Antelope Island Study: Guidelines for Recreational Land Use Planning for Antelope Island, Utah, Using Computer Techniques

Robert D. Scott Jr.
Utah State University

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ANTELOPE ISLAND STUDY: GUIDELINES FOR RECREATIONAL LAND USE PLANNING FOR ANTELOPE ISLAND, UTAH, USING COMPUTER TECHNIQUES

by

Robert D. Scott, Jr.

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF LANDSCAPE ARCHITECTURE

UTAH STATE UNIVERSITY
Logan, Utah

1974
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ABSTRACT

Antelope Island Study: Guidelines for Recreational Land Use Planning for Antelope Island, Utah Using Computer Techniques

by

Robert D. Scott, Jr., Master of Landscape Architecture

Utah State University, 1974

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Department: Landscape Architecture and Environmental Planning

Throughout the history of traditional land use planning, justification for allocating a land use for a particular area has been accomplished generally in a debilitated fashion. For example, decisions have generally been arrived at by (1) political process—incorporating fringe areas into present land use patterns, or (2) short-term revenue producers are given a land use change from a tax base incentive, or (3) revelations implemented, or other subjective justifications. Except in very few instances, data used to base land use planning decisions was not accurately interpreted for adequate input or not even gathered.

Recently, new and innovative methods for land use planning processes have evolved to gather, interpret and measure data more accurately. More notable processes have been developed by Ian McHarg, Peter Jacobs, Phillip H. Lewis, G. Angus Hills, David Stinton and Carl Steinitz. David Stinton and Carl Steinitz developed a program
called "GRID" which basically utilizes the computer as a tool to process data and display data through computer graphics as maps.

The process implemented in this project to compile and graphically display data was the GRID computer program. The program utilized Utah State University's Burroughs 6700 digital computer. This system has been found to be faster and more economical than the traditional method of overlays without sacrificing accuracy.

Utilizing computer graphic techniques, this project conducted a detailed environmental inventory and analysis of Antelope Island, Utah. Various land use activities were evaluated for their potential impact upon certain natural systems of the island.

The major objective of this thesis is to provide, for interested levels of government and concerned citizens, guidelines for land use planning that will assist them in making more meaningful and accurate decisions of present and future land use in the study area.

This project established recreational guidelines for Antelope Island, Utah, and acts as a study model for recreational land use planning for the cold desert biome states of Arizona, Nevada, and Utah. The study is an environmental analysis and attempts to recognize problem areas sensitive to development. Guidelines deal directly with maximizing recreation potential of the island while minimizing impacts on natural systems such as vegetation, wildlife and soil erosion.
1. Introduction
CHAPTER ONE
INTRODUCTION

Study Area Background

Location
Antelope Island is situated in the southeast portion of the Great Salt Lake and 18 miles northwest of downtown Salt Lake City (see Figures 1-3). The largest of eight islands within the Great Salt Lake, Antelope Island's shoreline elevation is approximately 4,200 feet (depending upon lake level fluctuations). A mountain range runs north-south along the backbone of the island and spreads out over the majority of the island. Vertical rise of the island is 2,400 feet to the maximum peak (elevation 6,596 feet) along the backbone.

Origin
Antelope Island originated as a block faulted structure, typical of most mountain ranges lying within the Great Basin region. Later in geologic time, the island was fragmented into several smaller islands during the stage of Lake Bonneville, a fresh water lake believed to have existed 14,000-100,000 years ago. The ancient lake covered an area of over 20,000 square miles in Utah, Nevada, and Idaho. Depth of the lake at that time was 1,000 feet. Lake levels oscillated, and ancient shorelines are visually prominent, especially the Bonneville, Provo, and Stansbury levels.

Antelope, along with other "islands" in the Great Basin area, is a peninsula that was formed during the drying periods of Lake Bonneville
Figure 2. Regional location map.
Figure 3. Islands of the Great Salt Lake.
following the Ice Age. Later wet periods formed independent basins of water such as the Great Salt Lake. Antelope is the largest of the islands, having an area of 25,918 acres—16 miles long and 5 miles wide.

The island's name

The island was named by John C. Fremont after he and Kit Carson conducted a successful antelope hunt in the fall of 1845. Accordingly, on October 19 that year he wrote: "On the island we found grass and water and several bands of antelope. Some of these were killed, and in memory of the grateful supply of food they furnished, I gave their name to the island." (Fremont, 1887, p. 431)

History of the Island Environment

Fauna

Many small mammals that are typical of Great Basin wildlife live on Antelope Island. Some that may be seen are pocket mice, kangaroo rats, kit fox, and badgers. Coyotes are now extinct from the island. Elk were put on the island in 1894 but adapted unsuccessfully. In 1849 the Mormon Church used the island for stock range. Cattle and horses collected by the Church as tithes were placed there, and for a period, the island became known as Church Island. Years later about 1,000 head of horses inhabited the island with the majority wild as deer. In 1870 one antelope was seen galloping over the hills with a band of wild horses, probably the only one left to represent its once numerous kind (Daughters of Utah Pioneers, 1948). A later attempt was made to range a herd of antelope, but the conditions resulting from overgrazing by
livestock led to the tragic story of an entire herd that perished when they headed for the mainland. Only one reached the mainland shore where it died from exhaustion. No antelope exist on the island at the present time.

Buffalo, or bison, were believed to have roamed the Great Basin for thousands of years and may have inhabited the island before Jim Bridger's discovery of the Great Salt Lake in 1824; however, in 1893 buffalo were introduced to the island. A herd of bulls and cows were driven by cowboys from the mainland. Loading them on an old cattle boat took quite some "coaxing" and several days, for buffalo couldn't be handled like cattle (Daughters of Utah Pioneers, 1948).

The herd grew to 400-500 head, and in 1922 performed a role in the movie "Covered Wagon." Eventually the buffalo herd diminished, and today approximately 50-60 head may be observed occasionally near the state park boundary fence. The herd is privately owned and on private property.

**Bird life**

Archaeological records reveal waterfowl to have been important diet for the Indians on Antelope Island and the surrounding area and perhaps the reason for settlement in the dry and desolate Salt Lake Valley. Jim Bridger, Howard Stansbury, and John C. Fremont reported seeing great numbers of waterfowl during their explorations. The California gull inhabits Egg Island, located one-fourth mile north of Antelope Island, as a rookery or nesting place during the months of March and April. Some of the many birds seen are Canada goose, whistling swan, double crested commorant, white pelican, golden eagle, chukkar,
partridge, western grebes, great blue heron, terns, hawks, ducks, avocets, stilts, curlew, and Wilson's phalaropes.

**Water life**

The large body of the Great Salt Lake has a 27 percent salt content—six times more salty than the ocean. Naturally, few things live in this water except brine shrimp, brine flies, and tiny one-celled plants, of algae, which give the water a blue-green or reddish-brown color. The combination of shrimp and algae produce a distinctive odor near the shoreline. Attempts to place clams, oysters and salmon in the briny water have been made but without success.

**Insect life**

Insects have always been an important food for the birds in the area. Midges, mosquitoes and brine flies (buffalo gnats) are present in swarms during certain periods of the year.

**Current Trends**

The majority of the recreational user public live in the Wasatch Front metropolitan area. For most recreationists, travel time to the island is less than 45 minutes from most points along the Front. In general, land use impacts have been moderate with grazing of buffalo and overgrazing by sheep and cattle as the island's main land uses for the past 100 years. The Utah Travel Council has been campaigning nationwide to promote Utah's recreational and scenic areas; the Great Salt Lake is listed as one attraction. The Travel Council feels that Antelope Island offers various recreational opportunities. The island has
vistas of the Great Salt Lake unmatched anywhere. Sunsets in the Great Salt Lake are world renowned and their prisms of colors are unexcelled anywhere (Miller, 1968). At any particular point along the island's backbone ridge a unique contrast of visual irony can be experienced. One can view westward at that point, down the island's western slope, and out into the Great Salt Lake and experience a natural setting of primitive wildland in contact with an ancient inland sea. A ribbon of white salt keeps the deep blue of the water from kissing the shore.

The scene is placid and tranquil. The islands to the north and west, Carrington, Stansbury, Fremont and Bird, lay calmly silent with their backs above the lake like giant crocodiles warming their rugged bodies in the sun (Ashby, 1966, p. 110).

By contrast, one can reverse his field of vision eastward and overlook the shoreline of the mainland in the foreground with manscapes of industry and urbanization in the middleground and the Wasatch Front silhouetted in the background.

**Present status**

Since its first discovery, Antelope Island has been relatively undisturbed from human impact despite its immediate proximity to Salt Lake City and the Wasatch Front. Antelope Island has retained a natural frontier-like identity. Much of the island has never been driven over because of its rugged topography and the salt water moat around the island. The resources of Antelope Island have, up until now, been of no particular value to the State of Utah.

However, the perspective of Antelope Island is dramatically changing. As the recreation boom is inflating in Utah, pressure has
mounted for the state to locate and develop more campgrounds, hiking areas, sight-seeing spots and other outdoor recreation activities. Antelope Island is one of the top priorities under consideration for its outdoor recreation potential by the Utah Division of Parks and Recreation.

Antelope Island has features of national significance. A senate bill (S. 25) is alive and sponsored by Senator Frank E. Moss (D-Utah) that proposes to allocate money to the National Park Service to buy Antelope Island and develop the island as a national monument. Before any planning and designing of the island can proceed, objectives and guideline criteria need to be resolved. The natural character of the island needs to be maintained to maximize the values of outdoor experiences unique to the island. To work within this framework, guidelines for planning recreational land need to be established.

Objectives

Regardless of the number of proposals intended for Antelope Island, at some point in time decisions about recreational and associated land uses must be coped with. Decisions have to be based upon activities that are attractive but will not cause serious degradation to biological and physical systems and the compatibility levels of those uses.

With this in mind, the objectives of the project are to derive planning and design guidelines which will demonstrate maximizing the utilization and service of the recreational resources in terms of recreational land use types and those land uses associated with
recreation for the study area. Minimizing impacts of those selected land uses also will take place concurrently.

The problem is rather complex and requires the recognition of various components. The first of these is coding data source material for the development of a data bank. The second component is to recognize and list a myriad of potential recreational land uses applicable for the study area. The third component is the recognition of all impacts that might be considered and their application with proposed and existing land uses and the nature of the study area. The fourth component entails the strategies for coordinating land uses and an objective method to evaluate those strategies.

Before introducing the procedural aspects of the study, specific terminology frequently used in the project is defined below:

1. **Attractiveness**: How a particular proposed activity fits a particular site based on criteria standards.

2. **Data bank**: A storage house for all information applicable to the study area.

3. **Data variables**: Information about site resources and physical characteristics of the area.

4. **GRID**: Computer program created to provide a means for graphic display of large quantities of information.

5. **Impact**: What the effect would be on a site resource system if a particular activity was placed on that site.

6. **Processing**: Manipulation of the data and preparation of the map within the computer's memory.
7. **Subvariable**: Specific resources or character describing a particular data variable.

8. **Vulnerability**: How susceptible the site resource systems are to potential damage by proposed activities.

**Procedure**

The methodology in effect for the study area is outlined in the phases below:

- **Phase One**: Data collection.
- **Phase Two**: Attractiveness model development.
- **Phase Three**: Impact model development.
- **Phase Four**: Evaluations of plans and planning strategies.
- **Phase Five**: Guidelines and performance standards for planning and design.

In **Phase One** the creation of a data bank for the study area and the associated site resources was made. The inventory consisted of existing sources for data, aerial photographic interpretations, USGS maps, and field surveys.

Other inventory was supplied by technical consultants and field experts. The coordination of those various resources, data collection and compiling research was a necessary and integral part of the project.

The inventory data was displayed through the utilization of graphically constructed computer maps. Mapped data was stored, analyzed, and displayed by using computer graphics techniques. The computer program to be used (GRID) was created by David Stinton and Carl Steinitz.

The GRID program is simply a way of preparing maps with the aid of a computer. This program utilized Utah State University's Burroughs 6700 digital computer. GRID provides for a highly efficient means for handling graphically displaying large quantities of information collected on the basis of a rectangular coordinate grid (Stewart, 1970). All mapped data was converted through a spatial coordinate system, "UTM," reference notation to the GRID program and displayed on map printouts.

"UTM," Universal Tranverse Mercator System, is simply a metric measuring device that will locate on a grid coordinate basis all data mapped in the data bank. The data bank is a storage of all data collected, mapped, and transferred to the computer. UTM is used because it permits an accurate and economical formula for computation. UTM coordinates are compatible with systems used elsewhere and are convenient for use at local, state, or national government levels. The UTM coordinate system provides a rapid method for determining positions within an accuracy desired. The coordinates are usable for existing as well as future applications (Steinitz and Rogers, 1972).

The graphically constructed maps all display one common cell located in the extreme northwest corner of the study area which is listed under each subvariable as UTM Coordinate Origin. It simply implies a starting point for all "x" and "y" coordinates within the study area, which is a procedural requirement for the GRID program.
Concurrently in the process of data collection was the scaling of a base map scale and grid cell size. To define the correct cell size, the rule of the "least common denominator" was implied. The cell size which most adequately captured the scale and texture of the individual data sets while losing the least amount of given data detail was selected (Fredrick and Lutty, 1972).

Other factors which determined grid cell size were: (1) the scale at which the majority of the data was available, (2) spatial scale of the land uses of which analysis was to be applied, (3) practicality in efficiency in handling data, and (4) computer costs for cell size and number of cells. From a preliminary study of data and Antelope Island's physical size (26,000 acres) a selection of 1/9 kilometer (25 acres) cell size was adequate in handling the overall objectives of data and land use requirements for the study area (see Figure 4); 1082 cells are located in the study area.

The accuracy of a data inventory and subsequent analysis is limited by the grid cell size. In the case of point data (for example, the location of individual dwelling units), the coordinates of the cell in which the object is located are known, but not the specific location within the cell. For line data (roads, trails, etc.), origin and destination cells can be specified but not specific routes within the cells. For area data (tree density, exposed bedrock, etc.), a value can be specified, but not the pattern of that value within the cell. As a rule, any analysis derived from a combination of several variables from several types of zones is spatially accurate only to the scale of its coarsest data zone (Hanson and Skinner, 1973, p. 19).
Chapter Two deals with the background and processing of the data inventory.

Phase Two was the selection of a variety of recreational and associated activities which were considered as components for use of the study area. For each activity an evaluation was made of its space requirements and site criteria. A final list of models was derived from the requirements expressed and availability of data in the research for each activity. Eighteen attractiveness models were constructed for the study. From research of each land use, space requirements and site criteria were converted to related data variables and their subvariables. GRID Program cross analyzed and graphically displayed the most attractive areas for each land use without, at this point, any consideration of impacts. Chapter Three further investigates criteria related to the attractiveness models.

The development of impact models in Phase Three was based upon potential impact of each activity on each site resource system and on each possible location within the study area. The model consisted of the functions of environmental quality, anthropocentric demand satisfaction and fiscal costs and benefits. Models were built to evaluate its vulnerability to damage by each of the programmed recreational land uses. The models measured particular impacts and carrying capacities created by certain land uses on various physical and biological systems. By utilizing this modeling process, it enabled one to locate areas of potentially serious impact from land uses on that system. Through impact maps displayed from the computer, specific cells were pinpointed and problem areas could be identified. Fifteen impact models were
constructed for the study. Discussion of impact models are covered in Chapter Four.

The **Fourth Phase** is evaluation. This phase evaluated two strategies by two separate governmental agencies' master plans. The GRID Program has the capability of evaluating master plans done for Antelope Island and to rate it for attractiveness and impacts. For example, where a plan may have scored poorly in attractively used areas and impacts in a first interaction, a gaining situation evolved, whereby the poor scores could be improved upon and recycled back through the evaluation cycle as a second iteration with the assumption of improving individual and mean scores. Master plans from the National Park Service and the State Division of Parks and Recreation were fed into the Burroughs 6700 as a first iteration. Chapter Five covers these strategies and their evaluations.

**Phase Five** is the development of guidelines and performance standards for planning and design. From the evaluation phase those unidentified limitations and constraints were brought to surface. With respect to environmental constraints, performance standards were brought about with an attempt to smooth over or reduce some of the limiting factors. Through a synthesis of criteria, attractivenesses and carrying capacities, principles of the guidelines for planning and design were expressed.

In summary, the methodology of this study carried through one of the more sophisticated and highly successful planning processes yet devised for land use planning. Figure 5 is an abstract designed by Richard E. Toth which best illustrates this process.
Figure 5. Study process.
2. data variables
CHAPTER TWO

DATA VARIABLES

Data Inventory

Chapter Two deals with the process of data collection for the Antelope Island study area. It is not uncommon when a land use inventory project is started to simply go out and collect all data available. This approach is usually a waste of energy, time and money.

Data

The data base has been determined on two premises: 1) requirements dictated by the analysis of proposed land uses, and 2) the availability of information. Analysis of proposed land uses was based upon various studies of the island. Those land uses incorporated are found in more detail in Chapter Three. Availability of information was compiled from previous studies in which data had been collected that was valid, complete, and useful. Data which is accurate, objective, interrelatable, and representative of the models to be used later may be considered comprehensive, reliable data. For example, data that was collected but found to be at too gross a scale to be interpretable was not fed into the data bank. Precipitation and freeze-free days data existed at too gross a scale to interpolate to become accurate, useful data. However, since the design of the data must be compatible with its use and since its use is often unpredictable, the data bank is expandable and able to be updated. As future data collection improves and becomes increasingly accurate, recycling of new data and removal of old data from the data bank will occur.
Data types

An inspection of the data collected and required for use in the study area has been broken down into three types: raw data, inferred data and created data (Fredrick and Lutty, 1972, pp. 21-22). Raw data was found in a form that was readily usable and compatible with the analysis of land uses. The information was coded directly from its source onto coding maps. Elevation and water by type are variables using this data type. Inferred data needed alteration or derivation before it could be coded on maps. For example, Permeable Bedrock Formations data map was extracted from descriptions and characteristics of bedrock from geologic studies and maps. Created data was data that required derivation from two or more sources of raw data (Fredrick and Lutty, 1972). Vegetation by physiotype was coded in this manner.

Three steps are required in the preparation of a computer map (Murray et al., 1971): 1) The computer must be provided with data in a compatible form (input). 2) The program must allow for the internal manipulation of data in order to produce a computer printout map (processing). 3) The actual printout must have a range of values that are readable (output). Data must be available in a form that is compatible with the computer equipment (hardware) and the programs (software) with which it is processed to be displayed as a map (Steinitz et al., 1969).

Data source

Data collection was extracted from a variety of sources. Major sources consisted of United States Geological Survey (USGS) maps, aerial photographs, previous studies and literature, local technical
experts, and field investigations. The Utah Division of Parks and Recreation also provided useful information.

Data coding

Three separate methods were used in the study area to code data types. First was simply recording the presence of lack of a particular data item within a cell. The second is coding by predominant type. This records the data item which occupies the largest area within the cell. The third method is percentage coding. This records the percentage of the area of the cell occupied by a data item (Fredrick and Lutty, 1972).

The following is a list of 21 data variables and 117 data subvariables selected.

Data Inventory Variables

1. Elevation
   - 0 - 4200-4500
   - 1 - UTM coordinate origin
   - 2 - 4500-4800
   - 3 - 4800-5100
   - 4 - 5100-5400
   - 5 - 5400-5700
   - 6 - 5700-6000
   - 9 - 6000-6596

2. Orientation
   - 0 - Water
   - 1 - UTM coordinate origin
2 - Flat (<3% topographic slope)
4 - South-southwest
5 - East-southeast
6 - West-northwest
9 - North-northeast

3. Land ownership
0 - Private (Antelope Island Cattle Company, Inc.)
1 - UTM coordinate origin
4 - State (Division of Parks and Recreation)
5 - Fresh water body
6 - Salt water body

4. Circulation
0 - No road
1 - UTM coordinate origin
5 - Jeep trail
7 - Unimproved dirt road
9 - Graded dirt road

5. Major lake shorelines
0 - No shoreline
1 - UTM coordinate origin
2 - Lake water
3 - Great Salt Lake shoreline (4200')
4 - Stansbury shoreline (4500')
5 - Provo shoreline (4820')
9 - Bonneville shoreline (5200')
6. Surface water by type
   0 - No surface water
   1 - UTM coordinate origin
   4 - Intermittent stream
   6 - Fresh lake body
   7 - Salt lake body
   8 - Reservoir
   9 - Spring area

7. Exposed bedrock
   0 - None
   1 - UTM coordinate origin
   5 - 1-25%
   6 - 26-50%
   9 - 50%+

8. Vegetation crown density
   0 - None
   1 - UTM coordinate origin
   5 - 1-25%
   6 - 26-50%
   9 - 50%+

9. Slope
   0 - Water
   1 - UTM coordinate origin
   2 - Flat (<2%)
   3 - 2.0-8.0%
   4 - 8.1-16.0%
5 - 16.1-30.0%
8 - 30.1-50.0%
9 - 50%+

10. Permeable geologic formations
0 - QAG-Colluvium/Alluvium (very permeable)
1 - UTM coordinate origin
3 - TW-Wasatch formation (permeable)
4 - P6F (fractured)-Farmington Canyon Complex (permeable)
5 - P6F (not fractured)-Farmington Canyon Complex (non-permeable)
6 - P6M-Mutual formation (non-permeable)
9 - P6MF-Mineral Fork formation (non-permeable)

11. Wildlife: Bird habitat
0 - None
1 - UTM coordinate origin
3 - Great Blue Heron, California Gull, Double Crested Commorant
4 - Ring Neck Pheasant, Canada Goose
5 - Canada Goose, Mallard Duck, California Gull
6 - California Gull, Long Billed Curlew
9 - Chukar Partridge

12. Wildlife: Buffalo habitat
0 - None
1 - UTM coordinate origin
9 - Buffalo range

13. Wildlife: Mule deer habitat
0 - None
1 - UTM coordinate origin
9 - Mule deer habitat
14. Existing land uses

0  - None
1  - UTM coordinate origin
4  - State recreation area
5  - Grazing
6  - Dry farming
9  - Ranch

15. Unique physical features

0  - None
1  - UTM coordinate origin
2  - Burrow pit
3  - Egg Island
4  - Historical dwelling
5  - Mines
6  - Maximum peak (elevation 6596')
9  - Springs

16. Proximity to springs

0  - 3 or more cells away
1  - UTM coordinate origin
4  - 2 cells away
5  - Adjacent cell
9  - Same cell

17. Proximity to intermittent streams

0  - 3 or more cells away
1  - UTM coordinate origin
4  - 2 cells away
5 - Adjacent cell
9 - Same cell

18. Proximity to graded dirt road
0 - 3 or more cells away
1 - UTM coordinate origin
4 - 2 cells away
5 - Adjacent cell
9 - Same cell

19. Proximity to island shoreline
0 - 3 or more cells away
1 - UTM coordinate origin
4 - 2 cells away
5 - Adjacent cell
9 - Same cell

20. Vegetation by physiotype
0 - Barren
1 - UTM coordinate origin
3 - Halophytes
4 - Grassland
5 - Sage/grass association
6 - Raparian
9 - Pinyon/juniper

21. Centroid elevation and view
Data Variables

1. Topographic elevation

Topographic elevation is the measure in feet of the earth's height above mean sea level (Hanson and Skinner, 1973). Elevation differences affect location of vegetation associations and changes in wildlife habitat, soil conditions and changes in microclimate.

The shoreline of Antelope Island, elevation 4200', is the lowest altitude while Maximum Peak, elevation 6596', is the highest point. Vertical rise of the island is about 2400'.

Raw data from USGS maps (scale 1:24,000) were used. The maps are contoured at 20' intervals. The coding of elevation is accurate to the nearest 10'. The data subvariables with the exception of subvariable number nine are broken down into six 300' elevation categories.

Data subvariables:

0 = 4200-4500'
1 = UTM coordinate origin
2 = 4500-4800'
3 = 4800-5100'
4 = 5100-5400'
5 = 5400-5700'
6 = 5700-6000'
9 = 6000-6596'

The average elevation of Antelope Island is 5500' (Cohenour and Thompson, 1966). Over 50 percent of the island lies in subvariable one (4200-4500'), as the data map indicates. Other percentages of
subvariables break down as follows: 21%, 4500-4800'; 13%, 4800-5100'; 7%, 5100-5400'; 3%, 5400-5700'; 2%, 5700-6000'; 1%, 6000-6596'.
Figure 6. Elevation.
2. Topographic orientation

Orientation is the direction in which land is sloping. It was interpreted from USGS maps. Orientation determines the quantity of solar radiation on a given parcel of land (i.e., the amount of sunlight striking the ground or vegetative cover). The amount of solar radiation varies over the year as the position of the sun, time of day, cloud cover and orientation. Of these factors, orientation is the most significant. The more exposed an area is to sunlight, the greater the solar radiation. Orientation, coupled with slope and wind data, is a major indicator of microclimate. It influences air and ground temperatures. Areas facing the sun are generally warmer and dryer. Orientation is also used in visual studies and helps to determine land use suitability (Fredrick and Lutty, 1972).

Data subvariables:

0 = Water
1 = UTM coordinate origin
2 = Flat (<3% topographic slope)
4 = South-southwest
5 = East-southeast
6 = West-northwest
9 = North-northeast

Antelope Island is located at 42° latitude and the following conditions are most prevalent in descriptions of the subvariables:

Flat areas were defined as areas of less than 3 percent slope. Slopes less than this are not significant in reference to orientation. Six percent of the island is located here.
Water areas have been described as cells covered by 50 percent or more salt or fresh water.

South, southwest areas are the warmest slopes and least in shadow because they receive the sun later in the afternoon after cool morning temperatures. The slopes comprise about 11 percent of the island.

East, southeast areas receive solar radiation earliest in the day and are in shadow less than northerly orientations. They are predominantly located along the eastern and western shorelines. The subvariable comprises 17 percent of the study area.

West, northwest areas receive some sun, but are mostly in shadow. They are found mostly along the western canyons and account for about 26 percent of the study area. These slopes are also in the direction of prevailing winds.

North, northeast slopes receive the least solar radiation and account for 25 percent of the study area.
Figure 7. Topographic orientation.
3. Land ownership

The size of the study area is 26,000 acres. However, acreage varies inversely to the increased and decreased size of the Great Salt Lake. A chart illustrating the fluctuations of the Great Salt Lake is discussed under data variable 5, lake shorelines. Acreage has varied from 23,000-29,000 acres over the same period of recording lake levels.

Over 90 percent of Antelope Island is owned by a private corporation from Denver, Colorado--Antelope Island Cattle Company Incorporated. The remainder of the island is publically owned. The Division of State Parks and Recreation under the State Department of Natural Resources owns the north end.

Data subvariables:

0 = Private (Antelope Island Cattle Co., Inc.)
1 = UTM coordinate origin
4 = State (Division of Parks and Recreation)
5 = Fresh water body
6 = Salt water body

Historical background of island ownership began when Mormon pioneers claimed title to it from Utah Indians (Paiutes Tribe). The pioneers pastured cattle, sheep and horses in 1849. During that period the island was renamed Church Island. However, "the authorities of the Mormon Church could see Church Island and their long used stock pasture, slipping away from their grasp like a fish released from a hook."

(Ashby, 1966, p. 53) In the 1870's with completion of the transcontinental railroad in 1869, the Union Pacific Railroad Company was granted
the land by the federal government. In 1884 the Island Improvement Company bought the island from Union Pacific and Wells Fargo. Several private individuals bought chunks of the north end of the island in the early 1900's. July 1, 1967, the State of Utah, under the Great Salt Lake Authority, bought 2000 acres of the north end of the island. In the summer of 1972 Antelope Island Ranching Company sold out to the present owners.
Figure 8. Land ownership.
4. Circulation

No paved roads have been constructed in the study area. The state has proposed to surface main roads located on the park end of the island.

Category breakdowns are taken from interpretations from USGS maps, state park maps and field investigations.

Data subvariables:

0 = No road
1 = UTM coordinate origin
6 = Jeep trail
7 = Unimproved dirt
9 = Graded dirt

Circulation of the study area includes 27 percent jeep trails of which are primarily located in canyons along the rugged western slopes. Thirty-one percent are unimproved dirt roads and 42 percent consist of graded dirt roads which are found on the north end and eastern side of the island.
DATA INVENTORY VARIABLE #1: CIRCULATION

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

DATA INVENTORY PREPARED BY ROBERT G. SCOTT, UTAH STATE UNIVERSITY

DATA SUBVARIABLES:

4 ROAD
5 HWY COORDINATE ORIGIN
6 DIRT ROAD
7 GRADED DIRT ROAD
8 RIVER
9 FOREST
10 BARREN
11 APPEARANCE (1 = GOOD, 5 = POOR)

DATA GATHERED, JUNE 1973

LEVELS

SYMBOLS

FREQUENCY

Figure 9. Circulation.
5. Major lake shorelines

The Great Salt Lake is situated in the eastern portion of the Basin and Range Physiographic Province and remains as a surviving remnant of vastly larger ancestral lakes of varying sizes and depths which covered this portion of the Great Basin during the Ice Age of the Pleistocene Epoch. The Pleistocene refers to that period of colder, wetter climate which began one million years ago and ended approximately 10,000 years ago (S. 25 Hearings, Part 2, June 12, 1967). Former strand lines include Bonneville, Provo, and Stansbury at approximately 1000, 600 and 300 feet above the present level of the Great Salt Lake.

Prehistoric shorelines have played a significant part in the process of weathering the island's surface as it is seen today. The topography of Antelope Island changed prominently during the stages of Lake Bonneville. During the Bonneville stage, the action of the waves, assisted by other weathering agencies, cut the island into six smaller ones. As water lowered to the Provo stage, these islands were again connected. During the Provo stage, however, small passes formed which divided the island into five others; as water again lowered, these were connected and at the Stansbury stage, the island had practically the same form as it has now (Larsen, 1957, p. 121). The lake has remained below the Stansbury level throughout the last 10,000 years (Rudy, 1973). Lake level fluctuations through geologic time are illustrated in Figure 10.

Data subvariables:

0 = No shoreline

1 = UTM coordinate origin
Figure 10. Lake level fluctuations. (Source: Eardly, 1957)
2 = Lake water
3 = Great Salt Lake shoreline (4200')
4 = Stansbury shoreline (4500')
5 = Provo shoreline (4800')
9 = Bonneville shoreline (5200')

No shoreline are areas denoted that have no distinct markings of previous shorelines. There are a few exceptions; however, lake level markings are generally poorly defined in these cases.

