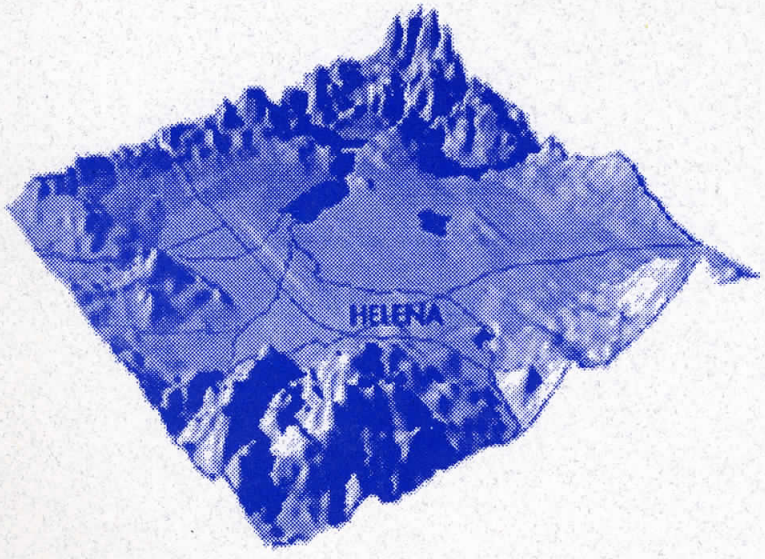
CONFERENCE PROGRAM

MONTANA GIS:
COMMON GROUND IN A COMPLEX WORLD

7TH ANNUAL MONTANA GIS CONFERENCE



COLONIAL INN

Helena, Montana
May 8-11, 1995

WELCOME TO THE 7th ANNUAL
MONTANA GIS CONFERENCE

COMMON GROUND IN A COMPLEX WORLD

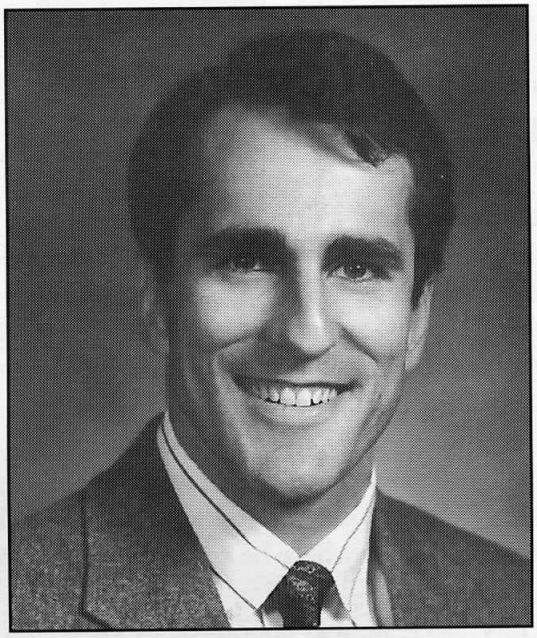
A quick browse through the abstracts of the papers presented at this years conference may leave you wondering what the Conference Committee was thinking about. ***Common Ground***???? There seems to be more diversity than ever in applications that are utilizing GIS. But it is precisely that diversity that may drag GIS, possibly kicking and screaming, into the mainstream of decision making tools used by governments, researchers, and very soon the general populace.. Spatial data is readily available via the Internet. GIS software is available to query the data that has the look and feel of popular PC programs. Businesses now realize this geography is vital to their survival and expansion. Very soon, you may not have to mumble some lame explanation when asked what you do for a living - the term "GIS Professional" being recognized as a viable way to make a living and contribute to society. These indicators point to the fact that GIS is indeed becoming common ground and **you** are the ones making it happen!

In keeping with this theme, **keynote speaker Richard Varn**, Director of the Office of Telecommunications at the University of Northern Iowa will address the need for more and easier public access to geo-spatial data. The concurrent sessions will present more panel discussions giving you an opportunity to participate in the conference. A new feature this year, the **Vendor Workshop**, will allow you to draw upon the collective GIS expertise of the vendors in a non-sales orientated atmosphere. The usual conference events, **Public Night**, the **Poster Session**, and **Wednesday Evening Social** all are designed to help you forge common ground with your GIS colleagues. The **Exhibits** of GIS products and services, by vendors will be on display through-out the conference and we encourage you to tap their wealth of GIS experiences.

The Conference Planning Committee and the Montana GIS Users' Group Board of Directors thanks you for your participation in this event and hopes you can learn what you did not know, teach others what you can, and most of all -**HAVE FUN!**

All Montana GIS conferences are sponsored by the Montana GIS Users' Group, Inc., a statewide consortium of government agencies and businesses involved with GIS technology. Serving as hosts for this year's conference are Tom Ring and Loretta Reichert.

Richard J. Varn

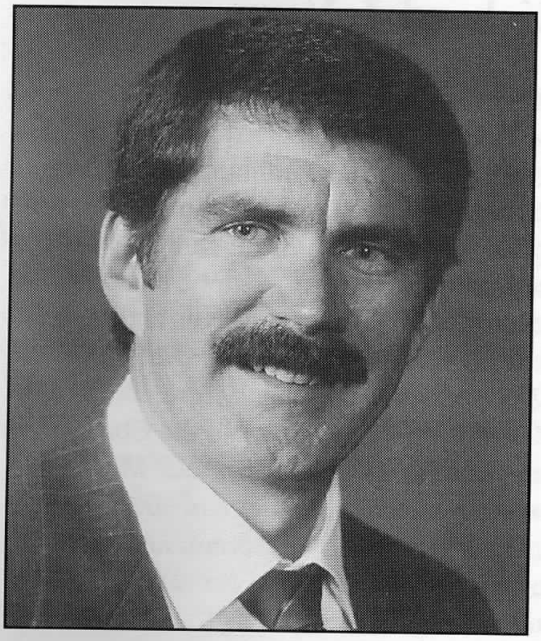


Richard Varn is the Director of Telecommunications at the University of Northern Iowa. He is responsible for coordination of telecommunications programs and policy, overseeing operation of a mobile KU band uplink, coordination of on-campus programs to utilize the State of Iowa's fiber-optic network, and development of new resources and applications such as desktop video conferencing. Mr. Varn has also served 12 years in the Iowa legislature, most recently as Majority Whip and Chair of the Communication and Information Policy Committee. Mr. Varn was instrumental in the passage of such cutting-edge programs as the Iowa Communications Network, Iowa's single smart card for all government services, and statewide open access to libraries. He has held numerous positions of state and national leadership in the information policy area including three years as Chair of the National Conference of State Legislatures Task Force on Information Policy, Chair of the State Information Policy Consortium, and member of the National Academy of Public Administration's Panel on Information Management. He was a delegate to the White House Conference on Libraries and served on the Depository Library Council of the U.S. Government Printing Office. He is program co-chair of Interchange '94, the Summit of the Intergovernmental Enterprise.

Richard Varn has authored several published articles on information technology and education issues and is writing a book for Oryx Press on electronic democracy. Mr. Varn's publications include America's Information Technology Agenda, *Chapter 7--The Leadership Gap in the Information Technology Agenda*, Center For Strategic Computing and Telecommunications in the Public Sector, John F. Kennedy School of Government, Harvard University, (1994); State Government News, *Does Anti-Stalking Legislation Violate the Constitutional Rights?*, (1994), the State Information Policy Consortium: *National Information and Service Delivery System, A Vision for Restructuring Government in the Information Age*, (1992); Spectrum Journal of State Government, *Electronic Democracy: Jeffersonian Boom or Teraflop?*, (1992); Dialogue, *Perspectives on Excellence: World Class Schools,* (1991).

He earned a bachelor of arts degree with Phi Beta Kappa and other honors and a juris doctorate with distinction from the University of Iowa. Mr. Varn has distinguished himself as one of the nation's leading policy makers, thinkers, and public speakers on issues related to information technology and its impact on government, education, libraries and society. He was recently named by Federal Computer Week as one of The Federal 100 and recipient of the Readers' Choice Award for his impact on federal information technology policy.

Lieutenant Governor
Dennis Rehberg



Dennis Rehberg, a fifth generation Montana rancher, has been involved in public service for the majority of his adult life. In 1977, he began by working as an intern in the Montana State Senate. Two years later, he joined the Washington, D.C. staff of Montana Congressman Ron Marlenee as a legislative assistant.

In 1984, Rehberg decided to join the political arena himself and was elected to the Montana House of Representatives where he served for three terms.

In July 1991, he was appointed by Governor Stan Stephens to fill a vacancy in the Lieutenant Governor's office. That following January when Governor Stephens decided not to seek re-election, then Attorney General Marc Racicot and Rehberg teamed up to seek the state's top offices. They were elected in November 1992.

As Lieutenant Governor, Rehberg has focused on several different areas. He chaired the Governor's Workers Compensation Task Force which helped in many of the changes undertaken by the state's system. He chairs the Montana Drought Advisory Council which focuses on drought preparedness. He worked to establish the Montana Consensus Council which is intended to resolve disputes in the area of natural resources. He has worked hard in the area of economic development and helped organize the Montana Rural Development Council, a federal-state-local-private economic development partnership.

The Lieutenant Governor has managed the family ranch near Billings throughout his years in public service. Rehberg has a degree in public administration/political science. His wife Janice is a private practice attorney who chaired the Montana Board of Natural Resources until 1992. The couple have two children.

