The California Ranger

A JOURNAL FOR PARK PROFESSIONALS

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A Question of Balance

John Quirk

There is a coin of inestimable worth and indeterminate substance. The face bears the symbol of professional pride. The reverse portrays the likeness of mediocrity. We carry it with us throughout our career, often letting it tumble across our fingers, first this side up then that, watching the vision of exemplary achievement ever tempered by the reality of a mountain only halfway climbed. Heads or tails? It is our choice. But remember it is but one coin; the flipside is inexorably ours as well.

With this coin in pocket, confident that our stetson-topped image is intact, we stride forward dedicated to the task of preserving the natural beauty of our environment. We are sure that we will prevail; that people will like us; that we will reach them. If deterred, we will reach their children, or reach out into their urban, ethnic, or economic niche and show them the beauty of the larger habitat we cherish. In our hearts are we not professionals extraordinaire?

Too bad we are only government workers. Think of all we might accomplish if freed of the burden of being just a tiny part of a huge slow-motion machine. But then, it is axiomatic of organizational life that the very energy, enthusiasm, and knowledge that gets us hired must be harnessed, and even curtailed at times, before we become valued.

For public servants organizational life is further complicated. Our leaders seem to act mostly as sails in a political wind. "Good'nuf for guvmint work" is the unofficial and unwanted company motto. Mediocrity is the standard. The status is well below that of Doctor, Lawyer, or Indian Chief.

Yet another reality of public service is that agencies are status ranked within government. The Department of Parks and Recreation is not exactly near the top. It is ironic that we professionals extraordinaire work for an agency historically viewed as one for which anyone could work. Consequently it is exceedingly convenient to insert personnel with little or no field experience or qualification into high level positions to achieve all sorts of ends: to return political favors; to balance the inadequate work-force parity efforts of higher status agencies; or simply to "park" someone else's problem until it recedes or retires.

And how professional are we perceived in view of our varied functions? What esteem/status/worth does society attribute a cop? teacher? groundskeeper? security guard? bureaucrat? How do we extrapolate this notion of professional extraordinaire? How do we answer when confronted by the questionnaire used by insurance companies, magazines, and multitudinous others which in part always asks something like "please check the term which best describes your employment: Professional; Trades; Service Industry; Government; Other?" Should we check them all?

Perhaps our confidence sprouts from a shared knowledge that professionalism is but a state of mind, an attitude, a moral conviction. We know that professionalism, like quality, is ephemeral. Once defined it is lost. Such things are pointed at and universally recognized whence they occur. Lacking an essential ingredient, no amount of practice can produce them.

Those of us committed for the duration share this essential ingredient as a family secret. Part magician's trick, part wizard's skill, part Zen master's perception, our resulting craft is surprisingly not occult at all but rather quite scientific. It is a well-honed eye for opposites in attraction: for day and night, life and death, earth and water, wind and fire. We strive to make sense of the gray area between disparate objects. We dare to appreciate mushrooms and the myriad of slimy slithery things often thaught fit only for a witch's cauldron. We as well as anyone understand what Muir meant when he spoke of things being hitched to everything else. For us it is always a question of balance. We find answers where others see only questions, and in answers we find questions.

Our professionalism is crafted by the ranger leading a nature walk who transforms a slough surrounded by tract homes into an estuary alive and vital to the coastal environment's health and beauty. It is shaped by the patrol ranger who adroitly balances the letter and the spirit of the law while handling a dangerous situation safely, efficiently, and correctly. It is there for all to see during fires, floods, lesser emergencies, and during just plain tough times when all those who work in a park pull together to make it through. Harder to discern but no less important is the professionalism that occurs in the paper pushed across the desks and in the issues discussed in countless meetings and phone calls by rangers behind desks.

We are just government workers, but in that gray area between the individual and the organization we see a system. All the slow moving paper and often tedious bureaucracy serve to give substance to the inspiring nature walk, to the dramatic rescue, to the team effort, to professional pride. We know that we are more than what we appear.

And sometimes, when the pieces fall together just right, in the periphery we notice that someone is watching. Our eyes meet those of the stranger and we see for an instant that we have just been perceived as larger than life. And if this is not enough to make our day, the Doctor/ Lawyer/ Indian Chief approaches and enthusiastically says something which sounds like "I always wanted to be a Park Ranger. You know what? You have a great job!"

We smile and let the coin tumble across our fingers. Without looking at it we put it in our pocket. The world seems right. Once again we are reminded that it is all worthwhile.

ABOUT THE AUTHOR

John Quirk is a California State Park Ranger. Writing is his avocation.

A Harvard graduate, John worked as a private investigator before obtaining a graduate degree and certification as a psychologist. In 1977 he left a federal job in Washington, D.C. to seek a more rewarding career. In 1978 he decided that a California State Park stetson would fit just fine. After a six-year effort, he was appointed in 1984.

