and Codify the Rules Governing Activity Siting on SNI

This involves determining what restrictions apply to performing different types of activities in areas where sensitive resources are found. If an overlap occurs between an area proposed for military activity and where one or more resource occurs, SNI resource managers determine if the activity is allowed to take place and if any restrictions to the performance of the activity are required.

Establishing a set code of rules regarding what activities are allowed in different areas was difficult since the resource managers make these decisions based on a number of different factors, not all of which are recorded in an objective fashion. The first step in replicating this process for the PM-CAPS prototype involved establishing the types of military activities that are likely to occur on SNI and, therefore, required consideration by the application. Consulting with NAWS, Point Mugu resource managers as to the types of activities that they typically must consider in the performance of their jobs resulted in the creation of the four activity classes used by the prototype. However, it is anticipated that these classes may require further refinement in order to accommodate the full range of activities that may be proposed by military planners on SNI. It is also a possibility that additional activity classes may need to be added to future versions of PM-CAPS.

After the activity classes used in the initial prototype had been defined, it was necessary to determine the rules and regulations that restrict conduction such activities in

areas where each sensitive resource occurs. Once this information was gathered, it was organized and recorded into the database lookup tables used by the application. This process is described in detail in section III.D., Develop Lookup Tables, of this document.

The data entered into the LUTs are believed to be accurate based on the information provided to the application developer. However, it is expected that changes will be required once resource managers begin using the application. It is anticipated that once these managers review the restriction information provided by the PM-CAPS prototype, they will discover further additions, omissions, and modifications to the restriction database are required. Also, changes to existing laws and policies will require further updates in the future.

It is important to note that this is the first time that an attempt has been made to codify all of the applicable restriction laws and policies for all of the sensitive resources occurring on SNI into one database. Since the rules of applying some of the policies have never been formally recorded, it is understandable that the establishment of this database should require additional time and changes.

VI.A.3. Create a Prototype Application for Activity Site Planning

The culmination of this project is the prototype PM-CAPS application. It cannot yet be determined if this application meets all of the original design criteria. Several hours of testing revealed several minor programming or design errors that have since been corrected. Additional testing suggests that the application now is virtually error free.

The evaluation process described in section IV. of this document indicates that the application is usable by non-expert ArcView operators. In the evaluation questionnaires, all respondents answered that they believed the application provided information that they considered useful in making activity siting decisions. While these results do not insure that SNI resource managers will share the evaluators' opinions, they may be indicative of a higher likelihood that SNI personnel will consider the prototype to be a useful tool.

VI.B. Limitations of Study and Recommendations for Future Work

The PM-CAPS project is expected to continue to change and to progress beyond its current condition. The application, at this time, is considered to be a prototype that will require further revisions as it is used and evaluated by SNI resource managers. Further, it was designed to be an adaptable application that will evolve as resource management needs and conditions change. It is not possible to predict exactly what changes will become necessary in the future, but there are some recommendations for future work that can be made at this time.

VI.B.1. Delivery and End-user Evaluation

The single most obvious limitation to the this project is the failure to deliver the completed PM-CAPS prototype to SNI resource managers for their evaluation. Since they are the intended users of the application, the results gathered by using student evaluators to gauge the performance of the prototype must be viewed somewhat skeptically. The subjects used in the evaluation cannot be considered to be representative

of SNI personnel in regards to their experience, knowledge of the island and its resources, or expectations as to what the application should accomplish. After training SNI personnel in the operation of the application, an evaluation procedure should be implemented. It is expected that this will result in a number of comments suggesting further modifications or corrections to the application.

VI.B.2. Evaluation and Possible Revision of LUTs Restriction Information

When populating the lookup tables containing specific restriction information, the application developer assumed that the information used in the initial prototype would require revisions after SNI resource managers evaluated the application. The constraint information specific to each resource and each activity class was derived primarily from conversations with NAWS, Point Mugu personnel, but was not expected to be definitive. SNI resource managers likely will find discrepancies between restrictions provided by the prototype and what they themselves would provide.

VI.B.3. Disparity of PM-CAPS and Point Mugu GIS Databases

Another limitation to the PM-CAPS prototype, in its present form, is that it requires its GIS database to be slightly different than the standard database currently used at NAWS, Point Mugu. The GIS database for the entire facility, while developed by the Advanced Resource Technology (ART) Group at The University of Arizona, is stored and managed at NAWS, Point Mugu's mainland headquarters. The database developed and used specifically for the PM-CAPS project currently resides at the ART Group's facility.

While these differences are slight, it still would be preferable to have a single shared GIS database for the use of the entire Point Mugu facility.

One disparity between the databases concerns the themes for the "weed" species. The themes for these species in the database at Point Mugu utilize an ARC/INFO specific data format called "regions." Essentially, regions allow information on several "weed" species to be held in a single data theme. However, the PM-CAPS application is not designed to use themes containing regions. In the development of the application, a separate theme was created for each of the individual "weed" species.

Another disparity exists that affects every theme used in the PM-CAPS application. In order allow the attribution information held in the LUTs to be physically related to the species themes, a key field titled "Res_ID" was added to the feature attribute table of each resource theme. Each species has a unique identification designation in this field that relates the appropriate data from the LUTs.

These differences should be addressed by the GIS manager at NAWS, Point Mugu. It seems logical to establish a single GIS database that is accessed by all GIS users at Point Mugu, including those operating PM-CAPS. This would simplify maintaining and updating the database, tasks that are required for any GIS database whose subject information changes through time.

Potential use of themes with regions should be investigated by PM-CAPS project managers. It may be possible to modify the application so that it can utilize the "weed" themes held in the Point Mugu database. If such changes are not deemed possible or feasible, the main database would require modifications or additions. Options would be

either to eliminate the themes with regions and use an individual theme for each species, or to add the individual species themes to the existing database without eliminating the region themes, thus storing duplicate information in multiple themes.

In order for the themes in the main Point Mugu database to be used by the PM-CAPS application, the "Res_ID" field must be added to the feature attribute table of each of the species themes and the appropriate identifying numerical designation entered. This is a simple process that will not affect the use the themes for any other purpose.

VI.B.4. Establish GIS Database Updating Protocol

Spatial extents of SNI resources as delineated in the coverages used by the PM-CAPS prototype will require periodic review. The data used to define where the sensitive resources occur on SNI are believed to be accurate, but reflect a static point in time of when the information was collected . The level of precision used to create resource polygons is high; it is sub-meter for the many resources recorded using global positioning system equipment. It is not expected that any bird or plant species will continue to be found in exactly the same areas on a continuing basis. That is why a long term monitoring program is established for many of the species. As new location information becomes available for these resources, the coverages used in PM-CAPS will require updating.

This process is necessary to maintain the utility of the database for all its uses, not just the PM-CAPS application. Protocols for keeping the database current will be established by the NAWS, Point Mugu GIS Coordinator. However, this emphasizes the importance

of modifying PM-CAPS to utilize the standard database at Point Mugu instead of continuing to use its own application specific one. Otherwise, revisions to one database would not necessarily be reflected in the other. Since updates are more likely to be done to the main GIS database as opposed to the PM-CAPS database, this disparity in the resource information undermines the efficacy of PM-CAPS as a resource management tool since it would not necessarily have the most up-to-date information available for SNI.

VI.B.5. Consideration of PM-CAPS as an ArcView Extension

PM-CAPS currently exists as an ArcView project. The viability and practicality of establishing it as an ArcView extension should be investigated. Extensions allow the sharing of customizations, documents, or any other objects in a project independent manner. As a project, PM-CAPS is opened into an existing ArcView session.

Ordinarily, any modifications made to a project (e.g. modifying a view document or creating new tables) can be saved to the project file. However, in order to maintain the integrity of the PM-CAPS application, the "Save" and "SaveAs" scripts were modified to prevent the user from saving any changes to the PM-CAPS project file. However, it still is possible to overwrite or delete the file by using the Windows (or other operating system's) File Manger. Doing so potentially could eliminate the entire application from the user's computer.

An ArcView extension would reflect the modifications made to the standard ArcView view and table documents, including the addition and elimination of several

tool and button features. Any number of projects could be created, modified, and saved without threatening the integrity of the PM-CAPS application. However, converting PM-CAPS to an extension would have drawbacks, such as possible difficulty in automatically loading resource themes and establishing the Base Map. Further investigation is required before deciding whether this major modification should be undertaken.

VII. APPENDIXES

VII.A. Database Lookup Tables

VII.A.1. cd_Name

This table lists all of the resources that are integrated into the PM-CAPS application. It contains three fields:

1. "Res_ID" This is a unique numerical designation used to relate all attribute information to the resource.
2. "Cov_Name" This lists the name of the theme for the resource as it exists in the PM-CAPS specific GIS database.
3. "Res_Name" This lists the name of the resource.

This table is related via the "Res_ID" field to the tables "cd_TypeR", "cd_LawR", "cd_NoteR", "cd_FlyR", "cd_WalkR", "cd_SurfR", and "cd_SubR".

