West National Cooperative Soil Survey Conference

Agenda

King Kamehameha Hotel
Kailua Kona, Big Island of Hawaii

June 25 through July 1, 2000

Sponsored by: College of Tropical Agriculture and Human Resources, University of Hawaii

Sunday, June 25

7:30 – 8:00	Registration
8:00 – 6:00	Field trip to Hawaii Volcanoes National Park (Optional) – Box Lunch, Meet in front of Lobby at 7:30 AM
6:00 – 7:00	Registration

Monday, June 26

8:00 – 8:45	Registration

Moderator – Chris Smith – State Soil Scientist, NRCS, Hawaii

8:45 – 9:15	Aloha Kakahiaka! E Komo Mai! Opening Remarks – Perspectives from paradise – Chris Smith
9:15 – 9:30	Welcome – NRCS Hawaii – Larry Yamamoto, Assistant State Conservationist, NRCS, Hawaii
9:30 – 9:45	Welcome – University of Hawaii – Samir El Swaify – Chair, Natural Resources and Environmental Management
9:45 – 10:00	Welcome – Forest Service – Duane Lammers and Paul Scocroft
10:00 – 10:15	Break

Agency Reports

10:15 – 10:30	U.S. Army: Status and Use of Soil Surveys of U.S. Army Installations – George Teachman
10:30 – 11:00	Bureau of Land Management – Bill Ypsilantis
11:00 – 11:30	Forest Service – Dwayne Lammers
11:30 – 11:45	Soil Survey Activities in the National Park – Pete Biggam

11:45 – 12:00	Natural Resources Conservation Service, Soil Survey Division – Horace Smith
12:00 – 1:15	Lunch @ King Kam Hotel and Overview of Hawaiian Islands and Natural Environment –Bob Gavenda, NRCS Hawaii and Guam
1:15 – 1:45	Update on NCGC - SSURGO, & Digital Map Finishing – Tom Parham, NRCS
1:45 – 2:30	Agency breakout sessions
2:30 – 2:45	Break
2:45 – 5:00	Agency breakout sessions

Tuesday, June 27

Technical Presentations and Recommendations

8:00 – 8:45	Presentation: Nitrogen Adsorption in Soils with pH-dependent Charge – Goro Uehara, Johnathan Deenik - University of Hawaii and Chris Smith - NRCS
8:45 – 9:30	Discussion and recommendations for review of soil rating criteria modification for leaching potential and tailor for N for NASIS and Toolkit.
9:30 – 9:45	Break
9:45 – 10:30	Presentation: Phosphorous Management in Soils of Hawaii – Russel Yost, Xiufu Shuai, and Adrian Ares, University of Hawaii.
10:30 – 11:00	Discussion and recommendation for creation of a P runnoff and leaching rating criteria for soil survey publications and Toolkit
11:00 – 11:30	GIS as a Rule Based Tool for Soil Survey of Large Areas – Henry Shovic
11:30 – 12:30	Lunch –Individual choice
12:30 – 1:15	Presentation: Elemental Analysis at the Soil Survey Laboratory: Methods and Applications – Mike Wilson, Rebecca Burt, M. Dwayne Mays, and C.W. Lee – National Soil Survey Laboratory, NRCS
1:15 – 1:30	Discussion and recommendation for creation of heavy metal baseline database for soils in the US.
1:30 – 2:00	NASIS Interpretations generator – Terry Aho, NRCS
2:00 – 2:15	Break
2:15 – 2:45	Landscape and Soils Modeling Project: Greater Yellowstone Area – Henry Shovic & John Nesser, Forest Service
2:45 – 3:45	Data presentation preview for field trip

Wednesday, June 28

8:00 to 5:00	**Field Trip** – Soil Property Flux in Even Age Ash Across the Kohala Mtns. Climosequence – Chadwick, UCSB & Gavenda, NRCS
6:00 – 9:00	Luau at King Kamehameha hotel (individual arrangements)

Thursday, June 29

8:00 – 8:30	Adding value to Soil Surveys with a Dynamic Soil Properties Database – Arlene Tugel, SQI, NRCS
8:30 – 8:45	Discussion on use dependent property data collection
8:45 – 9:15	Presentation: Hawaiian Hydrology, Pesticides and soils: understanding the types and interactions – Richard Green, Professor Emeritus, University of Hawaii. Presented by Chris Smith, NRCS
9:15 – 9:30	Discussion and recommendations on how to improve/create pesticide leaching/runoff interpretation criteria
9:30 – 9:45	Break
9:45 – 10:15	Presentation: Nutrient Dynamics in Forested Andisols of the Big Island - Paul Scowcroft, USFS, Hawaii plus comments on USFS activities of the Institute of Pacific Islands Forestry
10:15 – 10:30	Discussion: Whether to include inherent soil fertility interpretations in soil surveys
10:30 – 11:00	Soil Data Viewer demo – Terry Aho, NRCS, Fort Collins
11:00 – 11:30	NRCS Field Office Toolkit Content – Terry Aho
11:30 – 12:30	Lunch @ King Kam Hotel and presentation on Hawaiian culture

Committee Reports and Related Presentations:

12:30 – 1:00	Research Agenda: National Cooperative Soil Survey – "What soils are out there?" – H. Curtis Monger, NMSU
1:00 - 1:15	Discussion
1:15 – 1:45	Western Coordinating Committee: Western Region Soil Survey and Inventory Report – Randy Southard
1:45 – 2:15	Soil Taxonomy – Bob Engle
2:15 – 2:30	Discussion – Soil Taxonomy: New issues?
2:30 – 2:45	Break

2:45 – 3:00	Current Hydric Soils Research Update – Russ Pringle, NRCS. Presented by Chris Smith
3:00 – 3:	Discussion – Hydric soils: New issues?
3:30 – 4:00	WNCSS Bylaws – Carl Hipple

Friday, June 30

8:00 – 9:45	Committee breakout sessions
9:45 – 10:00	Break

Development of New Committees

10:00 – 11:15	Discussion on future actions related to topics presented during the week
11:15 – 11:30	Selection of next host and site
11:30 – 12:30	Adjourn, Lunch – Individual choice
12:30 – 1:30	Business meeting

Saturday, July 1

8:00 – 4:00	Field Trip (Optional) Oahu Geomorphology and Soil Genesis – pick up between 7:30 and 8:00 AM at Waikiki hotels. Arrange with Chris Smith at registration Sunday 25th or Monday 26th.

List of Participants

Aho, Terry, Information Technology Center, NRCS, Fort Collins, Colorado

Biggam, Pete, Soil Survey Program Manager, National Park Service, Denver, Colorado

Broderson, Bill, State Soil Scientist, NRCS, Salt Lake City, Utah

Burt, Rebecca, Research Soil Scientist, National Soil Survey Center, NRCS, Lincoln, Nebraska

Busacca, Alan, Department of Crop & Soil Sciences, Washington State University, Pullman, Washington

Camp, Phil, State Soil Scientist, NRCS, Phoenix, Arizona

Chadwick, Oliver, Geography Department, University of California, Santa Barbara

Dollarhide, Bill, State Soil Scientist/MLRA Office Leader, NRCS, Reno, Nevada

Davis, Scott, State Program Leader, Bureau of Land Management, Lakewood, Colorado

Daughterty, LeRoy, Associate Director, Agricultural Experiment Station, New Mexico State University, Las Cruces, New Mexico

Dye, Hayes, MLRA Office Leader, NRCS, Phoenix, AZ

El-Swaify, Samir, Chair/Professor, Natural Resources & Environmental Management, University of Hawaii at Manoa, Hawaii

Engel, Bob, Soil Scientist, National Soil Survey Center, NRCS, Lincoln, Nebraska

Gavenda, Bob, Resource Soil Scientist, NRCS, Honolulu, Hawaii

Gordon, Chuck, State Soil Scientist/MLRA Office Leader, NRCS, Bozeman, Montana

Hipple, Karl, State Soil Scientist, NRCS, Spokane, Washington

Harrington, Keith, Soil Scientist, Hawaii Resource Office, NRCS, Hilo, Hawaii

Hendricks, Dave, Associate Professor, Department of Soil & Water Sciences, Arizona State University, Tucson, Arizona

Hoover, Dave, State Soil Scientist, NRCS, Boise, Idaho

Hutchison, Dennis, Soil Scientist, Senior Staff Specialist, United States Department of Interior, Bureau of Land Management, Roseburg District Office, Roseburg, Oregon

Kelley, Gene, Associate Professor, Soil Science Department, Colorado State University, Fort Collins, Colorado

Lammers, Duane, Pacific Northwest Region, United States Forest Service, Portland, Oregon

Loerch, Cameron, State Soil Scientist/MLRA Office Leader, NRCS, Lakewood, Colorado

McGrath, Chad, State Soil Scientist/MLRA Office Leader, NRCS, Portland, Oregon

Miles, Scott, United States Forest Service, Shasta-Trinity National Forest, California

Monger, Curtis, Department of Agronomy, New Mexico State University, Las Cruces, New Mexico

Nakamura, Saku, Resource Soil Scientist, NRCS, Honolulu, Hawaii

Nielsen, Gerry, Department of Plant & Soil Science, Montana State University, Bozeman, Montana

Parham, Tom, Director, National Cartography & Geographic Center, NRCS, Ft. Worth, Texas

Scheffe, Ken, State Soil Scientist, NRCS, Las Cruces, New Mexico

Scowcroft, Paul, Pacific Southwest Research Station, United States Forest Service, Honolulu, Hawaii

Smith, Chris, State Soil Scientist, NRCS, Honolulu, Hawaii

Smith, Horace, Director, Soil Survey Division, NRCS, Washington, D.C.

Southard, Randy, Interim-Associate Dean, College of Agricultural & Environmental Sciences, University of California, Davis, California

Southard, Sue, Soil Scientist, NRCS, Davis, California

Shovic, Henry, United States Forest Service, Gallatin National Forest, Montana

Teachman, George, Soil Scientist, Environmental Compliance Division (Liaison), U.S. Army Environmental Center, U.S. Environmental Compliance Division Center, Maryland

Tugel, Arlene, Soil Scientist, Soil Quality Institute, NRCS, Las Cruces, New Mexico

Uehara, Goro, Professor of Soil Physics, Agronomy & Soil Science, University of Hawaii, Honolulu, Hawaii

Wilson, Mike, Research Soil Scientist, National Soil Survey Center, NRCS, Lincoln, Nebraska

Yamamoto, Larry, Assistant State Conservationist, NRCS, Honolulu, Hawaii

Yost, Russ, Tropical Plant & Soil Science, University of Hawaii at Manoa, Hawaii

Wangemann, Dr. Stephen G., Resource Soil Scientist, Bureau of Indian Affairs, Yakama Agency, Toppenish, WA 98948

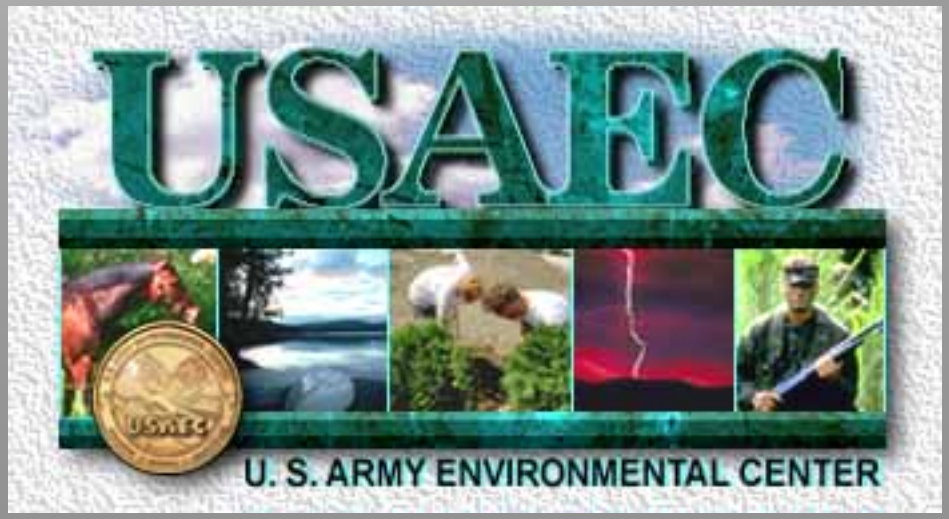
Ypsilantis, Bill, Soil Scientist, Bureau of Land Management, Denver, Colorado

Status and Use of Soil Surveys of U.S. Army Installations

Who Am I?

George Teachman

USDA NRCS Natural Resources Conservation Service



Duties?

- Soil Scientist Liaison to USAEC (since 1995)
  - Procure up-to-date soils information
  - Provide guidance on use of soils data in modeling efforts
- Integrated Training Area Management Team (ITAM)
  - Co-Chair - Army Training and Testing Area Carrying Capacity (ATTACC) Working Group
  - Chair - Wind Erosion Advisory Group (WEAG)
  - Lead - Land Rehabilitation and Maintenance (LRAM)
  - Lead - ITAM R & D
- Range Sustainment - Unexploded Ordnance
  - Range Response Screening Tool

Soil Survey Requirement

- About 180 Army training and testing installations need an Integrated Natural Resources Management Plan (INRMP)
- In many cases, the level of existing natural resource inventory is not adequate
- Order 2 survey is required

DoD Acreage

> 7,000,000 acres

12,000,000 acres

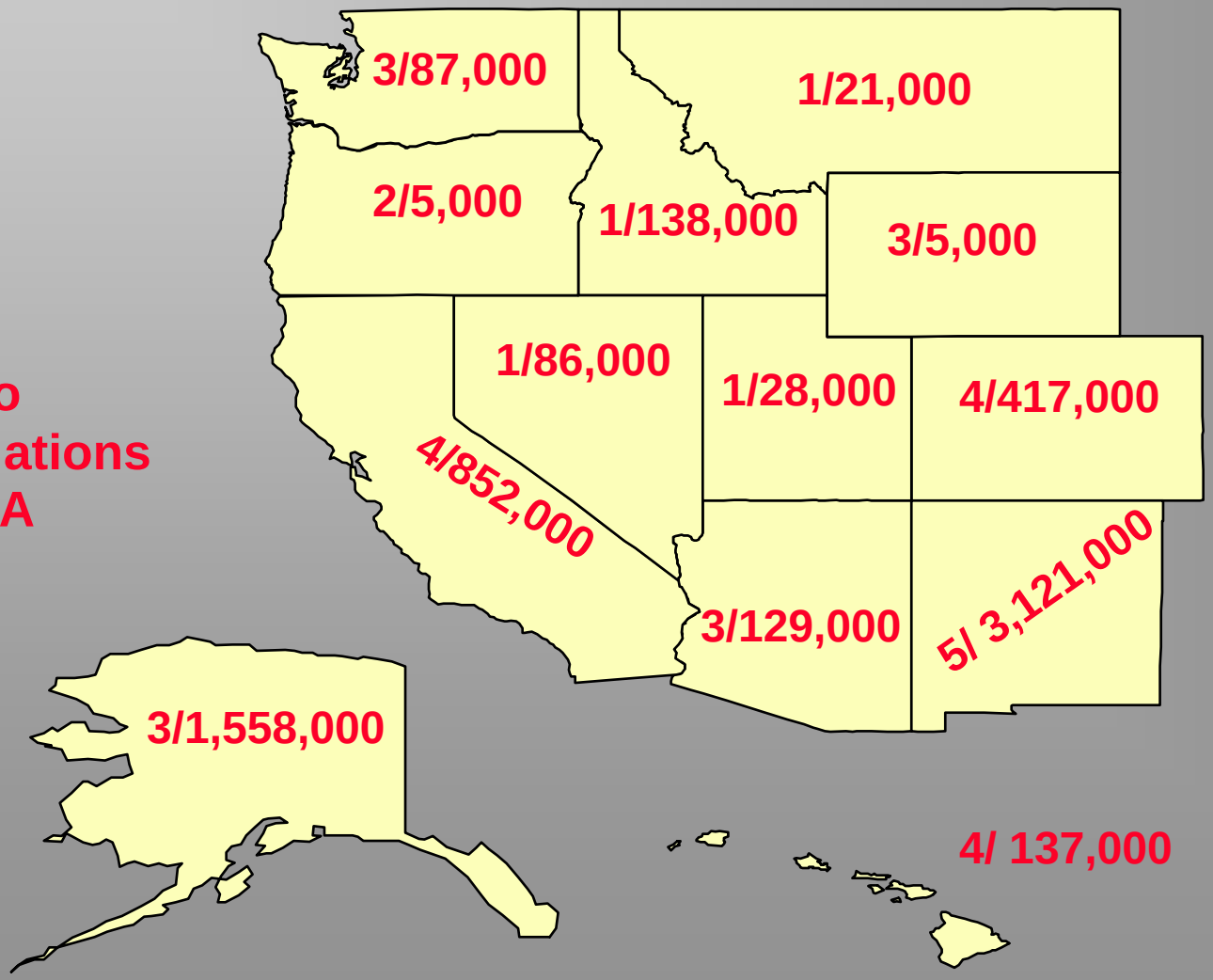
> 2,000,000 acres

25,000,000 acres

Actions

West Region

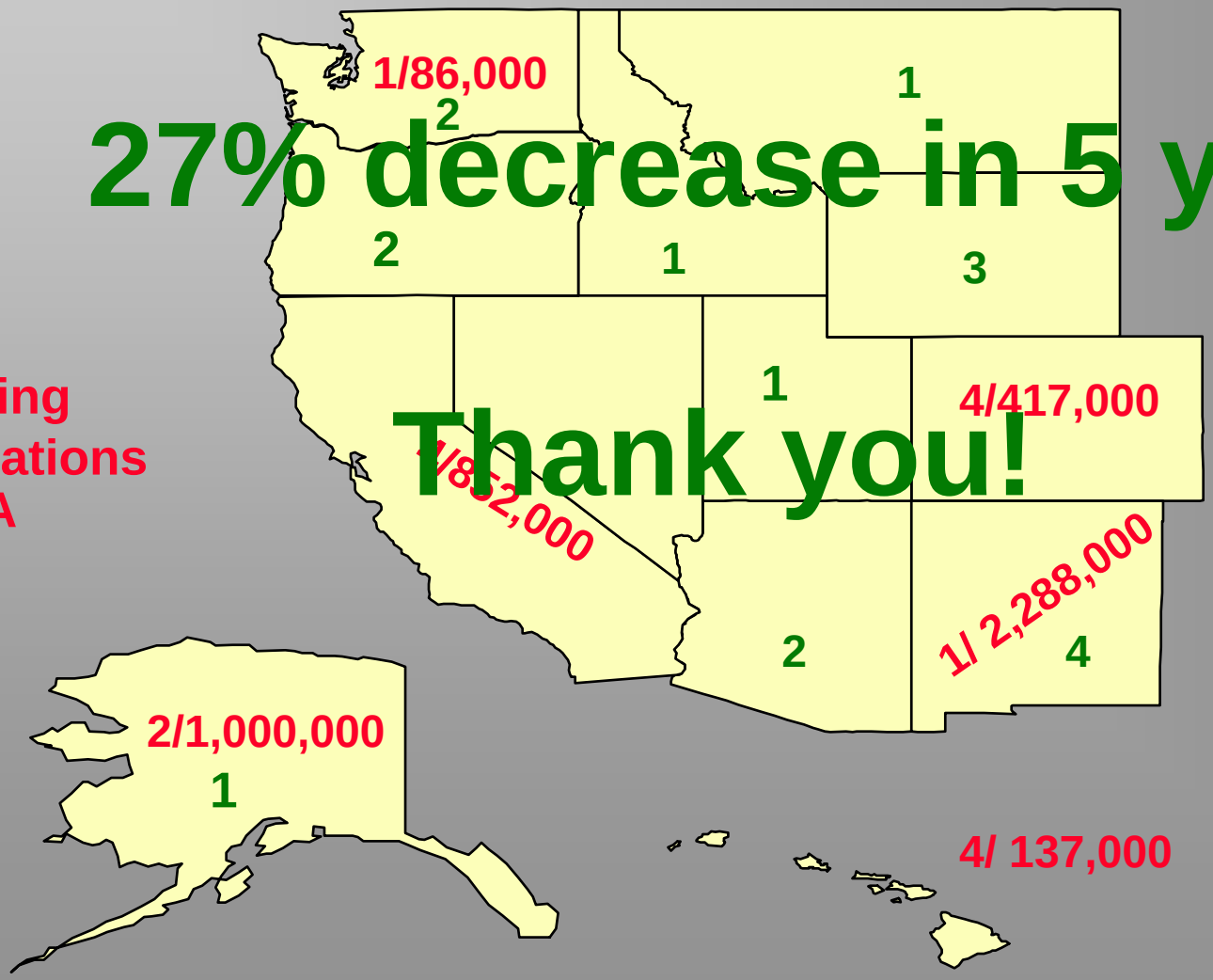
(Installations/Acres Needing Survey 1995)



To Do
35 Installations
6.6 MA

West Region

(Installations/Acres Needing Survey 2000)



27% decrease in 5 yrs

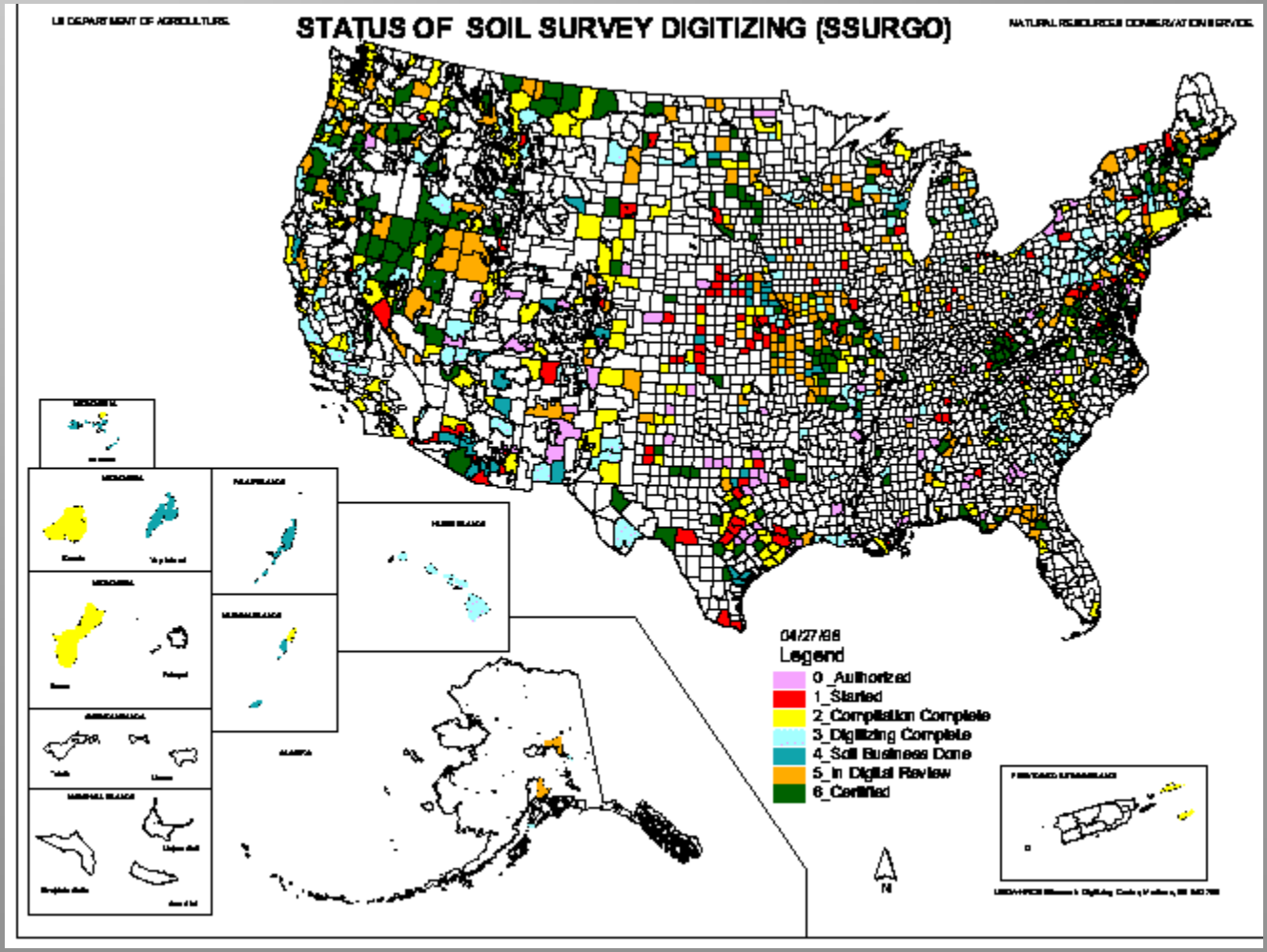
Thank you!

Remaining
16 Installations
4.8 MA

Actions

- ☑ Determine installations needing soil survey
- ☑ Broker soil surveys ($$$ dependent)
- ☑ Determine digital status of existing surveys

Status of Soil Survey Digitizing



Actions

- ☑ Determine installations needing soil survey
- ☑ Broker soil surveys ($$$ dependent)
- ☑ Determine digital status of existing surveys
- ☑ Provide $$$ for digitizing of priority installations

Integrated Training Area Management

Army Training and Testing Area Carrying Capacity

- Predict soil erosion and land rehabilitation costs based on training load, soils, vegetative, etc. data
  - Sheet/Rill Erosion (in place)
  - Wind Erosion (by end FY00)
  - Gully Erosion (by end FY01)

ATTACC

(Army Training and Testing Area Carrying Capacity)

Sheet/Rill Erosion

- Military Modified RUSLE

Wind Erosion

- Modified WEQ
  - based on work done at Yuma Proving Ground by NRCS

Gully Erosion

- Concentrated Flow model
  - based on work done at Fort Hood by NRCS

LRAM
(Land Rehabilitation And Maintenance)

Practice Factors (P factors)

- More construction oriented than farming (OSM)

Standard Practices (NRCS)

NRCS Engineer Support

- Fort Hood Model
  - Agreements to fund NRCS engineers

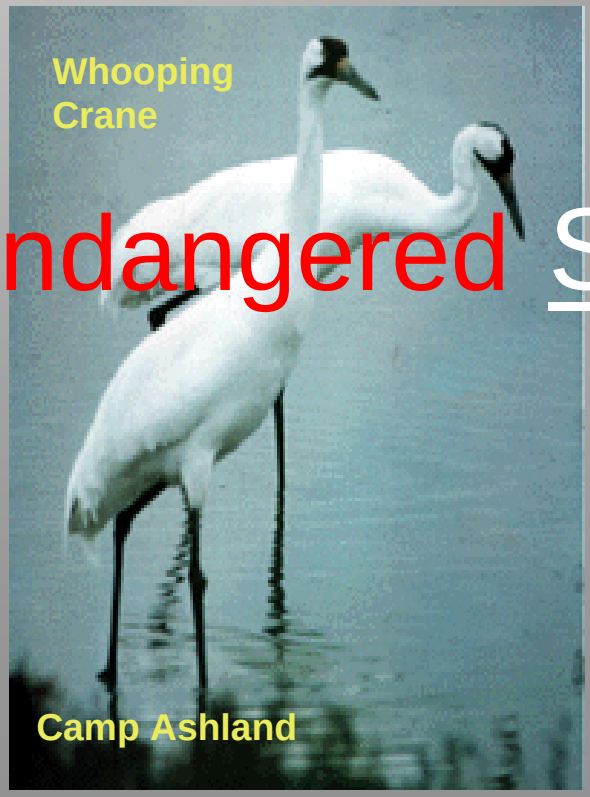
Range Sustainment

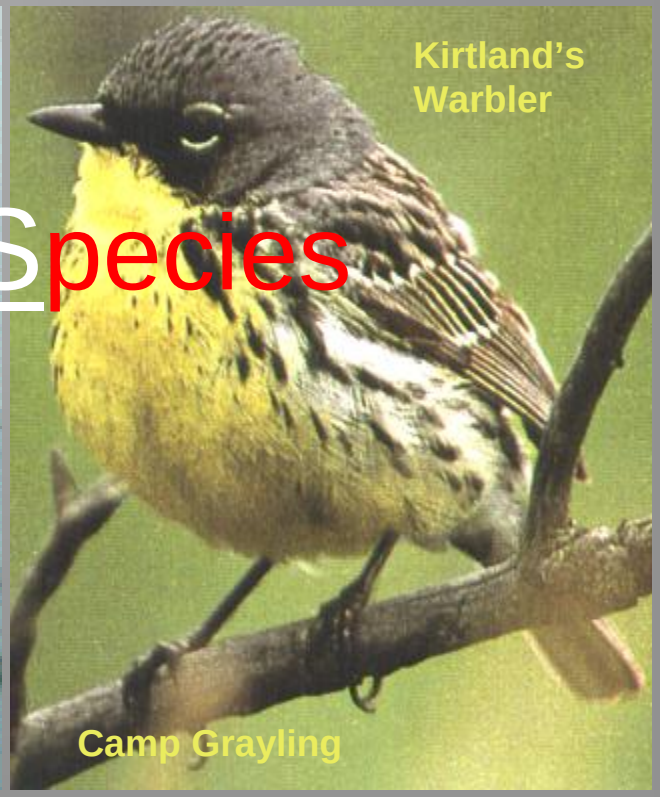
Unexploded Ordnance Clean Up

- Some areas inherently more ecologically valuable than others
- The high quality is result of training/testing mission
- Technology to detect/discriminate unexploded ordnance not mature (90/70)

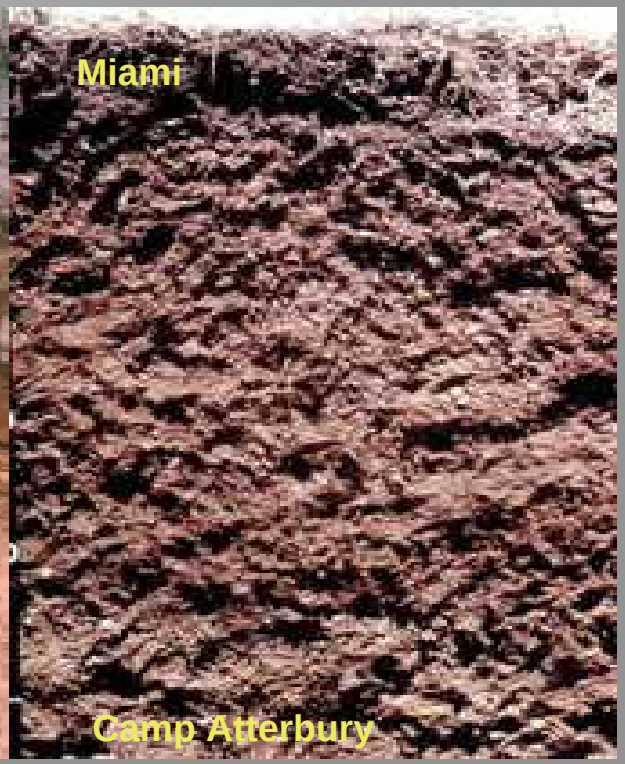
- Removal amounts to moonscape
- Cost Prohibitive (1400 acres/6” & 500 ac/4’ =$7.3 M)

Threatened and Endangered Species





Threatened and Endangered Soils



Threatened and Endangered Soils

How are soils threatened?

- Draining/Protecting
  - Wetlands
    - Prairie Potholes
    - Flood plains
- Development
  - Housing
  - Infrastructure
    - Roads
    - Light/heavy rail
  - Retail/Business

Farming

- Farming
  - Moldboard plowing can change classification

Exclusion of Fire

- Exclusion of natural ecosystem processes
  - Suppressing wildfires encourages buildup of organic matter changing soil dynamics

Forest Operations

Timber harvesting

Threatened and Endangered Soils

How does this affect you?

- Typical Pedon Type Locations can be destroyed
- OSD Type Locations can be destroyed
- Benchmark soil type locations can be destroyed
- State Soil Locations can be destroyed

Site Under Pressure?

Site Under Pressure?

Threatened and Endangered Soils

Not all soils are created equal. For one reason or another

State Soil vs Benchmark?

Forkwood

Orovada

Seitz

Taylorsflat

Benchmark Soils

Not all soils are equal in the eyes of soil scientists

A benchmark location within the major land resource area is identified for each soil series designated as a benchmark soil. The soil series type location and the benchmark location are the same if feasible. **When a new type location is selected for a soil series that is designated as a benchmark soil, consider its permanency and its suitability as a benchmark location**. Sites that remain accessible for many years allow follow-up sampling. (NSSH 630.04)

Under No Pressure

State/Representative Soils

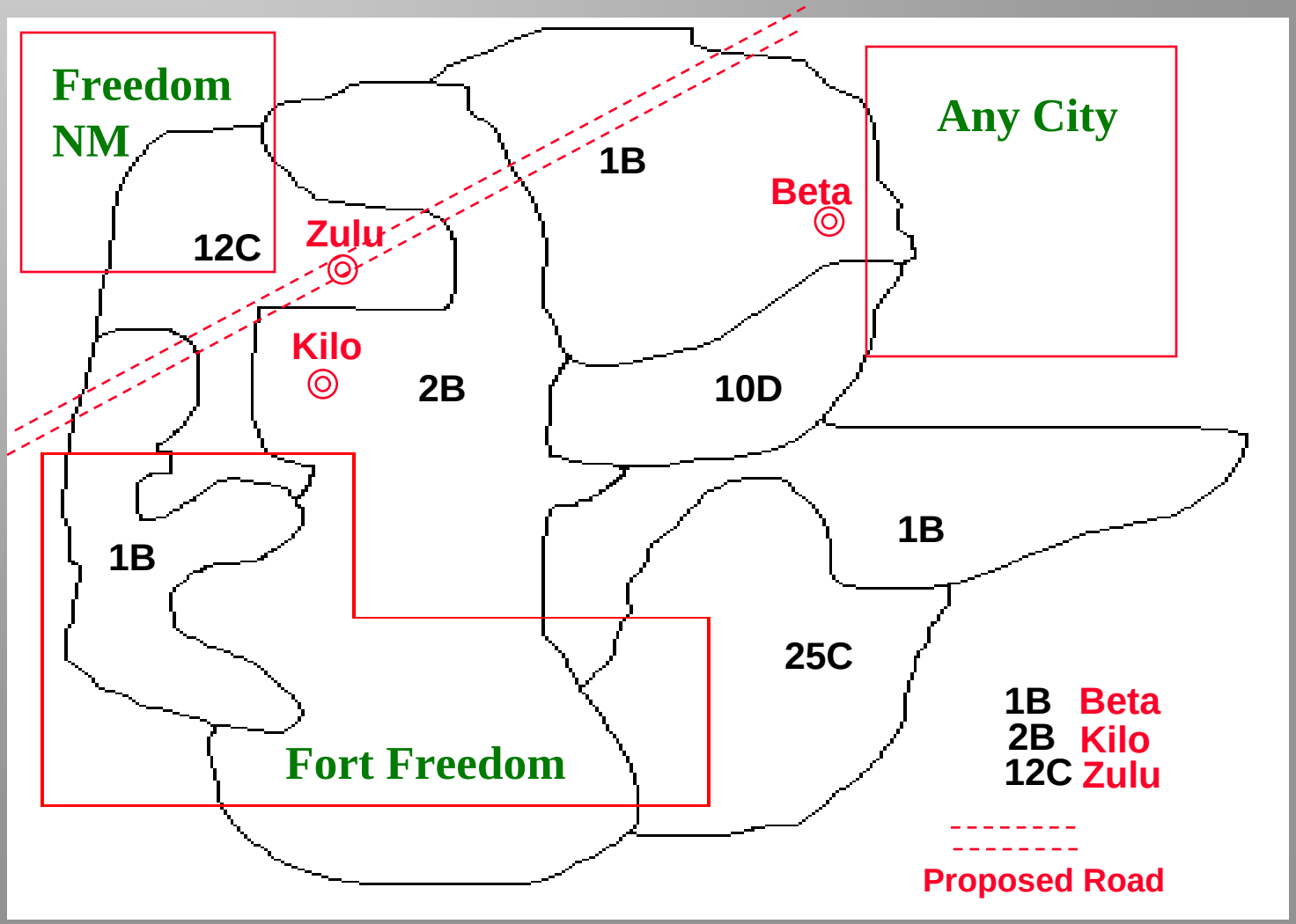
- 11 State/Representative Soils are on Army installations

• Port	Fort Sill
• Jory	Camp Adair
• Dickson	Fort Campbell
• Downer	Fort Dix
• Houston Black	Fort Sam Houston
• Sassafras	Fort George Meade
• Ruston	Fort Polk/Camp Beauregard
• Tifton	Fort Gordon/Fort Stewart
• Miami	Camp Atterbury/Newport AAP
• Crider	Fort Campbell/Fort Knox
• Cecil	Camp Butner

Threatened and Endangered Soils

- More and more OSD type locations are going to developed on in the future.
- Many of you are mapping Army installations for me.
- I propose locating OSD type locations on Army installations.
- Or, alternatively, any public land. (NWR, NP, NF, NERPs, National Grassland, etc.)

Before


Freedom NM
12C
Zulu
Kilo
2B
1B
Beta
Any City
10D
1B
1B
25C
Fort Freedom
1B Beta
2B Kilo
12C Zulu
Proposed Road

Public Lands

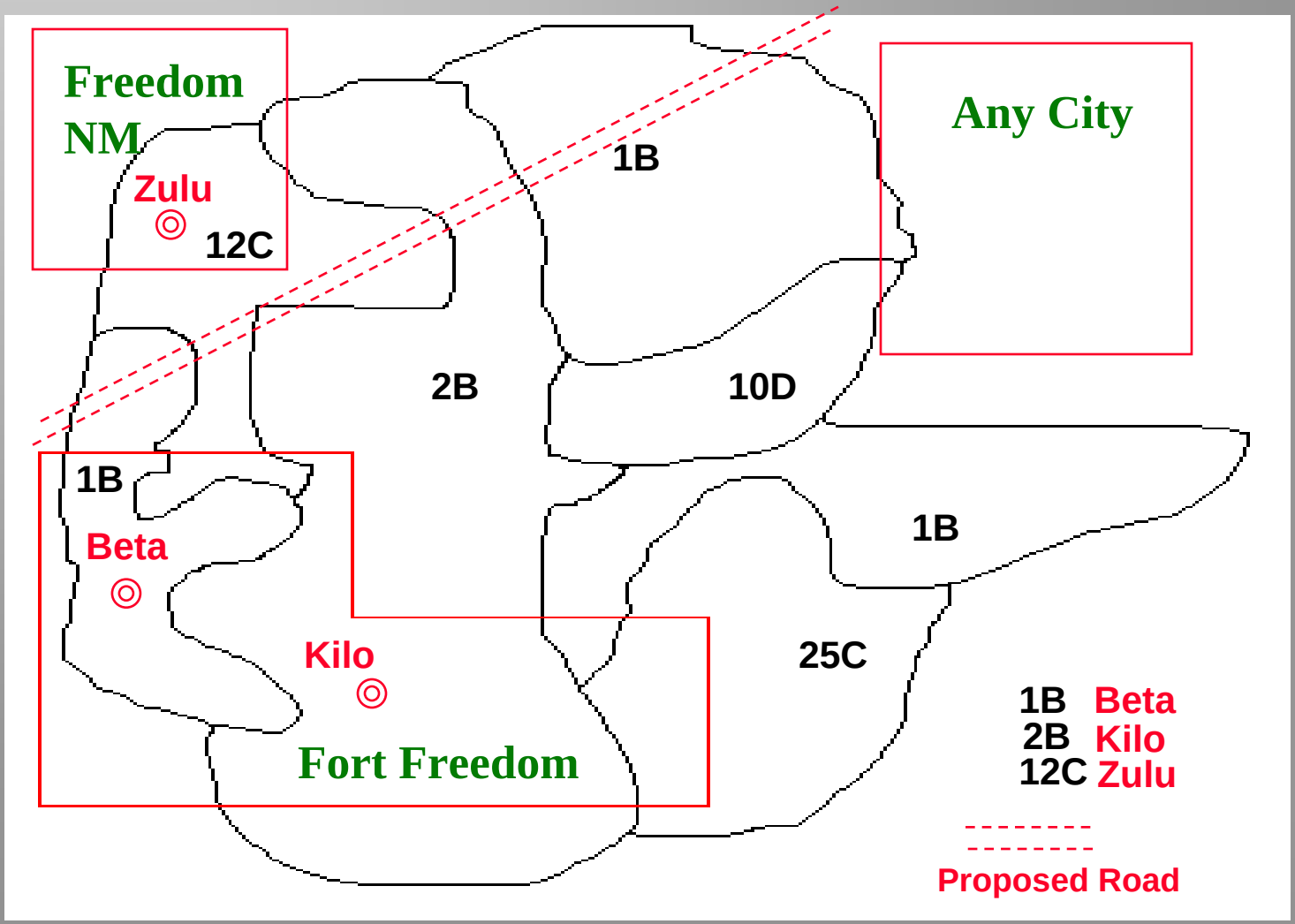
Federal Public Lands (>730 MA)

National Forests and Grasslands (Agriculture) > 200 MA
National Estuarine Research Reserves (Commerce) > 1 MA
Army, Navy, Air Force, Marine (Defense) > 25 MA
National Environmental Research Parks (Energy) > 2 MA
Bureau of Indian Affairs (Interior) > 55 MA
Bureau of Land Management (Interior) > 270 MA
National Wildlife Refuge (Interior) > 90 MA
National Park Service (Interior) > 83 MA

Non Federal Public Lands (50 MA)

State Forests
State Parks
County Parks

After


Freedom NM
Zulu
12C
1B
Any City
2B
10D
1B
Beta
1B
Kilo
25C
Fort Freedom
1B Beta
2B Kilo
12C Zulu
Proposed Road

I WANT YOU
FOR U.S. ARMY
NEAREST RECRUITING STATION

"Me future is settled, Willie. I'm gonna be a perfessor on types of European soil."

Highlights of BLM's Soil Information Needs
Western Regional NCSS Conference
Bill Ypsilantis
June 26, 2000

Introduction

The Bureau of Land Management is committed to working with our partners in the National Cooperative Soil Survey to accomplish our goals in soil and natural resource management. This needs to be on a routine basis throughout the year at all levels of the agencies. Collaboration is needed on a variety of issues that are confronting us. I will touch upon these as I discuss the focus of the Bureau's efforts in soils.

The 264 million surface acres of public lands administered by BLM represents a major portion of real estate in the West. BLM lands encompass the full gamut of ecosystems in the west from frigid arctic and alpine tundra, through lush Pacific rainforests and expansive sagebrush steppe to the torrid Sonoran and Mojave deserts. Correlated to these ecosystems are the equally diverse soils of the public lands of the West.

Issues

The population explosion in the West, cultural value changes, and increased emphasis upon recreational activities has greatly multiplied the demands on public lands. Issues have become increasingly more complex and have come under magnified scrutiny by the public.

Many of the Bureau's high priority issues require accurate and readily accessible soil resource information. For example, rangeland health assessment requires knowledge of soil properties and related ecological site potential to determine current condition status. Likewise, the implementation of guidelines and selection of appropriate management strategies requires site potential knowledge. Forest health concerns about epidemic disease and insect infestation risks require additional information about soil biology and nutrient status.

Restoration of threatened watersheds and habitat for listed species can't be accomplished without understanding the capability and potential of the land. Selection of appropriate restoration techniques and strategies requires soil property and capability knowledge.

Soil information can help determine the ecosystem benefits of restoring natural fire processes. The potential impacts of fire on soil and water resources must be analyzed before implementing prescribed burning programs.

Permit/lease renewal for grazing, oil and gas, and other uses is dependent upon an adequate environmental assessment of impacts to the soil resource. Grazing permit renewal activities have been a major workload the past couple years and soil information has been a key component of this effort.

The risk of spread of invasive plant species on a watershed or sub-basin scale can be predicted using information contained in soil surveys.

Sound soil stewardship including use of BMPs and evaluating water and wind erosion and landslide hazard are essential for compliance with laws and regulations governing water and air quality.

Soil Survey Status

Currently, soil surveys are complete on about 81 percent of public lands in the lower 48 states with approximately 56 percent of the mapped acreage digitized. The individual states have varying proportions of soil survey completed on BLM land from the 100 percent for New Mexico to the 0.1 percent for Alaska. The Bureau has soil surveys completed on over 143 million acres of public land. However, many areas with critical soil information needs remain unmapped, much of the soil survey work in Wyoming is not correlated, and some surveys in other states are outdated or inadequate.

Soil Staffing

The Bureau employs less than 40 soil scientists. Oregon is relatively well staffed with 17 soil scientists. However, some states have one or no soil scientists. Outside Oregon, this represents 1 soil scientist for every 12 million surface acres managed. Obviously, the Bureau lacks soil expertise in many areas and other agencies are also losing soil expertise. One of the options that we may want to look at is developing Regional interagency soil science and technical assistance teams. Interagency sharing of soil expertise on a local level, zoning of soil scientists within BLM, and other innovative options also need to be evaluated.

Investment in Soil Surveys

The Bureau has invested approximately $70-80 million in soil surveys on over 140 million acres of public land. To appreciate the magnitude of this amount of money, it's enough to pave a 4-lane highway the 35 miles from Washington D.C. to the Chesapeake Bay with dollar bills. We also have an additional investment of approximately $300-$400 thousand in digitizing soils on over 80 million acres of public land. However, the way that soil information is being utilized now we are NOT getting our money's worth. Soil surveys are strategically positioned to lead implementation efforts in resource information automation. To fully accomplish this, digitizing soil surveys on an additional 63 million acres must be completed. Automated soil survey databases should be deployed in all BLM field offices. We need to work together to achieve this goal.

Soil Biology

Soil biology is becoming a greater issue with BLM and we need to address this aspect of soils more in our surveys. Last year a small BLM team developed a web site on Soil Biological communities to help educate resource specialists, managers, range users, students, and the public on the crucial role of soil organisms in rangeland health. As a product of the

last Western Regional conference, I refined draft protocols for inventory of biological soil crusts. Perhaps we should adopt a consistent methodology on this across agency boundaries and work together to implement this. We need to know more about correlation of soil biological characteristics to other soil attributes.

Program Emphasis and Direction

The following recommendations were made to BLM managers recently based on issues identified by our field people. Complete soil surveys where vital to support critical resource management issues. The California Desert District and Las Vegas area are examples of public land with increasing pressure from large, rapidly growing populations. Correlate existing soil surveys and enhance outdated or inadequate soil surveys where essential. Wyoming is an example where correlation is sorely needed. Digitize existing soil surveys and link to soil attribute data bases acquired from NRCS. We still have over 60 million acres of existing soil surveys to digitize.

Establish minimal soil expertise workforce levels in the Bureau to support critical issues. Some states have none or only one soil scientist.

Maintain a skilled and highly professional soil scientist work force by promoting training and technology transfer. Training funds have shrunk drastically within the Bureau. The agencies need to work together on soil training and workshops. It helps spread the costs and increases interaction between agency soil specialists. Provide training and technical guidance tools for managers and other resource specialists in use of existing soils information, soil quality assessments, and erosion models. It's important for these individuals to gain a greater understanding of how soils information can improve land management efficiency.

Promote and facilitate development of emerging cost saving technology for soil inventory and soil data set development. A NASA funded pilot project is underway in the California desert to develop an expert system for mapping soils utilizing remote sensing and GIS tools. The MO 2 leader in California is interested in working with BLM to extend this technology onto public land. BLM's NARSC has also been working on similar technology and has utilized it on pilot projects in Utah and Wyoming. The result of our collaboration would be substantial cost savings and improved soil survey reliability. There are many efforts ongoing in this arena that need to coordinate better.

Soil Data Automation

NRCS has developed the Soil Data Viewer and STATSGO browser software for making automated interpretations from the SSURGO and STATSGO soil databases. The software interface could potentially be customized for users such as BLM and modified to make custom queries related to range and forest land management interpretations. BLM is interested in coordinating with NRCS on adapting the Soil Data Viewer to meet our needs. BLM's Service Center in Denver is working on a similar project with the Soil Suitability Extension. This product is more of a simplified approach to automation of soil information

with all parameters set for the user. It is designed for the user with little or no knowledge of soils. These powerful tools can revolutionize how resource information is used in BLM.

NRI

The Bureau's efforts in the Colorado NRI pilot project are ongoing. The purpose of the project was to determine if this method could be used to efficiently and cost effectively provide information to Congress and the public regarding the productivity trends of public lands. Lab analysis of soil samples collected is ongoing. A report is being prepared evaluating the methods used, effectiveness in determining ecological processes and land health, and utility and cost effectiveness of NRI to BLM.

Erosion/Sedimentation Modeling

BLM has organized several Interagency workshops on WEPP. We plan to cosponsor 1 or 2 more workshops in 2001. One area of concern is that there needs to be additional water erosion validation on rangeland. Also, there has been little validation of wind erosion models on rangeland that I am aware of. This might be a worthwhile opportunity for NCSS cooperators to work together.

Summation

The fundamental goal of the Bureau is to maintain the health of the land; the land is soil. So in a very real sense the Bureau's mission is to sustain the soils on public land for present and future generations. I believe that we are entering a new era of soil surveying and soil information technology but we need to work together to attain our goal.

Bureau of Indian Affairs - Yakama Agency
Submitted by Steve Wangemann,
Soil Scientist

Navajo Region Soil Survey Program

The BIA-Navajo Regional Office Soil Survey Program is located in the Land Inventory & Classification Section of the Navajo Regional Office in Gallup New Mexico. (505) 873-8487

The soil survey team is made up of 5 Soil Scientist, 2 Range Management Specialists, 1 Computer Specialist, and 1 Land Inventory Technician.

There are currently 5 active soil surveys on the Navajo Nation. The BIA provides field crews and support for 2 of the active surveys and the NRCS provides field crews and support for the other 3.

Active BIA supported surveys include:

Ft. Defiance Soil Survey (715), 3,210,000 acres, mapping completed with additional data being collected.

Chinle Soil Survey (713), 1,930,000 acres, mapping just starting.

Active NRCS supported surveys include:

Shiprock Soil Survey (717): 1,835,230 acres, mapping completed by NRCS, **Awaiting editing and certification.**

Mckinley County, New Mexico (8692), which includes the Eastern Agency of the Navajo Nation.

Little Colorado Soil Survey (707): 2,240,000 acres, mapping just starting, by NRCS, Flagstaff.

Unfunded survey areas to be scheduled:

Navajo Mountain Soil Survey (711): 2,559,440 acres, not funded

Published soil surveys:

Navajo Indian Reservation San Juan, Utah; 1,336,185 published March 1980, need of update

Additional surveys that include Navajo Lands that occur outside the boundary of the 5 agency area of the Navajo Nation include but are not limited to the following:

San Juan East, New Mexico (8619), published, November 1980, NRCS
Sandoval County Soil Survey (8692), Field mapping completed in for edit.
Rio Arriba Soil Survey (8650), Field mapping completed in for edit.
Cibola Soil Survey (8682); published, March 1993

Certified soil surveys will become part of the Navajo Nation GIS database.

Survey Area WA676:

The Yakama Agency currently has project office responsibility for soil survey area WA676 which covers approximately 1,015,000 acres of range and forest land on the eastern slope of the Cascade Range in Washington State. Mapping was completed by the tribe under a Public Law 93-638 contract but final correlation and certification was not. The BIA-Yakama Agency Soil Scientist has been working with the Portland NRCS-MO staff to bring this survey to completion. The Yakama Nation has an advance copy of the polygon data in their GIS. The BIA soil scientist provides current attribute data for specific projects in a dbf format compatible with ArcInfo.

Survey Area WA678:

The report for Soil Survey Area WA678 was issued in 1976. The BIA has been working with the NRCS-Washington State Soil Scientist to initiate an update of this area. Approximately 141,611 of the 230,000 acre is assessed Operation and Maintenance fees under the BIA-Wapato Irrigation Project. The tribe, through the Yakima River Basin Watershed Enhancement Project, is working on a major renovation of Wapato Irrigation Project infrastructure and improvement in on farm water use efficiency. The soil survey is viewed as one of the most important resource surveys in support this effort.

Soil Survey Activities in the National Park Service

Pete Biggam
Soil Scientist
Natural Resources Information Division
Inventory and Monitoring Program
Denver, Colorado

Mission Statement

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The National Park Service cooperates with various partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

Introduction

From the spectacular mountain ranges and glacier fields of Alaska to the Sonoran deserts of the American Southwest, from the volcanic landscapes of Hawaii to the magnificent barrier islands of the northeastern United States, the National Park Service acts as steward for natural resources that have inspired, awed, and brought enjoyment for more than a century. Responsible for nearly 80 million acres of public land, the National Park Service preserves and protects some of the world's most scenic and important natural resources.

Unfortunately, many National Park Service units are being subjected to a wide variety of impacts. Air pollution degrades the magnificent views of Grand Canyon, while water quality and quantity problems threaten the delicate aquatic ecosystems in Everglades. Many parks today face urban encroachment; many more suffer from the impacts of excessive visitation. Left unchecked, these factors of change could threaten the very existence of many biotic communities within the parks.

In 1991, the National Park Service published its Vail Agenda, a comprehensive strategy for serving America's noble trust into the 21st century. To meet our resource stewardship responsibilities, the

Vail Agenda action plan calls for park managers and superintendents to have solid natural resource information at their disposal.