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Public Trust Principles, Water Rights and Our Parks

Felix E. Smith
U.S. Fish and Wildlife Service
March 14, 1988

The views, ideas ,and opinions discussed are those of Felix E. Smith, Environmental Specialist, U.S. Fish and Wildlife Service, Sacramento, California. They are to help stimulate discussion and strategy formulation. They do not necessarily represent the views of the Fish and Wildlife Service or the Department of the Interior. Presented March 14, 1988 at the California State Park Rangers Association/Park Rangers Association of California Conference, Sacramento, California.

Ovid, the Roman poet (43 B.C. to about 17 A.D.), is credited with saying "Nature has made neither sun, nor air, nor waves private property; they are public gifts."

The federal, state, regional and local parks with their many and varied environmental resources, uses, and values have been set aside for the people by the people. These areas are also gifts that were given in yesteryear for today, for the enjoyment of today's and future generations.

Are the many and varied enviromental resources of our parks, such as fish, wildlife, and water as an aquatic ecosystem, and the parks themselves held as a public trust?

Let's look at some historical concepts of the public trust.

The public trust concept (public trust doctrine) has persisted in European, and American law throughout history. It dates back to Roman times. The Institutes of Justinian in the sixth century A.D. stated: "by law of nature these things are common to mankind; the air, running water, the sea, and consequently the shores of the sea." This was also considered the "law of nations." The Justinian compilations were a restatement of law which was already considered ancient at the time (Althaus 1978). The "things are common to mankind" implies that such things were common property (i.e., equivalent to public property), held in trust for all the people and future generations. This definition is similar to the "common" pasture described in the "Tragedy of the Commons" by Hardin (1968) and the common pool resources of Baden (1977).

Professor Joseph Sax (1970) has indicated that the public trust, of all the concepts known to American law, seems to have the breadth and substantive content to make it a useful tool for general application for developing a comprehensive legal approach to resource management problems. Others such as Cohen, Dunning, Johnson, Stevens, and Wilkinson are also very supportive of the public trust doctrine and its principles in the management of natural resources or objects held in trust.

The public trust generally imposes a trust obligation on the State, in behalf of all the people. For example, under the principles of the public trust, resources, uses, or objects in which the public has a special interest are held subject to the duty of the State not to impair such resources, uses, or objects even if there are private interests held or involved.

The public trust, in its traditional sense, imposes a trust in favor of public rights and uses of navigable waters and the public owned bottoms or beds of such waters including submerged and submersible tidelands, shorelands, stream channels, and fish and wildlife resources.

The public trust responsibility has expanded to apply to waters over privately held bottoms and beds, when considered navigable under State tests of navigability by motor boat or pleasure craft. In navigable waters public rights are paramount to private rights. The trust is generally considered inalienable. If title is conveyed to public use, it is still subject to the trust purposes and to paramount State interests (Althaus 1978, Stevens 1980).

Over the years courts have broadened the scope of the public trust to meet contemporary situations and changing public needs. The California Supreme Court in Marks v. Whitney (1971) helped redefine the scope of the State's interest in navigable waters and tidelands. It recognized and clarified that uses encompassed within the tidelands trust, in addition to the traditional purposes of navigation, fishery, and commerce, also included the preservation of those lands in their natural state as open space and as environments which provide food and habitat for birds and marine life and which favorably affect the scenery and the climate of the area. The California court recognized that tidelands, with their plant and animal life, the water over them, and the sand, gravel, or mud substrat, all interact and are valuable ecosystems in themselves and have public uses and values.

There is also great public interest in the water as instream flows, fish spawning, nursery, rearing and of course, migration. The stream bed, the water in it, the riparian vegetation, the fish and wildlife resources also support public trust uses and values.

This brings us to the Mono Lake Decision National Audubon Society v. Superior Court Alpine County (33 Cal Rpt. 346 {1983}). The California Supreme Court ruled that long established water rights are now subject to limitations protecting the public in navigable waters. The decision also was an expression by the court for the State to treat common heritage resources wherever they are found under its public trust authority (Dunning 1983). It is reasonable to conclude the court recognized that instream flows, riparian vegetation and associated ecosystems interact and have similar uses and values as the tidelands discussed in Marks v. Whitney. These enviromental resources can be considered a part of our "common heritage" resources.

A very important point made by the California court in the Mono Lake Decision was that "the public trust is more than the affirmation of State powers to use public property for public purposes; it is an affirmation of duty of the State to protect the people's common heritage of streams, lakes, marshlands and tidelands, surrendering that right of protection only in rare cases when abandonment of that right is consistent with the purposes of the trust." If there is a surrendering of the trust protection, there must be an effort to minimize harm to trust resources, uses, and values to the maximum extent feasible. Project facilities can be modified or changes in project operations can be instituted to mitigate or minimize this harm.

Now let's look at California's State Parks for a moment. According to the Public Resources Code, 5019.74, the purpose of these parks shall be to preserve outstanding natural, scenic, and cultural values, indigenous aquatic and terrestrial fauna and flora, and significant examples of the ecological regions of California.

Each park is to be managed as a composite whole in order to restore, protect and maintain its natural environment consistent with the park's primary purpose. Improvements for public enjoyment and education are to be consistent with preserving the natural, scenic, cultural, and ecological values of the area.