Res_ID	Cov_Name	Res_Name
37	c_stdi	Achnatherum diegoensis
51	c_aesp	Aeonium sp.
2	c_apbl	Aphanisma blitoides
3	c_archeo	Archaeological sites
4	c_ame	Artemisia nesiotica
52	c_asof	Asparagus officinalis
5	c_astr	Astragalus traskiae
6	c_atpa	Atriplex pacifica
7	c_bloy	Black Oystercatcher
47	c_bloyvw	Black Oystercatcher viewshed
8	c_brco	Brandt's Cormorant
48	c_brcovw	Brandt's Cormorant viewshed
9	c_brpe	Brown Pelican
34	c_seln	California Sea Lion
45	c_selnvw	California Sea Lion viewshed
10	c_camaam	Calystegia macrostegia ssp. Amplissima
1	c_abalon	Chinese Abalone processing site
53	c_chco	Chrysanthemum coronarium
54	c_coat	Cortaderia atacamensis
55	c_coor	Cotyledon orbiculata
11	c_crtr	Cryptantha traskiae
56	c_cyca	Cynara cardunculus
57	c_dimi	Diptatherum miliaceum
13	c_dima	Dithyrea maritima
12	c_dcco	Double Crested Cormorant
14	c_duvi	Dudleya virens

15	c_elsl	Elephant Seal
43	c_elslvw	Elephant Seal viewshed
58	c_ercf	Eriogonum cinereum/ E. fasculatum
16	c_ergrti	Eriogonum grande var. timorum
17	c_esra	Eschscholzia ramosa
18	c_fovu	Foeniculum vulgare
19	c_hsel	Harbor Seal
44	c_hselvw	Harbor Seal viewshed
20	c_hecl	Hemizonia clementina
21	c_hoin	Hordeum intercedens
25	c_lizhi	Island Night Lizard (high density)
26	c_lizmod	Island Night Lizard (moderate density)
22	c_jema	Jepsonia malvaefolia
24	c_leob	Lepidium oblongum
28	c_loma	Lobularia maritima
27	c_loin	Lomatium insulare
23	c_lari	miscellaneous Laridae
49	c_larivw	miscellaneous Laridae viewshed
29	c_nace	Nassella cernua
30	c_nale	Nassella lepida
31	c_napu	Nassella pulchra
32	c_orpabr	Orobanche parishii subs. Brachyloba
59	c_oxpe	Oxalis pes-caprai
33	c_peco	Pelagic Cormorant
60	c_phaq	Phalaris aquatica
35	c_snpl	Snowy Plover
46	c_snplvw	Snowy Plover viewshed
36	c_sso	Southern Sea Otter
40	c_trpo	Tragapon porrifolius
38	c_trmi	Trifolium microdon
39	c_trpa	Trifolium palmeri
42	c_wegu	Western Gull
50	c_weguvw	Western Gull viewshed

VII.A.2. cd_TypeR

This table is used to relate each resource to an attribute describing what type of resource it is. It contains two fields:

1. "Res_ID" This is a unique numerical designation used to relate all attribute information to the resource.
2. "TypeR_No" This is a numeric designation used to relate attribution information regarding resource type to each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "TypeR_No" field to the "cd_TypeD" table.

Res_ID	TypeR_No
1	3
2	2
3	3
4	2
5	2
6	2
7	1
8	1
9	1
10	2
11	2
12	1
13	2
14	2
15	1
16	2
17	2
18	5
19	1
20	2
21	2
22	2
23	1
24	2
25	1
26	1
27	5
28	2
29	2
30	2
31	2
32	2
33	1

34	1
35	1
36	1
37	2
38	2
39	2
40	5
42	1
43	4
44	4
45	4
46	4
47	4
48	4
49	4
50	4
51	5
52	5
53	5
54	5
55	5
56	5
57	5
58	5
59	5
60	5

VII.A.3. cd_TypeD

This table contains information regarding the type of each resource. It contains two fields:

1. "TypeR_No" This is a numeric designation used to relate attribution information regarding resource type to each resource.
2. "Type_Df" This lists the type of resource used to categorize each sensitive resource.

This table is related via the "TypeR_No" field to the "cd_TypeR" table.

TypeR_No	Type_Df
1	Sensitive Animal
2	Sensitive Plant
3	Cultural Resource
4	Viewshed for protected species
5	Invasive "weed"

VII.A.4. cd_LawR

This table is used to relate each resource to information regarding the laws and regulations that protect it. It contains two fields:

1. "Res_ID" This is a unique numerical designation used to relate all attribute information to the resource.
2. "LawR_No" This is a numeric designation used to relate attribution information regarding the laws and regulations protecting each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "LawR_No" field to the "cd_LawD" table.

Res_ID	LawR_No
1	13
2	6
3	13
4	1
5	14
6	6
7	2
8	2
9	8
10	6
11	5
12	2
13	15
14	6
15	12
16	16
17	7
18	1
19	12
20	1
21	1
22	6
23	2
24	1
25	17
26	17
27	6
28	1
29	1
30	1
31	1
32	18
33	2

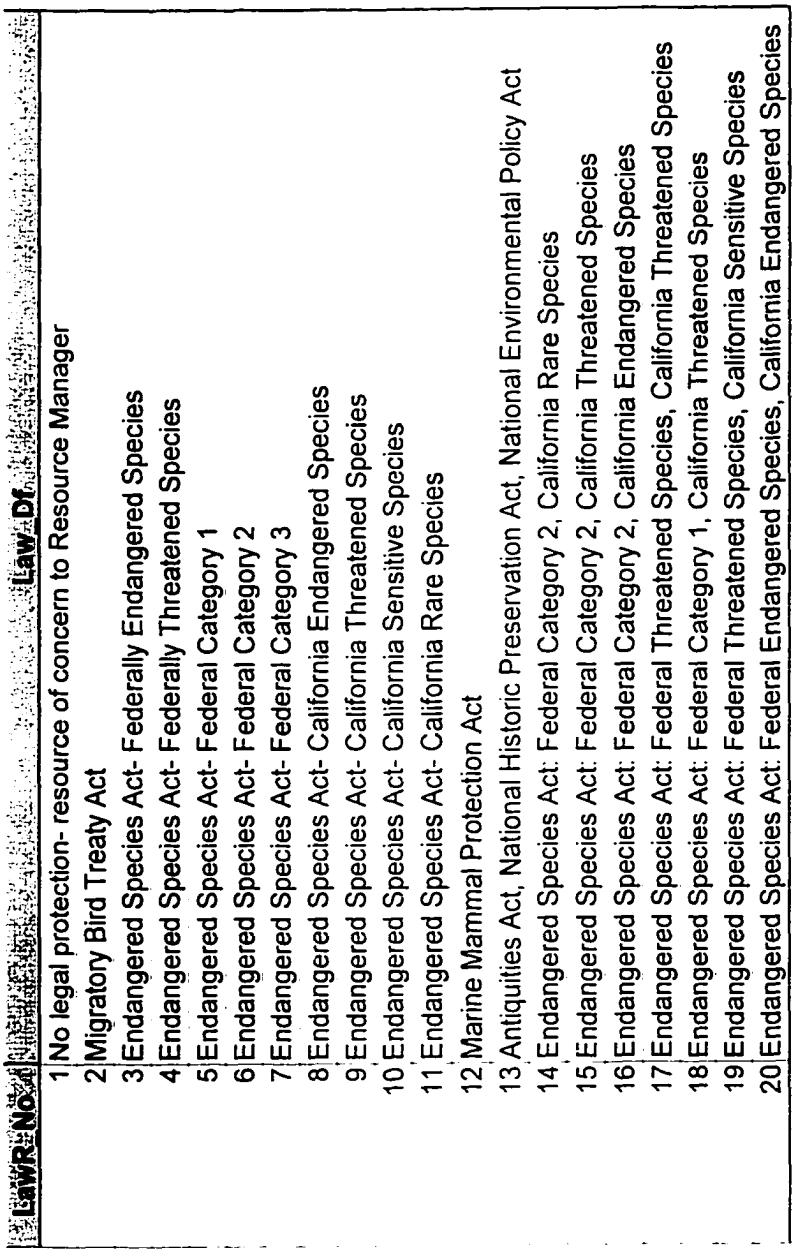
34	12
35	19
36	20
37	1
38	1
39	1
40	1
42	2
43	12
44	12
45	12
46	19
47	2
48	2
49	2
50	2
51	1
52	1
53	1
54	1
55	1
56	1
57	1
58	1
59	1
60	1

VII.A.5. cd_LawD

This table contains information regarding the laws protecting the resources. It contains two fields:

1. "LawR_No" This is a numeric designation used to relate attribution information regarding the laws and regulations protecting each resource..
2. "Law_Df" This lists the laws and regulations protecting each resource.

This table is related via the "LawR_No" field to the "cd_LawR" table.



LawR_No	Law_Df
1	No legal protection- resource of concern to Resource Manager
2	Migratory Bird Treaty Act
3	Endangered Species Act- Federally Endangered Species
4	Endangered Species Act- Federally Threatened Species
5	Endangered Species Act- Federal Category 1
6	Endangered Species Act- Federal Category 2
7	Endangered Species Act- Federal Category 3
8	Endangered Species Act- California Endangered Species
9	Endangered Species Act- California Threatened Species
10	Endangered Species Act- California Sensitive Species
11	Endangered Species Act- California Rare Species
12	Marine Mammal Protection Act
13	Antiquities Act, National Historic Preservation Act, National Environmental Policy Act
14	Endangered Species Act: Federal Category 2, California Rare Species
15	Endangered Species Act: Federal Category 2, California Threatened Species
16	Endangered Species Act: Federal Category 2, California Endangered Species
17	Endangered Species Act: Federal Threatened Species, California Threatened Species
18	Endangered Species Act: Federal Category 1, California Threatened Species
19	Endangered Species Act: Federal Threatened Species, California Sensitive Species
20	Endangered Species Act: Federal Endangered Species, California Endangered Species

VII.A.6. cd_NoteR

This table is used to relate each resource to additional information of interest to resource managers. It contains two fields:

1. "Res_ID" This is a unique numerical designation used to relate all attribute information to the resouce.
2. "NoteR_No" This is a numeric designation used to relate additional information to each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "NoteR_No" to the "cd_NoteD" table.

Res_ID	NoteR_No
1	1
3	1
7	12
8	12
9	3
15	13
18	6
19	14
23	4
28	6
34	15
35	10
36	11
40	6
42	12
43	5
44	8
45	9
46	10
47	2
48	2
50	2
51	6
52	6
53	6
54	6
55	6
56	6
57	6
58	6
59	6
60	6

VII.A.7. cd_NoteD

This table contains additional attribute information regarding each resource. It has two fields:

1. "NoteR_No" This is a numeric designation used to relate additional information to each resource.
2. "Note_Df" This lists the additional attribute information that is related to each resource.