- MONTANA GIS 1995: Common Ground in a Complex World -

USERS' CONFERENCE --- THE COLONIAL INN --- HELENA, MONTANA

Mon - May 8	Pre-Conference Workshops						
8:00-8:30		Arc/Info Tips, Tricks, and Techniques G Daumiller, NRIS Ken Wall, U of M Jack Horton, ESRI					
8:30-9:00			GPS # 1 Intro to the Global Positioning System Fred Gerlach, Private Consultant				
9:00-9:30	Intro to GIS: Basic Concepts Allan Cox and Fred Gifford, NRIS			Principles of Thematic Mapping for GIS Users Paul Wilson, Kurt Knowles, Robert Batchelder, U of M		Surfing the Internet for Spatial Data 1 M Mayer, Ed Madej, Desktop Assistance	Local Government Applications John Wilson, J Magnant, MSU
9:30-10:00							
10:00-10:30							
10:30-11:00							
11:00-11:30							
11:30-12:00							
12:00-1:00	ON YOUR OWN FOR LUNCH						
1:00-1:30	Intro to GIS: Basic Concepts Allan Cox and Fred Gifford, NRIS		GPS # 2 Familiarization & Field Operation of GPS Receivers Fred Gerlach, Private Consultant	Principles of Thematic Mapping for GIS Users Paul Wilson, Kurt Knowles, Robert Batchelder, U of M	GIS on a Budget: Volkswagens & Cheap Cafes on the Information Super Highway Scott Purl, U of M		Local Government Applications John Wilson, J Magnant, MSU
1:30-2:00						Surfing the Internet for Spatial Data 2 M Mayer, Ed Madej, Desktop Assistance	
2:00-2:30							
2:30-3:00							
3:00-3:30							
3:30-4:00							
4:00-4:30							
4:30-5:00							
5:00-6:30	TECHNICAL WORKING GROUP DINNER MEETING						
6:30-9:00	**PUBLIC NIGHT** We will host our fourth annual Public Night at the 1995 Users' Conference. The event is free and open to anyone who would like to participate. Public Night is an evolving part of our annual conference. This year, poster presenters, vendors, and GIS Specialists will have booths set up for the general public to see, use, and hear about GIS. In addition, we will have several programs set up for school children, including internet access to geography-related materials and games. For more information, contact the Natural Resource Information System at (406)444-5691.						

Tues - May 9	PLENARY		
8:00-9:30	**KEYNOTE: Richard Varn, Director of the Office of Telecommunications, University of Northern Iowa**		
9:30-10:00	Welcome & Opening Comments: The Honorable Dennis R. Rehberg, Lieutenant Governor		
	TRACK I **NATURAL RESOURCES** Cathy Maynard - Hans Zuuring	**TRACK II** **LOCAL GOVERNMENT** Stu Kirkpatrick	**TRACK III** **APPLICATIONS** Mark Tepley - Craig Bacino
	Theme: Watershed Analysis in GIS Moderator: Dennis Heffner	VENDOR WORKSHOP Moderators: Mark Tepley & Larry Cawfield	
10:30-11:00	**NR-1** Comparison of Anusplin Precipitation Surfaces and Hand-contoured Maps in Southwestern Montana and Wyoming Sara Stillman, Montana State University, Bozeman	The vendor workshop will be a panel style discussion in which vendors will be able to answer users' questions in a non-sales atmosphere. Some of the items for discussion include: * I'm developing my GIS implementation plan and realize that I won't be able to assemble the staff and/or computing resources to accomplish several key tasks and will have to contract out for services. What should I be looking for in a GIS contractor? * What have you observed to be the top three tips for a successful GIS and the top three pitfalls for GIS failures? * What direction do you think GIS hardware and software will go in the next few years? A microphone will be available for the audience to ask additional questions. We are also providing an area to submit questions in writing, for those that would prefer to remain anonymous. We would like to encourage everyone to participate.	
11:00-11:30	**NR-2** Using GIS in Watershed Education and Planning Patricia Hettinger, Lewis & Clark Water Quality Protection Dist.		
11:30-12:00	**NR-3** Carrying Capacity Study for North Flathead Valley Betty Marshall, Marshall and Associates, North Flathead Valley		
12:00-1:30	LUNCH - TWG PRESENTATION		
	Theme: GIS in Environmental Management Moderator: Hans Zuuring	Theme: City Government in Montana Moderator: Allan Grover	Theme: GIS Modeling Moderator: Patricia Zuwerink
1:30-2:00	**NR-4** Implementation of GIS for Decision Support Rick LaPlume, Terrain Resources LTD, Alberta	**LG-1** Advantages of Parcel Specific GIS Mapping Rick Breckenridge, Flathead County, Kalispell	**AP-1** Spatial Variability of Grassland NDVI Values By Ecoregion and Landcover Type in the Northern Great Plains Linda Gillett, Montana State University, Bozeman
2:00-2:30	**NR-5** Applications of Electronic Atlases for Environmental and Natural Resource Management Stuart Blundell, Integrated Geoscience & Engineering, Helena	**LG-2** Local Government GPS Applications: What we have learned Tom Tully and Loran Davy, Butte Silver Bow City Government	**AP-2** Using Terrain Attributes to Improve the Accuracy of Landsat Remote Sensing Vegetation Maps Jonathan Wheatley, Montana State University, Bozeman
2:30-3:00	**NR-6** Baby Dean Fire - Use of ARCVIEW Ted Tower, Fort Belknap Agency, Harlem		**AP-3** Indicators of Plant and Grasshopper Community Composition in Montana Kerri Skinner, Montana State University, Bozeman
	Theme: Water Resources & Habitat Mapping Moderator: Sonja Hoagland	INTRODUCTION to Local Government	Theme: Cultural Resources Moderator: Kristina Gurrieri
3:30-4:00	**NR-7** Development of a Spatial Data Base for Water-Right Information in Pahrump Valley, Nevada Lorri Peltz-Lewis, USGS, Carson City	**LG-3** *Implementing GIS in Local Government* *Terry Bartlett, ESRI, Olympia* More & More local governments are being faced with the prospect of implementing a computerized GIS. The history of GIS Implementation in local governments has been one of many successes but also plenty of not-so-successful implementations. This session will present an overview of the different parts of a GIS implementation as well as the GIS implementation process. It will focus on hardware, software, data, people, and procedures in regards to GIS implementation.	**AP-4** Users of GIS in Historic Preservation Projects: The Anaconda Building Survey Case Study Kim Morrison, State Historic Preservation Office, Helena
4:00-4:30	**NR-8** Blackfoot River Habitat Mapping: A Pilot Project of GIS & Remote Sensing Capabilities Ron Pierce, Fish Wildlife & Parks, Missoula		**AP-5** GIS in Hunter-Gatherer Archeology Methods Models and Management Dave Schwab, Schwab Cultural Consulting, Helena
4:30-5:00	**NR-9** Vegetative and Wildlife Diversity Across Temporal and Spatial Scales in the Seeley-Swan Landscape Melissa Hart, University of Montana, Missoula		**AP-6** The Future Meets the Prehistoric Past: The Flying D Archeological Project Mark Baumler, SHPO, & Peter Langen, NRIS, Helena
7:00-???	POSTER NIGHT - NO HOST SOCIAL		

Wed May 10	Theme: Modeling Soil Features Moderator: Ken Wall	Theme: GIS in Planning Moderator: Tom Tully	Theme: Panel Discussion Moderator: Craig Bacino
8:30-9:00	**NR-10** GIS-based Solute Transport Modeling Applications: Scale Effects and Estimation Methods John Wilson, Montana State University, Bozeman	**LG-4** GIS and Social Legitimacy Steve Mullen , Design Workshop, Denver	*GIS Disasters:* *Problems, Recoveries, Lessons Learned* Geographic information systems make it possible to use large spatial data sets and produce impressive output. Numerous potential pitfalls and traps, however, await even the most seasoned GIS users, affecting operations and output. Problems encountered originate from a range of sources, including programming errors, software misuse, vendor software bugs, staffing, budgeting, and policy. The "dark side" of GIS is often overlooked, but confronting problems and mistakes can be an important step in the learning curve. A panel of GIS users representing a variety of experience, applications, and organizations, discuss GIS problems and ways to handle them.
9:00-9:30	**NR-11** Sensitivity of Rusle Outputs to GIS Methods Used to Calculate Topographic Inputs Skip Repetto, Montana State University, Bozeman	**LG-5** Use of GIS for Critical Land Strategic Planning in Bozeman Dale Baland, Bozeman Planning Office	
9:30-10:00	**NR-12** Using GIS and Expert System Technology to Map Soils in Glacier National Park Barry Dutton, Land & Water Consulting, Missoula	**LG-6** GIS in the Master Planning Process Stu Kirkpatrick, Butte Silver Bow City Government	
10:30-12:00	BUSINESS MEETING		
12:00-1:30	LUNCH		
	Theme: Panel Discussion Moderator: Cathy Maynard	Theme: Panel Discussion Moderator: Stu Kirkpatrick	Theme: Accessing & Displaying Data Moderator: Mark Tepley
1:30-2:00	*GIS and Conflict Resolution* Quality information, spatially displayed, can often serve as a common ground for resolving resource use conflicts. The panel will discuss how managers can use GIS for conflict resolution and will include individuals experienced in making policy decisions. The discussion will address how mapped information can influence public decisions; ways to improve or increase the use of GIS in providing accurate and more integrated resource information; and suggestions on how to apply GIS products in conflict resolution. A question and answer period will follow and the audience will be encouraged to share examples of using GIS for conflict resolution.	*Status of Montana's Parcel Base Mapping -* *Where are We At and Where are We Headed?* In Montana, local government GIS users have traditionally relied on the state Department of Revenue parcel base mapping for input when building digital parcel databases. Unfortunately, this source varies drastically in accuracy and availability - and in most rural areas is nonexistent. This panel will assess the present quality and quantity of parcel base mapping across the state. It will then attempt to qualify the level of effort and financial support required to speed the cadastral research an mapping necessary if a statewide digital parcel layer compatible with Revenue's CAMA data is to be developed.	**AP-7** National Spatial Data Infrastructure Allan Cox, Natural Resource Information System, Helena
2:00-2:30			**AP-8** You have a GIS, But Can You Make a Map? Steven Holloway, University of Montana, Missoula
2:30-3:00			**AP-9** Data Visualization and GIS Michael Sweet, University of Montana, Missoula
	Theme: Mapping Wildlife Resources Moderator: Michael Sweet	Theme: Low or No Cost Data Moderator: Steve Hellenthal	Theme: GIS in Mining & Reclamation Moderator: Jim Hill
3:30-4:00	**NR-13** Grizzly Bear Cumulative Effects Model Implementation in the NCDE Katherine Ake, Flathead National Forest, Kalispell	**LG-7** GPS & Digital Orthophotos as Data Sources for GIS Base Maps; A Ranch Management Case Study Ken Wall, Geodata Service, Inc, Missoula	**AP-10** GIS, Federal Restrictions, and Mining Claims Paul Hyndman, U.S. Bureau of Mines & Geology, Spokane
4:00-4:30		**LG-8** How to Access Census Data for GIS Patricia Roberts, Census Bureau, Helena	**AP-11** Use of GIS & Database Info. to Determine Potential Effects from Abandoned & Inactive Mines on Resources Bob Wintergerst, USFS< Philipsburg **AP-11B** GIS for the Butte Mine Flooding/Berkeley Pit Superfund Project to Communicate Hydrogeologic Issues to a Lay Public Jim Scott, Dept of Health & Environmental Sciences, Helena
4:30-5:00	**NR-14** Using GIS to Analyze Winter Wolf Habitat Selection in Northwest Montana Peter Singleton, University of Montana, Missoula		**AP-12** Baseline Groundwater Monitoring for Documenting Potential Impact of Abandoned Mine Flooding: Berkeley Pit Ginette Abdo, MBMG, Butte **AP-12B** A GPS Survey of Butte/Silver Bow Creek Superfund Monitoring Wells & Its Integration into a GIS Dirk S. Vandervoort
	PLENARY		
6:00-7:00	DINNER		
7:00-???	DIAMOND CITY BAND		