The meaning of this language sounds like public trust duties and responsibilities. Therefore, it seems reasonable that public trust protection extends to many of the environmental components and resources found in the State Park System including wilderness, reserves, parks, and natural and cultural preserves. These areas could be either terrestrial or underwater environments. They could be freshwater or marine environments or cultural-historical attributes. The more unique, rare, or limited the park or its resources, the greater the role of public trust.

The Mono Lake Decision indicates that the public trust is more than just the affirmation of the State's duty to protect public property (common heritage resources) as well as the public trust (fish, wildlife, and water quality). It is an expression that if the State surrenders that duty/obligation of protection, it must be for the trust and long-term public interest. And in cases where there is a private interest held or permission to use a resource, such as water, the State can review the situation at anytime.

An important point of the Mono Lake Decision is that the court recognized the rivers and streams are an integral ecosystem from their headwater tributaries to their receiving waters. Therefore activities, such as fills, land use activities, water diversions, waste discharges, or any use or activity that can impair or destroy public resources, uses, or values of a stream or receiving waters can be constrained under both the State's public trust authority and its law.

Water rights, water quality, aquatic ecosystems, and instream flows are integral components of almost any park or park system. These aspects must be protected by the State, as trustee and can be protected under the public trust, as well as statute law.

Let's look at government agencies and their past role as trustee of the public trust. Governments are supposed to protect public trust resources, properties, uses, and values. Yet government agencies, supposedly acting to protect the public trust and the public interest, are the ones primarily responsible for the degradation of the physical, chemical, and biological components and uses of state waters and associated resources. Activities conducted with government approval such as dredging and filling, stream improvement (channelization), discharging wastes, constructing roads, timber management-logging, and land clearing, grading and irrigation projects have impacted streams, their resources, uses and values. Areas that are particularly hard hit are those downstream or downslope from such activities. Today, the evidence indicates that the cumulative impacts of piecemeal review and development can be disastrous to one or more components of the natural environment, associated resources, uses, and values covered by the State's public trust responsibilities.

In the years ahead the water rights/water quality/instream flow aspects of our parks and our streams will be a growing concern. Clearly, parks must be protected against those interested in exploitation of their resources, uses, or values. For example, regarding the aquatic environment, the public expects that the waters and associated aquatic environments will maintained as clean as they should be to protect public health, public uses, and aquatic resources consistent with the primary purpose for which the park was established.

It would be unrealistic to expect the water quality of the lower San Joaquin River to be equal to that of a mountain wilderness area. It would also be just as unrealistic to permit the degradation of water quality of the mountain wilderness to that of the lower San Joaquin River. However, the water quality of each area should be protected consistent with the primary purposes for which the area was acquired/developed to protect the aquatic flora and fauna native to the area and, last, but not least, the public health and uses of the area.

While no one would deliberately set out to degrade or destroy a park or similar area, many land/water use activities can and do cause effects which degrade such areas or are incompatible with the area's primary purpose. One of the most noticeable examples is the impact of timber management/ logging on parks and ecosystems adjacent to or downstream from the timber management site. In Humboldt County at Big Lagoon, one can watch the transformation of a lagoon to a marshlands to upland vegetation as silt carried from the managed uplands, by the winter rains, fills the lagoon.

In other areas trace elements and chemicals from agricultural areas are degrading water quality, and as a result, are impacting the public resources, ecosystems, uses, and values of parks and other public areas. This is of concern throughout the Central Valley and at selected locations along the Central Coast where agriculture, parks, and aquatic ecosystems are neighbors.

The land-water interface is an important component of almost any park. Protecting water quality at public beaches, natural areas, and ecological reserves must be a continuing concern. Domestic or industrial pollutants would significantly detract from the many resources, uses, and values found in the parks, be they along the Pacific Coast, at Lake Tahoe, or along the many rivers and streams of the state. Water quality and associated ecological and biological values are also protected under the public trust responsibilities of the State. In addition, the State also has the same rights as an ordinary landowner to protect and maintain its possession and to prosecute trespassers.

Water quality and instream flows, fish and wildlife and other environmental resources are important components of many parks. The American River Parkway with its many uses and values would not be much without adequate instream flows and the runs of chinook salmon, steelhead, and American shad. Instream flows or inplace waters with their resident and anadromous fishes, and their associated uses and values are important components of many parks throughout the state. These uses and values also can be protected by the public trust duties and responsibilities of the states.

The State Supreme Court has recognized the standing of public interest organizations to sue to enjoin unreasonable uses of water and for any member of the general public to raise a claim of harm to the public trust. Such a claim may be brought in the courts or before the State Water Resources Control Board (Environmental Defense Fund v. East Bay Municipality District {1980} 26

Cal. 3d 183 and National Audubon Society v. Superior Court {1983} 33Cal. 419 at 441). Similar standing would apply to public interest organizations or a member of the general public to enjoin and activity or to take affirmative action to protect a park's resources or uses and values.