Lakewater consists of the Farmington Bay freshwater estuary. The bay flows out the north causeway into the Great Salt Lake and is fed by eastern slope drainages, springs and the Jordan River primarily.

Great Salt Lake shoreline has existed at this stage for probably about 3800-7000 years (Morrison, 1965). However, fluctuations of the shoreline have been very erratic as the lake level fluctuation chart indicates (see Figure 11). The highest and lowest levels ever recorded are 4211.65 (1873) and 4191.30 (1963) respectively. The lake is the result of drainage from 54,000 square miles, most of the water coming from mountains to the east (Rudy, 1973).

Stansbury shoreline (4500') formed a series of shoreline cliffs, beaches and spits similar to the two upper levels. The level was reached at probably about 8000-11,000 years ago and lasted several thousand years (Broecker and Orr, 1958). Buffalo Point stood as a separate island. The terraces developed here are characterized as short and narrow with long lines of talus (Larsen, 1957). The water line oscillated during this period between 4470' and 4500' to form several terraces. It was the last of the lakes to contain fresh water.
Figure 11. Great Salt Lake level fluctuations (Caldwell, Richards, and Sorensen, 1970).
Provo shoreline (4800') has the characteristic formations of cliffs, beaches, and spits. Two promitories stood over 1600' and 2000' above the water level. Terraces cut during this period are most prominent and distinctively cut of any of the lake terraces. The Provo period occurred 10,000-13,000 years ago (Broecker and Orr, 1958).

Bonneville shoreline (5200') is a remnant of the vast body of water that spread in basins of Utah, Nevada and southern Idaho (see Figure 12). Coverage was nearly 20,000 square miles, equal to the present size of Lake Michigan (Thornbury, 1969). Lake Bonneville was the largest Pleistocene pluvial lake in the Western Hemisphere (Morrison, 1966). The lake was 285 miles long and 140 miles wide, and it filled and emptied several times during the Pleistocene (Rudy, 1973). Through isotopic dating, the high water level of Lake Bonneville was believed to occur 25,000-14,000 years ago (Morrison, 1966). Ancient levels of Bonneville probably are marked by a prominent terrace with long slopes of talus (Larsen, 1957). This can be clearly seen around the mountain peaks. The terrace averages less than 70' in width, although along the crest of the island in the southern half it exceeds 700' (Larsen, 1957). Formations of spits, beaches and cliffs are also present. An increase in precipitation from 10 to 18 inches annually, with a change of five degrees centigrade cooler annual temperature, would be sufficient to raise the lake to the Bonneville level (Broecker and Orr, 1958).
Figure 12. Lake Bonneville.
Figure 13. Major lake shorelines.
6. Surface water by type

The system used in classifying water types are those expressed by the United States Geological Survey. Overlapping water features in any one cell have yielded to the more predominant surface water type.

Data subvariable:
0 = No surface water
1 = UTM coordinate origin
4 = Intermittent stream
6 = Fresh lake body
7 = Salt lake body
8 = Reservoir
9 = Spring area

No surface water suggests that no surface water of any type is contained within that cell.

Intermittent stream is important to locate the area of natural drainage. Land uses may be affected from locations of drainages. Runoff is carried through the natural channels from late winter snows, heavy summer thunderstorms and fall snowstorms.

Fresh lake body cells are oriented along the eastern periphery of the study area. Cells containing greater than 50 percent area covered by fresh water are included under this subvariable. These cells help aid in locations of freshwater oriented land uses and activities.

Salt water body cells are found along the western periphery of the study area. Cells containing greater than 50 percent area covered by salt water are included under this subvariable. These cells help determine locations of salt water oriented land uses and activities.
The salt water brine is composed of 75 percent water, 18.7 percent sodium chloride, 2.5 percent magnesium chloride, 2.5 percent sodium sulfate and 1.3 percent potassium chloride (Gadd, 1967).

**Reservoir.** One modest sized reservoir exists near the ranch on the eastern side of the study area. It serves as a water supply for inhabitants nearby as well as some livestock. It may have future development possibilities.

**Spring area.** Since water is a rare resource of the study area its most productive use is of critical importance for future development. Cells under this subvariable have at least one or more flowing springs. To date 57 springs have been spotted on the island (Ashby, 1966). Along shorelines and in creek bottoms, the water table is exposed and seeps occur (Larsen, 1957, p. 90). The island has two spring types: 1) Springs resulting from fractured reservoir rock (chiefly schistose rock of the Farmington Canyon Complex (see Data Variable 10, Permeable Geologic Formations); 2) springs from alluvial reservoirs. The former gives off variable outflows of water affected directly by water level which is affected directly by season. The latter contains a consistent percolation and issues a more consistent flow. Wherever the zone of saturation intersects the surface, usually in deep narrow canyons eroded into the terrace gravels, a ground water discharge occurs. As transmissibility in fractures of the schistose rock is much greater than in the terrace gravel, the flow of water is more rapid and produces springs. Seepages occur near the shoreline where the junction of the water table in the alluvium is intersected by a small cliff. Owing to friction in the alluvium, the flow of ground water is retarded and...
is not dissipated quickly; therefore, a supply of water is maintained through long periods of drought.

Much of the alluvium near the present shore has been inundated at least three times during the past 75 years (Larsen, 1957). Porous material along the shore, therefore, has been saturated with salt water. The flushing out of the reservoir depends on its permeability, amount of fresh water available for discharge and freedom with which water could pass through its underlake extension. Much of the unconsolidated material near or under the lake has not been flushed completely and still contains salt water. Although this water is not as salty as the lake water, it is too salty for most uses.

Where the permeable terrace gravels and alluvium are within reach of saline lake water, the water permeates them to lake level except where the level is depressed by fresh water (see Figure 14). The physical principle that governs the relation of the volume of salt water necessary to displace an equal volume of fresh water is directly proportional to the specific gravity. As the salt water is 1/5 (sp. gr. = 1.2) heavier than fresh water, a column of salt water must be balanced at the shoreline by a column of fresh water 6 feet high, 5 feet of which is below the lake level resulting in a water table 1 foot above lake level. A water table 2 feet above lake level would require approximately a 10 foot depth of water, or perhaps slightly less, as the interface of the salt water and fresh water may mix slightly, causing a higher specific gravity.

Most springs on Antelope Island yield palatable water, much of it exceptionally low in mineral content. Water which issues from House
Figure 14. Section of spring occurrences on Antelope Island. (Source: Larsen, 1957)
Spring is said to contain 8 p.p.m. of lithium chloride; other springs on the island are said to be slightly higher in mineral content (Larsen, 1957, pp. 128-130).
Figure 15. Surface water by type.
7. Exposed bedrock

This data variable had direct application to construction and development limitations. The variable also acts as an indicator for rough calculations of depth to bedrock. The bulk of the island is composed of some of the oldest rocks exposed in the Great Basin region. Data was extracted from aerial photographs and interpreted on 1/9 sq. kilometer grid cells.

Data subvariables:

0 = None
1 = UTM coordinate origin
5 = 1-25%
6 = 26-50%
9 = 50%+

None. The subvariable represents those cells having no occurrence of visible bedrock. It may be assumed that greatest depths to bedrock occur here.

1-25%. If any bedrock is exposed and covers up to one-quarter area of a cell, it is categorized here. It is assumed depth to bedrock to be less than above but greater than the subvariable below.

26-50%. Bedrock existing in part or parts and in total, covering greater than one-quarter but less than one-half the area of a cell are denoted here. Depth to bedrock is less deep than subvariables above but deeper than subvariables below.

50%+. Exposed bedrock occurring over more than one-half of the cell area is represented here. Thirteen cells have been recorded. Shallowest depths to bedrock occur in this category.
### DATA INVENTORY VARIABLE X: EXPOSED BEDROCK

**ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH**

DATA INVENTORY PREPARED BY ROBERT D. SCOTT, IOWA STATE UNIVERSITY

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Figure 16. Exposed bedrock.
8. Vegetation crown density

Tree and shrub vegetation is a rare resource on the island. Eight hundred-seventy-four cells have less than 1 percent of tree or shrub form. Density influences wildlife habitat and soil depth, moisture, and texture. The variable also influences visual quality and visual absorption in terms of development capabilities and capacities. Aerial photographs and field investigation were used in collecting this data variable.

Data subvariables:

0 = None
1 = UTM coordinate origin
5 = 1-25%
6 = 26-50%
9 = 50%+

None. Eighty-one percent of the study area has little or no tree or shrub representation. However, through field investigations, up to 25 trees or shrubs were counted in parts of the island under this sub-variable.

1-25%. The category denotes about 17 percent of the island. The majority of cells are located along the canyons and mountain slopes.

26-50%. Of the 1 percent of the study area represented under this category, most cells are present along the upper mountain slopes.

50%+. Six cells representing this subvariable are located near the Maximum Peak area.
Figure 17. Vegetation crown density.
9. Slope

Topographic slope is defined as to the degree to which a given stretch of land is inclined away from the horizontal. Measurement of slope was calculated in percent. The formula used for calculating slope is:

\[
\text{Slope} = \frac{h - h'}{d - d'} = \frac{\Delta h}{\Delta d} \times 100\% ,
\]

h is initial elevation at location d and h' is the elevation at location d'. The distance between h and h' is Δh, and d and d' is Δd (Fredrick and Lutty, 1972, p. 31).

The western slopes are the steeper slopes of the island. Geologic history accounts for this. As in the formation of most mountain ranges in this region, Antelope Island is a homoclinal or block faulted structure from the result of crust tension relieved into great tilted blocks. The structural makeup of the island is a northwest-southeast trending assymetrical anticline as is defined in the Farmington Canyon Complex (see Data Variable 10, Permeable Geologic Formations). Folding is believed to occur in Middle Precambrian time (25 billion years ago). Metamorphism was a result of the Laramide Orogeny (mountain building period--63 million years) and high angled normal faults followed metamorphism (Cohenour and Thompson, 1966).

The data subvariables were formulated from studies of significant slope groupings in their direct relationships to construction for land uses and activities. The slope categories were measured directly from gridded USGS maps and recorded under the following codings:
Data subvariables:

0 = Water
1 = UTM coordinate origin
2 = Flat (<2% slope)
3 = 2.0-8.0%
4 = 8.1-16.0%
5 = 16.1-30.0%
8 = 30.1-50.0%
9 = 50.0%+

Water designates cells containing greater than 50 percent of a cell area covered by water.

Flat (<2% slope). This category is regarded as nearly level to flat and allocates most land uses. Five percent of the island is denoted here.

2.0-8.0% slope is considered to be gently sloping and allows for natural drainage. Eighteen percent of the study area is categorized here. Development possibilities are not limited.

8.1-16.0% slope are moderate slopes, but restricts some land use location, and construction costs begin to increase. The island is made up of 27 percent of 8.1-16.0% slopes.

16.1-30.0% slope are steep slopes that place limitations for many land uses. Increased costs of construction and excessive cuts and grades retard most land use activity. Twenty-four percent of Antelope Island lies here.

30.1-50.0% slope are very steep slopes that prevent most activities and land uses from occurring. Cuts and fills and grading are maximized. Ten percent of the study area lies here.
50.0%+ slope are excessively steep slopes whereby substantial limitations are placed on nearly all land uses and activities. The slopes are most exposed to environmental impacts by land uses. Fifty percent + slope occupy 8 percent of the island.
DATA INVENTORY VARIABLE #6 SLICE

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

DATA INVENTORY PREPARED BY ROBERT D. SCOTT, UTAH STATE UNIVERSITY

DATA VARIABLES:

3 WATER
3 X COORDINATE ORIGIN
4 Y COORDINATE ORIGIN
4 X COORDINATE SLICE (X)
5 Y COORDINATE SLICE (Y)
6 VALUES = 0, 0.00
9 VALUES = 10.00

MAP CELL SIZE = 0.5 SCALE (1/4" = 1.0, DELI U.S.)
DATA SOURCE: U.S.G.S. EOS INTERPRETATION
1974 LAMINATED MAP - U.S.G.S.

Figure 18. Slope.
10. Permeable geologic formations

From aerial photographs the study area appears as a grassland-desert range with a dominant randomly situated north-south trending backbone. Ridges extending downward from the backbone are separated by deep canyons. Alluvium covers about one-third of the upslope onto the bedrock. Physiographic features of recent faulting and border faults of the Basin and Range system are not visually evident (Larsen, 1957, p. 107).

Denoting permeable geologic formations are important for groundwater location. Spring and seep occurrences indicate the existence of important underground water supplies. Average annual precipitation is 16-13 inches. As precipitation falls to the surface of Antelope, the capacity of the rocks to absorb, store and yield water depends on the size and slope of their openings. The openings may be primary, consisting as the pores in the sand, gravel and clay of the ancient lake terraces, or secondary, consisting as the fractures in the schistose rocks. The occurrence of water depends on the character of the rocks and their position with respect to the land surface and the extent to which they are exposed to recharge. With the exception of the slope wash (composed of thin patches of unsorted and unconsolidated debris), all rock above 5200' is schistose. Some schistose rock is also exposed at lower elevations. As the rock has been metamorphosed, the primary pore spaces have been scaled by recrystallization processes, but because of the enormous number of fractures present it is an important reservoir rock. The upper surface of the zone of saturation in permeable soil or rock is denoted as the water table. Not necessarily a
level surface, the water table of the study area slopes with many irregularities caused by differences in thickness and transmissibility of the water-bearing material and by differences in recharge to and discharge from the ground water reservoir at different places. The slope wash and much of the terrace deposits lie above the zone of saturation and do not contain ground water. These deposits do make up a good recharge area because the deposits absorb a considerable amount of precipitation which then percolates into the underlying reservoir area (Larsen, 1957, pp. 127-128). Figure 19 best illustrates this. Various locations of alluvium containing reservoir pockets have a definite influence of development patterns. Areas of higher runoff and shallow watertables are determined by the permeability locations.

The northern third of the island is underlain by Upper Precambrian strata (Mutual and Mineral Fork Formations) and is generally of lower relief. The steeply inclined strata of the Farmington Canyon Complex exist on the southern part of the island and produce many "crags and short" (hogback-like ridges), which uphold a generally higher and precipitous surface (Larsen, 1957, p. 107).

Data subvariables:

0 = QAG-Colluvium/alluvium
1 = UTM coordinate origin
3 = TW-Wasatch Formation
4 = PEF-Farmington Canyon Complex (fractured)
5 = PEF-Farmington Canyon Complex (not fractured)
6 = PEM-Mutual Formation
9 = PEMF-Mineral Fork Formation
Figure 19. Section of geologic formations (Larsen, 1957).
QAG-Colluvium/alluvium represents the most permeable formation of the study area. It consists of sand, gravel and local lenses of silt and clay. Large boulders are numerous and more prevalent near the foothills. The thickness of the unconsolidated material is from the influences of Lake Bonneville with the greatest thickness of unconsolidated sediments located in the area of existing wheat fields along the east side of the island. Small amounts of alluvium are present along the western slopes, with Red Rocks Canyon and Buffalo Scaffold Canyon representing areas of greater thickness. Alluvium is the main reservoir of ground water and supplies most of the water for domestic and livestock use. Water supplies are most prominent where the alluvium is thickest. Forty percent of the island lies in this subvariable.

TW-Wasatch Formation or group consists of variegated continental sediments varying from limestone to coarse conglomerate, both of permeable character. Located along the eastern shorelines, the tertiary rock is divided into two units, the lower unit and upper unit. Make-up of the lower unit is coarse, red conglomerate. The upper unit is primarily pinkish-grey limestone. The limestone unit contains quartzite and limestone boulders aged Mississippian. The formation is 100' thick and represents approximately 4 percent of the study area.

PEF-Farmington Canyon Complex is composed of schistose, gneiss and pegmatites. Fracturing has occurred from faulting and folding in the bedrock. The natural fracturing of schistose rock provides access for an unknown quantity of groundwater which is stored in the fractures. The formation, aged 1580 million years (Odekirk, 1962) is composed of three units: the lower, middle and upper units. The lower unit is
4207' in thickness and comprises of quartzofeldspathic schists containing thin intercalcated amphibolite beds. The middle unit, 2520' thick, is made of quartzofeldspathic schist, mica schist, and amphibolite. Rock color varies from dark green to golden brown. The upper unit is metamorphic rock which is primarily composed of quartzofeldspathic schist and interbeds of amphibolite, quartz schist and metaquartzite. This unit is mostly exposed over the southern part of the island. The positions of these units are illustrated in Figure 19.

The study area contains 5 percent fractured and 35 percent unfractured formations of the Farmington Canyon Complex.

**P6M-Mutual Formation** is chiefly purple quartzite and dolomite with some slate. Maximum Peak (6596') is capped by dolomite. The dolomite is 3-20' thick and precipice forming as relief along western slopes indicates. The thickness of purple quartzite is up to 850'. Sixteen percent of the study area is the Mutual Formation.

**P6MF-Mineral Fork Formation** is located south of White Rock Bay and Elephant and trends southeast toward Maximum Peak. The composition is of metamorphosed sediments including boulders, clay, slate and tillite. Tillite overlies the Farmington Canyon Complex (see Figure 19). The slate unit is 118' thick. This formation makes up 1.5 percent of the island.
Figure 20. Permeable geologic formations.
ll. Wildlife: Bird habitat

Bird species acquainted with the island are coded and mapped in this variable. Selection of species are based upon definite species locations, sporting characteristics and availability of data. Locations of various species were determined in part by the Utah Division of Wildlife Resources and Glen A. Barrett, former manager and ranger on Antelope Island.

Data subvariables:
0 = None
1 = UTM coordinate origin
3 = Great Blue Heron, California Gull, Double Crested Commorant
4 = Red Neck Pheasant, Canada Goose
5 = Canada Goose, Mallard Duck, California Gull
6 = California Gull, Long Billed Curlew
9 = Chukar Partridge

None. Obviously bird species are found here. However, species selected and data limitations have not determined the extent of bird habitat here.

Great Blue Heron, California Gull, Double Crested Commorant. This combination of bird colonies is located on Egg Island, an eighth of a mile off the north tip of Antelope Island. The Great Blue Heron is a large wading bird with long legs, spearlike bill and long neck. The blue-gray bird is 4' tall and has a wing spread of 6'. Food requirements are fish, frogs, aquatic insects, rodents, and insects. Nests are contrived of interwoven sticks forming a platform up to five feet across. Three to six bluish eggs are laid. A survey of Howard
Stansbury's journal states that his men made off with 76 heron eggs when surveying the island and so called it Egg Island. However, today the numbers have dwindled considerably. The shy birds are easily frightened off. **California Gull** is the most numerous specie found in the study area. The adult bird has a white head, gray back and white front. Juvenile birds are gray or brown. They area in the Great Salt Lake region from the west coast in late February and early March. Diets of these scavengers consist of fish, rodents, cereal grains, dead animals, insects and brine shrimp. Nests are selected upon arrival and two or three eggs are laid between April and May. Egg Island is the only site where the double crested commorants have built their nests on the lake proper (Behle, 1958).

**Ring Neck Pheasant, Canada Goose** are located in fields of dry farmed areas along the eastern slopes. **Ring Neck Pheasant** is a bird species not native to the area; however, it is a major game bird source. **Canada Goose** is another important game bird. As Dr. William H. Behle, a noted authority of bird life of the Great Salt Lake, states, "Canada geese by the hundreds congregate on Antelope Island, feeding in the grain and alfalfa fields there." (Behle, 1958, p. 158)

**Mallard Duck, Canada Goose, California Gull** habitat is found along the eastern shoreline that also marks the western boundary of the popularly known Farmington Bay Estuary and Wildlife Refuge. Farmington Bay houses large numbers of **Mallard Duck** and **Canada Goose** game birds.

**California Gull, Long Billed Curlew** exist along mud flats of the eastern shoreline of the study area.
Chukar Partridge has been introduced to the intermountain region and has adapted very well to the varying environmental conditions. Varying habitats of this naturalized game bird consist of grass/sagebrush, pinyon juniper and barren talus slopes between 4600-5800' elevation.
Figure 21. Wildlife: Bird habitat.
Buffalo were first introduced on Antelope Island in 1893. Five years later the initial herd of 12 grew to 17. By 1915 the herd had increased to more than 300 and the island was more popularly known as "Buffalo Island." In 1926 the herd of 450 bison was known as the largest in America. Owners of the herd during that time advertised a perennial "Great Buffalo Hunt" to all parts of the country. For several years after 50-100 bison were killed off or sold annually. Today 50-60 buffalo roam the island.

Data subvariables:

0 = None
1 = UTM coordinate origin
9 = Buffalo range

None. The buffalo herd is confined in the area noted on the data map by fences. The north end of the island has an eight foot chain link fence separating state and private boundaries. The fence extends from White Rock Bay over to Buffalo Bay. The southern end of the island has cedar post fence strung across it.

Buffalo range is the area noted between the two fence lines. The western slopes of the island provide an excellent winter range. The summers find the herd along the northern slopes and in late summer and fall the bison roam the eastern slopes.
DATA INVENTORY VARIABLE #17 WILDLIFE: BUFFALO HABITAT

ANTELOPE ISLAND STUDY AREA, DAVIE COUNTY, UTAH

DATA INVENTORY PREPARED BY MONFET N. SCOTT, IUTAH STATE UNIVERSITY

DATA SURVEYED FOR:
1. HERD COORDINATE ORIGIN
2. BUFFALO HABITAT

MAP CELL SIZE: 2% ACRES (1/100 KILOMETERS)

Figure 22. Wildlife: Buffalo habitat.
13. Wildlife: Mule deer habitat

Well-known in Utah as a major big game species, the mule deer ranges over the island's foothills, canyons and upper slopes. No estimate of the deer population is known.

Data subvariables:
0 = None
1 = UTM coordinate origin
9 = Mule deer habitat

None. The subvariable denotes areas mule deer are generally not found. However, deer have been spotted browsing or prancing through these areas.

Mule deer habitat are the primary areas where mule deer are found. During the summer the big game species moves up to higher slopes and canyons while wintering in the lower foothills.
<table>
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<tr>
<th>Levels</th>
<th>Symbol</th>
<th>Frequency</th>
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<td>3276</td>
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<tr>
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<td>.</td>
<td>1236</td>
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</tbody>
</table>

Figure 23. Wildlife: Mule deer habitat.
14. Existing land uses

Present land uses of the study area were determined from aerial photograph interpretation, state park and USGS maps interpretations.

Data subvariables:
- 0 = None
- 1 = UTM coordinate origin
- 4 = State recreation area
- 5 = Grazing
- 6 = Dry farming
- 9 = Ranch

None. Currently these cells are privately owned and not utilized for agricultural or other purposes. Conservation is the major function of these areas presently.

State recreation area. Two thousand acres of the north end are being prepared for various recreational purposes. Camping, picnicking, and beach activities are being planned and located.

Grazing. This subvariable represents privately owned livestock feeding areas. A majority of the island has been overgrazed several times in the past 100 years by sheep, cattle and horses. Cattle is the predominant livestock used for range grazing, particularly in winter.

Dry farming. Much of the soil overlying the alluvium contains coarse sand and gravel and is utilized for dry farming. However, the particular areas of dry farming are located where unconsolidated material is less coarse. Wheat, alfalfa and hay are the main crops raised.
Ranch. This is the residence of the island's manager. The dwelling and immediate areas surrounding the dwelling have unique features as the next variable will emphasize.
Figure 24. Existing land use.
15. Unique physical features

The definition for identifying an area as being unique is not a simple objective decision in some cases. Uniqueness has a cultural and absolute component (Fredrick and Lutty, 1972, p. 141). The features were interpreted from USGS maps.

Data subvariables:

0 = None
1 = UTM coordinate origin
2 = Burrow pit
3 = Egg Island
4 = Historical dwelling
5 = Mines
6 = Maximum Peak (elevation 6596')
9 = Springs

None. The subvariable represents all cells having no uniqueness identified with them. Ninety-eight percent of the study area is represented under this subvariable.

Burrow pit is located within the state boundary at the north end of Antelope Island. The pit is about 25 acres in area and 35 feet deep. Material from here has been transferred enroute as fill along the north causeway connecting the north end of the study area with the mainland. Although this pit is visually obtrusive, the walls along the parameter display distinct strands of colluvium deposits which are of particular geologic interest.

Egg Island is shoal (small rocky mass) located one-quarter mile off the north end of Antelope Island. Although completely devoid of
vegetation, the entire island is dominated by bird colonies: Great Blue Heron, White Pelican and California Gull in particular. The subvariable represents a unique visual feature.

**Historical dwelling.** Two dwellings exist either in whole or part and possess unusual historical and cultural character. The former is the dwelling of the manager. It has been recorded in historical analogs as the longest continuously lived in dwelling in the state with original occupancy dating back to 1849. Peach and apple orchards nearby have been acclaimed as the first fruit producing orchards in the state. The island was the birthplace for the state's apple industry (Bywater and Barlow, 1909). Walnut sized peaches were first presented to Brigham Young in 1856 when he toured the island. The latter dwelling is located near Lone Tree Springs. The gravesite of Alice Phillips, wife of an island miner and mother of four children, is the only grave known to exist on the island. The remains of their three room hut and homestead are the foundation, a few boards scattered around, the nearby spring and two or three shade trees.

**Mines.** During the 1890's silver and copper had been discovered on Antelope Island. Although mines dotted the hillsides, the mining era on the island was short lived. The larger, more prominent mines have been depicted in this subvariable.

**Maximum Peak** is located slightly above the center of the study area. Representing the highest point of the study area, the elevation (6596') is 2400' above and 11,000' to either shoreline. The average slope to either shoreline is 22 percent. The views from the peak are most spectacular. As William C. Ashby (1966) stated, "A ribbon of
white salt keeps the deep blue of the water from kissing the shore. The scene is placid and tranquil. The islands to the north and west, Carrington, Stansbury, Fremont and Bird, lay calmly silent with their backs above the lake like giant crocodiles warming their rugged bodies in the sun."

**Springs.** Since water is a major limiting factor for development, the springs in themselves are very significant. Nearly all of the island's 57 springs are fenced off to prevent livestock from polluting the precious resource.
Figure 25. Unique physical features.
16. Proximity to springs

The data variable is significant due to the nature of land uses and their probable effects upon water. Design criteria standards in terms of location greatly varies to each individual land use or activity. For example, construction of septic tank drainfields must be located at a minimum of 1500 feet from all shallow sources of culinary water supply, according to State Department of Health Standards (Hanson and Skinner, 1973). The subvariables are coded and self-explanatory.

Data subvariables:

0 = 3 or more cells away
1 = UTM coordinate origin
4 = 2 cells away
5 = Adjacent cell
9 = Same cell
Figure 26. Proximity to springs.
17. Proximity to intermittent streams

The variable denotes natural drainage courses and nearness to them. Drainages become active during spring peak runoff and flash floods caused by heavy summer thunderstorms. Construction and development patterns and their land uses and activities should be limited by location and nearness to intermittent streams. Since vegetation over the island and along the banks of drainages is sparse, erosion impacts and vulnerabilities are high if and when stream banks are disturbed. The sub-variables have been interpreted off USGS maps and are self-explanatory.

Data subvariables:

0 = Three or more cells away
1 = UTM coordinate origin
4 = 2 cells away
5 = Adjacent cell
9 = Same cell
DATA INVENTORY VARIABLE: PROXIMITY TO INTERMITTENT STREAMS

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

DATA INVENTORY PREPARED BY ROBERT P. SCOTT, UTAH STATE UNIVERSITY

DATA SURVARIABLES:
- TRIBAL OR HIGH CELLS AWAY
- HTN COORDINATE ORIGIN
- LVT
- INTERCEPT CELL
- MAP CELL SIZES: 2% RELIES (1% OFF, EXCEPT)

LEVELS

SYMBOLS

FREQUENCY

Figure 27. Proximity to intermittent streams.
18. Proximity to graded dirt road

The data variable is served to record nearness to graded dirt roads which is the major road type and circulation access. Proximity locations aid in designating noise and visual buffers and activities largely dependent upon roadway nearness and access. Data was interpreted from USGS and state park maps. Subvariables are self-explanatory.

Data subvariables:
0 = 3 or more cells away
1 = UTM coordinate origin
4 = 2 cells away
5 = Adjacent cell
9 = Same cell
Figure 28. Proximity to graded dirt roads.
19. Proximity to island shoreline

The data variable is used for denoting nearness to shorelines for regular design standards of salt and fresh water oriented land uses and activities. Data was recorded and coded directly onto USGS maps. The subvariables are self-explanatory.

Data subvariables:

0 = 3 or more cells away
1 = UTM coordinate origin
4 = 2 cells away
5 = Adjacent cell
9 = Same cell
DATA INVENTORY VARIABLE 4144 PROXIMITY TO ISLAND SHORELINE

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

DATA INVENTORY PREPARED BY ROBERT B. SCOTT, UNIVERSITY OF UTAH

DATA SURVARIABLES:

- 0: TONEX: ONE HOME CELL AAWAY
- 1: THE COORDINATE ORIGIN
- 2: ISLAND ANGLE
- 3: ISLAND CELL

MAP CELL SIZE: 24 ACRES (1/4 X 1/4 DEGREES)
DATA SURVEYED: JULY 4, 1979, 4:00 PM

LEVELS

SYMBOLS

FREQUENCY

Figure 29. Proximity to island shoreline.
Vegetation by physiotype

One of the more important data variables is vegetation. Vegetation is influenced by topographic, climatic, hydrologic conditions and their associated functions that encourage plant growth. Vegetative growth occurs under specific conditions which are different at various sites, depending upon the moisture, elevation, orientation, soil type and slope. These factors directly influence the climatic requirements. Soil type and moisture assert more effect on the growth and diversity of physiotypes and their survival under natural conditions (Fredrick and Lutty, 1972). Vegetation physiotypes are used as an indicator of environmental conditions. Vegetation is used for interpolation of such data as soil conditions, such as salt content, available nutrients and physical make-up (Billings, 1970). The fact that soil data for the study area is inadequate permits vegetation physiotype to help interpret soil character. W.D. Billings (1970, p. 42) stated, "Because of the difference in palatability of various plant species to animals, vegetation is a very delicate indicator of the kinds and numbers of animal present and grazing history of the land." For over 100 years Antelope Island has been periodically overgrazed by livestock. Invader species, Bromus tectorum (cheatgrass) and Artemisia tridentata (common sagebrush) dominate some parts of the island.