Thurs May 11	TOURS		
	DEPARTMENT OF NATURAL RESOURCES & CONSERVATION	**DESKTOP ASSISTANCE**	**NATURAL RESOURCE INFORMATION SYSTEM**
8:00-10:00	The Department of Natural Resources and Conservation uses its geographic information system to preform a variety of analyses for reserved water rights for certain federal lands and Indian reservations, and siting of large energy generation and transmission facilities. Join the department's staff for a tour of DNRC's facilities and let the staff describe how different bureaus saved money by sharing costs on system development. DNRC is located in the capitol complex at 1520 East Sixth Avenue. For more information, contact Tom Ring, 444-6785.	The GIS Program at Desktop Assistance is a unique non-profit conservation biology mapping program, run by Ed Madej and Marshall Mayer in Helena. Desktop GIS specializes in collecting publicly available geodata in the Northern Rockies from a variety of sources, analyzing that data for agencies and other non-profits. Current projects have included grizzly bear habitat mapping, historical trend analysis of wildlands from satellite imagery, and open space mapping in the Helena area. Desktop GIS runs Arc/Info 7.0, ArcView 2, ERDAS Imagine 8.1 and IRIS Explorer on several Silicon Graphics unix workstations along with Adobe Photoshop and Adobe Illustrator on a Power Macintosh. Map output is done on a Canon Color Laser 300, which produces outstanding full color prints at 400 dot per inch resolution. Desktop GIS is located one block west of Last Chance Gulch in downtown Helena, in the Professional Building above the Sweetgrass Bakery. For more information, contact Marshall Mayer or Ed Madej, 442-1018.	The Natural Resource Information System (NRIS) was created by the Legislature to make sources of data and information on Montana's natural resources easily and readily accessible. NRIS operates a clearing house and referral service to link users with the best sources of information. The NRIS Geographic Information System was established in 1987 as a program of NRIS at the Montana State Library. The GIS program at NRIS provides public access to its GIS, application specific spatial analyses, maps, and database services. The GIS program also provides project design and development support to public agencies that have a need for in-house GIS capabilities. The system at NRIS consists of Sun SPARC graphics workstations networked with PCs and many GIS peripherals. The GIS software utilized at NRIS is Arc/Info. NRIS is located in the capitol complex at 1515 East Sixth Avenue. For more information, contact Fred Gifford, 444-5337.

NATURAL RESOURCE TRACK

NR-1.

COMPARISON OF ANUSPLIN PRECIPITATION SURFACES AND HAND-CONTOURED MAPS IN SOUTHWESTERN MONTANA AND WYOMING

Sara T. Stillman, John P. Wilson, Stephan G. Custer and Philip E. Farnes, Montana State University, Bozeman, MT

Spatially varying precipitation estimates are required for regional resource assessments and environmental modeling applications. Interpolation of precipitation data to unmeasured locations is especially difficult in mountainous regions and at the mountain-plains interface. ANUSPLIN produces precipitation estimates for three-dimensional surfaces (DEMs) by fitting thin-plate splines to measured climate station data. This modeling software was used to estimate 1961-90 mean monthly and annual precipitation for the Bozeman, Billings, Ashton, and White Sulphur Springs 1-by-2 degree USGS quadrangles in southwestern Montana and the Cody quadrangle in Wyoming as follows: 1) the locations, elevations, and precipitation measurements at National Weather Service climate stations, SNOTEL sites and SCS snow-courses were used in SPLINA to develop thin-plate splines, and 2) these splines and 3 arc-second DEMs for the study area 1-by-2 degree USGS quadrangles were used in LAPGRD to interpolate the final precipitation surfaces (grids). The hand-contoured maps produced from the same input data by one of the authors (Farnes) were then digitized, transformed into an ARC/INFO grid, and compared with the predicted annual precipitation grid. This continuing work is part of a larger comparison of the ANUSPLIN, PRISM, and MT-CLIM-3D models.

NR-2.

USING GIS IN WATERSHED EDUCATION AND PLANNING

Pat Hettinger, Lewis and Clark County Water Quality Protection District, Helena, MT

The Lewis and Clark County Water Quality Protection District is developing a watershed protection plan for the upper Tenmile Creek watershed, the primary drinking water source for Helena, Montana. The District is in the process of completing a characterization of the watershed's biophysical components and diverse land uses to identify potential and existing threats to water quality resulting from natural conditions or human activities. A considerable amount of natural resource data collected by state and federal agencies exists in an electronic (ArcInfo) format. Pertinent information is being compiled from several sources into a PC ArcInfo system to analyze watershed characteristics. A series of GIS overlays will be created and used to display a variety of the upper Tenmile watershed's key features to local authorities and the community. The Water Quality District plans to use GIS maps as an educational tool to increase local awareness of watershed issues, and provide a scientific foundation from which to initiate long range planning to protect the upper Tenmile Creek watershed.

NR-3.
CARRYING CAPACITY STUDY FOR NORTH FLATHEAD VALLEY
Betty Marshall, Marshall and Assoc.; Bob Anderson, Golder Associates; Joe Russell, Flathead City-County Health Dept., Kalispell, MT

A project was initiated by the Flathead City-County Health Department to assess the carrying capacity of groundwater resources in North Flathead Valley, Flathead County, Montana. The project focuses on determining the septic system development capabilities of hydrologic zones in the North Flathead Valley by developing key aquifer parameter data, modeling nutrient loading, and developing carrying capacity for the Valley. The key to this project will be to develop the existing data completely and efficiently, using GIS, and selecting, using and calibrating an appropriate model. The County is developing a GIS-based septic system map. The consultants are using GIS to collect and analyze aquifer parameter data, researching appropriate hydrogeologic models, and preparing final carrying capacity assessments. Deliverables for this project include GIS coverages that can be used by County staff to better manage water resources in the future.

NR-4.
IMPLEMENTATION OF GIS FOR DECISION SUPPORT
Rick LaPlume, Roy Penniket, Don Taylor, Terrain Resources Ltd., Lethbridge, Alberta, Canada

This paper discusses the general steps in the implementation of a GIS, in a forestry context, and some of the potential uses of the information for decision support at various levels. The usefulness of any GIS map base is directly related to the relevancy of the information to the user and whether that information can be retrieved in a meaningful format. To that end, the examples shown demonstrate the gathering, storage, analysis and retrieval of geographically referenced information and some of the potential uses, and pitfalls, of using a GIS for decision support. The implementation process is more than simply moving maps into a digital environment, and the design phase must therefore incorporate adequate planning and information gathering for present needs and a structure to allow for potential future requirements. Equally as important in the design is to include the means to retrieve required information to support various levels of decision support. With sufficient planning for both the uses of the GIS, and of the structuring and information retrieval of the data, a GIS map base can provide the technical and the non-technical user with visual and quantitative responses to aid in various levels of decision support.

NR-5.
APPLICATIONS OF ELECTRONIC ATLASES FOR ENVIRONMENTAL AND NATURAL RESOURCE MANAGEMENT
Stuart Blundell, Integrated Geoscience & Engineering, Helena, MT

Geographic Information Systems (GIS) provide a powerful platform to view, manipulate, and analyze spatial data elements and related attributes. Applications of this technology to environmental and

natural resource management projects are both far-reaching and comprehensive. Unfortunately, due to the expense and complexity of most hardware and software platforms potential users of GIS products perceive the technology as beyond the reach of their needs. A new low-cost and efficient technology has emerged, however, that allows potential users of GIS to design customized electronic atlases containing any combination of raster, vector, CADD, or TIN data structures and associated data base attributes.

Atlases are composed of hyperindexed stacks that include all necessary executable programs required to view and manipulate spatial data. Hyperindex stacks are spatially related layers of information that are linked geographically or spatially in a hierarchical tree structure. The atlas is published on a CD-ROM and is completely portable for viewing on any computer and operating software platform. For example, a project manager responsible for a hazardous waste remediation site might design an atlas that includes color aerial photographs, USGS contour maps, CADD elements depicting locations of monitoring wells, and polygons outlining surface soil types. The associated data base containing water quality and soil geochemistry data would then be linked geographically to all pertinent data layers and objects. The atlas could then be distributed internally within the organization or to clients. Viewing the atlas is just a matter of pointing and clicking with the mouse.

NR-6.