We have learned that common heritage resources, associated uses and values are covered by the public trust. This includes common heritage objects - our parks. We have also learned that the State has an affirmed duty to protect the people's common heritage of streams, lakes, marshlands and tidelands, surrendering that right of protection only in rare cases when abandonment of that right is consistent with the purposes of the trust.

What does one do when he or she believes that a park's resources, uses, or values are being adversely affected by a use or activity? First it should be brought to the attention of the park's managing officials in writing. Create a record of what you have done. Keep the elected officials advised, as well as on notice. The managing entity should take strong, forceful action, even legal action, to protect the public trust uses and values as well as the park themselves from harm or degradation. The individual should follow up on the complaint to see what really happened.

If the concern is about water, such as instream flows or water quality problems, a complaint/protest can be filed with the Regional Water Quality Control Board. This complaint can be filed by any downstream water right holder, water user, land owner, individual or public interest group that believes their water rights or associated resources have been adversely affected. The complaint should indicate the offending use or uses of water and why such uses are incompatible with the primary purposes of the park and the many beneficial uses of water outlined in the Basin Water Quality Control Plan. In either situation a copy of the complaint/protest should be sent to the State Attorney General and to the State Lands Commission.

A lawsuit could be filed by a user or public interest group, professional society, or organization on behalf of the people. Litigation, or even the threat of it, is one way to get attention or equality of bargaining position. Some professional organizations are taking a very active part in such activities including the initiation of law suits to protect resources and objects covered by the public trust. The American Fisheries Society has entered into a lawsuit to protect the winter-run chinook salmon of the Sacramento River.

Summary

The logic of the public trust protection is straightforward. It is the inherent authority and the duty of the State to protect the public trust and other common heritage resources.

The State of California is the trustee of its fish, its wildlife, and its water, and I believe, its parks. The State, as the trustee, has the power to bring suit to protect the corpus of the trust, e.g., the water, fish, and wildlife of its parks—for the beneficiaries of the trust—the people.

The Department of Parks and Recreation (also regional and local agencies) has a trust to protect the natural, scenic, recreational, biological, and ecological aspects of the areas it manages. The Department must in this regard be continually on guard against activities or uses adjacent to or within its areas that are incompatible with the primary resources, uses and purposes for which any given area was established. The Department and its employees must use all available legal resources to protect the public parks.

The Department must count on the help of other agencies, e.g., the Department of Fish and

Game, the Water Resources Control Board and its Regional Boards, and the State Lands Commission to carry out and enforce their trusteeship responsibilities as a part of the overall State obligation.

The State must make the protection of public trust uses and values and the objects it manages in trust, our parks, a top priority. Our parks surely belong on Ovid's list of public gifts.

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Geographical Information System and Resource Management In Southern Region State Parks Units

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INTRODUCTION

GIS: A Working Definition

A "Geographical Information System" (GIS) is a complex set of computerized tools designed for and used in the collection, storage, retrieval, transformation and display of spatial data about aspects of the earth's surface. The speed and efficiency with which digitalized spatial data can be retrieved, displayed, transformed, and analyzed using GIS technology make this a powerful tool in planning and resource management decision making. One of the many advantages of GIS is the ability to overlay, compare, and analyze multiple maps in digital form, allowing for the introduction of additional or modified factors in the spatial analysis or modeling process.

The three most important components of an effective GIS are: 1) the computer hardware necessary to run the system; 2) a software package appropriate to the needs of the organization; and 3) the successful integration of the system into an organizational context.

The standard computer hardware of a central processing unit (the computer itself), a disk drive (for storing data and programs), and a visual display unit (terminal) are necessary components to run even the simplest of geographical information systems. In addition to these essentials, most systems will require a digitalizer, or other device, for converting data from maps, aerial photographs, etc., into digital form that can be sent to a computer. A plotter is needed to present the results of the data processing (in the form of hardcopy maps). A tape drive may be useful for storing data and programs on magnetic tape or in communication with other systems.

There are, at present, a number of commercially available GIS software programs. The selection (or design) of an appropriate software applications program may be the single most critical decision to be made in introducing GIS to an organization. Current programs can cost from $30 to $20,000, depending upon the complexity of the system and the needs of the user. In this paper we will focus on only the larger, commercially successful software packages available for use with IBM-compatible personal computers and VAX minicomputers. These two systems are: 1) Earth Resources Data Analysis System's ERADS, a raster-based system, and 2) Environmental Systems Research Institute's ARC-INFO, a vector-based system. A brief discussion of the advantages and disadvantages of these two systems is offered below. Both ERADS and ARC-INFO systems are currently employed in resource management programs within the Department's Southern Region.

Successful integration of the system into an organizational context is equally critical to the overall effectiveness of a GIS. As with any new tool introduced into a business or organization, a geographical information system can be used effectively only if it is properly integrated into the whole work process and not merely thrown in as an add-on. The mere acts of purchasing the hardware and software and training one or two individuals in their use are not sufficient to produce instant results nor to insure effective use of such a system.