This table is related via the "NoteR_No" to the "cd_NoteR" table.

NoteR_No	Note_Df
1	Exact site boundaries are restricted access data; consult Cultural Resource Manager
2	Restrictions apply during nesting season - March to August
3	Does not breed on SNI, but roost sites receive equivalent protection under recovery plan
4	Eggs, nests, and chicks are protected
5	Breeding/ pupping season is December to April (approximate)
6	Invasive and unwanted species
7	Lethal take is prohibited
8	Breeding/ pupping season is March to July (approximate)
9	Pupping occurs in May/June, but nursing occurs year round
10	Restrictions apply during nesting season - March to September
11	Translocated experimental population not covered by ESA. Informal consent with USFWS required.
12	Eggs, nests, and chicks are protected. Restrictions apply during nesting season- March to August.
13	Lethal take is prohibited. Breeding season is December to April (approximate)
14	Lethal take is prohibited. Breeding/ pupping season is March to July (approximate)
15	Lethal take is prohibited. Pupping occurs in May/June, but nursing occurs year round.

VII.A.8. cd_FlyR

This table is used to relate restriction information regarding fly-over activities to each resource. It contains two fields:

1. "Res_ID" This is a unique numeric designation used to relate all attribute information to the resource.
2. "FlyR_No" This is a numeric designation used to relate attribution information regarding restrictions to fly-over activities to each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "FlyR_No" field to the "cd_FlyD" table.

Res_ID	FlyR_No
1	3
2	3
3	3
4	3
5	3
6	3
7	1
8	1
9	1
10	3
11	3
12	2
13	3
14	3
15	1
16	3
17	3
18	3
19	1
20	3
21	3
22	3
23	1
24	3
25	3
26	3
27	3
28	3
29	3
30	3
31	3
32	3
33	2
34	1

35	1
36	2
37	3
38	3
39	3
40	3
42	1
43	3
44	3
45	3
46	3
47	3
48	3
49	3
50	3
51	3
52	3
53	3
54	3
55	3
56	3
57	3
58	3
59	3
60	3

VII.A.9. cd_FlyD

This table contains information regarding restrictions to fly-over activities for the sensitive resources. It has two fields:

1. "FlyR_No" This is a numeric designation used to relate attribution information regarding restrictions to fly-over activities to each resource.
2. "FlyR_Df" This lists the fly-over restriction information for the sensitive resources.

This table is related via the "FlyR_No" to the "cd_FlyR" table.

FlyR_No	FlyR_Df
1	Activity is restricted; contact SNI Resource Manager
2	Alternate site selection is encouraged; contact SNI Resource Manager
3	No restrictions exist

VII.A.10. cd_WalkR

This table is used to relate restriction information regarding walk-over activities to each resource. It contains two fields:

1. "Res_ID" This is a unique numeric designation used to relate all attribute information to the resource.
2. "WalkR_No" This is a numeric designation used to relate attribution information regarding restrictions to walk-over activities to each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "WalkR_No" field to the "cd_WalkD" table.

Res_ID	WalkR_No
1	6
2	2
3	6
4	4
5	2
6	4
7	3
8	3
9	1
10	2
11	1
12	2
13	1
14	2
15	1
16	1
17	4
18	5
19	1
20	4
21	4
22	2
23	3
24	4
25	2
26	2
27	2
28	5
29	4
30	4
31	4
32	1
33	2

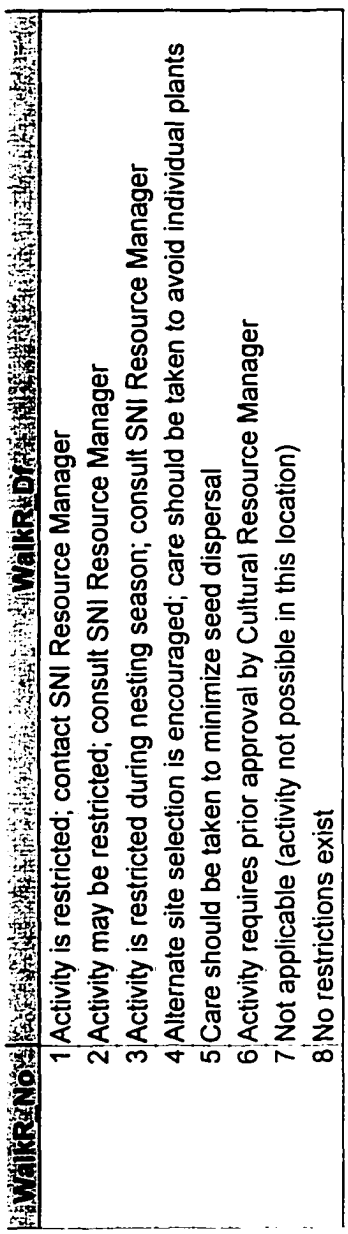
34	1
35	1
36	7
37	4
38	4
39	4
40	5
42	3
43	1
44	1
45	1
46	1
47	1
48	1
49	1
50	1
51	5
52	5
53	5
54	5
55	5
56	5
57	5
58	5
59	5
60	5

VII.A.11. cd_WalkD

This table contains information regarding restrictions to walk-over activities for the sensitive resources. It has two fields:

1. "WalkR_No" This is a numeric designation used to relate attribution information regarding restrictions to walk-over activities to each resource.
2. "WalkR_Df" This lists the walk-over restriction information for the sensitive resources.

This table is related via the "WalkR_No" to the "cd_WalkR" table.



WalkR_No	WalkR_Df
1	Activity is restricted; contact SNI Resource Manager
2	Activity may be restricted; consult SNI Resource Manager
3	Activity is restricted during nesting season; consult SNI Resource Manager
4	Alternate site selection is encouraged; care should be taken to avoid individual plants
5	Care should be taken to minimize seed dispersal
6	Activity requires prior approval by Cultural Resource Manager
7	Not applicable (activity not possible in this location)
8	No restrictions exist

VII.A.12. cd_SurfR

This table is used to relate restriction information regarding surface construction activities to each resource. It contains two fields:

1. "Res_ID" This is a unique numeric designation used to relate all attribute information to the resource.
2. "SurfR_No" This is a numeric designation used to relate attribution information regarding restrictions to surface construction activities to each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "SurfR_No" field to the "cd_SurfD" table.

Res_ID	SurfR_No
1	8
2	2
3	8
4	6
5	2
6	2
7	1
8	1
9	1
10	2
11	1
12	2
13	1
14	2
15	1
16	1
17	2
18	7
19	1
20	2
21	2
22	2
23	1
24	2
25	2
26	2
27	2
28	7
29	2
30	2
31	2
32	1
33	2

34	1
35	1
36	9
37	2
38	2
39	2
40	7
42	1
43	4
44	4
45	4
46	3
47	3
48	3
49	3
50	3
51	7
52	7
53	7
54	7
55	7
56	7
57	7
58	7
59	7
60	7

VII.A.13. cd_SurfD

This table contains information regarding restrictions to surface construction activities for the sensitive resources. It has two fields:

1. "SurfR_No" This is a numeric designation used to relate attribution information regarding restrictions to surface construction activities to each resource.
2. "SurfR_Df" This lists the surface construction restriction information for the sensitive resources.

This table is related via the "SurfR_No" to the "cd_SurfR" table.

SurfR_No	SurfR_Df
1	Activity is restricted; contact SNI Resource Manager
2	Activity may be restricted; consult SNI Resource Manager
3	Activity restricted during nesting season; contact SNI Resource Manager
4	Activity restricted during breeding or "hauling out"; contact SNI Resource Manager
5	Disturbance of individual animal is restricted; consult SNI Resource Manager
6	Alternate site selection is encouraged; consult SNI Resource Manager before proceeding
7	Care should be taken to minimize seed distribution
8	Activity restricted; contact Cultural Resource Manager
9	Not applicable (activity not possible in this location)
10	No restrictions exist

VII.A.14. cd_SubR

This table is used to relate restriction information regarding sub-surface construction activities to each resource. It contains two fields:

1. "Res_ID" This is a unique numeric designation used to relate all attribute information to the resource.
2. "SubR_No" This is a numeric designation used to relate attribution information regarding restrictions to sub-surface construction activities to each resource.

This table is related via the "Res_ID" field to the "cd_Name" table. It is related via the "SubR_No" field to the "cd_SubD" table.

Res_ID	SubR_No
1	8
2	2
3	8
4	6
5	2
6	6
7	3
8	3
9	1
10	6
11	1
12	6
13	1
14	6
15	4
16	1
17	6
18	7
19	4
20	6
21	6
22	2
23	3
24	6
25	2
26	2
27	2
28	7
29	6
30	6
31	6
32	1
33	6

34	4
35	1
36	9
37	6
38	6
39	6
40	7
42	3
43	4
44	4
45	4
46	3
47	3
48	3
49	3
50	3
51	7
52	7
53	7
54	7
55	7
56	7
57	7
58	7
59	7
60	7

VII.A.15. cd_SubD

This table contains information regarding restrictions to sub-surface construction activities for the sensitive resources. It has two fields:

1. "SubR_No" This is a numeric designation used to relate attribution information regarding restrictions to sub-surface construction activities to each resource.
2. "SubR_Df" This lists the sub-surface construction restriction information for the sensitive resources.

This table is related via the "SubR_No" to the "cd_SubR" table.