- Park managers must have comprehensive information about the nature and condition of major biotic and abiotic natural resources placed under their stewardship.
- Park managers need to know how resource conditions change over time.

Only by having reliable scientific information can park managers take corrective actions before those impacts severely degrade ecosystem integrity or become irreversible.

Natural Resource Inventory and Monitoring Program

The Natural Resource Inventory and Monitoring (I&M) Program was established to help prevent the loss or impairment of significant natural resources in more than 265 of the 368 units of the National Park System. Many natural resources in the system are subjected to unfavorable influences from a variety of sources, for example, air and water pollution, urban encroachment, and excessive visitation. Left unchecked, such effects can threaten the very existence of many natural communities in the units.

The principal functions of the I&M Program are the gathering of information about the resources and the development of techniques for monitoring the ecological communities in the National Park System. Ultimately, the inventory and monitoring of natural resources will be integrated with park planning, operation and maintenance, visitor protection, and interpretation to establish the preservation and protection of natural resources as an integral part of park management and improve the stewardship of natural resources by the National Park Service.

The detection of changes and the quantification of trends in the conditions of natural resources are imperative for the identification of links between changes in resource conditions and the causes of changes and for the elimination or mitigation of such causes. Inventory and monitoring provides important feedback between natural resource conditions and management and trigger specific management and evaluation of managerial effectiveness.

Guidelines for the acquisition of natural resource inventories on NPS units are as follows:

- Data collected for each park unit will contain a “core” set of data for universal park planning and management purposes
- All data will be collected and maintained in accordance with clearly defined protocols and quality-assurance standards.
- Data will be compatible for use at ecosystem and other broad levels

Recommended minimal dataset for all natural resource parks:

- Natural Resource Bibliographic Database
- Base Cartography
- Soils

Recommended minimal dataset for all natural resource parks (continued):

- Geology
- Vegetation
- Species Survey and Distribution
- Water Resources/Water Quality
- Air Quality
- Climate

Soil Management Policies

Management Policies and Guidelines for soil resource management are contained in **NPS-77 "Natural Resources Management".** The NPS Management Policies states:

The NPS will actively seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources.

Resource managers, with the assistance of the Inventory and Monitoring Division, will acquire appropriate, detailed soil maps, define the distribution of soil series, determine their physical and chemical characteristics, and provide interpretations needed to promote soil conservation and to guide resource management and development decisions.

Potential impacts on soil resources will be routinely monitored. Management action will be taken to prevent, or if that is impossible, to mitigate adverse, potentially irreversible impact on soils. Conservation and soil amendment practices may be implemented to reduce impacts. Importation of off-site soil or soil amendments may be used to restore damaged sites. Off-site soil will normally be salvaged, but it will not be removed from pristine sites if such actions would impair the ecosystem overall. If off-site materials are used, a soil management specialist will develop a prescription and select materials needed to restore the original native soil physical and chemical characteristics. Caution will be exercised to avoid introduction of nonnative species.

Soil Management Objectives

Soil management objectives follow from the overall resource management objectives in NPS management policies. The objectives are not mutually exclusive, and, typically, more than one objective applies in a given situation. Soil management objectives are as follows:

1. Preserve intact, functioning, natural systems by preserving native soils and the processes of soil genesis in a condition undisturbed by humans.
2. Maintain significant cultural objects and scenes by conserving soils consistent with maintenance of the associated historic practices, and by minimizing soil erosion to the extent possible.
3. Protect property and provide safety by ensuring that developments and their management take into account soil limitations, behavior, and hazards.
4. Minimize soil loss and disturbance caused by special use activities and ensure that soils retain their productivity and potential for reclamation.

Soils Inventory and Mapping Status

In 1997, I&M Program staff assisted parks with identifying soil mapping needs and priorities so that park objectives could be met through appropriate data collection. National Park Service is currently working with the Natural Resource Conservation Service (NRCS) and private contractors to complete Order 3 soil surveys in all parks, except where more detailed surveys are required for park management. All surveys will follow National Cooperative Soil Survey (NCSS) standards, and will be digitized following SSURGO standards.

The Natural Resources Conservation Service has completed soils mapping on survey areas which cover 141 NPS units, and is currently conducting soil surveys that cover 37 NPS units and will continue to support soil mapping until the project is completed.

Soil map digitization has been completed through SSURGO certification and archival on 29 soil survey areas which cover NPS units, with 10 currently in process of being digitized, and an additional 53 surveys planned to be digitized over the next few years.

Future Directions

The National Park Service is committed to continue its relationship with the National Cooperative Soil Survey and its cooperators at all levels.

National Park Service is also involved in evaluating new soil mapping technologies such as “fuzzy logic” and “predictive soil mapping” on park units in Alaska, California, and Tenneesee, where the sheer size of these units lend themselves to utilizing labor saving approaches, while maintaining high quality results.

National Park Service also wants to keep current on the direction the National Soil Information System (NASIS) is heading to ensure it can provide input on development of soil interpretations to meet agency needs.

Soil Survey Status and Priorities for the New Millennium[1]

by

Horace Smith
Director, Soil Survey Division
USDA Natural Resources Conservation Service
Washington, D.C.

I want to thank Ken Kaneshiro, Dr. Chris Smith, and others for inviting me to be a part of this conference. I was able to be on the field trip yesterday and believe me, that was a great experience. The sites that we saw and the discussions that followed in Volcanoes National Park and other areas confirm that we have some unique opportunities and challenges in soil classification, and in developing soil-related technical guides for use by conservationists on these islands and other tropical areas. I spent parts of last week at the North Central and Northeast Conferences. At the North Central Conference, they wanted me to provide a report on the National Conference that convened in St. Louis, Missouri last year, give an update on the status of the National Program, and talk briefly about challenges and priorities for the new millennium. With your permission, I think I will use that same theme here, even though it may vary slightly from the subject printed in your agenda.

The 1999 National Conference

In 1999 the National Cooperative Soil Survey (NCSS) celebrated one hundred years of providing valuable resource information to the American people. Our mission, to help people understand soils, concentrates on the job of providing leadership and service to produce and deliver scientifically-based soil resource information to the United States and the world. During 1999, the Soil Survey Program experienced perhaps its busiest year ever--with numerous programs and activities planned and carried out to celebrate and commemorate the Centennial of the Soil Survey. One of the highlights of these activities was the NCSS Conference that convened in St. Louis Missouri June 17 through July 2, 1999. The theme of the conference was: *Back to the Future – A Centennial Celebration of Service to the Nation.* A few highlights of the conference included:

- A special presentation in honor of Dr. Curtis F. Marbut, native Missourian and second leader (1911–1934) of the NCSS;
- Presentation of the first **NCSS Soil Scientist Of the Year Award;**
- A panel presentation on centennial memories consisting of retirees representing five level of the NCSS;
- Reports from the regional conferences, the National Society of Consulting Soil Scientists (NSCSS), the Bureau of Land Management (BLM), the US Forest Service (USFS), the National Park Service (NPS), and the 1890 land-grant institutions;
- Report on soil survey and related activities in Canada;

[1] Presented at the West National Cooperative Soil Survey Conference, June 26, 2000, Kailua Kona, Hawaii

- Reports from standing committees on *Soil Taxonomy* and new technology, and a final report of the eroded soils committee;
- Topics on deep soil investigations, site-specific management, soil mapping using GIS, expert knowledge, and fuzzy logic technologies;
- Committee breakout sessions: (1) Data acquisition for problem solving, (2) Training and marketing soil scientists for the future, and (3) Selling soil science to society; and
- A task force on soil survey products of the future.

This was an excellent conference. It also included a field trip and many other important topics. I encourage you to read the proceedings of that conference.

Soil Survey Program Status

Although budget and personnel constraints have created challenges, I am happy to report that we are making slow but steady progress in all major areas of the Soil Survey Program. I am particularly pleased with the progress we have made digitizing our soil surveys to Soil Survey Geographic Database (SSURGO) Standards. The following is a brief report on the status of several major areas of the Soil Survey Program:

Mapping	
Total Area	2,313,207,929 acres
• Percent of private land mapped	91
• Percent of public lands mapped	80
• Percent of Indian lands mapped	75
• Percent of total area mapped	90
• Percent of total area updated	4
• Percent of total area in need of updating	41
Manuscripts	
Soil Survey Areas	3,253
• Soil survey areas published	2,539
• Soil survey areas being updated	597
Digitizing	
Number of Surveys Tracked for SSURGO	1384
• Surveys digitized and SSURGO Certified	793
• Surveys certified during FY-99	366

Examples of Products Completed and Distributed in 1999

- Fifty Published Soil Survey Reports and 407 Digitized Soil Surveys (SSURGO) data sets—primary source of soils information for the nation on a county level. This information is distributed nationally to the public through NRCS field offices, libraries, universities and the internet;
- *Soil Taxonomy*, Agriculture Handbook 436--international standard for soil classification for making and interpreting soil surveys. It is used as a university textbook and in over 20 countries, and has become the *de facto* international soil classification system;
- *Revised Field Guide for Describing Soils* (Spanish version is also being finalized in

cooperation with Argentina)--descriptive standard for describing soils in the field and is used nationally and internationally;

- Soil Quality Thunderbook and technical information products--soil quality information sheets and technical notes to increase knowledge of and integrate soil quality into conservation technical assistance;
- Soil Quality Card Design Guide and Soil Quality Test Kit Guide Book--tools for field staff to assist in measuring soil quality locally; and
- *Soil Biology Primer I*—The first in a series of educational materials dealing in soil biology directed to agency field staff and the public.

Personnel and Staffing

At the present time, there are approximately 1,100 soil scientists working in the production phase of the Soil Survey Program—930 employed by NRCS and 70 by other agencies. In a recent analysis of the NRCS workforce, it was determined that 675 of the soil scientists are 45 years old or older; 175 can retire within five years, and 70 can retire now.

As a result of a 1998 workforce planning exercise by NRCS and the goal of trying to maintain diversity, a limited soil science scholars program was established with five 1890 institutions, an Hispanic-serving institution and a Native American-serving institution. The 1890 institutions are Virginia State University, Alabama A&M University, Tennessee State University, Prairie View A&M University, and the University of Arkansas – Pine Bluff.

Staffing at the National Headquarters (NHQ) has not changed much. Dr. Sheryl H. Kunickis, the newest addition to the staff, reports July 5th as a soil scientist (landscape analyst). She will have national leadership for the development of new and innovative approaches to integrating natural resource data with soils information for landscape analysis and landscape modeling to meet the needs of field operations and clients. The National Soil Survey Center (NSSC) has been reorganized with Dr. Robert Ahrens being named director and the creation of five functional areas: 1) Soil Survey Laboratory (Dr. Dewayne Mays, Head); 2) Soil Survey Investigations (Dr. Carolyn Olson, National Leader); 3) Soil Survey Interpretations (Dr. Berman Hudson, National Leader); 4) Soil Survey Technical Services (James Culver, National Leader); and 5) Soil Classification and Standards, (vacant, National Leader). Dr. Craig Ditzler is the director of the Soil Quality Institute (SQI). Other personnel associated with the SQI have remained stable.

Budget

The amount budgeted for soil survey operations in FY-2000 is $78,323,000, the same as it has been for the last 3 years. About 18 percent of this budget supports agency-wide functions such as Global Climate Change research, management and support for the National Soil Information System (NASIS), support for the NSSC and the SQI, other national initiatives, and the procurement of national digital orthophotography and aerial photography. The remaining $63,464,700 is allocated to the 50 states and two territories for soil survey production mapping and services.

International Activities

The NCSS has major responsibility for making and interpreting soil surveys. Both of these activities require tools, both physical and conceptual, and a determination to ensure that the information is current, reliable, and designed to meet current and future needs of the NCSS and its customers in general. As leader of the NCSS, the NRCS has traditionally accepted the charge of being the repository for global soil resource information. The reason for this is that our linkages with sister organizations in other parts of the world have benefited our domestic Soil Survey Program tremendously. Soil survey standards developed by the NCSS such as *Soil Taxonomy, Soil Survey Manual, National Soil Survey Handbook,* etc., are used and continually tested by countries around the world. Our standards are used and referenced throughout the world and have been tested in all soil and climatic conditions, which strengthens our domestic program.

During the year, our budget that supports international travel was severely reduced due to the Agency's overall budget shortfall. This has frustrated some of our scientists, as they have been forced to cancel some important trips. Some individuals have gone as far as to question whether or not we are still committed to a strong international component within the NCSS. We are as committed as ever to maintaining and strengthening the international component of the NCSS. We continue to host visiting scientists and sabbaticals from foreign countries at the NSSC and the SQI. We will continue to be actively involved, within the limits of our budget, in global activities that support the objectives and priorities of the NCSS. To do otherwise would be foolish. Collaboration with the international community strengthens the overall Soil Survey Program; however, in an era of public scrutiny and accountability, all activities must be totally justified.

NASIS

NASIS is a comprehensive information system for collecting and managing soil data and distributing soils information. NASIS software is installed at all 17 MLRA Offices plus the NSSC. The system is providing services to about 950 soil scientists from NRCS USFS, BLM, Bureau of Indian Affairs (BIA), NPS, and several universities at a wide variety of locations—from soil survey project offices to NHQ. NASIS 5.0 is scheduled to be released November, 2000. The biggest change for this version is the implementation of a central server. Windows Pedon 1.0 is schedule to be released in August 2000 and will facilitate importing field descriptions to NASIS.

Special Projects and Investigations

During the past several years, we have made tremendous progress leveraging a few dollars in support of special initiatives of the NCSS, mainly monitoring projects relating to wet soils. Data from these projects are being used to update and refine several soil series; better understand the hydrology of some soil systems; and refine the hydric soil status of some soils. We are phasing out some of the wet soil monitoring projects that were started more than 10 years ago. We will continue to support some of those projects, especially those in areas where we still have severe data gaps relative to Hydric Soil Indicators.

Soil Science Institute

The Soil Science Institute is a very intense four-week training course for mid-career NCSS soil scientists who are mostly involved in production soil survey. The course updates participants in all phases of soil science and introduces them to new, innovative and cutting-edge topics. In previous years, the Institute has been held at Cornell University, Iowa State University, University of Florida, Texas A&M University, North Carolina State University, and University of California, Davis. This year the Institute was held at Alabama A&M University. Course evaluations and other feedback from participants indicate that it was a very successful session.

NCSS Soil Scientist Awards

During 1999--the Centennial Year of the Soil Survey Program--two awards were established by the NCSS to honor soil scientists who were making or had made unusual contributions in the production phase of the NCSS. These two awards are **NCSS Soil Scientist of the Year** and **NCSS Soil Scientist Achievement**. Recipients for the NCSS Soil Scientist of the Year and Soil Scientist Achievement awards in 1999 were Dr. Sam Indorante, Major Land Resource Areas (MLRA) Project Leader, NRCS, Carbondale, Illinois; and Dr. Ed Redmond, Resource Soil Scientist, NRCS, Mt. Vernon, Ohio, respectively. The 2000 recipients for these awards are Marcus Clark, Soil Survey Project Leader, NRCS, Palmer, Alaska and Bill Dollarhide, State Soil Scientist/MLRA Leader, NRCS, Reno, Nevada. I want to congratulate these scientists and commend them for the outstanding contributions they are making to the NCSS.

Priorities and Initiatives for the New Millennium

Implement Super MLRA Project Offices

I believe the keystone of the field portion of the Soil Survey Program of the future will be the "Super MLRA Project Offices". I use the term "Super" for the lack of a better word. All I am talking about is fewer and better-equipped soil survey project offices. We can no longer afford to equip and maintain one- and two-person project offices. Illinois has taken the lead in implementing this concept. Several other States have also moved forward with the idea. I believe the Super Project Office will:

- Enhance a safer and more professional environment for soil scientists working in the field;
- Make it easier and more economical to install and maintain the latest computers, digitizing and GIS equipment, Global Positioning Systems, Digital Orthophotoquads, Digital Elevation Models, Satellite Imagery, etc;
- Provide an opportunity to locate on university campuses where possible—some could be small institutions or community colleges. The university's internet could be utilized and students could be employed part time;
- Provide an excellent opportunity to utilize the MLRA concept by locating offices in areas without regard to State, county of other political boundaries; and
- Attract and maintain a highly qualified staffs and provide an opportunity to employ specialists other than soil scientists such as GIS experts, foresters, soil conservationists, etc.

Emphasis Areas for 2001 and the Near Term

- Hire diversified cadre of soil scientists;
- Develop a diversity of products that support NCSS priorities and meet customer expectations;
- Continue to accelerate NASIS and SSURGO development;
- Implement the Super MLRA Project Office concept;
- Implement digital map finishing;
- Develop use-dependent or dynamic soil properties database;
- Update Agriculture Handbook 296: *Land Resource Regions and Major Land Resource Areas of the United States* publication and STATSGO;
- Emphasize technical soil services and urban interpretations;
- Support the development and utilization of expert knowledge systems—ones that can make decisions—at the field level;
- Continue to employ Fuzzy Logic in generating soil survey interpretations and in other areas of the Soil Survey Program;
- Emphasis the application of GIS to landscape modeling, especially as it relates to the update process;
- During the update process and in the remaining once-over soil survey projects, emphasize making observations to depths >2m, or to whatever depths that are needed;
- Develop web-based applications for delivering soil survey data and products;
- Increase soil survey mapping on American Indian lands;
- Continue to emphasize and support the subaqueous soils research initiative that was initiated by the University of Maryland and NRCS in Maryland;
- Continue to play a major role in the National Soil Phosphorus Benchmark Study in cooperation with the Agricultural Research Service, Environmental Protection Agency, and others. This study has pilots in Virginia and Colorado and will involve some MLRA Soil Survey Offices in selected locations;

2002 Budget Initiative

The Agency is proposing a budget initiative of $18.55 million for 2002. The main purpose of this initiative is to start rebuilding the soil science infrastructure at the field level. The initiative will be used to:

- Add 150 new soil scientist positions;
- Accelerate mapping of private lands;
- Accelerate mapping in urban and urban-fringe areas and develop urban interpretations;
- Continue to accelerate the development of NASIS and the SSURGO initiative;
- Accelerate implementation of the MLRA concept field structure;
- Accelerate development of web-based applications to manage, achieve, and deliver soil survey data and products.

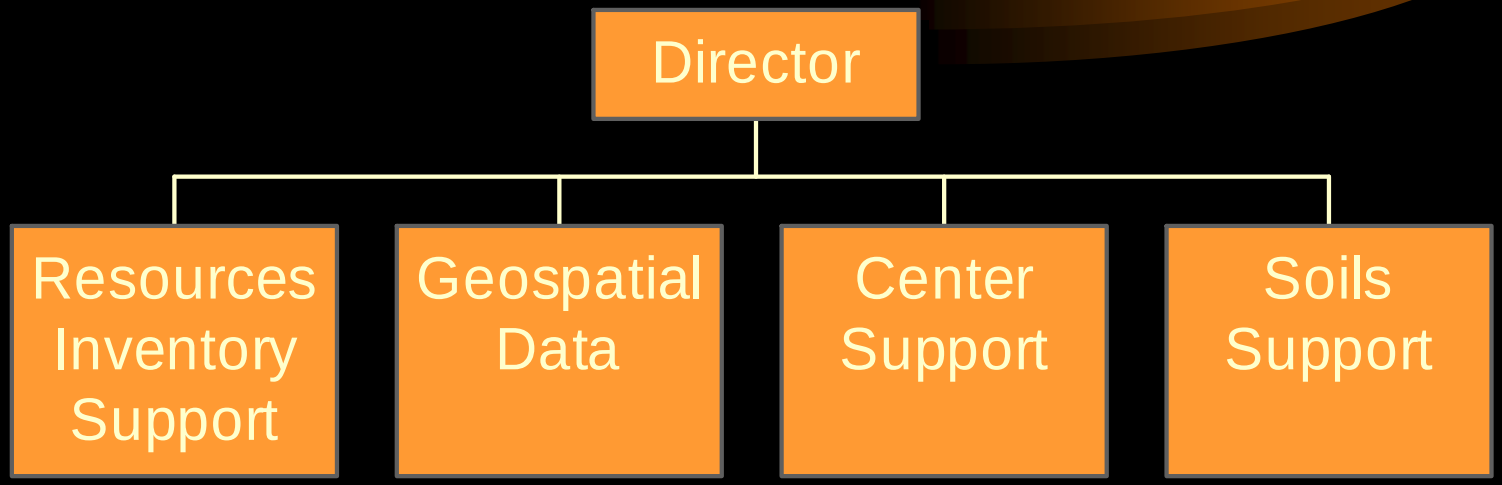
Thank you again for allowing me to be a part of your conference. I will be with you during the entire week.

USDA NRCS

Natural Resources Conservation Service

National Cartography and Geospatial Center

Organizational Chart



Mission

- Mapping and spatial data center for NRCS
- Support regional offices and states
- Provide services, products, and leadership
  - Cartography
  - Natural resources data access and distribution
  - Geospatial data base development
  - Assistance in map finishing, SSURGO QA & archiving, and publishing soil surveys

Map Products and Services

- Digital Imaging
- Modern Mapping
- Global Positioning Systems
- Geographic Information Systems
- Remote Sensing
- Natural Resources Data Collection and Analysis
- World Wide Web Coordination
- Data Archive and Distribution

National Cartography and Geospatial Center

- Renewed Emphasis on Customer Satisfaction
- Target NRCS State Partnership Needs
- Serve Service Centers (Field Offices)

National Cartography and Geospatial Center

- YOUR CARTO & GEOSPATIAL CENTER
  - “TASTE IT AGAIN FOR THE FIRST TIME”

Ordering Products and Services

- Prototype in development which will:
  - Enable online interactive order placement
  - Report order progress and status
  - Report services provided
- Transition phase CARTO-19 to ONLINE
  - Telephone call into NCG contact
  - Enter directly via web

DIGITAL MAP FINISHING KEY TASKS

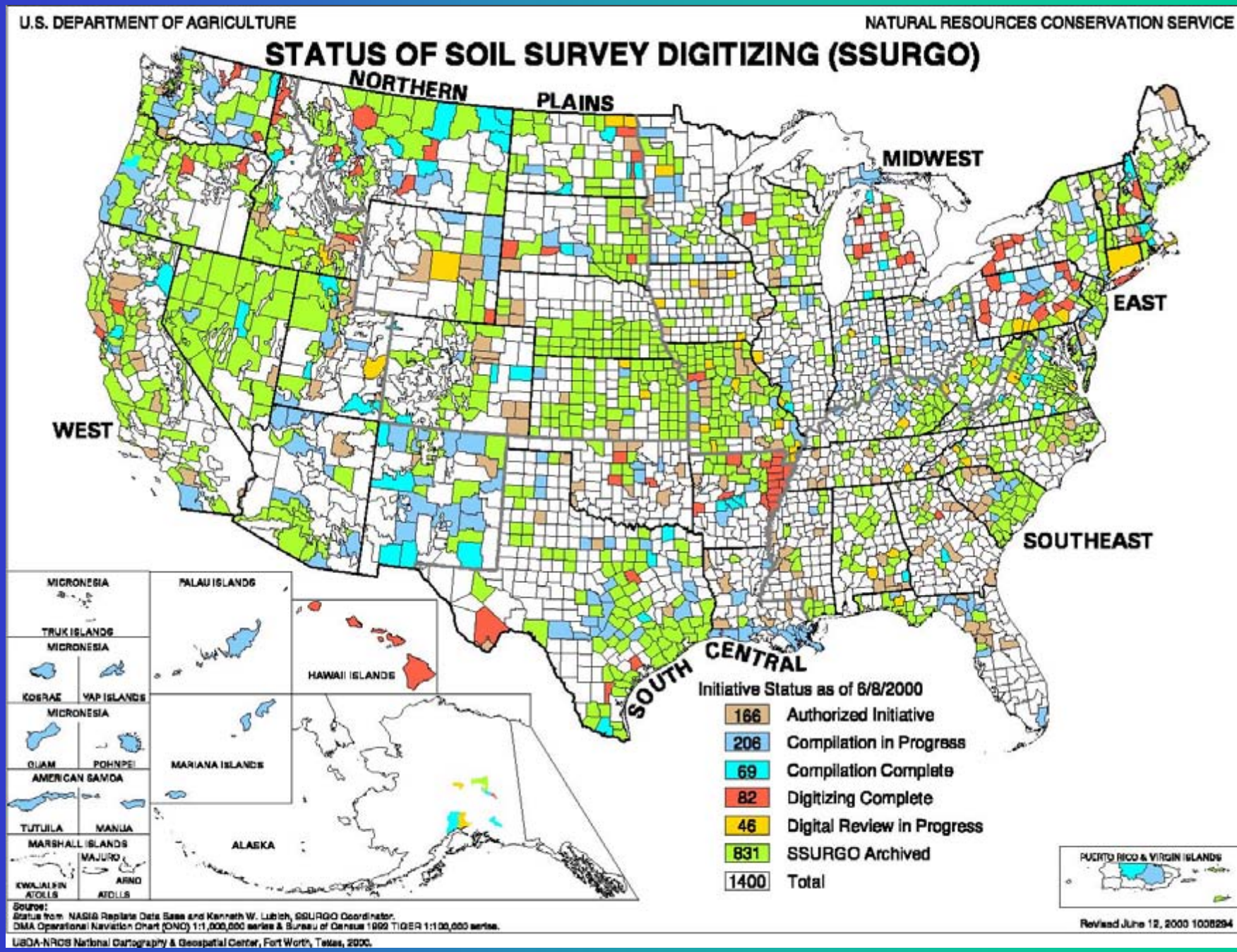
June, 2000

West NCSS Work Planning Conference

Tommie Parham

National Cartography and Geospatial Center

DMF SITES KEY TASKS


U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STATUS OF SOIL SURVEY DIGITIZING (SSURGO)
NORTHERN
PLAINS
MIDWEST
EAST
WEST
SOUTHEAST
SOUTH CENTRAL
MICRONESIA
TRUK ISLANDS
MICRONESIA
KOSRAE
YAP ISLANDS
MICRONESIA
GUAM
POHNPEI
AMERICAN SAMOA
TUTUILA
MANUA
MARSHALL ISLANDS
MAJURO
KWAJALEIN ATOLLS
ARNO ATOLLS
PALAU ISLANDS
HAWAII ISLANDS
MARIANA ISLANDS
ALASKA
Initiative Status as of 6/8/2000
166 Authorized Initiative
206 Compilation in Progress
69 Compilation Complete
82 Digitizing Complete
46 Digital Review in Progress
831 SSURGO Archived
1400 Total
PUERTO RICO & VIRGIN ISLANDS
Source:
Status from NASIS Replicate Data Base and Kenneth W. Lubich, SSURGO Coordinator.
DMA Operational Navigation Chart (ONC) 1:1,000,000 series & Bureau of Census 1992 TIGER 1:100,000 series.
Revised June 12, 2000 1008294
USDA-NRCS National Cartography & Geospatial Center, Fort Worth, Texas, 2000.

USDA-NRCS-NCGC

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

NRCS DIGITAL MAP FINISHING SITES AND THEIR JURISDICTION

PORTLAND

BOZEMAN

RENO

INDIANAPOLIS

COLUMBIA

NASHVILLE

FORT WORTH

MICRONESIA

TRUK ISLANDS

MICRONESIA

KOSRAE

YAP

MICRONESIA

GUAM

POHNPEI

AMERICAN SAMOA

TUTUILA

MANUA

MARSHALL ISLANDS

KWAJALEIN ATOLLS

MAJURO ATOLLS

ARNO ATOLLS

PALAU ISLANDS

MARIANA ISLANDS

HAWAII

ALASKA

PUERTO RICO & VIRGIN ISLANDS

Digital Map Finishing Sites

- National Cartography & Geospatial Center, Fort Worth, Texas
- Indianapolis, Indiana
- Bozeman, Montana
- Columbia, Missouri
- Reno, Nevada
- Nashville, Tennessee
- Portland, Oregon

SOURCE:
DMA Operational Navigation Chart (ONC) 1:1,000,000 series and Bureau of the Census 1992 TIGER line files, and information from NRCS field personnel. Albers Equal Area Projection, NAD27.

DECEMBER 1999 1008515

Receive all publication data layers in DLG-3 format from the S.O.

↓

Download SSURGO data from an NCGC *ftp* site and process ALPs once all DLGs are in place

↓

Perform Digital Map Finishing on all quads in a SSA

↓

Edit all quads in SSA, including labels, moving text, etc.

Create set of final checkplots on all quads and perform final edit of map interior and marginalia

Submit final checkplots to SO for review and signing or co-signing of map finishing quality assurance letter

Create postscript files for all quads. Copy workspaces, Metadata and DLGs to tape or deliver via NCGC *ftp* site. Submit to NCGC for review (with a copy of final checkplots.

NCGC KEY TASKS

DEVELOP DMF PROCESS PROCEDURES, TRAINING, AND SUPPORT DMF SITES

DEVELOP DMF PROCESS PROCEDURES

- Developing transition to NT system
- Latest Release of Software May, 2000
  - Eliminate marginal overprinting
  - Installed new editing tools
  - Automated postscript file generation

Receive all postscript files/workspaces and metadata written to tape or NCGC FTP site from MFS

Review final checkplots (10% edit review)

If problems arise

Submit materials to DMFS for correction

IF okay

Generate final publication negatives and register to image

Forward maps to contract printer through GPO

Additional NCGC Tasks

Coordination with National Production Support Service staff on readiness of manuscript

Coordination with MLRA, DMFS, and S.O. on maps & manuscripts, and photobases

Coordinate Edits

STATE OFFICE KEY TASKS

Acquire field imagery and submit to Soil Survey Office for progressive soil survey

Determine publication format of SSA, as well as ortho publication base

Determine layers to be represented in final publication

Assess availability of existing digital data for use in map finishing and determine map compilation needs

If not suitable, compile all needed layer(s) from ortho publication base onto separates with soils

SSURGO process

Scan and/or manually digitize all publication layers

Process and place in DLG-3 format. Review final checkplots from DMFS and sign or co-sign map finishing quality assurance letter

Run DMF validation routines and prepare metadata

DMF Options to Generate DLG-3 Files

- DMFS will set the standards for delivery of data to their location.
- This will involve a combination of state-created DLGs, compiled ancillary data for scanning and editing.
- Culture data should be digitized, not compiled !!

DMF Options to Generate DLG-3 Files

- ADDITIONAL OPTIONS MAY INCLUDE:
- Train SO staffs to edit scan files and correctly provide DLG-3 format for ancillary layers
- Partner with Digitizing Centers to generate DLG-3 ancillary layers
- Fund DMF sites time to convert ancillary layers to proper format

If suitable, generate checkplots, edit where needed and register to ortho base

Prepare data in DLG-3 format

Prepare metadata. Send all publication data layers in DLG-3 format to selected DMFS.

MLRA OFFICE KEY TASKS

Coordinate the development of soil survey manuscripts and publication maps to ensure proper scheduling

Coordinate with state and DMF site on data layers and publication base to be represented in final publication

Performs 10% QA review of state check plots and sign or co-sign map finishing quality assurance letter and return

Publication Options - Hardcopy

- Traditional Publication
  - Wrap Around Cover
  - Expando Jacket
- Loose Leaf Publication
- Print on Demand

Possible Publication Options

Maps in Acrobat *pdf* Format

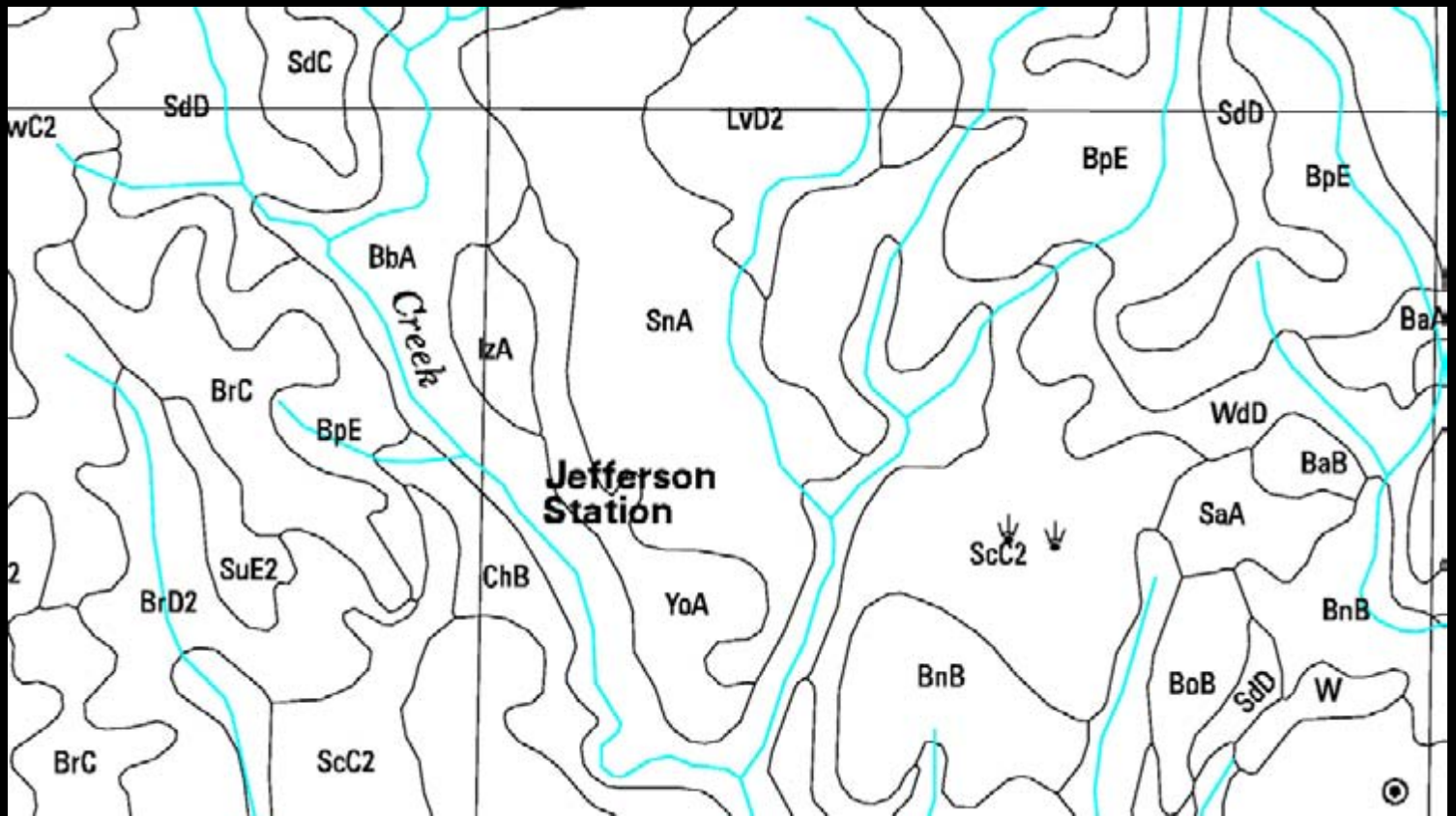
Publish Soil Surveys on CD-ROMs

key will be

Digitally Map Finished

NCGC - Soils Support Branch Digital Map Finishing

- ‘pdf’ without Digital Ortho Quadrangle backdrop
- Matches what will be published

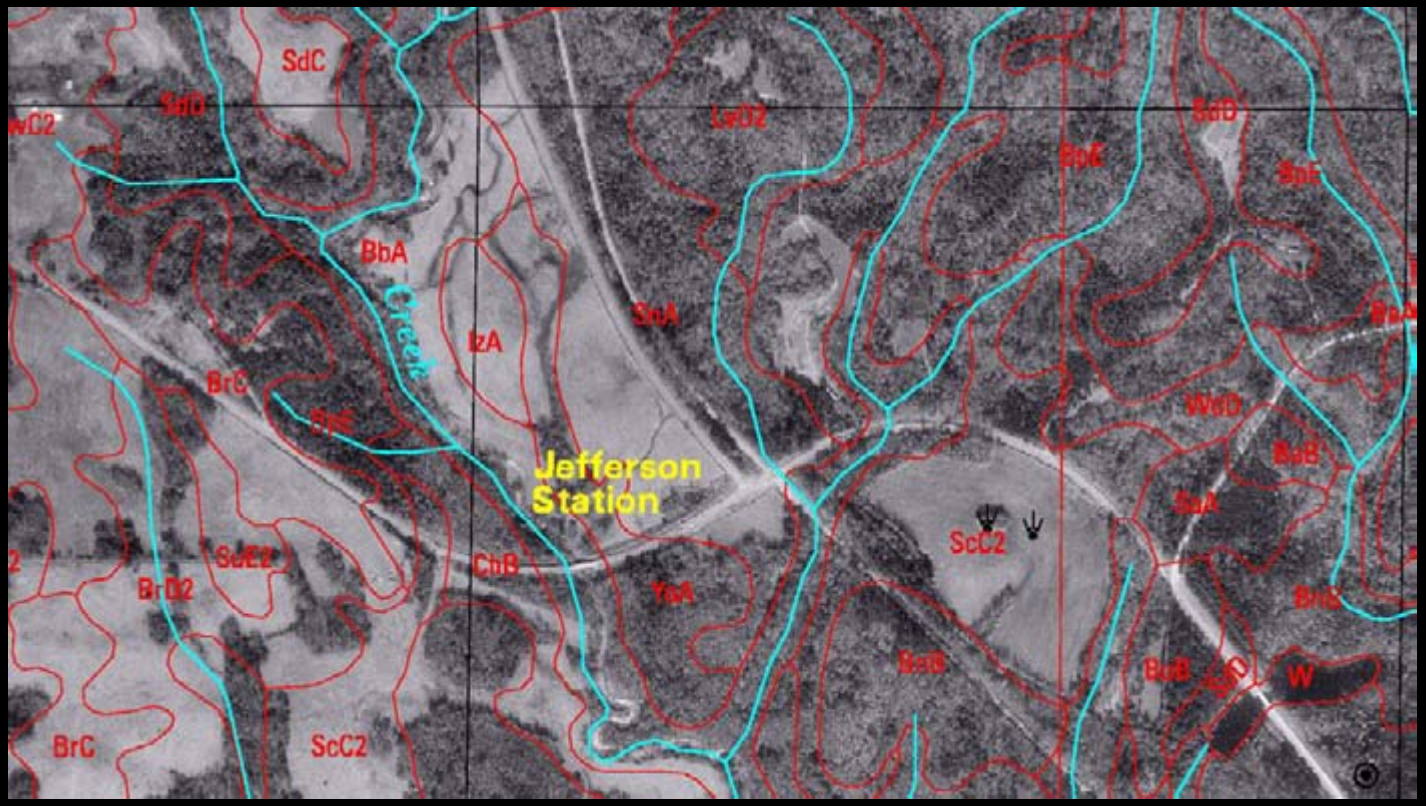


Possible Publication Options

- Use Digital Ortho Quadrangle (DOQ)
- Panel Map to Retain Original Scale
- Select Just Desired Map Area
- Print on 8.5” x 11” Paper

NCGC - Soils Support Branch Digital Map Finishing

- ‘pdf’ with Digital Ortho Quadrangle backdrop
- Enhancement to line color



The End…

Nitrate Adsorption in Soils with pH-Dependent Charge

Goro Uehara, Jonathan Deenik and Chris Smith

The use of surface charge characteristics as differentiating criteria to categorize soils into behavioral and performance classes is largely based on the premise that mineral surfaces are net negatively charged. We need a set of criteria that will do the same for soils with significant amounts of positive charge. Before we define what we mean by a significant amount of positive charge, it is first necessary to ascertain whether new criteria to accommodate such soils are needed.

Soils with pH-dependent charge

The charge on soil particles is either of the constant or variable charge type. If it is of the constant charge type, the sign is for all practical purposes, negative. On the other hand, if it is on the variable charge type, the sign can be negative, zero or positive depending of pH and the zero point of charge. The Andisol, Histosol and Oxisol soil orders are mainly composed of variable charge materials. In all three soil orders, surface charge is pH-dependent. The surface charge on variable charge material remains net negative so long as soil pH is higher than the zero point of charge. The zero point of charge of organic matter is below pH3. For this reason Histosols and organic matter are for all practical purposes, always net negatively charged. A point not always appreciated is the tendency of soil pH to migrate to the pH of the zero point of charge. For this reason, under intense leaching, pH tends to decrease in organic materials. The zero point of charge of hematite is pH 8.5 (Parks and De Bruyn, 1962) so that Oxisols can maintain relatively high pHs even when intensely leached. In a mixture of organic matter and hematite, the zero point of charge reflects the material with the largest surface area (Uehara, 1995). In soils high in iron oxides, pH increase with depth because organic matter content decreases and the zero point of charge increases. The pH is higher in the subsoil even though the sum of bases is lower there than in the organic rich surface horizon. In variable charge systems, soil pH is often better correlated to the zero point of charge than to base saturation. In fact, application of constant surface charge principles to soils with variable charge makes it virtually impossible to predict soil behavior and performance.

In addition to the Andisols, Histosols and Oxisols, several groups of soils frequently fall in the variable charge category. Soil materials with low CEC clay (<24 cmol/kg) are likely to be of the variable charge type. Ultisols materials frequently fall in this category. Spodic horizons are also high in variable charge materials. But the most compelling reason for distinguishing high positive variable charge from constant charge materials is that the former tend to occur in clusters making them difficult to ignore. The state of Hawaii is such a place. In fact the entire Big Island of Hawaii is mantled with variable charge materials.

Examples of soils with variable charge

The best examples of soils with variable or pH-dependent charge in the State of Hawaii are found on the Island of Kauai. These soils are best developed there because Kauai is the oldest of the major islands and also because the Island has a large area covered by a low silica, readily weatherable basic rock. The total chemical composition of a soil weathered from this rock is shown in table 1. Selected chemical properties of the same soil are given in table 2.

A telling feature of this soil is its low total silica content. The higher silica content of the surface horizon is attributable to biologically recycled silica (phytoliths) and to tropospheric quartz particles blown in from the Gobi desert of China. Sugarcane grown on these soils responds to calcium silicate application. Silicon is considered an agronomically essential element for many members of the grass family. Properly managed these soils are highly productive and are prized for their outstanding physical properties.

From table 2, it is clear that the materials in the first two horizons are net negatively charged, but are net positively charged in the lower horizons. Generally, the pHs in water and KCl increase with depth, but in this case only the latter do so. We believe the low pH in the subsoil is related to the high amount of sulfate adsorbed. Adsorbed sulfate neutralizes positive charge and shifts the zero point of charge to lower pHs. In these soils silicate and phosphate ions are even more strongly adsorbed, and when added in large quantities to such soils, can measurably increase cation exchange capacity (Mekaru and Uehara, 1972; Gillman and Fox, 1980). In this particular soil, the last 1.5m of the soil has 11 to 14 cmol/kg of adsorbed sulfate, but still registers a net positive charge indicating it still can adsorb more anions.

In table 3 we have a similar soil but with less adsorbed sulfate. The pH in water and INKCl increases with depth even though the sum of bases decreases to near zero. As stated earlier, in these and similar soils, soil pH is determined not so much by base saturation but by the zero point of charge. Like the glass electrode of a pH meter, the potential on a particles in variable charge soils varies according to the Nernst equation

$$\Phi = (kT/e)\ln(H^+/H^+o) \quad (1)$$

where Φ = surface potential in volts
R = Boltzman constant
T = absolute temperature
e = election charge
H^+ = hydrogen ion concentrion
H^+o = hydrogen ion concentration at the zero Point of charge or isoelectric point

Equation 1 can be rewritten as:

$$\Phi = (kT/e)2.303(pH_o - pH)$$

In variable charge soils, there is a natural tendency of pH to approach pH_O so that Φ approaches zero. Mattson (1928), a Swedish scientist working with synthetic iron and aluminum oxides referred to this phenomenon as isoelectric weathering.

Data in tables 1, 2, and 3 are from Oxisols. In table 4, the data are from an Andisol. It turns out that anion adsorption can occur even in soil materials that are net negatively charged.

Chemistry of variable charge materials

The pH-dependence of variable charge soil materials can be described by the equation (Uehara and Gillman, 1980),

$$?? = 1.67 \times 10^{-6}\ n^{1/2}\ (pHo - pH) \quad (2)$$

where: ?? = net variable charge in esu/cm^2
n = electrolyte concentration in number if ions per cm^3
pH_o = zero point of net charge or isoelectric point

According to equation 2, the charge on a soil material will be net negative if pH > pH_o, net positive if pH < pH_o and net zero if pH = pH_o. When pH = pH_o and ?? = o, the soil material retains equal quantities of anions and cations.

The pH of the iron oxide hematite is about 8.5. An Oxisol rich in hematite will be net positively charged if soil pH is below pH_o. Since soil pH tends to shift towards pH_o with leaching, organic rich horizons tend to be acid and oxide rich horizons tend to be less acid.

Equation 2 also predicts that if salt concentration n is increased, pH will decrease if pH > pH_o, increase if pH < pH_o and remain unchange if pH = pH_o. The change in pH or delta pH (Δ pH),

$$\Delta pH = pH\ (H_20) - pH\ (KCl) \qquad (3)$$

can therefore be used to determine the sign of the charge on a soil material. In equation 3, pH (H_20) refers to the suspension pH measured in water and pH (KCl) is the pH measured in KCl.

Equation 3 holds so long as the salt is an indifferent electrolyte. If the salt is not an indifferent electrolyte such as $CaCl_2$ or K_2SO_4, the ΔpH will vary with the salt. For example, a ΔpH that registers zero with KCl will be positive with K_2SO_4 and negative with $CaCl_2$. This occurs because Ca^{++} and $SO_4{}^{=}$ are not indifferent ions and are specifically adsorbed. When calcium and sulfate ions are specifically adsorbed they respectively shift the zero point of charge to higher and lower pHs by neutralizing negative and positive variable charges. The capacity of $K_2\ SO_4$ to detect positive charge not seen by KCl can be exploited as an indicator of materials with significant amounts of positive charge.

Nitrate adsorption

The nitrate ion is repelled (negatively adsorbed) by a net negatively charged surface. Since most soils are net negatively charged and are cation exchangers, the nitrate ion leaches rapidly from soils and enters ground water, streams and lakes.

In variable charge soils with significant amounts of positive charge, the arrival of nitrate in ground water, streams and lakes may be delayed for many years. For example, Deenik (1998) measured KCl extractable nitrate in the vadose zone underlying Oxisols and Ultisols on the island of Oahu which have been under pineapple production for nearly a century and found up to 11 tons of absorbed nitrate nitrogen per hectare. (see fig. 1). Even in the high rainfall zone, the nitrate was retained within 25 meters of the soil surface. Nitrate adsorption capacity determinations indicate that in the deeply weathered, high rainfall zone, capacity for more nitrate adsorption still exists. In the drier low elevation zone, the variable charge material abruptly ends at shallow depths and weathering of basaltic rock produces smectite. It is likely that in this drier zone the nitrate retention capacity has been reached and excess nitrate is entering the ground water.

What would be helpful is a simple measurement that marks a material as a nitrate adsorber. It would be better still if an existing measurement could be used, for this purpose.

Criterion for nitrate adsorption potential

In 1972, Mekaru and Uehara (1972) measured ΔpH of a range of soils from Hawaii using both INKCl and INK_2SO_4. As expected, the number of positive and zero ΔpHs was higher when K_2SO_4 was used as the salt.

If we plot ΔpH by KCl against ΔpH by K_2SO_4 (see fig. 2) we obtain a straight line in which zero ΔpH by K_2SO_4 coincides with a ΔpH by KCl of about -0.5. Since pH with INKCl is a commonly measured quantity and K_2SO_4 is not, a ΔpH of - 0.5 or higher computed from INKCl pH can be used to identify soil materials with significant amounts of positive charge.

Since positive ΔpHs are sometimes encountered in saline soils, they should not be used for soil interpretation in saline or in soils with high activity clays.

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Table 1. Total Chemical Analysis of Pooku Silty Clay

Depth (cm)	S_1O_2	T_1O_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI*
				%						
0-38	8.5	8.9	31.3	45.5	--	--	0.06	0.23	0.70	5.0
38-48	2.9	8.0	20.6	48.2	--	--	0.07	0.23	0.63	19.7
48-75	1.0	8.3	20.8	46.4	--	--	0.07	0.10	0.60	20.5
75-100	0.4	7.3	28.5	42.3	--	--	0.07	--	0.61	20.7
100-155	0.4	6.8	30.1	41.3	tr	--	tr	--	0.64	20.2
155-225	0.6	7.1	31.1	40.9	tr	--	tr	--	1.18	19.4

*Loss on Ignition

Source: SCS, Staff, 1976.

Table 2. Selected data from Pooku silty clay

Depth (cm	OC %	Sum of bases (cmol/kg)	Extr. SO_4= (cmol/kg)	pH (H_2O)	pH (INK Cl)	?pH
0-38	3.88	1.3	1.6	5.2	4.2	-1.0
38-48	2.43	0.2	5.0	4.7	4.4	-0.3
48-75	1.58	0.6	6.5	5.0	5.1	+0.1
75-100	1.10	Tr	11.3	4.8	5.3	+0.5
100-155	0.60	0.5	14.5	4.8	5.4	+0.6
155-225	0.16	0.1	14.4	4.9	5.3	+0.4

Source: Staff SCS, 1976

Table 3. Selected data from Makapili silty clay

Depth (cm)	OC %	Sum of Bases (cmol/kg)	Extr. SO_4 (cmol/kg)	pH (H_2O)	pH(INK Cl)	?pH
0-25	4.53	4.3	0.6	5.9	4.6	-1.3
25-33	2.31	1.7	1.7	5.4	4.9	-0.5
33-53	1.83	1.4	1.7	5.5	5.3	-0.2
53-83	1.53	1.0	0.9	5.9	5.7	-0,2
83-123	0.82	0.3	2.0	6.0	6.2	+0.2
125-163	0.57	0.2	1.5	6.0	6.4	+0.4

Source: Staff SCS, 1976

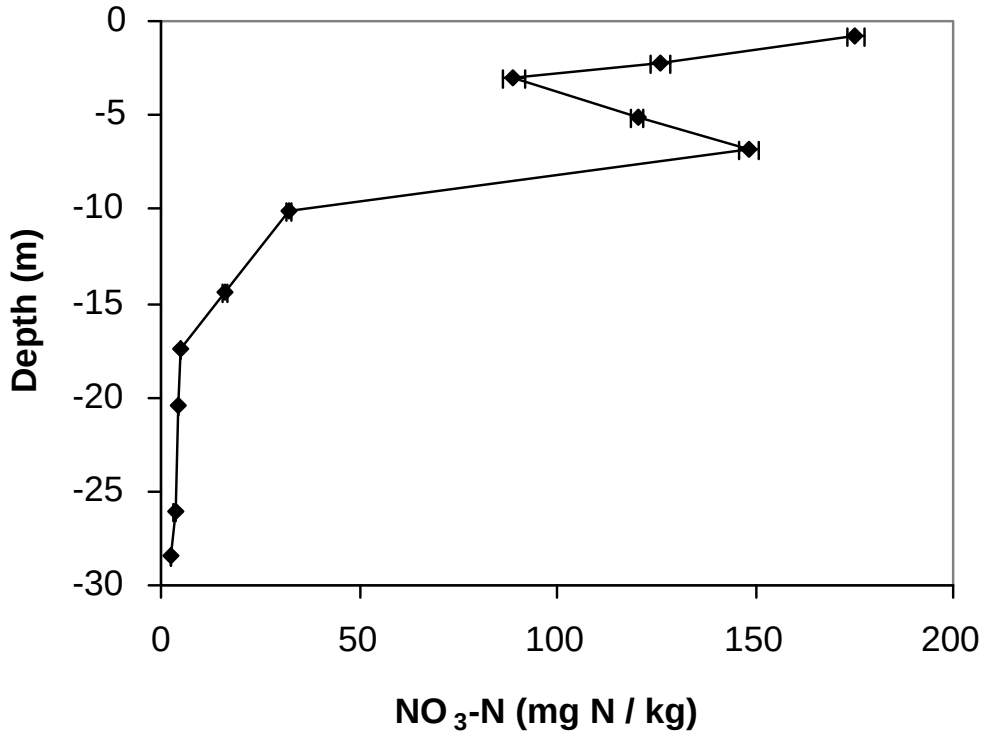

Figure 1. Nitrate-N in borehole #4101 (Wahiawa series).