BABY DEAN FIRE - USE OF ARCVIEW

Ted Tower, GPS/GIS Coordinator, USDI-BIA Ft. Belknap Agency, Harlem, MT

The Baby Dean fire, which occurred during the week of September 9-16, 1994, burned over 60,000 acres of the Northern Cheyenne Indian Reservation, including 11,000 of commercial timber. The rehabilitation team which convened immediately after the fire used GPS and GIS technology to determine the extent of damage, and to help plan the course of rehabilitation. Subsequent to that, this same GPS and GIS groundwork was extended to evaluate the alternatives available in salvaging the burned timber. ArcView maps produced from this work were included with the environmental assessment of this timber salvage project.

NR-7.

DEVELOPMENT OF A SPACIAL DATA BASE FOR WATER-RIGHT INFORMATION IN PAHRUM VALLEY, NV

Lorri Peltz-Lewis, USGS; and Kelvin W. Hickenbottom, Matt J. Dillon, Tracy Taylor, Nevada Division of Water Resources, Carson City, NV

The Nevada Division of Water Resources (NDRWR) and the U.S. Geological Survey (USGS) are developing a spatial data base for water-right information for Pahrump Valley, Nevada, using a Geographic Information System (GIS). The State of Nevada follows the doctrine of prior appropriation for allocating a water right. To administer the distribution of these rights, NDWR requires that all water users file a water-right application and a supporting map, as defined by the

Nevada Revised Statutes (Legislative Council Bureau 1991). In 1991, the tabular Water Right Data Base was put into an INGRES[1] Relational Data Base Management (RDBM) system. In 1993, a data base was created for the Pahrump Valley with the ARC/INFO GIS for storing spatial information. The methods of developing the spatial data base and linking it to the INGRES RDBM are discussed.

NR-8.

BLACKFOOT RIVER HABITAT MAPPING

Ron Pierce and Don Peters, Montana Dept. of Fish, Wildlife and Parks, Missoula, MT

High resolution multi-spectral imagery collected with the ADAR S500 is being used to describe pool area, relative depth and other major habitat features of the Blackfoot River. Imagery consists of the red, blue, green and near infra-red bands at a spatial resolution of 1 meter-per-pixel. The unsupervised stream inventory relies on the visible bands and a 3-dimensional color cubical to produce a "true color" spectral image. Both color palette and classified spectral values are directly translated from the image processor to raster-based GIS. In GIS, the Infra-rd vector layer is used to "mask" the interface between the aquatic and terrestrial ecosystems. Field verification for final polygonal layers will determine substrate types, stream velocities and water depths for river habitat types. Final GIS habitat layers will be combined with biotelemetry relocation points for bull trout and other native fishes.

NR-9.

VEGETATIVE AND WILDLIFE DIVERSITY ACROSS TEMPORAL AND SPATIAL SCALES IN THE SEELEY-SWAN LANDSCAPE

Melissa Hart, Cooperative Wildlife Research Unit, University of Montana, Missoula, MT.

Landscape components of biodiversity were explored using the ARC/INFO geographic information system (GIS). Existing vegetation was classified and labeled according to cover type from 1991 Landsat TM imagery, and then compared with historic vegetation as digitized from 1930s maps.

Predicted habitat, past and present, was mapped for 20 wildlife species. Spatial statistics were calculated for vegetation and wildlife habitat layers using FRAGSTATS (McGarigal and Marks, unpublished software). Since the 1930s the Seeley-Swan landscape has become increasingly fragmented; mature/overmature forests have declined in total area, while seedling and sapling seral stages have become more widely distributed. This shift is reflected in habitat predictions for wildlife species using older forests.

Scale effects were examined by comparing GIS layers of existing vegetation at 8 minimum mapping units (MMU) ranging from 2 to 400 ha created using MergeRP (Guo, unpublished software), which merges polygons based on similarities between cover types. As would be expected, the proportion of the landscape occupied by each cover type changed as MMU increased. Of 25 cover types present in the 2 ha MMU layer, 10 disappeared at 400 ha MMU, while 6 cover types, all forested, increased

in area. Furthermore, most landscape metrics exhibited distinctly nonlinear relationship with MMU, indicating a need for caution in interpreting statistics calculated at different resolutions.

NR-10.

GIS-BASED SOLUTE TRANSPORT MODELING APPLICATIONS: SCALE EFFECTS AND ESTIMATION METHODS

by John P. Wilson, William P. Inskeep, Jon M. Wraith and Robert D. Snyder, Montana State University, Bozeman, MT

The Weather Generator (WGEN) and Chemical Movement through Layered Soils (CMLS) computer models were modified and combined with two sets of soil and climate inputs to evaluate the sensitivity of model outcomes to different map scales and attribute estimation methods. The basic soil and climate inputs required by WGEN and CMLS were acquired from either 1) the USDA-SCS State Soil Geographic Data Base (STATSGO) and Montana Agricultural Potential Systems (MAPS) databases, or 2) the USDA-SCS Soil Survey Geographic (SSURGO) database and a series of monthly climate surfaces developed by the authors using ANUSPLIN, published climate data and USGS 1:250,000-scale digital elevation models. Fifteen years of daily precipitation and evapotranspiration values were generated with WGEN and combined with the other soil and pesticide inputs in CMLS to estimate the depth of movement of picloram at the end of the growing season for every unique combination (polygon) of soil and climate attributes in a 320 km2 in Teton County, Montana. The model results were transferred to ARC/INFO to produce the final leaching susceptibility maps and develop a series of overlays to evaluate the sensitivity of the final leaching susceptibility hazard ratings to the choice of soil and/or climate input data.

NR-11.

SENSITIVITY OF RUSLE OUTPUTS TO GIS METHODS USED TO CALCULATE TOPOGRAPHIC INPUTS

Skip Repetto, John P. Wilson, Montana State University, Bozeman, MT and Randy Sounhein, Panhandle Health District, Coeur d'Alene, ID

The Revised Universal Soil Loss Equation (RUSLE) can be implemented in a GIS framework to predict soil erosion in agricultural, range, and forested catchments. RUSLE incorporates six multiplicative factors representing rainfall erosivity (R), soil erodibility (K), slope length (L), slope gradient (S), crop cover (C), and supporting practices (P) and all but the first term are usually varied in large area applications. This study examined the sensitivity of computed soil loss estimates to the methods used to calculate the length-slope (LS) factor in Priest Lake, Idaho's 65 km2 Two Mouth catchment. LS factor values were computed with the original RUSLE method and a simplified method proposed by Moore and Wilson which also incorporates the effects of 3-dimensional terrain (i.e., flow convergence and divergence). Contributing areas were calculated from 30 m USGS DEMs using the classical D8 (deterministic-eight node) algorithm that allows flow from a node to one of only eight nearest neighbors based on the direction of steepest descent in ARC/INFO, and the FRho8 (modified random eight-node) algorithm that allows flow to be distributed to multiple

nearest-neighbor nodes in upland areas above defined channels in TAPES-G. Similar R, K, C, and P factor values were used for all the model runs and a series of ARC/INFO grids were produced to evaluate the sensitivity of the final soil loss estimates to the methods used to calculate contributing areas and length-slope factor values.

NR-12.

USING GIS AND EXPERT SYSTEM TECHNOLOGY TO MAP SOILS IN GLACIER NATIONAL PARK

Barry L. Dutton, President/Soil Scientist, Land & Water Consulting, Inc., Missoula, MT

The purpose of this project was to provide soil information for park managers in Glacier National Park. Soil information will be used for specific projects such as road and trail construction or maintenance, weed management and facility siting. Other uses include vegetation and wildlife research, fire effects studies, general ecological information and planning.

The McDonald Drainage project area is approximately 110 square miles and includes a diversity of elevations, geologic materials, vegetation, land uses and soils. An initial soil map was generated in less than 30 days using an expert system based on fuzzy logic connected to a GIS system. Soil maps were refined through additional fieldwork. GIS layers used in this effort included the DEM (elevation, aspect, microtopography), surficial geology, Landsat, water and wetland features. The expert system knowledge base was derived from a local soil scientist and limited fieldwork.

This process is recommended for all large soil mapping efforts, especially where time schedules and budgets are limited. The expert system used in this effort may also be adapted to vegetation mapping, wildlife studies and other purposes.

NR-13.

GRIZZLY BEAR CUMULATIVE EFFECTS MODEL IMPLEMENTATION IN THE NCDE

Katherine Ake, NCDE data base manager, Flathead National Forest -Kalispell, MT

The 1993 Grizzly Bear Recovery Plan requires a cumulative effects analysis using the Cumulative Effects Model (1990) to be run on an entire ecosystem every five years to monitor habitat, habitat effectiveness, and trends over time. CEM has two routines: habitat and disturbance. The habitat routine is a relative measure of the inherent quality of an area to support bears. The disturbance routine is a relative measure of the impacts of all human activities within an area. The product of these two routines is habitat effectiveness, and reflects the ability of an area to support bears given the quality of the habitat and the level of human impact.

Traditionally, biologists have developed habitat and activity coefficients using the DELPHI method. In 1991, with the cooperation of bear researchers from the South Fork Grizzly Bear study, the NCDE-West model team began assessing grizzly bear location data to help determine coefficients.

While the basic process and equations for habitat value and effectiveness are unchanged from the 1990 Unified CEM manual, the habitat quality maps and human activity coefficients are derived from statistical analyses (habitat use/availability) of actual grizzly bear telemetry locations.

In October 1994, the Flathead National Forest completed a baseline run of the CEM for a large portion of the forest located within the NCDE. The entire analysis was completed using ERDAS version 7.5 GIS software. The CEM process and results of the baseline run will be presented.

NR-14.