The study area is typical of many areas in the Great Basin, that of a cold desert-grassland ecosystem. Climate is characterized by severe winters in which most of the 16 inches of annual precipitation occurs and dry summers (Oostings, 1956). Precipitation increases proportionately with altitude.
Data subvariables:
0 = Barren
1 = UTM coordinate origin
3 = Halophytes
4 = Grassland
5 = Sage/grass association
6 = Raparian
9 = Pinyon/juniper

Barren areas are nearly devoid of any vegetation. The cells under this category are along the island's shoreline and consist of water primarily. Egg Island is located in this subvariable.

Halophytes are plants that can tolerate the concentrations of salt found in saline soils (Oostings, 1956, p. 202). The community associations are: rabbitbrush (Chrysothamnus nauseosus), shadscale (Atriplex confertifolia) and greasewood (Sarcobatus vermiculatus). Flowers (1934) states several factors that are characteristic with this association. The plants are good groundwater indicators with measurements recorded from 3-10' depth to water table. Soil pH ranges from 8.0-9.4. Flowers notes that physical agencies of wind and water are continually reducing the salt content of the soil. Wind has carried significant amounts of non-saline dust and deposited it. Water acts by carrying salt in solution to the lake.

Grassland is the predominant vegetation physiotype existing within the study area. Cheatgrass (Bromus tectorum) dominates those grass species covering the island (Wyckoff, 1971).
Sagebrush/grassland is a category representing cells of common sage (*Artemisia tridentata*) invading grasslands. Typical grassland vegetation has been and still is giving way to invaders species via overgrazing and fire control. Fire controls by man permit unnatural conditions to exist in what would be otherwise a climax grassland environment. Common sage invaders will continue successfully so long as fire controls are implemented. The woody shrubs continue living during hot summers, maintaining themselves by thick cuticles on the leaves, restricting transpiration. The shrubs are naturally controlled in grassland environments by fire which destroys all shrubs above ground level. Fire, conversely for many grasses, germinates its seeds (Wyckoff, 1971).

Raparian vegetation are species found along water corridors or intermittent stream beds. Several species have root systems sensitive to water and require direct contact with water for seed germination. Groundwater is important and vital for plant species of this category. Species include shrubby willows (*Salex exigua*), narrowleaf cottonwood (*Populus angustifolia*) and box elder (*Acer regunda*). Other species, mountain brush species, considered as marginal raparian species but included under this subvariable are: mountain maple (*Acer glabrum*), gambel oak (*Quercus gambelli*) and Utah serviceberry (*Amelanchier utahensis*).  

Pinyon/juniper is a forest climax typically found in the Great Basin region and along the island's mountain ridges. This open forest of widely spaced, small trees (10-30') consist of junipers including *Juniperus scopulorum*, *J. osteosperma*, *J. monosperma* and pinyons, such as *Pinus cembroides* and *P. edulis* (Oostings, 1956, pp. 202-203).
Figure 30. Vegetation by physiotype.
21. Centroid elevation and view

The data variable recorded the centroid or average elevation of each cell within the study area. The interpretations were from USGS maps, scale 1:24,000, having an accuracy to 1/2 ± the 20' contour interval. Coding was to the nearest 10'. The lowest and highest elevation subvariables were 4200' and 5360' respectively. No subvariables are listed because of the vastness of elevation codings. A maximum of 240 subvariables are available in the 2400 vertical feet of the study area.

View is a computer program developed by Elliot L. Amidon and Gary H. Elser to be applied to the grid based data bank and graphically portrayed under the GRID program (Amidon and Elser, 1968). In this study it analyzed a topographic surface to determine areas of intervisability from a point or points on a surface. The data variable is also useful in the development of models for the analysis of the visual impact of development in a landscape area (Sinton, 1970).

Twelve view maps (see Figures 31-42) were developed with scanners placed at various points on the island in the Great Salt Lake and Farmington Bay. A composite view map was displayed, pinpointing cells not visible by the scanners. These cells are particularly important for visually unattractive land uses and helped determine planning decisions in Chapter Five.
Figure 31. Visibility for point 10 12.
Figure 32. Visibility for point 181.
Figure 33. Visibility for point 22 36.
Figure 34. Visibility for point 22 19.
Figure 35. Visibility for point 28 17.
Figure 36. Visibility for point 34 18.
Figure 37. Visibility for point 37 22.
Figure 38. Visibility for point 38 17.
Figure 39. Visibility for point 46 26.
Figure 40. Visibility for point 51 1.
Figure 41. Visibility for point 54 36.
Figure 42. Visibility for point 61 24.
Figure 43. Composite map for 12 view points.
3-attractiveness models
CHAPTER THREE
ATTRACTIVENESS MODELS

At this point in the study is the discussion of the proposed land uses and activities. It is anticipated those land uses chosen might be of a variety or range usable for any recreational plan proposed for Antelope Island.

Model Selection

The final selection of activities is based upon two major criteria. The first criteria is the potential of the range of activities that might presumably take place in an area such as Antelope Island under normal circumstances. Activities such as oil drilling and processing and hydroelectric power plants are not considered land uses of normal circumstances and are not included. The second criteria consists of the display of varieties of land use characteristics as demonstrated in space requirements, their demands or their impacts on the site (Murray et al., 1971).

All land uses, including those proposed for the study area, have definite spacial pattern demands. Those spacial demands can be categorized into three pattern types: point, linear and area. Point activities included in the study are those demanding small spacial areas relative to area activities whose scale and context were of much greater proportions. Linear activities were line or corridor oriented and could not function without this dimension. Listed below are
The initial development of each model began by scanning all known
data sources in search for literature on each activity. The methodology
used for the model development is adopted from the Honey Hill Study
of 1971 (Murray et al., 1971). Information is displayed under the following categories:

1) general space requirements;
2) site criteria;
3) service requirements and improvements;
4) related activities;
5) conflicting activities; and
6) data variables.

General space requirements are dimensional standards of space for a specific land use or recreational activity. Site criteria are physical requirements demanded by each land use. Service requirements and improvements are functions in the form of accessibility to and from and maintenance demanded by each use. Improvements are generally minor developments and refinements upgrading the attractiveness of an activity on a particular site. This occurs after initial site development has taken place. Related activities are complimentary land uses or activities occurring on the site or around the fringe area of the site. Conflicting activities are those activities or uses degrading the attractiveness of a site for a specific land use in a visual or physical sense or both. Data variables are those major variables considered most descriptive and essential in determining and meeting site criteria demands. Included in each data variable are explanations of those subvariables relative in terms of site criteria descriptions.
Model Coding

The data variables selected for each attractiveness model had to be prepared for computer processing. All data variables and subvariables were numerically coded single digits ranging from 0 to 9, based upon their related importance to the model. All subvariables were pooled together, interfaced, and aligned in order of most to least essential requirements for meeting the site criteria demands. The most essential subvariables were coded numbers upwards to 9 and least essential coded a minimum digit of 0. The GRID Program has capacity for ten subvariables for each data variable. The maximum number of subvariables employed by any data variable is seven. In examining the coding sheets one may notice the symbol $\#$. This denotes a blank subvariable which represents a symbol that the GRID computer program acknowledged.

Data Variable Weighting

The data variables are displayed according to their importance. More important variables are given heavier weight and are numerically coded as number three for computer processing. The number itself represents a multiple; for example, a data variable having a three weighting is considered three times as important as a variable weighted a one. The data variable weightings are shown along the right margin of the coding sheets.
Map Interpretation

Upon completion of the coding sheets the numerical codes were key-punched and programmed into GRID for processing. Eighteen attractiveness maps have been completed. Each attractiveness map displays prime and poor areas or cells for each land use or activity. Format for interpretation of each map is designated as follows: The darker tone symbols are the more attractive cells and lighter toned symbols are less attractive cells.

Land Use Activities

Attractiveness Model #1: Roads

Data used in the model are specified for two lane paved and one lane graveled roadways and design speeds of 30-45 miles per hour with low DVH (daily vehicle per hour) count in mind. There are three major factors used to determine road location in economic terms. These are based in terms of design, construction and maintenance.

It has been assumed that horizontal alignment must be as directional as topographic considerations permit. Alignment should be consistent; long to short radius curves should be avoided. Vertical alignment should be as smooth flowing as topographic considerations allow. A smooth grade line is desired with "roller coaster" effect avoided (Forest Service Handbook, 1963).

General space requirements:

Road widths--graveled, 14 foot widths (Forest Service Handbook, 1963); paved, 24 foot widths (Utah Department of Highways, 1967).
Right of way—50-80 feet (De Chara and Koppelman, 1969); sufficient to provide for a minimum clearance outside the top of fill slopes and top of cut slopes (Utah Department of Highways, 1967).

Intersections—Site clearance should be 200 feet minimum in each direction; horizontal and vertical alignment should compliment each other; avoid short radius horizontal curves near a pronounced crest or sag vertical curves (Forest Service Handbook, 1963).

Site Criteria:

Slope variation, 0-16 percent (Murray et al., 1971); or in rugged terrain, steeper cut and fill slopes will be required when excessive quantities would result with special slopes. Slopes are subject to variation as may be recommended where existing right of way is restrictive and costs for providing additional right of way are excessive (Utah Department of Highways, 1967).

Depth to bedrock, 3-10 feet (Murray et al., 1971);
Depth to watertable, greater than 5 feet (Murray et al., 1971); location of crossings with natural drainage swales should be avoided.

Orientations, southeast, south, southwest;
No crown density of vegetation;
Shorter, younger, deciduous vegetation preferred;
Coarse sand and gravel soil (Murray et al., 1971);
No land forms.
Service requirements and improvements:

Required road access, snow removal, road maintenance station, rest stops, periodic upgrading, roadside parking.

Related activities:

Motor bikes, bicycling, utilities, commercial center, parking lot, horseback riding, other uses dependent upon road access.

Conflicting activities:

Any use blocking road access.

Data Variables:

Of those variables considered, the major data variables are listed below:

2--Orientation
6--Surface water by type
7--Exposed bedrock
8--Vegetation crown density
9--Slope
10--Permeable geologic formations
20--Vegetation by physiotype

Orientation is the first category of data. 100% water is not acceptable because of design and construction limitations as well as economic considerations. Flat (<3% topographic slope) is highly desirable for maximum flexibility to horizontal alignment and minimal costs in design construction and maintenance. East-southeast is next preferred for reasons of frost action and duration of exposure to the sun in winter. South-southwest slopes are the warmest slopes.
Consequently, during winter freeze-thaw cycles it causes potentially higher slumping problems in cut and fill areas; thus, it is not as desirable. West-northwest and north-northeast are not desirable because of safety hazards and ice maintenance problems.

**Surface water by type** is the second data category. Areas of no surface water or drainage are most acceptable for cost and construction considerations. Intermittent streams and spring areas and other natural drainage swales may be affected in terms of surface runoff in quantity and directional flow for reasons of fill operations and diking water along side a road. Road location near these water areas are not desirable. Fresh lake bodies and salt lake bodies should be avoided because of increased costs in construction for spanning those features and problems affiliated with lake level fluctuations. Reservoirs are not acceptable areas for possible interference of vertical and horizontal alignment.

The third data category is **exposed bedrock**. Areas of no exposed bedrock are desirable for economic considerations in construction and particularly minimization of blasting and ripping operations. 1-25% exposed bedrock is next preferred for lower depths to bedrock that are most likely here. Lower depths to bedrock minimize cutting costs and reduce need for blasting and ripping under normal practices. 26-50% exposed bedrock is acceptable; however, bedrock depths are likely to be shallower than the above subcategories. 50%+ exposed bedrock is least desirable for reasons of shallow bedrock depths and inflated construction costs in horizontal alignment.
The fourth data variable is vegetation crown density. No vegetation density is most preferred. However, some vegetation may be allowed along road right of ways and remaining subvariable rankings from most desirable to least desirable are as follows: 1-25%, 25-50%, and 50%+. The fifth data category is slope. 100% water is not acceptable because of design and construction limitations as well as economic considerations. Flat (<2% slope) is most preferred for flexibility of horizontal alignment and minimal costs in design, construction and maintenance. 2.0-8.0% is next preferred. Cuts and fills are moderate and horizontal alignment is flexible. 8.1-16.0% represents an upper limit. Cuts and fills increase and flexibility for horizontal alignment is reduced. Costs in design and construction increase proportionately to increased erosional problems. 16.0%+ is not desirable for reasons of excessive cuts and fills, sheet erosion problems and high construction costs.

Permeable geologic formations is the sixth category of data. Qag-colluvium/alluvium is most desirable for its coarse sand and gravel character. This is favorable for road sub-base and backfill in construction. TW-Wasatch formation is next preferred because of its coarse conglomerates and also favorable for sub-base and backfill. PEF-Farrington Canyon complex, PEM-Mutual Formation and PEMF-Mineral Fork Formation are predominately metamorphosed rock and do not contain coarse sands, gravel or conglomerates in significant amounts and are not as desirable.

Vegetation by physiotype is the seventh data category. Barren is not favorable for maintenance costs of persistent erosional problems.
An exception is an area composed primarily of bedrock. Halophytes, grassland and sage/grass association are preferred because of minimal interference with sunlight penetration during winter months which reduces winter maintenance.  *Raparian* is deciduous in character and does allow sunlight penetration for snow melt, thus is acceptable. *Pinyon/juniper* acts as a windbreak barrier causing snowdrifts and increased winter maintenance. It is not a desirable type of vegetation also because of its coniferous character and preventing snowmelt by sunlight.
ATTRACTIONNESS MODEL NO. 1 Roads

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<td>Permeable Geologic formations</td>
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<tr>
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<td>Vegetation by physiotype</td>
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</table>

**Figure 44. Coding form: Roads.**
Figure 45. Attractiveness Map 1: Roads.
Attractiveness Model #2: Grazing

Grazing is the longest and periodically most overused activity on Antelope Island. The model was focused on grazing habitat by domestic livestock, sheep and cattle.

**General space requirements:**

Variable, depending upon domestic specie;

not less than one cow per acre;

not less than five sheep per acre.

**Site criteria:**

Vegetation—grasses and shrubs (Parker, 1969), cover of native and naturalized grasses, shrubs, forbs and other forage plants and trees.

Slopes—0-8 percent.

Water—1.5 miles maximum to surface water (Parker, 1969);

   water types to contain year round flows.

**Service requirements and improvements:**

Some fencing required and construction of small reservoirs.

**Related activities:**

Horseback riding, buffalo habitat, deer habitat.

**Conflicting activities:**

Any use or activity terminating grazing areas and increased competition by buffalo, deer and/or antelope.

**Data variables:**

2--Orientation

6--Surface water by type

9--Slope
Orientation is the first data category. South-southwest and east-southeast are most preferred for sun radiation and snowmelt and more readily exposing winter feed. Flat (<3% topographic slope) is next preferred because of low exposure to winter sunlight. All other orientations are not nearly as desirable.

Surface water by type is the second data variable. Fresh water body, reservoirs and spring areas are most favorable for their availability of year round water supplies. Intermittent stream is next preferred but is limited by not containing surface water part of the year. No surface water and salt water body are not acceptable. Salt water is too strong to be palatable.

Slope is the third data category. Studies show that cattle have been able to graze up to 55 percent slopes (Cook, 1966). However, slopes of this nature are extremely hazardous not only for cattle but compounded erosional problems caused by overgrazing. Flat (<2% slope) areas are most favorable. 2.0-8.0% slope is next preferred. Slopes greater than 8.0% are not as preferable and are proportionately less desirable with the increased percentage of slope.

The fourth data variable is existing land uses. Areas of dry farming are most desirable because ideal food sources are available in the cropland fields. Ordering of the other land uses from most to least desirable are: grazing, none, state recreation area and ranch.
The fifth and sixth data categories are proximities to springs and intermittent stream. Obviously, the closer proximity to these water types is the more preferred. Subcategory listings from most to least preferred are: same cell, adjacent cell, two cells away and three or more cells away.

Vegetation by physiotype is the final data category used in this model. Grassland and sage/grass association are the most favorable sources of food supply. Raparian and pinyon/juniper are next preferred. Barren and halophytes are least desirable because of their scanty food source supply and seasonal toxic character possessed by some halophytes.
### ATTRACTIONNESS MODEL NO. 2 Grazing

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<td>Proximity to spring</td>
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<td>Proximity to intermittent stream</td>
</tr>
<tr>
<td>20</td>
<td>Vegetation by physiotype</td>
</tr>
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</table>

### Figure 46. Coding form: Grazing.
Figure 47. Attractiveness Map 2: Grazing.
Attractiveness Model #3: Reservoir

Small reservoirs create new water fowl habitat areas and alternate scenic values. Small reservoirs proposed for the study area would serve several functions. Flood control of drainage swales would reduce the danger of swales prone to flash flooding. Recreation uses could be developed. The development of trout fishing ponds and row boating and ice skating could take place. Water storage could supplement existing irrigation water sources. Water supplies are limited in many parts of the study area. Reservoirs would ease some sites. In considering new reservoirs, land forms forming natural bowls or pockets need to be identified and protected from development.

General space requirements:

10-20 acres; drainage swale within close proximity to water source.

Site criteria:

Good water quality, water source minimum 5 parts per million oxygen content, pH 6.0-8.0, temperature range 33°-75°F.

(Marriage, Borell, Scheffner, 1971).

Pond depth, 10-12 feet over one-quarter or more of pond area. Elevation above 5000 feet for more precipitation; low annual temperatures and less evaporation (Marriage, Borell, Scheffner, 1971).

Soil that holds water without excessive seepage. Thickness of strata, permeability and relation to underlying strata, consideration of foundation conditions (Bureau of Reclamation, 1960).
Service requirements and improvements:

Emergency spillway, parking, clearing of aquatic vegetation before winter ice forms; periodic inspection of emergency spillway, dam structure and water quality, trickle tube and fencing from livestock. In some areas where soils are permeable, impervious linings may need to be installed.

Related activities:

Picnicking, fishing, rowboating and ice skating.

Conflicting activities:

Any use that destroys water quality or activity causing increased erosional problem of the earth fill dam structure.

Data variables:

1--Elevation
6--Surface water by type
9--Slope
10--Permeable geologic formations
16--Proximity to springs

The first data category is **elevation**. Minimum elevation of 5000 feet is preferred for desirable water temperatures and higher water quality. Elevations below 5000 feet are not as desirable.

The second category of data is **surface water by type**. Water types having cold fresh water are most favorable. **Spring area** is the most preferred subvariable. **Intermittent stream** and **reservoir** are next desirable for flood control purposes. **Fresh lake body** has limitations for not having efficient water quality standards desired in the model. No
Surface water is not acceptable. Salt water body is obviously not acceptable because of low water quality and excessive pH readings.

Slope is the third category of data. Slopes 2.0–8.0% are most desirable, especially for trout habitat requirements. Flat (<2% slope) is next preferred. 8.0%+ slopes are not preferred. Water subvariable is not desirable because of high pH readings and generally low water quality.

The fourth data variable in the model is permeable geologic formations. The model requires nonpermeable materials for prevention of seepage and leakage. P6F-Farmington Canyon Complex (not fractured), P6M-Mutual Formation and P6MF-Mineral Fork Formation are acceptable for the nonpermeable character in these formations. The permeable formations of Qag-Colluvium/Alluvium, TW-Wasatch Formation and P6F-Farmington Canyon Formation (fractured) are not preferred. In some cases a reservoir site may be favorable but increased costs for construction of a nonpermeable membrane liner would need to be considered.

The final data variable used in the reservoir model is proximity to springs. Closer location to spring sources are more preferred for higher water quality. Subvariables listed from most to least preferred are: same cell, adjacent cell, two cells away and three or more cells away.
### ATTRACTIVENESS MODEL NO. 3 Reservoir

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<td>Permeable geologic formations</td>
</tr>
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<td>16</td>
<td>Proximity to springs</td>
</tr>
</tbody>
</table>

Figure 48. Coding form: Reservoir.
Figure 49. Attractiveness Map 3: Reservoir.
Attractiveness Model #4: Trails

For purposes of this model related trail activities have been combined together. However, individual trail type demands have been given special considerations. Those trail types employed in the model are: hiking trails, nature trails and riding trails (nonvehicular).

**General space requirements:**

**Hiking trail**—Day use, 20 hikers per mile;

- well defined and maintained tread, 4-6' wide,
- 10' right of way, maximum distance 20 miles;
- 24 acres of land;
- gradient average 0-5%, not to exceed 16%;
- parking for 25 autos minimum located at trail head (California Public Outdoor Recreation Plan, 1960).

Parking 10 acres (Louisiana Parks and Recreation, 1966).

**Nature trail**—Identification of natural feature and ecology with 15-18 features first one-half mile (Forest Service Miscellaneous Publication 968, 1964);

- trail length, 2 miles and width 4-6', 10' right of way;
- 10 people per mile of trail carrying capacity (Louisiana Parks and Recreation Commission, 1966);
- preferred loop or figure 8 loop (Forest Service Miscellaneous Publication 968, 1964).
Riding trail (nonvehicular)—Ten foot width and maximum distance of 20 miles (Louisiana Parks and Recreation, 1966). Grades not to exceed 8 percent with sections of 4 percent or less gradient at 500 foot lengths every mile (BLM, 1966).

Site criteria:

Slopes, 0-16%;
medium to low vegetation crown density;
vegetation height 20 feet desirable;
surface water at 6 mile intervals;
view points, vista areas, overlooks, high visual contrast;
close proximity to unique features;
minimum trail distance from roads, 500 feet.

Service requirements and improvements:

Parking near trail head for accessibility;
periodic cleanup control;
rest stops and benches 2-3 mile intervals;
campsites, two campsites 5 acres each, 15 miles apart (Murray et al., 1971);
trailside markers interpretive and orientation signage (Forest Service, 1964);
nature study or interpretation center;
bridges and mulch cover along trail.
Related activity:
Photography, picnicking, nature study center.

Conflicting activity:
Hunting, roads, domestic grazing, and most types of development.

Data variables:
5—Major lake shorelines
8—Vegetation crown density
9—Slope
15—Unique physical features
16—Proximity to springs
18—Proximity to graded dirt road

Major lake shorelines is the first data category. Bonneville, Provo and Stansbury shorelines are most preferred because of the significant geological and physical character featured on the island. The lake terraces meet most site criteria included for trail activity. The higher Provo and Bonneville lake terraces possess very fine visual resources via vistas and views. The Great Salt Lake shoreline is next preferred followed by no shoreline cells. Lake water is not desirable because of increased construction expenses in spanning these features and water quality is not suitable for drinking purposes.

The second data variable is vegetation crown density. Since vegetation of any crown density occupies less than 20 percent of the study area utilization of this resource would greatly add to a diversity of visual experiences. Higher densities are more suitable. Rankings of subvariables from most to least preferred are 50%+, 26–50%, 1–25% and none.
Slope represents the third data category. Site criteria for slope ranges from 0-16 percent. Flat (<2% slope) and 2-8.0% are most preferred. 8.1-16.0% is next preferred. Increased percentages over 16.0 percent are proportionately less preferred.

Unique physical features is the fourth data variable. All features except burrow pit are most preferred along side or at destination points of the trail. Burrow pit is generally considered an eyesore presently.

The fifth category of data is proximity to springs. Closer proximities are more desirable particularly for purposes of drinking and interpretation of the unique feature. Subvariables ranked from most to least desirable are: same cell, adjacent cell, two cells away, and three or more cells away.

Proximity to graded dirt road is the sixth data variable. The greater distance away from roads is more desirable for providing greater buffer zones. Three or more cells away, two cells away, adjacent cell and same cell are subvariables rated from most to least desirable.
### ATTRACTIVENESS MODEL NO. 4 Trails

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<td>Unique physical features</td>
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<td>Proximity to springs</td>
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<tr>
<td>18</td>
<td>Proximity to graded dirt road</td>
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<td>Vegetation by physiotype</td>
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#### Coding form: Trails

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Figure 50. Coding form: Trails.
Figure 51. Attractiveness Map 4: Trails.
Attractiveness Model #5: Beach activities

The model incorporated two beach types: freshwater and saltwater beaches. Fresh water areas are located along the eastern shoreline and salt water areas are oriented along the western shoreline of the study area.

**General space requirements:**

Twenty-five feet of shoreline front per swimming party, including 5000 square feet for sunbathing; 25,000 square feet for buffer and picnic area.

Each foot of shoreline should include 100 foot band of water minimum, 200 foot wide band of beach, 100 foot wide buffer for utilities and picnicking per 50 people per day maximum, including turnover rate of three times daily (California Public Outdoor Recreation Plan, 1960).

One hundred-200 square feet of swimmable water per swimmer, 50-100 square feet of beach per swimmer; distance to bathhouse, 800 feet maximum; distance to drinking water 100-300 feet maximum, distance to restrooms, 100-300 feet maximum; distance of bathhouse to parking area 800 feet maximum (Guidelines to Planning, Developing and Managing Rural Recreational Facilities, 1966).

Minimum shoreline length 100 feet.

Three supporting acres of water for each acre of beach; 185 swimmers per acre, over 12 years old, with turnover rate of three per day (Comprehensive Plan for Wisconsin, 1966). Shoreline swimming unit length is 600 feet and width of
665 feet, minimum unit size is 9.2 acres = 1.4 acres water and 7.8 acres land (Louisiana Parks and Recreation, 1966).

Site criteria:

Clean water over deep feet;
sandy bottom free of obstructions;
near picnic facilities (Murray et al., 1971).
Adequate subsurface slopes which will in no way create safety hazards (Guidelines to Planning, Developing, and Managing Rural Recreational Facilities, 1966).
Water temperature 60°+;
easy access.

Service requirements and improvements:

Routine maintenance, water cleanup, glass and litter pickup, road access, gravel or paved roadway;
depth markers at 5 foot depths or greater;
lifeline located at 5 foot depths (Guideline to Planning, Developing, and Managing Rural Recreational Facilities, 1966).
Lifeguard required for every 100 yards of beach.
Improvements of toilet facilities, dock and raft, snack bar, telephone, lighting and controlled parking (Murray et al., 1971).
Two single bath change houses or one partitioned provided for each beach area attracting over 50 swimmers per day (Federal Power Commission, 1965).

Related activities:

Picnicking, hiking, rowing, riding (horse or bike), sailing, and other sporting activities.
Conflicting activities:

Motorboating, fishing, hunting, motorbikes, golf and field sports, shooting range and above ground utilities.

Data variables:

6--Surface water by type
9--Slope
10--Permeable geologic formations
19--Proximity to lake shoreline

Surface water by type represents the first category of data. Fresh lake body and salt lake body are the most preferred subvariables. All other water types are not preferred.

Slope is the second data variable. Flat (<2% slope) is preferred. Water is preferred because of the nature of this subvariable containing pieces of shoreline possible and beach locations. Increased percentages of slope are proportionately less preferred.

The third category of data is permeable geologic formations. The subvariable Qag-Colluvium/Alluvium is the only acceptable subvariable because of physical character of this formation, particularly the composition of oolitic or fine grained sands.

Proximity to lake shoreline is the fourth data variable. The closer proximities to shorelines are obviously more favorable. Maximum acceptable distance is 1000-1500 feet. Subvariables same cell, adjacent cell and two cells away are favorable. Three or more cells away is not acceptable.
**ATTRACTIONESS MODEL NO. 5 Beach Activities**

<table>
<thead>
<tr>
<th>DV. NO.</th>
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<td>Permeable geologic formations</td>
</tr>
<tr>
<td>19</td>
<td>Proximity to island shoreline</td>
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</tbody>
</table>

![Coding form: Beach activities.](image)

**Figure 52. Coding form: Beach activities.**
Figure 53. Attractiveness Map 5: Beach activities.
Attractiveness Model #6: Picnicking

The picnicking attractiveness model desires specific space requirements and site criteria to sustain the desirability and success of that point activity.

**General space requirements:**

- Distance to water, 150-200 feet maximum from any unit;
- Distance to comfort station, 500 feet maximum from any unit;
- Garbage container, 150 feet maximum from any unit;
- Average number of people per picnic site, 5-8 people per table;
- 8-10 family units or 16 group units or picnic tables per acre;
- 50-150 picnickers per toilet;
- Entrance roads, one way, treated desirable;
- 100 feet away from water minimum;
- Fireplace, one for every two units (Guide to Planning, Designing and Managing Rural Recreational Developments, 1960).


Ten picnic units per acre;

Wide walkways for access;


**Site criteria:**

- Slopes 0-8 percent;
- Ground water supply;
- Orientation not north, northeast or northwest;
- Dry, well drained soil;
- Trees, open areas, and rock outcroppings;
view of water;
vegetation height greater than 20 feet;
proximity to water, away from development, near unique features (Murray et al., 1971).

Service requirements and improvements:
Service involves maintenance including trash collecting and general upkeep requiring hard surfaced or graveled road (Murray et al., 1971).
Sanitary facilities;
multipurpose playfields and turf;
campfire circle in bowl of amphitheater;

Related activities:
Hiking, field sports, swimming, beach activities, visual (views, vistas).

Conflicting activities:
Hunting, golf course, archery and riflery range, vacation homes and roads.

Data variables:
2--Orientation
4--Circulation
9--Slope
15--Unique physical features
16--Proximity to springs
17--Proximity to intermittent stream
18--Proximity to island shoreline

20--Vegetation by physiotype

The first data category employed by the model is orientation. All orientations are suitable except north, northwest, and northeast. These orientations are not suitable because of their low sun radiation reception and shorter season.

Circulation is the second category of data. Access is a requirement; however, picnic locations away from circulation corridors are more desirable. The most favorable subvariable is no road. All other subvariables under this category are not suitable.

Slope is the third data variable. 2-8.0% slopes are most preferred for drainage and flat (<2% slope) is next preferred. Increased percentages over 3.0% are proportionately less preferred.

The fourth data category is unique physical features. Picnic locations are more highly desirable and more attractive if special features are within close visual proximity. However, picnic sites nearby Egg Island and Maximum Peak are not totally feasible both environmentally and economically. Burrow pit is a hazardous feature and not desirable in this model.

The fifth, sixth and seventh data variables are proximities to springs, intermittent stream and shoreline respectively. Closer proximities to all these features are more desirable. Subvariables listed from most to least preferred are same cell, adjacent cell, two cells away and three or more cells away.