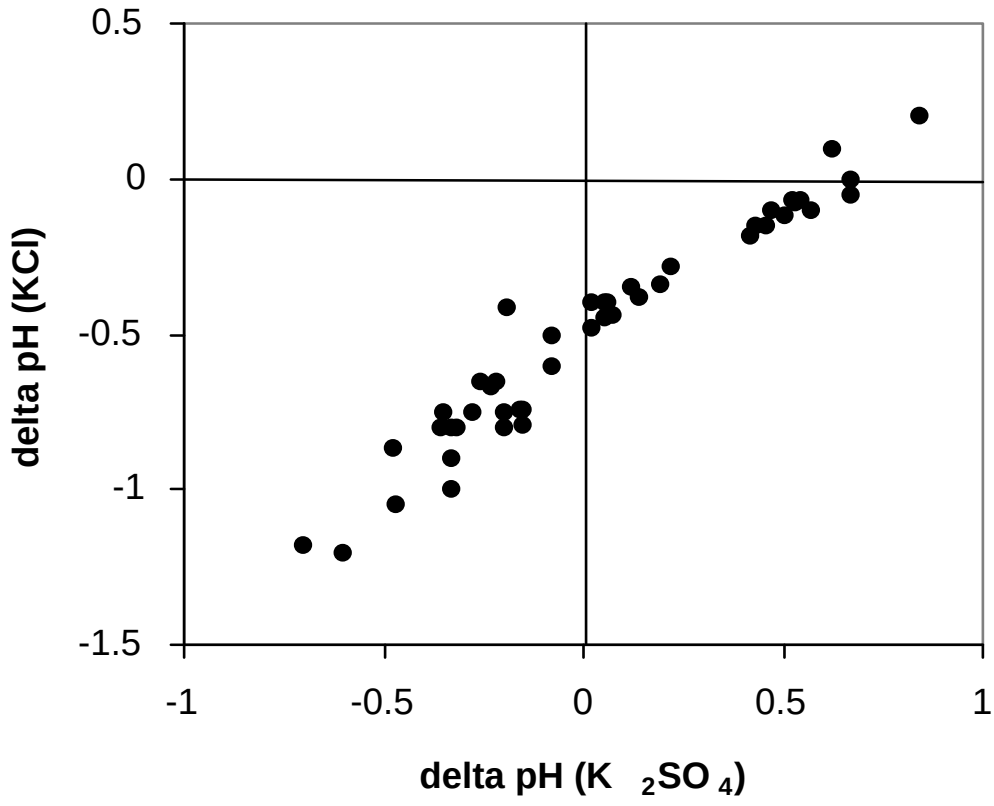

Figure 2. KCl versus K_2SO_4 delta pHs.

Phosphorus management in Soils of Hawaii

Russell Yost, Xiufu Shuai, and Adrian Ares

The management of nutrient phosphorus in Hawaii soils is a serious challenge, not only because we have at least eleven of the twelve soil orders, but also because we have a variety of uses of the land and a wide variety of users who appreciate our natural resources for very different types of activities and purposes. Holding this conference on the Island of Hawai`i is quite appropriate considering the variety in soils and types of land use that are found here.

One of the pioneers of soils of the tropics, Robert Fox, has worked feverishly for decades to characterize the soils of Hawaii and has done an immense service to the State and Tropics in general with his work. It is only fitting to begin this discussion by drawing attention to his techniques of P sorption curves to describe the range in soil P content and sorption. Bob always pointed out that measuring P without knowing the potential for sorption, or how much of the added P would remain in "soil solution" was futile. Certainly there is an enormous range in both P in "soil solution" – a concentration that Bob would like to call "external P requirement," and in the amount of P sorbed.

Phosphorus, extractable, sorbed and desorbed

The range of values for extractable P in soils of the Island of Hawaii ranges widely as shown in Figure 1 (Olsen extractable P), but the range of levels of extractable P is only part of the story. While quite a few regions of the Island have low P, there is a huge difference within the "low P soils" with regard to P sorption, or roughly the amount of P needed to restore P availability (Figure 2). As shown in Figure 2, values range from considerably more P in 'solution' than 0.02 mg P L^{-1} in some cases to very high requirements (more the 600 mg P kg^{-1}). These values correspond to either very, very young soils or those highly weathered on the northeast coast of the Island or at certain places along the Kona coast on the west, southwest corner of the Island.

The P sorption method proposed by Fox and Kamprath (1970) has been one of the classic methods in soil phosphorus. An example of the results produced by this method included those illustrated in Table 1 (Fox et al., 1990), see "Standard P Requirement."

Table 1. Categories of P sorption in relation to soil mineralogy (Fox et al., 1990).

[1]"Standard P requirement" (mg P/kg soil)	Relative amount	Usual mineralogy
Less than 10	Very low	Quartz and/or organic mineralogy
10 - 100	Low	2:1 clays and/or 1:1 clays+quartz
100 - 500	Medium	1:1 clay with oxides
500 - 1000	High	Oxides, moderately weathered ash
More than 1000	Very high	Desilicated amorphous materials

[1]Refers to the amount of P required to raise soil solution P to 0.02 mg P L^{-1} in 0.01 *M* $CaCl_2$

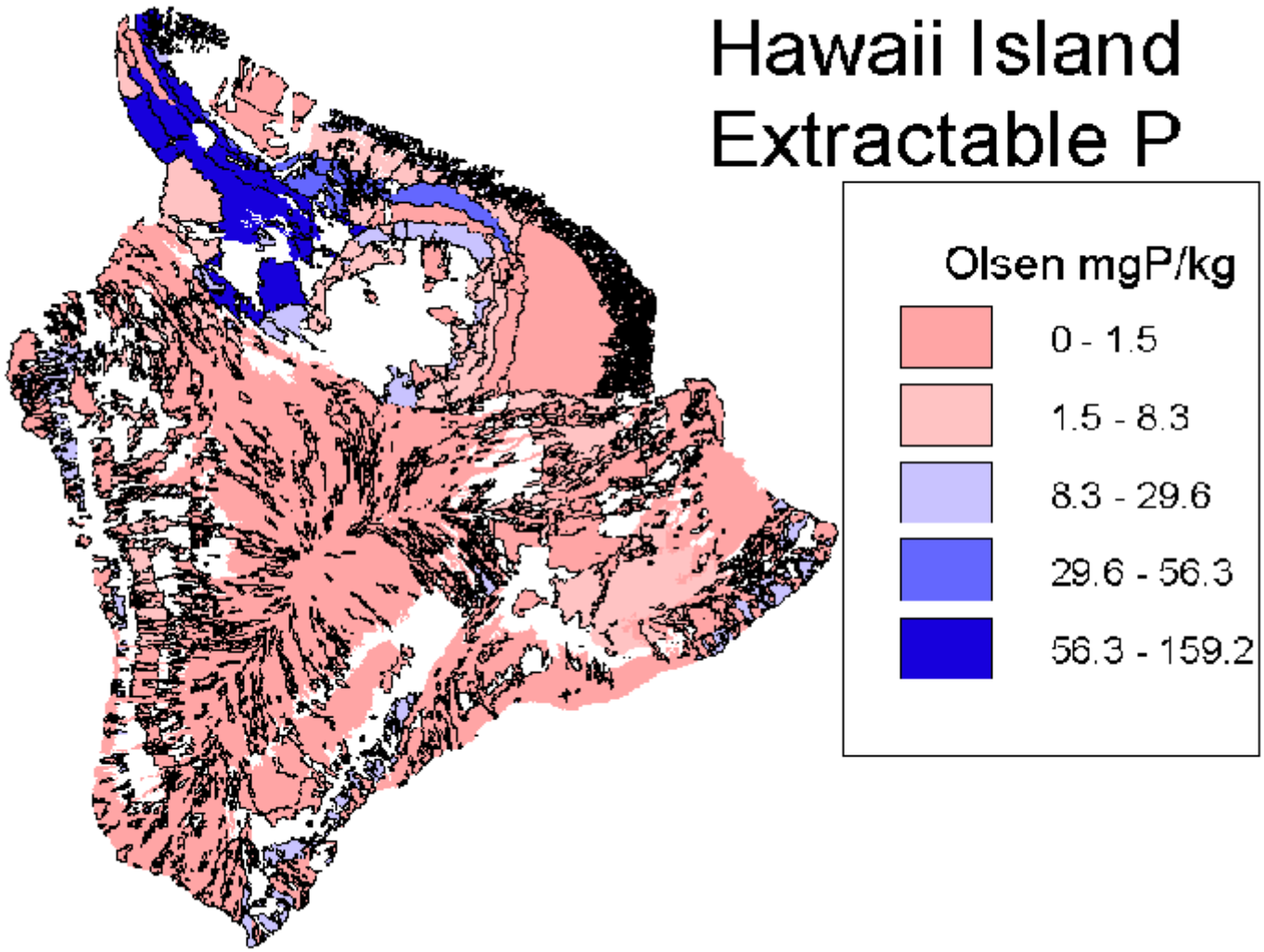

Figure 1. Olsen extractable P, estimates from data of Yost and Fox, 1982, replotted according to mapunit.

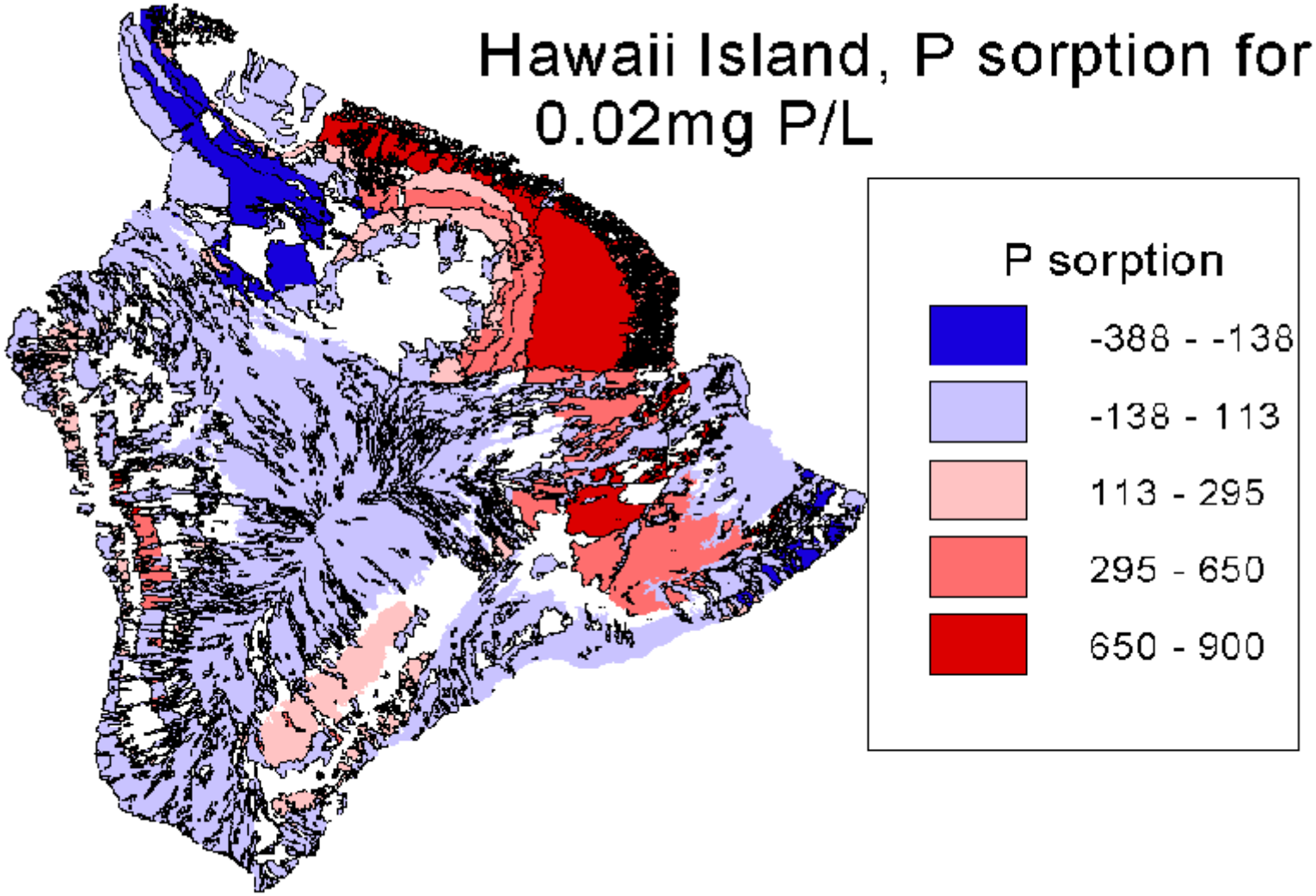

Figure 2. Phosphorus required to equilibrate to 0.02 mg P L^{-1} after 6 days (Fox and Kamprath, 1970). Data plotted according to mapunit from earlier work (Yost and Fox, 1982).

Table 2. Amounts of "amorphous materials" in selected soils of Hawaii (Jones et al., 2000; Babcock 1996)

Soil	Order	Oxalate amorphous	Rietveld amorphous
		- - - - - - - - %	- - - - - - - -
Hai`ku	Ultisol	20	53.2 +/- 0.29
Hali`i	Oxisol	14	58.1 +/- 2.21
Kaiwiki (Big Island)	Andisol	58	85.7 +/- 0.81
Kapa`a	Oxisol	13	44.1 +/- 0.89
Maile	Andisol	50	85.6 +/- 0.91
Makapili	Oxisol	5	57.1 +/- 1.63
Moloka`i	Oxisol	15	39.8 +/- 3.31
Pulehu	Mollisol	10	65.2 +/- 2.77
Wahiawa	Oxisol	11	35.0 +/- 4.44
Waialua	Mollisol	18	58.3 +/- 2.70

The highly weathered soils are well on the end member of weathering as described by Fox et al., (1991), Figure 3, with little remaining in the soil matrix but resistant Fe and Al oxides. Amounts of amorphous material, whether measured conventionally, or measured by the new Rietveld techniques is exceedingly high in these soils (Table 2). These new methods of assessing amorphous materials are very interesting and provide a new perspective on amorphous and crystalline materials in highly weathered soils.

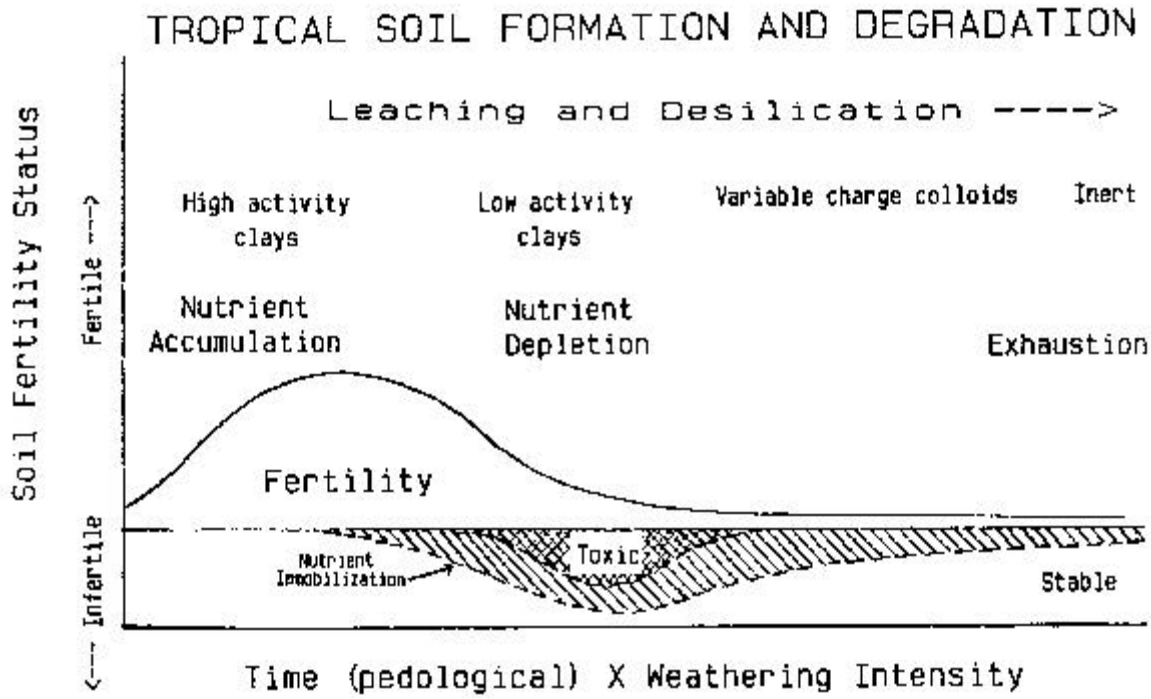

Figure 3. Generalized soil formation and degradation in relation to desilication by weathering and leaching through time (Fox et al., 1991)

Thus it is no surprise that there is a high degree of P sorption given the high amounts of amorphous Fe and Al oxides and the enormous surface area provided for possible P sorption sites. Some of our recent studies have indicated that the wide range of sorption properties of our soils can, to a large extent, be predicted (Jackman et al., 1994). Jackman, by characterizing the crystalline soil minerals with the Rietveld method, and estimating the density of A-hydroxyls, the primary source of P sorption, was able to predict potential P sorption rather closely (Figure 4).

There are some difficulties with the Fox and Kamprath (1970) method of estimating P sorption. One of the difficulties is that soil aggregates are usually pulverized as a part of the sorption process. Linquist et al., (1997) have shown that sorption curves determined with the Fox and Kamprath procedure over-estimate P sorption when compared with those that are shaken more gently and thus preserving the aggregate integrity. Linquist et al., (1997) showed that P was sorbed on the external surfaces of

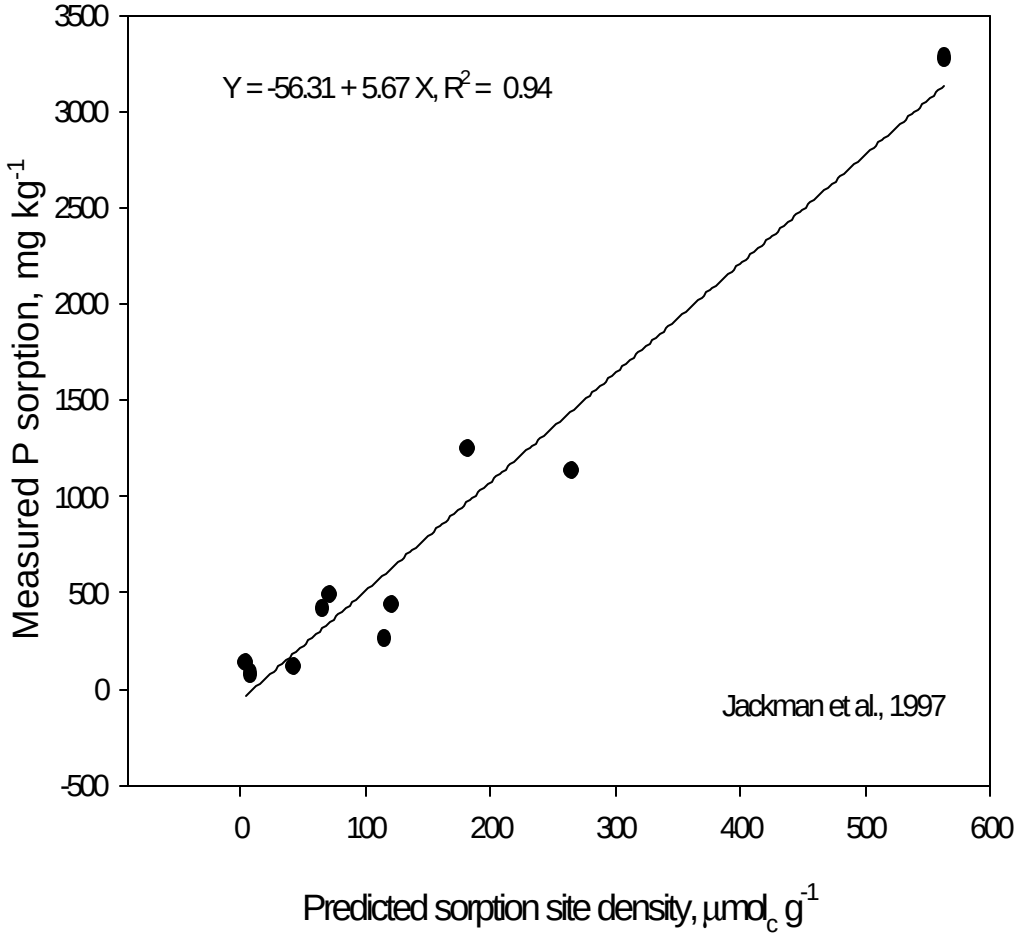

Figure 4. Measured P sorption as predicted from sorption site density predicted from clay mineralogy and morphology (Jackman et al., 1997).

aggregates and thus aggregation substantially changed the "reactive mass" of the soil. The result was that when P was added to the whole soil extractable P was greater in the small aggregates than in the large ones. In further studies Wang et al., illustrated that P desorption varied with soils of approximately the same level of extractable P, Kapaa and Leilehua (Fig. 5).

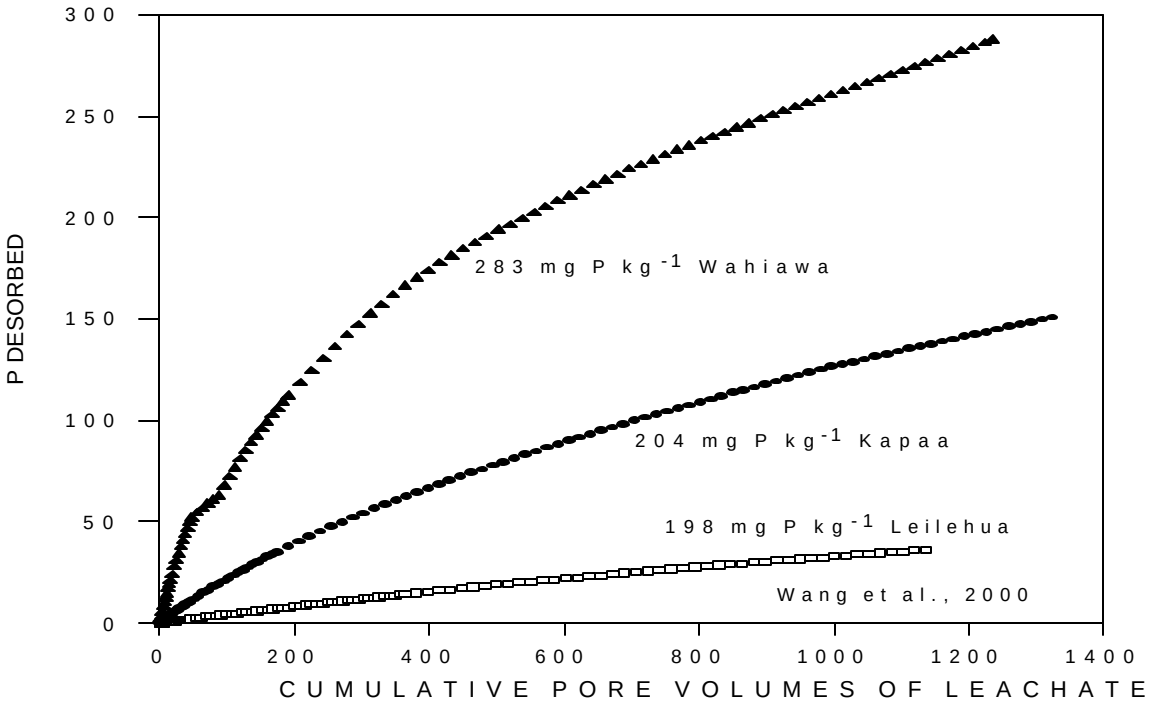

Figure 5. Desorption of P from soils with moderately similar amounts of extractable P.

One of the reasons for the variation in amounts of desorbed P from soils with similar levels of extractable P might have been the variation in aggregation of the two soils. Wang et al. (2000) compared the amounts of P desorbed from varying sized aggregates from a Leilehua soil (highly aggregated) and showed that the smaller sized aggregates desorbed considerably more P than did the larger ones (Fig. 6). The reaction was reversed, however, with regard to sorption. That is the larger aggregates sorbed less P than did the smaller aggregates. The geometric mean diameter among three soils seemed to be a useful predictor of the aggregation effect on P sorption and desorption.

Phosphorus buffer coefficients are presently considered a time invariant constant for annual crops. However, it may be time variant for perennial crops because soil extractable P is of for the several years instead of just a certain time point. For annual crops, our decision unit is crop by crop, and our goal is to maintain a certain available phosphorus level after each harvest (Yost et al., 1992). For perennial crops, our decision unit is one crop with continuous and much longer growing period. We may need the time dependent buffer coefficients in order to apply to aid our decision at any time instead of one time point.

How to estimate the a time dependent PBC? Supposing the phosphorus sorption and desorption by the soil process as a linear dynamic system, the kinetics of phosphorus sorption and desorption by the soil is the relationship between input and output. If these kinetics are known, then the output is the convolution of the input and the kinetic function. The input of phosphorus can be extended to arbitrary function of time rather than single application at the beginning. The output is the system response to the whole input history. Thus, we can make an application decision at any time and with any combined application practice.

The following is an example estimation of the time dependent PBC from phosphorus incubation experiments. Ten soils including Andisols, Oxisols, Ultisols, and Mollisoils were used in the incubation experiments (Jackman et al., 1997). Each soil was treated with five rates of phosphorus. Four sets of P levels were established for the incubation study: 0, 25, 50, 100, 200 mg P kg^{-1} soil; 0, 50, 100, 200, 400 mg P kg^{-1} soil; 0, 100, 200, 400, 800 mg P kg^{-1} soil; 0, 250, 500, 1000, 2000 mg P kg^{-1} soil. The set of P rates selected for a soil was based on the general sorption level expected for that soil. The samples were incubated at 25 $\pm$ ^{o}C for 180 days while the bags were kept open to allow the soils to dry. When soil had dried they were rewetted back to field capacity and allowed to go through wetting and drying cycles according to the rate at which the soil dried. The soil moisture content was monitored throughout the incubation period. The Kaiwiki and Maile soils were not allowed to dry out but always maintained with a moisture level that prevented a change in physical or chemical properties of the hydric matericals (Lim, 1979).

Soils were sub-sampled for extractable phosphorus content at nine times: 2, 4, 8, 16, 32, 96, 128, 180 days. These samples were analyzed for extractable phosphorus with the following methods. The Olsen extractant is 0.5*M* $NaHCO_3$ at pH 8.5, with a mixing ratio of 1:20 soil : solution and shaking time of 30 minutes (Olsen et al., 1954). The Mehlich-3 extractant, 0.2 *M* acetic acid, 0.013 *M* nitric acid and 0.001 *M* EDTA with a mixing ratio of 1:10 soil : solution and shaking time of 5 minutes (Mehlich, 1984). The modified Truog extractant is 0.01 *M* H_2SO_4 with 3% ammonium sulfate, and the extraction procedure utilizes a 1:100 soil : solution ratio with a shaking time of 30 minutes (Ayres and Hagihara, 1952; Truog, 1930). Phosphate concentrations in all analyses were measured with ammonium molybdate reagent with ascorbic acid according to Murphy and Riley (1962) and Watanabe and Olsen (1965).

Mathematical model for the data fitting

A model which considers both equilibrium and kinetic reactions to describe the adsorption was proposed by Selim et al., (1976). Two groups of adsorption sites responsible for solute adsorption by soils were recognized in the model. The first group (type I) reaches equilibrium instantaneously. The second group (type II) are time dependent. According to this two site kinetic adsorption-desorption mechanism, a mathematical model can be written to fit the incubation data.

$$P_{ext} = P_0 + P_{add} [f*\exp(-kt) + 1-f]$$

Where P_{ext} is the extractable P by various methods, P_0 is the extractable P when no P was applied, P_{add} is the amount of P added to the soil, f is the fraction factor of the sites occupied by type II, and k is

the kinetic coefficient. An example for the Olsen extractable P method is used the estimated fraction factor and exponential coefficients are listed in Table 3.

Table 3: The estimated fraction factor and exponential coefficient and P-sorption density when Olsen method is used to extract phosophorus.

Soil	fraction factor	Exponential coefficient	P-sorption site density
Haiku	0.931	1.338	66
Halii	0.873	1.091	115
KaiwikiC	0.995	2.934	563
Kapaa	0.908	1.138	121
Maile	0.988	2.295	265
Makapili	0.940	1.376	182
Moloka	0.696	0.604	4.2
Pulehu	0.770	0.565	8.3
Wahiawa	0.817	0.773	71.6
Waialua	0.778	0.579	42.8

The relationship between the fraction factor (f) and P-sorption site density (ss) is:

$$f = 0.608 + 0.0617 \ln(ss) \qquad R^2 = 0.85$$

The relationship between the exponential coefficient (k) and the P-sorption site density (ss) is:

$$k = 0.630 + 0.0044\, ss \qquad R^2 = 0.90$$

Thus, Olsen-P in the incubation experiment can be simulated by the model:

$$P_{ext} = P_0 + P_{add} \{[0.608 + 0.0617\ln(ss)]*\exp[(-0.630-0.0044ss)t] + 0.392- 0.0617\ln(ss)\}$$

According to the definition of PBC,

$$PBC = (P_{ext} - P_0) / P_{add}$$
$$= [0.608 + 0.0617\ln(ss)]*\exp[(-0.630-0.0044ss)t] + 0.392- 0.0617\ln(ss)$$

When Mehlich-3 method is used to extract phosphorus from soils, Pulehu soil should be excluded because it is a Mollisol with a significant amount of $CaCO_3$. The estimated fraction factor and exponential coefficient are listed in Table 4 for each soil.

Table 4. Estimated fraction factors and exponential coefficients and P-sorption density when Mehlich-3 method is used to extract phosophorus.

Soil	Fraction factor	Exponential coefficient	P-sorption site density
Haiku	0.975	1.534	66
Halii	0.890	1.013	115
KaiwikiC	0.999	3.258	563
Kapaa	0.936	1.240	121
Maile	0.993	2.284	265
Makapili	0.983	1.802	182
Moloka	0.693	0.576	4.2
Pulehu	0.858	0.481	8.3
Wahiawa	0.865	0.932	71.6
Waiahua	0.883	0.707	42.8

The relationship between the fraction factor (f) and P-sorption site density (ss) is:

$$f = 0.624 + 0.0646 \ln(ss) \qquad R^2 = 0.84$$

The relationship between the exponential coefficient (k) and the P-sorption site density (ss) is:

$$k = 0.721 + 0.0048\, ss \qquad R^2 = 0.90$$

Thus, Mehlich-3 P in the incubation experiment can be simulated by the model:

$$P_{ext} = P_0 + P_{add} \{[0.624 + 0.0646 \ln(ss)]*\exp[(0.721 + 0.0048ss)t] + 0.279 - 0.0646\ln(ss)\}$$

According to the definition of PBC,

$$PBC = (P_{ext} - P_0) / P_{add}$$
$$= [0.624 + 0.0646 \ln(ss)]*\exp[(0.721 + 0.0048ss)t] + 0.279 - 0.0646\ln(ss)$$

When modified Truog method is used to extract phosphorus from soils, Pulehu soil should be excluded because it is a Mollisol with a significant amount of $CaCO_3$. The estimated fraction factor and exponential coefficient are listed in Table 5 for each soil.

Table 5: the estimated fraction factor and exponential coefficient and P-sorption density when modified Truog method is used to extract P.

Soil	Fraction factor	Exponential coefficient	P-sorption site density
Haiku	0.925	1.226	66
Halii	0.814	0.436	115
KaiwikiC	0.992	2.612	563
Kapaa	0.889	0.929	121
Maile	0.975	1.73	265
Makapili	0.882	0.876	182
Moloka	0.517	0.243	4.2
Pulehu	0.810	0.122	8.3
Wahiawa	0.747	0.877	71.6
Waiahua	0.661	inf	42.8

The relationship between the fraction factor (f) and P-sorption site density (ss) is:

$$f = 0.367 + 0.101 \ln(ss) \qquad R^2 = 0.92$$

The relationship between the exponential coefficient (k) and the P-sorption site density (ss) is:

$$k = 0.439 + 0.0039\, ss \qquad R^2 = 0.83$$

Thus, Truog-P in the incubation experiment can be simulated by the model:

$$P_{ext} = P_0 + P_{add} \{[0.367 + 0.101 \ln(ss)]*\exp[(-0.439-0.0039ss)t] + 0.633- 0.101\ln(ss)\}$$

According to the definition of PBC,

$$PBC = (P_{ext} - P_0) / P_{add}$$
$$= [0.367 + 0.101 \ln(ss)]*\exp[(-0.439-0.0039ss)t] + 0.633- 0.101\ln(ss)$$

From the models above, as P-sorption site density (ss) and time (t) become larger, PBC becomes smaller. PBC can be predicted at any time based on the models if P-sorption site density is given.

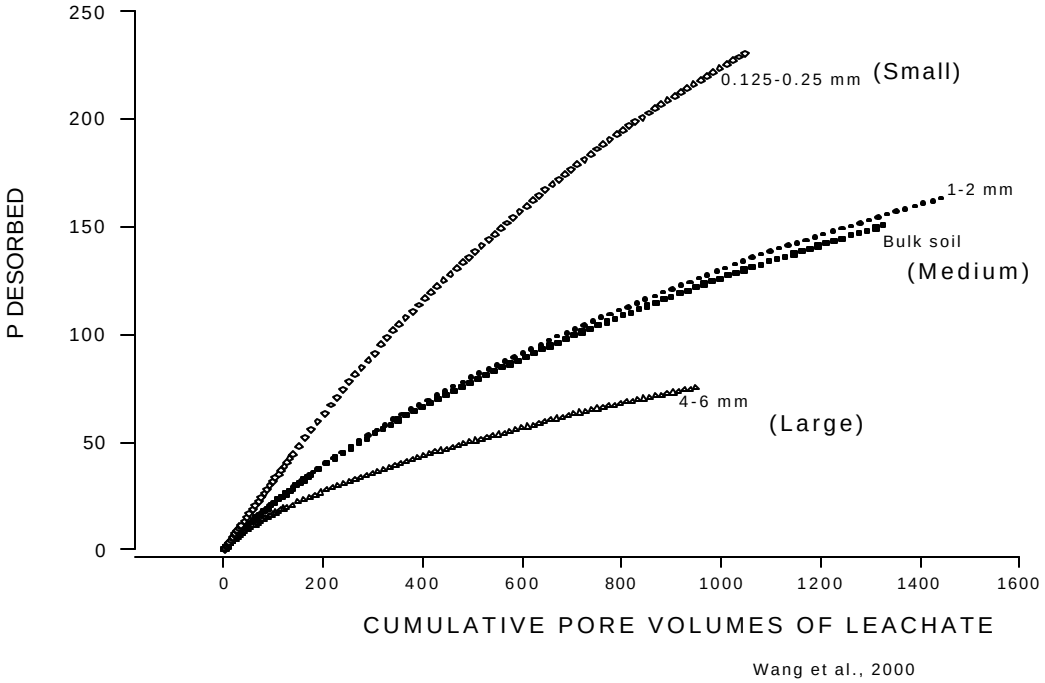

Figure 6. Effect of aggregate size on P desorption, Leilehua soil.

Managing P as a nutrient factor in production

Extractable P While P sorption is important for description of the processes affecting nutrient status, it is not a method that can easily be adapted to routine laboratory analysis. For that we must turn to extractable P methods. Historically, the modified Truog extractant has been the major extractant used in soils of Hawaii with water pH less than 7, while Olsen P is used for those with soil pH greater than 7. There are nonetheless, difficulties with various extractants in Hawaii soils. Similar to problems noted elsewhere, sometimes acidic extractants remove too much undissolved P, especially rock phospate. In addition, some extractants such as NH_4F in the Bray 1 & 2 extractants, are sometimes consumed by the amorphous aluminum oxides resulting in a neutralization of the extracting power. This has been detected with the highly amorphous soils of the Island of Hawaii. Lastly, one of the complications is in the interpretation. A measure of extractable P is of use for "Diagnosis" (see Appendix1) but in order to be used to estimate actual P fertilizer requirements ("Prediction", see Appendix 1) it must be interpreted in terms of P requirement. Traditionally this has been the purpose of "calibration" experiments. Given modern constraints on time and funds for multi-year, multi-location field experiments we are using an alternative method of estimating P requirements given soil test values

(Cox et al., 1981; Yost et al., 1992). The algorithm that we use for calculating P requirement is the following:

P requirement = Pc - Po / a2 * depth/10 * application method (1)

where:

- P requirement is the P fertilizer requirement needed to increase soil P from the Po level to that required by the intended crop Pc.
- Pc is the critical level of extractable P for the intended crop (using the same extractant as used for the measurement of Po and a2
- Po is the measured level of extractable P
- a2 is the "buffer coefficient" or the amount of fertilizer P needed to increase extractable P by one unit
- depth is the depth of application in the event that the fertilizer is incorporated into the soil
- application method is a code that we use to estimate the fraction of unit surface area that actually receives the fertilizer P. For example, if the P is applied in a 10 cm band within a 100 cm row, the application value that we use is 0.1. This is back calculated from the de Wit method of estimated the relative nutrient uptake when only a fraction of the row width is fertilized.

The challenge then becomes how to estimate a2, the phosphorus buffer coefficient. In our Phosphorus Decision Support System work we use the equation proposed by Cox (1994), but it doesn't work so well in soils of Hawaii that are of heavy to very heavy texture (greater than 40% clay). Consequently, we have had to include a term to account for the aggregation status of the soil in the estimation of the P buffer capacity (Wang et al., 2000a). In the interim we have used data from Tamimi (1994, personal communication) to estimate the buffer coefficients for major soils of Hawaii.

One of the several challenges in using extractable P is the effects of aggregation in our soils (Linquist, 1997; Wang et al., 2000b), (Fig. 7). Instead of aggregates having similar values of extractable P, smaller sized aggregates contained as much as five to eight times more P than did large aggregates. Wang further verified that this effect of greater extractable P in smaller aggregates varies with soil series (Wang et al., 2000b). For example, two soils showed strong evidence of this factor (Leilehua (Fig. 3) and Kapa`a), which are, respectively, an Ultisol and an Oxisol but an oxisol, the Wahiawa soil, did not demonstrate this effect. Interestingly a measure of soil aggregation status, the geometric mean diameter, appears to account for this difference in prediction equations (Wang et al., 2000b).

Differences in crop requirement We have indicated how soil sorption varies and how extractable P varies, crop requirements for P vary considerably as well. Some values that are used in our P prediction methods are listed in Table 3.

Similarly the amounts of nutrient absorbed by crops varies significantly. This is an important factor, not only for the supplying of nutrients but in the situations in which there may be nutrient excesses – such as occurs not infrequently in animal waste operations.

In addition to the crop having different critical levels, there appear to be different critical levels for a given crop within the season, hence the often observed condition that early response may be substantial

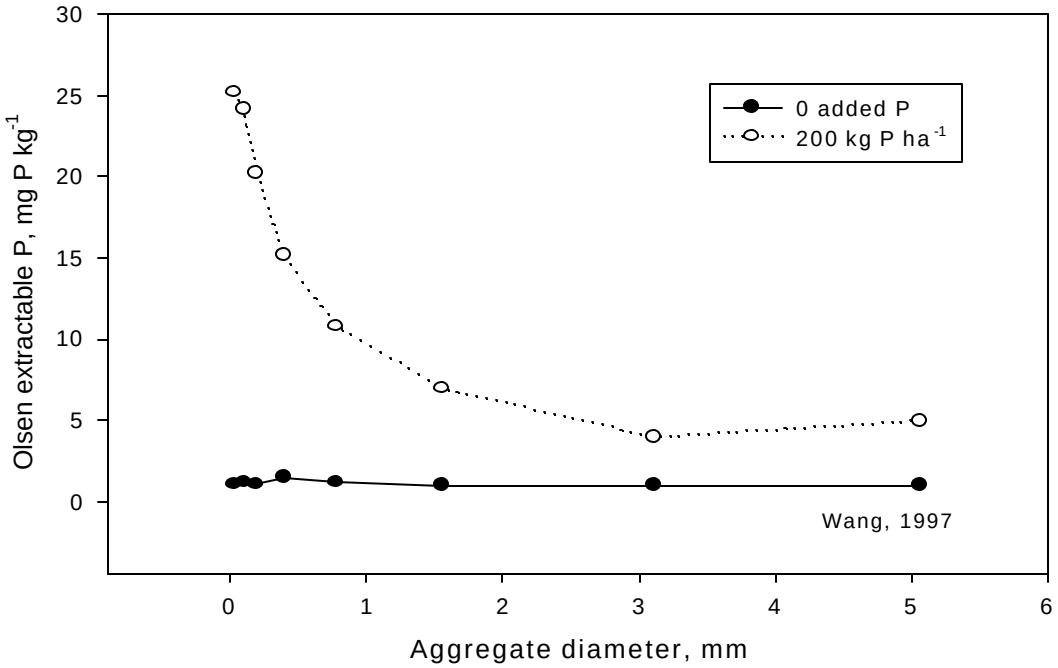

Figure 7. Extractable P of various sized aggregates. Leilehua soil.

but the initial differences in response disappear and no differences remain by harvest time. For example, Fox et al., (1974) recognizes that leguminous crops may have a much higher 'establishment' critical level that when already established.

Table3. Crop critical levels for P used in the Phosphorus Decision Support System (PDSS2).

Crop	NuMass Critical level (0.5*M* $NaHCO_3$)	Fox1	Fox P in 0.01 *M* $CaCl_2$
	mg P kg^{-1}		mg P L^{-1}
Tropical grasses	3 -5		-
Cassava	8		0.005
Sugarcane			0.012
Peanut	5		
Maize	15	30	0.02
Lettuce		80-100	
Tomato			0.2

NuMass, Nutrient Management Support System; Fox and Xi, 1986, (interpolated from field data)

Environmental issues with phosphorus

Traditionally, most P research has dealt with the issues of how to determine when nutrient P is limiting crop growth and how much fertilizer P to add to supply the deficit. A growing concern in P management is how to determine how much P is too much (Sims et al., 2000). This is occurring in the concentrated animal feeding operations and in other nutrient management situations, either when applications are repeated for many years or for high value crops where the consequences of too little P are sometimes thought to be far more serious than those of too much. Consequently, many managers seek to err on the high side of nutrient application. The repeated application of fertilizers may result in surprisingly misbalanced levels of nutrients. Many managers apply mixed fertilizers such as a 15-15-15 and do so continuously for many years. They don't realize that while the N and K seldom accumulate when a little excess is added, such is not the case for P, it does accumulate.

There are several situations in the State in which P accumulates, often to levels considerably above that necessary for plant growth. One of those is associated with animal feeding operations that are concentrated in a relatively small parcel of land. Several swine and dairy operations in the state process very large amounts of nutrients by many animals in a short period of time (Yost et al., 2000). In this study we found that extractable P levels accumulated to very high levels, even on soils with sorption capacities in the range of 500-1000 mg P/kg. Eventually, it becomes difficult to dispose of those excessive nutrients, usually in the form of manures and effluents. In a recent survey of lagoon effluent disposal onto adjacent pastureland, we found a considerable build up of nutrient P, as well as K, Ca, and Mg. The selected lagoons and fields to which the effluent were applied were usually located on soils with high P sorption capacity. Previously it had been thought that there was little opportunity for P to accumulated on soils with high P sorption capacity, but our results showed that was not the case. Furthermore, the results showed that the main reason for the accumulation was the surface accumulation of organic material from the lagoon effluent, while the underlying soils could continue with low or even deficient levels of P.

In 1996, the State, following EPA's *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, identified the following threatened or impaired coastal waters

as Water Quality Limited Segments:

Segment	Major Source of Contributing to Violation
1. Ala Wai Canal	Urban runoff, storm drains, construction dewatering
2. Hanapepe Bay, Kauai	Storm water runoff, agriculture
3. Hilo Bay, Hawaii	Natural groundwater flow, cesspools
4. Honolulu Harbor, Oahu	Industrial, storm water, residential runoff
5. Kahana Bay, Oahu	Stormwater, residential runoff
6. Kahului Bay, Maui	Industrial commercial, urban stormwater
7. Kaneohe Bay, Oahu	Stormwater, urban runoff, small farms, nutrient cycling
8. Keehi Lagoon, Oahu	Stormwater, urban runoff, industrial runoff
9. Kihei, Maui	Stormwater runoff, agricultural, natural goundwater flow
10. Kewalo Basin, Oahu	Stormwater, urban runoff, commercial runoff
11. Nawiliwili Bay, Kauai	Stormwater runoff, natural (mangrove), turbidity, agricultural runoff
12. South Molokai, Maui	Wind/water erosion, stormwater, agricultural runoff
13. Pearl Harbor, Oahu	Stormwater runoff, agricultural, construction
14. Waialua-Kaiaka Bay, Oahu	Agricultural, stormwater runoff
15. Waimea Bay, Kauai	Erosion (major river flows), agricultural runoff, resuspension of bottom sediments
16. West Maui, Maui	Stormwater runoff, agricultural, natural groundwater flow

Recently, May 1999, the National Resource Conservation Service has adopted a policy for providing nutrient management-related technical assistance. Included in the new policy is the following statement regarding nutrient assessments:

"In areas with an identified or designated nutrient-related water quality impairment, an assessment shall be completed of the potential for nitrogen and/or phosphorus transport from the field. The Leaching Index (LI) and/or Phosphorus Index (PI), or other recognized assessment tools may be used to make these assessments."

"When animal manures or other organic by-products are applied, a field-specific assessment of the potential for phosphorus transport from the field shall be completed. This assessment may be done using the Phosphorus Index or other recognized assessment tool. In such cases, plans shall include:

- a record of the assessment rating for each field or sub-field and
- information about conservation practices and management activities that can reduce the potential for phosphorus movement from the site."

While the "Phosphorus Index" seems logical it has been given specific interpretation regarding how to plan for the rates of phosphorus to be applied to specific fields:

- ***Phosphorus Index (PI) Rating*** – The application of P will depend on the combined evaluation of four factors: 1) Relation of soil test P with runoff P, 2) P application rate and timing, 3) Surface runoff and erosion potential
- ***P Threshold Approach*** – Critical soil test P levels are determined for each soil above which

manure cannot be applied

- ***Soil Test Approach*** – Critical soil test P levels are determined but unlike the P Threshold Approach, they are determined based on P requirements of the crop.

Thus with these three candidate approaches the "Phosphorus Index" is the most comprehensive, while the "P Threshold approach" is essentially a soil series determined critical P level, while the "Soil Test Approach" depends on the crop.

The original descriptions of the P index suggested that it be comprehensive and holistic. Unfortunately, in some of the initial implementations have expressed the concept in terms of a numerical multiplication of component factors and then attempting to use the combined value of the multiplication to indicate something about the field, land parcel, or production unit being evaluated. We have suggested that there is no need to force knowledge into a numerical scheme in order to manage the knowledge. Instead of doing so we have proposed an implementation of the P index, that in our view, comes closer to expressing the more comprehensive, holistic view of the complex systems being evaluated for potential impairment of associated streams and water bodies. In so doing we have proposed a decision-aid that is comprised of three components that together approximate, in our initial view, the major factors and opportunities for improvement of management in order to reduce, alleviate, and eventually eliminate adverse effects of production and leisure activities on associated streams, waterbodies and estuaries. We have proposed this alternative scheme (outline in Appendix 2).

The major features of our effort to develop a "P Index" include the following:

1. We want the system to focus on improving management through better knowledge of the factors and conditions that influence and determine the extent of impairment of water bodies by excessive P.

2. There should be a learning aspect to the decision-aid eventually developed such that users come away from using such a system with increased knowledge and awareness of the issues, factors, and management alternatives.

3. The system should be holistic in that it considers the system rather than a single practice, factor, or activity. This requires that a cross-section of disciplines, responsibilities, skills, and contacts are needed in order to capture the diversity and achieve a holistic view of the problems and vision of potential solutions.

Implementation We expect to work through an interdisciplinary group that has already begun to form around the problem and alternatives for solution.

Conclusions

While soils of the State of Hawaii appear very different from those of mainland USA, there are both differences and similarities. Often we can learn from the differences and from the extremes because they put our own soils into better perspective. Our intent was to illustrate that while we do have volcanic ash soils with very unusual behavior, we also have extensive areas of Mollisols, Alfisols, Vertisols, with properties similar to soils of these orders on the mainland USA. As usually is the case, we may be using soils very similar to those present in other states, but in substantially different cropping systems and intensities made possible with the tropical climate and steep elevation gradients.

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Appendix 1. Structuring the knowledge required in nutrient management.

Recently we have been organizing our knowledge and data around a structure for nutrient management that is designed to support how management decisions might be made in nutrient management. That structure is the following, which we find to match the actual decision-making more closely than the traditional approach: 1) The diagnosis of whether or not there is a nutrient management problem (*Diagnosis*), 2) The determination of what is required to remedy the deficiency or excess (*Prediction*), 3) An economic analysis to determine if the predicted solution is likely to be economically valid (*Economics*), and 4) The summary information to be communicated to the grower or manager (*Recommendation*). This structure recognizes and emphasizes the need for the actual growers and managers to be observant and willing to call attention to a suspected problem during the diagnosis phase. The best observers, in terms of frequency and familiarity with the particular status of a crop, stand, or production system are logically the persons managing the stand the most closely. It is thus best if this person can be the first to call attention to a possible problem, crisis, or emergency situation. An analogy would be taking one's temperature when a sickness is suspected. Taking one's temperature is easy to do and gives an indication whether one should see a medical doctor – it is an action decision, call or not call. Once a problem is suspected, more specific data can be taken to confirm and if confirmed, determine remedy options.

Appendix 2. Outline of the Phosphate Contamination Risk Evaluator

Draft (5/1/00)

Phosphate Contamination Risk Evaluator (Pindex)
Hawaii version

1. Potential for P release from the soil

a. Soil P levels
   i. Estimate the amounts of P in solution that would equilibrate with the soil. Use Fox and Kamprath sorption curves with the Linquist modification to estimate sorption (Linquist et al., 1999). Use 1 or less mg P L^{-1} as action levels? Data to be used to estimate the potential for P release from the soil:
      (1) Sorption / desorption curves. For the example desorption studies of Wang et al., (2000c)
      (2) Alternative: Use extractable P levels corresponding to 1 mg P L^{-1} solution (NC tentative rule) in the surface 5 cm for:
         (a) Mehlich III
         (b) Truog
         (c) Olsen
      (3) Two sample depths: 0-5 cm is required and a 5-20 as an alternative in anticipation of remediation by tillage (Yost and Ares, 2000).
      (4) Tillable to 20 cm?
b. Group soils as follows (with Fox's approx. "Standard P requirement in parentheses"):

(a) Histosols / a'a soils (0 - 10 mg P kg^{-1})
(b) Vertisol / mollisols (10 - 50)
(c) Ultisols / oxisols (low sorption category) (100 - 300)
(d) Ultisols / oxisols (high sorption category) (300 - 800)
(e) Hydrudands, Dystrandepts, etc. (800 - 5000)

c. Literature:
   (a) Guo thesis
   (b) Wang thesis
   (c) Jackman thesis
   (d) Fox (beginning with Fox and Searle, Fox et al., 1990)
   (e) Yost & Fox data, 1979

d. Manure and fertilizer applications
   i. Effluent applications
      (1) Evaluate the irrigation requirement to ensure that application rates do not exceed PET with adjustments for rainfall and irrigation
      (2) Evaluate the nutrient balances associated with the recommended irrigation requirement (determined in just above).
         (a) Adjust possible applications to account for normal plant nutrient absorption and utilization efficiencies. (This is often overlooked in nutrient balance estimates)
   ii. Solid manure applications
      (1) Evaluate the possibility of incorporation at least periodically to reduce high surface nutrient levels that lead to high potential P release conditions.
   iii. Inorganic fertilizer applications
      (1) Assess current P release potential with methods suggested above. Seek to minimize surface applications whereever possible.
   iv. In general, advise to not apply if extractable P levels in the surface 5 cm exceed levels in (1.a). Apply in subsurface layers only if clearly demonstrated that it is necessary.

e. Erosion losses
   i. Estimate soil loss with RUSLE or update
   ii. Use curve no to estimate runoff (for section 2 below)

f. Data inputs for this step:
   i. Soil database with soil categories and soil map units
   ii. Extractable P data from the site
   iii. Proposed manure quantity and quality (database)

g. *Conclusions from this section on P release potential:*
   i. There is high potential for P release to runoff from this site, we recommend a further evaluation to determine management options to reduce P release potential to acceptable limits.
      (1) Surface management (tillage or soil turnover?)
      (2) Surface protection (see factor 2 "Potential for transport off site" below

ii. The potential for P release from this site seems moderate and not likely to be a serious problem under current and anticipated management conditions. See options above.
iii. The potential for P release from this site is neglible under current conditions and management. Please check other factors for any special conditions that require particularly low P release potential.

2. Potential for transport off site

a. Use curve no. or existing algorithms to estimate from soil, crop, and location properties.
   i. Use National Engineering Handbook, NRCS.
b. Or estimate a rough water balance using the PET from rainfall medians, regional climate data, and irrigation quantities to determine an estimate of excessive applications exceed infiltration expectations or retention expectations (rought water balance). This calculation could also produce an estimated irrigation requirement or in the case of effluent an estimated maximum application rate. Requires a substantial statewide database, of which there are several efforts underway.
c. Slope from DEMs
d. Surface condition, bare soil, grassed, (from land use coverages? or direct inquiry).
e. ? see KINEROS water and soil loss model for other possible factors to consider
f. *Conclusions from this section on P transport potential:*
   i. There is high potential for runoff from this site, we recommend a further evaluation to determine management options to reduce runoff potential to acceptable limits
   ii. The potential for runoff from this site seems moderate and not likely to be a serious problem under current and anticipated management conditions.
   iii. The potential for runoff is minimal under current conditions and management. Please check the other factors to ensure that especially low runoff potential is not required.