USING GIS TO ANALYZE WINTER WOLF HABITAT SELECTION IN NW MONTANA

Peter H. Singleton, Robert R. Ream, Daniel H. Pletscher, School of Forestry, University of Montana, Missoula, MT

The recolonizing population of wolves in the North Fork of the Flathead River drainage in northwestern Montana has been intensively monitored since 1979. One component of this research effort has been the mapping of wolf movement routes. During the winter months, field researchers routinely follow fresh wolf tracks in snow, recording data on home range use and predation rates. Snow tracking data from the winters of 1984 to 1994 have been analyzed for habitat and landscape use patterns using GIS. PAMPAP software, run on 486-66 and Pentium-90 personal computers were used for all analyses. A total of 2,947 km of wolf travel routes, mapped during 375 separate tracking sessions were analyzed. Wolf travel routes were compared to slope , aspect, topographic position, proximity to water, proximity to open roads, total road density, and vegetation type. Because animals select habitat at a variety of scales, habitat use will be analyzed at three scales. Used areas will be compared to available at basin-wide (macro), home range (meso), and movement route (micro)scales. Information derived from GIS overlays will be used for the macro and meso scale analyses. Habitat information collected along wolf travel routes during tracking efforts in the winter of 1993-1994 will be used for the micro scale analysis.

LOCAL GOVERNMENT TRACK

LG-1.
ADVANTAGES OF PARCEL SPECIFIC GIS MAPPING
Rick Breckenridge, Flathead County GIS, Kalispell, MT

Parcel specific mapping offers advantages and contributes immensely to the process of identifying potential areas of concern that local governments face each day. With no limiting parameters, the only constraints placed on this approach to GIS is the request for information itself. Built into this type of system is the needed flexibility to cope with ever changing technological advances in all aspects of computing, mapping and applications.

As time allows, I may explore examples from a valley wide ground water study and the scenic corridor zoning change that illustrate the validity of the parcel specific mapping approach in solving important local government issues.

LG-2.
LOCAL GOVERNMENT GPS APPLICATIONS - WHAT WE HAVE LEARNED
Tom Tully, GIS Analyst; Loren Davy, GIS Technician; Butte-Silver Bow GIS, Butte, MT

For a local government, especially one without an engineering department, the purchase and use of a GPS system can provide a reliable method of data collection at a reasonable cost. The added advantage of being able to download GPS data to a GIS can enhance the usefulness of the GPS considerably. However, all is not as simple and straight forward as those glossy magazine advertisements make it out to be

Butte-Silver Bow GIS purchased a GPS receiver and base station in the spring of 1994. All staff members participated in a three day training session and have used it on a variety of projects since. We have located section and mining claim corners, waste dumps and shaft locations for the reclamation of abandoned mine sites. Other projects include tracking progress of refuse dump reclamation, verifying building locations, more precisely locating well locations for a water quality district and collecting weed infestation and bug release sites for the weed control program. As we used the GPS more extensively, we encountered problematic situations where revisiting our training manuals did not provide solutions, nor did technical support have instantaneous answers. Through trial and error we have developed practices and methodologies that provide more reliable data collection. Our goal is to share the real benefits GPS/GIS data capture can provide local governments and look at some mistakes we have made, pitfalls we have encountered and solutions we have devised.

LG-3.
IMPLEMENTING GIS IN LOCAL GOVERNMENT
Terry Bartlett, ESRI, Olympia, WA

More and more local governments are being faced with the prospect of Implementing a computerized Geographic Information System (GIS). The history of GIS implementation in local governments has been one of many successes but also plenty of not-so-successful implementations.

I will present an overview of the different parts of a GIS implementation as well as the GIS implementation process. I will focus on hardware, software, data, people and procedures in regards to GIS implementation. I will also take a look at some of the general factors that appear to be keys to the success or failure of GIS implementation at the local government level.

LG-4.
GIS AND SOCIAL LEGITIMACY
Steven B. Mullen, Design Workshop, Inc.

Two public planning trends in recent years would appear to be conflicting with one another.

One, the movement toward increased public participation in community planning to validate the social legitimacy of the planning efforts. For most of planning history, the planner has relied on *expert* values, rather than community values, to guide policy decisions throughout the planning process and as a result, *ownership* of those plans by the local citizens has been very poor. Public oriented planning processes, where citizens have the ability to participate and contribute throughout, have led to products with high levels of public consensus, thus general acceptance of both the initial plans and the implication of those plans over time.

The second public planning trend that appears to be in conflict with public oriented planning processes is the new GIS technology that has revolutionized the way planners plan. By it's nature this new technology is expert based, requiring a high level of technical knowledge to understand and utilize. It is not inherent in this technology that these systems be used to express 'expert' values, rather it is a reflection of the stage of evolution of how we are currently using the technology.

The flexibility that is inherent in GIS technology, allows us to devise planning methodology that not only reconciles the potential conflict between *expert* vs. *community* values, but enables us to vastly enhance the opportunities of a participatory public planning process.

Case Study: Verde River Greenway, 1993; and the Butte-Silver Bow Greenway are examples of how GIS can be used to enhance the public planning process and produce a plan with a high level of community ownership. These plans were derived from GIS maps that literally depicted community will in a spatial manner. By using public survey and focus group responses as weighting factors when combining GIS map layers we were able to present maps showing the areas that are literal depictions

of community will. The plan defines the locations for program elements that maximize public benefit while minimizing costs to the environment, visual resources and the construction budgets.

LG-5.
USE OF GIS FOR CRITICAL LANDS STRATEGIC PLANNING IN BOZEMAN
Dale Beland, Bozeman City-County Planning Office, Bozeman, MT

GIS technology is being used by the Bozeman City-County Planning Office to indicate "critical lands" within the 87-square mile planning jurisdiction area. As requested by the Bozeman City Commission, this information is intended to help guide land use decisions by defining and distinguishing environmentally sensitive lands from those which are suited for development. In addition, the data base will be incorporated into a pending update of the Bozeman Area Master Plan.

The Geographic Information & Analysis Center (GIAC) of MSU was contracted to provide a series of mapped layers describing key factors. These include the 100-year floodplain with floodway, streams and ditches, potential hydric soils and seasonal high water table, geophysical constraints, wildlife habitat, prime agricultural lands, and wetlands.

The wetlands determination was made by a team of resource conservationists and soil scientists using the latest interagency protocols as agreed with the Corps of Engineers, and Fish and Wildlife Service. This task involved an agreement between the Planning Board and the Natural Resource Conservation Service (NRCS).

The GIS-mapped layers will be displayed on an aerial photo mosaic at a scale of 1"= 7,000'. A Critical Lands Technical Committee, consisting of agency representatives from NRSC; Fish, Game & Parks, and other experts, will use the map system to determine critical lands, in association with Planning Office staff members.

Andy Epple AICP, Planning Director, and R. Dale Beland AIA, AICP, Associate Planner/Urban Designer, are responsible for the project.

LG-6.
GIS AND THE MASTER PLAN PROCESS
Stu Kirkpatrick, Butte Silver Bow GIS, Butte, MT

Recent controversy in many western Montana counties over land use planning has brought the issue out into the open instead of existing as a dusty old map rolled away in a planning departments' map case. Is the government out to usurp the constitutional rights of property ownership, or is rational planning for the future a way to ensure property rights are maintained? Has a highly vocal and well organized minority over-influenced the majority of citizens into believing that land use planning, gun

control legislation, and taxation can all be neatly wrapped into a package of undo governmental influence? These are questions that planners must face at every public meeting they attend. GIS technology can help them provide the public a clear and accurate view of what is intended, provide quick turnaround of public input into cartographic output to assure those who voice opposition that they are being heard, and sell the final product to the voting public.

Since 1971, the city of Butte and Silver Bow County have had elements of a future land use plan in writing. After city-county consolidation in 1977, independent zoning districts outside the original city limits were merged with city zoning to reflect the consolidation and a new zoning ordinance was adopted in 1978. A county-wide master plan became effective in 1987.

In 1994, in response to community need; i.e. the impacts of a changing economic base, shifts in population and development patterns and to address land use issues as they relate to Superfund remediation and reclamation activities, the Butte-Silver Bow Planning Board directed the Planning Department to update the county-wide master plan. GIS, because of its spatial analysis and cartographic capabilities, became an integral part of this update procedure.

Both zoning and master plan boundaries had been input into the GIS prior to the update process. However, under GIS scrutiny, problems with the original delineations began cropping up. The boundaries did not necessarily correspond to a spatially accurate road base and many of the boundaries were nebulous in nature, not following any natural geographic or cadastral boundary. Additionally, it seemed that the master plan had been developed to accommodate zoning instead of zoning being a logical extension of the master plan. The Planning Department used GIS to eliminate as many of the anomalies as possible before initiating the master plan changes. During the public input phase of the master plan update, GIS products were repeatedly used to display what was being proposed for change. GIS products could be quickly updated when public input indicated important neighborhood issues had been overlooked.

This presentation focuses on GIS update of land use planning databases, cartographic products that enhance the public input process, and spatial analysis procedures that assist planners when making multiple changes in a land use plan.

LG-7.
GPS AND DIGITAL ORTHOPHOTOS AS DATA SOURCES FOR GIS BASE MAPS: A RANCH MANAGEMENT CASE STUDY
Ken Wall, Geodata Service, Inc, Missoula, MT

This presentation will cover the use of several input tools to create a relatively inexpensive GIS base map using case studies from a working cattle ranch and weed mapping on the urban wildland fringe. First we will explore the use of global positioning system {GPS) as data input for digital base mapping. Important topics will include strategies for field collection of GPS points for multiple

attributes; differential correction techniques to improve spatial accuracy; data documentation; and appropriate vs inappropriate use of GPS data.

We will also present the use of orthophotos as a digital raster backdrop for GIS maps. Only a few dozen digital orthophotos in Montana are currently available from the USGS, We will describe the process of scanning and registering orthophotos and importing these into GIS systems. We will address the potential for alternative input sources to supplement and extend traditional sources like digitizing and importing public domain data.

The case study areas for this project include the Greenough Cattle Ranch in the Blackfoot drainage and the urban wildland interface along Mt Sentinel adjacent to the city of Missoula. We will cover the application of these data sources for practical day to day mapping and spatial analysis needs for a working cattle ranch, and for weed mapping and monitoring efforts.

LG-8.