The final data category for this model is vegetation by physiotype. Raparian vegetation is most preferred for its mixture of species and
character. Pinyon/juniper is next preferred for shade and canopy character. Grassland, sage/grass, halophytes and barren are preferred in that order.
## ATTRACTIVENESS MODEL NO. 6 Picnicking

### DATA VARIABLES

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### DV. NO. SUBVARIABLE RECODING WEIGHT

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Figure 54. Coding form: Picnicking.
ATTRACTIONNESS MODEL #6: PICNICKING
ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH
MODEL PREPARED BY ROBERT N. SCOTT NOVEMBER 1973

Figure 55. Attractiveness Map 6: Picnicking.
Attractiveness Model #7: Golf course

The model is constructed from research in a way most preferred by golfers in terms of layout and acreage. Safety is another consideration. Under this consideration more acreage allotments are preferred and elimination of as many nonparallel fairways has been favored (Hanson and Skinner, 1973). Criteria for a source layout in the model included a practice putting green, practice range, clubhouse, restaurant and parking.

General space standards:

40-50 acres/9 holes, 100 acres/18 holes (Federal Security Agency, 1958);
50-60 acres/9 holes, 125 acres/18 holes (Baltimore County, 1958);
60-90 acres/9 holes, 120-180 acres/18 holes (Erie-Niagra Regional Plan, 1961);
90-acres/9 holes, 180 acres/18 holes (Regional Planning Agency of South Central Connecticut, 1966);
80-90 acres/9 holes, 160-180 acres/18 holes (National Golf Foundation, 1964);
75-90 acres/9 holes, 130-200 acres/18 holes, 30-50 acres/short 18 holes (A Planning Guide, 1965);
40-60 acres/9 holes, 100 acres/18 holes (Guidelines to Planning, Developing and Managing Rural Recreation Facilities, 1966);
70-90 acres/9 holes, 120-160 acres/18 holes, 45-60 acres/3 par 9 hole (The Athletic Institute, 1965);
50-90 acres/9 holes, 110-160 acres/18 holes minimum (Gaylord, 1965);
160 acres/18 holes (Guide for Planning Recreation Parks in California, 1956).
Clubhouse, .25 acres/9 holes;
public and service roads 1.75 acres/9 holes (Sacramento Planning Commission, 1960).

Site Criteria:
Less than 10 percent exposed bedrock;
near stream and open water;
gently flat and rolling slopes, 0-16 percent;
well drained permeable soils;
irrigation water available;
access to main roads;
north and south orientations preferred;
medium to low vegetation density.

Service requirements and improvements:
Service includes parking, vegetation maintenance, fertilizing, service deliveries, and irrigating.
Improvements include lighting, housing development, practice putting greens, driving range, swimming pool, tennis courts and restaurant.

Related activities:
This model is characteristic of a presumptive use. Other than reservoirs it is the only activity that can occur at a given time on the given area.
Conflicting activity:

Since it is a presumptive use, nearly any other activity will conflict with the model.

Data variables:

2--Orientation
7--Exposed bedrock
8--Vegetation crown density
9--Slope
10--Permeable geologic formations
18--Proximity to intermittent stream
19--Proximity to shoreline

The first category of data is orientation. Aspects of east-southeast and south-southwest are preferred for reasons of less confrontation with sun angles and extended seasonal length. Flat (<3% topographic slope) is also preferred for construction and layout economy. West-northwest and north-northeast is not as desirable as the above subvariables. Water is desirable for aesthetic considerations, but may, however, increase construction costs.

Exposed bedrock is the second data variable. Areas of no exposed bedrock are preferred. 1-25% bedrock exposure is next preferred. Other data subvariables included under this variable are not acceptable. Vegetation crown density is the third data category. The visual amenities provided by vegetation densities are most desirable. However, vegetation density and construction cost increase proportionately for tree removal of some areas. Subcategories arranged from most to least favorable are: 28-50%, 1-25%, 50%+ and none.
**Slope** is data category four. Slopes 0-16% are acceptable. Increased percentages of slope are proportionately less preferred.

**Permeable geologic formations** is the fifth data category. Oag-Colluvium/Alluvium and TW-Wasatch Formation are desirable for advantages of permeability. P6F-Farmington Canyon Complex (fractured) is groundwater recharge material; therefore, it is not desirable for the model. All other subvariables are not acceptable because they are nonpermeable in nature.

The sixth and seventh data categories are **proximities to intermittent streams** and shoreline. Closer proximities to these features are most favorable for visual amenities, reservoirs and their holdings for irrigation purposes, and fresh lake water for irrigation.
### ATTRACTIVENESS MODEL NO. 7 Golf Course

**DATA VARIABLES**

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#### SUBVARIABLE RECODING

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Figure 56. Coding form: Golf course.
Figure 57. Attractiveness Map 7: Golf course.
Attractiveness Model #8: Riflery and archery

The model includes space and site criteria for activities not only for riflery and archery but including softball field, soccer field and other active recreation types. Activities under riflery include pistol, rifle, trap and skeet.

General space requirements:

Archery--75 acres including buffer space for safety and 35 acres for 14 stations of field archery. Level unobstructed space 150 yards depth, minimum (A Planning Guide, 1965).

Riflery--50-100 acres according to terrain and distance required to protect adjoining areas from noise (A Planning Guide, 1965).

A trap field is 100 yards by 300 yards in area in open country, 300 yards by 300 yards in wooded areas (add 30 yards for each additional trap). A skeet field is 600 yards wide by 300 yards long (add 50 yards to width for each additional skeet field).

Acreages of trap and skeet fields include facilities for parking, equipment storage shed, and clubhouse (N.R.P.A., 1964).

Site criteria:

Orientation south and north (The Athletic Institute, 1966); north-northeast (N.R.P.A., 1966);

flat slopes, with some slopes (particularly for skeets);
no exposed bedrock;
distant proximities from wildlife habitats, major roads and unique features.

**Service requirements and improvements:**
Periodic maintenance and management supervision;
improvements, including activity building, individual and group picnic units, water and sanitary facilities, parking, fence enclosure, utilities, food and beverage concessions.

**Related activity:**
The model is a presumptive use model. Other than picnicking, it is the only activity that can occur at a given time or a given area.

**Conflicting activity:**
Since the model is dealing with a presumptive use, any other activity will conflict with the model.

**Data variables:**
2--Orientation
7--Exposed bedrock
9--Slope
11--Wildlife: Bird habitat
12--Wildlife: Buffalo habitat
13--Wildlife: Mule deer habitat
15--Unique physical features
18--Proximity to graded dirt road

**Orientation** is the first data category. **Flat (<3% topographic slope)** and **north-northeast** are preferred. All other subcategories are not preferred.
Under the second data category are areas of less exposed bedrock which are proportionately more preferred.

_Slope_, the third data variable, has subvariables _flat_ (<2% slope) most preferred and 2.0-8.0% next preferred. All other data subvariables are less preferred.

The fourth, fifth and sixth data categories represent wildlife habitats. Subvariables that do not have habitat for wildlife are desirable. Wildlife habitat areas are not acceptable for the model.

The final data category is _proximity to graded dirt roads_. The more distant the road proximity, the more favorable. Subvariables arranged from most to least favorable are: _3 or more cells away_, 2 _cells away_, _adjacent cell_ and _same cell_.


Figure 58. Coding form: Riflery and archery.
Figure 59. Attractiveness Map 8: Riflery and archery.
Attractiveness Model #9: Primitive camping

The study area is believed to have strong recreation potential in primitive camping. The western slopes of the island in particular are believed to be highly suitable for primitive camping by the fact that there are minimum impacts in terms of anthropocentric influences on the landscape.

General space requirements:
Campsite, 400-600 square feet per party of two;
3.5 acres per man day is average carrying capacity;
water source, 300-500 feet maximum (Brown and Shoemaker, 1973).

Site criteria:
Slope 0-8.0 percent (Brown and Shoemaker, 1973);
drinking water supply;
well drained soils (Murray, 1971);
near trail;
high visual quality;
high visual absorption for anthropocentric features in particular;
dense vegetation desirable;
close proximity to wildlife;
low exposed bedrock amounts.

Service requirements and improvements:
Campsite rotation and management;
designated campsite;
signage.
Related activities:
Trail system, conservation; natural environmental activities.

Conflicting activities:
Most other recreational activities other than related activities conflict with primitive camping.

Data variables:
4--Circulation
6--Surface water by type
7--Exposed bedrock
8--Vegetation crown density
9--Slope
12--Wildlife: Buffalo habitat
13--Wildlife: Mule deer habitat
16--Proximity to springs
17--Proximity to intermittent stream
18--Proximity to graded dirt road

Circulation is the first category of data. The model prefers no interference with all circulation types. Corridor interference degrades the quality of primitive experience. The only acceptable subvariable is that of no road. All other subvariables are not acceptable.

Surface water by type is the second data variable. Subvariables have been viewed in terms of water quality. Subvariables listed from most to least suitable are spring area, intermittent stream (because of seasonal limitations), reservoir, fresh lake body, salt lake body and no surface water.
Exposed bedrock represents the third variable in the model. Areas of little or no exposed bedrock are most suitable for activities such as tent pitching and garbage burial. 1-25% exposed bedrock is next preferred. Increased percentages over 25% exposed bedrock are proportionately less desirable.

Slope is data category number five. 2.0-8.0% is most preferred for maximum site suitability and drainage justifications. Flat (<2% slope) is next preferred. Increased percentages over 8.0 percent are proportionately less preferred.

Wildlife habitats of buffalo and mule deer represent the sixth and seventh data categories respectively. Areas of habitat of these fauna are desirable for increasing the camping experience quality.

The eighth and ninth categories of data are proximities to springs and intermittent streams. Closer proximities to these features are more attractive. Subcategories arranged from most to least attractive are same cell, adjacent cell, two cells away, three or more cells away.

The tenth and final data category in the primitive camping model is proximity to graded dirt road. Viewing from the point of noise pollution greater distances from these corridors produce stronger buffers, reducing this pollution type. Cells farther away from these corridors are thus preferred for maintaining the primitive experience quality.
# Attractiveness Model No. 9: Primitive Camping

<table>
<thead>
<tr>
<th>DATA VARIABLES</th>
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<tbody>
<tr>
<td>4 Circulation</td>
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<td>6 Surface water by type</td>
</tr>
<tr>
<td>7 Exposed bedrock</td>
</tr>
<tr>
<td>8 Vegetation crown density</td>
</tr>
<tr>
<td>9 Slope</td>
</tr>
<tr>
<td>12 Wildlife: Buffalo habitat</td>
</tr>
<tr>
<td>13 Wildlife: Mule deer habitat</td>
</tr>
<tr>
<td>16 Proximity to springs</td>
</tr>
<tr>
<td>17 Proximity to intermittent streams</td>
</tr>
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<td>18 Proximity to graded dirt roads</td>
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Figure 60. Coding form: Primitive camping.
Figure 61. Attractiveness Map 9: Primitive camping.
Attractiveness Model #10: Septic tank and absorption field

Septic tank sewage disposal systems have been used for decades in both rural and suburban communities. Such a system should function well for many years if it is properly installed and maintained and if the soil of the disposal area is satisfactory (U.S. Dept. of H.U.D., 1968).

General space requirements:

The size of an absorption field needed is determined primarily by the amount of sewage to be filtered and the absorptive capacity of the soil. The amount of sewage depends naturally upon the number of people occupying a house (Bender, 1971). The following page exhibits a graph describing the size of absorption field required for a residence (see Figure 62). Absorption systems should be 1500 feet minimum from shallow sources of culinary water supply. Effluent moving horizontally must pass through six feet of undisturbed soil before surfacing. A septic tank should be six feet from seepage pit minimum, ten feet from a water line minimum, five feet from a foundation wall minimum and five feet from property line minimum (Utah State Division of Health, 1965).

Site criteria:

Four feet minimum of soil material between the bottom of the trenches or seepage beds and any rock formation is necessary for absorptive capacity (Bender, 1971). Well drained soils (preferably sandy and gravelly); 0-16 percent slope;
Figure 62. Absorption field sizes (Bender, 1971).
away from alluvial soils;
soil percolation rate should be one inch per hour (Bender, 1971).

Service requirements and improvements:
Trenches need to be surrounded by six inches of gravel before backfilling with access for inlet and outlet for septic tank. Improvements include sewer hookups and treatment facilities (Hanson and Skinner, 1973).

Related activity:
None.

Conflicting activity:
Any use improperly constructed or located from absorption field.

Data variables:
7--Exposed bedrock
9--Slope
10--Permeable geologic formations
16--Proximity to springs
17--Proximity to intermittent stream
19--Proximity to shoreline

Data category number one is exposed bedrock. Rock outcrops generally are an indication of the formations within the study area that contain shallow soils. These are not suitable for the model. Subvariables arranged from most to least preferred are none, 1-25%, 26-50% and 50%+

Slope is the second data variable. Slopes up to 16 percent usually do not create serious problems, either for construction or functional
maintenance of an absorption field. Increased percentages over 16 percent are not acceptable.

The third data variable is permeable geologic formations. Permeable soils are desirable as was stated in the site criteria. Qag-Colluvium/Alluvium is desirable for the porous character except in canyon bottoms where alluvium prevails with a seasonal high water table. Wasatch Formation is next preferred for its permeable character. The remaining subvariables are nonpermeable, therefore, not as desirable.

The fourth, fifth, and sixth data categories are respectively proximities to springs, intermittent stream, and shoreline. Closer proximities to these water features are less suitable. Arrangement of subvariables from most to least attractive are as follows: three or more cells away, two cells away, adjacent cell, and same cell.
### Attraciveness Model No. 10: Septic Tank and Absorption Fields

#### Data Variables

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<td>Permeable geologic formations</td>
</tr>
<tr>
<td>16</td>
<td>Proximity to springs</td>
</tr>
<tr>
<td>17</td>
<td>Proximity to intermittent streams</td>
</tr>
<tr>
<td>19</td>
<td>Proximity to lake shoreline</td>
</tr>
</tbody>
</table>

#### Coding Form

- **DV No.**
- **Subvariable**
- **Encoding**
- **Weight**

![Coding Form](image)

*Figure 63. Coding form: Septic tank and absorption fields.*
Figure 64. Attractiveness Map 10: Septic tanks and absorption fields.
Attractiveness Model #11: Tent and car camping

The model has space requirements and site criteria covering day, overnight, family and enroute campgrounds for car, trailer and tent camping units. A camping unit is an area that has been developed to accommodate a party of campers. Usually a group of up to eight campers is the maximum high density load or carrying capacity for a camping unit (Douglass, 1969).

Eight principles govern the selection of campsites. These are: size, accessibility, topographical features, soils and drainage, water supply, aquatic areas, natural and artificial hazards and functional suitability (Shivers, 1971).

General space requirements:

Groups—Five acres per fifty persons, short time periods (including sanitary water supply, cooking facilities, open space for tents and space for 25 autos (California Public Outdoor Recreation Plan, 1960).

Tent—Four units per acre including parking (California Public Outdoor Recreation Plan, 1960). One campground should provide a maximum of 90–120 campsites on 12–30 acres; sites include parking space, tent area, table, bench, and camp stove (National Park Service, 1961). Fifteen people or 3 campsites per acre (Recreation in Wisconsin, 1963). Maximum of 3 units per acre (American Camping Association, 1965).
Four units per acre (unit includes table, cooking facilities, tent space bedding and screening), 300 activity days per unit annually (California Outdoor Recreation Plan, 1960).

Tent space, 15 feet by 15 feet for each campsite with separation of 75 feet on each side (FPC, 1965).

Spacing units, 105-120 feet along centerline (BLM, 1967).

Three units per acre (Bureau of Reclamation, 1966).

Ten people per acre or 4350 square feet per person (ORRRC Report, 1962).

**Trailer**—Fifteen units per acre or 50 people per acre (California Public Outdoor Recreation Plan, 1960).

Campsite is 3000 square feet per unit (includes tent space, vehicle parking, cooking and eating facilities, wood storage, trash disposal);

14 units per acre or 56 people per acre;

privacy size is 4000-8000 square feet per unit,

5-11 units per acre, 20-44 people per acre (Soil Conservation Service, 1964).

Fifty acres for 400 people or 100 campsites, 8 acres for 100 autos (Candeub, Cabot and Associates, 1961).

**Family**—Eighteen units per acre of family tent camping

(unit includes tent pad, parking, tables and fire pit, potable water and nearby toilet facilities);
19 acres of undeveloped land to support one developed acre (Louisiana Parks and Recreation Commission, 1966).

Unit located at minimum of 50 feet from camp road, 100 feet from lake, stream or access road; units spaced at least 100 feet apart (Douglass, 1969).

Fifty acres minimum, two way access into and out of campground for fire control, 4 units per acre (A Planning Guide, 1966).

**General**—Camp facilities required within 65-125 miles of user;

4 units per acre in destination campgrounds;

10 units per acre in enroute campgrounds (New Mexico State Planning Office, 1965).

Enroute includes 6 units per acre (space for parking of car and trailer, table, cupboard, stove) (A Planning Guide, 1966).

Forty-five-100 feet between campsites (NRPA, 1962).

For privacy 2500 square feet per site minimum (NRPA, 1964).

Day camp minimum 50 acres for basic facilities and parking for 25 autos or 2 buses per 50 persons (A Planning Guide, 1965).

Overnight camp minimum of 50 acres for basic facilities including cooking stove, sleeping area, parking for 80 persons (A Planning Guide, 1965).
Site criteria:

Slopes 0-8 percent;
orientation not north, northeast or northwest (Murray et al., 1971);
vegetation medium to low density and height greater than 20 feet;
high visual quality;
close proximity to water types;
accessibility to major roads;
close proximity to unique features (Murray et al., 1971);
distant proximity from developments;
well drained soils;
no shallow depths to bedrock and no exposed bedrock;
diverse vegetation;
available water supply for drinking and washing.

Service requirements and improvements:

Maintenance including day to day cleanup and trash pickup, collection of fees (if any), patrol (Murray et al., 1971), paved roads and wood supply.
Improvements include playground, barriers (visual and noise), electrical hookups, paving, hot water, reforestation and landscaping.

Related activities:
Fishing, hiking, swimming, rowing, trails.

Conflicting activities:
High impacting land uses, housing development, golf course, hunting, shooting ranges.
Data variables:

2--Orientation
7--Exposed bedrock
8--Vegetation crown density
9--Slope
15--Unique physical features
16--Proximity to springs
19--Proximity to shoreline
20--Vegetation by physiotype

The first category of data is orientation. Warmer slopes increase seasonal length. Southerly exposures are desirable. Flat (<3% topographic slope) is desirable for primarily economic among other reasons. Northwest, north and northeast orientations are not preferred.

Exposed bedrock represents the second data category. No exposed bedrock is the most preferred subvariable. For reasons of data limitation depths to bedrock have been assumed to be shallower in areas of large percentages of exposed bedrock. Therefore, this subvariable is assumed to contain deeper bedrock depths which is an important consideration for construction costs and toilet infiltrations. Increased percentages of exposed bedrock are proportionately less preferred.

Vegetation crown density is the third data variable. Crown density compliments aesthetic qualities of a camping experience including visual quality. The study does not possess abundant supplies of this resource. Maximization of this resource without consuming it is a sensitive issue. Construction costs are another consideration. Subvariables arranged from most to least preferred are: 26-50%, 50%, 1-25% and none.
The fourth category employed in the model is slope. Acceptable slopes for the model range from 0-8%. Higher percentages are less favorable because of higher construction and maintenance considerations.

Category number five is unique physical features. Unique features add to the attractiveness for camping sites. However, two features of this variable are not feasible attractivenesses. These are Maximum Peak and burrow pit. Maximum Peak can be visually enhancing but close campsite proximities to this feature are unreasonable.

The sixth and seventh data variables are represented by proximities to springs and shoreline respectively. Closer proximities to these water features are more attractive.

The final data category is vegetation by physiotype. Site criteria in the model lists diversity of vegetation. Antelope Island has little diversity. Raparian is most preferred for its greater diversity over other physiotypes. Pinyon-Juniper is next desirable for canopy character. Other data subcategories listed in order of preference are grassland, sage/grass association, halophytes and barren.
**ATTRACTIONNESS MODEL NO. 11 Tent and Car Camping**

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<tr>
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<td>Slope</td>
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<td>Proximity to shoreline</td>
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<td>20</td>
<td>Vegetation by physiotype</td>
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**DV. NO. SUBVARIABLE RECODING WEIGHT**

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</tr>
<tr>
<td>20</td>
<td></td>
<td>1 0 6 4 3</td>
<td>8 2</td>
</tr>
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</table>

Figure 65. Coding form: Tent and car camping.
Figure 66. Attractiveness Map 11: Tent and car camping.
Attractiveness Model #12: Low density vacation homes

The model was viewed with the assumption that these dwellings were considered as second homes for seasonal use in summer as well as winter. The dwelling units were assumed to be rented or leased. Aesthetic considerations strongly influence the marketability of second residences. Sites oriented towards visual amenities or features were noted.

General space requirements:
- Five acres per unit minimum (Murray et al., 1971);
- 2 parking spaces per unit;
- minimum proximity to water features 300 feet.

Site criteria:
- Slopes 0-10% desirable 10-30% available (Urban Land Institute, 1968).
- Well drained permeable soil;
- orientations—flat, southeast, east, west, northwest;
- visual quality desirable;
- high vegetation crown density;
- access to major roads and utilities;
- no geologic hazards;
- vegetation height 10-15 feet;
- depth to bedrock, greater than ten feet (Murray et al., 1971);
- no exposed bedrock.

Service requirements and improvements:
- General road and utility maintenance.
- Improvements include all weather roads, night lighting,
swimming pool, activity center, underground utilities, landscaping, picnic shelter.

**Related activity:**
Golf course, commercial center, trout ponds, hiking trails, picnicking, and other outdoor recreation activities.

**Conflicting activity:**
Any activity upsetting the visual quality or original character of the site including gravel quarries and sanitary landfills.

**Data variables:**
- 2--Orientation
- 4--Circulation
- 6--Surface water by type
- 7--Exposed bedrock
- 8--Vegetation crown density
- 9--Slope
- 10--Permeable geologic formations
- 20--Vegetation by physiotype

Category one, orientation, had subcategories viewed in terms of seasonal maintenance, access availability, micro climate character and vegetational aspects. Morning sun radiation was preferred over afternoon radiation. Orientations arranged in order of preference are east-southeast, flat (<3% topographic slope), south-southwest, west-northwest and north-northeast.

The second category of data is circulation. Access to dwellings is essential. Circulation corridors within the study area are poorly
developed and establishment of improved flow patterns are critical for the attractiveness of home sites.

Surface water by type is the third category of data. Water features are a natural amenity which inflates market values of home sites. Visual quality is complimented. However, avoidance should be considered for construction in drainage swell bottoms because of flash flooding vulnerability.

Exposed bedrock represents the fourth data variable. Areas of no exposed bedrock are most favorable. Bedrock depths are generally greater in areas of little or no exposed bedrock. Increased percentages of exposed bedrock are proportionately less preferred.

The fifth category is vegetation crown density. Visual amenities of higher densities are more desirable. Marketability of sites is influenced positively. Micro climatic influences can be taken advantage of. However, higher initial construction costs are associated with high densities in terms of site clearing. Subcategories 50%, 26-50%, 1-25%, and none are preferred in that order.

The seventh category is permeable geologic formations. Colluvium/Alluvium is most preferred. This formation has greatest depth to bedrock and porous soils excellent for treatment considerations. Most groundwater reservoir supplies are found here. TW-Wasatch Formation is next preferred for soil permeability and depth to bedrock character. All other subvariables are not preferred.

The final data variable employed by this model is vegetation by physiotype. Vegetation diversity is another major amenity for complimenting visual quality. Subvariables arranged by order of desirability
are: raparian, pinyon/juniper, grassland, sage/grass association, halophytes and barren.

The sixth data variable is slope. For justification in construction costs, maintenance costs, and visual quality of topographic diversity, 2.0–8.0% is most preferred. Flat (<2% slope) and 8.1–16.0% are next preferred. 16.1–30.0% is acceptable but caution is stressed for erosional problems and increased construction costs. Slopes over 30.0% are not suitable.
## ATTRACTIVENESS MODEL NO. 12  Low Density Vacation Homes

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<td>20</td>
<td>Vegetation by physiotype</td>
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</table>

Figure 67. Coding form: Low density vacation homes.
Figure 68. Attractiveness Map 12: Low density vacation homes.
Attractiveness Model #13: Conservation

The model deals with the enhancement, insurance, and perpetuation of natural resources. Natural character of the landscape is to be maintained in its undeveloped primitive or wilderness status for protection. For example, preservation of aquifer recharge areas and watersheds are required to avoid possible upsets of natural system chains. The quality of a conservation area is the degree to which it is a natural ecosystem and is able to provide opportunities for physical challenge, independent and creative thinking and spiritual renewal (Brown and Schomaker, 1973). The purpose of this model is then to maintain environmental and aesthetic values of Antelope Island.

**General space requirements:**

Variable, protection and preservation of areas having environmental components consisting of biological, physical, historical and cultural features.

No specific space requirements are cited in the literature. Space requirements have been based upon value judgments.

**Site criteria:**

Areas of wildlife habitat;
unique features;
recharge zones for ground water maintenance;
steep slopes for erosion prevention by anthropocentric influences;
tree stands and vegetation preservation.
Service requirements and improvements:

Fire trails for fire control of dry grass and other vegetation (Hanson and Skinner, 1973).

Reforestation programs for suitable areas; management supervision and control.

Improvements are few except for enforcement of management practices.

Related activity:

Nature trails, primitive camping, swimming, reservoirs and trout ponds.

Conflicting activity:

Any activity causing visible or physical change in the landscape which disrupts visual quality or increases erosion or sedimentation.

Data variables:

5--Major lake shorelines
9--Slope
11--Wildlife: Bird habitat
12--Wildlife: Buffalo habitat
13--Wildlife: Mule deer habitat
15--Unique physical features

Major lake shorelines is the first category. All shoreline strands are important for recharge considerations except the Great Salt Lake shoreline. Greater emphasis has been stressed upon the Bonneville and Provo terraces because the higher elevation levels of these strands receive more precipitation amounts whereby they are fed into the talus for aquifer recharge.
Slope is the second data variable. Steeper slopes are more susceptible for increased vulnerability to erosion, and produce scarring problems. Visual quality of slopes by vegetation removal is not complimentary. Slopes 50%+ are most in need of preservation.

The third, fourth and fifth data variables are wildlife habitats for birds, buffalo and mule deer, respectively. Habitat areas of these fauna are desired for the conservation model.

The sixth data category is unique physical features. All unique features are suitable except the burrow pit subcategory.
## ATTRACTIVENESS MODEL NO.

**Data Variables**

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### Table: Coding Form - Conservation

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</table>

Figure 69. Coding form: Conservation.
Figure 70. Attractiveness Map 13: Conservation.
Attractiveness Model #14: Cliff climbing

Due to the physical nature and hardness of rock material within the study area, the model in no way represents attractive areas for expert cliff climbers. However, the model does express potentially attractive sites for novice and nonprofessional climbers.

General space requirement:
No specific space requirements are available in the literature.

Site criteria:
- Slopes 50%+
- exposed bedrock
- cliff forming or precipice formations.

Related activities and improvements:
- Primitive camping, and road access of moderate proximity;
- little or no site improvements.

Conflicting activity:
- Few known, if any, that influence the site character of the model.

Data variables:
- 7--Exposed bedrock
- 9--Slope
- 10--Permeable geologic formations

Exposed bedrock is the first data category. Greater amounts of exposed bedrock are more suitable. 50%+ exposed bedrock is most preferred. Other subcategories are less preferred proportionately with less exposed bedrock percentages.
Slope is the second data variable. Steeper slopes are more desirable in the model. Slopes over 50% are acceptable and under 50% are not preferred.

Permeable geologic formations is the third data variable. The geologic formations found within the study area that are nonpermeable consist of harder rock material. The nonpermeable rock material is not easily erodible, therefore sustaining steeper slopes once initially formed from uplifts occurring in the Laramide orogeny. The PEM-Mutual Formation contains dolomite material which is precipice forming and highly suitable for the model. Nonpermeable formations of PEMF-Mineral Fork Formation and PEF-Farmington Canyon Complex are next preferred. Remaining subvariables contain softer material and are not acceptable.
**ATTRACTIVENESS MODEL NO.** 14  Cliff Climbing

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<td>10</td>
<td>Permeable geologic formations</td>
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Figure 71. Coding form: Cliff Climbing.
Figure 72. Attractiveness Map 14: Cliff climbing.
Attractiveness Model #15: Small commercial center

The small commercial center model contains activities such as grocery and drugs, service station, restaurant, laundry, tourist and other small shops and parking.

**General space requirements:**

**Service station**—One-half acre including parking, gas and repair service, restroom, underground storage, hydraulic lift.

**Grocery**—One-half acre without parking (contains grocery and household supplies), parking for 15 autos required.

**Restaurant**—One-half acre without parking (50 people maximum capacity), parking for 25 autos at 400 square feet per car (Lynch, 1971).

**Motel**—450 square feet per unit, 10-30 units, parking for 2 autos per unit at 400 square feet per stall.

**Drugs**—One-half acre without parking (contains drugs, soda fountain, variety, sporting goods), parking for 15 autos required.

**Laundry**—One-fourth acre without parking, 1/2 parking stall per washing unit required.

**Service**—One truck per day for every 4000 square feet of selling area (Lynch, 1971).

Parking distance maximum of 300-500 feet from store area (Lynch, 1971).
Site criteria:

Slopes, 0-8 percent;
away from geologic hazards;
dry, well drained soil (permeable for septic tank operation);
lower elevations—less snow buildup or depth;
culinary water supply;
access to major roads;
utilities;
views, vistas;
orientation—south, southwest, southeast;
medium to low vegetation density;
no exposed bedrock.

Service requirements and improvements:

Access for trash disposal and deliveries.
Improvements include drop off and pick up area, emergency vehicle zones, all weather roads, night lighting and underground utilities.

Related activity:

Roads, parking lot.

Conflicting activities:

The model is a presumptive use model and nearly any other activity will conflict with the model.

Data variables:

2—Orientation
4—Circulation
7—Exposed bedrock
Orientation is data variable number one. For reasons of less winter maintenance and warmer micro climates associated with stronger sun radiation, south, southwest, southeast, west, and flat orientations are favorable. Other subvariables possess lesser degrees of sun exposure and are not as desirable.

Circulation represents the second category of data. Access is an important element for attractive sites. Major roads are most preferred. Arrangements of subcategories from most to least suitable are graded dirt road, unimproved dirt road, jeep trail and no road.

The third data variable is exposed bedrock. The model desires cells of no exposed bedrock for subsurface construction and waste disposal sites. Greater depths to bedrock are more desirable and areas of no exposed bedrock are presumed to have deeper soils than the other subvariables.