3. *Sensitivity of the water body*

a. Evaluate current "Water Quality Limited Segments" of the State to determine whether the above factors, in fact, identify and designate these as impaired by fields to be evaluated with this decision-aid.
b. Evaluate selected water bodies to determine whether they are indeed P limited. Use the methods of D. Hoover, Dep. Oceanography, University of Hawaii at Manoa.
c. Consider USDA 'A procedure to estimate the response of aquatic systems to changes in P and N inputs.' Interesting dichotomous key in Figure 4.
   i. Questions regarding the procedure:
      (1) Intermittent streams seem not to be covered
      (2) Are the end points of the decision-tree relevant to the Hawaii case?
      (3) Is this a structure that could be depended upon to identify the major water bodies that are of concern with regard to P (or other nutrient or chemical) contamination? If not, what structure might be preferable?
      (4) Who would be able to assist in revising the tree for Hawaii conditions?

d. *Conclusions from this section on sensitivity of the water body to P contaminaton:*
   i. The water body or bodies most likely affected by the evaluated area appears to be sensitive according to the data provided. We suggest listing the factors contributing to the contamination potential and evaluating each according to effectiveness, cost-effectiveness, and other appropriate factors. Most likely reduction of contamination potential will require:
      (1) Reducing either of the other factors in this evaluation: 1) Potential for P release or 2) Potential for runoff that might transport nutrients, chemicals, to the sensitive body of water. These factors are likely to be more amenable to management than reducing water body sensitivity.
      (2) Can the sensitivity of the water body be reduced?
   ii. The water body or bodies most likely affected by the evaluated area is not particularly sensitive according to the data provided. We suggest, however, exploring ways to reduce contamination potential should conditions change by considering factors such as:
      (1) Reducing either of the other factors in this evaluation: 1) Potential for P release or 2) Potential for runoff that might transport nutrients, chemicals, to the sensitive body of water.
      (2) Can the sensitivity of the water body be reduced?
   iii. The water body or bodies most likely affected by the evaluated area is not particularly sensitive according to the data provided.

4. Overall summary recommendation
   a. Under current and expected conditions the P contamination hazard is of concern and some adjustments in current or proposed management are necessary. Please note the results of the assessment of P release potential, P transport potential, and water body sensitivity for improving management. An important followup of this consultation will be to develop a plan to reduce the component hazards as described in either P release potential (1), P transport potential (2), or Sensitivity of the water body (3).
   b. Under current and expected conditions the P contamination hazard is relatively low and no remediation or change in management seems necessary. Please note the results of the assessment of P release potential, P transport potential, and water body sensitivity for improving management and decreasing the likelihood of contamination and harm to the water body.
5. Implementation environments suggested for the above evaluation
   a. Arcview GIS
   b. Standalone decision-aid
   c. Hand-held decision-aid together with a soil testing kit for on-site estimating of nutrient status and its interpretation.

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Elemental Analysis at the Soil Survey Laboratory: Methods and Applications

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NRCS-Soil Survey Laboratory, Lincoln, NE

INTRODUCTION

The conceptual foundation of soil survey is related to the inventory and management of soils and landscapes. Our future, though indelibly linked to this foundation, will continue to evolve with changing needs of both rural and urban society. Data elements essential to a set of "soil characterization data" also continue to evolve as new questions are asked and the clientele of the NCSS expands. Interpretive and investigative requirements as well as technological advancements have resulted in the NRCS-Soil Survey Laboratory (SSL) expanding the capability of major and trace elemental analysis over the past several years.

Elemental analysis of the fine earth (<2-mm) or other soil particle-size fractions provide data for the study of soil properties on a pedon, landscape, or ecosystem basis. These data are used to provide information on processes, parent material uniformity (Chapman and Horn, 1968; Kaup and Carter, 1987), pedogenesis (Wilson et al., 1996; Brimhall et al., 1991; Jersak et al., 1997), or mineral weathering, composition, and phase quantification (Nettleton et al., 1970; Dubbin et al., 1993; Amonette and Sanders, 1994).

These data also have application for use in studies of metal-contamination through atmospheric deposition (Burt et al., 1995; Storm et al., 1994) or transport in surface or groundwaters (D.A. Martens and D.L. Suarez, 1997; Mesuere et al., 1991; Jones et al., 1997). In an environmental context, elevated concentrations of inorganic trace elements in soils, waters, plants, and animals can pose a threat to agriculture as well as human and animal health. The mobility of these metals is critically important (Jones et al., 1997) and is affected by sorption reactions, soil pH, organic matter, or oxidation state (Gambrell, 1994; Masscheleyn et al., 1991; Yin et al., 1996). Essential to the understanding or interpretation of soil is the background or baseline metal levels in soils (Holmgren et al., 1992; Hansford and Boerngen, 1984).

Sequential chemical extractions (Keller and Vedy, 1994; Berti and Jacobs, 1996; Miller et al., 1986) have also been proposed as a means to characterize trace metals in soils. Selective or sequential extraction attempts to partition metals from specific phases, such as adsorbed or exchangeable, Fe and Mn oxides, carbonate, organic, and clays (Tessier et al., 1979, Gruebel et al., 1988; Wilcke and Amelung, 1996). With selective solubilization of meaningful chemical forms, various components from these extractions can be used to evaluate bioavailability, transport, or fate of these metals. Characterizing the species or oxidation state of a particular element is often critical in order to assess toxicity (Martens and Suarez, 1997; James, 1994; Onken and Hossner, 1995). The difficulty lies with the potential redistribution of extracted metals onto residual phases and the difficulty of executing multiple schemes on large numbers of samples (Mesuere et al., 1991). To date, there is no

commonly accepted method of sequential extraction, but various extraction schemes have been used to evaluate problems (Miller et al., 1986; Pierzynski and Schwab, 1993; Berti and Jacobs, 1996).

The SSL has been working on both the methodology and application of major and trace elemental data. The objectives of this paper are: (1) briefly describe factors which govern the concentration of elements (major and trace) in soils; (2) discuss current methods used for elemental analysis in the SSL; (3) describe work underway to analyze selected U.S. soils for "background levels" of trace elements; and (4) illustrate applications of elemental data in soil surveys using specific examples.

SOIL ELEMENTAL CONCENTRATIONS

Elements (major or trace) in soils can be divided into *lithogenic* (elements from the parent material), *pedogenic* (lithogenic elements that are redistributed by soil forming processes), and *anthropogenic* (elements in soils as a result of man's activities) (Kabata-Pendias and Pendias, 1992). Igneous rocks contain a variety of minerals and therefore have variable elemental concentrations: SiO_2 can vary from 40-70%, Al_2O_3 from 1-25%, Fe_2O_3+FeO generally < 5%, with lesser amounts of other elements (Klein and Hurlbut, Jr., 1977). Rocks can be metamorphosed or undergo weathering and transformation as sedimentary rock materials. These processes may alter both the chemical constituents and mineralogical form of elements.

During soil formation, mineralogical alteration from weathering results in translocation or accumulation of elements via chemical and biological processes such as leaching, podzolization, and oxidation-reduction. Relative solubility of specific minerals in soils is governed by their chemical composition and structural form. Individually, elements undergo redistribution or removal from soils to varying degrees. For example, silica is generally mobile in solution and concentrations decrease relative to other elements in soils with free drainage under leaching conditions. Alteration and mobilization of Fe and Mn are in part controlled by soil redox conditions.

Similar to major elements, trace elements exhibit differences in mobility (or bioavailability) within soils. Mobility is tied to elemental form or reactivity with soil components and is also governed by soil chemical conditions such as pH. Trace elements can be present in soils as cations (e.g., Co^{+3}, Cu^{+2}, Ni^{+2}), oxyanions (e.g., MoO_4^{-2}, AsO_4^{-3}, SeO_4^{-2}), or anions (e.g., Cl^{-1}, Br^{-1}). Reactivity varies in soils via bioaccumulation or ion exchange, complexation, and precipitation by soil consitituents such as oxides, organic matter, clays, or carbonates. Soil pH can alter the degree of reactivity by affecting either the metal ion or soil component. Also, changes in the soil redox conditions can alter the chemical state of elements such as As, Mn, Se, and Cr (Pierzynski, 1994; Kabata-Pendias and Pendias, 1992; Davies, 1980).

For evaluation of the heavy metal burden of soils in most countries, only the "total" concentration is measured, generally after *aqua reqia* treatment (Houba et al., 1996). To date, there is no accepted method of estimating the bioavailability of heavy metals. Bioavailability relates to the possibility of a chemical having a positive or negative effect on

an organism (Pierzynski et al.,1994). For example, a metal can be "phytoavailable", resulting in adsorption by plants. If absorption results in negative growth response to the plant (phytotoxic) or is harmful to an animal that consumes the plant, then the metal is regarded as bioavailable. Bioavailable assessment would provide important additional information to the "total" contents and several different extracts have been suggested, such as DTPA or $CaCl_2$ (Houba et al., 1996). These extractants are incomplete measures of bioavailability and most research on this topic has involved field studies relating metal applications to soils and plant absorption (Singh and Jeng, 1993; Sterrett et al., 1996; White et al., 1979).

When assessing the risk of metals in soil to animals and humans, an interesting aspect is "Soil-Plant Barrier" concept (Chaney, 1983; Chaney et al., 1999). Metals such as Pb, Cr, Sn, and Hg are absorbed or precipitated by soil components limiting the concentration of their uptake in plants. Therefore, these interactions acts as a barrier to effects on human health. Secondly, phytotoxicity of Zn, Cu, Ni, and Mn occurs at concentrations in plants below the health risks to humans or animals. Third, there are elemental interactions that result in decreased uptake and decreased bioavailability, for example, Zn limiting Cd uptake from soil. These three factors act to help limit the negative health effects of metals on humans or animals in the food chain.

DIGESTION AND ANALYTICAL METHODS IN THE SSL

Two analytical methods have been developed for use in the SSL to characterize major and trace elemental constituents in soils.

(a) MAJOR ELEMENTS: Microwave digestion (180°C for 9.5 min) of 0.25 g soil in 4 ml HF + 9 ml HNO_3 + 3 ml HCl. Boric acid (2.5%) is added following digestion and solution is brought to a final volume of 100 ml. Elemental analysis by inductively coupled plasma optical emission spectroscopy (ICP-OES) (radial mode, cross-flow nebulizer) for Si, Al, Fe, Ca, Mg, K, Na, Mn, P, Ti, and Zr.

(b) TRACE ELEMENTS: Microwave digestion (180°C for 7 min) of 0.5 g soil in 9 ml HNO_3 + 3 ml HCl. Final solution volume is 50 ml. Elemental analysis is with ICP-OES (axial mode and ultrasonic nebulization, using internal standardization and inter-elemental correction) for Cu, Zn, Cd, Co, Ni, Pb, Cr, and P. Cold vapor atomic absorption spectrometry is used for analysis of Hg.

STUDY OF BACKGROUND LEVELS

One aspect of our work on elemental analysis has been to begin the systematic analysis of a large number of benchmark pedons and other important soils for development of a database of native or "background-level" trace element concentrations. To date, we have completed nearly 500 analyses from 77 pedons. These data are completed with depth in selected soil horizons, with some satellite samples. These data represent soils from every state within the coterminous U.S. as well as Hawaii, Alaska, Puerto Rico, Virgin Islands, and Guam. Data will useful for comparative purposes in order to establish levels of anthropogenic inputs from urban, agricultural, or mining activities in certain areas. Information can also be used to examine pedogensis of soils in differing climatic regions or soil orders by examining metal

distribution with depth and relating it to soil properties such as clay, organic C, or dithionite-citrate extractable Fe.

APPLICATIONS OF ELEMENTAL DATA IN SOIL SURVEY PROJECTS

Applications of major and trace element data to the U.S. Cooperative Soil Survey Program are broad and diverse. Some of these data applications are related to the study of soil genesis and geomorphology. More recent applications are specific to environmental studies of soil and water. Over the last several years, the Soil Survey Laboratory has received a number of samples with both naturally and anthropogenically elevated metal levels.

Some of the recent work we have provided data for include anthropogenic metal contamination (Pb, As, Hg, Cd, Cu, Zn) from a copper smelter in Deer Lodge Valley, Montana; nutrient deficiencies (Ca, N, P, K) and metal enrichment (Co, Cr, Fe, Ni) in serpentinitic soils in Klamath Mountains, Oregon; and metal accumulation (As, Pb, Hg) in hydrothermally active soils in Yellowstone National Park. Other examples include urban areas (e.g., New York City and Baltimore) where the concentration of industry and the presence of intensive human activity may have resulted in elevated levels of trace elements such as Pb. In any of these studies, elevated metal levels may be interpreted for some elements, dependent upon current or proposed land use and bioavailability of those elements. In the Montana study, we have analyzed the soils beyond total metal content by partitioning metals from specific phases using sequential fractionation. These data will be used to help interpret the organic or inorganic phases of selected elements.

CONCLUSIONS

Major and trace elemental concentrations in soils are governed by parent materials, pedogenesis, and anthropogenic inputs. Elemental data are important to facilitate evaluation and understanding of these three soil factors. These type of data have broad application to the soil survey program and can be used to improve and better define soil mapping units, help to understand soil genetic processes, and to determine relationships between mapping units across the landscape. Knowledge of trace elements in soils will also expand the utility and application of soil survey knowledge in areas of environmental concern such as urban, mine spoil reclamation, and agricultural waste applications.

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- Create custom interpretations
- Fuzzy logic vs. discrete breaks
- Create re-useable building blocks
- Still use interpretation rating classes

Interpretation Generator

- Rules

  Base rule **–** a logical statement about one limiting feature

  Primary rule **–** a collection of base rules or evaluations that make up an interpretation

- Evaluations

  An assessment of a particular soil property

- Properties

  The specific soil data retrieved from the soil database

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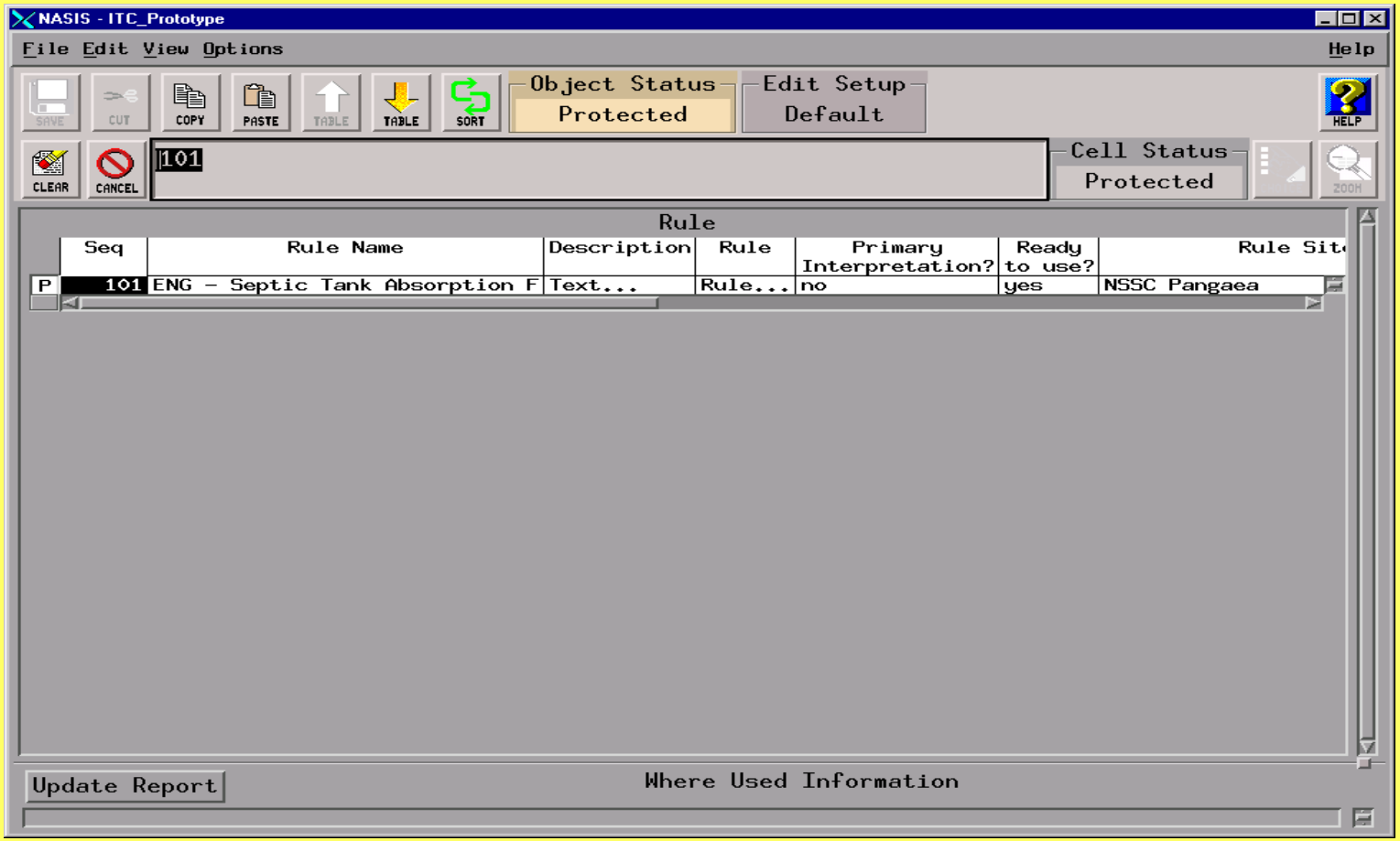
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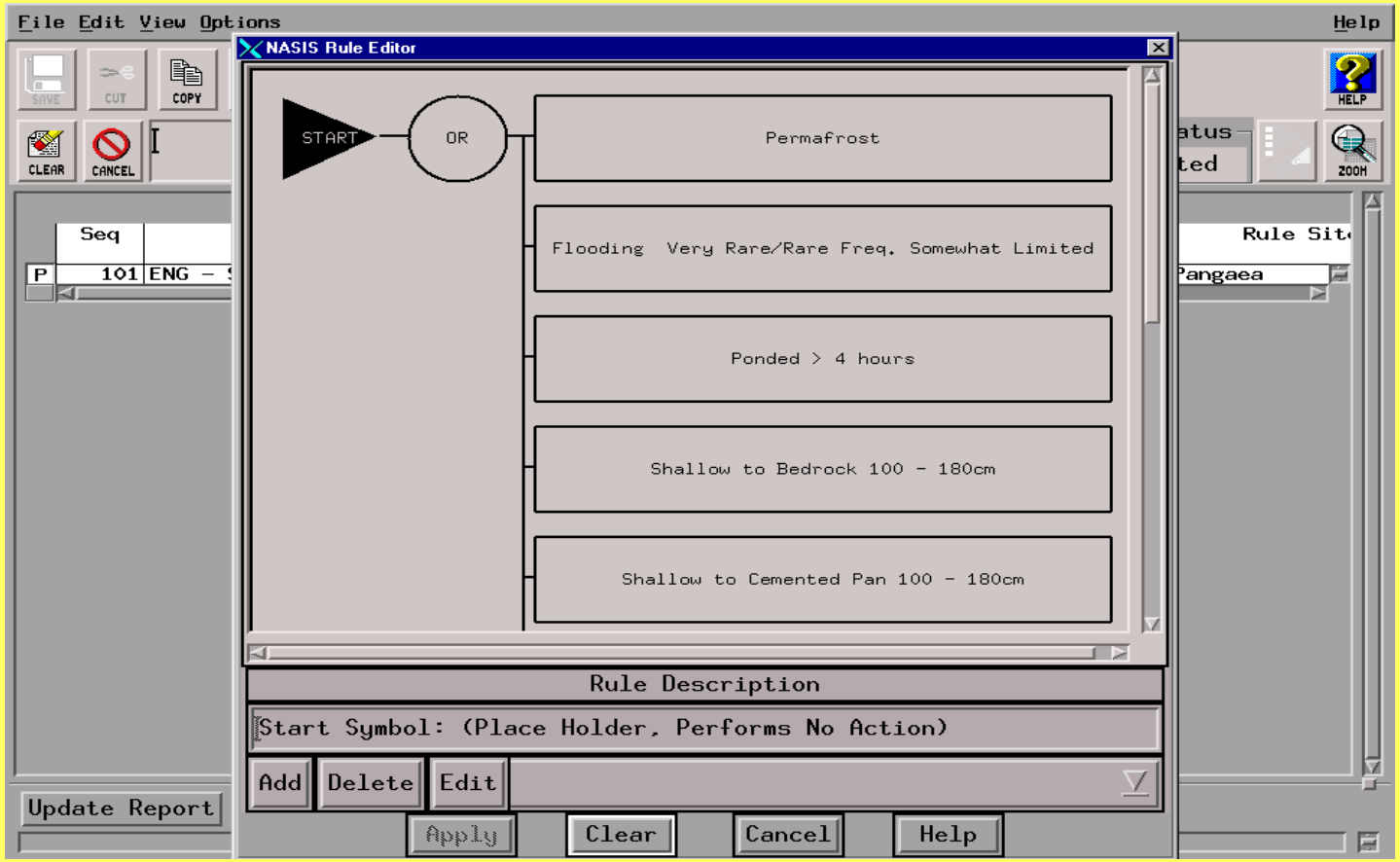

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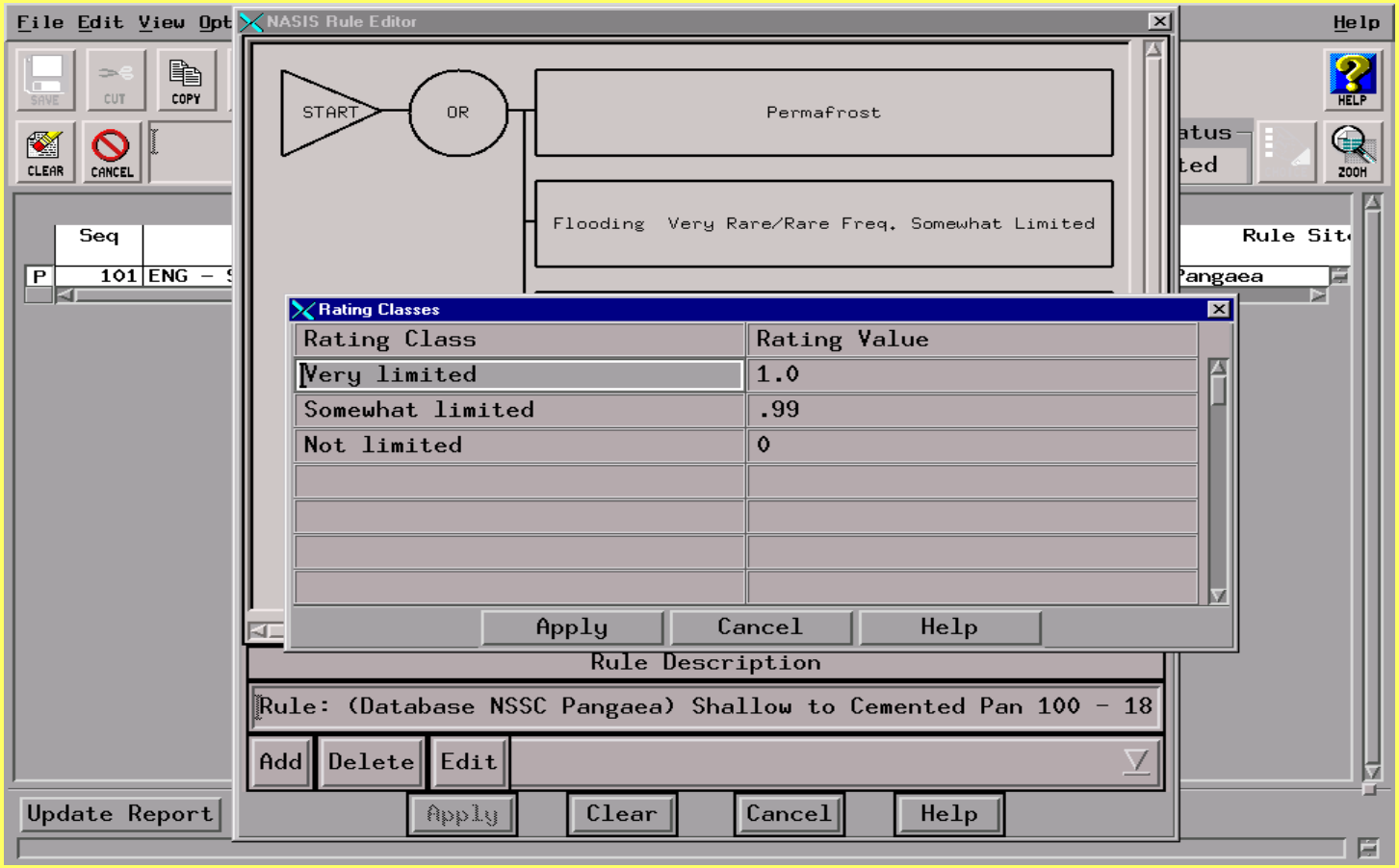

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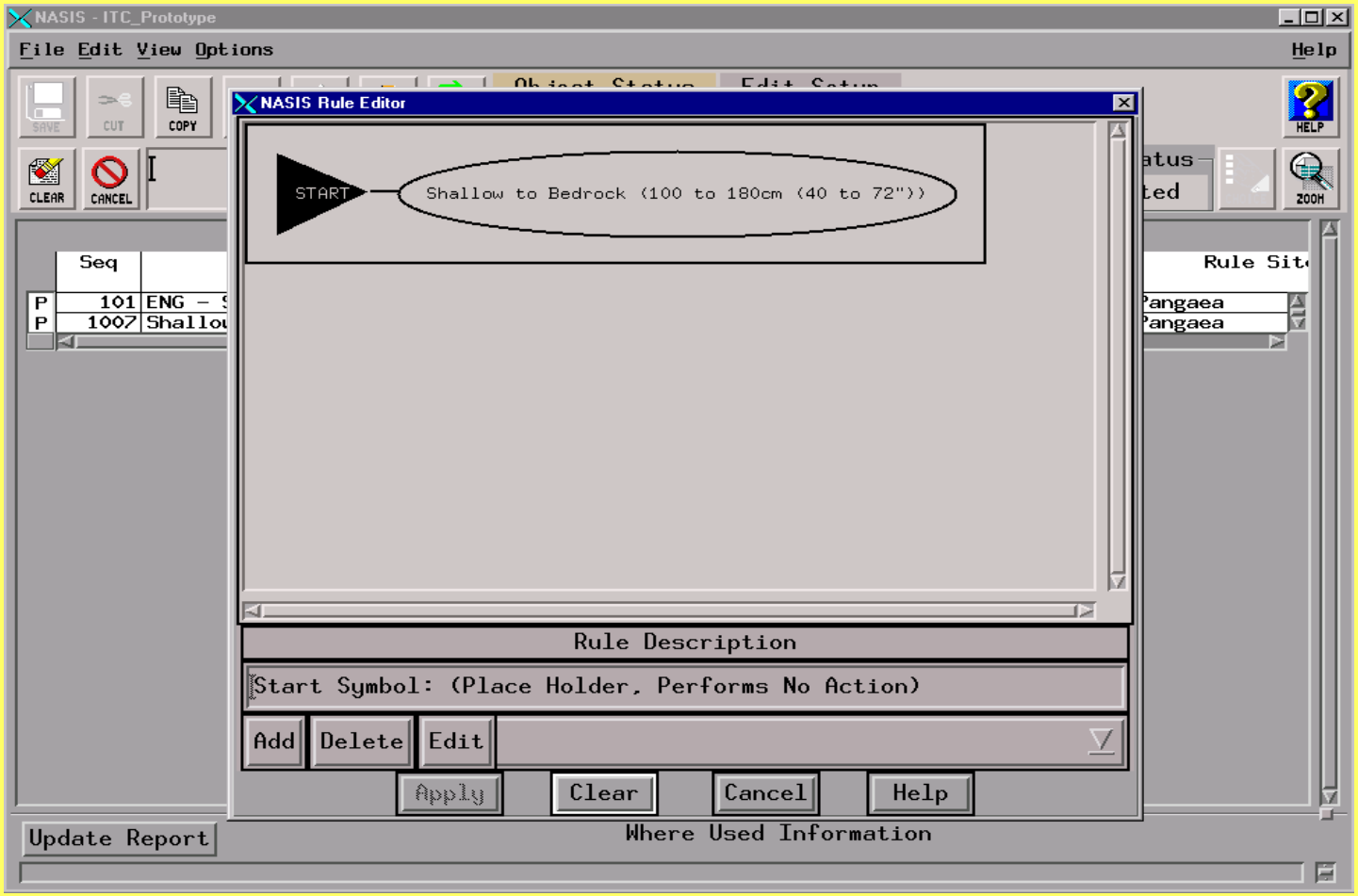
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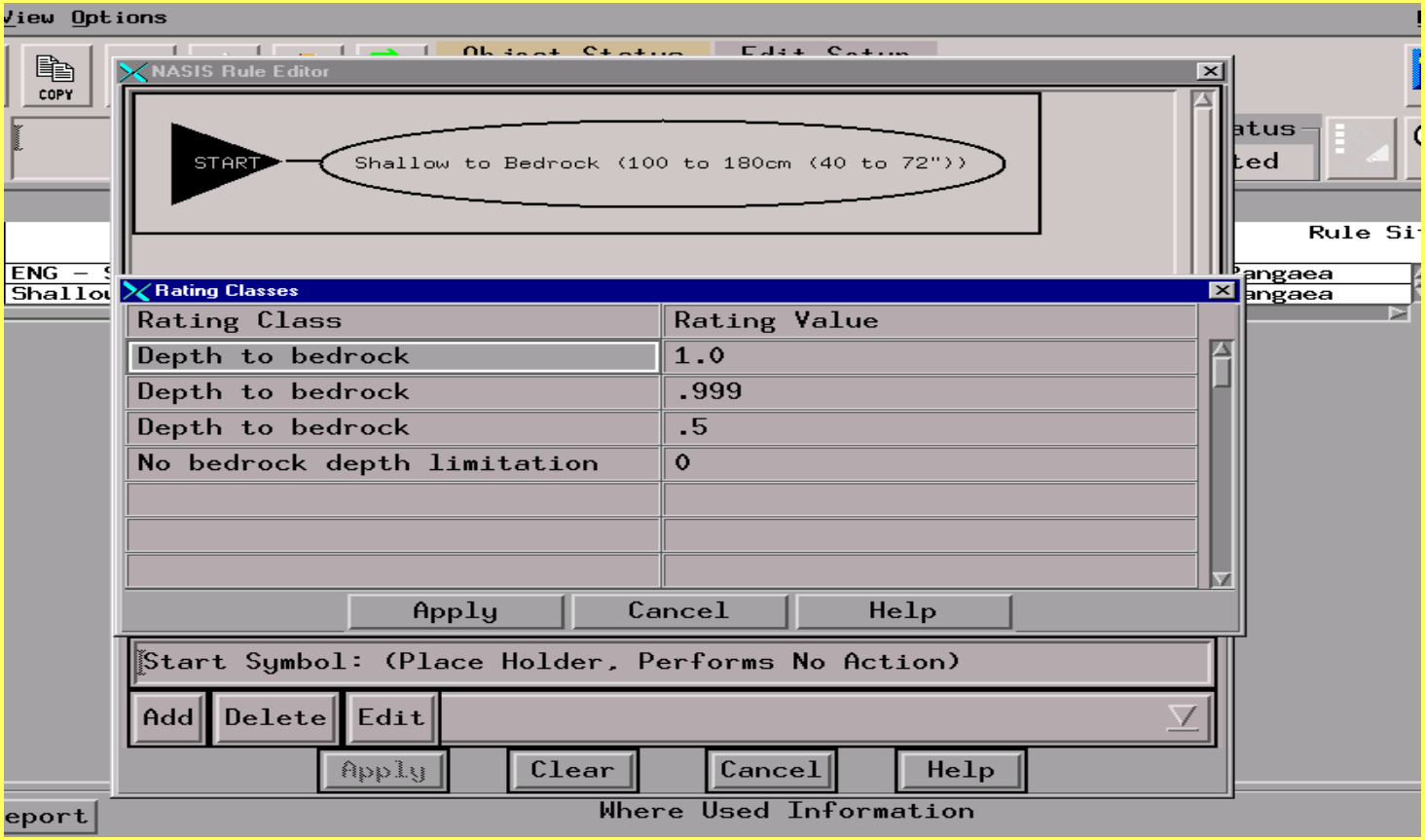

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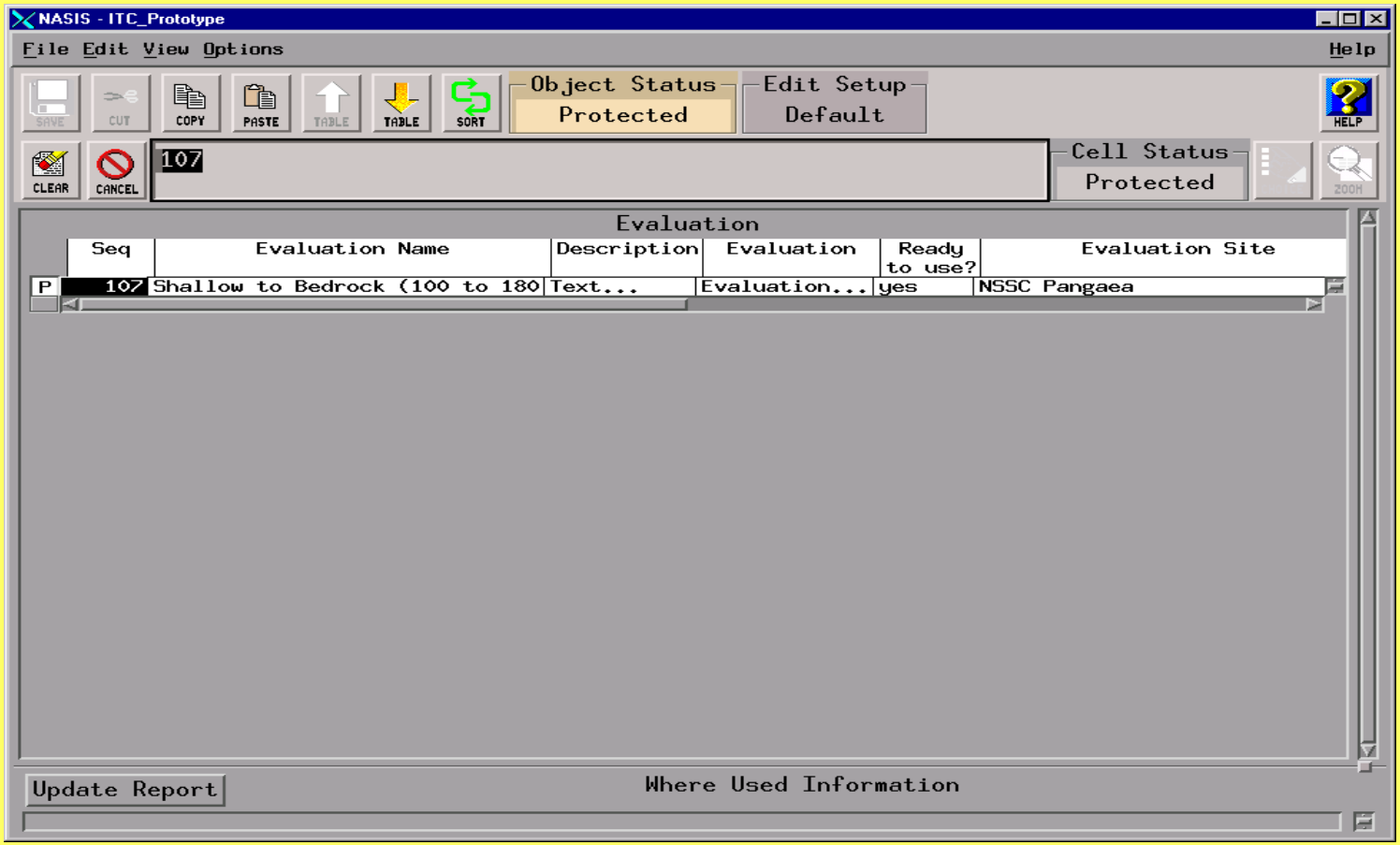

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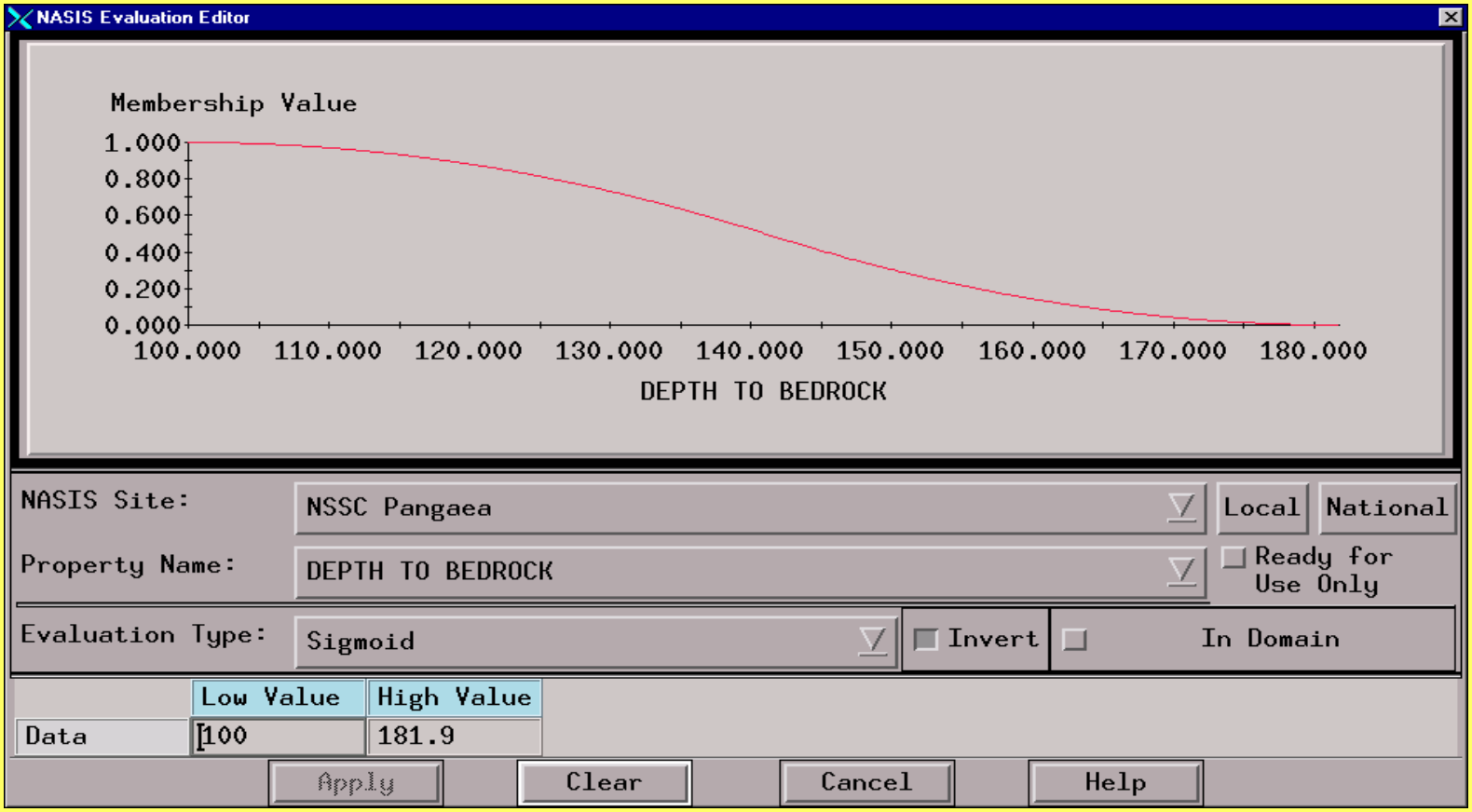

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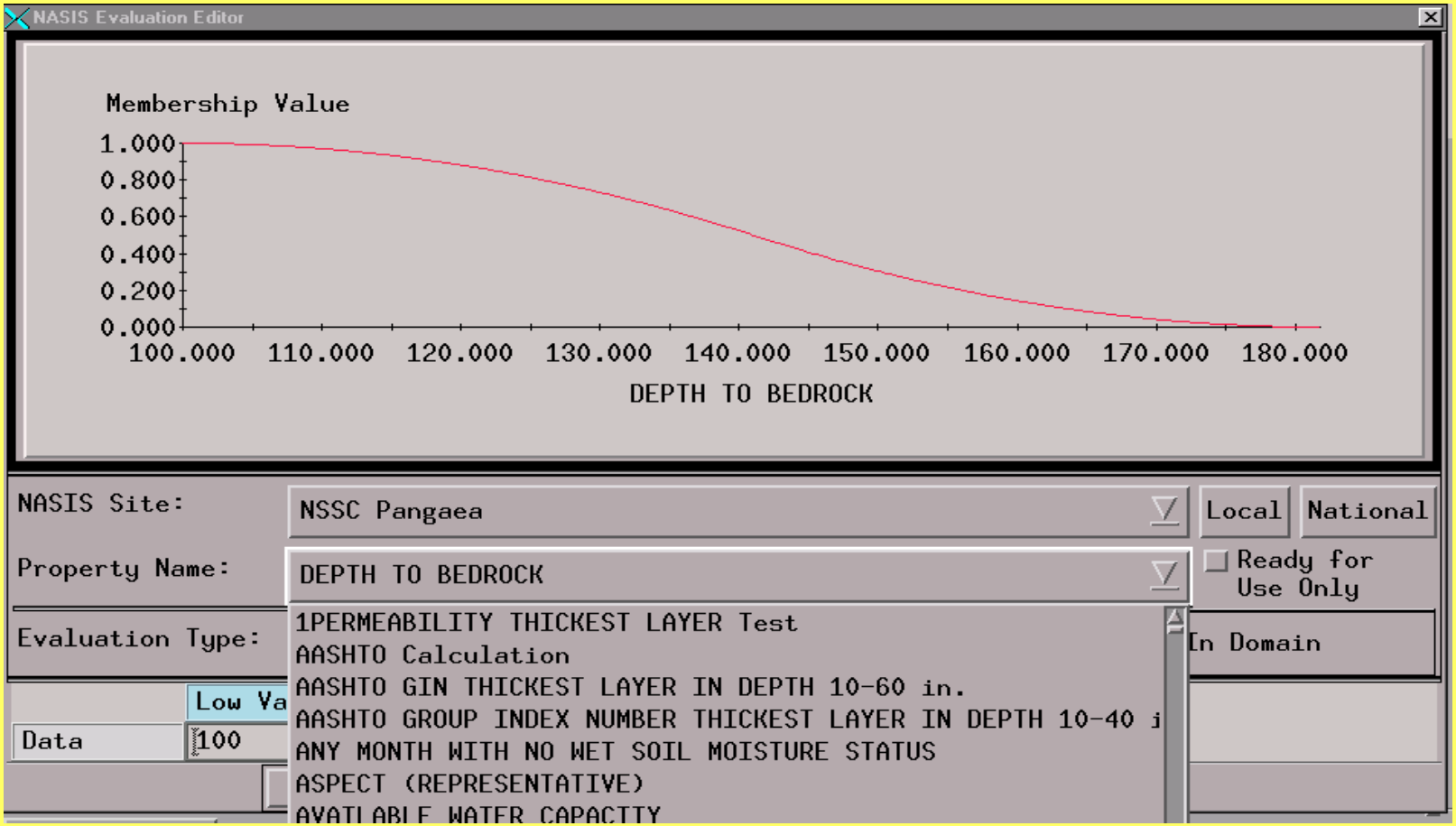

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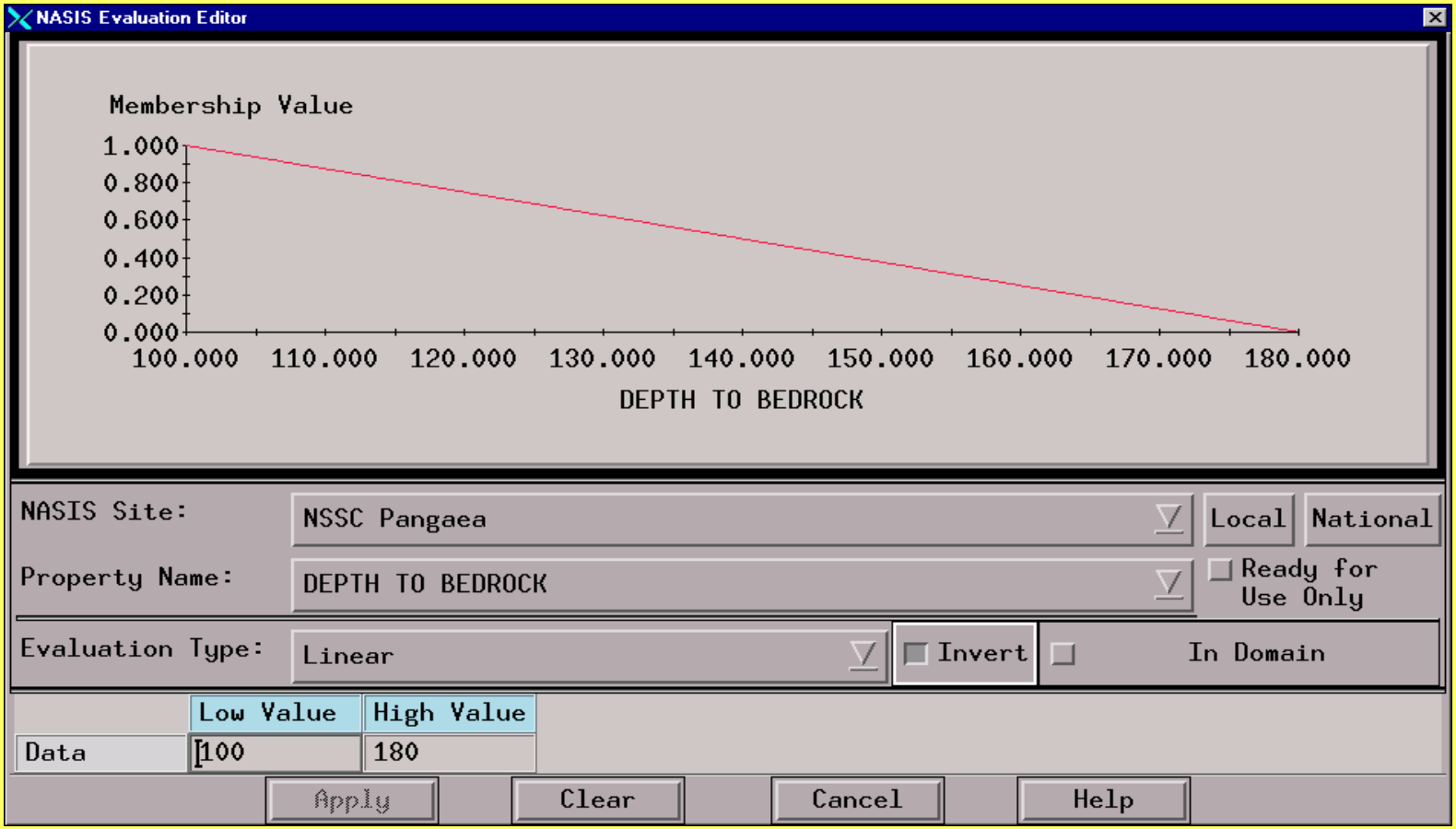

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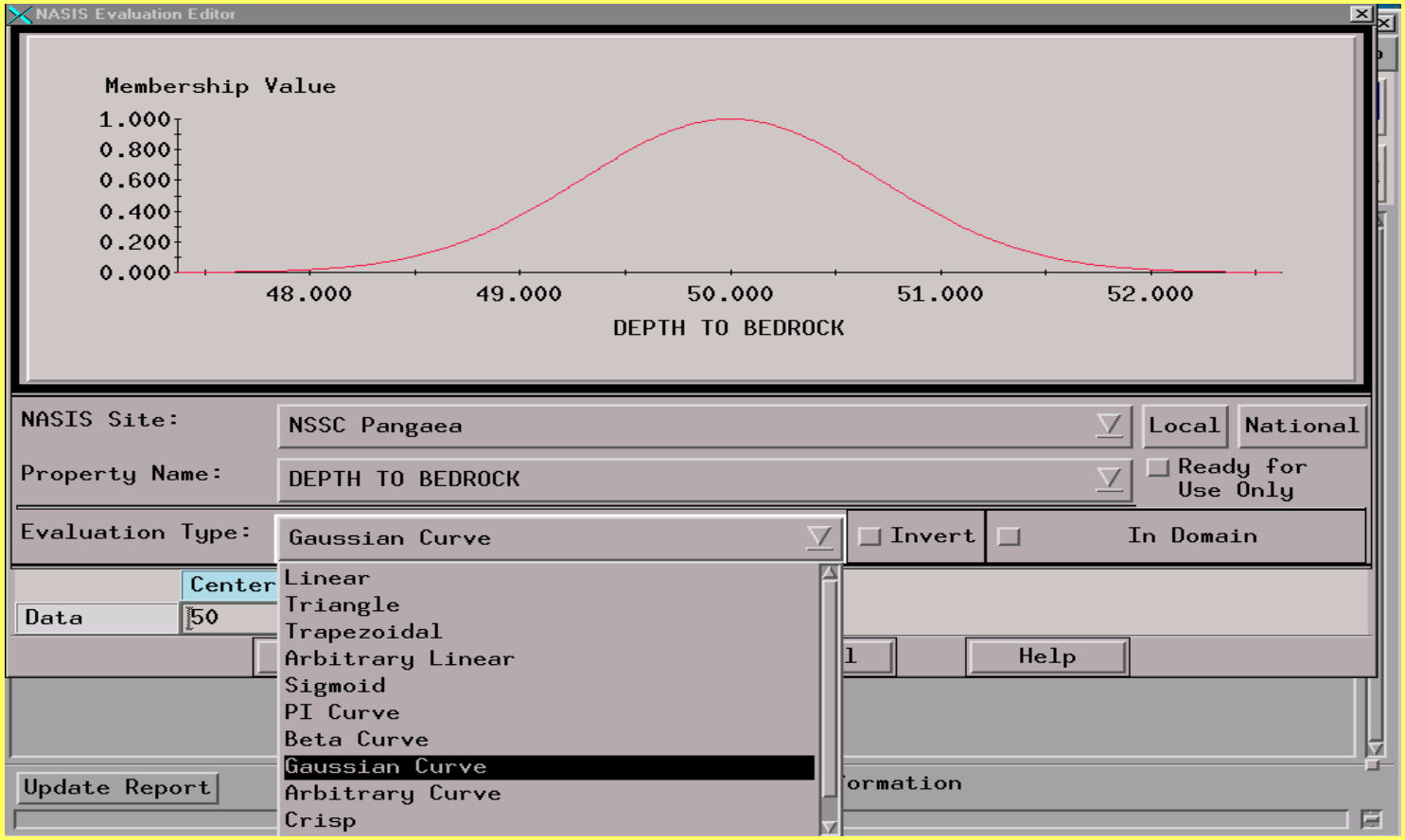

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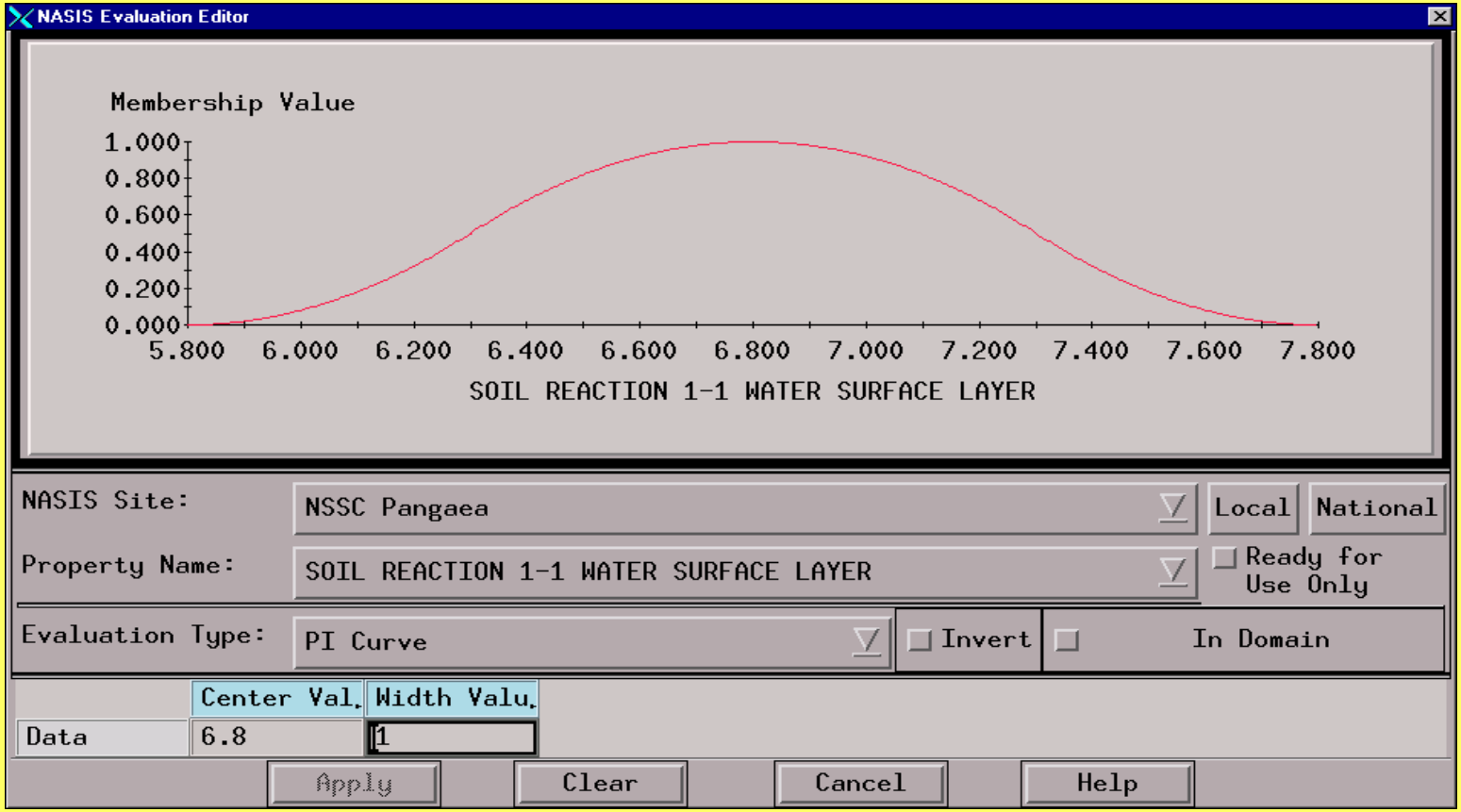

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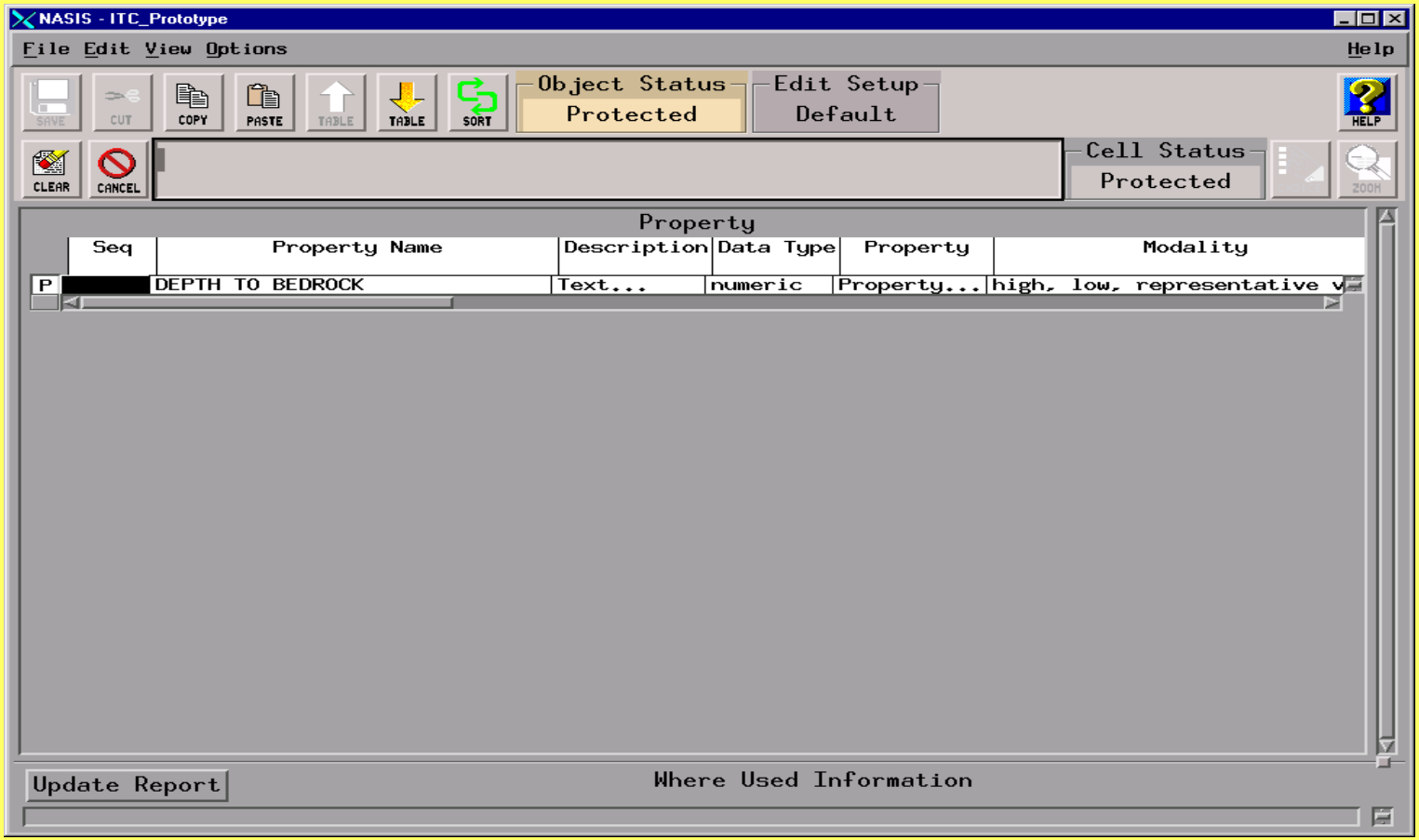

Property SQL

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# Select first occurrence in case there is more than one.