SubR_No	SubR_Df
1	Activity is restricted; contact SNI Resource Manager
2	Activity may be restricted; consult SNI Resource Manager
3	Activity restricted during nesting season; contact SNI Resource Manager
4	Activity restricted during breeding or "hauling out"; contact SNI Resource Manager
5	Disturbance of individual animal is restricted; consult SNI Resource Manager
6	Alternate site selection is encouraged; consult SNI Resource Manager before proceeding
7	Care should be taken to minimize seed distribution
8	Activity restricted; contact Cultural Resource Manager
9	Not applicable (activity not possible in this location)
10	No restrictions exist

VII.B. Avenue Scripts

VII.B.1. c_Project.Close

This script runs automatically when the user closes the PM-CAPS project. It prompts the user to use SaveAs in order to save their work.

```
' This runs when the user closes the project from the Project document
'  It prompts the user to do a SaveAs before closing in order to save their work

theProject = av.GetProject

if (nil <> theProject) then
  if (theProject.IsModified) then
    if (av.Run("Project.CheckForEdits",nil).Not) then
      return nil
    end
    res = MsgBox.SaveChanges("Do you want to save your changes to a new file?", "ArcView", false)
    if (nil = res) then return nil end
    if (res) then
      av.Run("c_Project.SaveAs", nil)
      if (theProject.IsModified) then return nil end
    end
  end
  theProject.Close
  theProject = nil
end
```

VII.B.2. c_Project.Save

This script runs when the user issues the "Save" command.
It performs the following operation:

1. Inform the user that they cannot overwrite the PM-CAPS project file and asks if they want to do a SaveAs instead.
2. If the user replies in the affirmative, the "c_Project.SaveAs" script is run.

```
' This tells the user that they cannot save over the PM-CAPS.apr project and has
'  them do a SaveAs instead

aList = {"Save As"}
saveText = MsgBox.ChoiceAsString (aList,"Warning!    Use Save As instead of Save to avoid overwriting
application script.","PM-CAPS")
if (saveText = "Save As") then
 av.Run ("c_Project.SaveAs",nil)
 else
  MsgBox.Warning ("No selection made.  Project not saved at this time.","PM-CAPS")
end
```

VII.B.3. c_Project.SaveAs

This script runs from either the SaveAs project command or if called by the "c_Project.Save" script.
It assists the user in saving their project to a new file.

```
'This is a modified Project.SaveAs script written for the PM-CAPS application
' it will not allow the user to overwrite the original pm_caps.apr file

theProject = av.GetProject
if (av.Run("Project.CheckForEdits",nil).Not) then
 return nil
end

defName = "userproj.apr".AsFileName

theFName = FileDialog.Put(defName, "*.apr", "Save Project As")
if (theFName = "pm_caps.apr".AsFileName) then
  MsgBox.Error ("Cannot overwrite PM_CAPS project.  Please try again using a different name.","PM-
CAPS")
 else if (nil <> theFName) then
  theProject.SetFileName(theFName)

  if (theProject.Save) then
   av.ShowMsg( "Project saved to '"+theProject.GetFileName.GetBaseName+"'")
  end
 end
end
```

VII.B.4. c_Project.Startup

This script runs automatically when the PM-CAPS project file is first loaded into ArcView. It performs the following operations:

1. Load all lookup tables into the project.
2. Relate each of the definition lookup tables to its corresponding relate table by executing the "c_Table.JoinToLUTs" script.
3. Relate the attribution information for each resource to its feature attribute table by executing the "c_Table.JoinToFATs" script.
4. Create the Base Map view by loading the appropriate themes into the project.
5. Group the resource themes in the Base Map table of contents by their resource type by executing the "c_View.OrderThemes" script.

```
'This will create the "Base Map" view which contains the c_shore and c_roads themes
' and the resource themes
thisProject = av.GetProject
baseView = View.Make
if (nil = baseView) then
 MsgBox.Error ("Unable to create the Base Map view","PM-CAPS")
 exit
 end

baseView.SetName ("Base Map")
baseViewDpy = baseView.GetDisplay
baseViewDpy.SetUnits (#UNITS_LINEAR_FEET)
baseView.SetComments ("This is the base map for San Nicolas Island")


' This will load all of the look up tables (.dbf) into the project

dbfList = {"cd_Name","cd_TypeR","cd_TypeD","cd_LawR","cd_LawD","cd_NoteR",
 "cd_NoteD","cd_FlyR","cd_FlyD","cd_WalkR","cd_WalkD","cd_SurfR","cd_SurfD",
 "cd_SubR","cd_SubD"}

for each lut in dbfList
 aFileString = "d:\thesis\luts\"+lut+".dbf"
 aFileName = aFileString.AsFileName
 if (VTab.CanMake (aFileName) ) then
  aVTab = VTab.Make (aFileName, false, false)
  if (aVTab.HasError) then
   MsgBox.Error ("Unable to access file"+lut+".dbf","")
  else aTable = Table.Make (aVTab)
  baseFileName = aFileName.GetBaseName
  aFileString = baseFileName.AsString
  periodIndex = aFileString.IndexOf (".")
  aFileString = aFileString.Left (periodIndex)
  aTable.SetName (aFileString)
  end
```

```
  end
 end

' Now, get the names of the themes to be loaded into Base Map view
'   from the cd_Name table and import them setting the names to the Res_Name field
theTable = av.GetProject.FindDoc ("cd_Name")
if (nil = theTable) then
 MsgBox.Error ("Unable to access table cd_Name", "PM-CAPS")
 exit
 end
theVTab = theTable.GetVTab
covField = theVTab.FindField ("Cov_Name")
nameField = theVTab.FindField ("Res_Name")
theTable.GetWin.Open

av.ShowMsg ("Loading resource themes...")
statusIndex = 0
av.SetStatus (statusIndex)
recordCount = theVTab.GetNumRecords
statusIncrement = 100 / recordCount

for each record in theVTab
 covName = theVTab.ReturnValueString (covField,record)
 aSrcName = SrcName.Make ("d:\thesis\covs\resource\"+covName++"polygon")
 aTheme = Theme.Make (aSrcName)
 baseView.AddTheme (aTheme)
 resName = theVTab.ReturnValueString (nameField,record)
 aTheme.SetName (resName)
 aTheme.SetVisible (False)
 aTheme.SetLegendVisible (True)
 statusIndex = statusIndex + statusIncrement
 Av.SetStatus (statusIndex)
 end
av.ShowMsg ("Process completed")

'Execute the c_Tables.JoinLUTs script
av.Run ("c_Table.JoinLUTs",nil)

'Execute the c_Tables.JoinToFATs script
av.Run ("c_Table.JoinToFATs",nil)

theTable.GetWin.Close

shoreSrcName = SrcName.Make ("d:\thesis\covs\geo\c_shore arc")
shoreTheme = Theme.Make (shoreSrcName)
baseView.AddTheme (shoreTheme)
shoreTheme.SetName ("Shoreline")

roadsSrcName = SrcName.Make ("d:\thesis\covs\geo\c_roads arc")
roadsTheme = Theme.Make (roadsSrcName)
baseView.AddTheme (roadsTheme)
roadsTheme.SetName ("Roads")
```

```
subrateSrcName = SrcName.Make ("d:\thesis\covs\sensit\subrate poly")
subrateTheme = Theme.Make (subrateSrcName)
baseView.AddTheme (subrateTheme)
subrateTheme.SetName ("Subsurf Sensitivity")

' Load the legend for the c_shore, c_roads, and subrate themes
shoreLegend = shoreTheme.GetLegend
shoreLegendFile = "d:\thesis\files\shoreleg.avl".AsFileName
shoreLegend.Load (shoreLegendFile,#LEGEND_LOADTYPE_ALL)

roadsLegend = roadsTheme.GetLegend
roadsLegendFile = "d:\thesis\files\roadsleg.avl".AsFileName
roadsLegend.Load (roadsLegendFile,#LEGEND_LOADTYPE_ALL)

subLegend = subrateTheme.GetLegend
subLegendFile = "d:\thesis\files\subrateleg.avl".AsFileName
subLegend.Load (subLegendFile, #LEGEND_LOADTYPE_ALL)

' Make the legend and the theme visible for c_shore and c_roads
shoreTheme.SetVisible (True)
shoreTheme.SetLegendVisible (True)
roadsTheme.SetVisible (True)
roadsTheme.SetLegendVisible (True)

shoreTheme.InvalidateLegend
roadsTheme.InvalidateLegend

baseViewWin = baseView.GetWin
if (baseViewWin.IsOpen) then
  baseViewWin.Close
  baseViewWin.Open
  baseViewWin.Activate
 else
   baseViewWin.Open
   baseViewWin.Activate
  end
baseViewWin.Maximize

' Re-order the themes in the table of contents according to their TypeR_No
av.Run ("c_View.OrderThemes", nil)

' Set the width of the TOC
baseView.SetTOCWidth (225)

' Create a message box welcoming the user
MsgBox.Info ("Welcome to the Point Mugu - Computerized Activity Planning System, PM-CAPS",
"PM-CAPS")
av.ClearMsg
av.ClearStatus
```

VII.B.5. c_Project.Shutdown

This script is run automatically when the user closes the PM-CAPS project.
It performs the following operations:

1. Warns the user that their project will be lost by closing the project and asks if they would like to perform a SaveAs.
2. If the user answers in the affirmative the "c_Project.SaveAs" script is executed.
3. Close the PM-CAPS project.

```
' This is the shutdown script for the PM-CAPS application

' This will allow the user to do a SaveAs before removing their work

answer = MsgBox.YesNoCancel ("Warning- Closing the project will eliminate any changes you have made
or any new documents you have created.  Would you like to do a Save As to retain your work before
closing the project?","PM-CAPS",False)
 if (answer = nil) then
   exit
   elseif (answer = True) then
   av.Run ("c_Project.SaveAs",nil)
  ' elseif (answer = false) then
 end
'  This will remove all non-script documents from the project

theProject = av.GetProject
theProject.CloseAll
finish = false
while (finish.not)
 finish = true
 docList = theProject.GetDocs
 for each item in docList
  if (item.GetClass.GetClassName <> "SEd") then
   theProject.RemoveDoc (item)
   finish = false
  end
  if (finish.not) then
   break
  end
 end
end

'This will remove all global variables
av.ClearGlobals
```

VII.B.6. c_Table.JoinToLUTs

This script is executed automatically by the "c_Project.Startup" script.
It performs the following operations:

1. Join each of the definition lookup tables to its corresponding relate table.
2. Join each of the newly joined tables to the cd_Name lookup table.

```
' This will join the definition tables to their respective relation tables

fileList = {"Sub", "Surf", "Walk", "Fly", "Note", "Law", "Type"}

for each record in fileList
 rString = "cd_"+record+"R"
 fieldString = record+"R_No"
 dString = "cd_"+record+"D"
 expString = "d:\thesis\joins\cd_"+record+"J.dbf"
 rTable = av.GetProject.FindDoc (rString)
 rVTab = rTable.GetVTab
 rJoinField = rVTab.FindField (fieldString)
 dTable = av.GetProject.FindDoc (dString)
 dVTab = dTable.GetVTab
 dJoinField = dVTab.FindField (fieldString)
 rVTab.Join (rJoinField, dVTab, dJoinField)
 rVTab.Export (expString.AsFileName, dBASE, false)
 jFileName = expString.AsFileName
 if (VTab.CanMake (jFileName)) then
  jVTab = VTab.Make (jFileName, false, false)
  if (jVTab.HasError) then
  errorString = "Unable to access file"++jFileName
   MsgBox.Error (errorString, "PM-CAPS")
    exit
  else jTable = Table.Make (jVTab)
  if (nil = jTable) then
   errorString = "Unable to make table"++jFileName
   MsgBox.Error (errorString, "PM-CAPS")
   exit
  else baseFileName = jFileName.GetBaseName
  jFileString = baseFileName.AsString
  periodIndex = jFileString.IndexOf (".")
  jFileString = jFileString.Left (periodIndex)
  jTable.SetName (jFileString)

'This will join the joined tables to the cd_Name table
nameTable = av.GetProject.FindDoc ("cd_Name")
nameVTab = nameTable.GetVTab
nameJoinField = nameVTab.FindField ("Res_ID")
jString = "cd_"+record+"J"
jTable = av.GetProject.FindDoc (jString)
jVTab = jTable.GetVTab
```

```
jJoinField = jVTab.FindField ("Res_ID")
nameVTab.Join (nameJoinField, jVTab, jJoinField)

   end
  end
 end
end
```

VII.B.7. c_Table.JoinToFATs

This script is executed automatically by the "c_Project.Startup" script.
It relates the attribution information from the lookup tables to each resource feature attribute table via the following procedure:

1. Create and export a new table consisting of the specific attribution information for each resource.
2. Load each of these exported tables into the PM-CAPS project.
3. Join each of these tables to the feature attribute table of the appropriate resource theme.

```
' This will export the cd_Name table once for each theme in the Base View
' view as "cd_temp#" and join the temp table to the FTab

 'First, export the cd_Name table once for each theme

theView = av.GetProject.FindDoc ("Base Map")
themeList = theView.GetThemes

recIndex = 0
for each record in themeList
 recIndex = recIndex + 1
  'Select the record with the name of the theme
   nameTable = av.GetProject.FindDoc ("cd_Name")
   nameVTable = nameTable.GetVTab
   nameBitMap = nameVTable.GetSelection
   record = record.AsString
   qString = "[Res_Name] = "+record.Quote
   nameVTable.Query (qString, nameBitMap, #VTAB_SELTYPE_NEW)
   nameVTable.UpdateSelection
 'Export this selection as a temp file
   expString = "d:\thesis\joins\temp"+recIndex.AsString
   nameVTable.Export (expString.AsFileName, dBASE, True)

 ' Now load the new table to the project
 impFile = expString+".dbf"
 jFileName = impFile.AsFileName
 jVTab = VTab.Make (jFileName, false, false)
 jTable = Table.Make (jVTab)
 baseFileName = jFileName.GetBaseName
 jFileString = baseFileName.AsString
 periodIndex = jFileString.IndexOf (".")
 jFileString = jFileString.Left (periodIndex)
 jTable.SetName (jFileString)

 ' Join the exported file to the .FAT for each theme
 theView = av.GetProject.FindDoc ("Base Map")
 theTheme = theView.FindTheme (record)
```

```
  themeVTab = theTheme.GetFTab
  themeJoinField = themeVTab.FindField ("Res_ID")
  attTable = av.GetProject.FindDoc (jFileString)
  attVTab = attTable.GetVTab
  attJoinField = attVTab.FindField ("Res_ID")
  themeVTab.Join (themeJoinField, attVTab, attJoinField)

  fileDoc = av.GetProject.FindDoc (jFileString)
    av.GetProject.removeDoc (fileDoc)
end
```

VII.B.7. c_Table.ActivateBaseMap

This script is executed by depressing the Activate Base Map View button from the Table document graphical user interface.
It returns the user to the Base Map view.

```
' This will return to the Base Map View from a Table Document

bmWin = av.FindDoc ("Base Map").GetWin
bmWin.Activate
bmWin.Maximize
```

VII.B.9. c_View.OrderThemes

This script is executed automatically from the "c_Project.Startup" script.
It groups the themes in the Base Map view together according to their type (e.g. animal or plant.)

```
' This will re-order the themes by their Typer_no

theView = av.GetProject.FindDoc ("Base Map")
themeList = theView.GetThemes

' First, move non-resource themes (eg. shoreline and roads) to the top,
'  As other themes are added, the ones on top will be moved to the bottom
for each thm in themeList
  thmVTab = thm.GetFTab
  typeField = thmVTab.FindField ("Typer_no")
  if (typeField = nil) then
    themeList.Shuffle (thm, (0))
  end
end

'Move the weed themes to the top of the TOC
for each thm in themeList
  thmVTab = thm.GetFTab
  typeField = thmVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end
  typeNo = thm.ReturnValueString (typeField.AsString, 0)
  weedNo = "5"
  if (typeNo = weedNo) then
    themeList.Shuffle (thm, (0))
  end
end

'Move the cultural resource themes to the top of the TOC
for each thm in themeList
  thmVTab = thm.GetFTab
  typeField = thmVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end
  typeNo = thm.ReturnValueString (typeField.AsString, 0)
  cultNo = "3"
  if (typeNo = cultNo) then
    themeList.Shuffle (thm, (0))
  end
end

'Move the sensitive plants themes to the top of the TOC
for each thm in themeList
```

```
  thmVTab = thm.GetFTab
  typeField = thmVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end
  typeNo = thm.ReturnValueString (typeField.AsString, 0)
  plantNo = "2"
  if (typeNo = plantNo) then
    themeList.Shuffle (thm, (0))
  end
end

'Move the viewshed themes to the top of the TOC
for each thm in themeList
  thmVTab = thm.GetFTab
  typeField = thmVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end
  typeNo = thm.ReturnValueString (typeField.AsString, 0)
  viewNo = "4"
  if (typeNo = viewNo) then
    themeList.Shuffle (thm, (0))
  'Set the legend for viewshed themes
  viewLegend = thm.GetLegend
  viewLegendFile = "d:\thesis\files\viewleg.avl".AsFileName
  viewLegend.Load (viewLegendFile,#LEGEND_LOADTYPE_ALL)
  thm.InvalidateLegend

  end
end

'Move the sensitive animal themes to the top of the TOC
for each thm in themeList
  thmVTab = thm.GetFTab
  typeField = thmVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end
  typeNo = thm.ReturnValueString (typeField.AsString, 0)
  animalNo = "1"
  if (typeNo = animalNo) then
    themeList.Shuffle (thm, (0))
  end
end

theView.InvalidateTOC (nil)
```

VII.B.10 c_View.DisplayAnimals.On

This script is executed by depressing the Animal Themes Display On button from the Base Map view GUI.
It activates the display for all of the sensitive animal themes.

```
'This will turn the display on for all sensitive animals themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "1"
 if (typeNo = oneString) then
  if (t.IsVisible.Not)
    then t.SetVisible (True)
    t.SetLegendVisible (True)
  end
 end
end
```

VII.B.11. c_View.DisplayAnimals.Off

This script is executed by depressing the Animal Themes Display Off button from the Base Map view GUI.
It turns off the display for each of the sensitive animal themes.

```
'This will turn the display off for all sensitive animal themes


baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
aBox = Rect.MakeEmpty
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "1"
 if (typeNo = oneString) then
  if (t.IsVisible)
   then t.SetVisible (False)
  end
 end
end
```

VII.B.12. c_View.DisplayCultural.On

This script is executed by depressing the Cultural Resource Themes Display On button from the Base Map view GUI.
It activates the display for all of the cultural resource themes.

```
'This will turn the display on for all cultural resource themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "3"
 if (typeNo = oneString) then
  if (t.IsVisible.Not)
   then t.SetVisible (True)
   t.SetLegendVisible (True)
  end
 end
end
```

VII.B.13. c_View.DisplayCultural.Off

This script is executed by depressing the Cultural Resource Themes Display Off button from the Base Map view GUI.
It turns off the display for each of the sensitive cultural resource themes.

```
'This will turn the display off for all cultural resource themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
aBox = Rect.MakeEmpty
for each t in themeList
  themeVTab = t.GetFTab
  typeField = themeVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end

  typeNo = t.ReturnValueString (typeField.AsString, 0)
  oneString = "3"
  if (typeNo = oneString) then
    if (t.IsVisible)
      then t.SetVisible (False)
    end
  end
end
```

VII.B.14. c_View.DisplayPlants.On

This script is executed by depressing the Plant Themes Display On button from the Base Map view GUI.
It activates the display for all of the sensitive plant themes.

```
'This will turn the display on for all sensitive plant themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
for each t in themeList
  themeVTab = t.GetFTab
  typeField = themeVTab.FindField ("Typer_no")
  if (typeField = nil) then continue
  end

  typeNo = t.ReturnValueString (typeField.AsString, 0)
  oneString = "2"
  if (typeNo = oneString) then
    if (t.IsVisible.Not)
      then t.SetVisible (True)
      t.SetLegendVisible (True)
    end
  end
end
```