THE OPERATIONAL GIS

Computer Representations of Geographical Data: Raster vs. Vector Data Structures

Geographical information systems can be divided into two major types: vector-based systems and raster-based systems. The difference between the two is in how the programs record information. Vector-based systems record graphic information, such as the shapes on a map's surface, as a series of lines and arc segments which are described by the mathematics of plane geometry. Vector systems can be very precise and produce a product which has the appearance of a conventional map. However, the mathematical structures used to record data are complex and processing data in this format can be quite difficult.

A GIS employing a raster format uses a simpler if less precise method to record information. Raster-based systems superimpose a grid containing columns and rows of grid cells over the field that is being considered. A single numeric value is assigned to each grid cell for each file within a data base. The numeric value can correspond to any descriptive quality found in the original field. The assigned value is recorded in the computer's memory along with ordinals for the column and row of the grid cell. Only one value can be entered into each grid cell within a particular file. However, several files recording different descriptive qualities can be recorded within a data base. The simplicity of this system allows data to be mathematically manipulated with great ease. Programs can be used which manipulate the data within a single file or which interact information between different files within a data base.

The disadvantage of using a raster-based system is that it generalizes data into a single grid cell. Whatever real world size is assigned to the grid cell will be the finest resolution that will be achieved with that system. The grid cell structure will also lend a somewhat coarse and abstract appearance to any hard copy product that it generates. Selecting a grid cell size is a process of compromise between the interests of resolution and capacity. The smaller the cell, the greater the resolution of the final product; the larger the cell size, the greater the amount of information that can be stored in the computer's memory.

Data Entry

The process of data entry into the GIS is called digitizing. It involves the conversion of two-dimensional graphic data into digital information stored in the computer's memory. This can be done by several methods. The least complex is a device called a digitizing table. Digitizing tables have a grid work of wires beneath their surface. Graphic information such as maps or aerial photos are fixed to the table's surface. Known coordinates on the map or photo are located and entered into the GIS to orient it to the data source. Features on the field can then be traced using an electronic pointer. The areas traced will be recognized as a polygon by the machine. The operator can then assign a single numeric value to all areas within that polygon. All the grid cells within that polygon will be assigned a numeric value. Aerial photographs, satellite images, and similar images can be digitized automatically by use of a scanning video camera. The camera recognizes areas that have identical color values and enters them into the data base with a numeric value assigned by the operator.

Data Processing

The true value of the raster-type format is in the facility with which it can process information stored within a GIS data base. These manipulations can be made within a single field or between two or more fields that cover the same geographical area.

An example of the data processing power of the ERDAS GIS within a single field is the generation of aspect and slope maps. Using U.S. Geographical Survey 7.5-minute topographic maps as original data sources, contour lines can be digitized into a GIS field. Using a module called TOPO within the ERDS program, a continuous surface of elevation can be generated and an elevation value entered into each cell. By comparing the values between adjacent cells the GIS can generate new fields which classify areas by aspect (East, Northeast, North, Northwest, West, Southwest, South, Southeast and flat) and by slope (0-8%, 8.1-15%, 25.1-50% and >50%). Producing the same maps manually from a topographic map would involve days of tedious labor. Once the topographic data is digitized, the GIS is capable of producing slope and aspect maps in a matter of minutes.

Programs which combine data from two or more separate fields are also within the capacity of the ERDAS GIS. A simple example is the generation of a fire history map from separate wildlife history and prescribed fire maps. The GIS can superimpose the two original maps, recognize the most recent burn date for all areas, and create a new map based on that value. Similarly, a fuel class map can be generated by combining the fire history map with the vegetation map, producing a map that gives the vegetation type and age of all areas within the park. The GIS is able to accomplish this by comparing the values that have been entered into individual raster cells in separate fields within the GIS. The GIS can be programmed to recognize either the greater or lesser value assigned to each cell in the two original fields and record that value into a new field. The GIS can also mathematically manipulate the numeric value recorded in the original fields to produce new information. Values can be manipulated arithmetically (added, subtracted, multiplied, or divided), or can be entered as variables in algebraic equations. The operator can then define ranges of values to be assigned to the classes that will be recorded in the new field.

GIS APPLICATIONS IN SOUTHERN REGION RESOURCE MANAGEMENT

As resource managers our goals are to protect and enhance natural and cultural resources that occur on state park lands and to be able to provide planners, landscape architects, engineers and field staff with accurate, up-to-date information on the extent and precise location of such development, maintenance, or management activities.