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from component, corestrictions
where join component to corestrictions and reskind in ("bedrock
(lithic)", "bedrock (paralithic)");
sort by rv aggregate column low first, high first, rv first.
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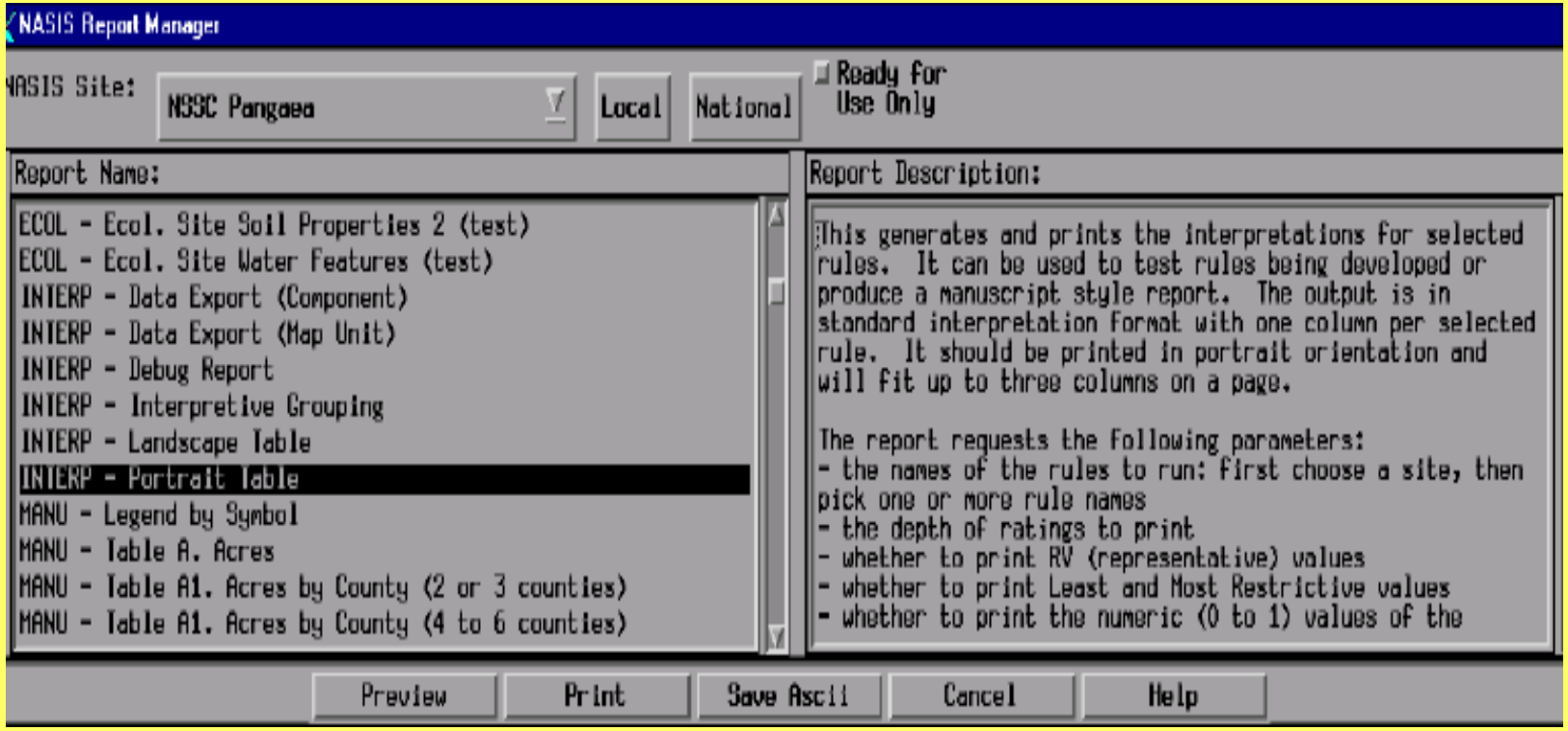

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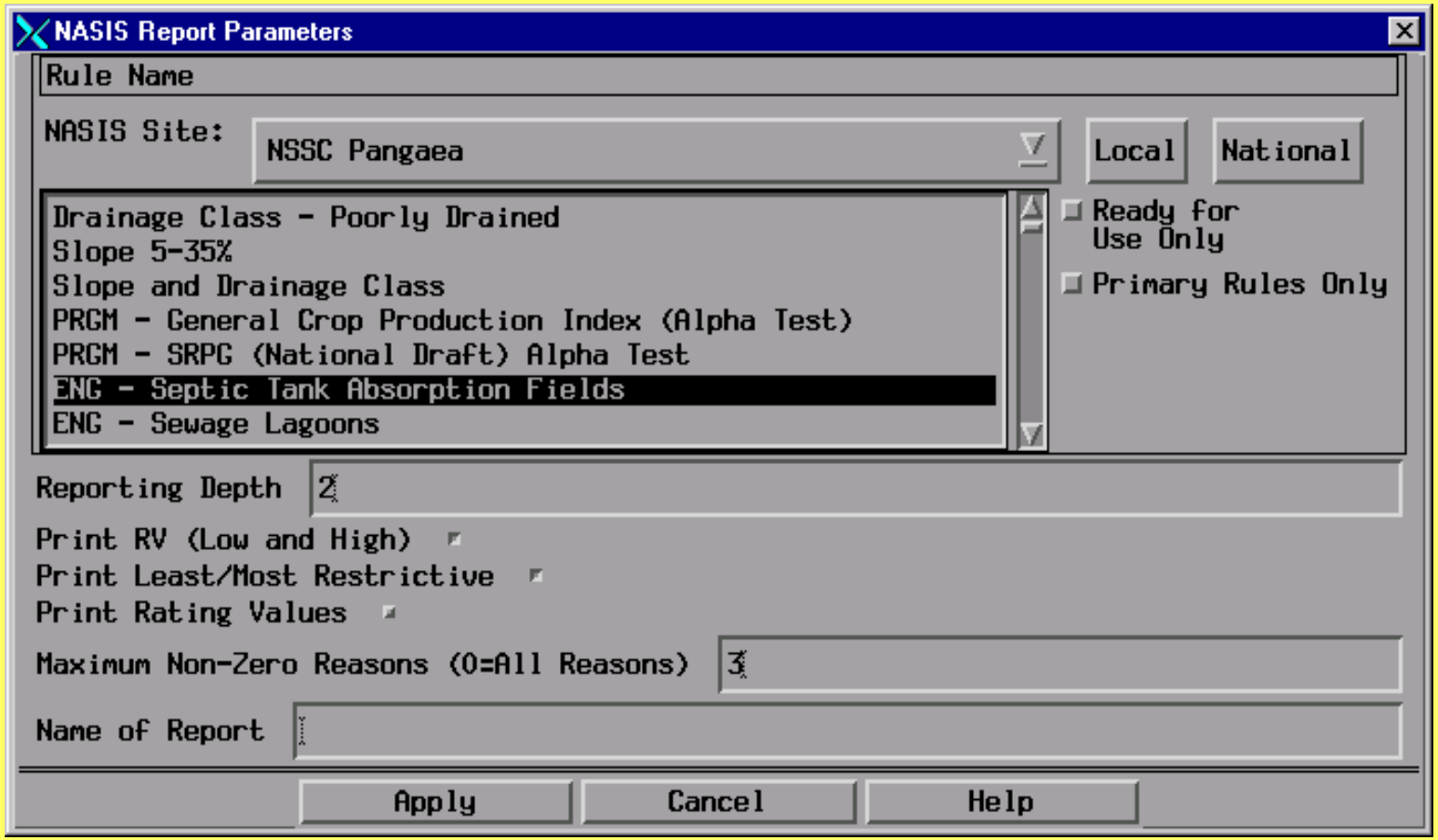


GREATER YELLOWSTONE AREA LANDSCAPES AND SOILS:

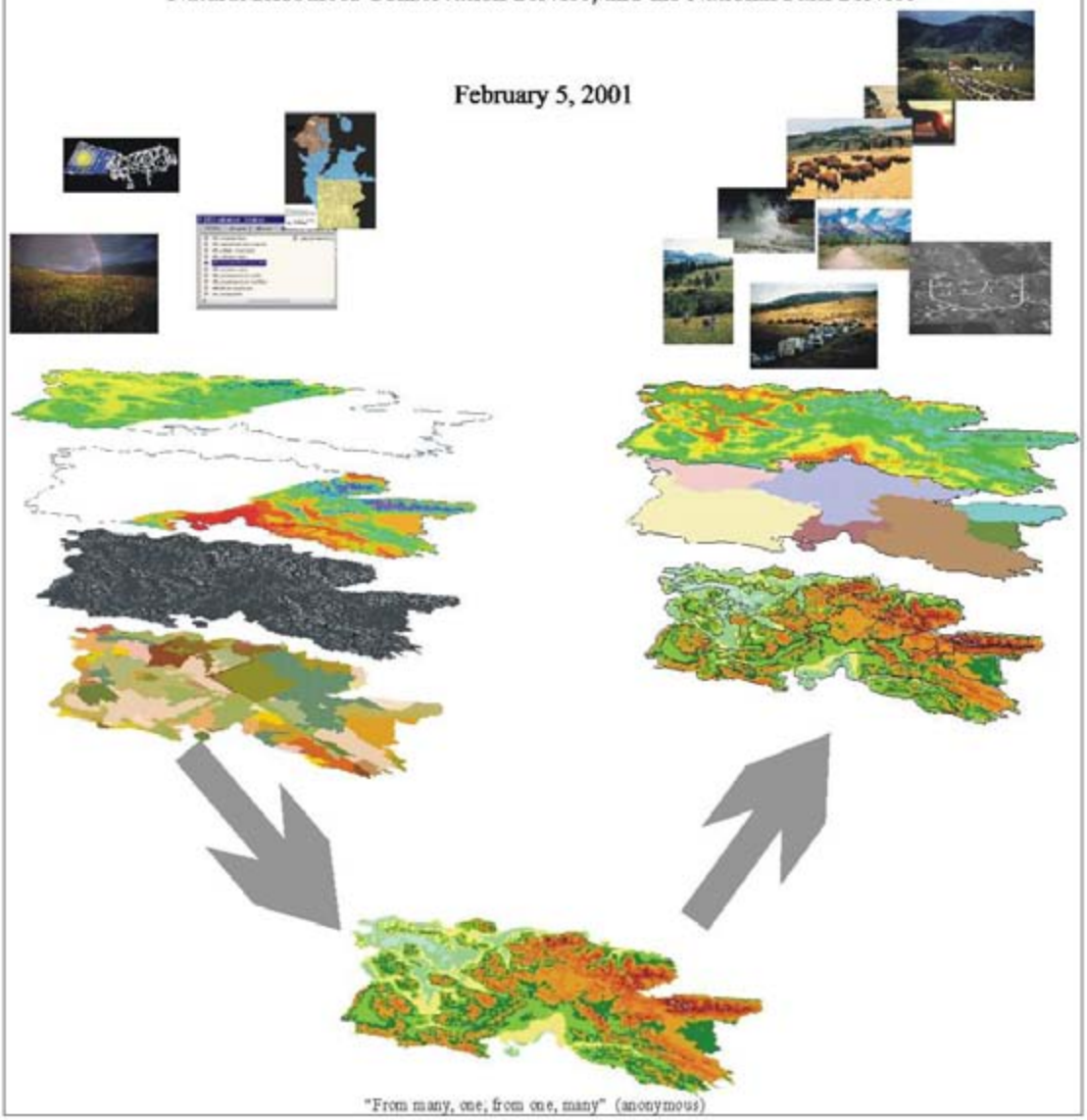
Final Report on the Greater Yellowstone Landscape Model
(Landtype Level)

By

Henry F. Shovic, Ph.D.

Part of a cooperative project between the U. S. Forest Service,
Natural Resources Conservation Service, and the National Park Service

February 5, 2001



"From many, one; from one, many" (anonymous)

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INTRODUCTION

Context and Project History

The Greater Yellowstone Area (GYA) Landscape Modeling Project is a cooperative effort between the Forest Service (Region One, Two, Four, the Gallatin National Forest, and the Rocky Mountain Research Station), the Natural Resources Conservation Service (NRCS), and the National Park Service (Yellowstone National Park.) Other supporting agencies include the Montana Natural Resources Information System -Montana State Library, and the Montana Natural Heritage Program.

The GYA is the largest block of relatively intact wildland and open land left in the lower 48 United States (about 31 million acres or 12 million ha.) It is a contiguous block of land almost 400 miles in length and 160 miles in width including parts of three states (Plate 1.) About one-half the area is public federal land, encompassing two world-renowned national parks and ten National Forests, interspersed with numerous private holdings (Plate 2.) It provides premiere habitat for numerous important species, and is an internationally famous recreational area. Change is rapidly coming to this area, as illustrated by nationwide news coverage of controversies over mining, private land development, interests of local communities versus wildlife protection; and arguments over the future of the bison, wolf, grizzly bear, and dozens of other species. One of the nation's greatest challenges in natural resource management is to appropriately administer the use of federal lands while supporting the ecologically sustainable development of private holdings in this immense area.

The GYA is home to a spectacular community of life forms, from the uncounted unique microorganisms inhabiting the Yellowstone National Park's thousands of thermal features, to the "great piney woods" of mountain man lore, to the remarkable collection of large mammals that make up one of North America’s last great predator-prey systems. The grizzly bear, the bald eagle, the cutthroat trout, and many other species share this landscape with a host of lesser-known but no less interesting and valuable creatures. Though humans have affected the area's ecological processes for thousands of years, and have changed it significantly in the past century, this unique environment is still widely recognized as among our most pristine of wild natural settings, making it increasingly popular as a living space as well as a source of recreation, education, and wisdom.

However familiar they may be with the GYA’s biological wonders, many fail to appreciate of the role the larger landscape plays in shaping and maintaining the plants, animals, and lifestyles of those who live within its boundaries. It is on a landscape scale that ecosystems and their many elements actually function and thrive, however, even the best educated and most interested people have had little opportunity to learn about nature on this scale. This is unfortunate, because it is on the landscape scale that we must understand nature reserves and their surroundings if we are to care for them with the sensitivity they require to maintain the ecological integrity necessary to support this majestic diversity. The science of "landscape ecology" attempts to place these ecosystems and the elements of which they are composed in a framework to better understand them. Most scientists agree that the basic elements of a landscape are landforms, soils, vegetation and the disturbance regimes (such as fire and flooding) that influence them (Forman and Godron, 1986). As these components are defined and mapped, the day comes closer

when investigators can evaluate landscape properties and functions and their effects on particular resources, thus better predicting the effects of human activities in the GYA.

To begin to understand these processes and their relationships to the landscape on such a grand scale, we must have relatively-detailed information over a very large area. The GYA is far too large and complex to manage using merely intuition. We need synthesized, consistent, and complete detailed natural resource information to begin to understand GYA-level ecosystems and their relationships to us.

There is a critical need in the GYA to be able to study and manage changes and events that occur across administrative boundaries. To date, there has been little cross-boundary mapping, and most resource data sets are not carried across the many administrative boundaries in the GYA. There is a need for consistently-compiled resource themes (based on ecological principles) for the entire area to provide a basis for cross-boundary analyses both for scientific and management purposes. These data sets must address multiple resources and provide enough information to allow ecological analysis without the necessity of interpreting a multitude of mapping scales and numerous legends.

Where do we find this kind of information? We live in an information age, and the GYA is certainly information-rich. For examples of the plethora of data sources available, visit the GYA Data Clearinghouse (www.mrc.montana.edu/gyadc.) However, to date there is not a single management and application-oriented, spatial data set available for entire GYA. We have investigated GYA data sources for years, and have come to the conclusion that to meet the goal there is probably enough information available now to meet our project goals by synthesizing it, rather than creating new inventories from scratch. Hence, this project was started in 1998 to explore where it might make sense to make progress. For the near-future, we selected two possible products. We feel potential lies in both *mid-scale general ecological themes*, as well as development of the most detailed base-level or *landtype-level* information contained in soil surveys.

The goals of the mid-scale project include the presentation of natural resource data and the development of appropriate applications of those data in an ecological context, at different scales for selected demonstration areas. The intent is also to demonstrate the use of, and present results for, previously developed ecological characterization and analysis tools. Constraints placed on this project also included using only existing data sets that were readily available, at no cost, for all locations in the contiguous GYA. The effort also required using methods that could easily be duplicated for any landscape area within the western United States. Preliminary results can be reviewed in Shovic, H. F., Maynard C. L, and Nesser, J. A., 1999.) Final results of the mid-level project will be reported at a later date. We deal only with the *landtype* level in the present report.

Study Area Description

Our study area contains more than 31,000,000 acres and includes areas not incorporated in other 'Greater Yellowstone Area' projects (Plate 4.) It is important to understand that this project is not connected to any other efforts related to the Greater Yellowstone Area and that the *selection of the boundary is in no way intended to make any political or management-related statements.* This study area boundary follows ecological boundaries related to the goals of the project, which include the presentation of natural resource data and appropriate applications of those data in an *ecological context* and the development of applications at different scales for selected demonstration areas.

In order to portray the Greater Yellowstone Area in an ecological context, the boundary of the area has been drawn to fit within a nationally recognized hierarchical-ecological framework (ECOMAP, 1993.) This system is a "regionalization, classification, and mapping system for stratifying the Earth into progressively smaller areas of increasingly uniform ecological potentials" (ibid.) At the highest scale of the Ecoregion (Domains, Divisions, and Provinces) map units are differentiated primarily on gross physiography and climate. At the Subregion scale (Sections and Subsections) characterization is by climate, geomorphic process, topography, and geologic stratigraphy. The Landscape scale (Landtype Associations) is defined by general topography, geomorphic process, surficial geology, soil, patterns of potential natural communities, and climate. The finest scale (the Land Unit) includes Landtypes and Landtype Phases and is characterized by local topography (landform), rock types, soils, climate, and vegetation.

Our project area boundaries follow Section lines (Plate 4.) The included Sections are briefly described below to give the reader a perspective on the area. Detailed descriptions are in McNab, et. al. (1994) and Nesser, et. al. (1997.)

The Yellowstone Highlands Section (M331A) is the central core of the area and is 27 percent of the total area. The landscape is predominantly glaciated mountains and high altitude plateaus underlain by Tertiary volcanic, Paleozoic sedimentary, and Precambrian metamorphic rocks and includes the Yellowstone plateau and the Absaroka, Madison, and Beartooth mountain ranges. Elevations range from 4,000 to 13,000 feet with much of the landscape above 9,000 feet. The land is generally steep with about one-third having slopes greater than 30 percent. Precipitation ranges from 20 to 45 inches. Land cover is dominantly coniferous forest with interspersed grassland and alpine areas. Many perennial lakes and streams occur in this Section. World-renowned geothermal features occur in Yellowstone National Park, the central part of this Section.

The Beaverhead Mountain Section (M332E) is 23 percent of the total area, and is a complex of linear mountains and large gravel filled basins with terraces underlain by Tertiary volcanic and sedimentary rocks and Paleozoic metamorphic rocks. The Section includes the Pioneer, Beaverhead, Ruby, Tobacco Root, Gravelly, and Snowcrest mountain ranges. Elevation range from 3,800 to 11,400 feet and precipitation is from 10 to 50 inches. The land is level to rolling with almost half having slopes less than 10 percent. Land cover is dominantly grassland and coniferous forest.

The Belt Mountains Section (M332D) includes isolated island mountains surrounded by rolling hills and broad valleys underlain by Precambrian and Palezoic metamorphic, Tertiary volcanic, and Cretaceous sedimentary rocks. This Section includes the Crazy, Bridger, Elkhorn, and Big Belt mountain ranges and is 19 percent of the area. Elevations range from 3,400 to 11,200 feet and precipitation is from 10 to 40 inches. The land is level to rolling with over half having slopes less than 10 percent. Land cover is over 50 percent grassland with some coniferous forest and agricultural lands.

The Overthrust Mountains Section (M331D) is 18 percent of the Greater Yellowstone Area and includes long, steep mountain chains that were glaciated at higher elevations and broad to narrow linear valleys underlain by predominantly in Palezoic and Mesozoic sedimentary rocks. This Section includes the Teton, Salt River, Gros Ventre, Wyoming, and Caribou mountain ranges and Jackson Hole. Elevations range from 5,000 to 12,500 feet with precipitation ranging from 16 to 40 inches. Over 20 percent of the land has slope in excess of 30 percent. Land cover is mostly forest and grassland with some agricultural lands. Grand Teton National Park is within this Section.

The Wind River Mountains Section (M331J) is 5 percent of the area and includes the heavily glaciated linear Wind River mountain range underlain by Precambrian igneous and metamorphic rocks. Quaternary glacial deposits also occur in valleys. Elevations range from 5,800 to 13,600 feet and precipitation is from 20 to 40 inches. More than 25 percent of the land is in excess of 30 percent slope. Land cover is dominantly coniferous forest and alpine meadow with a small amount of grassland. There are many perennial lakes and streams in this Section.

Parts of the Bighorn Basin (342A), Snake River Basalts (342D), and Green River Basin (342G) Sections also occur in the Greater Yellowstone Area. Together, these areas comprise 9 percent of the total area and are mainly arid steppes, plateaus, and foothills underlain by Tertiary sedimentary and volcanic rocks. Elevations range from 4,800 to 9,800 feet with precipitation ranging from 9 to 18 inches. The land is generally level with more than 90 percent having slopes less than 10 percent. Land cover is mostly grassland with significant area in agriculture.

Soil Surveys and Landscapes

Most land areas in the GYA already have inventories of many landscape components in the form of soil surveys. Areas without soil surveys are generally in the process of completion. These documents are made using well-developed and tested scientific methods, and have defined levels of quality, and a relatively high uniformity in presentation and definition. They not only provide important information on the nature and distribution of soils, but are also important sources of other resource information. Soil surveys contain information on landforms, vegetation types and potential, climate, geology and lithology- in other words they tell us about the landscape. These inventories are important on their own, but their usefulness could be multiplied if they were synthesized to produce ecological characterization data across administrative boundaries, on a variety of scales relating to natural ecosystems rather than just political ones.

In the past, regardless of the benefits, this "survey of surveys" has been impossible to create. Effort to pull the data together has been frustrated by the sheer size of the area and the

multiplicity of formats, styles, and survey objectives. But all this is changing. With the advent of usable geographic information systems (GIS), we have the capability to make sense of this complexity. Our local electronic soft and hardware are now able to handle the immense amount of data and we have the expertise and modeling capability to do the job. Federal GIS is operational and state of the art, and we have expertise in soils, mapping, database development, GIS, and information management. We have managers with vision, the vision to make this information resource a reality.

Though we have this capability, there are many problems to solve. There are 58 different soils or soils related layers in the GYA covering both public and private land. Scales are from 1:6,000 to 1:250,000 and completion dates are from the early 1950's to 1999. Management objectives of the surveys also vary depending on their potential uses, which in turn influence survey design. The variety and the sheer quantity of spatial data make across-boundary line matching, across-boundary legend matching, and even the preparation of a common legend become significant tasks. Interpolation of gaps in survey area data, quality control, the development of a realistic depiction of soils and landscapes over such a large area, and enlisting the cooperation of a large number of individuals are all major jobs. Creation of this "seamless" layer requires not only the automation of the edge-matching process, but also the carrying of logical integrity across those boundaries-a much more complex task. Manual methods or even manual GIS methods are not adequate. We determined the project was possible using a new set of methods, including automation of tasks, advanced database development, data mining, and three kinds of joining procedures.

We therefore proposed the development of a seamless, electronic soils map layer for the entirety of the GYA in a functional format allowing aggregation, display of properties and interpretations, and visualization of soil and landscape characteristics. We proposed using existing USDA equipment and technical support (government-standard software, national standards for data transfer and availability, and existing national databases.)

The Use of Soil Surveys to Make the GYA Landscape Model

Though the primary purpose of soil surveys is to delineate soil patterns on the landscape, there is a wealth of additional ecological information present either in the publication itself, or in associated documents and databases. This is so because discovering and documenting these relationships are inherent in the soil mapping process. Landforms, surficial materials, and vegetation all influence the character of the soils beneath and within them, and are used as visible indications of the nature and distribution of those soils (Buol, et. al., 1980), (Soil Survey Staff, 1993.) These attributes are also critical for making management interpretations of soils so are included in surveys as map unit properties or in associated tables (ibid.)

All modern soil surveys use consistent and standardized soil taxonomy (Soil Survey Staff, 1998), a relatively standard set of terminology for other features, and have been subjected to a quality control procedure (the “correlation” process). (Soil Survey Staff, 1993) There are national standards to which all surveys must adhere before certification and publication (ibid.) Though this process does not guarantee complete consistency, it does help assure that people knowledgeable in the process can compare and use surveys from different areas without learning entirely new terminology, format, or mapping concepts.

Based on our evaluation, there is an enormous quantity of source data already available in the GYA. The study area is 31 million acres, and there are 58 different survey areas (Plate 3.) Almost all of these have separate legends, documentation, spatial data, and all are in slightly different formats and have different levels of detail. About 76% of the GYA has data in a format suitable for this two-year project ("high potential" ratings derived from Table 1.)

Table 1. Soil Survey Area Data for the Greater Yellowstone Area Landscape Model Project (Status as of 1999).

Table 1. Continued

SURVEY AI	ACRES	SOIL SURVEY NAME	NASIS DATA	STATUS	DIGITAL DATA	LAND
ID712	224,479	Bearlake-Caribou		Project	low potential	private
ID713	516,861	Caribou National Forest		Project	high potential	public
ID719	95,651	Star Valley Area		Published	high potential	private
ID720	223,578	Salmon National Forest		NonProject	low potential	public
ID752	98,895	Custer-Lemhi	partial	Project	low potential	private
ID758	867,338	Targhee National		Completed	yes	public
ID759	543,511	Targhee National		Completed	yes	public
ID761	513,386	Clark County Area	partial	Project	low potential	private
ID762	639,142	Fremont County	partial	Published	yes	private
ID765	117,108	Jefferson County	partial	Published	high potential	private
ID766	174,089	Madison County Area,	partial	Published	high potential	private
ID767	201,721	Teton Area	partial	Out of Date	low potential	private
ID769	199,379	Bonneville County Area	partial	Out of Date	low potential	private
ID770	124,154	Bingham Area	partial	Out of Date	low potential	private
ID782	35,157	Yellowstone National	partial	Published	yes	public
MT604	2,142,066	Dillon Valley Area	partial	Project	low potential	private
MT605	2,142,486	Beaverhead National		Project	high potential	public
MT609	551,710	Broadwater County		Published	high potential	private
MT611	69,901	Carbon County Area		Published	high potential	private
MT613	336,878	Cascade County Area		Published	high potential	private
MT616	189,691	Deer Lodge County		Completed	high potential	private
MT622	881,969	Gallatin County Area	done	Completed	yes	private
MT623	1,423,985	Gallatin National Forest	partial	Published	yes	public
MT624	6,617	Wheatland County Area		NonProject	low potential	private
MT627	599,461	Jefferson County Area		Completed	high potential	private
MT630	607,249	Lewis and Clark County		Completed	high potential	private
MT631	727,473	Helena National Forest	partial	Completed	high potential	public
MT632	70,160	Lewis and Clark		NonProject	high potential	public
MT635	628,815	Deer Lodge National		Project	high potential	public
MT636	1,557,693	Madison County Area,	done	Published	yes	private
MT637	638,467	Meagher County Area		NonProject	low potential	private
MT639	217,108	SweetGrass County		Project	high potential	private
MT640	750,000	Absaroka-Beartooth	partial	Project	high potential	public
MT642	371,277	Absaroka-Beartooth		NonProject	low potential	public

MT644	193,468	Powell County Area		Completed	high potential	private
MT647	4,535	Bitterroot National		Project	high potential	public
MT655	100,779	Stillwater County Area		Published	high potential	private
MT664	153,362	Yellowstone National	partial	Published	yes	public
MT669	752,062	Park County Area		Project	high potential	private
MT670	311,028	Silver Bow County Area		Project	high potential	private
non-sur	47,555	Bridger Teton inholding		NonProject	low potential	private
WY617	206,894	Hot Springs County		NonProject	low potential	private
WY623	145,572	Star Valley Area,		Published	high potential	private
WY629	686,188	Park County, Eastern		NonProject	low potential	private
WY635	1,093,245	Sublette County,		NonProject	low potential	private
WY647	436,218	Wind River Indian		Project	high potential	private
WY656	2,166,080	Shoshone National		Project	high potential	public
WY661	1,613,371	Teton National Forest		Completed	yes	public
WY662	738,394	Bridger National Forest, E		Completed	yes	public
WY663	975,016	Bridger National Forest, W		Completed	yes	public
WY664	317,314	Targhee National Forest		Completed	yes	public
WY665	1,982,373	Yellowstone National	partial	Published	yes	public
WY666	428,214	Grand Teton National		Published	high potential	public
WY667	27,272	Rockefeller Parkway	none	Project	high potential	public
WY677	313,932	Fremont County,		Out of Date	low potential	private
WY713	48,425	Wind River Indian		Completed	high potential	private
WY723	257,815	Lincoln County Area	partial	NonProject	low potential	private
WY739	11,320	Teton Area, Idaho-	none	Out of Date	low potential	private
Total	31,497,887					

METHODS

Development of the Attribute Database

We selected attributes for the GYA Landscape model, i. e., soils, topographic parameters, landform, parent material, vegetation, and land cover. These are important ecological characteristics in the hierarchical system and have value in many ecological studies relating to the landscape (ECOMAP, 1993, Forman and Godron, 1986.)

The large quantity of attribute information necessitates some reduction in complexity during development. Attributes of the final layer are on a map unit basis, but component data are also included. Though component information is variable across inventories, it was integrated where it existed, and absence of information in those fields indicates either only map unit-based information was available or no information for that attribute was present in the unit legend.

Our attribute database table is non-relational, to enable the maximum use in GIS and other applications. This increases duplication and reduces flexibility. Using a relational model would eliminate this limitation, but at the cost of higher complexity. We limited map unit components to a maximum of three, excluding inclusions. Less than five percent of the map units have more than this number. To maximize retention of information, memo fields were used where data was more extensive than could be handled by normal text fields.

The table was designed to handle a variety of survey formats, yet be simple enough for use in this project. It is DBASE compatible, to enable transfer to GIS and database management software (hence the unique code numbers at the beginning of each field for DBASE naming conventions and the absence of relational tables.)

Since map unit identifiers may not be unique between inventories, source inventory identifiers were made unique by the addition of a unique unit identifier. This assured the final legend had unique identifiers for every map unit and can function as the primary key in the table.

We designed the table in the third normal form, considered a desirable level in database design (Pratt, J. P, and J. J. Adamski, 2000.) There are no repeating groups, since map unit components are geographically separate parts of each map unit, and not repeated expressions of the same entity. All non-key attributes are completely functionally dependent on the primary key, i. e. all attributes are dependent only on the map unit identifier. Finally, no attribute is dependent on any other non-key attribute, i.e. all map unit characteristics are determined by the map unit identifier, and are otherwise independent of one another.

A brief description of fields in the standard table is in Table 2. The full table description is in the project metadata. The field “s1MapUnitSymbol” is the primary key and unique GYA map unit identifier, a concatenation of “s2MapUnitSymbolLocal” and “s70SurveyArea”. Fields designated with a “GYA” prefix are not imported from unit

Table 2. GYA Standardized Map Unit and Component Attributes

Field Name and Description	
s1MapUnitSymbol	
Field Description:	Unique Map Unit Symbol for this project, the primary key and unique GYA map u r, a concatenation of "s2MapUnitSymbolLocal" and "s70SurveyArea"
s2MapUnitSymbolLocal	
Field Description:	Unique map unit symbol for the survey area (does not include GYA designator).
s70SurveyArea	
Field Description:	GYA designator for this survey area
s3NRCSmuid	
Field Description:	NRCS muid (map unit identifier)
s4MapUnitName	
Description:	Map Unit name in text. This is optional
s5MapUnitNotes	
Field Description:	Notes on the Map Unit
s6SoilsSummary	
	Soils Summary- This can be blank if soil components are described.
s7Soil Temperature	
Field Description:	Rating of the soil temperature class in Soil Taxonomy (frigid, cryic, etc)
s8WetAreas%	
Field Description:	Numerical proportion of wet areas in map unit. This can be blank if WetAreasPres
s9WetAreasPresent	
Field Description:	Textual indication of presence of wet areas in a map unit. This can be blank if Wet used.
s10SoilComponentOne	
Field Description:	Major soil component One- This can be blank if Soils Summary is present. This in name and classification.
s11SoilComponentTwo	
Field Description:	Major soil component Two- This can be blank if Soils Summary is present or if the ne component. This includes the name and classification.
s12SoilComponentThree	
Field Description:	Major soil component Three- This can be blank if Soils Summary is present or if th y two components. This includes the name and classification.
s13DissimilarSoils	
Field Description:	Dissimilar Soils Inclusions This can be blank if Soils Summary is present or if ther hree components. This includes the name and classification.
s14SoilComponentOne%	
Field Description:	Major soil component One % area - This can be blank if Soils Summary is present.
s15SoilComponentTwo%	
Field Description:	Major soil component Two % area - This can be blank if Soils Summary is present or if there is only one component.
s16SoilComponentThree%	
Field Description:	Major soil component Three % area - This can be blank if Soils Summary is present or if there are only two components.
s17DissimilarSoils%	

Table 2. Continued.

Table 2. GYA Standardized Map Unit and Component Attributes

Field Name and Description	
Field Description:	Dissimilar Soils Inclusions % area - This can be blank if Soils Summary is present ure only three components.
s18SoilSummaryNotes	
Field Description:	Notes on soils
s19LandformSummary	
Field Description:	Landform Summary- This can be blank if landform components are described.
s20LandformSummaryNotes	
Field Description:	Notes on landforms
s21LandformOne	
Field Description:	Major landform One - This can be blank if Landform Summary is present.
s22LandformTwo	
Field Description:	Major landform Two - This can be blank if Landform Summary is present or if ther ne component.
s23LandformThree	
Field Description:	Major landform Three - This can be blank if Landform Summary is present or if th two components.
s24LandformComponentOne%	
Field Description:	Major landform component One % area - This can be blank if Soils Summary is pr nknown.
s25LandformComponentTwo%	
Field Description:	Major landform component Two % area - This can be blank if Soils Summary is pr ere is only one component, or if unknown.
s26LandformComponentThree%	
Field Description:	Major landform component Three % area - This can be blank if Soils Summary is p here are only two components, or if unknown.
s27ParentMaterialSummary	
Field Description:	Parent material summary - This can be blank if parent material components are des
s28ParentMaterialSummaryNotes	
Field Description:	Notes on parent materials
s29ParentMaterialOne	
Field Description:	Major parent material One - This can be blank if Parent Material Summary is prese
s30ParentMaterialTwo	
Field Description:	Major parent material Two -This can be blank if Parent Material Summary is prese re is only one component.
s31ParentMaterialThree	

Table 2. Continued.

Field Description:	Major parent material Three -This can be blank if Parent Material Summary is present or if there are only two components.
s32ParentMaterialComponentOne%	
Field Description:	Major Parent Material component One % area - This can be blank if Parent Material Summary is present or if unknown.
s33ParentMaterialComponentTwo%	
Field Description:	Major parent material component Two % area - This can be blank if Parent Material Summary is present, if there is only one component, or if unknown.
s34ParentMaterialComponentThree%	
Field Description:	Major parent material component Three % area - This can be blank if Parent Material Summary is present, if there are only two components, or if unknown.
s35VegetationTypeSummary	
Field Description:	Vegetation Summary- This can be blank if vegetation components are described.
s36VegetationTypeSummaryNotes	
Field Description:	Notes on vegetation
s37VegetationExistingPotental	
Field Description:	yes if existing vegetation, no if potential vegetation
s38VegetationTypeComponentOne%	
Field Description:	Major vegetation type component One % area - This can be blank if Vegetation Type Summary is present or if unknown.
s39VegetationTypeComponentTwo%	
Field Description:	Major vegetation type component Two % area - This can be blank if Vegetation Type Summary is present, if there is only one component, or if unknown.
s40VegetationTypeComponentThree%	
Field Description:	Major vegetation type component Three % area - This can be blank if Vegetation Type Summary is present, if there are only two components, or if unknown.
s41VegetationTypeOne	
Field Description:	Major vegetation type One - This can be blank if Vegetation Summary is present.
s42VegetationTypeTwo	
Field Description:	Major vegetation type Two - This can be blank if Vegetation Summary is present, or if there is only one component.
s43VegetationTypeThree	
Field Description:	Major vegetation type Three - This can be blank if Vegetation Summary is present, or if there are only two components.
s44HabitatTypeSummary	
Field Description:	Habitat Type Summary -This can be blank if habitat type components are described.
s45HabitatTypeSummaryNotes	
Field Description:	Notes on habitat types
s46HabitatTypeOne	
Field Description:	Major habitat type One - This can be blank if Habitat Type Summary is present.
s47HabitatTypeTwo	
Field Description:	Major habitat type Two - This can be blank if Habitat Type Summary is present or if there is only one component.
s48HabitatTypeThree	
Field Description:	Major habitat type Three - This can be blank if Habitat Type Summary is present or if there are only two components.
s49HabitatTypeComponentOne%	
Field Description:	Major habitat type component One % area - This can be blank if Habitat Type Summary is present or if unknown.
s50HabitatTypeComponentTwo%	

Table 2. Continued.

Field Description:	Major habitat type component Two % area - This can be blank if Habitat Type Summary is present, if there is only one component, or if unknown.
s51HabitatTypeComponentThree%	
Field Description:	Major habitat type component Three % area - This can be blank if Habitat Type Summary is present, if there are only two components, or if unknown.
s52ElevationRangeLow	
Field Description:	Lowest value in elevation range (feet above MSL)
s53ElevationRangeHigh	
Field Description:	Highest value in elevation range (feet above MSL)
s54SlopeRangeLow	
Field Description:	Lowest value in slope range (%)
s55SlopeRangeHigh	
Field Description:	Highest value in slope range (%)
s56AspectSummary	
Field Description:	This is optional. It is only noted if there is a strong aspect orientation to occurrence of soils.
s57AspectNotes	
Field Description:	Notes on aspect
s58GYALandform	
Field Description:	Generalized or re-classified landform on a Map Unit basis
s59GYAParentMaterial	
Field Description:	Generalized or re-classified vegetation on a Map Unit Basis
s60GYAWetAreas	
Field Description:	Generalized or re-classified Wet Area description on a Map Unit Basis
s61GYASize	
Field Description:	notes on extent and distribution in GYA
s62GYAslope	
Field Description:	Generalized or re-classified slope range on a Map Unit Basis
s63GYASoilHorizon	
Field Description:	Generalized or re-classified representative soil horizon on a Map Unit Basis
s64GYASoilTemp	
Field Description:	Generalized or re-classified soil temperature on a Map Unit Basis
s65GYASoilTexture	
Field Description:	Generalized or re-classified soil texture on a Map Unit Basis
s66GYAVegetation	
Field Description:	Generalized or re-classified vegetation on a Map Unit Basis
s67GeneralForest%	
Field Description:	Forested vegetation component % area (relates to GeneralForest%, GeneralNon-Forest%, and GeneralRockOutcrop%)
s68GeneralNon-Forest%	
Field Description:	Non-Forested vegetation component % area (may not include rock) (relates to GeneralForest%, GeneralNon-Forest%, and GeneralRockOutcrop%)
s69GeneralRockOutcrop%	
Field Description:	Rock outcrop % area (relates to GeneralForest%, GeneralNon-Forest%, and GeneralRockOutcrop%)

legends, but are included to hold various user-defined query results. Not all fields are used for every map unit identifier.

Importing data to this database is relatively complex. To minimize errors manual entry was minimized. We extracted soil survey data from sources in database format (such as from NASIS) and in text format using an programming language (VISUAL BASIC ™) embedded in WORD™ (a word processor) and ACCESS ™ (a database management system.) Programming was necessary because the decision process for extracting the appropriate data was too complex to complete using standard queries or reports for databases, or simple macros in the case of word processing documents. Though some of these could be done manually, the structured, electronic method provided a trackable process that could be duplicated in the future.

Development of the Spatial Database

Users of ecological inventories expect certain consistencies from their authors. Legends should be consistent within the boundaries of the project, i.e., a delineation having a given map unit label should contain what is described and be mapped at a similar level of detail regardless of its location. The legend should contain no duplicates, i.e., multiple map unit symbols having the same definitions. The shape and location of delineation boundaries should reflect landscape complexity as described in the legend, not changes in land ownership, changes in objectives within the project boundary, or administrative use. The legend should be of manageable size, to be comprehended in a reasonable time. Terminology should be consistent across the legend. Though the variability of the landscape should be captured in the legend, it should be classified and categorized to allow use by those who need to reduce complexity to a manageable level, yet contain enough detail to adequately express that variation

A “seamless” GYA product (spatial data and accompanying legend) means that it meets the above criteria and is a single data file in a uniform format, with attached attributes. Ideally, maps produced from this data reflect only the complexity of the landscape, and that criterion holds across administrative boundaries and across a variety of scales of source data.

Of necessity, soil surveys have administrative boundaries. Map unit delineations end at these boundaries (Plate 5.) Conceptually, however, soils and landscapes do not end at the arbitrary line between administrative units. Ecosystems continue across them, responding to natural limits. Ideally, map units should be delineated to these limits, ignoring administrative boundaries. We want to approach this ideal in this project.

Ideally, removing a seam requires the “joiner” to add map unit delineations and definitions as far as appropriate, considering the existing combinations of ecological conditions, regardless of their location. A given set of ecological conditions could theoretically be mapped anywhere in the study area, and should be delineated there, under ideal conditions. The only controls on map unit delineation should be those imposed by the landscape, i.e., the spatial arrangement of conditions, not the administrative unit in which it is embedded.

Though in our time frame we cannot completely meet all these ideals, we will approach them all in the attempt to maximize the “seamlessness” of the GYA product. We have three methods of joining or attaching data from different administrative units. These are “cartographic joins,”

“boundary joins,” and “normalized joins.” The first is primarily a technical procedure relating to whether layers will electronically connect along their area boundaries. The second deal with the somewhat-ecologically arbitrary seams caused by administrative differences across boundaries, and third considers primarily the landscape and its representation across the entire span of different surveys.

Cartographic Joins

Joining maps manually usually involves the process of cutting maps on boundaries and pasting them together on those boundaries. Of course, this is easier said than done, since paper shrinkage, slight differences in printing, and cutting errors make it difficult to do over any significant area. This is also true when using electronic methods of joining in GIS. Though map boundaries often will appear to match to the naked eye, small gaps or overlaps will result in being unable to use the resultant data. Plate 5. shows small gaps in the center-left portion of the Gallatin County soil survey when geographically oriented to that of the Gallatin Forest landtype inventory. Though boundaries of individual soil survey areas are set with some care, and their electronic versions may be individually agency-approved, they may still have small differences due to their variation in age and changes in cartographic standards. Though each error can be repaired relatively easily, there can be many unmatched nodes (ends of arcs) and slivers (polygons created as artifacts of mismatched boundaries) that require manual attention. Our study area has more than 14,000 miles of survey perimeters. With an average of seven errors per mile as estimated in the pilot project, this is a total of more than 90,000 repairs. A proportion of these have already been matched through NRCS certification process, but it remains quite a large problem.

Boundary and Normalized Joins

Removing an administrative boundary with “Boundary” and “Normalized” joins is conceptually different from removing seams with the Cartographic join. The former two are performed on areas, not on boundaries. The primary difference between the two is their extent (Plate 7.) The red stars indicate the active area for Boundary joins. Map units are modified in this area only. The blue stars indicate map units that may be modified in Normalized joining. Both kinds of joins are essential for true “seamlessness” in a layer.

Boundary joins are performed in the area near the administrative boundary. It is an interim step, made to remove the artificial straight lines on map units that abut that boundary. It is illustrated for the Gallatin County Soil Survey and the Gallatin National Forest Soil Survey in Plate 6. Soil survey personnel from both units jointly made these decisions. Map units were added only to the older and less detailed survey (compare Plates 5. and 6.) They were extended as far as ecologically appropriate, without adding new delineations. The added units were then considered a part of the affected soil survey.

“Normalized” joining is a much larger proposition and involves both the legend and the spatial data. Since the entire study area has been previously mapped, existing map units having equivalent ecological conditions, regardless of name, location, and administrative unit should be combined less than one new map unit name. There are an estimated two thousand unique map-unit names in the source data for this project, each with a variety of attributes. Many of them

undoubtedly refer to similar ecological conditions, and could be combined to maximize seamlessness across the area and make the legend manageable with the software available for its use. We initially proposed a reclassification procedure to approach this goal. For each important attribute, we wanted a common set of values by combining existing data that refer to similar ecological conditions, and using the resultant values for the GYA attribute values. Once this is complete for all attributes, we would use each unique combination of attribute values for a GYA map unit. This would result in a large, but manageable legend. This process inevitably leads to some data loss. However, over the course of the project, data manipulation software advanced to the point where we no longer need to generalize unit attribute data. We retained the maximum data in the legend, and propose to create a variety of generalized legends for management needs through the development of SQL (Structured Query Language) queries and VISUAL BASIC ™ programming.

The Model Building Process

Development and Testing of Methods

This compilation is an analytical product, and is designed to represent landscape parameters of the Greater Yellowstone Area. Hence it is called a "model" of a variety of landscape parameters. It represents reality to a certain level of accuracy, and depicts a level of generalization of these parameters. The model process should be tested to establish that accuracy and the feasibility of completion.

We completed a pilot project using three soil survey areas (Gallatin County, Gallatin National Forest, and Yellowstone National Park.) This step lasted six months and established the feasibility of the project. We developed joining methods, established criteria for survey areas, determined adequate spatial data was available, and created the attribute database design. We also tested its usefulness and discussed how the landscape model fits into the larger project context (Shovic, H. F, Maynard, C. L, and Nesser, J. A., 1999.)

Availability of Spatial Data

One of the most important benefits of this project is having coverage of the entire GYA, crossing administrative boundaries, as well as including public and private lands. Meeting this objective requires that there be enough data to make the project worthwhile. Criteria for inclusion in this project included the following, as of June 1999: 1) available, complete digital spatial data in published form or draft form that could be obtained without major effort; 2) attribute legend data in electronic form, either in database or word-processing format; and 3) recognized as a cooperative soil survey in progress or published, and following NRCS soil survey guidelines. Thirteen survey areas met these criteria.

This is now the case (Plate 8.) Eighty-seven percent of the GYA is covered by soil surveys, either completed or in on-going project status (ibid.)

Since the Landtype level project relies heavily on the operational and developmental benefits of Geographic Information Systems (GIS), it is essential to have digital representations of that data

(Plate 8.) Seventy-six percent of the federal land in the GYA is covered by digital data, either in final approved form or expected to be completed during the duration of this project. All of these data are in ARC/INFO ™ format, simplifying its integration.

Availability of Attribute Data

Most NRCS soil surveys on private land have extensive attribute databases. They have extensive, though well documented coding, and have a relatively standard format for both tables and attribute values. They are compiled on a "component" basis (one or more soil components making up a map unit). They are in relational data format, which means that there are numerous tables of interrelated information often in a complex data scheme, relating to map unit components. They are stored in a standardized database termed NASIS (National Soils Information System.)

Soil surveys on public lands have less standardized schema. They may be in a variety of database formats, from word-processing documents to individual data tables. They are seldom in standardized relational formats such as the private lands discussed above. However, attribute data are often much simpler to use with less extensive coding. They may have attributes compiled only at the map unit level, with no component information.

Pre-processing

From the 58 Candidate surveys areas, thirteen met our criteria. Inventories in the following administrative units qualified for, and were used in this analysis. Symbols in () indicate soil survey areas included from Table 1. These are Gallatin National Forest (MT623 and MT640), Gallatin County (MT622), Yellowstone National Park (WY665, ID782, and MT664), Grand Teton National Park and Teton County (WY666 and WY667), Shoshone National Forest (WY656), the Targhee portion of the Caribou-Targhee National Forest (WY664), and Bridger-Teton National Forest (WY661, WY662, and WY663.) Some units had multiple individual inventories, which were combined. These were the Teton (WY661), Bridger-East (WY662), Bridger-West (WY663), and John D. Rockefeller Parkway (WY667) surveys. This makes a total of ten individual inventories, in seven administrative units. Each inventory area was individually added to the model.