VII.B.15. c_View.DisplayPlants.Off

This script is executed by depressing the Plant Themes Display On button from the Base Map view GUI.
It turns off the display for each of the sensitive plant themes.

```
'This will turn the display off for all sensitive plant themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
aBox = Rect.MakeEmpty
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "2"
 if (typeNo = oneString) then
  if (t.IsVisible)
   then t.SetVisible (False)
  end
 end
end
```

VII.B.16. c_View.DisplayViewsheds.On

This script is executed by depressing the Viewshed Themes Display On button from the Base Map view GUI.
It activates the display for all of the viewshed themes.

```
'This will turn the display on for all themes of viewsheds of sensitive species

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "4"
 if (typeNo = oneString) then
  if (t.IsVisible.Not)
   then t.SetVisible (True)
   t.SetLegendVisible (True)
  end
 end
end
```

VII.B.17. c_View.DisplayViewsheds.Off

This script is executed by depressing the Viewshed Themes Display On button from the Base Map view GUI.
It turns off the display for each of the viewshed themes.

```
'This will turn the display off for all themes of viewsheds for sensitive species

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
aBox = Rect.MakeEmpty
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "4"
 if (typeNo = oneString) then
  if (t.IsVisible)
   then t.SetVisible (False)
  end
 end
end
```

VII.B.18. c_View.DisplayWeeds.On

This script is executed by depressing the Weed Themes Display On button from the Base Map view GUI.
It activates the display for all of the "weed" themes.

```
'This will turn the display on for all invasive weed species themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "5"
 if (typeNo = oneString) then
  if (t.IsVisible.Not)
   then t.SetVisible (True)
   t.SetLegendVisible (True)
  end
 end
end
```

VII.B.19. c_View.DisplayWeeds.Off

This script is executed by depressing the Weed Themes Display On button from the Base Map view GUI.
It turns off the display for each of the "weed" themes.

```
'This will turn the display off for all invasive weed species themes

baseView = av.GetProject.FindDoc ("Base Map")
themeList = baseView.GetThemes
aBox = Rect.MakeEmpty
for each t in themeList
 themeVTab = t.GetFTab
 typeField = themeVTab.FindField ("Typer_no")
 if (typeField = nil) then continue
 end

 typeNo = t.ReturnValueString (typeField.AsString, 0)
 oneString = "5"
 if (typeNo = oneString) then
  if (t.IsVisible)
   then t.SetVisible (False)
  end
 end
end
```

VII.B.20. c_View.NewTheme

This script is executed by clicking the Draw Activity Area button on the Base Map view GUI.

It performs the following operations:

1. Prompt the user to name the activity area shape file they will create.
2. Create the shapefile.
3. Provide the user with instructions on how to define polygon features in the shapefile.

```
' This will create a new theme based on the polygon drawn by the user
' This will control the naming of the activity area shapefile
' It is to be associated with the clicking of the draw activity area button

MsgBox.Info ("Name the theme for the activity area that you will define","PM-CAPS")


theView = av.GetProject.FindDoc ("Base Map")
theView.SetEditableTheme (nil)
class = polygon
def = av.GetProject.MakeFileName ("impact","shp")
def = FileDialog.Put(def, "*.shp", "New Theme ")

if (def <> nil) then
 tbl = FTab.MakeNew(def, class)
 if (tbl.HasError) then
   if (tbl.HasLockError) then
     MsgBox.Error("Unable to acquire Write Lock for file " + def.GetBaseName, "")
   else
     MsgBox.Error("Unable to create " + def.GetBaseName, "")
   end
   return nil
 end
 fld = Field.Make("ID", #FIELD_DECIMAL, 8, 0)
 fld.SetVisible( FALSE )
 tbl.AddFields({fld})
 tbl.SetEditable(False)
 theTheme = FTheme.Make(tbl)
theView.AddTheme(theTheme)
 theTheme.SetActive(TRUE)
 theTheme.SetVisible(TRUE)
 theView.SetEditableTheme(theTheme)
 av.GetProject.SetModified(true)
else MsgBox.Info ("No area defined at this time","PM-CAPS")
' This will make the Pointer tool active
 theTools = av.getActiveGUI.GetToolbar
 for each t in theTools
  theTag = t.GetTag
```

```
   if (theTag = "pointer") then t.Select
   end
  end
 exit
end
```

```
MsgBox.Info ("Use the cursor to define the acivity area.  Single click the left mouse button to place a
vertex, double click to complete a polygon.  You may draw as many polygons for the activity area as you
want.  When you are finished drawing, click on the button for the type of activity analysis you would like to
perform.","PM-CAPS")
MsgBox.Info ("When you are finished defining the activity area, choose one of the activity analysis buttons
to view restrictions.","PM-CAPS")
```

VII.B.21. c_View.PolyTool

This script is executed by applying the Draw Activity Area tool from the Base Map view GUI.
It allows the user to define polygon features in their newly created shapefile.

```
'This script is to be associated with the "apply"function of the tool to draw a new theme

theView = av.GetProject.FindDoc ("Base Map")

p = theView.ReturnUserPolygon
theTheme = theView.GetEditableTheme

if (p.IsNull) then
 return nil
else
 if (theTheme <> nil) then
  theTheme.GetFTab.BeginTransaction
  thePrj = theView.GetProjection
  if (thePrj.IsNull.Not) then
   p = p.ReturnUnprojected(thePrj)
  end
  theField = theTheme.GetFTab.FindField("Shape")
  rec = theTheme.GetFTab.AddRecord
  theTheme.GetFTab.SetValue(theField, rec, p)
  theTheme.GetFTab.GetSelection.ClearAll
  theTheme.GetFTab.GetSelection.Set(rec)
  theTheme.GetFTab.UpdateSelection
  theTheme.GetFTab.EndTransaction
 else
  gp = GraphicShape.Make(p)
  theView.GetGraphics.UnselectAll
  gp.SetSelected(TRUE)
  theView.GetGraphics.Add(gp)
 end
 av.GetProject.SetModified(true)
end
```

VII.B.22. c_View.FlyOver

This script is executed by depressing the Fly-Over Activity Analysis button from the Base Map view GUI.

It performs the following operations:

1. Prompt the user to select a theme defining the proposed activity area.
2. Overlay the activity area's polygon features with each of the sensitive resources. If they intersect, the resource's name is added to a list.
3. Create a virtual table listing restriction information for each of the impacted resources on the list.
4. Activate the newly created virtual table displaying the restriction information.

```
' This selects the features of each resource theme in the Base Map view that
'  intersects the user-defined activity area for a Fly-over activity

' This will make the Pointer tool active
theTools = av.getActiveGUI.GetToolbar
for each t in theTools
 theTag = t.GetTag
 if (theTag = "pointer") then t.Select
 end
end

'Allow the user to choose the theme to be used for selection
theList = {}
theView = av.GetProject.FindDoc ("Base Map")
themeList = theView.GetThemes
for each t in themeList
 theVTab = t.GetFTab
 theName = t.GetName
 if (theName = "Roads" or (theName = "Shoreline") or (theName = "Subsurf Sensitivity")) then continue
 end
 theField = theVTab.FindField ("Res_ID")
  if (theField = nil) then
   theList.Add (t.AsString)
  end
end
theChoice = MsgBox.ChoiceAsString (theList, "Select the theme you would like to use as an activity
area","PM-CAPS")
 if (theChoice = nil) then
 MsgBox.Info ("No selection made at this time","PM-CAPS")
 exit
 end

' Loop through each resource theme and do a SelectByTheme using theChoice as the selection theme
for each t in themeList
```

```
  'Clear any previously selected features
  t.ClearSelection

  theVTab = t.GetFTab
  theName = t.GetName

  if (theName = "Roads" or (theName = "Shoreline")) then continue
  end
  impact = av.GetActiveDoc.FindTheme (theChoice)
  t.SelectByTheme (impact, #FTAB_RELTYPE_INTERSECTS, 0, #VTAB_SELTYPE_OR)
end

' Create a table that will consist of the desired fields
aFileString = "d:\thesis\temp\fly_"+theChoice.AsString
aFileName = aFileString.AsFileName
final = VTab.MakeNew (aFileName, dBase)
final.SetEditable (True)

'Define the fields for the new table
nameFinal = Field.Make ("Res_Name", #FIELD_CHAR, 75, 0)
lawFinal = Field.Make ("Law_Df", #FIELD_CHAR, 100, 0)
noteFinal = Field.Make ("Note_Df", #FIELD_CHAR, 125, 0)
restrFinal = Field.Make ("FlyR_Df", #FIELD_CHAR, 100, 0)

' Add the fields to the file
fieldList = {nameFinal,lawFinal,noteFinal,restrFinal}
final.AddFields (fieldList)

nameFinal.SetPixelWidth (225)
lawFinal.SetPixelWidth (475)
noteFinal.SetPixelWidth (575)
restrFinal.SetPixelWidth (400)

finalrec = -1

' Get appropriate fields from resource FTab and copy selected features to final
themeList = av.GetActiveDoc.GetThemes
for each t in themeList
  theVTab = t.GetFTab
  selected = theVTab.GetSelection
  if (selected.Count = 0) then continue
  else
    resField = theVTab.FindField ("Res_ID")
    if (resField = nil) then continue
    else

    nameField = theVTab.FindField ("Res_Name")
    lawField = theVTab.FindField ("Law_Df")
    noteField = theVTab.FindField ("Note_Df")
    restrField = theVTab.FindField ("FlyR_Df")
    theVTab.SetEditable (true)
    rec = -1
```

```
    rec = selected.GetNextSet (rec)
    nameString = theVTab.ReturnValueString (nameField, rec)
    lawString = theVTab.ReturnValueString (lawField, rec)
    noteString = theVTab.ReturnValueString (noteField, rec)
    restrString = theVTab.ReturnValueString (restrField, rec)

    finalrec = (finalrec + 1)
    final.SetEditable (true)
    final.AddRecord
    final.SetValue (nameFinal, finalrec, nameString)
    final.SetValue (lawFinal, finalrec, lawString)
    final.SetValue (noteFinal, finalrec, noteString)
    final.SetValue (restrFinal, finalrec, restrString)
    continue
    end
end
end

' Clear selected features from the activity area theme
impact.ClearSelection

aTable = Table.Make (final)
aTable.SetName (aFileName.GetBaseName)
tableWin = aTable.GetWin
if (tableWin.IsOpen.Not) then
  tableWin.Open
end

tableWin.Maximize
```

VII.B.23. c_View.WalkOver

This script is executed by depressing the Walk-Over Activity Analysis button from the Base Map view GUI.