Geographical information systems possess a number of features that greatly enhance our abilities to recover, examine, and analyze information on these resources, while significantly reducing the time required to perform such tasks. As described above, the utility of a GIS in the management of natural and cultural resources lies in the ability of the system to take an individual layer, or data base, and perform a variety of data manipulations, graphic overlays, and computational analyses upon them. Once the sets of geographical data pertaining to the natural or cultural resources of a park unit have been encoded and stored as individual variables (or GIS layers) within the GIS data base, and the different layers or variables registered to one another, they then form a data bank that can be queried to answer any number of specific questions or to examine any number of combinations of variables. For example, in the planning stages of a prescribed burn, using a GIS we are able to recall (in of just a few minutes) individual GIS layers for sensitive plant taxa, sensitive wildlife, archaeological sites, soil types, vegetation type, road and trail locations, etc., within a park unit or a particular burn plot. These layers can be examined individually, in various combinations, or to-

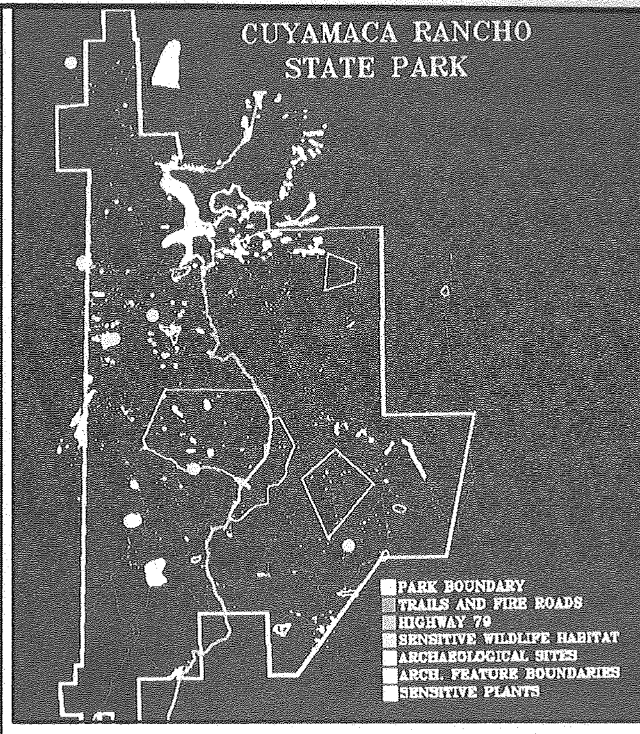

Figure 1. Sensitive resource map for Cuyamaca Rancho State Park

gether in a composite picture to show the total distribution of known natural and cultural resources within the park unit (see figure 1) or proposed burn plot.

During the past two years the California Department of Parks and Recreation has contracted with the geography departments at San Diego State University and the University of California at Riverside to produce geographical information systems for prescribed fire management programs at Cuyamaca Rancho State Park and Anza-Borrego Desert State Park, respectively.

The Cuyamaca GIS is an ERDAS raster-based system that was designed and assembled principally by David McKinsey of SDSU under the direction of Drs. Richard Wright, Douglas Stow and Walter Oechel. The program requires expansion of the IBM PC memory, high resolution graphics card, and monitors, as well as a variety of peripheral equipment used to enter data. It provides a predictive model for the prioritization of areas within the park for prescribed fire management based on factors such as predicted fire intensity and proximity to sensitive natural and cultural resources. The data base for the CRSP GIS uses a grid cell size of 25 meters on a side, dividing the park into layers representing the topography, vegetation, soils, roads and trails, slope, aspect, fire history, sensitive wildlife habitats, sensitive plant populations, and archaeological sites for the entire Park.

The Anza-Borrego GIS is an ARC-INFO, vector-based system developed by Drs. Richard Minnich and Thomas Fieldman of UCR for purposes of modeling potential fire behavior for prescribed fire management and wildlfire control efforts. The ABDSP GIS is not as complete as the Cuyamaca GIS, owing to Anza-Borrego's tremendous size (500,000+ acres) and the limited funding available for the project. Currently the ABDSP GIS data base contains layers on the roads and fire history of the park, plus the natural vegetation, as interpreted through aerial photographs. Other components critical to fire and resource management may be incorporated into the system at a later date.

Prescribed Fire Management

DPR has conducted prescribed burning at Cuyamaca Rancho State Park since 1977. In 1982 the prescribed fire management program was funded as a project of the Statewide Resource Management Program, and this funding has continued to date. The planning process for the park's prescribed fire program has generated a vast amount of information concerning the natural and cultural features of the unit, fire history, etc. In the past, making effective use of all that information has been difficult. The application of GIS technology to the CRSP prescribed fire management program has enabled us to synthesize and interpret a much greater volume of information in planning and making fire management decisions.

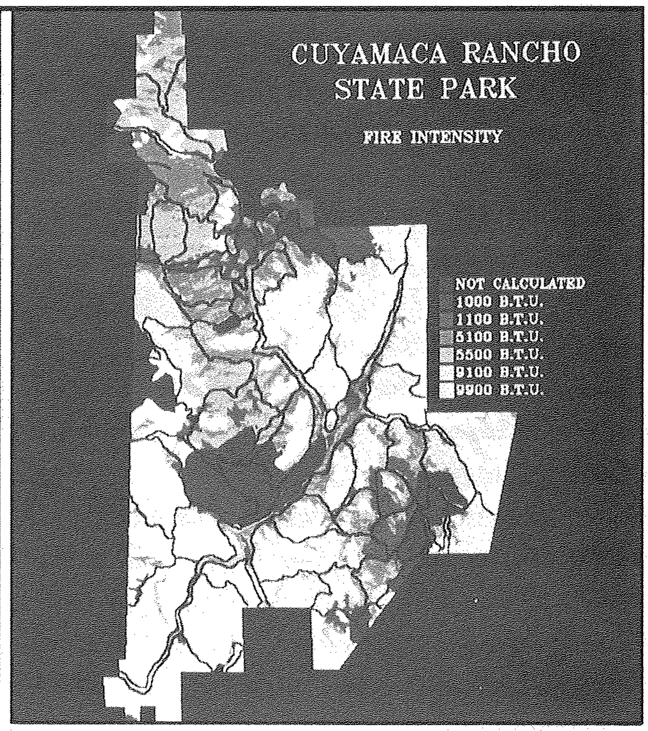

Figure 2. Fire intensity map for Cuyamaca Rancho State Park (after McKinsey 1988)