We first standardized each coverage. Data was projected to the model standard (UTM Zone 12, NAD 27, meters.) All variations of water body map units were renamed to "WATER." All map unit names were then prefixed with the appropriate GYA identifier. All unnamed units were identified or dissolved. All node, polygon, label, and intersection errors were repaired where necessary. All unit coverages were edgematched to adjoining units, appended, and dissolved if necessary as they were completed. Where background data was readily available, we modified some coverages on administrative boundaries to increase seamlessness. We did the digitizing on-screen using a background of digital topographic maps at the scale of the survey.

We kept the spatial database as clean of non-key attributes as possible. Only one attribute is directly tied to the database, a unique identifier for each map unit. The user can add attributes as desired, but is encouraged to use the attribute database for most tasks, since tools are readily available for its manipulation without directly affecting the spatial database, and temporary

categorizations can be easily attached to the spatial database for use in spatial analysis. All non-ARC attributes in each INFO file for each coverage were removed, save for the map unit label, which was standardized as "LABEL."

We examined each survey area's documentation and searched for electronic versions, discovering a variety of formats and a variable level of consistency within formats. We converted data to standard format and imported it to the standard database. A significant programming effort was required, to efficiently and accurately import the large volume of data, the variety of formats, and the priority to make the model development process repeatable. We provide program listings below where VISUAL BASIC ™ programming was used. However, we mean these only as examples of the procedures. Contact the author for complete listings for all survey areas.

Unit Processing

Because of the variety within survey areas, some customization was necessary for each. Below are summaries of processes unique to each area. Symbols in () refer to the GYA identifier used for each area.

Gallatin National Forest (GLNF)

Source information was obtained from the Forest (Davis, C. E. and H. Shovic, 1996.) This coverage was complete for all area in Forest boundaries, including wilderness. It was modified with four surrounding surveys; Shoshone N. F., Yellowstone National Park, the Targhee N. F., and Gallatin County. Unit delineations were extended back and forth across the Gallatin National Forest boundary to afford a seamless match between surveys. Units were extended to natural limits, generally less than 1 km into the neighboring unit. For Gallatin County/Gallatin National Forest matches, units were extended only into the Forest.

We derived the legend database from import of the existing DBASE legend. No components were defined, so component fields are empty in the standard table. NASIS data was only in draft form so was not used.

Gallatin County (GLCO)

Source for this coverage and attribute data was the NRCS at the Montana State Office (Natural Resource Conservation Service, draft 1998.) This coverage was complete, save for "DA (Denied Access) map unit delineations near the Forest boundary. Unit delineations were extended across the adjoining Gallatin National Forest boundary.

The legend database was derived from NASIS (National Soils Information System) data, provided as an ACCESS ™ database export. VISUAL BASIC ™ programming was required to populate standard table fields with component-based data. The first program (Appendix One) populated the table with map unit names. The second (Appendix Two) populated the rest of the data fields using those map unit records.

Yellowstone National Park (YLNP)

Spatial data was obtained from the NPS Web site, and attribute data from Yellowstone National Park (Rodman, A., H. F. Shovic, and D. Thoma, 1996.) Spatial data were complete and easily converted to the standard. They were modified using four surrounding surveys; Shoshone N. F., John D. Rockefeller Parkway (part of Grand Teton National Park), the Targhee N. F., and Gallatin National Forest. Unit delineations were extended back and forth across the Yellowstone boundary to afford a seamless match between surveys. Units were extended to natural limits, generally less than 1 km into the neighboring unit.

Attribute data was in NASIS format, but were in draft form so not used. Most of this data was also in DBASE form derived from PARADOX ™ tables used in the soil survey process, so were imported directly (see listing in Appendix Three.) However, a great deal of additional map unit information is in PAGEMAKER ™, a proprietary format unusable programmatically. We used keyboard "cut and paste" for each page to bring the legend document into WORD ™ format. This was not used at this time in the development of the standard table. Using VISUAL BASIC ™ for import would enable use of these detailed data.

Grand Teton National Park and Teton County Area (GTNP)

The source for this survey data is a published survey (Young, 1975) and digital data on the NPS web site. Since this survey was quite old, the spatial data required some cleaning and updating to match to the hard-copy publication. Four percent of delineations and labels were changed. No electronic attribute data were available. Because of its central location in the GYA and the small extent of the area, we manually added attribute data from the hard-copy publication. We also added more recent survey information from the John D. Rockefeller Parkway (Rodman, A., D. Thoma, and H. Shovic. 1995). Attribute information was added from an electronic document in WORD ™ format. We seamlessly matched the spatial data to Yellowstone National Park and the remainder of Grand Teton National Park. We published these integrated data separately for the Park's convenience (Shovic, 2000.)

Shoshone National Forest (SHNF)

This survey was in draft form when we obtained it. Because of its currency, it was quite easy to import. Spatial data were obtained from the Shoshone National Forest (Houston, K. draft 2000), and attribute data came from the NRCS in a NASIS export database. VISUAL BASIC ™ was used to place data in the standard table.

Spatial data were seamlessly matched to the Gallatin National Forest and Yellowstone National Park by the author and the Shoshone National Forest. Further matching is in process by the Shoshone National Forest.

Targhee National Forest (TGNF)

Attribute data came from the published ecological unit inventory of the Targhee National Forest (Bowerman, T. S., et. al. 1997.) Spatial data were provided by the Targhee National Forest.

The NASIS database was published and available, and we extracted attributes including map unit symbols and names using VISUAL BASIC ™. For an example of this kind of programming see Appendices One and Two. We obtained additional information from map unit descriptions in WORD ™ using VISUAL BASIC ™ (see listing in Appendix Four.)

Though the word-processing documents were of sufficient accuracy for publication, there were many small in-consistencies and formatting symbols that would disturb any automated extraction process. Therefore, some pre-processing was needed to prepare data for import, such as standardizing numerical formats and providing consistent start and stop keys for map unit description separation, as well as for the proper handling of missing data items. We used VISUAL BASIC ™ programs in WORD ™ to do most of this work. The main extraction program was designed to run iteratively, trapping errors in format or syntax before adding data to the standard table. It also performed summary calculations for interdependent fields, such as percentage of each map unit component. We returned the individual standard table to the Targhee National Forest for their use in resource analysis on the Forest. This Forest has since merged with the Caribou National Forest, but no survey data was imported from the Caribou part.

Bridger Teton National Forest (BTNF)

Processing the Bridger Teton National Forest information was the most complex. In fact, we received supplementary funding from the Forest to complete this part of our project. We obtained spatial data from the Forest web site and GIS personnel, and attribute data from the Forest and from original authors. Original data were in three blocks (Bridger East, Bridger West, and Teton), and there were small areas of additional information in various coverages (Gros Ventre Wilderness, Shoal Creek Wilderness, and Palisades Wilderness Study Area.) These smaller areas used legends from the larger surveys. We gave each map unit label a suffix of “E”, “W”, or “T”, depending on the survey from which map units were derived. None of these coverages were edgematched and some had significant topological errors. We merged the three coverages, corrected topology, and dissolved boundaries of adjacent polygons having identical map unit labels. We did minor editing on edges between areas where they would enhance a seamless join. At the request of the Forest, we eliminated all units defined by landslide delineators (ending in “LS”.) We clipped the Bridger coverage from the edgematched and merged GYA coverage, and returned it and standardized attribute tables to the Forest, including complete metadata.

For the Bridger East area we obtained NASIS data from the authors, and other attribute data in WORDPERFECT ™ word-processing format (Svalberg, T., D. Tart, D. Fallon, M. Ferwerda, E. Lindquist, and H. Fisk, 1997.) We used VISUAL BASIC ™ to attribute the standard legend table, using programs similar to those used for the Targhee National Forest for this process.

For the Teton area, we obtained WORDPERFECT ™ documents from the Forest (Nordin, J. and Melissa Blackwell, 1985.) This is a published soil survey in cooperation with the NRCS. We used VISUAL BASIC ™ to attribute the standard legend table. Since this is an older survey, no NASIS data were available, so we used programs similar to those used for the Targhee National Forest for this process.

For the Bridger West area, we obtained WORDPERFECT ™ documents from the Forest (Winthers, E. and R. Davis, 1995.) This is a published soil survey in cooperation with the NRCS. We used VISUAL BASIC ™ to attribute the standard legend table. Since this is an older survey, no NASIS data were available, so we used programs similar to those used for the Targhee National Forest for this process.

Final Processing for the GYA Landscape Model

We reviewed the final attribute database for consistency and accurate representation of the original data. We printed reports from each units' attribute tables and reviewed for accuracy. We found several unprintable (and invisible) characters (carriage returns and line feeds) embedded in text blocks. These were relics of the word processing extraction process and disturbed report writing and query processing. Since standard search/replace functions would not find these properly, we wrote a VISUAL BASIC ™ program to intercept and remove these (program listing in Appendix Five.)

The final GYA spatial data was error-checked for topology and completeness. We ran cross-checks to assure all labels in the spatial data corresponded with unique map unit labels in the database. We developed trial use applications to assure landscape parameters reasonably matched other geographic project data, and to show the usability of the attribute database.

THE GREATER YELLOWSTONE AREA LANDSCAPE MODEL

This document, the associated attribute and spatial databases, and representative programming and query examples are published electronically (see Appendix Six for details.) Plate 9. shows a schematic view of all delineations in the current version of the GYA landscape model. There are 1285 unique map units, 47,710 delineations, and a total areal coverage of 13,172,482 acres (5,330,714 ha.) This is about 85 percent of all federal lands in the GYA, and about 25 percent of the entire area including public and private lands. The attribute database has 70 attributes and 1285 records. Attributes are fully documented in our published metadata and in the ACCESS ™ database (see Appendix Six for reference.)

Usable scale is approximately 1:63,360 for 80 percent of the model. It is smaller for some wilderness areas, in particular for the Teton Wilderness (Plate 9.), where map unit delineations are much larger than for the rest of the Bridger Teton National Forest and larger for some county surveys.

We reduced complexity by standardizing formats of the legend. Instead of seven or eight separate legends in a variety of formats, we have produce one unified legend. Instead of a group of poorly matched ARC ™ coverages, all in different stages of completion, we have one large, unified layer, well correlated with the attribute database.

We accomplished seamless matching on about 14 percent of administrative boundaries (Plate 9.) This was because of time and resource constraints. Completing this would benefit the model's accuracy. Its benefits can be seen by comparing Plate 9 with Plate 12. The "Boundary" joins result in a much more natural looking surficial material map than where only "Cartographic" joins were completed.

This project resulted in a truly inter-agency product. We obtained and included spatial and attribute data from two counties in separate states, two National Park Service units, and four Forest Service units. With additional funding, we can add in spatial and attribute data from other units such as the Madison County, Montana; the Beaverhead National Forest; the Caribou National Forest; and final published data from the Shoshone National Forest. The Park County Soil Survey is underway, as is the Absaroka-Beartooth wilderness portion of the Custer National Forest. We can also add more attributes for units, such as individual map unit component for Yellowstone National Park. We can populate more GYA-wide fields, such as GYA-wide vegetation fields and GYA-wide landform fields.

The resulting product can be used on existing corporate software in all three agencies with existing hardware. Full documentation of methods and programming modules allow updates and evaluation for future projects.

Future management activities by government entities and private landholders can be enhanced using this scientific resource database. The product can be used for large scale interpretations of landscapes and soils in the GYA, ecosystem analysis at a variety of levels, an ecological framework for analyzing habitat fragmentation, as well as more detailed analyses that cross administrative boundaries

Though this publication marks the end of our modeling project, its productive life is just beginning. Though developing interpretive maps and tables are important uses of these data, the primary goal of the landtype level project was to provide the base resource layer, and production of interpretive maps is generally outside our scope and beyond our resources. However, the model's true value is only apparent in its use, hence our concluding section on present and potential uses.

APPLICATIONS

The GYA landscape model has been used in two projects. The first was a request from a university scientist working on a bird-habitat mapping project. He needed cross-boundary spatial data on landscapes having certain soil parent materials. We had just finished matching the two administrative units in his study area, and provided him the needed information. This request would have been impractical to fulfill without the landscape model because the spatial data existed only separately, in different formats and there was no unified legend across those boundaries.

The second request was from a group of hydrologists working in the Greater Yellowstone Area. They have rated stability-related features on a watershed basis. Most of these ratings are of sufficient quality for use in GYA-wide evaluations. However, one rating (watershed vulnerability) proved to be inconsistent, and the landscape model provided a systematic, consistent basis for re-evaluation of that feature across the GYA. This project is in process.

Completing projects such as describe above shows the practicality of the model's structure. It has a flexible, minimally structured organization. Since the model itself is not complex, its

strength in application is founded on the flexibility of the query process. This can be intricate, but is relatively non-limited by either the spatial or attribute database design.

Queries developed from these questions can be of two kinds, either "attribute" (dealing with the attribute database or legend), or "spatial" (dealing with the spatial relationships of map units combined with their attributes.) They can be relatively simple or complex, depending on the complexity of the question, the characteristics of the programming language, and the form of the base data.

SQL (Structured Query Language) queries are sufficient for most applications. However, more complicated decision structures require some programming in embedded VISUAL BASIC™ and these subroutines and functions are called through the SQL query or independently. The queries and VISUAL BASIC ™ programs described below are published in the attribute database (see Appendix Six for references.)

Using the Query Process

Perhaps the best way to discuss the query process used with the landscape model is by example. Below, we give a potpourri of potential uses, each illustrating aspects of the query building process. We feel this will give the reader a perspective on its usefulness and applicability from a management perspective.

Some management questions primarily address the attribute database, such as "where are all soils having volcanic ash as a significant component of the surface layer?" or "can we describe generalized surficial material classes and plot their location?" The spatial component is addressed by categorizing map units and plotting the spatial data.

Some management questions address the spatial data directly. For example, "where do map units having high drainage density lie next to map units having a high proportion of wet soils?", or "where do map units having a high talus component lie with respect to high-use roads?" Analysis and display of both the attribute and the spatial databases is needed to answer these questions.

The following examples illustrate the above kinds of questions, the basic programming philosophy used, and the application to the base spatial and attribute data. While we will describe the basic programming philosophy, we will not discuss in depth its application. This would go beyond the scope of this final report.

Generalization of Landtypes to Landtype Associations

The landtype association level of the ecological hierarchy (ECOMAP, 1993) is defined by general topography, geomorphic process, surficial geology, soil, patterns of potential natural communities, and climate. The system is designed to be hierarchical in that lower levels "fit" into higher ones. Higher levels are used in regional planning efforts where lower levels may be required for more local projects. In order to have properly-tiered planning efforts, the ecological data on which they are based should also be interlocking. We can use the GYA landscape model (which is based on landtype level data) to generalize to the landtype association level by using

the appropriate attributes, and dissolving polygons to produce the appropriate tiered model across the GYA.

Distribution of Volcanic Ash in Soils

The presence of a significant amount of volcanic ash or glass tends to increase productivity in otherwise poor soils. In fact, it may offset the effects of cold climate and low soil moisture in soils developed in rhyolite bedrock. A soil includes the text fragments “vitr” or “vitra” in its class name (Soil Survey Staff, 1998), if there is sufficient ash to affect productivity. Therefore, it is possible to locate all map units having these soil properties with the following query, written in SQL. See Table 2 for field descriptions.

```
UPDATE [Final 2000 GYA soil survey data] SET [Final 2000 GYA soil survey data].s63GYASoilHorizon = "vitric properties"
WHERE ((([Final 2000 GYA soil survey data].[s10SoilComponentOne]) Like "*vitri*" Or ([Final 2000 GYA soil survey
data].[s10SoilComponentOne]) Like "*vitra*")) OR ((([Final 2000 GYA soil survey data].[s11SoilComponentTwo]) Like "*vitri*" Or ([Final
2000 GYA soil survey data].[s11SoilComponentTwo]) Like "*vitra*"));
```

This query updates a field in the GYA legend if volcanic ash is present in either the first or second component of the map unit. This, in turn, is used to produce a map of its distribution (Plate 10.)

Cold Soils with Dark Surface Layers (Cryic Mollisols)

Soils with dark surface layers tend to have higher surface fertility and growth potential than those without that property. Soil temperature also influences that potential. It may be useful to know where these kinds of soils occur. Both of these properties can be inferred from the soil name. Average soil temperature is classified in the field “s7SoilTemperature” where “cryic” designates a relatively cold temperature regime. If the text fragment “olls” is present in the soil name, there is a darkened surface horizon (Soil Survey Staff, 1998.)

The most convenient way to answer this question in the database is to select a subset of cold (cryic) soils from the entire GYA Landscape legend, then select those having darkened surface layers (Mollisols.) The first query is titled “selects cryic map units only.”

```
SELECT [Final 2000 GYA soil survey data].s7SoilTemperature AS Expr1, [Final 2000 GYA soil survey data].*
FROM [Final 2000 GYA soil survey data]
WHERE ((([Final 2000 GYA soil survey data].[s7SoilTemperature])="cryic"));
```

The query below is applied to the that listed above to select all soils having the text fragments ”olls”, in upper or lower case in the first soil component of a map unit; or in greater than 30 percent of the second component. A field is updated if this is true. This, in turn, is used to make a map of Cryic Mollisols in the GYA (Plate10.)

```
UPDATE [selects cryic map units only] SET [selects cryic map units only].s63GYASoilHorizon = [s63GYASoilHorizon] & " cryic Mollisolls"
WHERE ((([selects cryic map units only].[s10SoilComponentOne]) Like "*olls*" Or ([selects cryic map units only].[s10SoilComponentOne])
Like "*OLLS*")) OR ((([selects cryic map units only].[s11SoilComponentTwo]) Like "*olls*" Or ([selects cryic map units
only].[s11SoilComponentTwo]) Like "*OLLS*") AND ((([selects cryic map units only].[s15SoilComponentTwo%])>=30));
```

Complex Queries for Vegetation from Geographical Subsets

Some questions are too complex for efficient programming in SQL. Also, some may apply only to geographical subsets of the GYA Landscape legend. Since each legend record has an identifier for administrative unit (s70SurveyArea), queries can be developed that re-classify landscape parameters for geographical subsets of the entire legend. In the following case, a table called "GTNP standard soil survey" has been selected from the larger legend. The query runs a VISUAL BASIC ™ program that re-classifies vegetation types according to a logical regime. Order of assignment is important to the results, so the logic of the function must be carefully reviewed during development.

```
UPDATE [GTNP standard soil survey] SET [GTNP standard soil survey].s66GYAVegetation  = vegetationclass([s35VegetationTypeSummary]);
```

The called function ("vegetationclass") is contained in the program listed in Appendix Seven. Other, similar queries calling different functions in this module were developed for generalized vegetation types, landforms, and soil surface textures. This was developed exclusively for Teton County, and therefore the field "S66GYAVegetation" is populated only for records in that administrative unit. Plate 11. shows generalized vegetation types for Teton County, Wyoming, including Grand Teton National Park. This map uses the field "s66GYAVegetation" for its legend, developed from the "vegetationclass" function in Appendix Seven.

Other Complex Queries

Some questions may be simple in concept, but because of data structure, may result in complex logical structures. This structure is too complex for SQL because of multiple branching requirements. These are developed entirely in VISUAL BASIC ™.

Appendix Eight contains an example of classifying parent or surficial material for the entire GYA Landscape legend. A relatively simple program works for those map units in Grand Teton National Park (Appendix Seven.) However, applying this over the entire GYA Landscape legend is more involved (see Appendix Eight.) Some values in applicable fields are highly text oriented. Some have slightly different terminology, and some designations may be unclear without close examination. Depending on the administrative unit, relevant information may be in different fields. Therefore, more advanced logical regimes are needed and a complete description is beyond the scope of this paper. Once completed, however, completion of a GYA-wide surficial material map is possible (Plate 12.) This map depicts a usable number of standardized classes from a large number of individual surficial material descriptions in a variety of formats and syntax.

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APPENDICES

Appendix One. VISUAL BASIC ™ program to extract tabular map unit labels from a table exported from NASIS, to the appropriate database field for Gallatin County.

```
Option Compare Database
Option Explicit

'-----------------------------------------------------------
' sub to populate GYA standard table for GALLCO Soil data (mu symbol only)
'henry Shovic   09-02-98
'
'-----------------------------------------------------------
Sub GYAStandard()

Dim mapunitsummary As Recordset
Dim dbs As Database

Dim GLCOstandard As Recordset
Set dbs = CurrentDb


Set mapunitsummary = dbs.OpenRecordset("Mapunit map unit ids and names")
Set GLCOstandard = dbs.OpenRecordset("GLCO Standard GYA soil survey data")

'modify the record, adding new records for GLCOstandard as mu symbols are added from Mapunitsummary
'go to first record for mapunitsummary  THIS SUB ASSUMES THERE IS ONLY ONE RECORD IN GLCOSTandard with a value of
'"dummy" in the first field.

mapunitsummary.MoveFirst
GLCOstandard.MoveFirst

nextrecord:

If mapunitsummary.EOF = True Then GoTo finish

    'add new values in GLCOStandard fields
    GLCOstandard.AddNew
    GLCOstandard!MapUnitSymbol = "GLCO" & mapunitsummary![musym:c]
    GLCOstandard!MapUnitSymbolLocal = mapunitsummary![musym:c]
   GLCOstandard!NRCSmuid = mapunitsummary![muid:c]
   'update the record
    GLCOstandard.Update
    mapunitsummary.movenext

GoTo nextrecord
finish:
End Sub
```

Appendix Two. VISUAL BASIC ™ program to extract tabular data from a set of tables exported from NASIS, to the appropriate database fields for Gallatin County.

```
Option Compare Database
Option Explicit

'-----------------------------------------------------------
' sub to populate GYA standard table for remainder of GLCO Soil data (single tables only)
'one table at a time, in the recordset from the object mapunitsummary
'henry Shovic   09-02-98
'
'-----------------------------------------------------------
Sub GYAStandardremainder()

Dim mapunitsummary As Recordset
Dim ntech As Recordset, deslink As Recordset
Dim dbs As Database, currentmusymbol As String

Dim GLCOstandard As Recordset
Dim stmu As Recordset, stmumusymbol As String
Set dbs = CurrentDb
Set mapunitsummary = dbs.OpenRecordset("mapunit map unit ids and names")
Set GLCOstandard = dbs.OpenRecordset("GLCO Standard GYA soil survey data", dbOpenTable)
Set stmu = dbs.OpenRecordset("stmu elevation and precip ranges for map units (state)", dbOpenTable)
Set ntech = dbs.OpenRecordset("ntechdes non-tech desc map unit (not linked)", dbOpenTable)
Set deslink = dbs.OpenRecordset("deslink link from ntechdes to map unit components", dbOpenTable)
'go to first record for mapunitsummary  THIS SUB ASSUMES THERE is a record for each map unit with unique symbols

'MAPUNITSUMMARY TABLE

mapunitsummary.MoveFirst
GLCOstandard.MoveFirst
GLCOstandard.Index = "primarykey"
mapunitsummary.Index = "primarykey"
stmu.Index = "primarykey"
nextrecord:

If GLCOstandard.EOF = True Then GoTo finish

   'add new values in GLCOStandard fields from mapunitsummary

      'add field values from mapunitsummary
   'find equivalent records  (same mapunitsymbol)
   currentmusymbol = GLCOstandard!MapUnitSymbolLocal
   mapunitsummary.Seek "=", currentmusymbol


   GLCOstandard.Edit
   GLCOstandard!mapunitname = mapunitsummary![muname:c]

   'STMU table
   'first, modify the currentmusymbol for the format in stmu, which requires a three digit numerical code in the muid at all times, unless it is
alpha, then no change
   '    so,   12C must be 012C, and then converted to 622012C, but W does not change, so converts to 622W; some have
   'There is one manual change, that of musym = 560.  This change is specific to this unit.
   If currentmusymbol = "560" Then GoTo assign
   If Len(currentmusymbol) = 3 And Val(currentmusymbol) <> 0 Then currentmusymbol = "0" & currentmusymbol
   If Len(currentmusymbol) = 2 And Val(currentmusymbol) <> 0 Then currentmusymbol = "00" & currentmusymbol

assign:     stmumusymbol = Mid(stmu![stssaid:c], 3) & currentmusymbol


   'find the map unit values in the STMU table
   stmu.Seek "=", stmumusymbol
   If stmu.NoMatch = True Then GoTo error1
   GLCOstandard![elevationrangehigh] = stmu![elevh:i]
   GLCOstandard![elevationrangelow] = stmu![elevl:i]

  'update the record
```

```
    GLCOstandard.Update
GLCOstandard.movenext

GoTo nextrecord



finish:
Exit Sub
error:
MsgBox ("no match for record  " & currentmusymbol & " in mapunitsummary table."): Exit Sub
error1:
MsgBox ("no match for record  " & currentmusymbol & " in stmu table."): Exit Sub
End Sub
```

Appendix Three. VISUAL BASIC ™ program to extract data from an existing DBASE database (converted to ACCESS ™) and distribute it to appropriate database fields (Yellowstone National Park.)

```
Option Compare Database
Option Explicit

'-----------------------------------------------------------
' sub to populate GYA standard table for remainder of Yellowstone Soil data
'henry Shovic   08-30-98
'
'-----------------------------------------------------------
Sub GYAStandardremainder()

Dim mapunitsummary As Recordset
Dim dbs As Database, currentmusymbol As String

Dim YELLstandard As Recordset
Dim YELLPercent As Recordset

Set dbs = OpenDatabase("F:\data\Wordperfect\gya soils\Yellowstone\YELL soil survey.mdb")

Set mapunitsummary = dbs.OpenRecordset("map unit summary")
Set YELLstandard = dbs.OpenRecordset("YELL Standard GYA soil survey data", dbOpenTable)
Set YELLPercent = dbs.OpenRecordset("YELL_mucomponents and area%", dbOpenTable)
'modify the record, adding new records for YELLstandard as mu symbols are added from Mapunitsummary
'go to first record for mapunitsummary  THIS SUB ASSUMES THERE is a record for each map unit with unique symbols
mapunitsummary.MoveFirst
YELLstandard.MoveFirst
YELLstandard.Index = "primarykey"
nextrecord:

If mapunitsummary.EOF = True Then GoTo finish

    'add new values in YELLStandard fields from mapunitsummary
    'find equivalent records  (same mapunitsymbol)
    currentmusymbol = "YELL" & mapunitsummary!MU
    YELLstandard.Seek "=", currentmusymbol
    If YELLstandard.NoMatch = True Then GoTo error
    'add field values
    YELLstandard.Edit
    YELLstandard!LandformSummary = mapunitsummary!Landforms
    YELLstandard!parentmaterialsummary = mapunitsummary![Parent Material]
    YELLstandard!vegetationtypesummary = mapunitsummary!Vegetation
    YELLstandard!soilcomponentOne = mapunitsummary!COM1
    YELLstandard!soilcomponenttwo = mapunitsummary!COM2
    YELLstandard!soilcomponentthree = mapunitsummary!COM3
    YELLstandard!dissimilarsoils = mapunitsummary!DI
    YELLstandard!Soilssummary = mapunitsummary![Soil Summary]

   'update the record
    YELLstandard.Update
    mapunitsummary.movenext

GoTo nextrecord



finish:
Exit Sub
error:
MsgBox ("no match for record  " & currentmusymbol)
End Sub
```

Appendix Four. VISUAL BASIC ™ program to extract text from a word processing document and distribute it to appropriate database fields (Targhee National Forest.)

```
Sub extractionfromMSWorddocToTable()

' sub to populate GYA standard table for TGNF Soil data from an MS WORD document.
'H.Shovic   02/22/2000  version 2.5

'this procedure generates the standard table from map unit descriptions.  It requires a blank table with no map unit symbols or any other records
'-------------------------------------------------------------
'

' define variables

Dim myrange As Range, message, title, default, myvalue
Dim checkrange As Range
Dim currentstartpos, currentendpos, pagecount As Long

Dim s2, s4, s5, s19, s13 As String
Dim response
Dim sst(10 To 13), s36, s37, svt(41 To 44), sht(46 To 49), s7 As String
Dim s17, stp(14 To 17), slf(21 To 24), s52, s53, s54, s55, s8, i, j, k As Integer


'initialize all map unit and component variables

s2 = s4 = s5 = s19 = s13 = s36 = s37 = ""
s17 = s52 = s53 = s54 = s55 = 0
   For j = 10 To 13
      sst(j) = " "
      sht(j + 36) = " "
      svt(j + 31) = " "
      stp(j + 4) = 0
      slf(j + 11) = 0
   Next
s8 = 0
s7 = "cryic"

'Open the document of interest as source data
message = "enter a path to the document of interest"
title = "document"
myvalue = InputBox(message, title)
Documents.Open FileName:=myvalue
'add a new temp document for individual map unit descriptions
Documents.Open FileName:="F:\data\gyasdbase\TGNF\temp.doc"

Documents(myvalue).Activate
Dim dbs As Database
Dim TGNFstandard As Recordset

'open the standard GYA table

Set dbs = OpenDatabase(Name:="F:\data\gyasdbase\TGNF\Targhee NF soil survey data modified from nasismdb.mdb")


Set TGNFstandard = dbs.OpenRecordset("TGNF Standard GYA soil survey data")


'initialize  start of range for doc beginning

pagecount = 0
currentstartpos = 0
' set range for  the page having map unit information
'make sure start at beginning of document
Selection.HomeKey unit:=wdStory, Extend:=wdMove

nextmapunitdescription:

' add a blank record
```

```
TGNFstandard.AddNew

'set range to current start position and extending to end of document
ActiveDocument.Range.SetRange Start:=currentstartpos, End:=ActiveDocument.Content.End

'find start character for this map unit description, which
'will always be first in the document.

    Selection.HomeKey unit:=wdStory, Extend:=wdMove
    Selection.Find.ClearFormatting
    With Selection.Find
        .Text = "Ñ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindStop
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute
    'if document end, go to finish
     If Selection.Find.Found = False Then GoTo finish:
    currentstartpos = Selection.Start - 4

    'find end character for this map unit description

    Selection.Find.ClearFormatting
    With Selection.Find
        .Text = "Ñ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindStop
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute
    currentendpos = Selection.End - 5
    'last map unit description in document check  if no second symbol can be found, select to end of document
    'and continue
        If Selection.Find.Found = False Then currentendpos = ActiveDocument.Content.End

'make a new temporary document of this selection
pagecount = pagecount + 1
Documents("F:\data\gyasdbase\TGNF\temp.doc").Activate
'clear temp document text
        Selection.WholeStory
        Selection.Delete

Documents(myvalue).Activate


Selection.Start = currentstartpos
Selection.End = currentendpos
Selection.Cut  'reducing the document for each map unit description
Documents("F:\data\gyasdbase\TGNF\temp.doc").Activate

Selection.Paste


 'move to beginning of range
 Selection.Start = ActiveDocument.Range.Start
Selection.Collapse
 'initialize map unit variables
```

```
s2 = s4 = s5 = s19 = s13 = s36 = s37 = ""
s17 = s52 = s53 = s54 = s55 = 0
s8 = 0
s7 = "cryic"
'extract all map unit description data

    'find symbol

    Selection.MoveUp unit:=wdLine, Count:=1, Extend:=wdMove
    Selection.Find.ClearFormatting
    With Selection.Find
        .Text = "Ñ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindStop
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute
    If Selection.Find.Found = False Then GoTo error
    Selection.Collapse Direction:=wdCollapseStart
    Selection.MoveLeft unit:=wdCharacter, Count:=5, Extend:=wdExtend
    s2 = Selection.Text

    'extract name

     Selection.Collapse Direction:=wdCollapseEnd
    Selection.Find.ClearFormatting
    With Selection.Find
        .Text = "slopes"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindStop
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute
    If Selection.Find.Found = False Then GoTo error
        Selection.Start = Selection.End
        Selection.MoveUp unit:=wdParagraph, Count:=1, Extend:=wdExtend
        'Selection.MoveRight unit:=wdCharacter, Count:=2, Extend:=wdExtend
        s4 = Selection.Text

    'extract slope low range and high range (s54 and s55)

    Selection.Find.ClearFormatting
        With Selection.Find
            .Text = " percent"
            .Replacement.Text = ""
            .Forward = True
            .Wrap = wdFindStop
            .Format = False
            .MatchCase = False
            .MatchWholeWord = False
            .MatchWildcards = False
            .MatchSoundsLike = False
            .MatchAllWordForms = False
        End With
        Selection.Find.Execute
        If Selection.Find.Found = False Then GoTo error
        Selection.Collapse Direction:=wdCollapseStart
        Selection.MoveStart unit:=wdWord, Count:=-1
        'Selection.MoveLeft unit:=wdWord, Count:=1, Extend:=wdExtend
```

```
    s55 = Selection.Text

    Selection.MoveLeft unit:=wdWord, Count:=2, Extend:=wdMove
    'Selection.MoveRight unit:=wdCharacter, Count:=1
    Selection.MoveStart unit:=wdWord, Count:=-1
    'Selection.MoveRight unit:=wdWord, Count:=1, Extend:=wdExtend
    s54 = Selection.Text

'extract summary (S5)

Selection.Collapse Direction:=wdCollapseEnd
Selection.Find.ClearFormatting
    With Selection.Find
        .Text = "Summary"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindStop
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
Selection.Find.Execute
If Selection.Find.Found = False Then GoTo error
Selection.MoveRight unit:=wdWord, Count:=2
Selection.MoveDown unit:=wdParagraph, Count:=1, Extend:=wdExtend
s5 = Selection.Text



'extract landform (s19)

Selection.Collapse Direction:=wdCollapseEnd
Selection.Find.ClearFormatting
With Selection.Find
    .Text = "Landform:"
    .Replacement.Text = ""
    .Forward = True
    .Wrap = wdFindStop
    .Format = False
    .MatchCase = False
    .MatchWholeWord = False
    .MatchWildcards = False
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
Selection.Find.Execute
If Selection.Find.Found = False Then GoTo error
Selection.MoveRight unit:=wdWord, Count:=1
Selection.MoveDown unit:=wdParagraph, Count:=1, Extend:=wdExtend
s19 = Selection.Text

  'extract elevation low range and high range (s52 and s53)

Selection.Collapse Direction:=wdCollapseEnd
Selection.Find.ClearFormatting
With Selection.Find
    .Text = "Elevations:"
    .Replacement.Text = ""
    .Forward = True
    .Wrap = wdFindStop
    .Format = False
    .MatchCase = False
    .MatchWholeWord = False
    .MatchWildcards = False
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
Selection.Find.Execute
```

```
    If Selection.Find.Found = False Then GoTo error
        Selection.MoveRight unit:=wdCharacter, Count:=2, Extend:=wdMove
        Selection.MoveRight unit:=wdWord, Extend:=wdExtend
        s52 = Selection.Text

        Selection.MoveRight unit:=wdCharacter, Count:=4, Extend:=wdMove
        Selection.MoveRight unit:=wdWord, Extend:=wdExtend
        s53 = Selection.Text



    '
    'component loop extraction

    'extract component data

    'loop for up to 4 components including dissimilar, IF dissimilar (contrasting)
    'inclusion, write to s13 and s17, and go to next map unit description.


    'component names and percentage   Note that soil components are in here also (see below under Soils)
        For i = 10 To 13
componentfind:

            'initialize component variables
              For k = i To 13
                  sst(k) = " "
                  sht(k + 36) = " "
                  svt(k + 31) = " "
                  stp(k + 4) = 0
                  slf(k + 11) = 0
             Next
            Selection.Find.ClearFormatting
            Selection.Collapse Direction:=wdCollapseEnd
            With Selection.Find
                .Text = "("
                .Replacement.Text = ""
                .Forward = True
                .Wrap = wdFindStop
                .Format = False
                .MatchCase = False
                .MatchWholeWord = False
                .MatchWildcards = False
                .MatchSoundsLike = False
                .MatchAllWordForms = False
            End With
            Selection.Find.Execute
            'if bold, assume component "(", otherwise find the next one.

                If Selection.Font.Bold = False Then GoTo componentfind

            'if no more components, go to next mapunit description

                If Selection.Find.Found = False Then GoTo nextmapunitdescription

            'extract name

            Selection.MoveLeft unit:=wdCharacter, Count:=1
            Selection.HomeKey unit:=wdLine, Extend:=wdExtend

            'if contrasting inclusions just extract name, place name in dissimilar variable  (s17)

            sst(i) = Selection.Text
            If sst(i) Like "Contrasting*" Then s13 = sst(i)

            'extract component % (s14, 15, 16) 17 for dissimilar  do sep for dissimilar
             Selection.Collapse Direction:=wdCollapseEnd

            Selection.MoveRight unit:=wdCharacter, Count:=1

            Selection.MoveRight unit:=wdWord, Count:=1, Extend:=wdExtend
```

```
        stp(i + 4) = Selection.Text

        'if contrasting inclusions just extract percentage, place name in dissimilar variable  (s17) and go to write, then next map unit description
          If sst(i) Like "Contrasting*" Then s17 = stp(i + 4): sst(i) = " ": stp(i + 4) = 0: Exit For

        'continue with properties of the component

        Selection.Find.ClearFormatting
        Selection.Collapse Direction:=wdCollapseEnd
        With Selection.Find
            .Text = "Landform position:"
            .Replacement.Text = ""
            .Forward = True
            .Wrap = wdFindStop
            .Format = False
            .MatchCase = False
            .MatchWholeWord = False
            .MatchWildcards = False
            .MatchSoundsLike = False
            .MatchAllWordForms = False
        End With
        Selection.Find.Execute
        If Selection.Find.Found = False Then GoTo error
        Selection.MoveRight unit:=wdCharacter, Count:=1
        Selection.EndKey unit:=wdLine, Extend:=wdExtend

        slf(i + 11) = s19 + ": " + Selection.Text
       'if rock outcrop or rubble, go to next component
          If sst(i) Like "*Rock*" Or sst(i) Like "*rock*" Or sst(i) Like "*Rubble*" Or sst(i) Like "*rubble*" Then
            GoTo componentend
          End If

        ' extract natural community  to s46, 47, 48 (habitat types)

        Selection.Find.ClearFormatting
        Selection.Collapse Direction:=wdCollapseEnd
        With Selection.Find
            .Text = "Present Vegetation"
            .Replacement.Text = ""
            .Forward = True
            .Wrap = wdFindStop
            .Format = False
            .MatchCase = False
            .MatchWholeWord = False
            .MatchWildcards = False
            .MatchSoundsLike = False
            .MatchAllWordForms = False
        End With
        Selection.Find.Execute
        If Selection.Find.Found = False Then GoTo error
        j = 1 'count for not found
nextpotentialvegetation:        'add all lines of potential natural community
          j = j + 1
         ' Selection.MoveEnd unit:=wdLine
        Selection.MoveStart unit:=wdLine, Count:=1
        Selection.Move unit:=wdCharacter, Count:=1
        Selection.MoveEnd unit:=wdParagraph
        If Selection.Text Like "*resent Vegetation*" Then GoTo presentvegetation 'Present vegetation
        s36 = "Potential Community types are equated to Habitat types and are in habitat type fields"

        'add all lines of potential natural vegetation
        sht(i + 36) = sht(i + 36) + ", " + Selection.Text
        'next line

        If j = 10 Then GoTo error

        GoTo nextpotentialvegetation

presentvegetation:        'add all lines of existing vegetation (s41, 42, 43)
```

```
        j = 1
nextpresentvegetation:
            Selection.Collapse Direction:=wdCollapseEnd
             j = j + 1
           'Selection.MoveStart unit:=wdLine, Count:=1
             Selection.Move unit:=wdCharacter, Count:=1
          Selection.MoveEnd unit:=wdParagraph
          If Selection.Text Like "*oils*" Then GoTo Soils  'go to soils

          s37 = "yes" ' vegetation type fields have existing vegetation
          'add all lines of existing vegetation
          svt(i + 31) = svt(i + 31) + ", " + Selection.Text
          'next line
          If j = 10 Then GoTo error

          GoTo nextpresentvegetation
Soils:       'extract soil information from component and place append to soil component variables (s10, s11, s13)

          'soil name
          Selection.Collapse Direction:=wdCollapseEnd
          Selection.Find.ClearFormatting
          With Selection.Find
             .Text = "Name:"
             .Replacement.Text = ""
             .Forward = True
             .Wrap = wdFindStop
             .Format = False
             .MatchCase = False
             .MatchWholeWord = False
             .MatchWildcards = False
             .MatchSoundsLike = False
             .MatchAllWordForms = False
          End With
          Selection.Find.Execute
           Selection.MoveRight unit:=wdCharacter, Count:=2
           Selection.MoveEnd unit:=wdParagraph
             If Selection.Find.Found = False Then GoTo error
           sst(i) = sst(i) + "; " + Selection.Text

        'soil classification
          Selection.Collapse Direction:=wdCollapseEnd
          Selection.Find.ClearFormatting
          With Selection.Find
             .Text = "Taxonomic class:"
             .Replacement.Text = ""
             .Forward = True
             .Wrap = wdFindStop
             .Format = False
             .MatchCase = False
             .MatchWholeWord = False
             .MatchWildcards = False
             .MatchSoundsLike = False
             .MatchAllWordForms = False
          End With
          Selection.Find.Execute
          If Selection.Find.Found = False Then GoTo error
           Selection.MoveRight unit:=wdCharacter, Count:=2
           Selection.MoveEnd unit:=wdParagraph
           sst(i) = sst(i) + " (" + Selection.Text + ")"

               'add frigid to s7  Frigid overrides cryic for the map unit.
               If sst(i) Like "*frigid" Then
                  s7 = "frigid"
               End If


           'soil drainage class goes into soil component prefaced by " ;drainage class:"
           Selection.Collapse Direction:=wdCollapseEnd
           Selection.Find.ClearFormatting
          With Selection.Find
             .Text = "Drainage class:"
```

```
            .Replacement.Text = ""
            .Forward = True
            .Wrap = wdFindStop
            .Format = False
            .MatchCase = False
            .MatchWholeWord = False
            .MatchWildcards = False
            .MatchSoundsLike = False
            .MatchAllWordForms = False
          End With
          Selection.Find.Execute
           Selection.MoveRight unit:=wdCharacter, Count:=2
           Selection.MoveEnd unit:=wdParagraph
             If Selection.Find.Found = False Then GoTo error

        sst(i) = sst(i) + " ;drainage class: " + Selection.Text

        'soil drainage classes used to determine percentage wet areas in map unit (additive)
        Select Case Selection.Text
           Case "moderately well drained", "poorly drained", "somewhat poorly drained", "very poorly drained"
              s8 = stp(i + 4) + s8
        Case Else
      End Select


           'parent material is not extracted here.  IT was done manually.

componentend:
      Next  'end of map unit component extraction

writeoutvariables:
'write variables to the standard table
TGNFstandard!s1mapunitsymbol = "TGNF" + s2
TGNFstandard!s2MapUnitSymbolLocal = s2
TGNFstandard!s4mapunitname = s4
TGNFstandard!s5mapunitnotes = s5
TGNFstandard!s7soilTemperature = s7
TGNFstandard![s8wetareas%] = s8
TGNFstandard!s19landformsummary = s19
TGNFstandard!s52elevationrangelow = s52
TGNFstandard!s53elevationrangehigh = s53
TGNFstandard!s54sloperangelow = s54
TGNFstandard!s55sloperangehigh = s55

TGNFstandard!s10soilcomponentone = sst(10)
TGNFstandard!s11soilcomponenttwo = sst(11)
TGNFstandard!s12soilcomponentthree = sst(12)
TGNFstandard!s13dissimilarsoils = s13
TGNFstandard![s14soilcomponentone%] = stp(14)
TGNFstandard![s15soilcomponenttwo%] = stp(15)
TGNFstandard![s16soilcomponentthree%] = stp(16)
TGNFstandard![s17dissimilarsoils%] = s17
TGNFstandard!s21landformone = slf(21)
TGNFstandard!S22landformtwo = slf(22)
TGNFstandard!S23landformthree = slf(23)

TGNFstandard!s36vegetationtypesummarynotes = s36
TGNFstandard!s45habitattypesummarynotes = s36
TGNFstandard!s37vegetationexistingpotental = s37
TGNFstandard!s46habitattypeone = sht(46)
TGNFstandard!s47habitattypetwo = sht(47)
TGNFstandard!s48habitattypethree = sht(48)
TGNFstandard!s41vegetationtypeone = svt(41)
TGNFstandard!s42vegetationtypetwo = svt(42)
TGNFstandard!s43vegetationtypethree = svt(43)

'update the record

   TGNFstandard.Update
'next map unit
```

```
    'clear first document text and activate source document
        Selection.WholeStory
       Selection.Delete
    Documents(myvalue).Activate
    GoTo nextmapunitdescription

error:
MsgBox ("error")
MsgBox (pagecount)
response = MsgBox(s2, , "mapunit")
MsgBox (Selection.Text)
MsgBox (Selection.Find.Text)

    Stop

'end of document
finish:
Documents(myvalue).Close
MsgBox ("normal end")
MsgBox (pagecount)

End Sub
```

Appendix Five. VISUAL BASIC ™ program to search for and replace undesirable characters in the GYA Landscape Model legend, relict from word processing conversions.

```
Option Compare Binary
'Binary because otherwise will replace spaces with "%" signs.
Option Explicit
Public totalcounter As Integer



'-----------------------------------------------------------

'Henry Shovic  102400
'modified from AC2000 article Q210433  from MS knowledge base
'-----------------------------------------------------------

'==============================================================
    ' The following function will:
    '   - Find the linefeeds (chr 10)or carraige returns (chr 13) in a Text or Memo field.
    '   - Call another function to replace the returns.
    'THIS  WORKS ON TEXT or memo FIELDS.
    'THE QUERY MUST BE  RUN TWICE TO OPERATE PROPERLY
'==============================================================

    Function Findreturns(WhichField As String) As String

      Dim intCounter As Integer


      Dim strText As String
      Dim response As String
      Dim intStart As Integer

      intStart = 1
      totalcounter = 0
      intCounter = 1
      If (WhichField = "") Then Exit Function
      strText = WhichField

      Do Until intCounter = 0 Or totalcounter = 30
        ' Chr(10) is the linefeed character.  Chr(13) is the carriage return character.
        ' Replace Chr(10) or Chr(13)with the ANSI code for the character
        ' you are searching for.
        intCounter = InStr(intStart, strText, Chr(10))
        If intCounter = 0 Then intCounter = InStr(intStart, strText, Chr(13))
        intStart = intCounter + 1
        If intCounter > 0 And Not IsNull(intCounter) Then
          strText = ReplaceReturns(intCounter, strText)

        End If
      Loop

      Findreturns = strText

    End Function

    '=====================================================================
    ' The following function is called from the FindReturns() function. It
    ' accepts two arguments, intStart and strText. The function replaces returns
    ' with a blank. It returns the updated text.
    '=====================================================================

    Function ReplaceReturns(intStart As Integer, strText As String) As String

      Dim response As String
      Mid(strText, intStart, 1) = " "
      ReplaceReturns = strText
      response = MsgBox(strText)
      totalcounter = totalcounter + 1
```

```
End Function

Sub checkallfields()
'This sub checks fields in the table for returns and linefeeds.
'user inputs field name, and the query runs once.  It works on the "Final 2000 GYA soil survey data" table
'Shovic  111500

 totalcounter = 0
Dim field As String
Dim response As String

field = ""
 Do
    field = InputBox("enter field name (enter 'done' when done)", , field)
    If field = "done" Then Exit Sub
    Dim querytext As String
    querytext = "(UPDATE [Final 2000 GYA soil survey data] SET [Final 2000 GYA soil survey data]." & field & " = findreturns([" & field
& "]))"
    response = MsgBox(querytext)
    DoCmd.RunSQL (querytext)

 Loop
End Sub
```

Appendix Six. Publication Data

GYA_Landscape_Model_Attributes.mdb: Attribute DataBase in MS ACCESS 2000 ™ format. This includes example VISUAL BASIC ™ code for applications.

GYAJOIN.E00: ARC/INFO ™ export file containing spatial data.

GYASOILMETA.HTML: This html document contains standard metadata for the spatial and attribute databases.

README.TXT: File listing and contact information.