It performs the following operations:

1. Prompt the user to select a theme defining the proposed activity area.
2. Overlay the activity area's polygon features with each of the sensitive resources. If they intersect, the resource's name is added to a list.
3. Create a virtual table listing restriction information for each of the impacted resources on the list.
4. Activate the newly created virtual table displaying the restriction information.

```
' This selects the features of each resource theme in the Base Map view that
'  intersects the user-defined activity area for a Walk-over activity

' This will make the Pointer tool active
theTools = av.getActiveGUI.GetToolbar
for each t in theTools
  theTag = t.GetTag
  if (theTag = "pointer") then t.Select
  end
end

'Allow the user to choose the theme to be used for selection
theList = {}
theView = av.GetProject.FindDoc ("Base Map")
themeList = theView.GetThemes
for each t in themeList
  theVTab = t.GetFTab
  theName = t.GetName
  if (theName = "Roads" or (theName = "Shoreline") or (theName = "Subsurf Sensitivity")) then continue
  end
  theField = theVTab.FindField ("Res_ID")
   if (theField = nil) then
    theList.Add (t.AsString)
   end
end
theChoice = MsgBox.ChoiceAsString (theList, "Select the theme you would like to use as an activity
area","PM-CAPS")
  if (theChoice = nil) then
  MsgBox.Info ("No selection made at this time","PM-CAPS")
  exit
  end

' Loop through each resource theme and do a SelectByTheme using theChoice as the selection theme
for each t in themeList

  'Clear any previously selected features
```

```
  t.ClearSelection

  theVTab = t.GetFTab
  theName = t.GetName
  if (theName = "Roads" or (theName = "Shoreline")) then continue
  end
  impact = av.GetActiveDoc.FindTheme (theChoice)
  t.SelectByTheme (impact, #FTAB_RELTYPE_INTERSECTS, 0, #VTAB_SELTYPE_OR)
end

' Create a table that will consist of the desired fields
aFileString = "d:\thesis\temp\walk_"+theChoice.AsString
aFileName = aFileString.AsFileName
final = VTab.MakeNew (aFileName, dBase)
final.SetEditable (True)

'Define the fields for the new table
nameFinal = Field.Make ("Res_Name", #FIELD_CHAR, 75, 0)
lawFinal = Field.Make ("Law_Df", #FIELD_CHAR, 100, 0)
noteFinal = Field.Make ("Note_Df", #FIELD_CHAR, 125, 0)
restrFinal = Field.Make ("WalkR_Df", #FIELD_CHAR, 100, 0)

' Add the fields to the file
fieldList = {nameFinal,lawFinal,noteFinal,restrFinal}
final.AddFields (fieldList)

nameFinal.SetPixelWidth (225)
lawFinal.SetPixelWidth (475)
noteFinal.SetPixelWidth (575)
restrFinal.SetPixelWidth (475)

finalrec = -1

' Get appropriate fields from resource FTab and copy selected features to final
themeList = av.GetActiveDoc.GetThemes
for each t in themeList
  theVTab = t.GetFTab
  selected = theVTab.GetSelection
  if (selected.Count = 0) then continue
  else
    resField = theVTab.FindField ("Res_ID")
    if (resField = nil) then continue
    else

    nameField = theVTab.FindField ("Res_Name")
    lawField = theVTab.FindField ("Law_Df")
    noteField = theVTab.FindField ("Note_Df")
    restrField = theVTab.FindField ("WalkR_Df")
    theVTab.SetEditable (true)
    rec = -1
    rec = selected.GetNextSet (rec)
    nameString = theVTab.ReturnValueString (nameField, rec)
```

```
    lawString = theVTab.ReturnValueString (lawField, rec)
    noteString = theVTab.ReturnValueString (noteField, rec)
    restrString = theVTab.ReturnValueString (restrField, rec)

    finalrec = (finalrec + 1)
    final.SetEditable (true)
    final.AddRecord
    final.SetValue (nameFinal, finalrec, nameString)
    final.SetValue (lawFinal, finalrec, lawString)
    final.SetValue (noteFinal, finalrec, noteString)
    final.SetValue (restrFinal, finalrec, restrString)
    continue
    end
end
end

' Clear selected features from the activity area theme
impact.ClearSelection

aTable = Table.Make (final)
aTable.SetName (aFileName.GetBaseName)
tableWin = aTable.GetWin
if (tableWin.IsOpen.Not) then
  tableWin.Open
end

tableWin.Maximize
```

VII.B.24. c_View.SurfConst

This script is executed by depressing the Surface Construction Activity Analysis button from the Base Map view GUI.
It performs the following operations:

1. Prompt the user to select a theme defining the proposed activity area.
2. Overlay the activity area's polygon features with each of the sensitive resources. If they intersect, the resource's name is added to a list.
3. Create a virtual table listing restriction information for each of the impacted resources on the list.
4. Activate the newly created virtual table displaying the restriction information.

```
' This selects the features of each resource theme in the Base Map view that
'  intersects the user-defined activity area for a Surface construction activity

' This will make the Pointer tool active
theTools = av.getActiveGUI.GetToolbar
for each t in theTools
 theTag = t.GetTag
 if (theTag = "pointer") then t.Select
 end
end

'Allow the user to choose the theme to be used for selection
theList = {}
theView = av.GetProject.FindDoc ("Base Map")
themeList = theView.GetThemes
for each t in themeList
 theVTab = t.GetFTab
 theName = t.GetName
 if (theName = "Roads" or (theName = "Shoreline") or (theName = "Subsurf Sensitivity")) then continue
 end
 theField = theVTab.FindField ("Res_ID")
  if (theField = nil) then
   theList.Add (t.AsString)
  end
end
theChoice = MsgBox.ChoiceAsString (theList, "Select the theme you would like to use as an activity
area","PM-CAPS")
 if (theChoice = nil) then
 MsgBox.Info ("No selection made at this time","PM-CAPS")
 exit
 end

' Loop through each resource theme and do a SelectByTheme using theChoice as the selection theme
for each t in themeList
```

```
  'Clear any previously selected features
  t.ClearSelection

  theVTab = t.GetFTab
  theName = t.GetName
  if (theName = "Roads" or (theName = "Shoreline")) then continue
  end
  impact = av.GetActiveDoc.FindTheme (theChoice)
  t.SelectByTheme (impact, #FTAB_RELTYPE_INTERSECTS, 0, #VTAB_SELTYPE_OR)
end

' Create a table that will consist of the desired fields
aFileString = "d:\thesis\temp\surf_"+theChoice.AsString
aFileName = aFileString.AsFileName
final = VTab.MakeNew (aFileName, dBase)
final.SetEditable (True)

'Define the fields for the new table
nameFinal = Field.Make ("Res_Name", #FIELD_CHAR, 75, 0)
lawFinal = Field.Make ("Law_Df", #FIELD_CHAR, 100, 0)
noteFinal = Field.Make ("Note_Df", #FIELD_CHAR, 125, 0)
restrFinal = Field.Make ("SurfR_Df", #FIELD_CHAR, 100, 0)

' Add the fields to the file
fieldList = {nameFinal,lawFinal,noteFinal,restrFinal}
final.AddFields (fieldList)

nameFinal.SetPixelWidth (225)
lawFinal.SetPixelWidth (475)
noteFinal.SetPixelWidth (575)
restrFinal.SetPixelWidth (475)

finalrec = -1

' Get appropriate fields from resource FTab and copy selected features to final
themeList = av.GetActiveDoc.GetThemes
for each t in themeList
 theVTab = t.GetFTab
 selected = theVTab.GetSelection
 if (selected.Count = 0) then continue
 else
  resField = theVTab.FindField ("Res_ID")
  if (resField = nil) then continue
  else

  nameField = theVTab.FindField ("Res_Name")
  lawField = theVTab.FindField ("Law_Df")
  noteField = theVTab.FindField ("Note_Df")
  restrField = theVTab.FindField ("SurfR_Df")
  theVTab.SetEditable (true)
  rec = -1
  rec = selected.GetNextSet (rec)
```

```
    nameString = theVTab.ReturnValueString (nameField, rec)
    lawString = theVTab.ReturnValueString (lawField, rec)
    noteString = theVTab.ReturnValueString (noteField, rec)
    restrString = theVTab.ReturnValueString (restrField, rec)

    finalrec = (finalrec + 1)
    final.SetEditable (true)
    final.AddRecord
    final.SetValue (nameFinal, finalrec, nameString)
    final.SetValue (lawFinal, finalrec, lawString)
    final.SetValue (noteFinal, finalrec, noteString)
    final.SetValue (restrFinal, finalrec, restrString)
    continue
    end
end
end

' Clear selected features from the activity area theme
impact.ClearSelection

aTable = Table.Make (final)
aTable.SetName (aFileName.GetBaseName)
tableWin = aTable.GetWin
if (tableWin.IsOpen.Not) then
  tableWin.Open
end

tableWin.Maximize
```

VII.B.25. c_View.SubConst

This script is executed by depressing the Sub-surface Construction Activity Analysis button from the Base Map view GUI.
It performs the following operations:

1. Prompt the user to select a theme defining the proposed activity area.
2. Overlay the activity area's polygon features with each of the sensitive resources. If they intersect, the resource's name is added to a list.
3. Create a virtual table listing restriction information for each of the impacted resources on the list.
4. Activate the newly created virtual table displaying the restriction information.

```
' This selects the features of each resource theme in the Base Map view that
'  intersects the user-defined activity area for a Sub-surface construction activity

' This will make the Pointer tool active
theTools = av.getActiveGUI.GetToolbar
for each t in theTools
 theTag = t.GetTag
 if (theTag = "pointer") then t.Select
 end
end

'Allow the user to choose the theme to be used for selection
theList = {}
theView = av.GetProject.FindDoc ("Base Map")
themeList = theView.GetThemes
for each t in themeList
 theVTab = t.GetFTab
 theName = t.GetName
 if (theName = "Roads" or (theName = "Shoreline") or (theName = "Subsurf Sensitivity")) then continue
 end
 theField = theVTab.FindField ("Res_ID")
  if (theField = nil) then
   theList.Add (t.AsString)
  end
end
theChoice = MsgBox.ChoiceAsString (theList, "Select the theme you would like to use as an activity
area","PM-CAPS")
 if (theChoice = nil) then
 MsgBox.Info ("No selection made at this time","PM-CAPS")
 exit
 end

' Loop through each resource theme and do a SelectByTheme using theChoice as the selection theme
for each t in themeList
```

```
  'Clear any previously selected features
  t.ClearSelection

  theVTab = t.GetFTab
  theName = t.GetName

  if (theName = "Roads" or (theName = "Shoreline")) then continue
  end
  impact = av.GetActiveDoc.FindTheme (theChoice)
  t.SelectByTheme (impact, #FTAB_RELTYPE_INTERSECTS, 0, #VTAB_SELTYPE_OR)
end

' Create a table that will consist of the desired fields
aFileString = "d:\thesis\temp\sub_"+theChoice.AsString
aFileName = aFileString.AsFileName
final = VTab.MakeNew (aFileName, dBase)
final.SetEditable (True)

'Define the fields for the new table
nameFinal = Field.Make ("Res_Name", #FIELD_CHAR, 75, 0)
lawFinal = Field.Make ("Law_Df", #FIELD_CHAR, 100, 0)
noteFinal = Field.Make ("Note_Df", #FIELD_CHAR, 125, 0)
restrFinal = Field.Make ("SubR_Df", #FIELD_CHAR, 100, 0)

' Add the fields to the file
fieldList = {nameFinal,lawFinal,noteFinal,restrFinal}
final.AddFields (fieldList)

nameFinal.SetPixelWidth (225)
lawFinal.SetPixelWidth (475)
noteFinal.SetPixelWidth (575)
restrFinal.SetPixelWidth (500)

finalrec = -1

' Get appropriate fields from resource FTab and copy selected features to final
themeList = av.GetActiveDoc.GetThemes
for each t in themeList
 theVTab = t.GetFTab
 selected = theVTab.GetSelection
 if (selected.Count = 0) then continue
 else
  resField = theVTab.FindField ("Res_ID")
  if (resField = nil) then continue
  else

  nameField = theVTab.FindField ("Res_Name")
  lawField = theVTab.FindField ("Law_Df")
  noteField = theVTab.FindField ("Note_Df")
  restrField = theVTab.FindField ("SubR_Df")
  theVTab.SetEditable (true)
  rec = -1
```

```
    rec = selected.GetNextSet (rec)
    nameString = theVTab.ReturnValueString (nameField, rec)
    lawString = theVTab.ReturnValueString (lawField, rec)
    noteString = theVTab.ReturnValueString (noteField, rec)
    restrString = theVTab.ReturnValueString (restrField, rec)

    finalrec = (finalrec + 1)
    final.SetEditable (true)
    final.AddRecord
    final.SetValue (nameFinal, finalrec, nameString)
    final.SetValue (lawFinal, finalrec, lawString)
    final.SetValue (noteFinal, finalrec, noteString)
    final.SetValue (restrFinal, finalrec, restrString)
    continue
    end
end
end

' Clear selected features from the activity area theme
impact.ClearSelection

aTable = Table.Make (final)
aTable.SetName (aFileName.GetBaseName)
tableWin = aTable.GetWin
if (tableWin.IsOpen.Not) then
  tableWin.Open
end

tableWin.Maximize
```

VII.C. PM-CAPS Prototype Evaluation Forms

VII.C.1. Instruction Form

Welcome to the Point Mugu Computerized Activity Planning System, PM-CAPS

PM-CAPS is designed to assist resource managers in siting the location for various human activities on San Nicolas Island (SNI) in order to minimize the impact on sensitive natural and cultural resources. SNI is one of the eight major Channel Islands off the coast of Southern California and has an area of approximately 13,400. It contains approximately 60 sensitive plant and animal species and extensive archaeological resources. Besides the species that are considered sensitive because of their relative scarcity, there also are several invasive "weed" species that are of concern to resource managers, who wish to minimize further distribution. These resources are protected by a number of state and federal laws as well as various policies implemented by the US Navy, which manages the island.

SNI is a part of the Point Mugu Naval Air Weapons Station and is managed by the US Navy primarily as a range instrument test site. The island is used for activities such as launching and tracking military ordinances for the purposes of testing the performance of the missiles and the equipment used to navigate and track them. SNI is one of the most heavily instrumented military sites in the world. Access to the island is highly restricted.

One of the more difficult challenges to SNI managers is managing the myriad of sensitive natural and cultural resources without unduly hindering the execution of the military mission. PM-CAPS is intended to assist resource managers in determining what resources would be impacted by proposed military activities and helping them select the most suitable locations. PM-CAPS allows the user to visualize the spatial extents of protected resources and corresponding attributional information. This information includes such things as the resource's legal status, and breeding or nesting season (when applicable). It also has a tool that allows the user to define an area on the island and see what resources would be affected by a certain type of activity in that location and what legal and political restrictions exist to such an impact.

The purpose of this evaluation is to determine if the PM-CAPS prototype is effective in meeting the aforementioned goals in a user friendly manner. You have been asked to use PM-CAPS in much the same manner as the Resource Manager will at SNI. After familiarizing yourself with the tools and data in the application, you will perform an activity impact analysis and review the restrictions provided by PM-CAPS.

Operation of PM-CAPS

The PM-CAPS application operates through an ArcView 3.0a interface. Many of the menus, buttons, and tools found in a default project are present in PM-CAPS. However, some functions have been removed and several new ones have been added. Most of the changes are found in the View document and one new button has been added to the Table document; the Chart and Layout documents remain unchanged from the default ArcView project. Upon loading the PM-CAPS application, the user will be looking at a simple base map view of SNI.

View Document

The Base Map View displays a shoreline and a road theme for SNI. Several resource themes are loaded into the view, but are not displayed initially. The first 10 buttons on the button bar are all new. They are five pairings of two buttons used to turn the displays on or off for all themes of a certain type. The 5 types of themes are animals, plants, cultural resources, weeds, and viewsheds for certain animal species. These themes are displayed by selecting the left button of a set and are turned off by selecting the right button.

There is one new tool added to the far right side of the tool bar of the View document. It is used to create a new theme to represent a user impact area for a proposed activity. Upon selecting this button the user is prompted to name the shapefile that will be created. He/she is then prompted to use the mouse to define one or more polygons on the Base View where they, hypothetically, would like to conduct a military activity.

There are four more new buttons on the far right of the button bar. These are used to conduct activity impact analyses. It has been determined that most military activities that occur on SNI can be categorized as belonging to one of four activity classes:

- fly-over: aircraft and missiles flying below 1000 ft. in elevation
- walk-over: humans passing through an area on foot
- surface construction: (semi-)permanent facility with minimal sub-surface disturbance (E.g. Roads)
- sub-surface construction: involves significant sub-surface impact (E.g. buried electric lines)

When one of these buttons is depressed, the user selects from a pull-down list which activity area theme he/she would like to use for the analysis. PM-CAPS then will create and display a new Table document that

lists each resource that would be impacted by the activity and certain relevant information including legal restrictions.

Table Document

There is one new button on the far right of the button bar. Selection will return the user to the Base Map View.

PM-CAPS Evaluation

After familiarizing yourself with the data and operation of PM-CAPS, please perform this analysis: Assume you are the Resource Manager at SNI and need to locate a site for a specific military operation (you can assume that it is of whichever activity class that you prefer). Use the activity area definition tool and analysis buttons to find a location where the activity is not prohibited.

VII.C.2. User Evaluation Form

PM-CAPS Evaluation Form

Thank you for assisting in the evaluation of the PM-CAPS application prototype. Please take a few minutes to answer each question as fully as possible.

View Document

1. Are the buttons that turn the display on/off for the different types of resources (e.g. animals, plants, etc.) easy to identify and use? How would you change their design or functionality?

2. Regarding the tool that allows the user to create a new theme by drawing the location of a proposed activity area:

a) Are the instructions that appear in the information pop-up windows easy to understand and follow?

b) Is the tool easy to operate?

c) How would you change the design or functionality of this tool?

Activity impact analysis

1. Are the buttons that perform an activity impact analysis (e.g. fly-over, surface construction, etc.) easy to identify?

2. Is it clear how to perform the analysis (I.e. is the process logical and easy to follow)?

3. Did this analysis help you to locate an acceptable site for your proposed activity?

4. How would you change the design or functionality of this process?

Activity impact table

1. Is the activity impact table easy to read and understand?

2. How would you change the design or layout of the table?

Overall impression

What was your overall impression of the PM-CAPS application prototype?

Are the controls easy to understand and operate?

How would you change the design or functionality of the application?

Do you have any final comments or suggestions regarding PM-CAPS?

Thank you for your time and assistance!

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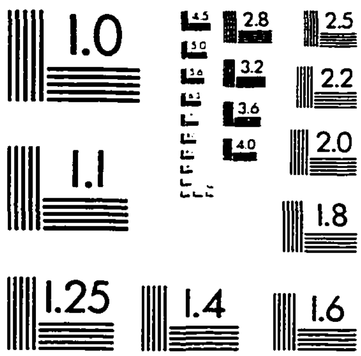
IMAGE EVALUATION TEST TARGET (QA-3)



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