The most complex products generated by the Cuymaca GIS are Fire Intensity Maps (see Figure 2) which predict the amount of energy released during a fire under a defined set of fire weather conditions. The basis for these maps are fire behavior models that have been developed by Richard Rothermel and the Boise Interagency Fire Center. Each model is developed for a particular fuel type or treats conditions of fuel as input variables. Variables for different topographic and weather conditions are entered into the models. The models predict fire behavior in flame height, rate of spread, and energy release over time. For the purposes of the Cuyamaca GIS, weather inputs were treated as constants. Two sets of weather constants were used. One set represented weather conditions that could be anticipated during a wildfire. The conditions used were taken from the narrative fire report for the Cuyamaca Peak Wildfire of August, 1986, the last large wildfire to occur in Cuyamaca Rancho State Park. The other set of weather conditions were taken from the prescription conditions gener ally used for understory burning at the park. These two sets of constants were intended to represent a worst case wildfire scenario on the one hand, and the likely result of prescribed burning on the other. The inputs for fuel conditions and topography were derived from information recorded in the GIS. Vegetation types were combined into a lesser number of fuel types which were then recorded (assigned new numeric values). Similar processes were used with the slope, aspect, and fire history layers from the GIS. The final output were maps that predicted fire intensity in BTUs/ min./ M^2.

The utility of these maps is that predicted fire behavior is spatially displayed. A burn boss can examine a map and identify areas where potential containment problems might exist. The maps can also be combined with sensitive resource maps to predict what degree of heat stress sensitive natural and cultural resources might be exposed to. This information can affect planning both fire suppression and prescribed fire management.

Sensitive Resource Management

Because of its large size (25,000+ acres), geographic location, and the diverse nature of its topography, geology and vegetation, CRSP contains within its boundaries a very large number of sensitive biological and cultural resources. These include some 80 sensitive plant taxa, eight sensitive species of birds and reptiles, and some 280 prehistoric and historic archaeological sites. The CRSP GIS has been a tremendous aid in the management of these resources, enabling region staff to more easily and efficiently maintain records on them and better provide fast and accurate information on them to fire managers, planning and development staff, and District staff for management decisions, public review meetings, etc.

One way in which the system can be used is to select a particular sensitive plant species as the variable of interest. We can then ask the system to retrieve, overlay, and display various informational layers pertaining to the distribution, habitat characteristics, and fire history of the entity in question. For example, you could ask the GIS to retrieve and display the distribution of Cuyamaca cypress (Cupressus arizonica ssp. stephensonii), a candidate species for the U.S. Endangered Species List, from both within and adjacent to Cuyamaca Rancho State Park. This information could them be overlaid with the geology and fire history data bases for the park, creating in a matter of just a few minutes a composite display, at an enlarged scale, showing the extent of the cypress population within and adjacent to the Park, the geographical formations on which it occurs, and the extent to which the population has been affected by wildfires during historic times. In a matter of a few additional seconds we could have the system print out for us computational analysis showing the acreage and percentages of Cuyamaca cypress found on the different geological substrates, as well as the acreage and percentage of the cypress population which burned in the 1970 Cuyamaca Peak wildfire.

The ability of a GIS to examine multiple layers of physical and ecological characteristics pertaining to habitats of sensitive organisms and/or archaeological sites gives the potential for revelation of previously unseen ecological, biosociological, and biogeographical patterns. This is due simply to the ease and speed with which this information can be compared and analyzed - a process that, in many cases, was formerly quite laborious.

GIS LIMITATIONS

The GIS is an extremely powerful tool that allows resource managers to access large quantities of information and synthesize it into an easily understood form. However, as with all applications of powerful technologies, the consequence of a single mistake also may be amplified. The ease of using a GIS may, at times, belie the weaknesses of a particular system. Our experience with the Cyuamaca GIS indicated that the quality of any output was influenced by three factors: the resolution of the system itself, the accuracy of the information that was entered, and the precision of the analytical tools used for data processing.

Resolution

GIS systems, like maps and other types of similar graphic displays, are relatively simple models of complex natural features and systems. These models necessarily delete a great deal of information in order to be intelligible to the user. Assumptions of homogeneity are made which have no basis in the natural world. The raster system employed in the ERDAS GIS extends the process of generalization an additional step. To the GIS, Cuyamaca Rancho State Park exists in homogeneous blocks 25 meters on a side. In reducing the park to this format a great deal of information and detail is lost.