GYA landscape model publication… in pdf format
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406 587 6714
hshovic@fs.fed.us

Appendix Seven: VISUAL BASIC™ program for re-classifying parent material, landforms, generalized soil surface textures, and vegetation for the Grand Teton National Park segment of the GYA landscape model.

```
Option Compare Database
Option Explicit



'
'-----------------------------------------------------------
  Function parentclass(WhichField As String) As String
'This function adds a classified attribute to the field s62GYAParentMaterial in the GTNP standard soil survey table
'H. Shovic  110100  Version 1.0

'-----------------------------------------------------------
'
Dim parentmaterial As String

'ordered parent material class assignments follow.

    If WhichField = "colluvium and alluvium" Then parentclass = "colluvium and alluvium"

    If WhichField = "glacial outwash" Then parentclass = "glacial outwash"

    If (WhichField = "rock" Or WhichField = "talus slopes of granite and gneiss") Then parentclass = "rock"

    If InStr(WhichField, "residuum") <> 0 Then
        If InStr(WhichField, "rhyolite") <> 0 Then parentclass = "weathered rhyolite, volcanic conglomerate, or sandstone"
        If InStr(WhichField, "sandstone") <> 0 Then parentclass = "weathered rhyolite, volcanic conglomerate, or sandstone"
        If InStr(WhichField, "volcanic conglomerate") <> 0 Then parentclass = "weathered rhyolite, volcanic conglomerate, or sandstone"
        If InStr(WhichField, "limestone") <> 0 Then parentclass = "weathered limestone"
        If InStr(WhichField, "shale") <> 0 Then parentclass = "weathered shale and other rock types"
    End If

'All values having loess as a component become loess, with exceptions below

    If InStr(WhichField, "loess") <> 0 Then parentclass = "loess"

'all values having alluvium as a component become alluvium, overrides all others (exceptions below)

    If InStr(WhichField, "alluvium") <> 0 Then parentclass = "alluvium"

    If InStr(WhichField, "alluvial") <> 0 Then parentclass = "alluvium"

    If InStr(WhichField, "local alluvium") <> 0 Then parentclass = "colluvium from rhyolite"

    If InStr(WhichField, "glaciofluvial") <> 0 Then parentclass = "glacial outwash"

    If InStr(WhichField, "glacial till") <> 0 Then
        parentclass = "glacial till"
        If InStr(WhichField, "some glacial till") <> 0 And InStr(WhichField, "residuum") <> 0 Then parentclass = "weathered rhyolite, volcanic
conglomerate, or sandstone"
    End If

    If InStr(WhichField, "landslide") <> 0 Then parentclass = "landslide debris"

End Function

Function landclass(WhichField As String) As String

'This function adds a classified attribute to the field s58GYALandform in the GTNP standard soil survey table
'from the field s19LandformSummary
'H. Shovic  110100  Version 1.0

'-----------------------------------------------------------
'

'ordered landform class assignments follow.
```

```
    If WhichField = "stream bottoms" Then landclass = "braided stream channels on alluvial fans, low stream terraces, and flood plains"

    If WhichField = "alluvial basins" Then landclass = "braided stream channels on alluvial fans, low stream terraces, and flood plains"

    If InStr(WhichField, "alluvial fans") <> 0 Then landclass = "alluvial fans" ' all except for "stream terraces and alluvial fans"

    If InStr(WhichField, "valley bottoms") <> 0 Then landclass = "narrow valley bottoms"

    If InStr(WhichField, "plateaus") <> 0 Then landclass = "glaciated plateaus"

    If InStr(WhichField, "terraces") <> 0 Then landclass = "alluvial terraces"

    If InStr(WhichField, "river bottoms") <> 0 Then landclass = "braided stream channels on alluvial fans, low stream terraces, and flood plains"

    If WhichField = "alluvial terraces" Then landclass = "alluvial terraces"

    If InStr(WhichField, "loess mantled terraces") <> 0 Then landclass = "alluvial terraces"

    If InStr(WhichField, "stream terraces") <> 0 Then landclass = "alluvial terraces"

    If InStr(WhichField, "flood plains") <> 0 Then landclass = "braided stream channels on alluvial fans, low stream terraces, and flood plains"

    If InStr(WhichField, "floodplains") <> 0 Then landclass = "braided stream channels on alluvial fans, low stream terraces, and flood plains"

    If InStr(WhichField, "oxbow") <> 0 Then landclass = "braided stream channels on alluvial fans, low stream terraces, and flood plains"

    If WhichField = "glacial kettle landscapes" Then landclass = "glacial kettle plains"

    If WhichField = "glacial moraine" Then landclass = "glacial moraine"

    If InStr(WhichField, "mountain fronts") <> 0 Then landclass = "mountainsides"

    If InStr(WhichField, "mountain slopes") <> 0 Then landclass = "mountainsides"

    If InStr(WhichField, "mountainsides") <> 0 Or InStr(WhichField, "breaklands") <> 0 Then landclass = "mountainsides"

    If InStr(WhichField, "glaciated mountainsides") <> 0 Then landclass = "glaciated mountainsides, trough valleys, and headslopes"

    If InStr(WhichField, "glacial headslopes") <> 0 Then landclass = "glaciated mountainsides, trough valleys, and headslopes"

    If InStr(WhichField, "hills") <> 0 Then landclass = "hills, uplands, and mountain foothills"

    If InStr(WhichField, "bluffs") <> 0 Or InStr(WhichField, "buttes") Then landclass = "bluffs and buttes"

    If InStr(WhichField, "landslide") <> 0 Then landclass = "landslides"

End Function

Function textureclass(WhichField As String) As String

'
'-------------------------------------------------------------
'This function adds a classified attribute to the field s58GYASoilTexture in the GTNP standard soil survey table from
's18SoilSummaryNotes
'H. Shovic  110100  Version 1.0

'-------------------------------------------------------------
'ordered soil texture class assignments follow.


    If WhichField = "moderately-fine textured" Then textureclass = "moderately-fine textured"

    If InStr(WhichField, "medium") <> 0 Then textureclass = "medium textured"

    If InStr(WhichField, "moderately-fine") <> 0 Then textureclass = "moderately-fine textured"

    If WhichField = "moderately-fine textured, silty" Then textureclass = "moderately-fine textured, silty"

    If WhichField = "disturbed soils" Then textureclass = "disturbed soils, gravel pits"
```

```
    If InStr(WhichField, "shallow") <> 0 Then textureclass = "shallow, rocky soils, with exposed bedrock or talus"

    If InStr(WhichField, "coarse") <> 0 Then textureclass = "moderately-coarse to coarse textured"

End Function

Function vegetationclass(WhichField As String) As String

'
'-------------------------------------------------------------
'This function adds a classified attribute to the field s66GYAVegetation in the GTNP standard soil survey table from
's35VegetationTypeSummary
'H. Shovic  110300  Version 1.0

'-------------------------------------------------------------
'ordered vegetation class assignments follow.

    If InStr(WhichField, "barren") <> 0 Then vegetationclass = "barren or with lichens, moss, and some grasses"

    If InStr(WhichField, "lodgepole pine") <> 0 Then vegetationclass = "lodgepole pine forest"

    If InStr(WhichField, "grasses") <> 0 Or InStr(WhichField, "NonForest") <> 0 Then vegetationclass = "grasses and shrubs"

    If InStr(WhichField, "grasses") <> 0 And InStr(WhichField, "lodgepole") <> 0 Then vegetationclass = "grasses and shrubs with some
lodgepole pine forest"

    If InStr(WhichField, "spruce") <> 0 Then vegetationclass = "spruce-fir forest, grasslands and meadows"

     If InStr(WhichField, "dry lodgepole pine forests predominate, with some areas of moist spruce-fir forest.") <> 0 Then vegetationclass =
"lodgepole pine forest"

    If InStr(WhichField, "willow") <> 0 Or InStr(WhichField, "wet meadow") <> 0 Or InStr(WhichField, "wet and") <> 0 Then vegetationclass =
"grasses, sedges, willows, and bare gravel"

    If InStr(WhichField, "grasses, with some spruce-fir forest") <> 0 Then vegetationclass = "grasses, with some spruce-fir forest"

     If InStr(WhichField, "NonForest and moist spruce-fir Forest") <> 0 Then vegetationclass = "grasses, with some spruce-fir forest"

    If InStr(WhichField, "lodgepole pine forest with some grasses") <> 0 Then vegetationclass = "lodgepole pine forest"

    If InStr(WhichField, "lodgepole pine forest, some grasses") <> 0 Then vegetationclass = "lodgepole pine forest"

End Function
```

Appendix Eight. VISUAL BASIC ™ program to classify parent material types to a generalized parent material legend for all records in the GYA Landscape Model legend.

```
Option Compare Database
Option Explicit


'-----------------------------------------------------------
Sub GYAParentMaterialClassification()
'This sub classifies the GYA standardized legend into parent material classes.  This does not include rock types.  Classes are pre-defined, but are taken
'from observation of the legend and objectives of the work.  First given parent material class is used in both summary and in components, as this is the usual
'dominant class (when mapped).
'H.Shovic
'5152000  version 1.1

'initialize and dimension
Dim GYAstandard, querytable, temptable As DAO.Recordset, temp, tablename As String, sql, pm As Variant, parentsummary As String
Dim dbs As Database, updates, totalrecords, totalunclass, GYAParentMaterial, mycheckparent, mycheckcomponent
Set dbs = CurrentDb
Set GYAstandard = dbs.OpenRecordset("Final 2000 GYA soil survey data")
Set temptable = dbs.OpenRecordset("temptable")

GYAParentMaterial = " "


GYAstandard.MoveFirst

'delete records from temptable
Call EmptyTable_TSB("", "temptable")
updates = 0
totalrecords = 0
totalunclass = 0

nextrecord:

GYAstandard.Edit
GYAParentMaterial = " "
'delete records from temptable
tablename = "temptable"
Call EmptyTable_TSB("", tablename)


'IF statements for rules

'Named parent materials in parentmaterial summary ()
mycheckparent = IsNull(GYAstandard!s27ParentMaterialSummary)

If mycheckparent = True Then GoTo component
parentsummary = GYAstandard!s27ParentMaterialSummary
'find the start position for each parent material class words if it exists in the summary.



temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvium")
temptable!NAME = "alluvium"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "residuum")
temptable!NAME = "residuum"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "colluvium")
temptable!NAME = "colluvium"
temptable.Update
```

```
temptable.AddNew
temptable!Value = InStr(parentsummary, "till")
temptable!NAME = "till"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rubbleland")
temptable!NAME = "rubbleland"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rubble land")
temptable!NAME = "rubble land"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rock outcrop")
temptable!NAME = "rock outcrop"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rockoutcrop")
temptable!NAME = "rockoutcrop"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "earthflow dep")
temptable!NAME = "earthflow dep"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "mass failure dep")
temptable!NAME = "mass failure dep"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "landslide dep")
temptable!NAME = "landslide dep"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "local alluvium")
temptable!NAME = "local alluvium"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvial material")
temptable!NAME = "alluvial material"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvial sands")
temptable!NAME = "alluvial sands"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "loess")
temptable!NAME = "loess"
temptable.Update

temptable.AddNew
```

```
temptable!Value = InStr(parentsummary, "mass movement")
temptable!NAME = "mass movement"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "glaciofluvial")
temptable!NAME = "glaciofluvial"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "lacustrine")
temptable!NAME = "lacustrine"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "earthflow debris")
temptable!NAME = "earthflow debris"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "glacial outwash")
temptable!NAME = "glacial outwash"
temptable.Update

DoCmd.Close acTable, "temptable", acSaveYes

'compare field values to find minimum by removing "0" values and sorting in ascending order.  This gives the first record as the earliest
occurence record

tablename = "temptable1"
Call EmptyTable_TSB("", tablename)

Set querytable = dbs.OpenRecordset("SELECT temptable.value, temptable.name FROM temptable WHERE (((temptable.Value) > 0)) ORDER
BY temptable.value;")
If querytable.EOF = True Then GoTo component ' no records in temptable means no words matched
querytable.MoveFirst

GYAParentMaterial = querytable!NAME
'DoCmd.DeleteObject acTable, "temptable1"

GoTo updaterecord

component:

' use the first component only
mycheckcomponent = IsNull(GYAstandard!s29ParentMaterialOne)
'if component is empty and parent summary is empty add "not assigned",
'if component is not empty, proceed
'if component is empty and parent summary is not empty assign default and go to next record
If mycheckcomponent = True Then
      If mycheckparent <> True Then
         GYAParentMaterial = "colluvium and residuum from bedrock"
      Else
         GYAParentMaterial = "not assigned"
      End If

   GoTo updaterecord
End If


parentsummary = GYAstandard!s29ParentMaterialOne

'find the start position for each parent material class words if it exists in the component.


temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvium")
temptable!NAME = "alluvium"
temptable.Update

temptable.AddNew
```

```
temptable!Value = InStr(parentsummary, "residuum")
temptable!NAME = "residuum"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "colluvium")
temptable!NAME = "colluvium"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "till")
temptable!NAME = "till"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rubbleland")
temptable!NAME = "rubbleland"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rubble land")
temptable!NAME = "rubble land"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rock outcrop")
temptable!NAME = "rock outcrop"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "rockoutcrop")
temptable!NAME = "rockoutcrop"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "earthflow dep")
temptable!NAME = "earthflow dep"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "mass failure dep")
temptable!NAME = "mass failure dep"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "landslide dep")
temptable!NAME = "landslide dep"
temptable.Update


temptable.AddNew
temptable!Value = InStr(parentsummary, "local alluvium")
temptable!NAME = "local alluvium"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvial material")
temptable!NAME = "alluvial material"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvial sands")
```

```
temptable!NAME = "alluvial sands"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "loess")
temptable!NAME = "loess"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "mass movement")
temptable!NAME = "mass movement"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "glaciofluvial")
temptable!NAME = "glaciofluvial"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "lacustrine")
temptable!NAME = "lacustrine"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "earthflow debris")
temptable!NAME = "earthflow debris"
temptable.Update

temptable.AddNew
temptable!Value = InStr(parentsummary, "glacial outwash")
temptable!NAME = "glacial outwash"
temptable.Update

DoCmd.Close acTable, "temptable", acSaveYes

'compare field values to find minimum by removing "0" values and sorting in ascending order.  This gives the first record as the earliest
occurence record


Set querytable = dbs.OpenRecordset("SELECT temptable.value, temptable.name FROM temptable WHERE (((temptable.Value) > 0)) ORDER
BY temptable.value;")
' If still no records match,
'If component unmatched, and the summary is not empty (by definition if we have reached this far),
'assume   pm is residuum and colluvium from bedrock
'if summary is empty, assign "not assigned".
   If querytable.EOF = True Then
      GYAParentMaterial = "colluvium and residuum from bedrock"
      GoTo updaterecord
   End If
querytable.MoveFirst
GYAParentMaterial = querytable!NAME


'update the record
updaterecord:
   GYAstandard!s59GYAParentMaterial = GYAParentMaterial
   GYAstandard.Update
   updates = updates + 1
movenextrecord:
   totalrecords = totalrecords + 1
   GYAstandard.movenext
   If GYAstandard.EOF = True Then GoTo finish
GoTo nextrecord

finish:
totalunclass = totalrecords - updates
MsgBox ("normal end, totalrecords= " & totalrecords)
MsgBox ("totalunclass= " & totalunclass)
Exit Sub
error:
```

```
End Sub
Function EmptyTable_TSB(strDatabase As String, strTableName As String) As Integer
  ' Comments  : deletes all records from the named table
  ' Parameters: strDatabase - path and name of database to look in or "" (blank string) for the current database
  '             strTable - name of the table
  ' Returns   : True if successful, False otherwise
  '
  Dim dbsTemp As Database
  Dim strSQL As String

  On Error GoTo EmptyTable_TSB_Err

  If strDatabase = "" Then
    Set dbsTemp = CurrentDb()
  Else
    Set dbsTemp = DBEngine.Workspaces(0).OpenDatabase(strDatabase)
  End If

  strSQL = "DELETE * FROM " & strTableName & ";"
  dbsTemp.Execute strSQL



  EmptyTable_TSB = True

EmptyTable_TSB_EXIT:
  Exit Function

EmptyTable_TSB_Err:
  EmptyTable_TSB = False
  Resume EmptyTable_TSB_EXIT

End Function
```

PLATES

Plate 1. The Greater Yellowstone Area: Location and Extent

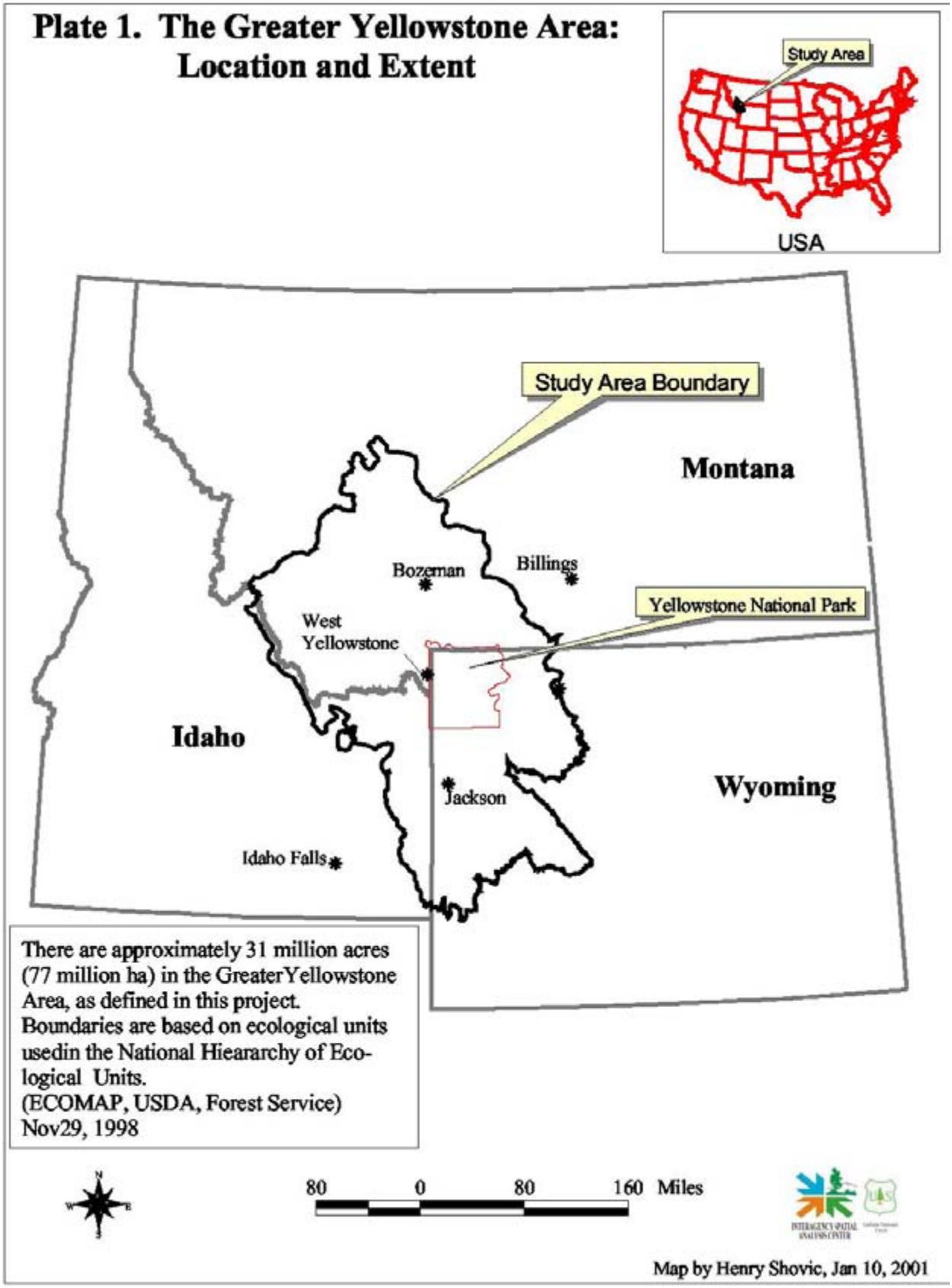


Plate 2. Land Ownership Status for the Greater Yellowstone Area

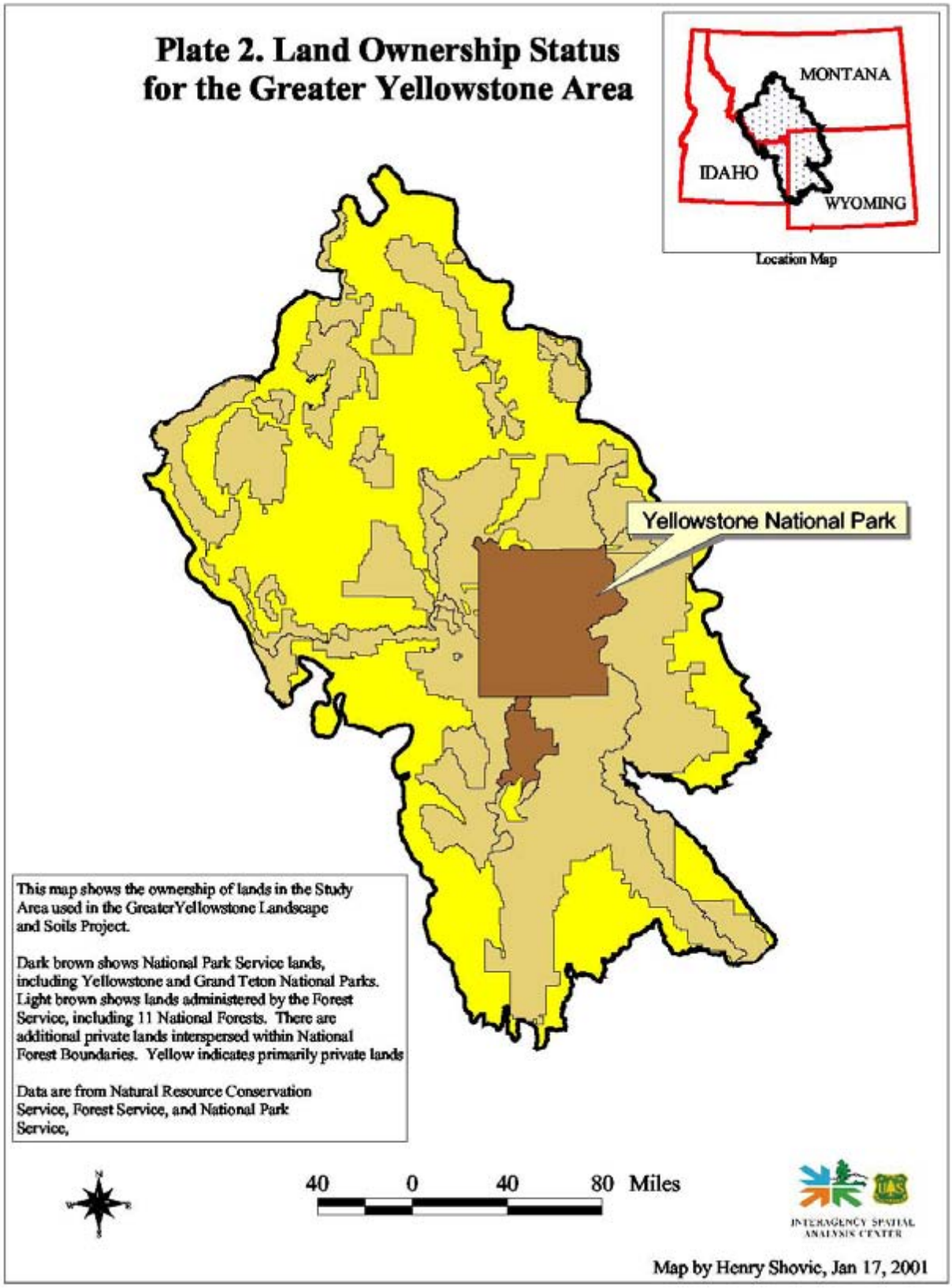


Plate 3. Soil Survey Areas in the GYA

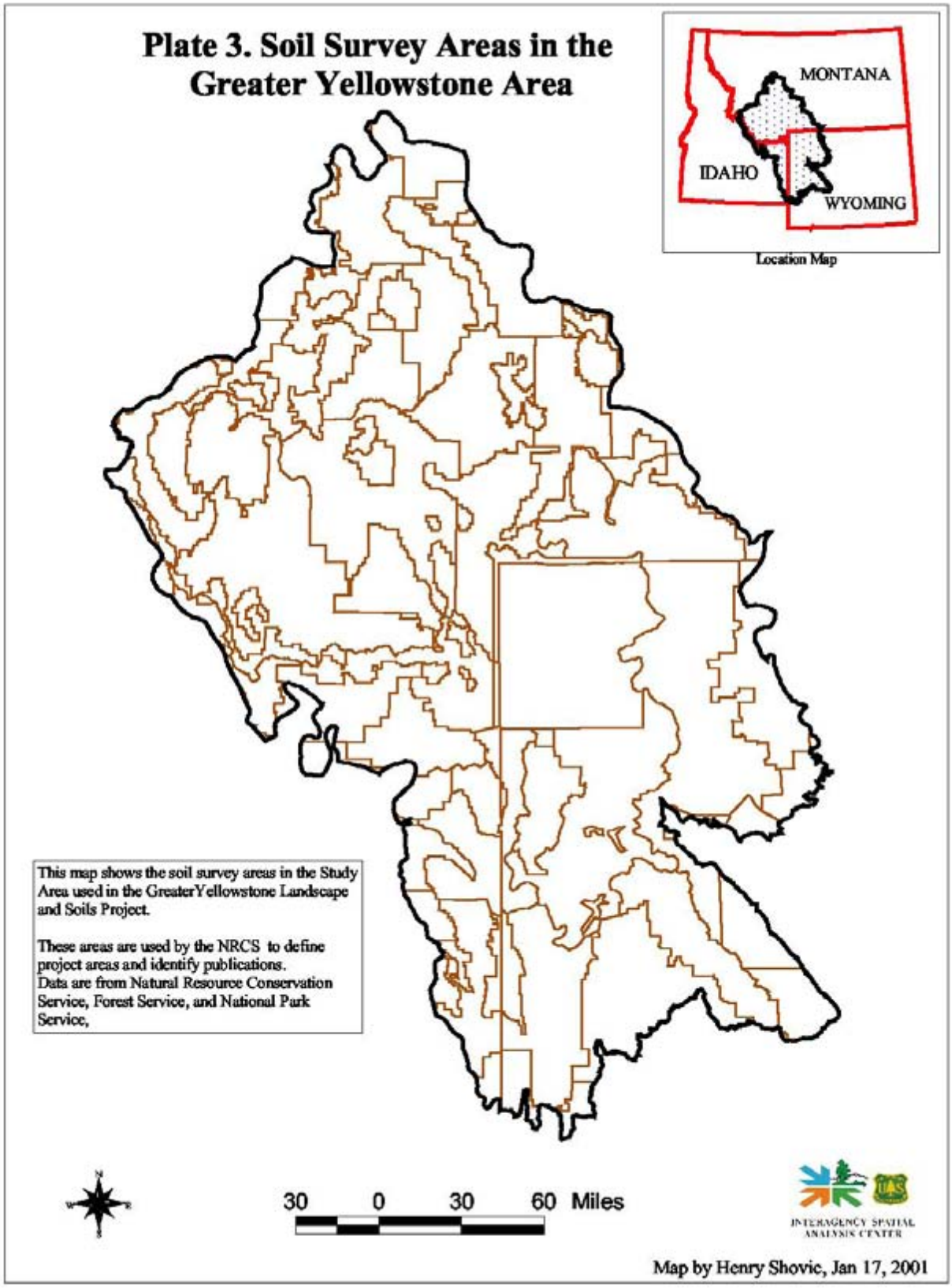


Plate 4. Ecological Units Defining the GYA

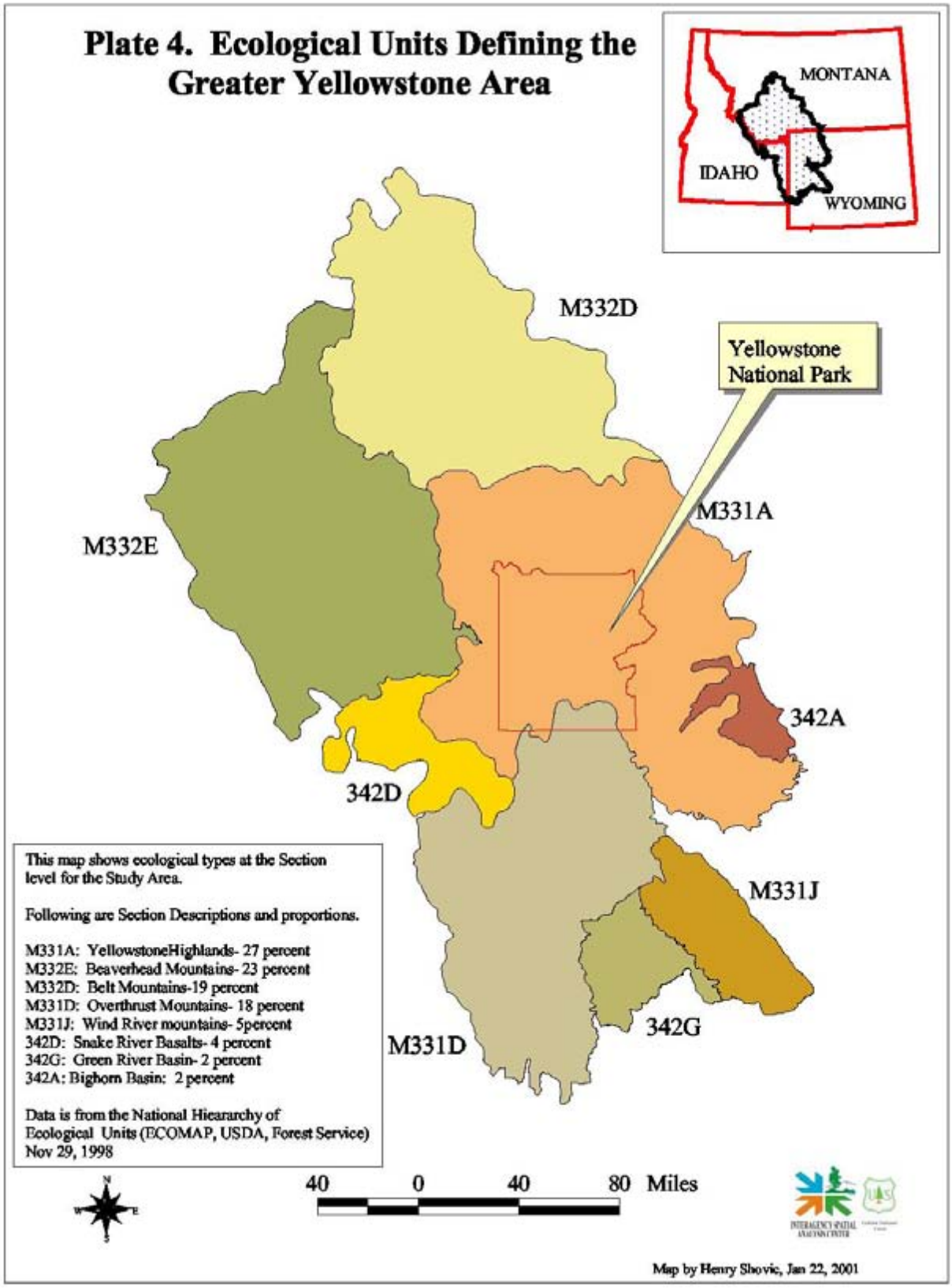


Plate 5. Closeup of Soil Survey Polygons without Boundary Matching

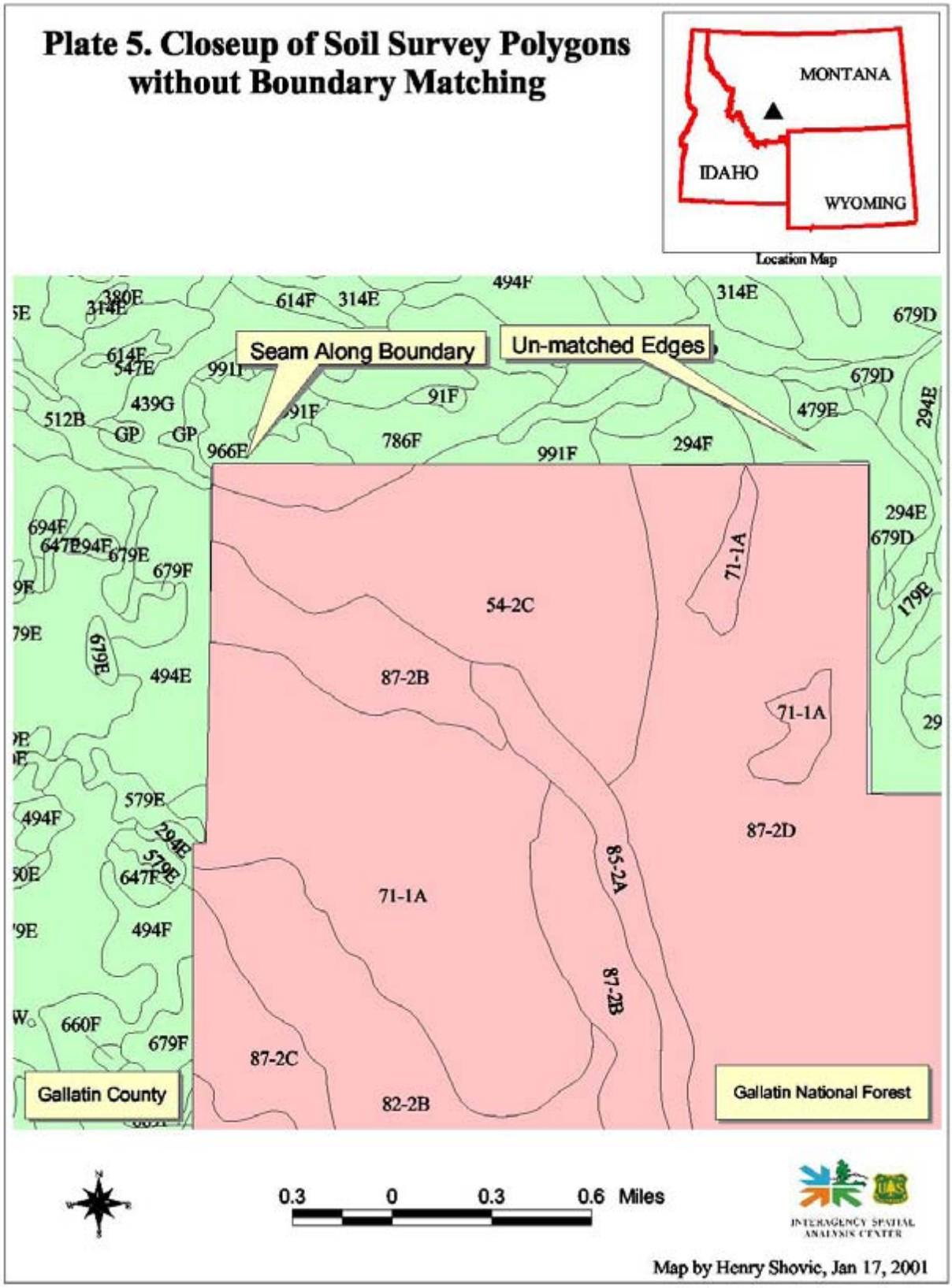


Plate 6. Closeup of Soil Survey Polygons with Boundary Matching

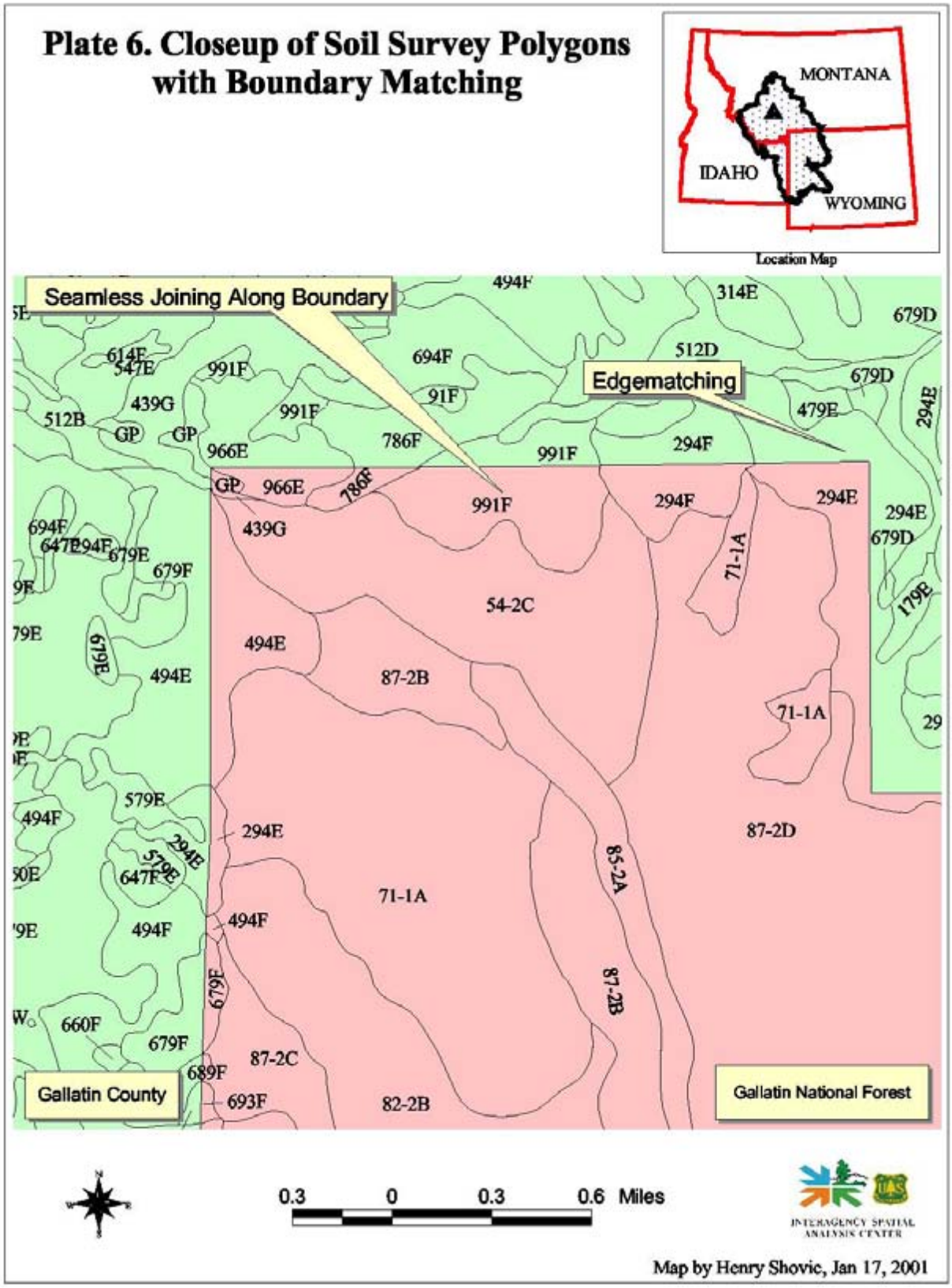


Plate 7. Join Concepts for Polygons in Gallatin County and the Gallatin National Forest Soil Surveys

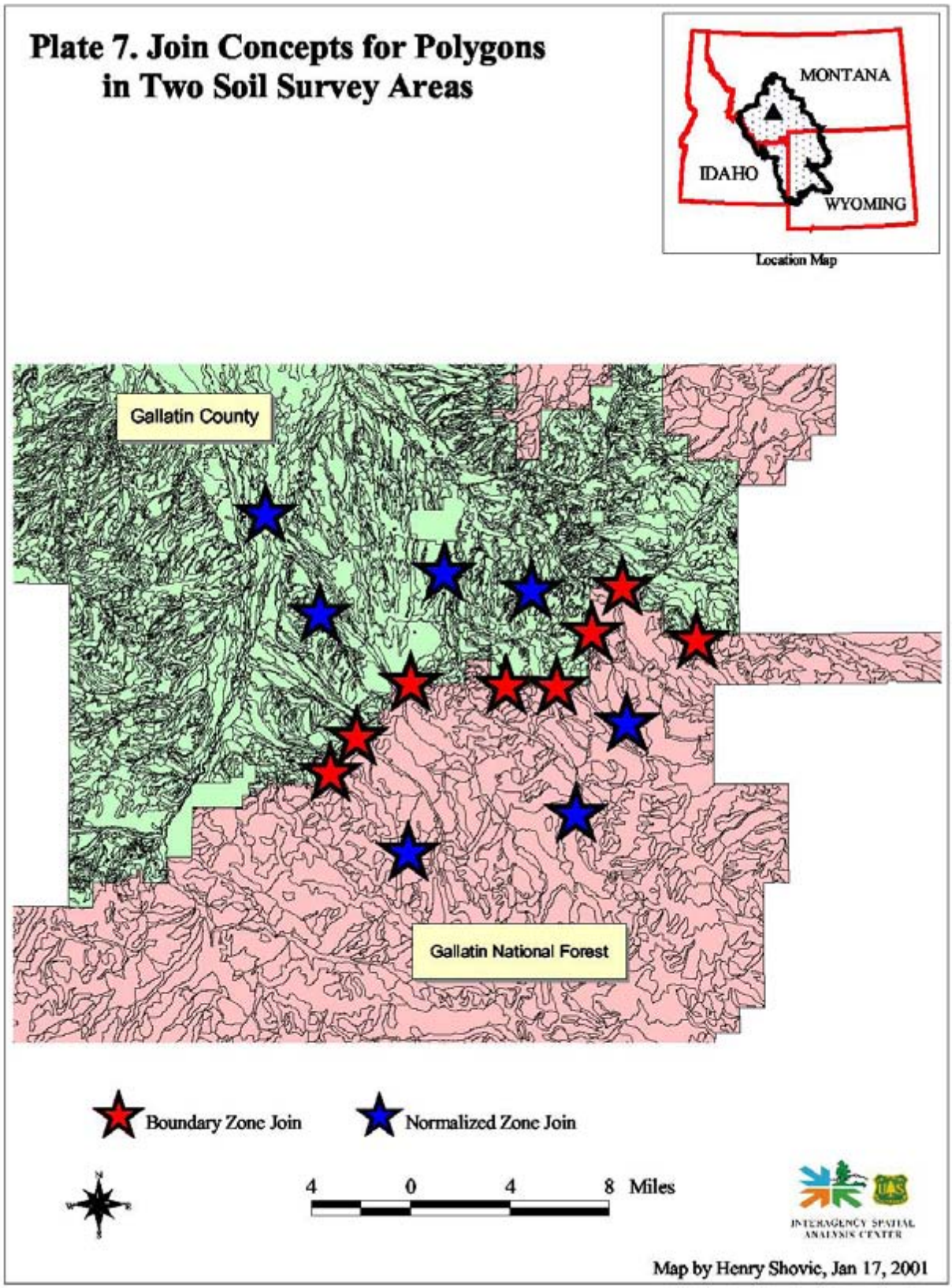


Plate 8. Base Data Status for the Greater Yellowstone Area Landscape and Soil Project

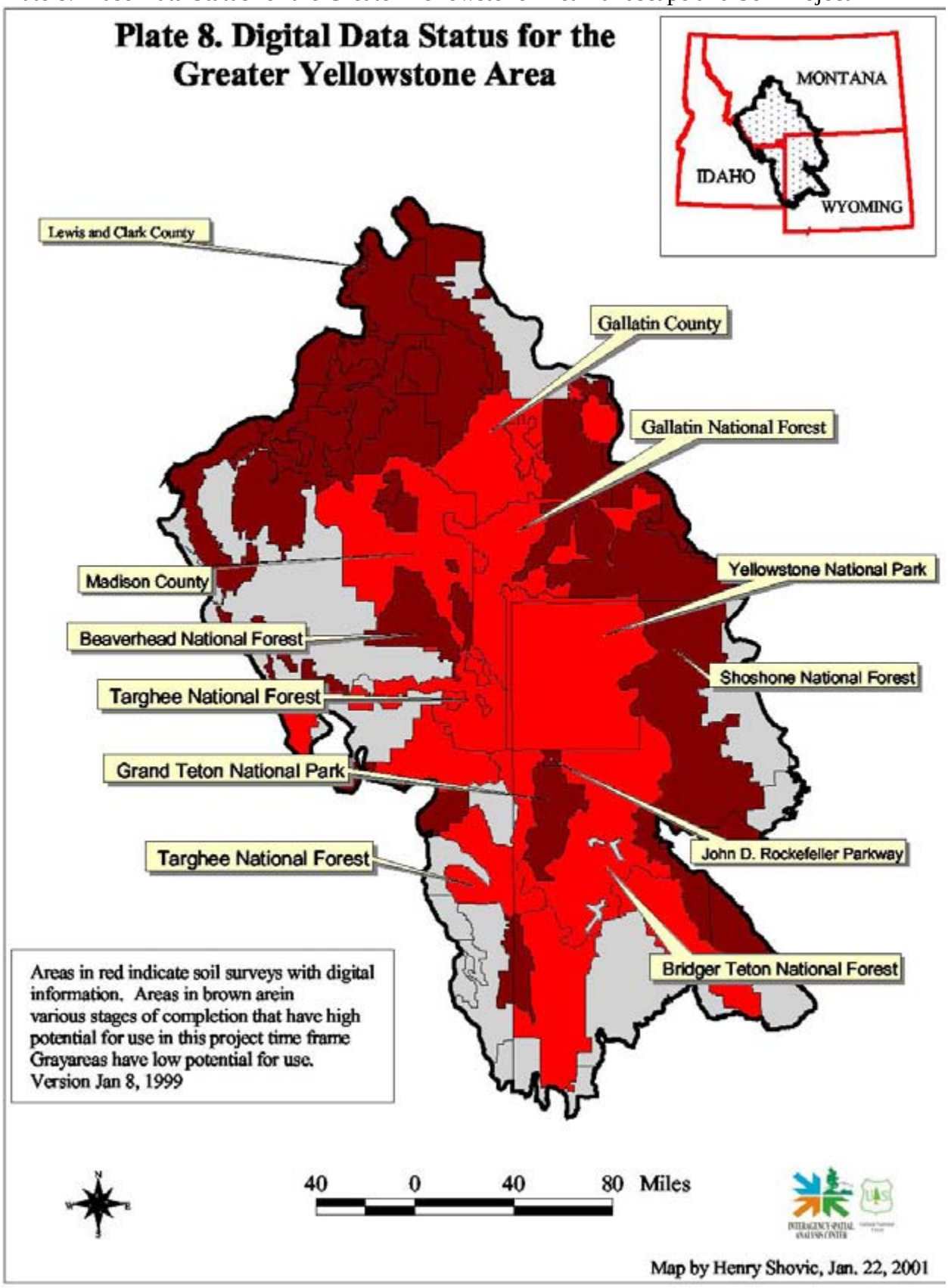


Plate 9. Map Unit Delineations in the Greater Yellowstone Landscape Model

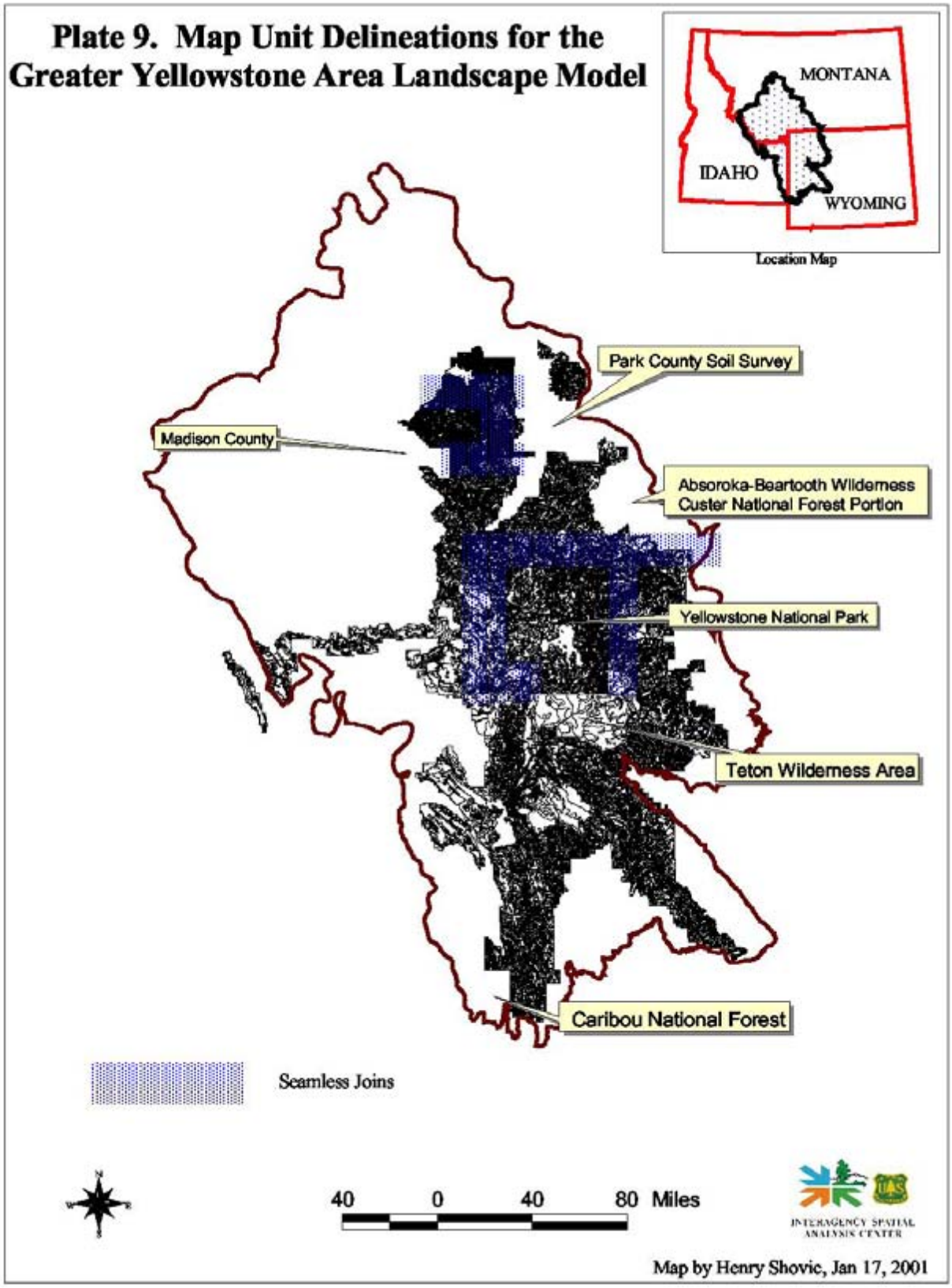


Plate 10. Distribution of Cryic Mollisols and Soils Having Significant Volcanic Ash in the GYA.