Slope is the fourth category. Most preferred slopes are flat (<2% slope) for economy in construction and maintenance. 2.0-8.0% slope is next desirable; however, some design limitations and increased construction costs deter higher slope percentages for attractivenesses. For example, terracing the complex, roads, and parking areas may be required. Slopes over 8.0 percent are not preferred for greater design and construction limitations.

Category five is represented by permeable geologic formations. Permeable formations are preferred for less excavation and construction
costs and for waste treatment sites. Gravelly and sandy formations of Qag-Colluvium/Alluvium is most suitable for the model. Well drained permeable soils of this formation is another desirable component. Next preferred is TW-Wasatch Formation. The unconsolidated conglomerate material is permeable and favorable in the model. The other subcategories are not acceptable because of their nonpermeable character.

The final data variable is proximity to graded dirt roads. In view of marketing considerations, closer proximities to major roads of the study area are more attractive. Subvariables arranged from most to least acceptable are same cell, adjacent cell, two cells away, three or more cells away.
**ATTRACTION MODEL NO.** 15  Small commercial center

<table>
<thead>
<tr>
<th>D.V. NO.</th>
<th>DATA VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Orientation</td>
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<tr>
<td>4</td>
<td>Circulation</td>
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<td>Slope</td>
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<tr>
<td>10</td>
<td>Permeable geologic formations</td>
</tr>
<tr>
<td>18</td>
<td>Proximity to graded dirt roads</td>
</tr>
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</table>

**Figure 73. Coding form: Small commercial center.**
Figure 74. Attractiveness Map 15: Small commercial center.
Attractiveness Model #16: Sanitary landfill

The sanitary landfill is defined as a method of disposing of refuse on land without creating nuisances or hazards to public health or safety, by utilizing the principles to reduce it to the smallest practical area, practical volume and to cover it with a thin layer of earth at the conclusion of each day’s operation or at such more frequent intervals as may be necessary (American Society of Civil Engineers, 1959).

The model is to determine attractive sites for disposing of large quantities of solid waste, including organic material and combustible and noncombustible garbage (Lynch, 1971). A landfill that is well controlled is a truly sanitary method of disposal of solid waste upon the land. It consists of four basic operations including: 1) The solid wastes are deposited in a controlled manner in a prepared portion of the site; 2) solid wastes are spread and compacted in thin layers; 3) solid wastes are covered daily or more frequently with a layer of earth; and 4) the cover material is compacted daily (Sory and Hickman, 1970).

General space requirements:

Volume of space required is dependent upon the character and quantity of the solid wastes, efficiency of compaction, depth of fill, and desired life of landfill. For instance, average waste generation rate is 5.3 pounds per day, solid waste density is 1000 pounds per cubic yard, mixture portions are one part earth to four parts waste, 1.5 acres per year per 1000 people.
Settlement is 90 percent years 1-5 and 10 percent over 5 years (Sory and Hickman, 1970).
Refuse volume equals two cubic yards per year per person (Committee on Refuse Disposal, 1966).

Site criteria:
Adherence to legal constraints and zoning regulations.
Accessibility by trucks;
all weather roads;
short haul distance more desirable for economic reasons;
availability of cover material desirable (if not, hauling costs, if not locally available, are increased);
soils with good workability and compaction characteristics are desirable (gravelly sand and loam);
close proximity to springs, lakes, and streams not desirable;
location of site groundwater table and movement of groundwater minimum of 4 feet above water table and bedrock (Hanson and Skinner, 1973).
Water available for fire control;
windbreaks to contain and minimize loose paper and dust problems;
1-16 percent slope;
high visual absorption;
no exposed bedrock.
Service requirements and improvements:

Excavation of trenches, differential settlement, causing need of resloping of surfaces to maintain good drainage and filling in small depressions.

Improvements include parks, playgrounds, golf course, parking, storage areas and botanical gardens upon completed landfill areas.

Related activity:

None (pit area selection may possibly come from empty burrow pits).

Conflicting activity:

Building construction avoided for settling and gas problems ($CO_2$, $CH_4$).

Data variables:

7—Exposed bedrock
9—Slope
10—Permeable bedrock formations
16—Proximity to springs
17—Proximity to intermittent stream
19—Proximity to shoreline

The first data variable is exposed bedrock. Areas of no exposed bedrock are most favorable. Increased percentages of exposed bedrock are proportionately less preferred.

Slope is the second data category. Acceptable slopes range from 0–16%. Flatter slopes are more desirable. Slopes over 16 percent are not acceptable.
Permeable geologic formations represents the third data category employed in the model. The permeable sand and gravelly character of Qag-Colluvium/Alluvium and TW-Wasatch Formation are suitable and attractive formations in the model. Other subvariables are not as permeable and therefore not as suitable.

The fourth, fifth and sixth data variables are proximities to springs, intermittent stream and shoreline, respectively. Close proximities to springs, streams, and lakes are not desirable for possible contamination problems of groundwater supplies. Arrangement of subvariables from most to least suitable are three or more cells away, two cells away, adjacent cell and same cell.
### DATA VARIABLES

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<td>Proximity to springs</td>
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<td>17</td>
<td>Proximity to intermittent streams</td>
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<tr>
<td>19</td>
<td>Proximity to island shoreline</td>
</tr>
</tbody>
</table>

### Figure 75

**Coding form:** Sanitary Landfill.
Figure 76. Attractiveness Map 16: Sanitary landfill.
Attractiveness Model #17: Desert bighorn sheep habitat

Of the existing races and subspecies of desert bighorn sheep, the model is specifically interested in the Nelson bighorn (*Ovis canadensis nelsoni*). The subspecies is found in the native environment of California, south and east of the Sierra Nevadas and in southern Nevada, southern Utah and northern Arizona (Fish and Wildlife Service, 1965).

**General space requirements:**

Movement of desert bighorn consists primarily of their daily activities but some local seasonal movements do occur. Migration over long distances are infrequent although, occasionally, a bighorn will roam from one mountain range to another. Local seasonal movements are in the nature of gradual shifts in elevation, governed by the availability of water and certain seasonal foods. In winter the desert bighorn is not dependent on waterholes which allows them to disperse over wider areas.

**Site criteria:**

Deep canyons, steep rocky slopes, high relief;
scanty vegetation;
precipitous areas;
preference for pinyon/juniper vegetation types;
various perennials of the sunflower family;
widely separated waterholes (sheep will go without drinking for weeks or months during cooler parts of the year, commonly 3-7 days without water);
lambing in rugged terrain;
grasses preferred food (forbs and shrubs) (Fish and Wildlife Service, 1965).

Vegetation—bigsage, bitterbrush, curled mountain mahogany and wheat grasses (Canadian Wildlife Service, 1971).

**Service requirements and improvements:**

Management of specie and salt licks.

Improvements include vehicular restrictions and elimination of domestic grazing.

**Related activities:**

Mule deer, buffalo and bird habitats.

**Conflicting activities:**

Natural competitors—Rabbits, rodents, mule deer, cougar, coyote, eagle.

Introduced competitors—Cattle, sheep, burros, horses (carriers of disease and parasites, especially sheep).

Man—Human encroachment, fences, roads, dwellings, recreational areas (Hall, 1946).

**Data variables:**

7—Exposed bedrock

9—Slope

11—Wildlife: Bird habitat

12—Wildlife: Buffalo habitat

13—Wildlife: Mule deer habitat

20—Vegetation by physiotype
The first category is exposed bedrock. Bighorn desire large areas of exposed bedrock. Lesser percentages of exposed bedrock are proportionately less preferred.

Slope represents the second category. Steep slopes are most preferred by these hearty animals. Slopes greater than 50% are most suitable. Percentages less than 50 percent are equally less suitable.

Wildlife: Bird habitat is the third data variable. Chukar partridge is the most favorable of bird habitats. Other bird habitats are more water oriented and not as suitable for the model.

The fourth and fifth categories of data respectively are wildlife habitats of buffalo and mule deer. These specie habitats are similar. Competition of these species is found in other native environments.

The final data variable employed in the model is vegetation by physiotype. The subvariables are listed by suitability order as bighorn vegetation preferences below. Pinyon/juniper, sage/grass association and grassland are most preferred. Halophytes and raparian are next preferred. Barren is least preferred.
**ATTRACTIVENESS MODEL NO.** 17  Desert Bighorn Sheep Habitat

<table>
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<td>Wildlife: Buffalo habitat</td>
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<tr>
<td>13</td>
<td>Wildlife: Mule deer habitat</td>
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<tr>
<td>20</td>
<td>Vegetation by physiotype</td>
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</table>

**Figure 77.** Coding form: Desert bighorn sheep habitat.
Figure 78. Attractiveness Map 17: Desert bighorn sheep habitat.
Attractiveness Model #18: Pronghorn antelope habitat

It was upon the arrival of John C. Fremont in the fall of 1844 when a feast of antelope tenderloin took place that the island's name was given. Within 30 years after the naming of the island, antelope (Antilocapra americana americana) had been completely wiped out from the island. Even today no antelope exist upon the island.

The model is geared to localize areas of prime habitat for this specie. It is hoped that once again antelope may be reintroduced back to their native island.

General space requirements:

Creature of great open spaces (Fish and Wildlife Service, 1966).

Moderate proximities to water supply, preferably springs (Hall, 1946).

Site criteria:

Vegetation—Shrubby plants, such as sagebrush, bitterbrush, saltbrush preferred over grasses and large weeds (Fish and Wildlife Service, 1966).

Open areas (Fish and Wildlife Service, 1966).

Service requirements and improvements:

Salt licks and elimination of domestic grazing.

Related activity:

Buffalo, mule deer, bird, and bighorn sheep habitat.
Conflicting activity:

Natural competitors—Cougar, coyote, eagle, mule deer, rabbits.

Introduced competitors—Cattle, sheep, horses (carrier of disease and parasites, especially sheep).

Man—Human encroachment, fences, cultivated fields.

Data variables:

8—Vegetation crown density
11—Wildlife: Bird habitat
12—Wildlife: Buffalo habitat
13—Wildlife: Mule deer habitat
16—Proximity to springs
20—Vegetation by physiotype

Vegetation crown density is the first data variable. Since antelope are creatures of open areas, the subvariable of no density is suitable. Increased percentages of vegetation densities are proportionately less preferred.

The second variable is wildlife: bird habitat. Of the species represented in this variable habitat areas of chukar partridge are most favorable. Other subvariables of bird species are not as desirable, particularly because of their water orientation.

Third and fourth categories are wildlife habitats of buffalo and mule deer. Habitat areas of these species of wildlife are desirable competition naturally found in other native habitats of antelope.

Proximity to springs represents the fifth category of data. Subvariable three or more cells away is most suitable for the model.
The final data category for this model is vegetation by physiotype. The subvariables below have arranged from most to least desirable for habitat: sage/grass association, grassland, halophytes, pinyon/juniper raparian and barren.
**ATTRACTIONNESS MODEL NO.** 18  Antelope Habitat

<table>
<thead>
<tr>
<th>D.V. NO.</th>
<th>DATA VARIABLES</th>
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<tbody>
<tr>
<td>8</td>
<td>Vegetation crown density</td>
</tr>
<tr>
<td>11</td>
<td>Wildlife: Bird habitat</td>
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<td>Wildlife: Buffalo habitat</td>
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<tr>
<td>13</td>
<td>Wildlife: Mule deer habitat</td>
</tr>
<tr>
<td>16</td>
<td>Proximity to springs</td>
</tr>
<tr>
<td>20</td>
<td>Vegetation by physiotype</td>
</tr>
</tbody>
</table>

![Coding form: Antelope habitat.](image)

Figure 79. Coding form: Antelope habitat.
Figure 80. Attractiveness Map 18: Pronghorn antelope habitat.
4. impact models
Chapter Four deals explicitly with models that evaluate effects of what particular land use activities may have on a specific natural resource system. These models, known as "impact models," are composed of pertinent physical and biological data on Antelope Island. These complex and interlocking sets of natural resource systems were divided into a series of distinct site resource systems (Murray et al., 1971).

Issues and Land Use Impacts

An investigation of issues and land uses and their nature of environmental impact was one criteria in determining which natural systems were to be modeled. Issues dealing with an analysis of impacts of extensive recreational and service uses are covered in this chapter with some special references listed below. Land uses such as trails, beach activities, and rock climbing desire vistas and attractive visual sites. Issues such as trampling soils and vegetation, litter waste disposal, sanitation problems, horses (feed, sanitation, and trail wear), fire risks, disturbance to birds and animal species requiring solitude for reproduction require investigation.

Conversion of a natural area to one of intensive use respecting the maintenance of the natural setting is essential. Service uses, such as campgrounds and activity area, need research focused on soil compaction, wildlife habitat disturbance, litter and waste problems,
erosion and damage to trees and plants, and radio and portable television noise nuisances.

Sanitary landfill land use has an unsightly character of deposition unless properly located. The 12-18 feet depth required for excavation is another source of air and water pollution if adjacent to streams and wastes are burned.

The land use of roads clashes with scenic values and does not blend with landscapes; alignments are unnaturally straight; natural drainages are filled or disturbed, and wildlife habitats are destructed. Roads also are a major source of air pollution and chemical control sprays; they contribute to increased siltation of streams and cause destruction of trees and scenic vistas in wide unsightly swaths.

Consideration of impacts caused by each land use in terms of short and long range effects require investigation.

Selection of which site resource systems to be modeled were based on relevance or significance of that particular system as it applies to the study area, types of land uses, both existing and proposed, and availability of data. Those impact models selected are listed below:

1. Vulnerability to erosion
2. Vulnerability by grazing
3. Vulnerability to noise
4. Change in runoff
5. Vulnerability to groundwater pollution
6. Vulnerability to surface water pollution
7. Vulnerability to change in shoreline area
8. Vegetation--vulnerability to wildfires
9. Change in visual absorption
10. Change in visual quality
11. Change in wildlife habitat: Mule deer
12. Change in wildlife habitat: Buffalo
13. Change in wildlife habitat: Desert bighorn sheep
14. Change in wildlife habitat: Pronghorn antelope
15. Vulnerability to waterfowl habitat

A systematic approach into the development of each impact model was formulated and is explained in the following paragraphs. There are four important procedures in the development of each model:

1. Selection of the three most important data variables which best describe that model.
2. Rate each data subvariable as to its sensitivity or vulnerability in respect to the model.
3. Subdivide the list of land uses into one of three categories for each model.
4. Evaluations derived in each of the four matrices.

**Selection of Data**

It must be thoroughly understood as to what purpose a particular model will accomplish. For example, an impact model dealing with wildfire vulnerability is directed to locate all cells very sensitive or very stable to vulnerability from fire relative to any of the selected land uses. In describing the function of a model, the use of data in terms of variables are selected. The three most articulate variables were employed and organized from an order of most important to least
important. Only three variables are utilized because of the impact format in GRID. A three dimensional impact matrix is used which has a variable capacity limited to three. This procedure is illustrated in Figure 81 in the section on Impact Model 1.

Classification of Data Subvariables

Each group of subvariables from each data variable was broken down into three degrees of sensitivity or vulnerability. These sensitivity boxes are broken down into degrees of most, moderate and least sensitivities. Sensitivity boxes with subvariables are shown in Figure 81.

Breaking Down Land Uses

Each land use established in Chapter Three was subdivided into three separate land use groups. Each group was characterized as to the degree of potential environmental impact capable of that group. Impacts were based upon maximum expected loads occurring through the construction, maintenance or user oriented activities of each land use. The three land use groups were broken down as: Land Use Group One, Land Use Group Two, and Land Use Group Three. Group One was assumed to have least impacting activities; Group Two, moderate impacting, and Land Use Group Three carried the heaviest impacting land uses or activities. Land use breakdowns are displayed in the impact model writeups and impact maps further in the chapter.
Matrices

The purpose for setting up matrices was to analyze through interfacing various combinations of degrees of sensitivities of subvariables from the three selected data variables. Four three by three matrices were constructed for each model.

The first matrix combined the two lesser important data variables to determine a combined sensitivity rating (Blank, 1973). All combinations of the three sensitivity groups of the two data variables were interfaced and given sensitivity values. Each box in this matrix possessed a given set of data subvariables which were evaluated numerically as 1 (high degree of sensitivity), 2 (moderate degree of sensitivity), or 3 (low degree of sensitivity). Figure 81 illustrates matrix one.

Matrices two, three and four deal with a mildly complex procedure of obtaining impact values. Included are the three sensitivity groups of the most important data variable lined along the "x" axis. Sensitivity values from matrix one are lined along the "y" axis. With this in mind, another dimension was incorporated which distinguishes each of the three matrices. Land uses from Group One, Group Two and Group Three were interfaced with matrix two, three and four, respectively. The purpose of this procedure is to determine the possible impact capable against each composite sensitivity box of matrix two, three or four. One of four degrees of impact is determined for each box of each matrix. The impact codes are: 1) compatible, having no short or long term effect on the resource; 2) moderate, causing some but not serious change in the resource; 3) severe, serious modification of
the resource, and 4) terminal, a threshold point in that modification is to the extent that recovery via natural processes is not feasible. Matrices two, three and four are illustrated in Figure 81.

**Model Format**

Each model is organized in the following format: A paragraph introduces the model and explains the purpose for which it is useful in the study. An investigation of the data variables and descriptions of their subvariables is made in terms of their degree of sensitivity or vulnerability. Land use groups then appear with each land use filed under one of the land use groupings. Impact model coding sheets are then displayed which graphically illustrate material which was recoded onto keypunch cards for compilation in the GRID program. The final section is the impact map itself. The vulnerability of each cell is mapped for the entire 1082 cell study area. The darker the cell tone the greater is the vulnerability potential of environmental impacts.

**Impact Model 1: Vulnerability to erosion**

Erosion is a comprehensive term applied by which mobile agencies, namely water and gravity, obtain and remove rock material (Thornbury, 1969). The model attempts to identify areas most susceptible to erosional processes. Erosion may have a direct impact on surface water quality. Landscapes suffering from heavy erosional impacts may also be visually unattractive. Extensive gullying and sheet erosion along stream borders can greatly affect the visual and natural character of the site (Hanson and Skinner, 1973).
Streams entering a small reservoir should have sediment yield reduced to a minimum to extend reservoir life. This is particularly important during heavy spring runoff.

Soil disruptions such as mud slides and soil creeps may be hazardous erosional impacts for nearly all land use suitabilities. Erosion, sedimentation and turbidity of natural drainages decrease photosynthesis. This can cause major changes in the aquatic system in the drainage. Once exposed to solar radiation the water temperature may change. As limiting factors, the temperature change, reduced photosynthesis, and aquatic disruption may cause fish species to move out or die off (Toth, 1972).

According to Leopold (1968), erosion takes place on the surface when the force exceeds the resistance of the soil. Erodability is a function of a number of factors: 1) intensity of rain; 2) permeability of the surface; 3) the chemical and physical properties that control the disintegration of the rocks and determine the cohesiveness of the soil and vegetation which directly affects both the stability and the infiltration capacity of the soil.

The data variables and subvariables employed in the model are:

1. #9--Slope
2. #10--Permeable geologic formations
3. #20--Vegetation by physiotype

Slope is the first data category. Subvariables 0-8.0% are least sensitive because resistance to gravitational forces is greatest here. 8.1-16.0% is moderately sensitive and 16.0%+ slopes are most vulnerable to erosion.
Permeable geologic formations is the second data variable. The very permeable character of Qag-Quaternary Colluvium/Alluvium is most susceptible to erosion. TW-Wasatch Formation and P6F-Farmington Canyon Complex (fractured) are moderately sensitive. Nonpermeable nature of P6F-Farmington Canyon Complex (not fractured), PGM-Mutual Formation, and PGMF-Mineral Fork are grouped as least vulnerable to erosion.

The third data category is vegetation by physiotype. Most sensitive categories are barren and halophytes because of their sparse density. Pinyon/juniper is moderately sensitive. Although the character of this subvariable is that of a rooting system capable of deferring most erosional processes, little vegetative cover survives within the driplines because of strongly acidic pH soils caused by needle and branch droppings and small amounts of sunlight filtering through the crown density. The crown densities of grassland, sage/grass association and raparian are minimally sensitive to erosional impact.

Land use groupings:

**Land Use Group One (least impacting)**--

#4 trails
#5 beach activities
#6 picnicking
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat
Land Use Group Two (moderately impacting)---

#2 grazing
#3 reservoir
#7 golf course
#8 riflery and archery
#11 tent and car camping

Land Use Group Three (heaviest impacting)---

#1 road
#10 septic tanks and absorption fields
#12 low density vacation homes
#15 small commercial center
#16 sanitary landfill
### IMPACT MODEL NO. 1 Vulnerability to Erosion

<table>
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<th>D.V. NO.</th>
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Figure 81. Coding form: Vulnerability to erosion.
Figure 82. Impact Map 1: Vulnerability to erosion.
Impact Model 2: Vulnerability by grazing

Grazing has been Antelope Island's most used land use activity since its first settling in 1849. However, the island since that time has been periodically overgrazed by domestic livestock. Exposure of soils to erosion can be triggered from overgrazing. An ecologically unbalanced environment caused by this triggering factor has produced severe changes in the vegetational character of the island, particularly of the grasses. Invader species of cheatgrass and sagebrush dominate many areas of the island as a result of grazing beyond the growth rate capacity of the grasses. The model has been constructed with the intent to identify cells in the study that are overgrazed or very sensitive to overgrazing.

The three data variables are:

1. #20--Vegetation by physiotype
2. #9--Slope
3. #8--Vegetation crown density

The subvariable most sensitive to grazing in vegetation by physiotype is riparian vegetation. The character of livestock in trampling paths through this vegetation type and compacting the surrounding soils causes a very sensitive impact. Moderately sensitive subvariables are grassland, sage/grass association and pinyon/juniper. Least vulnerable are seasonally poisonous halophytes and barren areas.

The second data category is slope. Low percentages of slope are most sensitive because of ease of accessibility with increasing slope percentages becoming less sensitive. 0-8.0% is most sensitive;
8.1-16.0% are moderately sensitive, and slopes greater than 16.0% are least vulnerable.

Low percentages of vegetation crown density are most sensitive to grazing because grasses are more readily available with sparse scatterings of pinyon/juniper stands for shade. 26-50% density is moderately sensitive. Vegetation crown densities greater than 50% are least susceptible to impact because adequate feed for grazing is not available.

Land use groupings:

Land Use Group One (least impacting)--

#4 trails
#5 beach activities
#6 picnicking
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope

Land Use Group Two (moderately impacting)--

#2 grazing
#3 reservoir
#7 golf course
#8 riflery and archery
#11 tent and car camping
Land Use Group Three (heaviest impacting)--

#1 roads

#10 septic tanks and absorption fields

#12 low density vacation homes

#15 small commercial center

#16 sanitary landfill
Figure 83. Coding form: Vulnerability by grazing.
Figure 84. Impact Map 2: Vulnerability by grazing.
Impact Model 3: Vulnerability to noise

Noise is sound that is undesirable by the listener. Acoustical experts call noise invisible pollution (Robinette, 1972). This impact model has been developed to indicate areas or cells sensitive to noise vibrations. The model also specifies cells that naturally buffer and absorb unnatural noise based upon criteria used in the data bank. Noise levels are measured in decibels, Db, in a logarithmic scale. A measurement of 1 Db is the threshold of human hearing and 140 Db at the threshold of hearing pain (Lynch, 1971).

Wildlife can be affected by noise in similar ways that humans are. However, their range and thresholds may vary tremendously. Kevin Lynch (1971, p. 79) states, "Although an environment with too little noise is conceivable, the usual problem is to reduce either the noise level or information content of the noise." He goes on to point out, "Sound sources are increasingly powerful ubiquetons." Sound waves can be absorbed, reflected, deflected or refracted when they meet a barrier or change of medium (Robinette, 1972).

Data categories in the model listed by order of importance are:

1. #7--Percent exposed bedrock
2. #20--Vegetation by physiotype
3. #8--Vegetation crown density

Low percentages of exposed bedrock are less sensitive to noise. Higher percentages of bedrock are proportionately more vulnerable to noise and noise reflection.
The second data variable is vegetation by physiotype. Barren is the most obvious subvariable vulnerable to noise. Denser vegetation types have natural noise absorption and deflecting capabilities. Stubby vegetation of halophytes, grasslands and sage/grass association are vulnerable to noise pollution. Pinyon/juniper is moderately vulnerable. Riparian vegetation has natural high crown density and is most absorptive to pollution by noise.

Vegetation crown density is the third data category. Increased crown densities absorb increased amounts of sound vibrations. High percentages of crown density are less vulnerable to noise; however, lower crown densities have low noise absorptive capacity.

Land use groupings:

Land Use Group One (least impacting)—

#4 trails
#5 beach activities
#6 picnicking
#7 golf course
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat

Land Use Group Two (moderately impacting)—

#2 grazing
#3 reservoir
Land Use Group Three (heaviest impacting)—

#1 roads
#8 riflery and archery
#10 septic tanks and absorption fields
#11 tent and car camping
#12 low density vacation homes
#15 small commercial center
#16 sanitary landfill
**IMPACT MODEL NO. 3 Vulnerability to Noise**

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<td>Percent Exposed Bedrock</td>
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<td>20</td>
<td>Vegetation by Physiotype</td>
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<td>8</td>
<td>Vegetation Crown Density</td>
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**CODING**

- X: most sensitive
- Y: moderately sensitive
- Z: least sensitive
- C: compatible impact
- M: moderate impact
- S: severe impact
- T: terminal impact

Figure 85. Coding form: Vulnerability to noise.
Figure 86. Impact Map 3: Vulnerability to noise.
Impact Model 4: Change in runoff

Runoff is water that flows over the land. This model identifies areas of which the change in runoff is most and least sensitive and areas susceptible to flash flooding. The most common type of runoff is in the form of stream flow. Stream runoff transports loosened soil particles. Five factors determining the amount of potential runoff are: precipitation rate and intensity, rate of infiltration of the soil, topographic slope, and vegetation type.

The three most important data variables used in the model are:

1. Slope
2. Permeable geologic formations
3. Vegetation by physiotype

Slope, the first data category, is the most significant variable. The prime influence of gravity acts as a directional force in moving water over soil. Velocity of runoff waters depends greatly on the amount and kind of vegetative cover and on the degree of slope of the landform. Subvariables 0–8\% slope are least sensitive. 8.1–16.0\% is moderately sensitive and slope of 16.0+\% most vulnerable.

Permeable geologic formations is data category number two. Subvariables most significant of great potential runoff are the non-permeable formations of PEF-Farmington Canyon Complex, PEM-Mutual Formation and PEMF-Mineral Fork Formation. TW-Wasatch Formation is moderately sensitive to change in runoff. The permeable character of Qag-Quaternary Alluvium/Colluvium is least vulnerable.
The third data variable is vegetation by physiotype. Barren, halophytes and grassland are most sensitive to changes in runoff. Sparse density of halophytes has little holding capacity of surface runoff. Grasslands are vulnerable to runoff, particularly in seasons of wildfires which are not at all uncommon to the study area. During winter and spring the grassland has an adequate holding capacity for soil stabilization. Riparian and pinyon/juniper are moderately vulnerable and sage/grass association is not as sensitive to changes in runoff.

Land use groupings:

**Land Use Group One (least impacting)**

- #4 trails
- #5 beach activities
- #6 picnicking
- #9 primitive camping
- #13 conservation
- #14 cliff climbing
- #17 desert bighorn habitat
- #18 antelope habitat

**Land Use Group Two (moderately impacting)**

- #2 grazing
- #3 reservoir
- #7 golf course
- #8 riflery and archery
- #11 tent and car camping
Land Use Group Three (heaviest impacting)—

#1 roads
#10 septic tank and absorption fields
#12 low density vacation homes
#15 small commercial center
#16 sanitary landfill
### IMPACT MODEL NO. 4 Change in Surface Runoff

#### D.V. DATA VARIABLES (listed in order of importance)

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<td>Permeable Geologic Formations</td>
<td>5,6,9 3,4 0,1</td>
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<td>20</td>
<td>Vegetation by Physiotype</td>
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#### CODING

- **X**: most sensitive
- **Y**: moderately sensitive
- **Z**: least sensitive
- **C**: compatible impact
- **M**: moderate impact
- **S**: severe impact
- **T**: terminal impact

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**Figure 87. Coding form: Change in surface runoff.**
Figure 88. Impact Map 4: Change in surface runoff.
Impact Model 5: Vulnerability to groundwater pollution

Water, beneath the earth's solid surface, contained in pore spaces within regolith and bedrock, is known as groundwater. The term is restricted by many geologists to the water beneath the water table (Longwell, Flint and Sanders, 1969).

The resource of groundwater is very important for domestic water supply potential. The quantity and quality of this resource will have direct influence on future recreational development. Pollution via addition of substances changing the resource's physical character in a degrading manner may severely impact or terminate the quality of the available supply. Consequently, protection of this resource should be a major objective of any recreational land use proposal.

Data variables employed in this model are:

1. #10--Permeable geologic formations
2. #9--Slope
3. #5--Major lake shorelines

Permeable geologic formations is the first data variable. The very permeable formation of Qag-Quaternary Colluvium/Alluvium ranked this subvariable as most sensitive to groundwater pollution. The permeable nature of TW-Wasatch Formation and PEF-Farmington Canyon Complex (fractured) are rated moderately sensitive. Least vulnerable to groundwater pollution are nonpermeable subvariables of PEF-Farmington Canyon Complex (not fractured), PGM-Mutual Formation and PGMF-Mineral Fork Formation.
Slope is the second data category. 0-8.0% slopes are most vulnerable due to the nature of ponding of water and extended time span for infiltration of pollutants (Murray et al., 1971). Slopes of 8.0-16.0% are moderately sensitive and slopes over 16.0% are least vulnerable due to rapid runoff and slight infiltration of pollutants.

Major lake shoreline terraces, the third data category, are prime recharge zones for groundwater supply. Bonneville and Provo shorelines are most vulnerable to groundwater pollution because of their terrace widths and higher elevations that receive greater amounts of precipitation. Stansbury level is a narrower terrace, lower in elevation and moderately sensitive. Subvariables of no shoreline and Great Salt Lake shoreline are least vulnerable.