Point data such as the location of individual rare plants or cultural features are lost or expanded to the minimum size of a single raster cell when digitized into the GIS. Since only a single numeric value can be recorded into each raster cell the presence of one feature can often obscure another. For instance; when two species of rare plants occur within the area of a single raster cell, only one can be entered within that field. Linear cultural features such as roads and trails also assume the minimum width of a single raster cell regardless of their actual dimensions. The operator must ensure that all information pertinent to the specific application is included if any degree of accuracy is to be obtained.

Accuracy

The importance of accuracy in data entry is essential when dealing with GIS. Errors, once they have been digitized into the computer's memory, will persist through any subsequent application. As an example, after the fire behavior maps were produced by the Cyuamaca GIS they were field checked against predictions based on the Boise Interagency Fire Center Fire Behavior: Field Guide (National Wildfire Coordination Group 1981). Ten random locations were selected in the park. At those locations predictions of fire behavior were made using the Field Guide. The weather conditions used as inputs were the same as those used as constants in producing the fire intensity maps in the GIS. When compared to the predictions made for the same locations by the fire intensity maps, the predictions were closely parallel with one notable exception. At one location the GIS had predicted a heat release of 4,250 BTUs while the field observations yielded a prediction of 98 BTUs. The divergence apparently was caused by an inaccuracy in the original vegetation map digitized into the GIS. The error had persisted through all the subsequent applications of the original information and was responsible for the errors in the final product (McKinsey 1988).

Precision of analytical tools

When comparing the outputs from the different fire intensity maps another problem become apparent. The predictions displayed on the two maps, though similar, often varied, despite the fact that they were generated from the same data base. The reason for the divergence lies in the weight that the models assigned to different input values. Rothermel's model developed to act as a basis to predict the flammability of different vegetation types. The inputs which drive the model describe characteristics of fuels. The predictions, therefore, had relatively little variation within each fuel type. The BIFC models were intended to act as predictors of fire behavior in the field. They take into consideration additional factors such as slope and wind which are not included as inputs for Rothermel's Fire Intensity Equations. Therefore, there is considerably more variation within a single fuel type for the predictions generated by the BIFC models.

Like the rest of the computerized information processing field, GIS technology is a dynamic, rapidly changing and improving field. More and more agencies and private companies are switching to geographical information systems as a means of land resource assessment and management. As a consequence of the demand for these systems, there most certainly will be new and improved software programs available in the near future. One of latest developments in GIS software technology with important implications for us in the Southwest Region office is the commercial availability of a software program that will link the ERDAS and ARC-INFO systems, allowing the user to convert data stored in either system to the other. The Department of Geography at SDSU is currently installing this link, which should allow us to take advantage of the graphics capabilities of ARC-INFO when using the Cyuamaca GIS and the data processing capabilities of the ERDAS system when using the Anza-Borrego GIS.

FUTURE APPLICATIONS

Future Development within DPR

At present, Resource Protection Division staff in Sacramento are working with SDSU's Geography Division to develop a GIS data base for Crystal Cove State Park that will become an important tool in future planning for that unit's prescribed fire management program, as well as facility development and natural and cultural resource protection. OHV Division has developed one GIS data base for Hungry Valley SVRA and is in the beginning stages of developing another one for Ocotillo Wells SVRA, both under contract with SDSU. A committee within the Department's Resource Protection Division was formed in October, 1988, to investigate the feasibility of acquiring in-house GIS capabilities for DPR and the standardization of hardware and software to ensure compatibility on a state-wide basis.

Links to Other Agencies

Numerous other agencies involved in land or resource management have already set up, or are presently contemplating the acquisition of, a comprehensive GIS. The U.S. Geological Survey is presently working toward the conversion of all its cartographic information from 55,000 7.8' map sheets to a GIS database. The National Park Service has formed a separate GIS Division to develop, coordinate and support the Service's extensive GIS program. The U.S. Department of the Interior, Bureau of Land Management's California Desert District hopes to implement a GIS for land management purposes within the next year. The California Department of Fish and Game's Natural Diversity Database is currently processing contract bids to design and provide a GIS to aid them in their efforts to monitor the state's sensitive habitats, plants and wildlife. The University of California Cooperative Extension's Integrated Hardwood Management Program, through UCR, has developed a GIS to map and monitor the geographical extent of Engelman oaks (Quercus engelmannii) within California. These are just a few examples of the growing number of resource management agencies that are turning to geographical information systems as an aid in their management activities.

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A Word From The Editor

This is the first issue of The California Ranger that I have put together. These articles were given to me by Doug Bryce; thanks a million! Thanks also to Dorene Clement, who proof read these articles. There is hope of publishing two issues a year. For this to happen, I will need your assistance. I need articles! **Articles should be 1,000 words or more, and include photographs and/or other graphics.** Please include a biographical sketch of no more than 100 words. (Articles may be edited with author's approval.) With your help and support, there will be future California Ranger issues.

David Brooks, Editor
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