HOW TO ACCESS CENSUS DATA FOR GIS

Patricia Roberts, Census and Economic Information Center, Helena, MT

Access to federal economic and demographic data sources with concentration on the decennial census files will be discussed. This type of data is used in land use planning, community analysis, environmental impact assessment, emergency management, economic development and other projects which study the human impact on a particular area. While the TIGER files will be discussed, the primary focus will be the subject files such as income, poverty, employment, vehicles available, type of house heating fuel, length of time to work and other variables. Levels of geography available, type and detail of subject matter as well as limitations of the data will be the major focus.

APPLICATIONS TRACK

AP-1.

SPATIAL VARIABILITY OF GRASSLAND NDVI VALUES BY ECOREGION AND LANDCOVER TYPE IN THE NORTHERN GREAT PLAINS

Linda E. Gillett, William P. Kemp, and John P. Wilson, Montana State University, Bozeman, MT

Satellite imagery offers spatially-variable and repetitive information about the earth's surface that may help with various kinds of resource assessments and hazard forecasts (drought, grasshopper outbreaks, etc.). Bi-weekly NDVI values were extracted from the 1988 and 1990 through 1993 AVHRR CD-ROMs produced by the EROS Data Center and these data are used in conjunction with Omernik's ecoregion map and the USGS prototype landcover database to examine the spatial and temporal variability in grassland NDVI values and their potential for quantifying drought hazard in the northern Great Plains. The 28 original grassland types delineated by the USGS were grouped into three categories representing grass/croplands, grasslands, and shrub/grasslands. Two types of statistical analysis were performed: 1) 100 1 km2 pixels were randomly selected from each unique combination of ecoregion and landcover type and these data are used in a series of ANOVA models to evaluate the seasonal and annual variability in NDVI values, and 2)growing season NDVI values have been extracted from the AVHRR database for National Weather Service climate station locations and these data are used in a series of regression models to quantify the relationship between NDVI and precipitation recorded at these sites.

AP-2.

USING TERRAIN ATTRIBUTES TO IMPROVE THE ACCURACY OF LANDSAT REMOTE SENSING VEGETATION MAPS

Jonathan M. Wheatley, John P. Wilson, and Gerald A. Nielsen, Montana State University, Bozeman, MT

Remote sensing is a tool widely used to map vegetation over large areas where less automated methods are too costly and time-consuming. The central problem is to identify vegetation types by their spectral reflectance. Often, remote sensing alone is unable to distinguish ecologically distinct vegetation types, so researchers employ ancillary information such as digital elevation data and soil survey data to help resolve ambiguities in remote sensing derived vegetation maps. This study integrates terrain attributes, computed by the Terrain Analysis Programs for the Environmental Sciences (TAPES) from 30 m digital elevation models, with a modified maximum-likelihood spectral classification developed by Zhenkui Ma and Roland Redmond at the University of Montana. We compare classification accuracy of Landsat thematic mapper vegetation maps with and without the addition of terrain attributes such as upslope drainage area, incident solar radiation, and soil wetness index, which are computed over a 1,800 km2 region in the Little Missouri National Grassland, North Dakota. Once techniques have been refined on this test area, all the USDA Forest Service Northern Region National Grasslands and Forests of North and South Dakota will be mapped.

AP-3.
INDICATORS OF PLANT AND GRASSHOPPER COMMUNITY COMPOSITION IN MONTANA
Kerry M. Skinner and William P. Kemp, Montana State University, USDA Rangeland Insect Laboratory, Bozeman, MT

Grasshopper communities vary with vegetation and local habitat. Digital vegetation and soil data may help predict grasshopper community characteristics if these data accurately describe field conditions. Our project goals were to identify spatial attributes which distinguish plant and grasshopper communities on a state-wide scale. Plant and grasshopper species composition data were collected in three areas of Montana in 1993. A geographic information system (GIS) was used to associate each sampling site with Omernik's ecoregions and the Montana State Soil Geographic Database (STATSGO). Detrended correspondence and statistical analyses were used to test differences and correlations among sampling areas, ecoregions, available water, and soil permeability. Three plant and four grasshopper species where correlated with soil permeability. Available water was correlated with five grasshopper species, but with none of the plant species. Soil permeability values differed significantly over all sampling areas and ecoregions. STATSGO plant percentages did not correlate with field percentages, indicating inadequate resolution for the scale of our study. Ecoregions were useful in identifying habitat and grasshopper community gradients across the three sampling areas, from mountains to plains. GIS data are useful for grasshopper community analysis when the resolution is sufficient to capture ecological gradients at the scale of investigation.

AP-4.
USES OF GIS IN HISTORIC PRESERVATION PROJECTS:
THE ANACONDA BUILDING SURVEY CASE STUDY
Kimberly Morrison, State Historic Preservation Office, Helena, MT

This short half-hour presentation will discuss the application of GIS to historic preservation projects, specifically the Anaconda Historic Building Survey project, which is currently being conducted by the State Historic Preservation Office in Helena. The presentation will be a discussion of the development and structure of an ArcInfo database designed to store categorized architectural, historical and Federal Census data about the town and its buildings, as well as the possible future uses of the data for geographical/demographical research purposes.

The Anaconda Survey database is designed as a pilot program, with the goal of making SHPO data and research more consistent, more accessible, and more user-friendly to the general public.

Queries and research possibilities will be discussed, such as ethnic and labor distribution in residential neighborhoods and other demographical research, map generation, and architectural categorization and distribution.

In all honesty, the exact format of the presentation will most likely change slightly as the conference

date draws nearer. SHPO personnel have just begun entering information into the database, and it will be a few months before all categories in the database will be finalized and all future research possibilities and queries explored. To answer the technical questions that may come up during the presentation, the database designer, Kristina Gurrieri will be on hand.

AP-5.

GIS IN HUNTER-GATHERER ARCHAEOLOGY: METHODS, MODELS AND MANAGEMENT

Dave Schwab, Schwab Cultural Consulting, Helena, MT

Application of GIS technology to hunter-gatherer archaeology in Montana is still in its infancy, but GIS and related technologies provide incredibly powerful investigative tools for documenting, sampling, modeling and managing prehistoric cultural resources. With rigorous application of GIS methods, major advances in archaeological research are predicted for the future. GIS will play an integral role in improving our understanding of the relationship of early hunter-gatherers with the natural world and the range of adaptations made by prehistoric peoples to changing environmental circumstances.

This paper presents four topics in hunter-gatherer archaeology where GIS has and will make increasingly substantial contributions. These are (1) documentation and mapping of archaeological sites, (2) sampling strategies for cultural resource surveys, (3) pattern analysis and predictive modeling efforts, and (4) cultural resource management approaches. Recognizing that these topics are interrelated, this presentation will provide examples and a discussion of current GIS applications in hunter-gatherer archaeology for each of the subject areas noted above. The author will also discuss new and innovative GIS applications and suggest approaches that might be considered for the future.

AP-6.

THE FUTURE MEETS THE PREHISTORIC PAST: GIS AND THE FLYING D RANCH ARCHAEOLOGICAL RESEARCH PROJECT

Mark F. Baumler, Ph.D, State Archaeologist, Montana Historical Society and Peter Langen, GIS Specialist, Natural Resource Information System, Helena, MT

The Montana Historical Society's Flying D Ranch Archaeological Research Project is one of the first large scale historic preservation projects in the state to employ GIS as a means for organizing, analyzing, and displaying archaeological data. In this paper we describe the methods being used to collect data and construct a GIS for gaining a better understanding of Montana's prehistoric past.

The study area centers on the 135,000 acre Flying D Ranch owned by Turner Enterprises, Inc., outside of Bozeman between the Madison and Gallatin Rivers. Archaeological research over the past several years involves the systematic survey, recording, and mapping of the locations and nature of campsites, hunting stations, stone mining localities, and other prehistoric activity located in the study

area. Over 300 archaeological sites have been identified so far representing occupations as far back as 9000 years ago.

Using archaeological information in conjunction with overlays of natural environmental data, GIS provides an unprecedented opportunity to explore patterns in the distribution of prehistoric sites on the landscape. We describe several examples of how GIS is helping to reconstruct ancient prehistoric behavior on the Flying D Ranch and offer suggestions for its further application in archaeological research and preservation in Montana.

AP-7.
STATUS OF THE NATIONAL SPATIAL DATA INFRASTRUCTURE
Allan Cox, Natural Resource Information System, Montana State Library, Helena, MT

A National Spatial Data Infrastructure (NSDI) was first proposed by the National Academy of Sciences, Mapping Sciences Committee as a means to integrate geographic information about features on the earth. The Federal Geographic Data Committee (FGDC) is now responsible for the actual design and development of the NSDI. This presentation will provide an overview of what the NSDI is and the status and activities of the FGDC in implementing the NSDI. Specific topics will include the status of the Spatial Transfer and Metadata Standards, Digital Geospatial Data Framework, Digital Thematic Data, the National Geospatial Data Clearinghouse, and how the NSDI is taking shape in Montana.

AP-8.
YOU HAVE A GIS, BUT CAN YOU MAKE A MAP?
Some Thoughts on Making Maps in a GIS Lab
Steven R Holloway, Wildlife Spatial Analysis Lab - UM & Oikos Work Arts, Missoula, MT

The software that drives most geographic systems has been focused along technologic and analytic lines. In turn many of the operators expedient in GIS work are focused along similar lines. This is to be expected by the nature of the work. There is an aspect of GIS work that can be problematic; presentation quality output. Presentation and artistic needs are not as seamlessly woven into out labs in either the software or the experience and training of our personnel. This separation of system and presentation, of GIS and map is a problem. When the time comes for a map, and not just any map, but one which will communicate and defend months of caring work, will you be able to produce it? Will your GIS software and staff be able to produce the kind of quality visual presentation you need, reflecting the same care and quality of your work?