Land use groupings:

Land Use Group One (least impacting)--

#4 trails
#5 beach activities
#6 picnicking
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat

Land Use Group Two (moderately impacting)--

#3 reservoirs
#7 golf course
#8 riflery and archery
Land Use Group Three (heaviest impacting)--

#1 roads
#2 grazing
#6 septic tanks and drain fields
#11 tent and car camping
#12 low density vacation homes
#15 small commercial center
#16 sanitary landfill
**IMPACT MODEL NO. 5  Ground Water Quality**

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<td>Slope</td>
<td>2, 3, 4, 0, 1, 5, 8, 9</td>
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<td>5</td>
<td>Major Lake Shorelines</td>
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</table>

**CODING**

- X: most sensitive
- Y: moderately sensitive
- Z: least sensitive
- C: compatible impact
- M: moderate impact
- S: severe impact
- T: terminal impact

Figure 89. Coding form: Vulnerability to ground water pollution.
Figure 90. Impact Map 5: Vulnerability to ground water pollution.
Impact Model 6: Vulnerability to surface water pollution

The function of this model is to identify specific cells most sensitive to water degradation. Since surface water on the island is a rare resource, protection of this resource is most important for domestic uses.

If the water quality and its influent spring systems are seriously jeopardized by the improper location of certain land uses or activities a significant portion of the recreational assets may be threatened. Despite sparse scatterings of springs and cumulative flows, points of vulnerability to water quality need to be delineated in planning for these attending design constraints.

Data categories employed in the model are:

1. #6--Surface water by type
2. #9--Slope
3. #10--Permeable geologic formations

Surface water by type is the first category of data. Perennial surface flows such as springs are most sensitive to alterations in water quality. Intermittent flows existing throughout most of the island are much less sensitive to pollution because of their limited duration.

The second data variable is slope. Slopes 0-8.0% are most vulnerable to degradation due to low velocity and relatively little mechanical re-aeration. The nature of this slope subvariable allows pollutants to remain for extended periods of time. There exists longer time intervals for sedimentation to take place and sitting with less opportunity for scour and transport action at seasonally high water
periods (Murray et al., 1971). Slopes 8.0-16.0% are moderately sensitive. Slopes greater than 16.0% are least vulnerable to surface water degradation by the natural cleansing action characteristic of stream channel waters of high velocities.

**Permeable geologic formations** is the third data variable. Most vulnerable formations are nonpermeable formations of P6F-Farmington Canyon (not fractured), P6M-Mutual Formation, P6MF-Mineral Fork Formation. P6F-Farmington Canyon Complex (fractured) is moderately sensitive. TW-Wasatch Formation and Qag-Quaternary Alluvium/Colluvium are least vulnerable to degradation because of the filtering character contained in large permeable granules of this formation type.

**Land use groupings:**

**Land Use Group One (least impacting)—**

#5 beach activities
#6 picnicking
#8 rifle and archery
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat

**Land Use Group Two (moderately impacting)—**

#3 reservoirs
#4 trails
#11 tent and car camping
Land Use Group Three (heaviest impacting)--

#1 roads
#2 grazing
#7 golf course
#10 septic tanks and absorption fields
#12 low density vacation homes
#15 small commercial center
#16 sanitary landfill
### IMPACT MODEL NO. 6 Vulnerability to Surface Water Pollution

**D.V. NO.** | **DATA VARIABLES** (listed in order of importance) | **DATA SUBVARIABLES** | **MOST** | **MODERATE** | **LEAST** |
---|---|---|---|---|---|
6 | Surface Water by Type | 9 | 8 | 0,1,4,6,7 |
9 | Slope | 2,3 | 4 | 0,1,5,8,9 |
10 | Permeable Geologic Formations | 5,6,9 | 4 | 0,1,3 |

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#### CODING

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**Figure 91.** Coding form: Vulnerability to surface water pollution.
Figure 92. Impact Map 6: Vulnerability to surface water pollution.
Impact Model 7: Vulnerability to change in shoreline area

The erratic fluctuation of the Great Salt Lake shoreline has been the most significant factor for prolonging recreational development there. The lake in 1963 had shrunk to half of its size of 3000 square miles which was recorded in 1873 (Rudy, 1973). When in 1963 the Great Salt Lake dropped to its lowest level in over 100 years of recorded history at 4191.30 feet, researchers predicted that the lake would be dry in 30 years. Today, 11 years later, the lake level has risen 8 feet to 4200 feet in elevation. No one can predict to what height the lake level will drop or increase. Numerous factors, such as the Central Utah Water Project, development of the Jordan River Parkway and water development of the Bear River, directly have influence on the lake fluctuation. The most significant variable influencing the lake level fluctuation is precipitation (Salt Lake Tribune, 1973).

This model represents vulnerable areas of natural beach sites and their impact from lake level fluctuations. The model directly affects the types of activities proposed near beach sites and limits certain activities in zones of high sensitivity which may utilize these zones as primary site resources (Murray et al., 1971).

The data variables listed in this impact model are:

1. #9—Slope
2. #19—Proximity to island shoreline
3. #6—Surface water by type

Slope is the first data variable. Flat slopes of less than 2.0% are most sensitive to water fluctuations. Increasing slope percentages are proportionately less vulnerable to shoreline oscillations.
The second data variable is **proximity to shoreline**. Most vulnerable subvariables are **same cell** and **adjacent cell**. Moderately sensitive is two cells away and least sensitive is **three or more cells away**.

The last data variable is **surface water by type**. Fresh and salt lake bodies are most susceptible to shoreline damage. Subvariables of **no surface water**, **intermittent streams**, **reservoir** and **spring area** are least vulnerable to change in shoreline area.

**Land use groupings:**

**Land Use Group One** (least impacting)---

- #5 picnicking
- #9 primitive camping
- #13 conservation
- #14 cliff climbing
- #17 desert bighorn habitat
- #18 antelope habitat

**Land Use Group Two** (moderately impacting)---

- #4 trails
- #5 beach activities
- #7 golf course
- #8 riflery and archery

**Land Use Group Three** (heaviest impacting)---

- #1 road
- #2 grazing
- #3 reservoir
- #10 septic tanks and drain fields
#11 tent and car camping

#12 low density vacation homes

#15 small commercial center

#16 sanitary landfill
**IMPACT MODEL NO. 7  Vulnerability to Change in Shoreline Area**

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<tr>
<td>Z</td>
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</table>

**CODING**

- X: most sensitive
- Y: moderately sensitive
- Z: least sensitive
- C: compatible impact
- M: moderate impact
- S: severe impact
- T: terminal impact

Figure 93. Coding form: Vulnerability to change in shoreline area.
Figure 94. Impact Map 7: Vulnerability to change in shoreline area.
Impact Model 8: Vulnerability to wildfires

Fire is not peculiar to man's activities and occurred here and there in North America before the white man came (Oostings, 1956). Fire is not an ever present environmental factor. However, during its usual short span of actual duration, it can scar a landscape requiring many years after to overcome (Billings, 1970). According to environmental studies on the island, fire in general acts as a natural controlling factor. Fire preserves a grassland biome by burning off invader species such as communities of common sagebrush. Fire also germinates several species of grass native to Antelope Island.

Man traditionally has connotated fire as a hazard and that it encroaches personal property. The feeling is mutual, however, that it should be perceived of the environmental role fire plays. Environmental studies make a point that man should contemplate how their land uses can fit into this environment without severely or terminally upsetting it (Wyckoff, 1971). The objective of this impact model is to recognize sites naturally sensitive to fire. Once those sites are identified, decisions and tradeoffs will need reckoning. One tradeoff is to adjust land use activities in a compatible manner allowing wildfires to occur naturally and only control them when man's safety and property are jeopardized. Consequently, negative visual quality of black scarred foothills may not be aesthetically pleasing.

Another tradeoff might be to manage the island's environment and control all wildfires. Visual quality may be preserved through burning sites or pockets not visible to most visitors. Either alternative may be valid to some extent. The author feels that compromising
the two may produce a better solution. Wildfires could take place in unseen pockets of the island with selected sites purposely burned to act as an educational tool for visitors and an environmental tool for Antelope Island's grassland climax.

Categories of data selected as most important for the model were:

1. #20--Vegetation by physiotype
2. #8--Vegetation crown density
3. #2--Orientation

The first and most important data variable is vegetation by physiotype. Grassland and sage/grass association are most sensitive to wildfire. Grass is essential in this region to carry fire any great distance except for the unusual circumstance where shrubs are very close together (Oostings, 1956). Halophytes, riparian and pinyon/juniper are moderately sensitive. Barren landscapes are least susceptible to wildfire.

The second data category is vegetation crown density. No crown density is obviously least vulnerable. 1-25% is moderately sensitive and areas 25%+ crown density are most sensitive to fire.

Orientation represents the third most important data variable. Warmer orientations of south-southwest and east-southeast are most sensitive to fires. Flat orientations are moderately vulnerable. Subvariables of water, west-northwest, and north-northeast are least susceptible to wildfire activity.
Land use groupings:

Land Use Group One (least impacting)---

#3 reservoir
#10 septic tanks and absorption fields
#13 conservation
#17 desert bighorn habitat
#18 antelope habitat

Land Use Group Two (moderately impacting)---

#2 grazing
#5 beach activities
#6 picnicking
#7 golf course
#14 cliff climbing

Land Use Group Three (heaviest impacting)---

#1 road
#4 trails
#8 riflery and archery
#9 primitive camping
#11 tent and car camping
#12 low density vacation homes
#15 small commercial center
#16 sanitary land fill
### IMPACT MODEL NO. 8 Vegetation—Vulnerability to Wildfires

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<tr>
<th>D.V. NO.</th>
<th>DATA VARIABLES (listed in order of importance)</th>
<th>DATA SUBVARIABLES MOST</th>
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<th>LEAST</th>
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<tr>
<td>20</td>
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<td>5</td>
<td>0,1</td>
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<td>Orientation</td>
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**MATRIX ONE**

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</table>

**Codings**

- X: most sensitive
- Y: moderately sensitive
- Z: least sensitive
- C: compatible impact
- M: moderate impact
- S: severe impact
- T: terminal impact

**Figure 95. Coding form: Vegetation—vulnerability to wildfires.**
Figure 96. Impact Map 8: Vegetation—vulnerability to wildfires.
Impact Model 9: Change in visual absorption

The model deals with sensitivity to changes of visual absorption. The model dictates from a visual standpoint where and how much development may aesthetically take place.

The potential of various landscapes to visually absorb land use activities is a function of visual transparency and visual complexity (Jacobs and Way, 1968). Visual transparency is the degree of vegetation density and the amount of topographic closure or percent of slope. Visual complexity is the amount and clarity of visual information which viewers can sort and evaluate. Jacobs and Way (1968, p. 2) state, "... that landscapes which are visually transparent with little visual complexity will be most susceptible to visual impact. At the other extreme, those landscapes which are visually opaque and composed of a high degree of visual complexity will be most absorptive" and least vulnerable to visual impact.

Data variables employed in the model are:

1. #8--Vegetation crown density
2. #9--Slope
3. #20--Vegetation by physiotype

Cells of little or no vegetation crown density are visually transparent and most vulnerable to changes in visual absorption. Subvariables 1-50% are moderately sensitive and cells of 50%+ crown density are most opaque, thus least vulnerable to changes in visual absorption.

Flat or relatively low slope percentages are most susceptible to visual absorption. 2.0-16.0% are of medium sensitivity. Slopes
increasing above 16.0% have a proportionately higher topographic closure and are visually opaque; therefore, these slopes are least susceptible to changes in visual absorption.

Third most important data variable is vegetation by physiotype. Low lying physiotype such as halophytes, grassland, and sage/grass association are most susceptible to change of absorption. Riparian is moderately vulnerable and pinyon/juniper is least sensitive by their dense nature and height of these stands.

Land use groupings:

Land Use Group One (least impacting) --
- #13 conservation
- #14 cliff climbing
- #17 desert bighorn habitat
- #18 antelope habitat

Land Use Group Two (moderately impacting) --
- #2 grazing
- #5 beach activities
- #7 golf course
- #11 tent and car camping
- #12 low density vacation homes

Land Use Group Three (heaviest impacting) --
- #1 road
- #3 reservoir
- #8 riflery and archery
- #10 septic tanks and absorption fields
#15 small commercial center

#16 sanitary land fill
Impact Model No. 9 Change in Visual Absorption

<table>
<thead>
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<th>D.V. No.</th>
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<td>9</td>
<td>Slope</td>
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<td>20</td>
<td>Vegetation by Physiotype</td>
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<td>M</td>
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<td>Y</td>
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<td>Y</td>
<td>S</td>
<td>M</td>
<td>T</td>
</tr>
<tr>
<td>Z</td>
<td>S</td>
<td>M</td>
<td>M</td>
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</tbody>
</table>

**Coding**

X: most sensitive  
Y: moderately sensitive  
Z: least sensitive  
C: compatible impact  
M: moderate impact  
S: severe impact  
T: terminal impact

---

Figure 97. Coding form: Change in visual absorption.
Figure 98. Impact Map 9: Change in visual absorption.
Impact Model 10: Change in visual quality

Eighty-seven percent of man's perception is through the visual sense. The model was built to specify locations in the study area where land use activities or construction would create the greatest disruptions of visual quality. This model more than any other model has been directly put together based upon values of the author and experts in the profession. The subjectivity of values as to what is visually attractive and unattractive need to be weighted for the purpose and type of activity proposed for the study area (Murray et al., 1971).

The model is a means for recreationists and other users of the site to consciously and subconsciously perceive and describe visual experiences. There are six components of the visual resource, both organic and inorganic, listed under the following categories: flora, fauna, land, water, air and artificial objects (man created) (Forest Landscape Management, USDA, 1971). Since the position and location of an observer is variable, relative to visible objects, recognition of fixed and finite landscapes becomes a conditional task that is dependent upon the knowledge of where the observer will be.

Visual quality means satisfying the recreationists' expectations of the site while appropriately selecting and locating user functions (Forest Landscape Management, USDA, 1971).

Data variables utilized by the model are:

1. #8--Vegetation crown density
2. #9--Slope
3. #19--Proximity to island shoreline
Vegetation crown densities of 0-25% are most sensitive because of maximum visual exposure. 26-50% is moderately sensitive with some feeling of visual enclosure. Subvariable 50%+ crown density is least sensitive with a variety of visual enclosure existing.

Slopes greater than 16.0% are most sensitive because larger amounts of surface areas are visually exposed. 8.1-16.0% are moderately sensitive slopes. Least vulnerable slopes are less than 8.0% because a minimum surface area is exposed to the viewer.

The third data variable is proximity to shoreline. Cells nearest the island's shoreline have maximum exposure due to a small proximity and minimum visual interference. Two cells away are moderately vulnerable. Three or more cells away is least susceptible and presents the greatest visual interference to viewers.

Land use groupings:

Land Use Group One (least impacting)—

#3 reservoir
#4 trails
#5 beach activities
#6 picnicking
#7 golf course
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat
Land Use Group Two (moderately impacting)—

#2 grazing
#8 riflery
#11 tent and car camping

Land Use Group Three (heaviest impacting)—

#1 roads
#10 septic tanks and absorption fields
#12 low density vacation homes
#15 small commercial center
#16 sanitary land fill
Figure 99. Views from Antelope Island.
### IMPACT MODEL NO. 10  Change in Visual Quality

**D.V. DATA VARIABLES** (listed in order of importance)  **DATA SUBVARIABLES**

<table>
<thead>
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<th>NO.</th>
<th>Variable</th>
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<th>LEAST</th>
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<td>Vegetation Crown Density</td>
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<td>6</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>Slope</td>
<td>5,8,9</td>
<td>4</td>
<td>1,0,2,3</td>
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<tr>
<td>19</td>
<td>Proximity to Island Shoreline</td>
<td>5,9</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 100.** Coding form: Change in visual quality.
Figure 101. Impact Map 10: Change in visual quality.
Impact Model 11: Change in wildlife habitat—mule deer

Impact Models 11, 12, 13 and 14 deal with the presence, maintenance and potential of wildlife within the study area. To promote and maintain the aesthetic qualities and an ecosystem characteristic of Antelope Island, land use plans should be perpetuated to preserve a diverse variety of fauna. Disturbance of particular fauna habitat may severely impact or terminate the species within the study area. Several species demand seasonal solitude for reproduction.

The habitat of the mule deer is briefly outlined below. Their diet consists of willow, aspens and shrubs in the summer. Bitterbrush, sagebrush and pinyon juniper is eaten in winter with grasses and forbs in their springtime diet. Mule deer browse higher mountain slopes in summer and lower foothills with southern orientations in winter.

The data categories used in the model are:

1. #13--Wildlife: Mule deer habitat
2. #20--Vegetation by physiotype
3. #6--Surface water by type

Obviously the subvariable habitat area is more sensitive than the subvariable of no habitat in the data variable wildlife: mule deer habitat.

The second data variable is vegetation by physiotype. Subvariables sage/grass association, riparian and pinyon/juniper are most vulnerable to mule deer habitat. Grassland is moderately sensitive and halophytes and barren are least sensitive to change in mule deer habitat.
Subvariables most sensitive in the variable surface water by type are intermittent streams and spring areas. Cells of no surface water and reservoir are moderately vulnerable. Salt and fresh water bodies are least susceptible to change in habitat.

**Land use groupings:**

**Land Use Group One** (least impacting)—

- #4 trails
- #5 beach activities
- #6 picnicking
- #9 primitive camping
- #13 conservation
- #14 cliff climbing
- #17 desert bighorn habitat
- #18 antelope habitat

**Land Use Group Two** (moderately impacting)—

- #3 reservoir

**Land Use Group Three** (heaviest impacting)—

- #1 road
- #2 grazing
- #7 golf course
- #8 riflery and archery
- #10 septic tanks and absorption fields
- #11 tent and car camping
- #12 low density vacation homes
- #15 small commercial center
- #16 sanitary land fill
Figure 102. Existing and potential wildlife (Exhibit A).
Figure 103. Existing and potential wildlife (Exhibit B).
### IMPACT MODEL NO. 11  Change in Wildlife Habitat: Mule Deer

<table>
<thead>
<tr>
<th>D.V. DATA VARIABLES (listed in order of importance)</th>
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<tr>
<td>20 Vegetation by Physiotype</td>
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<td>6 Surface Water by Type</td>
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<td>20 Vegetation by Physiotype</td>
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<td>0,1,3</td>
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<td>6 Surface Water by Type</td>
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#### MATRIX ONE

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#### CODING

X: most sensitive  
Y: moderately sensitive  
Z: least sensitive  
C: compatible impact  
M: moderate impact  
S: severe impact  
T: terminal impact

#### MATRIX TWO

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<td>C</td>
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### Figure 104. Coding form: Change in wildlife habitat—mule deer.
Figure 105. Impact Map 11: Change in wildlife habitat—mule deer.
Impact Model 12: Change in wildlife habitat--buffalo

Cells of the study area have been determined in this model to indicate their degree of impact potential of buffalo habitat. Each cell, as in all the impact models, has been scored either compatible, moderate, severe, or terminal degrees of impact.

_Bison bisoni_, the American buffalo, are believed to have roamed on Antelope Island long before the Great Salt Lake was first approached by white men. Presently, the island's buffalo herd of 50+ share grazing lands with domestic livestock.

Data variables in the model are:
1. #12--Wildlife: buffalo habitat
2. #20--Vegetation by physiotype
3. #9--Slope

In the first data variable habitat area is most vulnerable and areas of no habitat are least sensitive.

Vegetation by physiotype has subvariables of grassland and sage/grass association most susceptible to habitat change. Medium vulnerability are riparian and pinyon/juniper. Least sensitive are barren and halophytes.

The third category is slope. Slopes less than 16.0% are most vulnerable to habitat change. 16.1-30.0% slopes are medium vulnerability and slope greater than 30.0% are least sensitive because of the difficulty of terrain not attractive to their habitat.
Land use groupings:

**Land Use Group One** (least impacting) --

#4 trails
#5 beach activities
#6 picnicking
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat

**Land Use Group Two** (moderately impacting) --

#3 reservoir

**Land Use Group Three** (heaviest impacting) --

#1 roads
#2 grazing
#7 golf course
#8 riflery and archery
#10 septic tanks and drain fields
#11 tent and car camping
#12 low density vacation homes
#15 small commercial center
#16 sanitary land fill
**IMPACT MODEL NO. 12 Change in Wildlife Habitat: Buffalo**

<table>
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<tr>
<th>D.V. NO.</th>
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<tr>
<td>20</td>
<td>Vegetation by Physiotype</td>
<td>4, 5, 6, 9, 0, 1, 3</td>
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<td>9</td>
<td>Slope</td>
<td>2, 3, 4, 5, 0, 1, 8</td>
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**CODING**

- **X**: most sensitive
- **V**: moderately sensitive
- **Z**: least sensitive
- **C**: compatible impact
- **M**: moderate impact
- **S**: severe impact
- **T**: terminal impact

**Figure 106.** Coding form: Change in wildlife habitat—buffalo.
Figure 107. Impact Map 12: Change in wildlife habitat—buffalo.
Impact Model 13: Change in wildlife habitat--desert bighorn sheep

The model specified potential habitat areas for desert bighorn sheep that are sensitive to light, medium and heavy impacts. No bighorn live presently on Antelope Island. Attractiveness map number 17 (see Figure 78) specifies cells of prime habitat. The bighorn species of which this model is addressed to is the Nelson Desert Bighorn (*Ovis canadensis Nelsoni*).

The three most important data variables are:

1. #20--Vegetation by physiotype
2. #7--Exposed bedrock
3. #9--Slope

Barren, rocky physiotypes are most sensitive to the bighorn niche. Grassland and sage/grass association are moderately vulnerable. Halophytes, riparian and pinyon/juniper are least sensitive.

High percentages of exposed bedrock, 26%+, are much more sensitive to habitat changes than cells of lesser exposed bedrock. Lesser percentages are proportionately less sensitive to their habitat.

Slope is the third variable. Steep slopes, which compose a major portion of the island, are respectively most sensitive to their niche. Gentle slopes are less vulnerable to environmental changes of the desert bighorn.

**Land use groupings:**

Land Use Group One (least impacting)--

#4 trail

#5 beach activities
#6 picnicking
#9 primitive camping
#13 conservation
#17 desert bighorn habitat
#18 antelope habitat

**Land Use Group Two** (moderately impacting) --

#2 grazing
#3 reservoir
#7 golf course
#14 cliff climbing

**Land Use Group Three** (heaviest impacting) --

#1 road
#8 riflery and archery
#10 septic tank and drainfield
#11 tent and car camping
#12 low density vacation homes
#15 small commercial center
#16 sanitary land fill
### Impact Model No. 13: Change in Wildlife Habitat: Desert Bighorn Sheep

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<td>Exposed Bedrock</td>
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#### Matrix One

**VARIABLE 2**

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<tr>
<td>B</td>
<td>X</td>
<td>Y</td>
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</tr>
<tr>
<td>C</td>
<td>Y</td>
<td>Z</td>
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</tbody>
</table>

#### Coding

- X: most sensitive
- Y: moderately sensitive
- Z: least sensitive
- C: compatible impact
- M: moderate impact
- S: severe impact
- T: terminal impact

#### Matrix Two

**VARIABLE 1**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
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#### Matrix Three

**VARIABLE 1**

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#### Matrix Four

**VARIABLE 1**

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<td>T</td>
<td>T</td>
<td>S</td>
</tr>
<tr>
<td>Z</td>
<td>S</td>
<td>S</td>
<td>M</td>
</tr>
</tbody>
</table>

*Figure 108. Coding form: Change in wildlife habitat—desert bighorn sheep.*
Figure 109. Impact Map 13: Change in wildlife habitat—desert big-horn sheep.
Impact Model 14: Change in wildlife habitat—pronghorn antelope

Antelope which once pranced throughout the island have been extinct from the study area since the 1870's. Attractiveness map number 18 (see Figure 80) displays several areas in which environmental conditions for antelope are ideal. The impact model derived out of the data below designates cells in the study area that are most and least sensitive to changes in habitat.

Data variables listed in order of importance are:
1. #20—Vegetation by physiotype
2. #8—Vegetation crown density
3. #6—Surface water by type

Subvariables most vulnerable in vegetation by physiotype are grassland and sage/grass association. Halophytes, riparian and pinyon/juniper are moderately sensitive. Barren vegetation is least sensitive.

Pronghorn antelope is a creature of wide open spaces. Areas of no vegetation crown density are most susceptible to the change of antelope habitat. Medium sensitive cells are of 1-25% crown cover and least sensitive are cells of 25%+ density.

The third data category is surface water by type. Although water requirements for pronghorn are extremely low, small quantities of water are still needed in preserving their habitat. This is particularly so during the hot, arid summers. Intermittent streams and springs are most sensitive. Areas of no surface water and reservoir are moderately sensitive and fresh and salt water bodies are least sensitive to habitat changes.
Land use groupings:

Land Use Group One (least impacting)---

#4 trails
#5 beach activities
#6 picnicking
#9 primitive camping
#13 conservation
#14 cliff climbing
#17 desert bighorn habitat
#18 antelope habitat

Land Use Group Two (moderately impacting)---

#3 reservoir

Land Use Group Three (heaviest impacting)---

#1 road
#2 grazing
#7 golf course
#8 riflery and archery
#10 septic tanks and drain field
#11 tent and car camping
#12 low density vacation homes
#15 small commercial center
#16 sanitary land fill
**IMPACT MODEL NO. 14  Change in Wildlife Habitat: Pronghorn Antelope**

<table>
<thead>
<tr>
<th>D.V. NO.</th>
<th>DATA VARIABLES (listed in order of importance)</th>
<th>DATA SUBVARIABLES MOST</th>
<th>MODERATE</th>
<th>LEAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Vegetation by Physiotype</td>
<td>4,5</td>
<td>3,6,9</td>
<td>0,1</td>
</tr>
<tr>
<td>8</td>
<td>Vegetation Crown Density</td>
<td>0</td>
<td>5</td>
<td>1,6,9</td>
</tr>
<tr>
<td>6</td>
<td>Surface Water by Type</td>
<td>4,9</td>
<td>0,8</td>
<td>1,6,7</td>
</tr>
</tbody>
</table>

**CODING**

- X: most sensitive
- Y: moderately sensitive
- Z: least sensitive
- C: compatible impact
- M: moderate impact
- S: severe impact
- T: terminal impact

**Figure 110. Coding form: Change in wildlife habitat—pronghorn antelope.**
Figure 111. Impact Map 14: Change in wildlife habitat—pronghorn antelope.
Impact Model 15: Vulnerability to waterfowl habitat

The model indicates various impacts by three different impacting land use groups upon waterfowl related to the island. The presence, maintenance and potential of waterfowl in the study area has several recreational values. One is to maintain a population of waterfowl for sport hunting, particularly in the Farmington Bay Area along the eastern shoreline of Antelope Island. Another is to maintain the aesthetical and visual quality for observation of waterfowl by recreationists. Another is to maintain a balanced ecosystem on the island.

Habitat of species included in the model are sporting species of Canada goose and Mallard duck. Other species native to the island are California gull, longbilled curlew, great blue heron, and double crested commorant.

Data variables used in the model are:
1. #11--Wildlife: bird habitat
2. #6--Surface water by type
3. #19--Proximity to island shoreline

Subvariables sensitive to bird habitat are habitats of great blue heron, California gull, double crested commorant, ring necked pheasant, Mallard duck, Canada goose and long billed curlew. All other subvariables are less sensitive.

Most sensitive water types are fresh and salt lake bodies. Moderately sensitive are subvariables reservoir and spring area. Least vulnerable are no surface water and intermittent stream.
In the data variable *proximity to island shoreline*, closer proximities are more sensitive. Most vulnerable are *same cell* and *adjacent cell*. Moderately sensitive is *two cells away* and three or more cells away are least susceptible to the vulnerability of waterfowl habitat.

**Land use groupings:**

**Land Use Group One (least impacting)**—

- #3 reservoir
- #4 trails
- #9 primitive camping
- #13 conservation
- #14 cliff climbing
- #17 desert bighorn habitat
- #18 antelope habitat

**Land Use Group Two (moderately impacting)**—

- #2 grazing
- #6 picnicking
- #7 golf course
- #16 sanitary land fill

**Land Use Group Three (heaviest impacting)**—

- #1 road
- #5 beach activities
- #8 riflery and archery
- #10 septic tanks and drain field
- #11 tent and car camping
- #12 low density vacation homes
- #15 small commercial center
## Impact Model NO. 15 Vulnerability Waterfowl Habitat

<table>
<thead>
<tr>
<th>D.V. DATA VARIABLES (listed in order of importance)</th>
<th>DATA SUBVARIABLES</th>
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<tbody>
<tr>
<td>11 Wildlife: Bird Habitat</td>
<td>3,4,5,6</td>
</tr>
<tr>
<td>6 Surface Water by Type</td>
<td>6,7</td>
</tr>
<tr>
<td>19 Proximity to Island Shoreline</td>
<td>9,5,4</td>
</tr>
</tbody>
</table>

### Data Subvariables

- **3,4,5,6**: Most important
- **6,7**: Moderate importance
- **9,5,4**: Least important

### Coding

- **X**: Most sensitive
- **Y**: Moderately sensitive
- **Z**: Least sensitive
- **C**: Compatible impact
- **M**: Moderate impact
- **S**: Severe impact
- **T**: Terminal impact

### Matrices

#### Matrix One

<table>
<thead>
<tr>
<th>Variable 2</th>
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#### Matrix Two

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#### Matrix Three

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#### Matrix Four

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<tr>
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</table>

Figure 112. Coding form: Change in wildlife habitat—waterfowl.
Figure 113. Impact Map 15: Change in wildlife habitat—waterfowl.
Summary of Impact Models

The environmental impact models can be broken down into three categories: 1) impacts directly perceived by people, 2) impacts perceived by people with a greater degree of knowledge about the area, and 3) impacts which are indirectly perceived or which are perceived as long term impacts. Many of these are concerned with the quality of the land resources of the area, whether in a developed or natural state. Among these are systems related with water, i.e. change in runoff, erosion, and change in shoreline area. Impacts on wildlife and vegetation and non-renewable natural resources are also included in this grouping. Each of the fifteen impact maps illustrated the degrees of impact predicted on each system by numerical expressions. These expressions are more quantitatively related evaluations that were a result from the various environmental models. They do express in an overall sense an environmental analysis of each plan.
5 - evaluation
CHAPTER FIVE
EVALUATION PLANS

Evaluation Plans

At this juncture in the project, all data variables, attractiveness models and impact models were ready to be focused in on various strategies and synthesized into land use plans. This chapter deals with the development of planning strategies or proposals, the design of plans and evaluation of plans.

Four plans were submitted for evaluation by the GRID process. Actually two plans were originated with first and second iterations of each plan submitted. Plan One was prepared in part by the National Park Service and Utah Division of Parks and Recreation. The other plan, Plan Two, was prepared by the writer.

The GRID process computed the plans and printed out sixteen graphically displayed maps and one summary table for each plan. Of the sixteen maps, one was a composite attractiveness map evaluating land use allocations. Fifteen maps were impact maps graphically displaying and evaluating environmental impacts constrained on each natural system. Each plan and sets of maps are illustrated further in this chapter.

Plan One

In 1959 the National Park Service developed a master plan of Antelope Island with the circumstantial assumption that Congress would pass Senator Frank Moss' bill S. 25 allocating funds to purchase the
island for development into a National Park or National Monument.

Also included in Plan One is a master plan for 2000 acres owned by the State and done by the Utah Division of Parks and Recreation. Two iterations were made on Plan One.

**Plan Two**

Another plan, Plan Two, was developed by the writer which was coded, evaluated and displayed. Principally, the motivation of Plan Two was maximization of recreational opportunity in terms of attractive land use allocations, functional relationships, and minimization of environmental restraints of the fifteen selected natural systems.

**Evaluation maps**

Of the sixteen maps displayed in each plan, fifteen dealt with impacts and one dealt with land use allocations. These maps are interpreted in a similar manner as maps included in Chapters Three and Four. Following each set of map displays is a summary table illustrating how each plan fared.

The summary tables are listed as Figures 131, 149, 167, and 185. Interpretation of these tables are indicated as follows. Mean scores were given for both land use allocations and system impacts. Each land use and natural system displayed a raw score. The upper portion of the table dealt with land uses. Mean scores and number of cells allocated are the more significant of the statistical data. Scoring may range from 0 to 90. Scores below 50 are considered generally fair, 50-70 good and above 70 generally very good. A composite attractiveness mean score, summing up the allocation of land uses, is given.
Impact scoring in the summary tables indicated the number of cells declared compatible, moderate, severe, and terminal, and were assigned values 1 through 4, respectively. All impact calculations were computed to three decimal places. As indicated by the composite summary table in Figure , the third decimal place out is significant for system comparisons of first and second iterations. Finally, a composite mean score of environmental impacts was displayed.

Second iterations

At this point in the planning process some revisions of both plans were rather obvious, as indicated by some undesirable scores of particular land use allocations and impact systems. After locating problem cells, significant adjustments were made in both plans. Several land uses were reallocated new locations, eliminated or introduced in attempting to boost their attractiveness scores. In some instances cells were reallocated new land uses in an attempt to lower impact readings displayed by those cells under first iterations. In summary, the second iteration is used to relocate land uses which received low attractiveness scores or created high impacts or both. Subsequent iterations would ultimately plateau to an equilibrium phase where mean attractiveness scores would be improved without depreciating impact scores.

Summary of First and Second Iterations - Plan One

In comparing results of first and second iterations of Plan One, the overall mean attractiveness increased from 59 to 62 with 70 more
cells allocated with land uses in the second iteration. Nearly all land uses increased their attractiveness scores. Only shooting range and archery decreased from 60 to 50. More notable of the improved attractiveness scores were septic tanks and absorption field, 50 to 67; vacation homes, 50 to 66; conservation, 50 to 66; and small commercial center, 67 to 77.

Trails was an exceptionally sensitive model. Three submissions were made in an attempt to liberalize the model. Scores of iterations from both plans demonstrated the tightness of this model.

Mean impact scores decreased from 2.370 to 2.060. The number of terminal cells measured by the fifteen systems was reduced from 1129 cells to 853 cells. All environmental systems with the exception of one reduced their impact scores in the second iteration. The one exception was mule deer habitat which increased from 1.508 to 1.633.

Of the more significant impact reductions were noise absorption, 2.418 to 1.996; change in shoreline area 2.153 to 1.771; wildfires 3.111 to 2.616; visual absorption, 3.087 to 2.600; visual quality, 2.550 to 2.002; and antelope habitat, 3.195 to 2.782.
Figure 114. Plan One, Iteration One.

Antelope Island Study Area · Davis County, Utah
Figure 115. Evaluation of the attractivenesses on Plan #1.
Evaluation of the impact on plan 41-04: Vulnerability to erosion.

Antelope Island Study Area, Davis County, Utah

Plan prepared by National Park Service and Utah Division of Parks and Recreation

Figure 116. Vulnerability to erosion.
Figure 117. Vulnerability by grazing.
EVALUATION OF THE IMPACT ON PLAN AS THE VULNERABILITY TO NOISE

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

(FIRST ITERATION)

PLAN PREPARED IN MARCH 1979

HERE IS HOW THE LAND USES HAVE BEEN CHARTED:

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO
1 HEADQUARTERS 9 Attendant
2 Tents 10 Attendant
3 11 Attendant
4 12 Attendant
5 13 Attendant
6 14 Attendant
7 15 Attendant
8 16 Attendant

LEVELS

SYMBOLS

FREQUENCY

Figure 118. Vulnerability to noise.
EVALUATION OF THE IMPACT ON PLAN #1 OF CHANGE IN RUNOFF

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

FIRST ITERATION
PLAN PREPARED IN MARCH 1976
HERE IS HOW THE LAND USES HAVE BEEN GROUPED

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE
1 TRAILS 2 GRAZING 11 SMOKE, SAWDUST, FLORIC
2 DEER ACTIVITIES 3 MUSKETRY 12 CITY OF UTAH VACATION HOME
3 PERMISSIVE CAMPING 4 GOLF COURSE 13 COMMERCIAL CULTIVATION
4 HUNTING SHOOTING 5 RV PARKS AND ARCHERY 14 SATELLITE DISH INSTALLATION
5 ANTELOPE HABITAT 7 6 8 15

LEVELS

SYMBOLS

FREQUENCY

Figure 119. Change in runoff.
EVALUATION OF THE IMPACT ON PLAN #1: VULNERABILITY TO GROUNDWATER POLLUTION

ANTELOPE ISLAND STUDY AREA. LEVIT COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

(FIRST ITERATION)

PLAN PREPARED IN MARCH, 1976

HERE IS HOW THE LAND USES HAVE BEEN GROUPED

LAND USE GROUP NO. ONE
LAND USE GROUP NO. TWO
LAND USE GROUP NO. THREE

1. TRAILS
2. OPERATIONS
3. BEACH ACCESS
4. COASTAL PLANNING
5. AMERICAN HABITAT
6. SEWAGE TANKS/ANIMAL
7. SANITARY LANDFILL
8. VOLCANIC HABITAT

LEVELS

0
1
2
3
4
5
6
7
8
9
10

SYMBOLS

FREQUENCY

Figure 120. Vulnerability to groundwater pollution.
Figure 121. Vulnerability to surface water pollution.
Figure 122. Vulnerability to shoreline area change.
Figure 123. Vegetation—vulnerability to wildfires.
Figure 124. Change in visual absorption.
EVALUATION OF THE IMPACT ON PLAN #5: CHANGING VISUAL QUALITY

ANTELOPE ISLAND STUDY AREA, GILDER COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

(FIRST ITERATION)

PLAN PREPARED IN APRIL, 1978
MIÓN IS WITH THE LAND USE GROUPS MANAGED
LAND USE GROUP NO. NO. NO. LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE
1 MINE 1 2 OFFICE 2 3 URBAN
2 MARINE 2 4 PERMIT AND ARCHITECT 4 5 URBAN TANKS/ATC GROUP, FIELDS
3 IMPACT 3 6 TENT AND RV CAMPING 6 7 LOW DENSITY VACATION HOMES
4 PERMIT 4 8 INTRAMURAL CAMPING 8 9 SMALL COMMERCIAL CENTERS
5 ARCHITECT 5 10 LANDfills
6 IMPACT 6 11 IMPROVEMENTS, MAN. 11 ANTELOPE HABITAT
7 MINE 7 12 IMPROVEMENTS, MAN.
8 MARINE 8
9 IMPACT 9

LEVELS 1 2 3 4 5 6 7 8 9

SYMBOLS 1 2 3 4 5 6 7 8 9

FREQUENCY

Figure 125. Change in visual quality.
EVALUATION OF THE IMPACT ON PLAN #1: ONE CHANGE IN WILDLIFE HABITAT--MULE DEER

ANTELPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

(FIRST ITERATION)
PLAN PREPARED IN MARCH, 1974
HERE IS HOW THE LAND USES WERE GROUPED:

<table>
<thead>
<tr>
<th>LAND USE GROUP NO. ONE</th>
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<tr>
<td>TRAILS</td>
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<td>HOUSING</td>
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<td>SPECIAL ACTIVITIES</td>
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<td>SPORTING</td>
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<td>FISHING</td>
<td></td>
<td>WATERFLEET/ARCHERY</td>
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<td>CONSERVATION</td>
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<td>SPECIAL COLLECTION</td>
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<td>SANCTUARY HOMES</td>
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<tr>
<td>ANTELOPE HABITAT</td>
<td></td>
<td>SANCTUARY LANDFILL</td>
</tr>
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</table>

Figure 126. Change in wildlife habitat--mule deer.
EVALUATION OF THE IMPACT ON PLAN AS ONE CHANGE IN WILDLIFE HABITAT—BUFFALO

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

LEVELS

SYMBOLS

FREQUENCY

Figure 127. Change in wildlife habitat—buffalo.
Figure 128. Change in wildlife habitat—desert bighorn sheep.
EVALUATION OF THE IMPACT ON PLAN IF THE CHANGE IN WILDLIFE HABITAT—ANTELOPE

ANTELOPE ISLAND STUDY AREA, NAGIS COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DIVISION OF PARKS AND RECREATION

(FIRST ITERATION)
PLAN PREPARED IN MARCH 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

<table>
<thead>
<tr>
<th>LAND USE GROUP NO. ONE</th>
<th>LAND USE GROUP NO. TWO</th>
<th>LAND USE GROUP NO. THREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 TRAIL ACTIVITIES</td>
<td>1 RESERVOIR</td>
<td></td>
</tr>
<tr>
<td>2 BIRD CHASE</td>
<td>2 ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>3 WILDLIFE CAMPING</td>
<td>3 FISHING AND ARCHERY</td>
<td></td>
</tr>
<tr>
<td>4 CONSTRUCTION</td>
<td>4 PLACE TANKS/SHORES/FIELDS</td>
<td></td>
</tr>
<tr>
<td>5 DESERT TANKS/SHORES</td>
<td>5 LOW MAINTAINING FIELDS</td>
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</tr>
<tr>
<td>6 ANTILIOR FISHING</td>
<td>6 SMALL WATERSIDE CISTER</td>
<td></td>
</tr>
<tr>
<td>7 TANKS/SHORES</td>
<td>7 SANITARY LANDFILL</td>
<td></td>
</tr>
</tbody>
</table>

LEVELS

SYMBOLS

FREQUENCY

Figure 129. Change in wildlife habitat—antelope.
EVALUATION OF THE IMPACT ON PLAN #1 ON VULNERABILITY TO WATERFOWL HABITAT
ANTELope ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY NATIONAL PARK SERVICE AND UTAH DEPARTMENT OF PARKS AND RECREATION

(FIRST IterATION)
PLAN PREPARED IN MARCH 1978
HERE IS HOW THE LAND USES HAVE BEEN GROUPED
LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE
1 RECREATION 7 DIRECTIONS 1 ROADS
2 TRAILS 8 PICKLING 1 BEEF CATTLE
3 RECREATIONAL CAMPGROUND 9 SALT GLASS 1 CATTLE AND OTHERS
4 RECREATIONAL CARAVAN CAMPGROUND 10 SANITARY LANDFILL 2 LUGGAGE VACATION HOMES
5 DESERT BLOOM HAB. 11 DESERT BLOOM HAB.
6 ANIMAL HABITAT

LEVELS
1 2 3 4 5 6 7
SYMBOLS
1
FREQUENCY
0 1 2 3 4 5 6 7

Figure 130. Vulnerability to waterfowl habitat.
<table>
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<th>LAND USE</th>
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<td>Road</td>
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<td>Septic tank/absorption field</td>
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<td>Grazing</td>
<td>0</td>
<td>0</td>
<td>Tent/car camping</td>
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<td>51</td>
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<td>0</td>
<td>Low density vacation homes</td>
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</tr>
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<td>50</td>
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<tr>
<td>Beach activity</td>
<td>15</td>
<td>72</td>
<td>Cliff climbing</td>
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<tr>
<td>Picnicking</td>
<td>0</td>
<td>0</td>
<td>Small commercial center</td>
<td>9</td>
<td>67</td>
</tr>
<tr>
<td>Golf course</td>
<td>0</td>
<td>0</td>
<td>Sanitary landfill</td>
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<td>80</td>
</tr>
<tr>
<td>Riflery/archery</td>
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<td>60</td>
<td>Desert bighorn sheep habitat</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Primitive camping</td>
<td>0</td>
<td>0</td>
<td>Antelope habitat</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Composite Mean Score</td>
<td>380</td>
<td>59</td>
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</tbody>
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<table>
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<tr>
<th>SYSTEM</th>
<th>COMPATIBLE</th>
<th>MODERATE</th>
<th>SEVERE</th>
<th>TERMINAL</th>
<th>MEAN</th>
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<tbody>
<tr>
<td>Erosion</td>
<td>34</td>
<td>126</td>
<td>196</td>
<td>24</td>
<td>2.553</td>
</tr>
<tr>
<td>Grazing</td>
<td>46</td>
<td>142</td>
<td>70</td>
<td>122</td>
<td>2.705</td>
</tr>
<tr>
<td>Noise</td>
<td>86</td>
<td>49</td>
<td>245</td>
<td>0</td>
<td>2.418</td>
</tr>
<tr>
<td>Runoff</td>
<td>34</td>
<td>220</td>
<td>78</td>
<td>48</td>
<td>2.368</td>
</tr>
<tr>
<td>Groundwater pollution</td>
<td>191</td>
<td>108</td>
<td>79</td>
<td>2</td>
<td>1.716</td>
</tr>
<tr>
<td>Surface water pollution</td>
<td>125</td>
<td>125</td>
<td>127</td>
<td>3</td>
<td>2.021</td>
</tr>
<tr>
<td>Shoreline area</td>
<td>109</td>
<td>104</td>
<td>167</td>
<td>0</td>
<td>2.153</td>
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<td>Vegetation--wildfire</td>
<td>12</td>
<td>58</td>
<td>186</td>
<td>124</td>
<td>3.111</td>
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<td>Visual absorption</td>
<td>53</td>
<td>82</td>
<td>24</td>
<td>221</td>
<td>3.087</td>
</tr>
<tr>
<td>Visual quality</td>
<td>99</td>
<td>115</td>
<td>24</td>
<td>142</td>
<td>2.550</td>
</tr>
<tr>
<td>Mule deer</td>
<td>269</td>
<td>70</td>
<td>0</td>
<td>41</td>
<td>1.508</td>
</tr>
<tr>
<td>Buffalo</td>
<td>111</td>
<td>64</td>
<td>99</td>
<td>106</td>
<td>2.526</td>
</tr>
<tr>
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<td>98</td>
<td>77</td>
<td>161</td>
<td>44</td>
<td>2.397</td>
</tr>
<tr>
<td>Antelope</td>
<td>8</td>
<td>126</td>
<td>30</td>
<td>216</td>
<td>3.195</td>
</tr>
<tr>
<td>Waterfowl</td>
<td>343</td>
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<td>0</td>
<td>36</td>
<td>1.287</td>
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<td></td>
<td></td>
<td>1618</td>
<td>1467</td>
<td>1486</td>
<td>1129</td>
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</tbody>
</table>

Figure 131. Plan summary of Plan 1, iteration 1.
Figure 132. Plan One, iteration two.
Figure 133. Evaluation of the attractivenesses on Plan #1, iteration 2.
EVALUATION OF THE IMPACT ON PLANT AS VULNERABILITY TO EROSION

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LAEP, UTAH STATE UNIV.

(Figure 134: Vulnerability to erosion.)
EVALUATION OF THE IMPACT ON PLAN #1 VISUAL INTERFERENCE BY GRAZING

ANTELOPE ISLAND STUDY AREA: NAVE COUNTY, UTAH

PLAN PREPARED BY WINTON H. SCOTT, GRADUATE STUDENT, DEPT. LAPP, UTAH STATE UNIV.

(SECOND ITERATION)
PLAN PREPARED IN MARCH 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE
4 TRAILS 2 GRAVING 1 ROADS
4 BEEF ACTIVITIES 3 GRAVING 1 AQUATIC TENT/FISHING/FLIGHT
4 PASTURING 7 BOLT SHORES 17 ENVIRONMENTAL MONITORING
3 PRIMITIVE CAMPING 11 TENT AND CANOE CAMPING 14 SMALL COMMERCIAL CAMP
1 CONSERVATION 10 TENT AND CANOE CAMPING 16 SANITARY LANDFILL
2 WATERFALL 6 TENT AND CANOE CAMPING
1 ANTELOPE HATCHET

LEVELS
1
2
3
4
5
6
7
8
9
10

SYMBOLS
1
2
3
4
5
6
7
8
9
10

FREQUENCY
0
5
10
15
20
25
30
35
40
45
50

Figure 135. Vulnerability by grazing.
Evaluation of the Impact on Plan 1: On Vulnerability to Noise

Antelope Island Study Area, Davis County, Utah

Plan Prepared by Robert O. Schott, Graduate Student, Dept. Env. Utah State Univ.

(Second Iteration)
Plan Prepared in March 1976

Here is how the land uses have been grouped:

Land Use Group No. One: Land Use Group No. Two: Land Use Group No. Three:
1. Trails 1. Grafting 1. Golf Courses

Levels

Symbols

Figure 136. Vulnerability to noise.
EVALUATION OF THE IMPACT ON PLAN #1 ON CHANGE IN RUNOFF
ANTLERS ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT J. SCOTT, GRADUATE STUDENT, DEPT. LAFT, UTAH STATE UNIV.

(SECOND ITERATION)
PLAN PREPARED IN MARCH, 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

LAND USE GROUP NO. ONF LAND USE GROUP NO. TAG LAND USE GROUP NO. TAG
1a TAKE 2a SHAFTS 3a ROADS
1b ACTIVITIES 2b CHEMICALS 3b TRAFFIC/ARMS 1b TREES, WOODS
1c TAKING 2c OIL/FUEL 3c ROCK/STONE/OAK WOODS
1d PRIVET CAMPING 2d FIRE/PAINT 3d SMALL COMMERCIAL 1d TENT AND CAMP CAMPING
1e LEISURE 2e CONSERVATION 3e SCAFFOLD 1e WATERSHED
1f WATERSHED

LEVELS
SYMBOLS
FREQUENCY

Figure 137. Change in runoff.
EVALUATION OF THE IMPACT ON PLAN 1: VULNERABILITY TO GROUNDWATER POLLUTION

ANTELOPE ISLAND STUDY AREA, DAVES COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. EGF, UTAH STATE UNIV.

(SECOND ITERATION)

PLAN PREPARED IN MARCH, 1975

HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE

1. TRAILS 2. RESERVOIR 3. TRAILS
2. SCAVENGING 4. MINING 5. SCAVENGING
3. GATHERING 6. LAND USE 7. GATHERING
4. HUNTING 8. LAND USE 9. HUNTING
5. OCEAN 10. LAND USE 11. OCEAN
6. OUTDOOR 12. LAND USE 13. OUTDOOR
7. COMMERCIAL 14. LAND USE 15. COMMERCIAL
8. TOWNSHIP

LEVELS

SYMBOLS

FREQUENCY

Figure 138. Vulnerability to groundwater pollution.
EVALUATION OF THE IMPACT ON PLAN 81 OF VULNERABILITY TO SURFACE WATER POLLUTION

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT P. SCOTT, GRADUATE STUDENT, DEPT. LAFF, UTAH STATE UNIV.

(SECOND ITERATION)

PLAN PREPARED IN MARCH 1974

HERE IS HOW THE LAND USES HAVE BEEN GROUPED

<table>
<thead>
<tr>
<th>LAND USE GROUP NO. ONE</th>
<th>LAND USE GROUP NO. TWO</th>
<th>LAND USE GROUP NO. THREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEACH ACTIVITIES</td>
<td>MUSEUM</td>
<td>HISTORIC</td>
</tr>
<tr>
<td>PATHWAYS</td>
<td>TRAILS</td>
<td>DISPOSAL</td>
</tr>
<tr>
<td>TRAILS</td>
<td>WILDLIFE AND ANIMALS</td>
<td>DUMPSTERS</td>
</tr>
<tr>
<td>CONSERVATION</td>
<td>RESERVOIR</td>
<td>MINING</td>
</tr>
<tr>
<td>SALT PLANNING</td>
<td>MARINE BIRD GROUNDS</td>
<td>SMALL COMMERCIAL CENTERS</td>
</tr>
<tr>
<td>FISHING</td>
<td>ANTELOPE HERITAGE</td>
<td>LANDFILL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GOLF COURSE</td>
</tr>
</tbody>
</table>

LEVELS

SYMBOLS

FREQUENCY

Figure 139. Vulnerability to surface water pollution.
Figure 140. Vulnerability to shoreline area change.
EVALUATION OF THE IMPACT ON PLANT LIFE - VEGETATION - VULNERABILITY TO WILDFIRES

ANTELOPE ISLAND STUDY AREA, NELIS COUNTY, UTAH

PLAN PREPARED BY ROBERT R. SCOTT, GRADUATE STUDENT, DEPT. LAND, UTAH STATE UNIV.

Figure 141. Vegetation—vulnerability to wildfires.
EVALUATION OF THE IMPACT ON PLAN AS ONE CHANGE IN VISUAL ABSORPTION

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT G. SCOTT, GRADUATE STUDENT, DEPT. LAFF, UTAH STATE UNIV.

(SECOND ITERATION)

PLAN PREPARED IN MARCH 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

<table>
<thead>
<tr>
<th>LAND USE GROUP NO. ONE</th>
<th>LAND USE GROUP NO. THREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAILS 12</td>
<td>LOW INTEGRITY VACATION 12</td>
</tr>
<tr>
<td>DIRT-SIZE CAMPING 11</td>
<td>ANTELOPE WILDFL. HABITAT 12</td>
</tr>
<tr>
<td>LATERAL DRAINAGE 10</td>
<td>RESIDENCE AND ARCHIVE 12</td>
</tr>
<tr>
<td>DIRT ACCESS 9</td>
<td>TENT AND CAMP CAMPING 11</td>
</tr>
<tr>
<td>GRASS-UPTAKE CAMPING 8</td>
<td>BOAT CAMPING 7</td>
</tr>
<tr>
<td>WATER-BUILDING 7</td>
<td>FISHING 6</td>
</tr>
<tr>
<td>DEVELOPMENT 6</td>
<td>CHAINING 5</td>
</tr>
<tr>
<td>WHEAT 5</td>
<td>NURSERY 4</td>
</tr>
<tr>
<td>WOOL-CLIFT 4</td>
<td>SHEEP 3</td>
</tr>
<tr>
<td>POTATO 3</td>
<td>LEGUMES 2</td>
</tr>
<tr>
<td>CATTLE 2</td>
<td>FRUIT 1</td>
</tr>
<tr>
<td>BEEF 1</td>
<td>TRASH 0</td>
</tr>
</tbody>
</table>

LEVELS

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

SYMBOLS

1: LOW 2: MEDIUM 3: HIGH

FREQUENCY

1 2 3 4 5 6 7 8 9

Figure 142. Change in visual absorption.
Figure 143. Change in visual quality.
Figure 144. Change in wildlife habitat—mule deer.
EVALUATION OF THE IMPACT ON PLAN AS ONE CHANGE IN WILDLIFE HABITAT—BUFFALO

ANTELOPE ISLAND STUDY AREA, HAYES COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LAFF, UTAH STATE UNIV.

(Figure 145) Change in wildlife habitat—buffalo.
Figure 146. Change in wildlife habitat—desert bighorn sheep.
EVALUATION OF THE IMPACT ON PLAN #1 CHANCE IN WILDLIFE HABITAT—ANTELOPE

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT H. SCOTT, GRADUATE STUDENT, DEPT. LAPP, UTAH STATE UNIV.

(SECOND ITERATION)
PLAN PREPARED IN MARCH, 1974

Hence is how the land types have been grouped:

LAND USE GROUP NO. ONE  LAND USE GROUP NO. TWO  LAND USE GROUP NO. THREE
1 TRAIL  1 RESIDENC
2 DEER  2 RESIDENCE
3 BOAT  3 DEER USE
4 HUNTING AND ANCHERY
5 HUNTING  5 ANCHERY
6 CONSERVATION
7 DEER SICKENS
8 ANCHERY HABITAT
9 WILDLIFE
10 ROADS
11 DRIVE
12 MILITARY
13 SPRT. TANKS/AGROPY FIELDS
14 SALT-FLAT TANKING
15 ANCHRY TANKING
16 STAY FARM TANKING
17 GRAIN ELEVATOR CENTER
18 SMALL COMMERCIAL CENTER
19 SMALL COMMERCIAL CENTER
20 SALT FLAT LANDFILL

LEVELS

SYMBOLS

FREQUENCY

Figure 147. Change in wildlife habitat—antelope.
Figure 148. Vulnerability to waterfowl habitat.
<table>
<thead>
<tr>
<th>Land Use</th>
<th>No. of Cells</th>
<th>Mean</th>
<th>Land Use</th>
<th>No. of Cells</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
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<td>221</td>
<td>67</td>
<td>10 Septic tank/absorp. field</td>
<td>4</td>
<td>67</td>
</tr>
<tr>
<td>2 Grazing</td>
<td>0</td>
<td>0</td>
<td>11 Tent/car camping</td>
<td>11</td>
<td>51</td>
</tr>
<tr>
<td>3 Reservoir</td>
<td>0</td>
<td>0</td>
<td>12 Low dens. vacation home</td>
<td>9</td>
<td>66</td>
</tr>
<tr>
<td>4 Trail</td>
<td>103</td>
<td>47</td>
<td>13 Conservation</td>
<td>130</td>
<td>66</td>
</tr>
<tr>
<td>5 Beach activity</td>
<td>23</td>
<td>72</td>
<td>14 Cliff climbing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 Picnicking</td>
<td>0</td>
<td>0</td>
<td>15 Small commercial center</td>
<td>4</td>
<td>77</td>
</tr>
<tr>
<td>7 Golf course</td>
<td>0</td>
<td>0</td>
<td>16 Sanitary landfill</td>
<td>1</td>
<td>80</td>
</tr>
<tr>
<td>8 Riflery/archery</td>
<td>1</td>
<td>50</td>
<td>17 Desert bighorn sheep hab.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9 Primitive camping</td>
<td>0</td>
<td>0</td>
<td>18 Antelope habitat</td>
<td>0</td>
<td>0</td>
</tr>
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<td></td>
<td></td>
<td></td>
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<td>62</td>
</tr>
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<td>System</td>
<td>Compatible</td>
<td>Mod.</td>
<td>Severe</td>
<td>Terminal</td>
<td>Mean</td>
</tr>
<tr>
<td>1 Erosion</td>
<td>73</td>
<td>205</td>
<td>120</td>
<td>12</td>
<td>2.247</td>
</tr>
<tr>
<td>2 Grazing</td>
<td>71</td>
<td>229</td>
<td>62</td>
<td>38</td>
<td>2.371</td>
</tr>
<tr>
<td>3 Noise</td>
<td>195</td>
<td>62</td>
<td>193</td>
<td>0</td>
<td>1.996</td>
</tr>
<tr>
<td>4 Runoff</td>
<td>47</td>
<td>310</td>
<td>63</td>
<td>30</td>
<td>2.169</td>
</tr>
<tr>
<td>5 Groundwater pollution</td>
<td>285</td>
<td>88</td>
<td>75</td>
<td>2</td>
<td>1.542</td>
</tr>
<tr>
<td>6 Surface water pollution</td>
<td>249</td>
<td>83</td>
<td>117</td>
<td>1</td>
<td>1.711</td>
</tr>
<tr>
<td>7 Shoreline area</td>
<td>235</td>
<td>83</td>
<td>132</td>
<td>0</td>
<td>1.771</td>
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<td>8 Vegetation--wildfire</td>
<td>73</td>
<td>126</td>
<td>152</td>
<td>99</td>
<td>2.616</td>
</tr>
<tr>
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<td>102</td>
<td>143</td>
<td>38</td>
<td>167</td>
<td>2.600</td>
</tr>
<tr>
<td>10 Visual quality</td>
<td>219</td>
<td>113</td>
<td>16</td>
<td>102</td>
<td>2.002</td>
</tr>
<tr>
<td>11 Mule deer</td>
<td>231</td>
<td>186</td>
<td>0</td>
<td>33</td>
<td>1.633</td>
</tr>
<tr>
<td>12 Buffalo</td>
<td>152</td>
<td>130</td>
<td>79</td>
<td>89</td>
<td>2.233</td>
</tr>
<tr>
<td>13 Desert bighorn sheep</td>
<td>179</td>
<td>111</td>
<td>132</td>
<td>28</td>
<td>2.020</td>
</tr>
<tr>
<td>14 Antelope</td>
<td>15</td>
<td>241</td>
<td>21</td>
<td>173</td>
<td>2.782</td>
</tr>
<tr>
<td>15 Waterfowl</td>
<td>418</td>
<td>1</td>
<td>2</td>
<td>29</td>
<td>1.204</td>
</tr>
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<td></td>
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<td>Composite Mean Score</td>
<td>2544</td>
<td>2111</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td></td>
<td></td>
<td></td>
<td>2.060</td>
</tr>
</tbody>
</table>

Figure 149. Plan summary of Plan 1, iteration 2.
Summary of First and Second Iterations – Plan Two

Comparison of first and second iterations of Plan Two are discussed below. The mean composite attractiveness score increased from 68 for 859 cells to 69 for 879 cells. Several factors caused the slight increased attractiveness score. First, 36 cells were allocated for conservation in the second iteration which scored 57. No conservation cells were used in the first iteration. Grazing was eliminated in the second iteration, which in the first iteration achieved an attractiveness score of 75.

Activities decreasing in attractiveness scores were beach activities, 77 to 75; golf course, 77 to 75; primitive camping, 67 to 65 and septic tanks and absorption fields, 73 to 71. Activities which improved more notably were roads, 65 to 66; reservoir, 62 to 70; trails, 49 to 53; cliff climbing, 70 to 77; sanitary landfill, 73 to 80; and antelope habitat, 70 to 73.