To produce quality maps you need to employ cartographers, not GIS analysts. This can be as consultants or on your lab staff. It is not fair to expect GIS personal to develop materials for presentation, print or display. The language; the language of maps, graphics, color, type and space is a skilled discipline that demands special skills and experience. These are different skills than your GIS analysts or manager may have. In addition, you may need to use special software, hardware and

output devices to meet the needs of quality products. The capabilities of GIS software to produce quality maps has increased greatly during the past few years but it is not in the same class as graphic design software, and this is what is needed. There is clearly a need for better cartographic tools to be integrated into GIS software but even so this will never replace the need for the cartographer of graphic designer.

If you want a good looking map, ask a cartographer to help. Printed maps are often used, unfairly perhaps, to justify and speak for an entire contract or project. The help you get may well be worth the additional cost and time.

AP-9.
DATA VISUALIZATION AND GIS
Michael D. Sweet, School of Forestry, University of Montana, Missoula, MT

Increasingly, user's of Geographical Information Systems (GIS) need to address the question of 'when and why' as well as 'what and where.' In an effort to better depict spatial and temporal relationships, the GIS user is looking to extend the capabilities of the typical GIS toolbox. Like others, we have turned to data visualization software to gain a richer set of tools for investigating the complexities of geographical data.

The user needs to determine to what extent GIS can represent a given problem domain, and what capabilities they gain through the visualization environment. In generic terms, a typical GIS uses disparate data sources and data transformations to produce a set of images for display. Visualization software extends the analytical and visual capabilities of GIS by supporting a range of data types, time series, and multidimensional data. The investigative process is both visual and analytical. A key aspect of visual analysis is finding the "right" graphical presentation. Visualization environments reinforce the investigative process and allow us to easily experiment with alternative representations.

This presentation will discuss the visualization environment and provide examples of how we have begun to integrate visualization components into our GIS-based modeling and analysis efforts.

AP-10.
GIS, FEDERAL RESTRICTIONS, AND MINING CLAIMS
Paul Hyndman, US Bureau of Mines, Spokane, WA

The western half of Montana's vast lands (58 million of 94 million acres) were inventoried in 1989 for their legal and management restrictions on the Federal lands (23 million acres) and their effect on mineral exploration and development. GIS methods were used to capture the US Forest Service's management plans and incorporate them with the manually captured legal restrictions from the Master Title Plats of the Bureau of Land Management. GIS methods were also used to create KMDAs, Known Mineral Deposit Areas, and to compare them to the restrictions. Additionally, mining claim

information from 1994 was incorporated into the analysis and compared with the restrictions and with the KMDAs.

Three determinations were made: 1) where and how much of the Federal lands in Montana are available, restricted, or unavailable to mining, 2) where and how much of the known mineral deposit areas are available, restricted, or unavailable, and 3) where and to what extent do the 58,000 active mining claims occur.

Analysis determined that 20 % of the Federal lands are available, 22 % are slightly to moderately restricted, and 58 % are severely restricted to unavailable. The respective percentages for the 4.6 million acres of KMDAs are 34%, 31%, and 35%. About 80% of the mining claims occur within KMDA boundaries. Of these, about 70% are within available to moderately restricted areas.

AP-11.
THE USE OF GIS AND DATA BASE INFORMATION TO DETERMINE POTENTIAL EFFECTS FROM ABANDONED AND INACTIVE MINES ON NATURAL RESOURCES.
Bob Wintergerst, USDA Forest Service, Philipsburg Ranger District, Philipsburg, MT; Jim McNamara, USDA Forest Service, Butte Ranger District, Butte, MT

When mentioning southwest Montana we think of a colorful mining history. In fact ever since gold was first discovered in 1852 near Gold Creek, mining has played a major factor in States economy.

Mining has also played a major factor in the way the Deerlodge National Forest has been administered. Prior to 1991 it was difficult for the Forest to show relationships between mining activity and other resources. Since that time, the Deerlodge National Forest has been able to us information obtained from the Abandoned-Inactive Mines Program, developed under the agreement with the Montana Bureau of Mines and Geology, and Northern Region of the United States Forest Service.

Information gathered under this agreement has been placed in data bases and in a geographic information system (GIS). By doing this the Forest for the first time has been able to see elemental relationships between mining and the other resources it administers.

One of the first things looked at was the relationship of abandoned and inactive mines to the surface water resources. For the first time the effects of past mining activity on third order watersheds could be visualized as well as quantified in a meaningful manner.

Another application enabled the Forest Service to look at watersheds containing sensitive fish species that have been impacted by the effects of abandoned mines.

Future goals includes using GIS and data base information in determining relationships between abandoned mines and other resources. The Forest Service will also rank sites for possible reclamation.

AP-11B.

UTILIZING GIS FOR THE BUTTE MINE FLOODING/BERKELEY PIT SUPERFUND PROJECT TO COMMUNICATE FLOODING/HYDROGEOLOGIC ISSUES TO A LAY PUBLIC.

James O. Scott, DHES-Superfund Program; Gerald Daumiller, Natural Resource Information System, Helena, MT

The Berkeley Pit, located in the heart of Butte, Montana, is arguably the most visible and possibly the most alarming aspect of the Silver Bow Creek/Butte Area NPL site. This large open pit was the principal source for copper ore for the historic Anaconda Mining Company and its smelter in Anaconda, Montana. Mining in the Berkeley Pit began in 1955. When mining in the pit was stopped in 1982 the bottom of the pit was at an elevation of 4,265 ft msl (USGS datum) or 1,780 feet below the north rim of the pit (the highest point on the rim of the pit) and 1,280 feet below the south rim of the pit (the lowest point on the rim of the pit, i.e., 5,545 ft msl (USGS datum)). Overall the Berkeley Pit is about a mile by a mile and one-half at the rim and encompasses approximately 675 acres (1.06 square miles).

To allow open-pit and underground mining, the groundwater level in the Berkeley Pit hydrogeologic system was artificially lowered by pumping. When the dewatering system was stopped, the artificially lowered groundwater level began towards rise to its prepumping equilibrium condition and thus began to fill the Berkeley Pit. By 1983, flooding of the Berkeley Pit was visible to the general public at the Berkeley Pit public observation stand ("viewing stand") located on the west rim of the Pit, 5,580 ft msl (USGS datum). Today, thirteen years after pumping was stopped, the water in the pit is at an elevation of about 5,095 ft msl (USGS datum) which is about 400 feet below the viewing stand and 830 feet above the floor of the pit. This water is acidic and contains elevated levels of heavy metals and arsenic that are a potential threat to the environment and human health.

In response to this threat, the U.S. Environmental Protection Agency (EPA) and the Montana Department of Health and Environmental Sciences (MDHES), issued a Record of Decision (ROD) for "dealing" with the flooding Berkeley Pit and associated mine workings. Among other aspects of the ROD, a safe water level of 5,410 ft msl (USGS datum) was established. This is a level which water in the Berkeley Pit will not be allowed to rise above. By establishing this level, the acidic mine waters will continue to flow to the Berkeley Pit. The level will be maintained by pumping and treating the contaminated water and discharging the clean water away from the Berkeley Pit hydrogeologic system.

However, there is a misleading visual perception that this safe water level will cause environmental discharge of the contaminated water to the Butte valley. From the viewing stand, the public looks down on the Butte Valley. The Butte municipal airport, at its lowest elevation of about 5,480 ft msl (USGS datum) is "below" the viewing stand. Between the Colorado Tailings, which are the lowest point in the Butte valley and are at an elevation of 5,410 ft msl (USGS datum), and the Berkeley Pit exists a bedrock and an alluvial aquifer water level divide

or high. To assist the public in understanding these elevation issues and differences, GIS was utilized to create maps to clarify the system.

AP-12.

BASELINE GROUND-WATER MONITORING FOR DOCUMENTING POTENTIAL IMPACT OF ABANDONED MINE FLOODING: BERKELEY PIT, BUTTE, MONTANA

Ginette Abdo, Montana Bureau of Mines and Geology, Montana Tech, Butte, MT; Kris Larson, Natural Resource Information System, Helena MT.

The effects of flooding of the Berkeley Pit, an open-pit mine operated from 1955 to 1982, and connected subsurface mines are being monitored in both alluvial and bedrock aquifers. In addition to dedicated monitoring wells, 327 residential wells, within 75 mi^2, were visited by Montana Bureau of Mines and Geology personnel to collect water-level and ground-water quality data in the Butte area. A Geographic Information System (GIS) was used to plot well locations and facilitate display and data interpretation.

Water-elevation contours generated by GIS were the first step in determining ground-water flow directions. This map was revised based on the data and knowledge of the area; the final interpretation was a combination of GIS generated and digitized contours. Water-elevation contours show a ground-water divide between the Berkeley Pit and a residential area to the south. The present location of the ground-water divide and the elevation of the rising ground water in the Berkeley Pit suggest that existing degradation of alluvial ground water in the residential area south and southwest of the pit is most likely attributed to historic mining and milling tailings deposits and not to ground-water leakage from the pit or any underground mines. Seven of the 87 residential wells sampled had one or more exceedances of the primary maximum contaminant levels for arsenic, cadmium and nickel. Water chemistry was graphically displayed using GIS by creating a program to generate stiff diagrams. Most of the ground-water exceedances are just south and southwest of the pit in the alluvial aquifer, where a calcium sulfate water type predominates and specific conductance values are highest. Outside the area of degraded water quality, a calcium bicarbonate type water exists throughout most of the valley alluvial aquifer. The calcium sulfate type water is related to the oxidation of sulfide minerals in the tailings deposits and to subsequent transport through the unsaturated into the saturated zone. Tailings deposits in this area average 2 feet thick, with geometric mean concentrations of arsenic, cadmium, copper, lead and zinc of 362, <5, 1757, 468 and 3262 mg/kg, respectively. The data gathered during this study will be used to evaluate water quality conditions as the water level in the mining district continues to rise.

AP-12B.

A GLOBAL POSITIONING SYSTEM SURVEY OF BUTTE/SILVER BOW CREEK SUPERFUND MONITORING WELLS AND ITS INTEGRATION INTO A GEOGRAPHIC INFORMATION SYSTEM.