The mean composite impact score increased slightly from 1.737 to 1.739 in the second iteration. Environmental systems that increased in impacts were noise absorption, 1.533 to 1.549; ground water pollution, 1.367 to 1.372; surface water pollution, 1.351 to 1.355; change in shoreline area, 1.529 to 1.565; visual absorption, 2.247 to 2.280; visual quality, 1.645 to 1.700; and waterfowl, 1.156 to 1.166. Systems achieving impressive impact decreases were erosion, 1.799 to 1.785; grazing, 2.076 to 2.069; runoff, 1.891 to 1.875; wildfire, 2.137 to 2.097; mule deer, 1.453 to 1.428; buffalo, 1.844 to 1.840; desert bighorn sheep, 1.679 to 1.658 and antelope, 2.351 to 2.345.
Figure 151. Evaluation of the attractivenesses on Plan #2.
EVALUATION OF THE IMPACT ON PLAN #5 ON VULNERABILITY TO EROSION

ANTELOPE ISLAND STUDY AREA, FAVRE COUNTY, UTAH

PLAN PREPARED BY ROBERT O. SCOTT, GRADUATE STUDENT, DEPT. LAND, UTAH STATE UNIV.

(Figure 152. Vulnerability to erosion.)
EVALUATION OF THE IMPACT ON PLANT VULNERABILITY BY GRAZING
ANTELope ISLAND STUDY AREA, JAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LANDS UTAH STATE UNIV.

Figure 153. Vulnerability by grazing.
Figure 154. Vulnerability to noise.
Figure 155. Change in runoff.
Figure 156. Vulnerability to groundwater pollution.
Figure 157. Vulnerability to surface water pollution.
EVALUATION OF THE IMPACT ON PLAN BY TIDE DEFLECTION TO SHORELINE AREA CHANGE

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LAND USE, UTAH STATE UNIV.

(FIRST ITERATION)
PLAN PREPARED IN MARCH 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO
1. PATHEM 4. TRAILS
2. PREDATORY LAMING 5. MAP ACTIVITIES
3. ORGANIC 6. MAP CAMPING
7. REPORT 7. RESEARCH
8. FISHERY AND ANCHOR
9. ANTELOPE HABITAT
10. SHIFTING

LEVELS
1 2 3 4 5 6 7 8 9
SYMBOLS

Figure 158. Vulnerability to shoreline area change.
EVALUATION OF THE IMPACT ON PLAIN X ON VEGETATION--VULNERABILITY TO WILDFIRES

ANTELOPE ISLAND STUDY AREA, DAVIE COUNTY, UTAH

PLAN PREPARED BY NOBON B. SCOTT, GRADUATE STUDENT, NPPT, UTAH STATE UNIV.

(FIRST TYPING)
PLAN PREPARED IN MARCH, 1978
NOTE: HOW THE LAND USES HAVE BEEN GROUPED

LAND USE GROUP NO. ONE   LAND USE GROUP NO. TWO   LAND USE GROUP NO. THREE
1  CROPS/FRUIT/VEGETABLES  2  CROP/FRUIT/VEGETABLES  3  PRIMARY CATTLE
2  FOREST/HERBACEOUS  4  PASTURE  4  PREDOMINANTLY
3  GRAZING  5  PASTURE  5  CULTIVATION  6  GRASSLAND
4  BUSHY VEGETATION  6  FOREST  7  COMBUSTIBLE VEGETATION  8  SMOKE HABIT
5  BUSHY VEGETATION  8  COMBUSTIBLE VEGETATION  9  CLIFF CLEARING
6  COMBUSTIBLE VEGETATION  10  CLIFF CLEARING  11  FLYING AND BONFIRE
7  COMBUSTIBLE VEGETATION  12  CLIFF CLEARING  12  CLIFF CLEARING
8  CLIFF CLEARING  13  COMBUSTIBLE VEGETATION  13  CLIFF CLEARING
9  CLIFF CLEARING  14  COMBUSTIBLE VEGETATION  14  CLIFF CLEARING
10  COMBUSTIBLE VEGETATION  15  CLIFF CLEARING  15  CLIFF CLEARING
11  COMBUSTIBLE VEGETATION  16  CLIFF CLEARING  16  CLIFF CLEARING
12  COMBUSTIBLE VEGETATION  17  CLIFF CLEARING  17  CLIFF CLEARING
13  COMBUSTIBLE VEGETATION  18  CLIFF CLEARING  18  CLIFF CLEARING
14  COMBUSTIBLE VEGETATION

LEVELS
1  2  3  4  5  6  7  8

SYMBOLS
1  2  3  4  5  6  7  8

FREQUENCY

Figure 159. Vegetation--vulnerability to wildfires.
Figure 160. Change in visual absorption.
Figure 161. Change in visual quality.
EVALUATION OF THE IMPACT ON PLAN OF ONE CHANGE IN WILDLIFE HABITAT--MULE DEER

ANTELOPE ISLAND STUDY AREA, DAVIE COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. ENV. UTAH STATE UNIV.

(FIRST EDITION)

PLAN PREPARED IN MARCH 1974

HERE IS WITH THE LAND USES WHAT HAVE BEEN GROUPED

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO

1. TRAILS 3. MINING
2. PASTURE 4. FISHING
5. CAMPING 6. CORN 7. SPEC. HIGHWAY 8. SPEC. LANDFILL
9. WILDLIFE HABITAT 10. HIGH DENSITY 11. LOW DENSITY 12. MUNICIPAL LANDFILL
13. MUNICIPAL LANDFILL

LEVELS

SYMBOLS

FREQUENCY

Figure 162. Change in wildlife habitat--mule deer.
Figure 163. Change in wildlife habitat—buffalo.
Figure 164. Change in wildlife habitat—desert bighorn sheep.
EVALUATION OF THE IMPACT ON PLANT AND ANIMAL CHANGE IN WILDLIFE HABITAT—ANTELOPE

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT C. SCOTT, GRADUATE STUDENT, DEPT. LAND. UTAH STATE UNIV.

(FIRST IFFITIATION)
PLAN PREPARED IN MARCH 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED
LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE
1 TRAIL, 4 WEALTHY 4 ROADS
1 RESERVOIR 5 WILDLIFE
1 WOODY FARM 11 CONSERVATION
1 AGRICULTURAL FARM 12 TANKS/SHEDS, FIG LOOS
1 RESORT 13 LIVESTOCK AND CROP MAN.
1 ANTELOPE 14 ANTELOPE HABITAT
1 HABITAT

LEVELS

SYMBOLS

FREQUENCY

Figure 165. Change in wildlife habitat—anteelope.
Figure 166. Vulnerability to waterfowl habitat.
<table>
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<td>62</td>
<td>12 Low dens. vacation home</td>
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<td>71</td>
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<td>4 Trail</td>
<td>80</td>
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<td>7 Golf course</td>
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<td>8 Rifle/Archery</td>
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<td>17 Desert bighorn sheep hab.</td>
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<td>9 Primitive camping</td>
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Composite Mean Score 6077 4857 1245 721 1.737

Figure 167. Plan summary of Plan 2, iteration 1.
Figure 168. Plan Two, iteration two.
Figure 169. Evaluation of the attractivenesses on Plan #2, iteration 2.
EVALUATION OF THE IMPACT OF PLAN ON VULNERABILITY TO EROSION

ANTILLOPE ISLAND STUDY AREA, DAVIE COUNTY, UTAH

PLAN PREPARED BY ROBERT. C. SCOTT, GRADUATE STUDENT, DEPT., LAKE CITY IUTAH STATE UNIV.

(Fig. 170. Vulnerability to erosion.)
Figure 171. Vulnerability by grazing.
EVALUATION OF THE IMPACT ON PLAN #3 ON VULNERABILITY TO NOISE

ANTELOPE ISLAND STUDY AREA, DAVES COUNTY, UTAH

PLAN PREPARED BY ROBERT O. SCOTT, GRADUATE STUDENT, DEPT. LAPP, UTAH STATE UNIV.

(SECOND ITERATION)
PLAN PREPARED IN MARCH, 1978
HERE IS HOW THE LAND USES HAVE BEEN GROUPED

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO
1 TRAILS ACTIVITIES 9 RESERVATION
2 PICNICKING 10 GOLF COURSES
3 PRIVITHE CAMPING 11 RV PARKING
4 CAMPgrounds 12 LOW INTENSITY RESIDENTIAL
5 DEPARTMENT STORE 13 SMALL COMMERCIAL CENTER
6 FIRE DEPARTMENT 14 SMALL LANDFILL
7 POLICE DEPARTMENT 15 ASTROPHOTO CENTER
8 PARKS AND RECREATION 16 MUSEUM AND Heard

LEVELS

SYMBOLS

FREQUENCY

Figure 172. Vulnerability to noise.
EVALUATION OF THE IMPACT ON PLAN NO. ONE CHANGE IN RUNOFF

ANTILLOPE ISLAND STUDY AREA, HAVASU COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LPF, UTAH STATE UNIV.

(Figure 173)

LEVELS

SYMBOLS

FREQUENCY

Figure 173. Change in runoff.
Figure 174. Vulnerability to groundwater pollution.
EVALUATION OF THE IMPACT ON PLAN #2 ON VULNERABILITY TO SURFACE WATER POLLUTION

ANTELOPE ISLAND STUDY AREA, NAPA COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LAKE, UTAH STATE UNIV.

(SECOND EDITION)

PLAN PREPARED IN MARCH, 1976

HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

LAND USE GROUP NO. 1190 LAND USE GROUP NO. TAG LAND USE GROUP NO. THREAT

1. HIKING TRAILS
2. IN สไทยแฝก CAMPING, L TENT AND CAB CAMPING
3. CONSERVATION
4. POTENCY AND ARCHAEOLOGY
5. CONVEYING MAN.
6. ANTELOPE INHABIT

LEVELS

1 2 3 4 5 6 7 8 9 10 11 12 13 14

SYMBOLS

FREQUENCY

Figure 175. Vulnerability to surface water pollution.
EVALUATION OF THE IMPACT ON PLAN NO. 104 VULNERABILITY TO SHORELINE AREA CHANGE

ANTELOPE ISLAND STUDY AREA, NAVAJO COUNTY, UTAH

PLAN PREPARED BY ROBERT N. SCOTT, GRADUATE STUDENT, DEPT. LAKES, UTAH STATE UNIV.

(SECOND ITERATION)

PLAN PREPARED IN MARCH, 1976
HERE IS HOW THE LAND USES HAVE BEEN GROUPED

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO
1 PITCHING 6 TRAILS
2 PITCHING 7 BEACH ACTIVITIES
3 VEHICLE TRAILS 8 METAL SLUGS
4 GHOST HOGVES 9 MErrICITY AND ANCEHY
5 ANGLER HAVEN 10 TENT CAMP AND FISHING
6 ANGLER HAVEN 11 GHOST HOUSES
7 ANGLER HAVEN 12 FISHING
8 ANGLER HAVEN 13 INLAND FISHING HOMES
9 ANGLER HAVEN 14 SANITY LANDS
10 SANITY LANDS
11 SANITY LANDS

LEVELS

SYMBOLS

FREQUENCY

Figure 176. Vulnerability to shoreline area change.
EVALUATION OF THE IMPACT ON PLAN #2 ON VEGETATION--VULNERABILITY TO WILDFIRES

ANTELOPE ISLAND STUDY AREA, HAVASU COUNTY, UTAH

PLAN PREPARED BY ROBERT N. SCOTT, GRADUATE STUDENT, DEPT. LAFF, UTAH STATE UNIV.

(SECOND ITERATION)

PLAN PREPARED IN MARCH, 1974

HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

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LEVELS

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Figure 177. Vegetation--vulnerability to wildfires.
EVALUATION OF THE IMPACT ON PLAN 49 ON CHANGE IN VISUAL ABSORPTION

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, UEP, UTAH STATE UNIV.

(Second Iteration)

PLAN PREPARED IN MARCH, 1974

WHERE 35 OF THE LAND USES HAVE BEEN GROUPED

LAND USE GROUP NO. ONE LAND USE GROUP NO. TWO LAND USE GROUP NO. THREE

1 TRAILS TO 2 GRAZING 14960
2 FISHING TO 3 CAMPING 12829
3 RECREATION TO 4 GOLF COURSE 1 A 3179
4 CONSERVATION TO 5 TENT AND END CAPING 10 SPECIFIC TANKS/RESERVOIRS, EXPERIMENTAL SITES
5 SPORTS LEISURE ACTIVITY TO 6 LOW DENSITY VACATION 12 SMALL COMMERCIAL CENTERS
6 ANIMAL HABITAT TO 7 ANIMAL HABITAT 11 LANDS AT LANDFILL

Figure 178. Change in visual absorption.
EVALUATION OF THE IMPACT ON PLAN #7 ON CHANGE IN VISUAL QUALITY

ANTELOPE ISLAND STUDY AREA, NAKA COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LAPP, UTAH STATE UNIV.

(Second Iteration)

PLAN PREPARED IN MARCH 1974

HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

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<td>3. SMALL MARINE</td>
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<td>4. DEVELOPMENT</td>
<td>5. FISHING</td>
<td>6. SMALL COMMERCIAL</td>
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<tr>
<td>7. OIL AND GAS</td>
<td>8. SANITARY LANDFILL</td>
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LEVELED

SYMBOLS

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<th>FREQUENCY</th>
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</table>

Figure 179. Change in visual quality.
EVALUATION OF THE IMPACT ON PLAN B:1 OR CHANGE IN WILDLIFE HABITAT—MULE DEER

ANTELOPE ISLAND STUDY AREA, DAVIS COUNTY, UTAH

PLAN PREPARED BY ROBERT R. SCOTT, GRADUATE STUDENT, DEPT. LAND, UTAH STATE UNIV.

(SECOND ITPRATON)
PLAN PREPARED IN MARCH, 1974
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

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<td>13 TANK ACTIVITIES</td>
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<td>8</td>
<td>14 PASTURE AND MINE</td>
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LEVELS

SYMBOLS

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Figure 180. Change in wildlife habitat—mule deer.
EVALUATION OF THE IMPACT ON PLAN &D ON CHANGE IN WILDLIFE HABITAT--BUFFALO

ANTELOPE ISLAND STUDY AREA, HARRIS COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LAND, UTAH STATE UNIV.

(SECOND ILLUSTRATION)

PLAN PREPARED IN MARCH 1976

HERE IS HOW THE LAND USES HAVE BEEN GROUPED:

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<td>INDIANA DOWNTOWN</td>
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LEVELS

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SYMBOLS

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FREQUENCY

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Figure 181. Change in wildlife habitat--buffalo.
Figure 182. Change in wildlife habitat--desert bighorn sheep.
EVALUATION OF THE IMPACT ON PLAN #2 ON CHANGE IN WILDLIFE HABITAT--ANTELOPE

ANTELOPE ISLAND STUDY AREA, OAKES COUNTY, UTAH

PLAN PREPARED BY ROBERT D. SCOTT, GRADUATE STUDENT, DEPT. LABS, UTAH STATE UNIV.

(SECOND ITERATION)
PLAN PREPARED IN MARCH, 1978
HERE IS HOW THE LAND USES HAVE BEEN GROUPED:
LAND USE GROUP NO. ONE: LAND USE GROUP NO. TWO: LAND USE GROUP NO. THREE:
1 TRAIL
2 MOTOR ACTIVITIES
3 FISHING
4 HUNTING
5 PRAIRIE CAMPING
6 CONSERVATION
7 STATE LAND
8 ARIZONA LAND
9 ANTELOPE HABITAT
10 SHEEP
11 CAPTIVE SHEEP
12 CATTLE
13 FUR-FARMED SABLE
14 FUR-FARMED HARES
15 SMALL COMMERCIAL CENTRE
16 MILITARY LANDS

LEVELS
1 2 3 4 5 6 7

SYMBOLS

FREQUENCY

Figure 183. Change in wildlife habitat--antelope.
Figure 184. Vulnerability to waterfowl habitat.
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<tr>
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<td>11 Tent/car camping</td>
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<tr>
<td>3 Reservoir</td>
<td>10</td>
<td>70</td>
<td>12 Low dens. vacation home</td>
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<td>4 Trail</td>
<td>97</td>
<td>53</td>
<td>13 Conservation</td>
<td>36</td>
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<td>14 Cliff climbing</td>
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<td>6 Picnicking</td>
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<td>69</td>
<td>15 Small commercial center</td>
<td>2</td>
<td>75</td>
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<tr>
<td>7 Golf course</td>
<td>10</td>
<td>75</td>
<td>16 Sanitary landfill</td>
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<tr>
<td>8 Riflery/archery</td>
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<td>17 Desert bighorn sheep hab.</td>
<td>132</td>
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<td>9 Primitive camping</td>
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Composite Mean Score 879 69

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<td>4 Runoff</td>
<td>219</td>
<td>574</td>
<td>63</td>
<td>23</td>
<td>1.875</td>
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<td>5 Groundwater pollution</td>
<td>630</td>
<td>173</td>
<td>74</td>
<td>2</td>
<td>1.372</td>
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<tr>
<td>6 Surface water pollution</td>
<td>680</td>
<td>87</td>
<td>111</td>
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<td>1.355</td>
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<td>7 Shoreline area</td>
<td>482</td>
<td>297</td>
<td>100</td>
<td>0</td>
<td>1.565</td>
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<td>8 Vegetation--wildfire</td>
<td>285</td>
<td>324</td>
<td>170</td>
<td>100</td>
<td>2.097</td>
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<tr>
<td>9 Visual absorption</td>
<td>147</td>
<td>480</td>
<td>111</td>
<td>141</td>
<td>2.280</td>
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<td>431</td>
<td>348</td>
<td>33</td>
<td>67</td>
<td>1.700</td>
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<tr>
<td>11 Mule deer</td>
<td>554</td>
<td>297</td>
<td>5</td>
<td>23</td>
<td>1.428</td>
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<tr>
<td>12 Buffalo</td>
<td>388</td>
<td>332</td>
<td>71</td>
<td>88</td>
<td>1.840</td>
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<tr>
<td>13 Desert bighorn sheep</td>
<td>470</td>
<td>259</td>
<td>131</td>
<td>19</td>
<td>1.658</td>
</tr>
<tr>
<td>14 Antelope</td>
<td>40</td>
<td>662</td>
<td>11</td>
<td>166</td>
<td>2.345</td>
</tr>
<tr>
<td>15 Waterfowl</td>
<td>820</td>
<td>9</td>
<td>13</td>
<td>37</td>
<td>1.166</td>
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</tbody>
</table>

Composite Mean Score 6180 5013 1247 745 1.739

Figure 185. Plan summary of Plan 2, iteration 2.
Evaluation Summary

Of the four plans submitted for evaluation iteration two of Plan Two displayed the most attractive land use allocations with a composite mean score of 69. Iteration one of Plan Two displayed the least overall environmental impacts with a composite mean score of 1.737. Most systems of this plan work fairly compatibly with this land use plan.

The composite table summary on the following page illustrates the comparisons of all the land uses and environmental systems utilized in the project. Underlined in the columns are the best attractiveness scores achieved under those models and best impact scores achieved under those models.

Of the attractiveness evaluations, Plan One, iteration one, had only one land use system which had the best score of the four plans. Plan One, iteration two, had four land use systems with best scores. Plan Two, iteration one, and Plan Two, iteration two, each achieved best scores in ten land use systems. Several land systems had same best scores in several plans, accounting for 25 best scores in the 18 land use systems.

Neither iteration of Plan One had any best impact evaluation scores. Plan Two, iteration one, accumulated seven best impact scores. Plan Two, iteration one, achieved eight best impact evaluation scores. In summary, Plan Two, iteration two, allocated the most cells to land uses, 879, and accumulated the largest amount of best score evaluations with 18.
<table>
<thead>
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<th>Land Use</th>
<th>PLAN 1, ITERATION 1</th>
<th>PLAN 2, ITERATION 1</th>
<th>PLAN 1, ITERATION 2</th>
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<tr>
<td></td>
<td>No. of Cells</td>
<td>Mean</td>
<td>No. of Cells</td>
<td>Mean</td>
</tr>
<tr>
<td>1 Roads</td>
<td>271</td>
<td>0</td>
<td>164</td>
<td>67</td>
</tr>
<tr>
<td>2 Grazing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3 Reservoir</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4 Trail</td>
<td>118</td>
<td>45</td>
<td>103</td>
<td>47</td>
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<tr>
<td>5 Beach activity</td>
<td>15</td>
<td>72</td>
<td>23</td>
<td>72</td>
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<tr>
<td>6 Parking</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>8 Riffle/river</td>
<td>1</td>
<td>60</td>
<td>2</td>
<td>60</td>
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<tr>
<td>9 Primitive camping</td>
<td>0</td>
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<td>11 Tent/field camping</td>
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<td>50</td>
<td>4</td>
<td>50</td>
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<td>12 Low density vacation homes</td>
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<td>56</td>
<td>9</td>
<td>66</td>
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<td>130</td>
<td>66</td>
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<td>14 Cliff climbing</td>
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<td>70</td>
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<td>15 Small-scale center</td>
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<td>2</td>
<td>75</td>
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<td>16 Sanitary landfill</td>
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<td>0</td>
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<td>17 Desert bighorn sheep habitat</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>18 Antelope habitat</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>380</td>
<td>59</td>
<td>450</td>
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<th>Percentage</th>
<th>Terminal Mean</th>
<th>Classifications</th>
<th>Percentage</th>
<th>Terminal Mean</th>
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<td>122</td>
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<td>0</td>
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<td>Runoff</td>
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<td>220</td>
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<td>48</td>
<td>2.368</td>
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<td>Surface water pollution</td>
<td>125</td>
<td>127</td>
<td>127</td>
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<td>Shoreline area</td>
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<td>104</td>
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<td>0</td>
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<tr>
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<td>58</td>
<td>186</td>
<td>114</td>
<td>3.121</td>
<td></td>
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<td>Visual appearance</td>
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<td>52</td>
<td>24</td>
<td>211</td>
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<tr>
<td>Soil quality</td>
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<td>115</td>
<td>24</td>
<td>142</td>
<td>2.550</td>
<td></td>
<td></td>
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<td>Buffalo</td>
<td>111</td>
<td>64</td>
<td>99</td>
<td>106</td>
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<td>77</td>
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<td>44</td>
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<td>1486</td>
<td>1128</td>
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</table>

Figure 186. Comparative summary.
Summary and Conclusions
CHAPTER SIX
SUMMARY AND CONCLUSIONS

In summarizing this project, the objectives must be reviewed. This study presents to various levels of government a tool for planning. Those selected models illustrate both suitable land use sites and predicted environmental responses as well as acting guidelines for recreational development. The character of the study area is and shall be one sensitive to most types of developments. The task of pinpointing sites where development can occur with relatively minor environmental damage is the aim which the Antelope Island study hoped to have made some contribution.

The plans which culminated this project covered a spectrum of recreational land uses which may or may not be implemented by decision makers. A brief summation of the plans can be made as follows. Iteration one of Plan One had an attractiveness composite mean score of 59 and impact composite mean score of 2.373 for 380 cells. Iteration two of Plan One had scores of 62 and 2.060 for similar categories with 450 cells allocated. Iteration one of Plan Two had scores of 68 and 1.737 for similar categories with 859 cells allocated. Iteration two of Plan Two scored 69 in attractiveness and 1.739 in impacts for 879 cells of land use.

The writer feels the plans are not to be interpreted as master plans in themselves, but more as an illustrative tool or guidelines which may help decision makers. In particular, the writer does not
feel that Plan One, iteration one, is a master plan; however, the National Park Service and Utah Division of Parks and Recreation may or may not completely agree. The writer feels that their so-called "master plan" is hardly more than a brief surficial study. Justifications for various proposed land uses appear as if their placement resulted from decisions influenced only by U.S.G.S. maps. In reviewing and evaluating their "master plan" little if any research into environmental systems appears to have been deleted. In summary, the Plan One, iteration one, prepared by the National Park Service and Division of Utah Parks and Recreation is a mediocre effort for what might ultimately be considered a "master plan."

The process in which the writer has expressed does not work nearly as smoothly as this book or process chart illustrates. Several data maps were recoded and rerun because more accurate data was gathered at a later date. It is hoped this process will continue in expanding the data bank. A few attractiveness models had variables reweighted or deleted because the model behavior was out of character. For example, the conservation model was rerun with variables reweighted to open up more sites in the study area for more attractive conservation land use cells. Another model, trails, was rerun three different times to make the model more flexible in terms of sites in the site area in which more attractive trails could be planned. Of the four plan evaluations, iteration two of Plan Two scored the best trails attractiveness with a value of 53.
Conclusions

In preparation for and participation in a study such as this, the writer has several points he wishes to express.

The grid cell size used for the study worked out fine for both area and linear land uses. However, point uses were difficult to deal with both in their site requirements and their land use role at a scale of this project. Overall, though, with time and money commitment the 25-acre grid worked adequately.

The GRID program has an attractiveness model capacity of twenty models. The writer feels that the program may ultimately be limited as to the capacity of a study area size with a twenty land use limit.

The subvariable coding symbols in the data, attractiveness and impact maps are not readily distinguishable. Particularly, subvariable codings of 1, 2, and 3, and 7, 8, and 9 need more identity. Research and experimentation is required to develop an ultimate coding system.

The views program uses the centroid elevation data to predict what is seen and what is not seen. However, the scanner focuses its viewing point at ground level and not at eye level. This statement is illustrated on several views data maps. The scanner in several maps was placed out on the Great Salt Lake or Farmington Bay looking toward Antelope Island. Adjacent cells of water were picked up as seen but no other cells of water were seen until an elevation change was indicated which was the shoreline (see Figures 31-42). The writer recommends that by reassigning different values to the program cards or adjusting the subroutine the problem may be alleviated. Although the views maps display the UTM numbering as it should be, the inside
workings and codings run in reverse of what they are thought normally to be. Ultimately there is no effect upon the program itself; however, it presents a hassle for the planner. The writer suggests that rewriting this subroutine may remedy this problem.

The GRID program requires the study to begin in the very northwest portion of the computer map. This works very well with rectangular study areas which there are many of, but not particularly so with irregular outlines as the Antelope Island study is. To overcome this problem the writer had to include one cell of salt water located at the extreme northwest portion of all twenty data maps. In each data map it was listed as the UTM coordinate origin subvariable. This inconvenience also eliminated one possible subvariable. However, since the completion of the study, software has been incorporated, alleviating the problem.

The Grid Evaluation Program has not yet developed in its capacity for displaying individual attractiveness maps. Presently it displays one composite attractiveness map. It may be justified for reasons of cost with some land uses allocated for only two or three cells in a 1100-cell site. However, many celled land uses such as roads, trails, desert bighorn habitat and antelope habitat should have individual attractiveness evaluation maps.

The plans are evaluated, of course, at the same 25 acre grid scale. Where circumstances were such that several point uses could be combined with another point, linear or areas uses only the heaviest impacting use could be allocated for that particular cell. This process eliminated several possibilities for more attractive functional relationships to occur.
There are other minor software limitations. However, may it be emphasized that the writer's intent is not to criticize the process, but rather to stress areas of improving the GRID program.

The program has many advantages over the conventional overlay method. The major advantages are the methods of handling, storing, updating and displaying data. The amount of time and labor required by GRID is more economical. Perhaps the most significant advantage is that various plans can be evaluated relative to each other rather quickly and economically. The program is versatile geographically. It can be applied to any geographic region. Models can be adjusted to the region or new models built.

**Computer Costs**

Computer costs were an advantage at working on a 25 acre grid. Costs were reasonable when considering that 1182 cells were employed and 130 computer graphic maps were displayed in this study. A complete itemized breakdown of computer costs is found in the appendix.

**Further Studies**

The writer anticipates that this study may trigger further investigations. Various interests concerning both regionally oriented and site scaled planning with particular emphasis placed upon their relationship with environmental systems is an area in which this project has hope to act as a catalyst. The writer suggests this study could be expanded to include other islands in the Great Salt Lake and, ultimately, the Great Salt Lake inclusive. This study could also lead
to further research in land planning and recreational site design studies at a smaller scale for Antelope Island.

Whether or not investigations are immediately undertaken is not as important at this point in time as is the recognition that further, more thorough planning is obviously needed for the island. One issue which will ultimately be raised in the near future is how will the role of Antelope Island fit into the master plan of the Great Salt Lake.

Mediocre planning can handicap the island's recreation potential and visual quality certainly as badly as, if not worse than, no planning at all. A case in point is the horrendous barrow pit located within the state park. The pit was excavated for fill used in the north causeway. Theoretically not to be very noticeable, it has grown into an incredible eyesore for any quality of visual experience of the north end of the island. The writer does not believe that until the entire island can be planned for that a comprehensive recreational land use plan which focuses only upon the state park end can or will ever express the quality of recreational potential that Antelope Island has to offer.

The physical planning of any land area is a continuous process. It is forever seeking the best expression of that function or complex of functions (present or anticipated) best adapted to the natural and man-made elements of the environs (Simonds, 1961).

Whatever the consequences of recreational land use planning are for Antelope Island, it should be reiterated that this study focused primarily upon the environmental aspects. The final plans to be implemented rest with the decision makers and the concerned public.
The decisions must, in addition to environmental impacts, be weighed with economic, legal, social and political aspects. However, to this extent this project has been a profitable experience toward the understanding and improvement of planning and design methods.
LITERATURE CITED


County Regional Parks and Regional Recreation Areas. 1965. A planning guide. 12 p.


Computer Costs on the Antelope Island Study

Using the Burroughs B6700 Computer

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<th>Data</th>
<th>Priority 1*</th>
<th>Priority 2**</th>
<th>Priority 3***</th>
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<td>13 view maps</td>
<td>39.00</td>
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</tr>
</tbody>
</table>

**Attractiveness**

| Cost per attractiveness map | 3.00 | 2.55 | 2.10 |
| 18 attractiveness maps      | 54.00 | 45.90 | 37.80 |

**Impacts**

| Cost per impact map         | 3.00 | 2.55 | 2.10 |
| 15 impact maps              | 45.00 | 38.25 | 32.50 |

**Evaluation**

| Cost per plan at 16 evaluations per plan | 45.00 | 38.25 | 32.50 |
| 4 plans                          | 180.00 | 153.00 | 126.00 |

**Subtotal Cost of computer maps**

| 355.50 | 303.15 | 248.85 |

+ 20% for reruns and errors

| 71.10 | 60.60 | 49.80 |

+ 10% for miscellaneous administrative expenses

| 35.55 | 30.30 | 24.90 |

**TOTAL Cost for the Antelope Island Study**

| $462.15 | $394.05 | $323.55 |

**Note:**
Cost based upon figures for Spring, 1974.

*Processing time = 1 hour
**Processing time = overnight
***Processing time = 1 week