Dirk S. Vandervoort, Montana Bureau of Mines and Geology, Montana Tech; Tom Tully and Loren Davies, Butte/Silver Bow GIS, Silver Bow County Courthouse, Butte, MT

A Global Positioning System survey of Superfund monitoring wells in the Butte/Silver Bow Creek area was conducted in an effort to inventory and systematize well location and well attribute information. Existing well locations and attribute well data were recognized to have non-systematic locational inaccuracies and inconsistent or redundant names. These data were considered to be unreliable thus prompting need for this well inventory and survey. The project was conducted in a collaborative effort between the Montana Bureau of Mines and Geology (MBMG) and the Butte/Silver Bow GIS (BSBGIS) and was overseen by the Montana Department of Health and Environmental Sciences (MDHES).

The following tasks were performed as part of the well inventory and survey: (1) All known monitoring wells were visited and located using a GPS instrument operated by BSBGIS personnel. Wells were identified on the ground by MBMG personnel familiar with the monitoring well network. Each well was given a unique field designation to facilitate recognition in subsequent analyses. (2) Reports by well installation contractors, monitoring and oversight contractors and agencies, in addition to existing locational and attribute data sets were examined in order to determine well development histories and different naming schemes that have been used for the wells. (3) BSBGIS reduced the GPS location data and translated it to ESRI Arc/Info GIS format for subsequent map and report generation. A lookup table consisting of different well names and development histories was written to facilitate database queries.

The results of this project have been to develop a systematic and uniform geographic database from which monitoring well geographic locations, development histories, and redundant designation can be queried. In addition, the positional accuracy of the well network is accurate within systematic limits (both GPS and GIS), a characteristic of the well network that was previously lacking.

PANELS

VENDOR WORKSHOP

Panel **Moderators** - Mark Tepley, Dept. of Health and Environmental Sciences and Larry Cawlfield, Hydrometrics, Helena, MT

The vendor workshop will be a panel style discussion in which vendors will be able to answer users' questions in a non-sales atmosphere. Some of the items for discussion include:

* "I'm developing my GIS implementation plan and realize that, realistically, GIS technology may change by the time I've got the whole plan implemented. In general where do you see GIS heading and do you foresee as significant technological advances that might alter the way I view a GIS implementation plan today?"

* "I'm developing/implementing my GIS plan and realize that, realistically, I won't be able to assemble the staff and/or computing resources to accomplish several key tasks and will have to contract out for services. What should I be looking for in a GIS services contractor?"

* "In summary, from your perspective as vendors, what have you observed to be the top three tips for a successful GIS and the top three pitfalls for GIS failures?"

A microphone will be available for the audience to ask additional questions. We are also providing an area to submit questions in writing, for those that would prefer to remain anonymous. We would like to encourage everyone to participate.

GIS AND CONFLICT RESOLUTION: PANEL DISCUSSION

Moderator - Cathy Maynard; **Panelists** include: George Weldon, John Stephenson, Matt McKinney; Gerald Mueller; Tom Pansky

Quality information, spatially displayed, can often serve as a common ground for resolving resource use conflicts. The panel will discuss how managers can use GIS for conflict resolution and will include individuals experienced in making policy decisions. The discussion will address how mapped information can influence public decisions; ways to improve or I crease the use of GIS in providing accurate and more integrated resource information; and suggestions on how to apply GIS products in conflict resolution. A question and answer period will follow and the audience will be encouraged to share examples of using GIS for conflict resolution.

in Portland where they support a variety of projects including, most recently, the President's Forest Plan and the Interior Columbia Basin Ecosystem Management Project covering the entire Columbia River Basin. He is currently employed by Environmental Systems Research Institute as a Federal Program Manager and Consultant out of the Boulder, CO Regional Office. John is an honors graduate of the University of Oregon with a BS in Geography with an emphasis in Environmental Studies and Biogeography.

Tom Pansky graduated from Middlebury College in 1981 with a degree in philosophy and physics and went to work for Bonneville Power Administration+s Office of Conservation. In 1982, Tom moved to BPA's Power Planning Office and has been coordinating the development and use of regional rivers data systems for BPA ever since. Tom was instrumental in designing the region's Pacific Northwest Rivers Study, which resulted in the region's Hydropower Supply Model and Protected Areas Program (setting critical river reaches off limits to new hydroelectric power development). Tom is currently Bonneville's Program Manager for the regional Northwest Environmental Data Base and Coordinated Information System efforts.

PROPOSED QUESTIONS FOR THE CONFLICT RESOLUTION PANEL

General themes - identifying areas of conflict, tools and techniques for resolving those conflicts.

1) What do you see currently as the primary sources of natural resource use conflicts (i.e. conflicting management strategies, issues of ownership, lack of information)? What do you envision as conflicts that will emerge in the next 5-10 years?

2) Can you provide specific examples of successful techniques for resolving natural resource use conflicts. (Unsuccessful techniques?)

3) Do you feel improved communication of information can lead to the resolution of conflicts over natural resource use and management?

4) Based on your knowledge of GIS, how do you see it being used in the conflict resolution process?

5) In your opinion, do natural resource managers and land owners have adequate information to resolve conflicts over use?

STATUS OF MONTANA'S PARCEL BASE MAPPING- WHERE ARE WE AT AND WHERE ARE WE HEADED: PANEL DISCUSSION

Moderator - Stu Kirkpatrick; **Panelists** include: Sue Haverfield, Delores Cooney, Steve Hellenthal, and Judy Paynter

In Montana, local government GIS users have traditionally relied on the state Department of Revenue parcel base mapping for input when building digital parcel databases. Unfortunately, this source varies drastically in accuracy and availability - and in most rural areas is nonexistent. This panel will assess the present quality and quantity of parcel base mapping across the state. It will then attempt to qualify the level of effort and financial support required to speed the cadastral research an mapping necessary if a statewide digital parcel layer compatible with Revenue's CAMA data is to be developed.

Panel Members:

Sue Haverfield was appointed Flathead County Clerk and Recorder/Surveyor in 1985 and is presently serving her third elective term. She oversees one of the most unique land record offices in Montana, in that the entire county is covered by cadastral mapping and county personnel are responsible maintaining these parcel maps. She became involved with automated mapping/GIS in 1991 and is a shining example of an elected official going out on a limb to become the champion for GIS.

Delores Cooney is the Region 6 Manager of the Property Assessment Division for the Montana Department of Revenue for whom she has worked for 19 years. She holds a Montana Property Assessment License and is currently the only in the Department of Revenue to have a CAE designation from the IAAO. Delores was one of the original team responsible for instituting cadastral mapping in Silver Bow County and has been instrumental in gaining county support for converting Butte-Silver Bow land records to the GIS system.

Steve Hellenthal has been the Data Processing Director and GIS Manager of Yellowstone County for the past four years. Prior to that he worked doing GIS modeling in the oil industry for ten years. Steve has been actively involved in parcel mapping automation and parcel data base design in Yellowstone County and continually stresses the need for equal partnership between local governments and the Department of Revenue.

Judy Paynter, CPA, is Principal Tax Administrator of the Montana Department of Revenue. She has held this position since 1989. Prior to joining the Department , she taught at Weber State College, worked for a CPA firm, and the Montana Legislature. In 1980 she assumed the position the position of Legislative Fiscal Analyst, which she held until 1989. She earned bachelors and masters degrees from Montana State University.

GIS DISASTERS: PROBLEMS, RECOVERIES, LESSONS LEARNED: PANEL DISCUSSION

Moderator - Craig Bacino; **Panelists** include: Craig Bacino, Kristin Gerhart, Stu Kirkpatrick, and Hans Zuuring

Geographic Information Systems make it possible to use large spatial data sets and produce impressive output. Numerous potential pitfalls and traps, however, await even the most seasoned GIS users, affecting operations and output. Problems encountered originate from a range of sources, including programming errors, software misuse, vendor software bugs, staffing, budgeting, and policy. The "dark side" of GIS is often overlooked, but confronting problems and mistakes can be an important step in the learning curve. A panel of GIS users representing a variety of experience, applications, and organizations, discuss GIS problems and ways to handle them.

Panel Members:

Craig Bacino is a digital geographer for the Montana Reserved Water Rights Compact Commission, which quantifies federal and tribal water rights through negotiations. Following a M.A. in geography, University of Montana, he worked for the U.S. Government in Washington D.C. and Africa. He has also worked in the private sector as a GIS/GPS consultant.

Kristin Gerhart began her career with NRCS (formerly SCS) as a volunteer in 1986, serving in the position of GIS Specialist since 1990. B.A. Geography, Western Washington University, 1985; M.S. Geography, Montana State University, 1989, working with Dr. John Wilson on a soils data-related thesis.

Stu Kirkpatrick has been with Butte-Silver Bow GIS and the Butte-Silver Bow Planning Department for the last four years and presently holds the position of GIS Manager. During that time he has experienced the unpacking of the first workstation to managing a GIS handling 400 job requests and producing over 700 maps and 3000 map copies per year. While he has luckily had no major GIS disasters he nightly envisions them and spends many hours trying to avert them. He is also the incoming president of the Montana GIS Users Group and is working diligently to prevent that from becoming a disaster as well.

Hans Zuuring, School of Forestry, University of Montana. He received a Ph.D. in forest biometry from Iowa State University in 1975. His career at the School of Forestry, U.M. includes Research Assistant (1974), Associate Professor (1981), Professor (1986), Director, GIS Lab (1987), and Director of Quantitative Services (1995). Current research involves integrating simulators in a spatial context.

PANEL TOPICS (also, audience derived topics and questions):

- GIS Implementation
- Data (inc. collection, distribution/access)
- Personnel
- Systems Administration
- Software/Hardware
- Projects
- Budgeting

LIST OF EXHIBITORS
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1995 Montana GIS Conference
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Loretta Reichert, Mt. Dept. of State Lands

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Applications Track Organizers:
Mark Tepley, Mt. Dept. of Health and Environmental Sciences
Craig Bacino, Mt. Reserved Water Rights Compact Commission

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Rebecca Renz, SMD Engineering