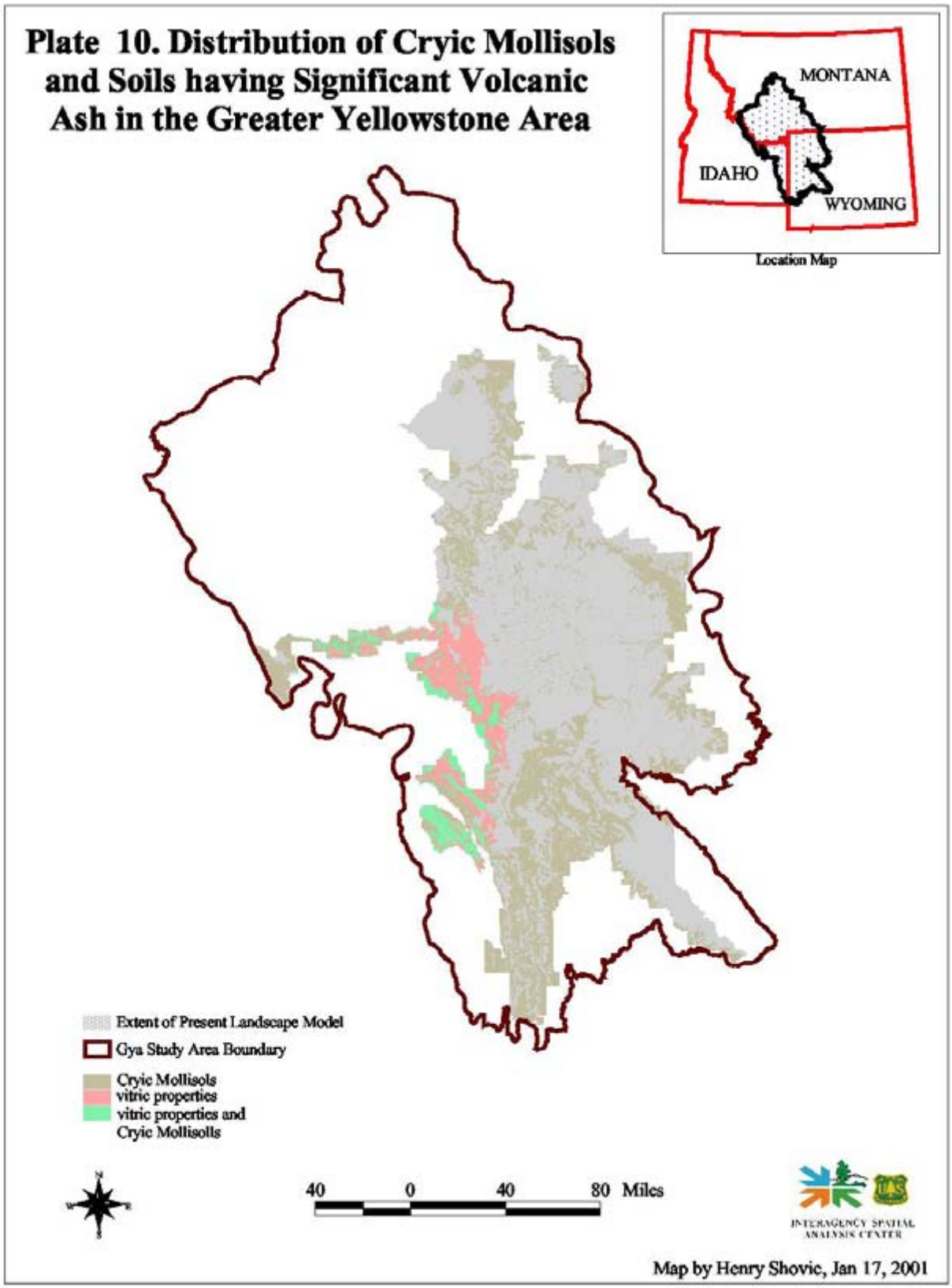


Plate 11. Distribution of Vegetation Types in Teton County, Wyoming, including Grand Teton National Park

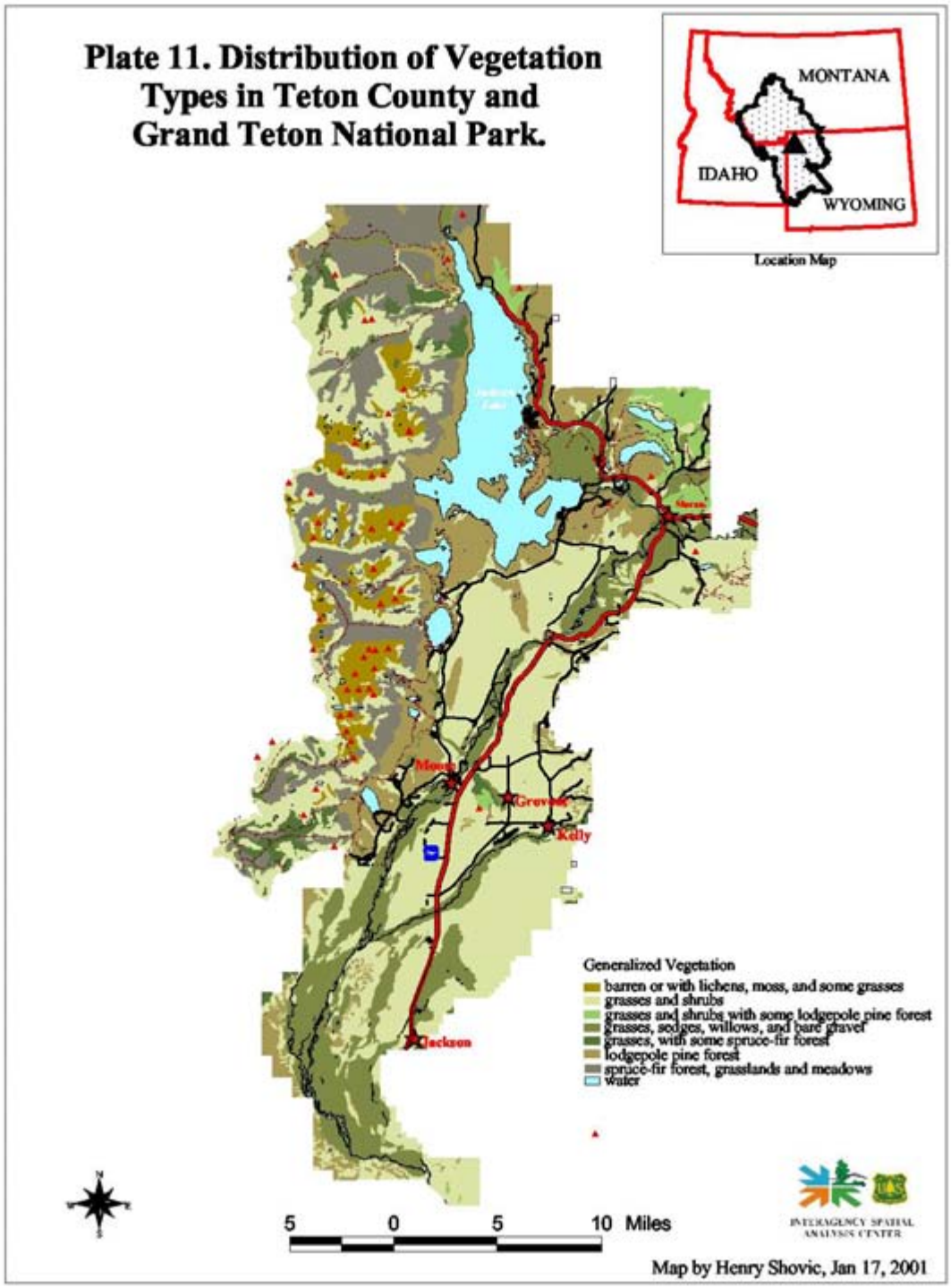
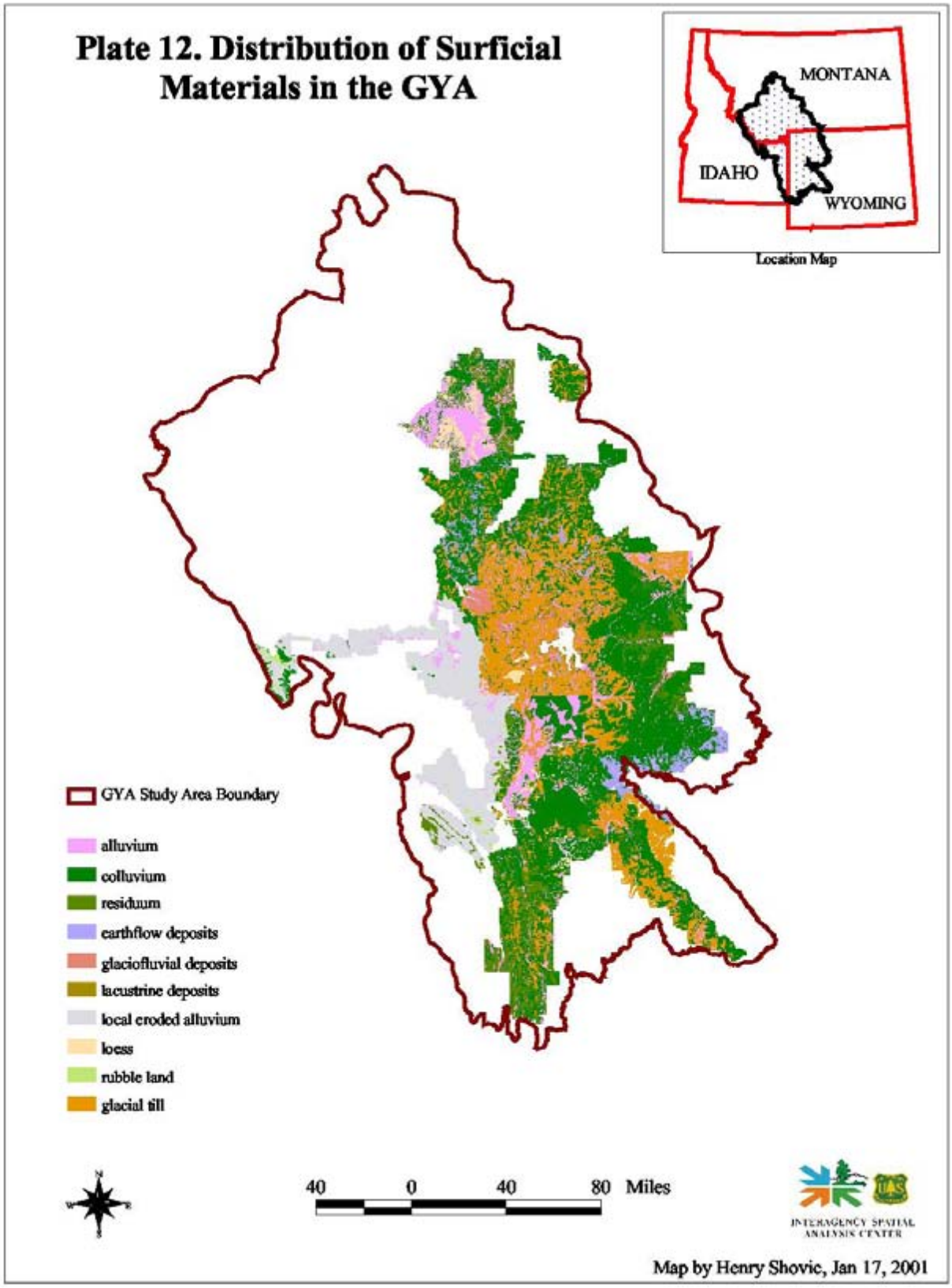


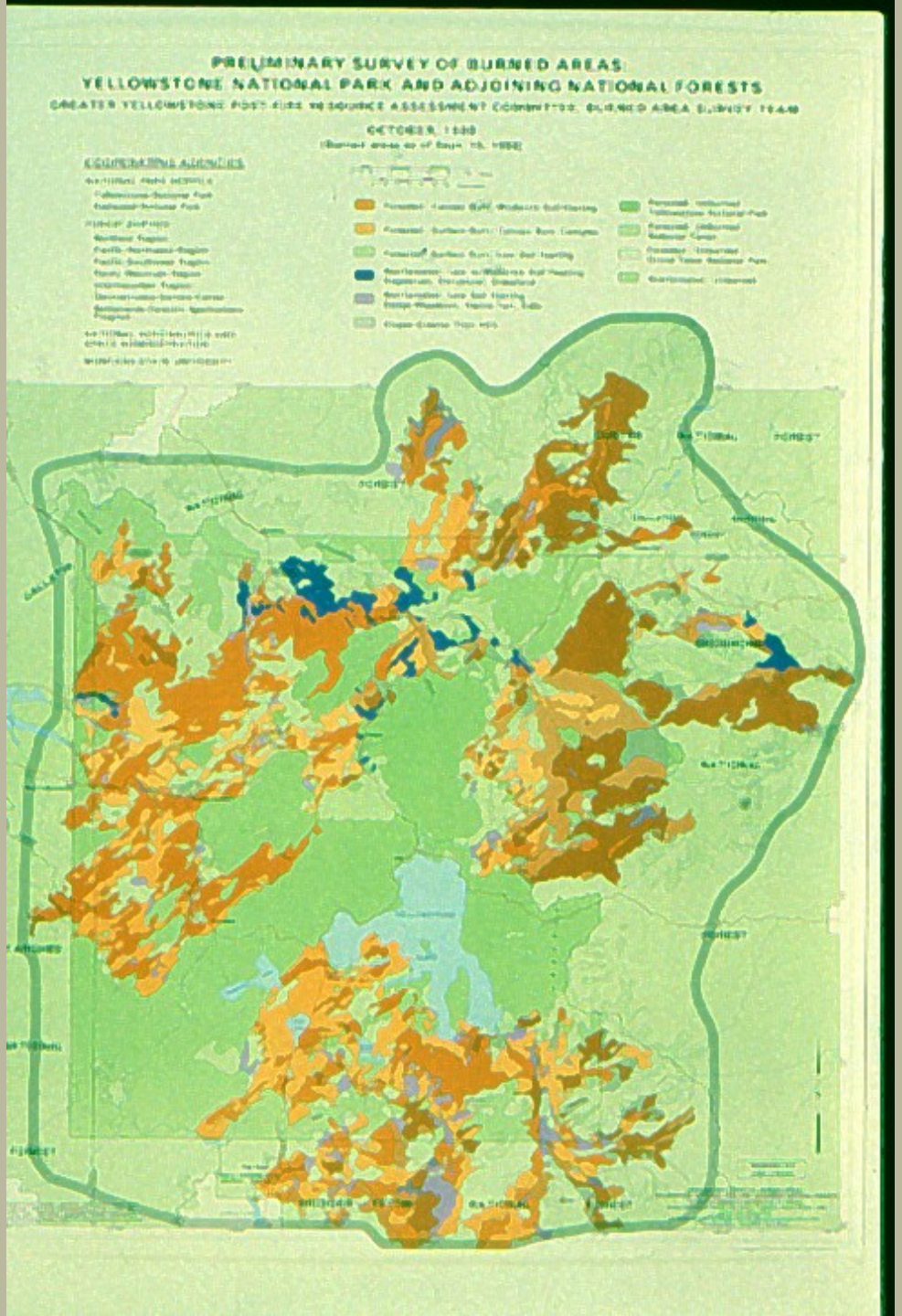
Plate 12. Distribution of Surficial Materials in the GYA.



Greater Yellowstone Soils and Landscapes: Final Progress Report

Henry F. Shovic, Ph.D
U. S. Forest Service

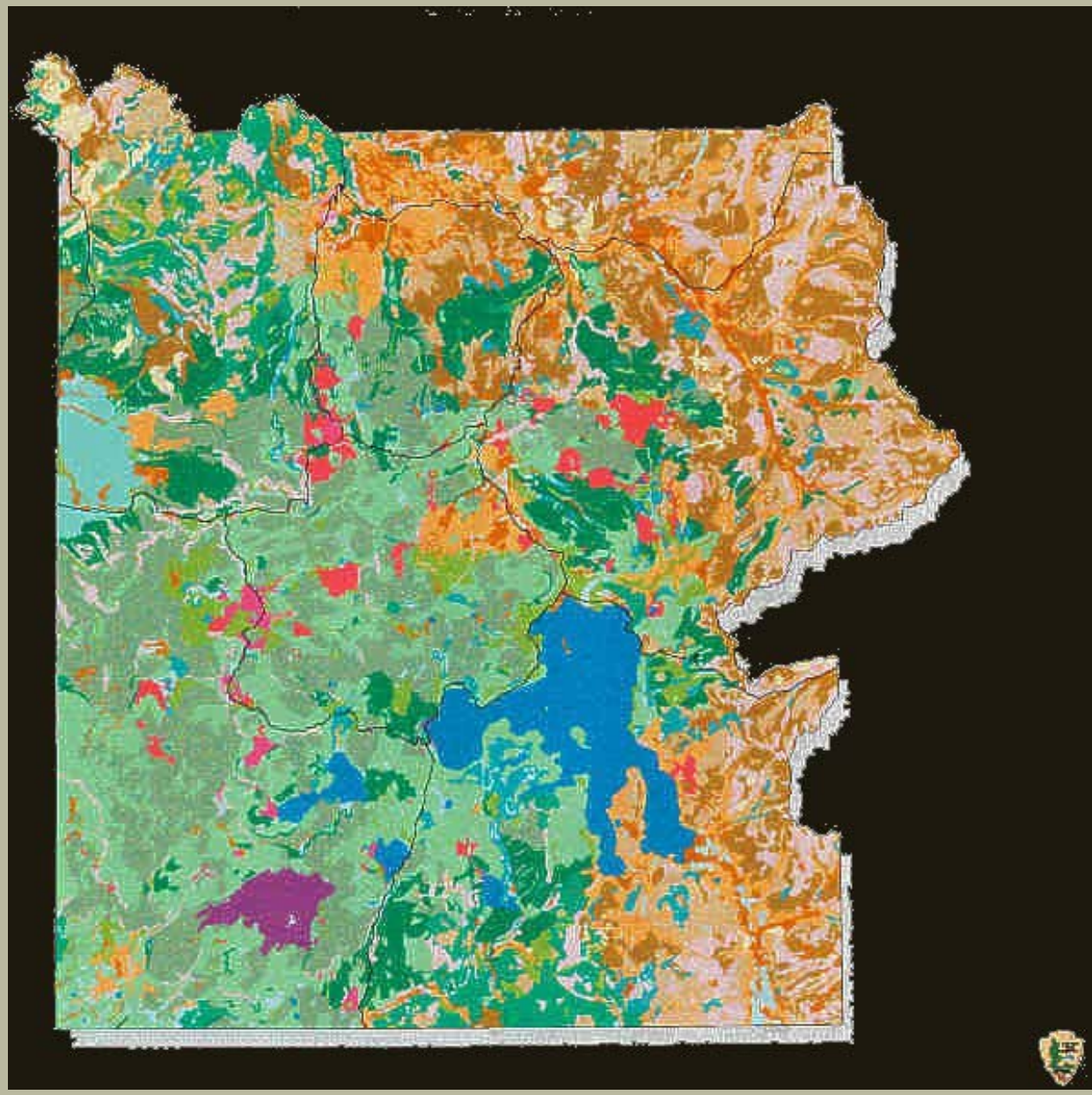
The Greater Yellowstone Area 1988 Fire Map



INTERAGENCY SPATIAL ANALYSIS CENTER

The Soil Survey of Yellowstone National Park

plus GIS



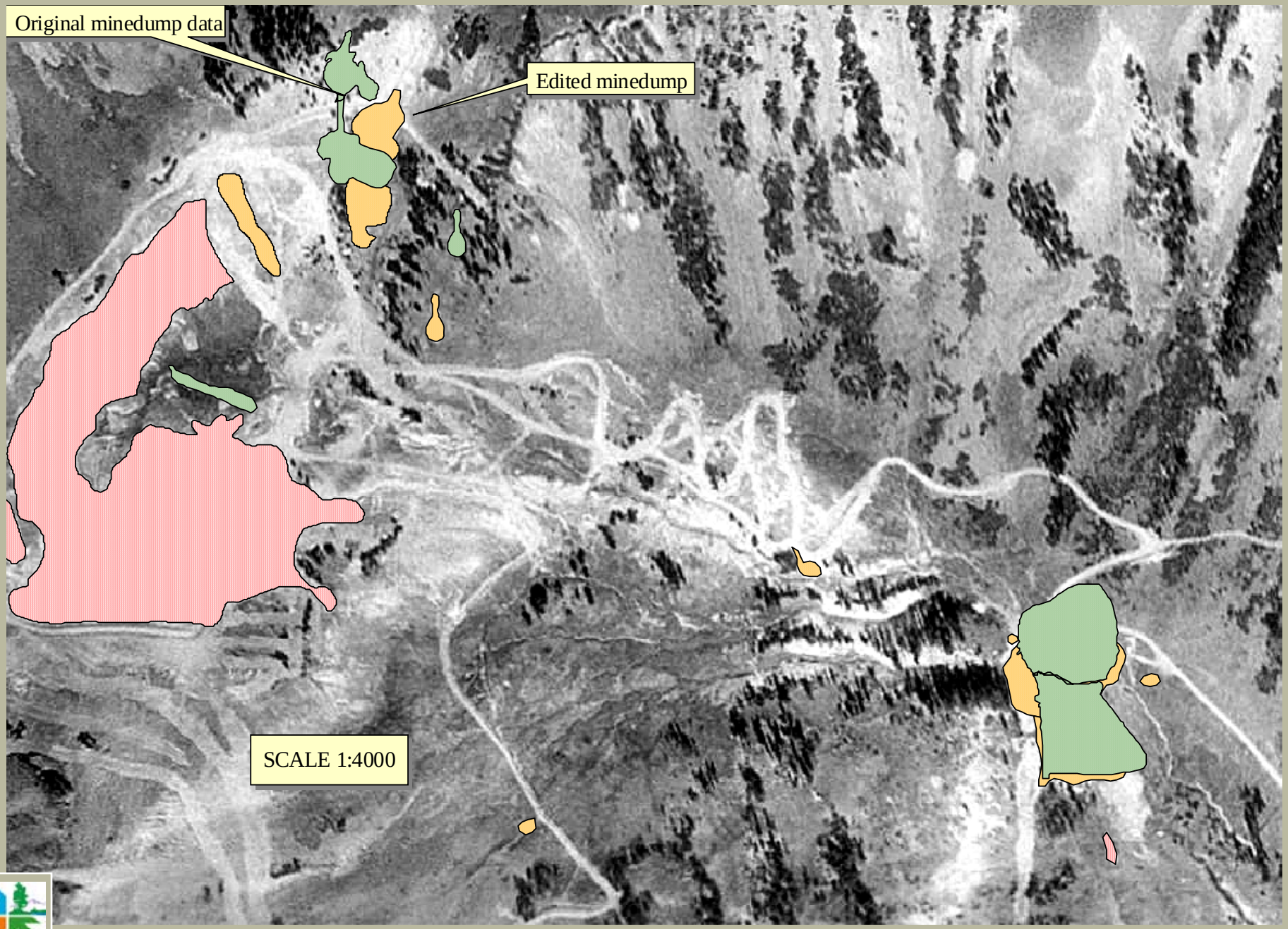
The Interagency Spatial Analysis Center

- Gallatin National Forest
- Interagency orientation
- Contracts with NRCS, National Park Service, Universities, Forest Service

INTERAGENCY SPATIAL ANALYSIS CENTER

Gallatin National Forest

New World Mine Reclamation

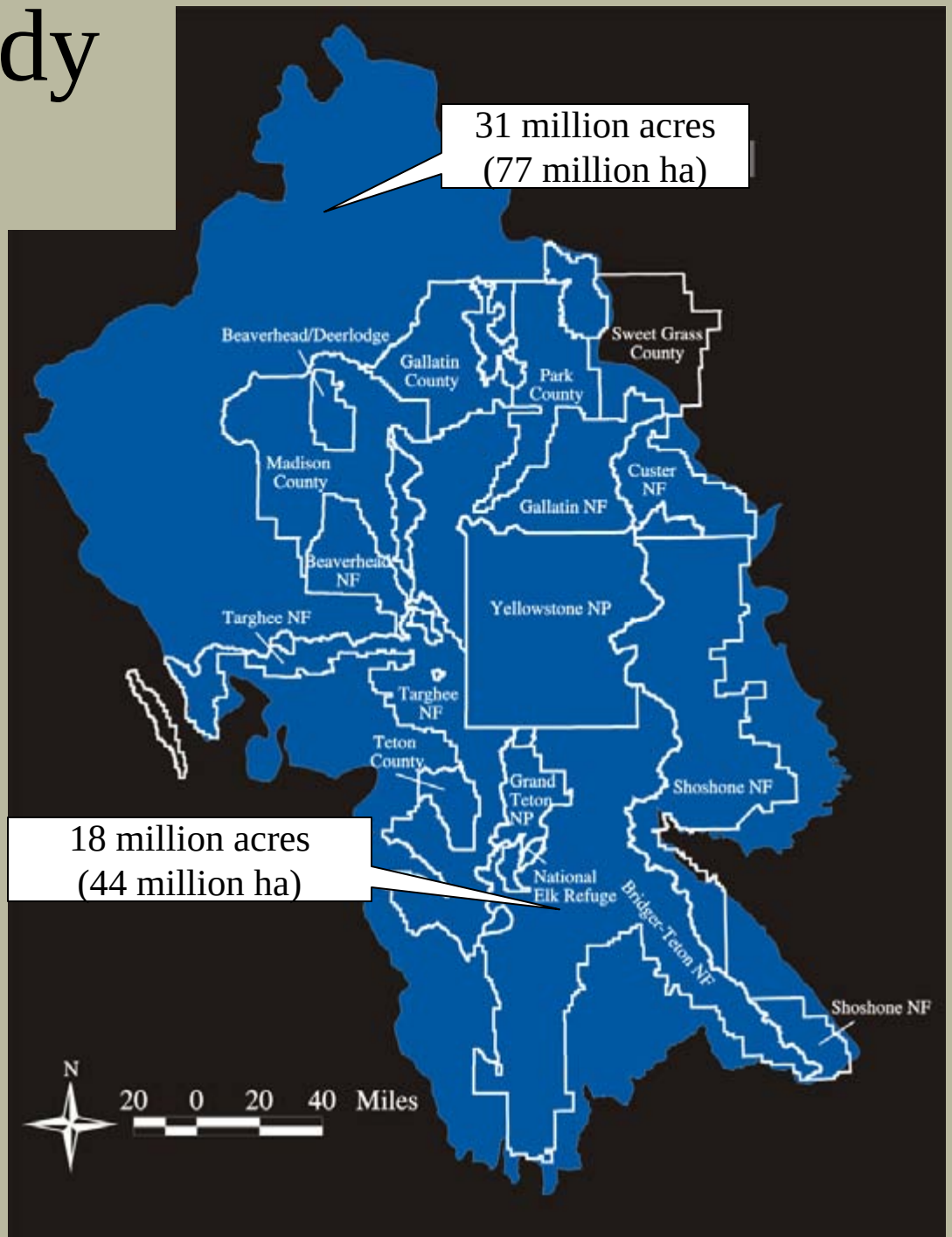

Original minedump data
Edited minedump
SCALE 1:4000

New Contracts

- Greater Yellowstone Coordinating Committee
  - High Priority GYA-wide projects
  - Graphical Support
  - Data Management
- Venezuela?
- EPA?
- Los Alamos National Laboratory?

INTERAGENCY SPATIAL ANALYSIS CENTER

The Study Area



This is a cooperative project.

- NRCS
- NPS
- USFS

Major Players

John Nesser, USFS R1

Cathy Maynard, NRCS

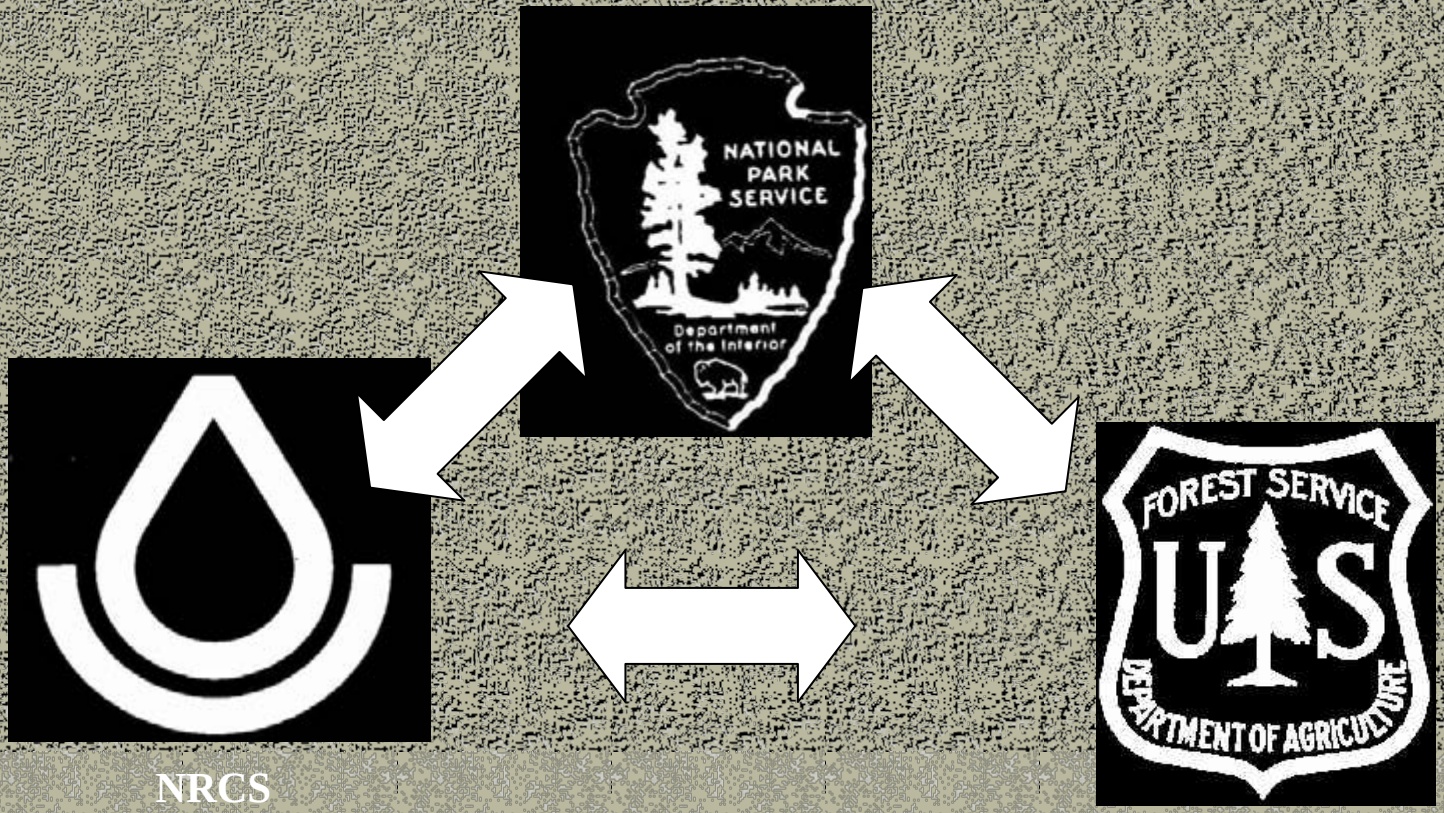
Henry Shovic, ISAC-USFS

INTERAGENCY SPATIAL ANALYSIS CENTER

Greater Yellowstone Issues

INTERAGENCY SPATIAL ANALYSIS CENTER

Greater Yellowstone Issues

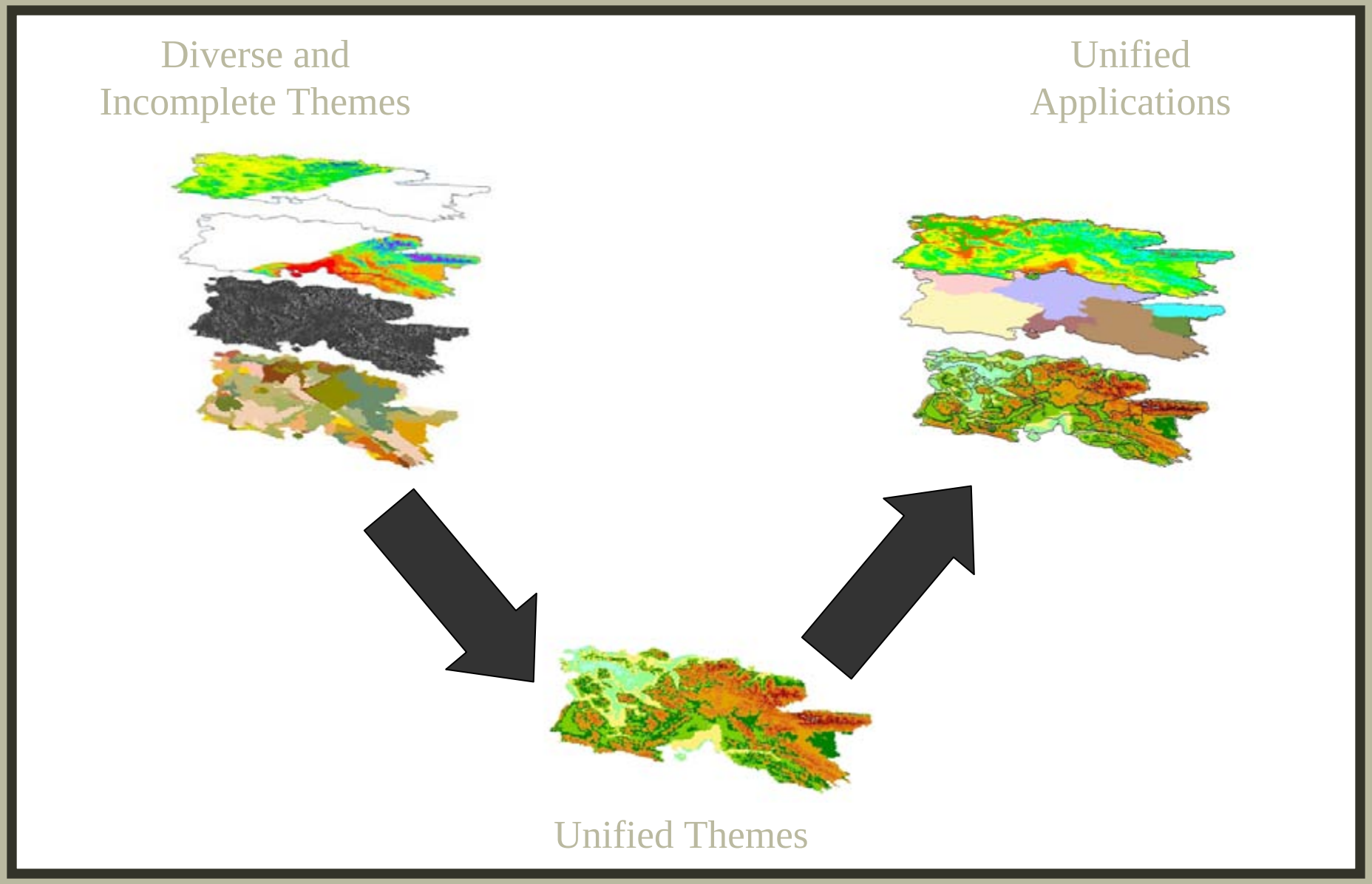


INTERAGENCY SPATIAL ANALYSIS CENTER

The Problem: There are no landscape layers that are:

- Digital
- Seamless, consistent, and continuous
- Private and Public (53% is public)
- Project Planning level
- Nationally standardized
- Quality controlled

Our Philosophy

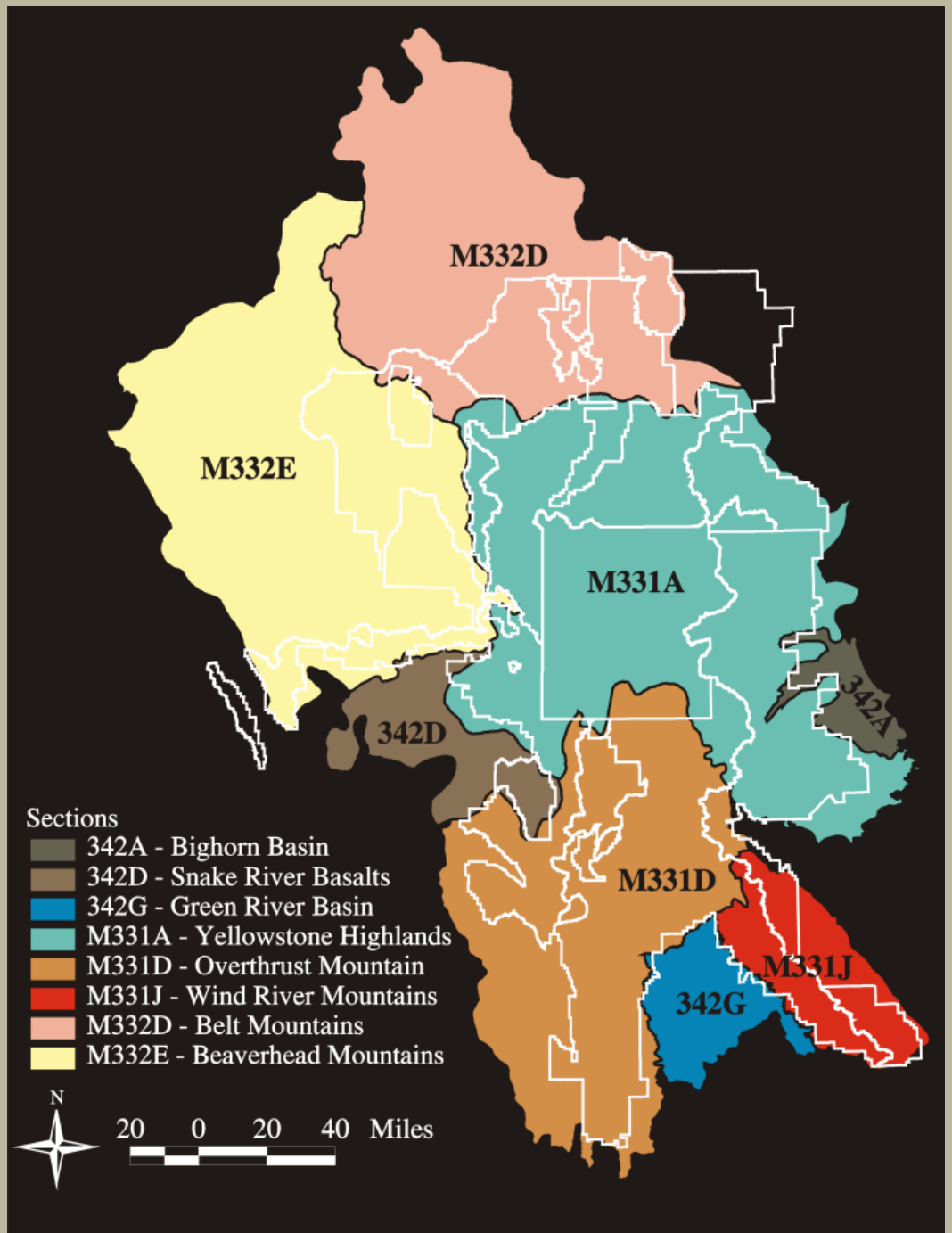


Products

- Seamless **soil survey** of the GYA at the Landtype Level (including elements of landscapes)
- Seamless **landscape** coverages of the GYA, at levels above the Landtype
- Application demonstrations
- Model for future data additions

INTERAGENCY SPATIAL ANALYSIS CENTER

Sections within the GYA



Current Status

Progress Report and Maps
Information Dissemination
Mid-scale Development
Edge Analysis
Data Preparation for Area Joins
Continuing Boundary Joins

INTERAGENCY SPATIAL ANALYSIS CENTER

Mid-Scale Models

- Large area project use (1:125,000 to 1:1,000,000)
- Knitting diverse coverages
- Characterization of Ecological Units
- Application development

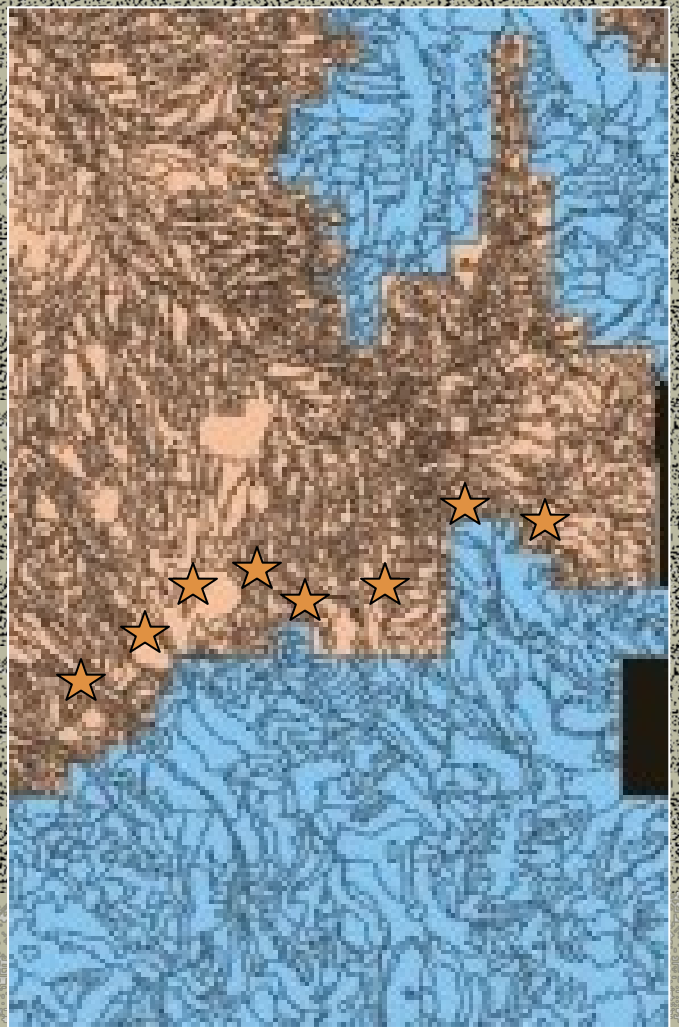
INTERAGENCY SPATIAL ANALYSIS CENTER

The Landtype Level Model

- Utilize Soil Surveys for soils, landforms, and parent materials at the LANDTYPE level
  - Standardized and field checked
  - GYA-wide coverage
  - Appropriate scales in most cases

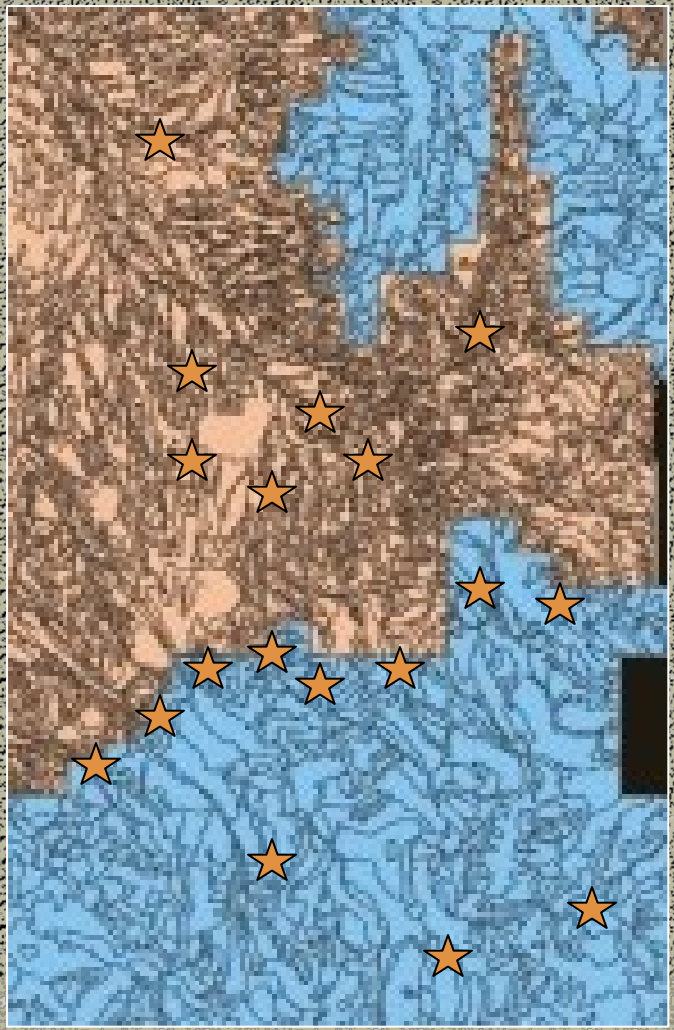
INTERAGENCY SPATIAL ANALYSIS CENTER

Spatial Analysis: The “Boundary Zone Join”Concept



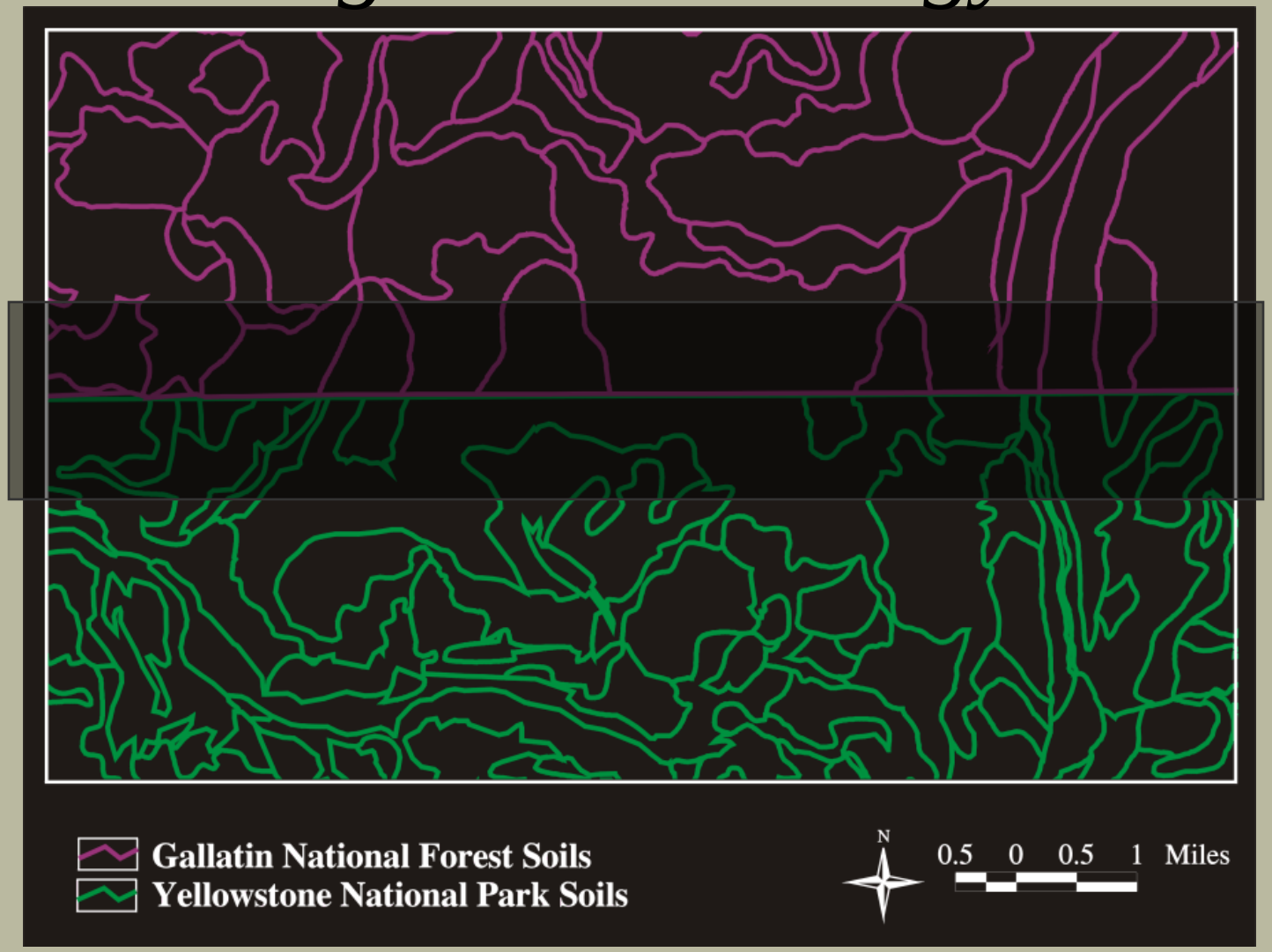
INTERAGENCY SPATIAL ANALYSIS CENTER

The “Normalized Join” Concept



INTERAGENCY SPATIAL ANALYSIS CENTER

Edges and Ecology



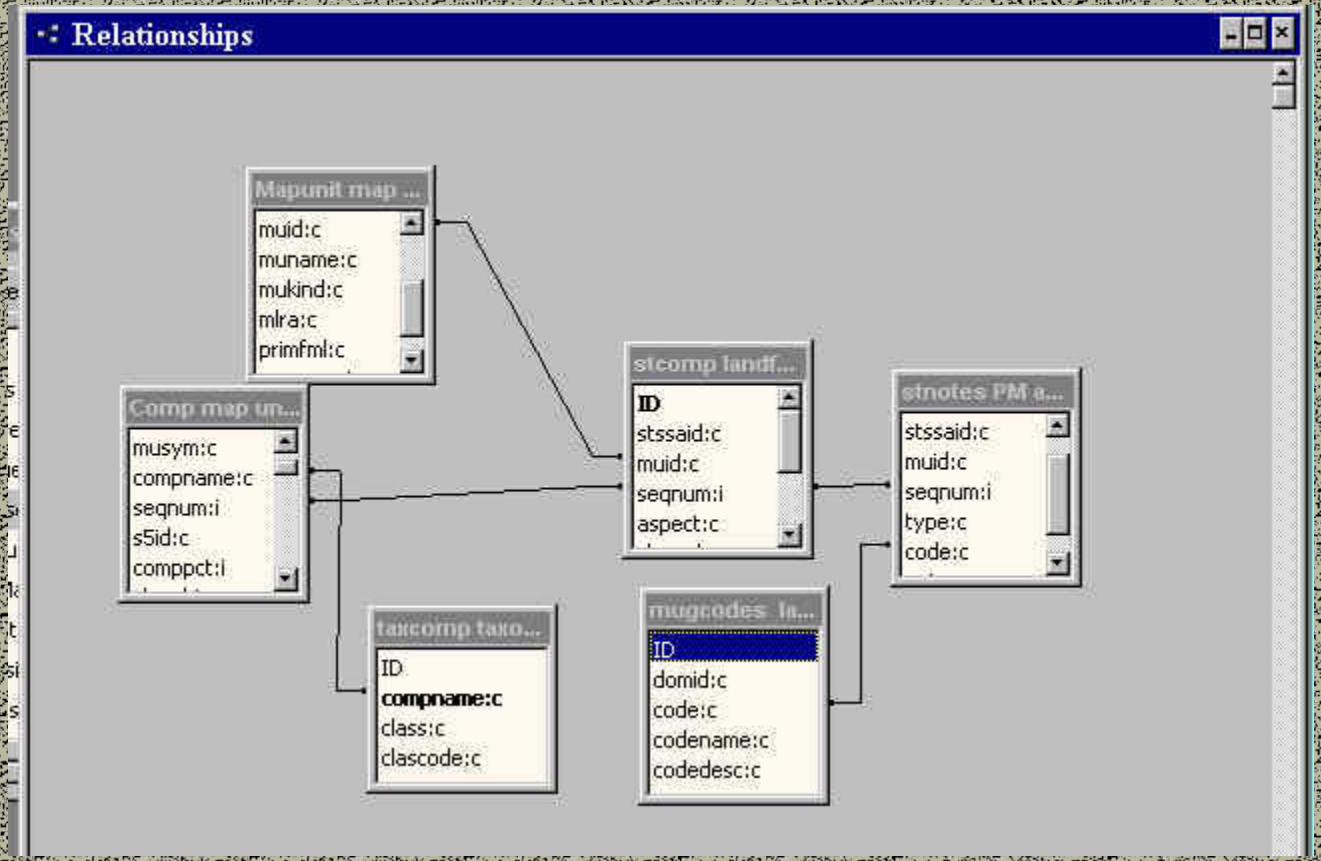
Length, character, location, frequency of shared boundaries within a zone

Edge Analysis

- Analyzing Edge Areas: Using the PAL file
  - generation of list of arcs
  - selection of common arcs
  - selection of zone polygons
  - automated decisions
- Knowing when finished: Selecting two-point arcs

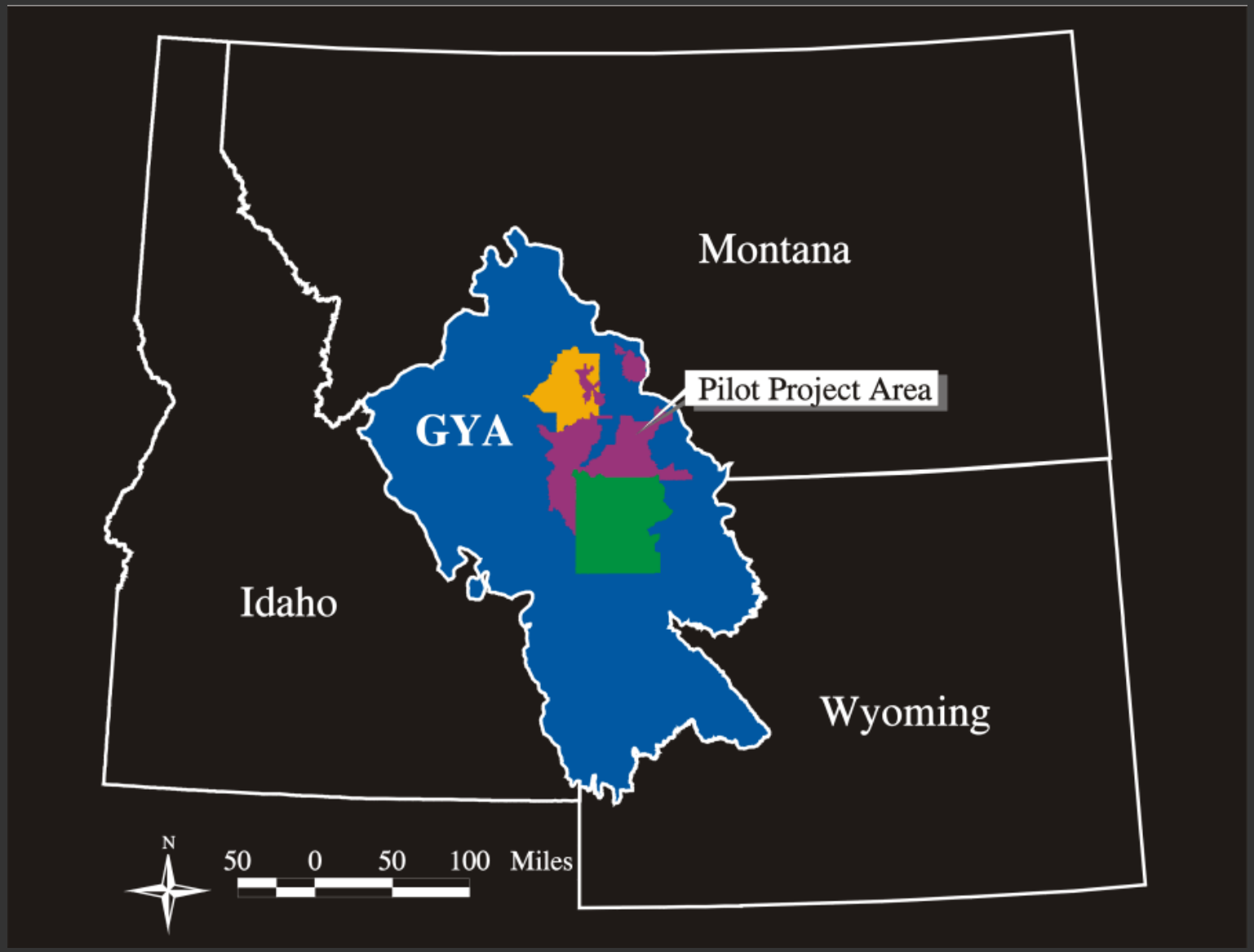
INTERAGENCY SPATIAL ANALYSIS CENTER

NASIS
Original Relational Data Tables



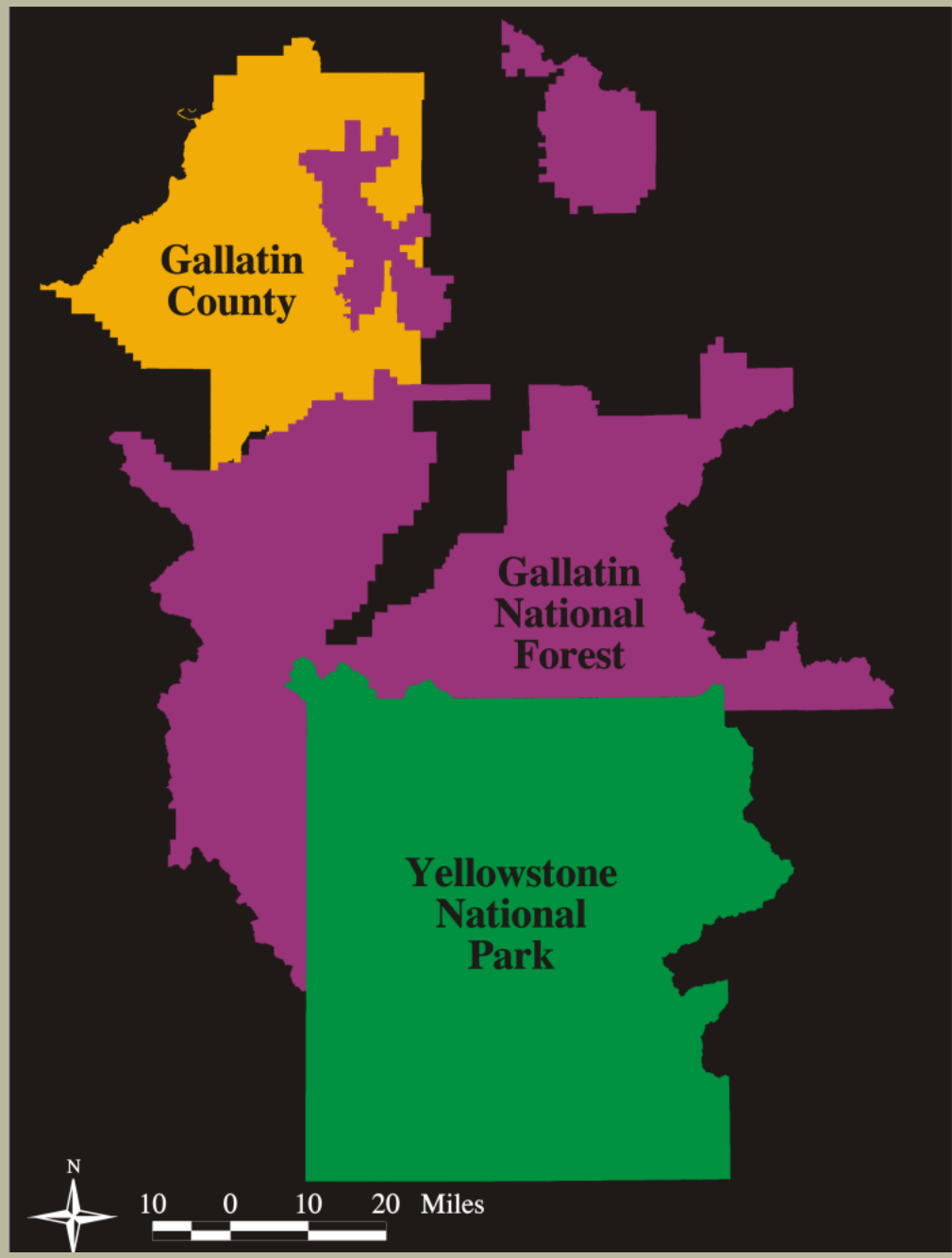
NASIS has no import functions

The Pilot Project



The Pilot Project

- Gallatin County
  - 480 map units
  - 13069 delineations
  - Order II: 1998
- Yellowstone National Park
  - 79 map units
  - 5583 delineations
  - Order IV-III: 1996
- Gallatin National Forest
  - 103 map units
  - 5883 delineations
  - Order III: 1984



ca 17 percent of the GYA

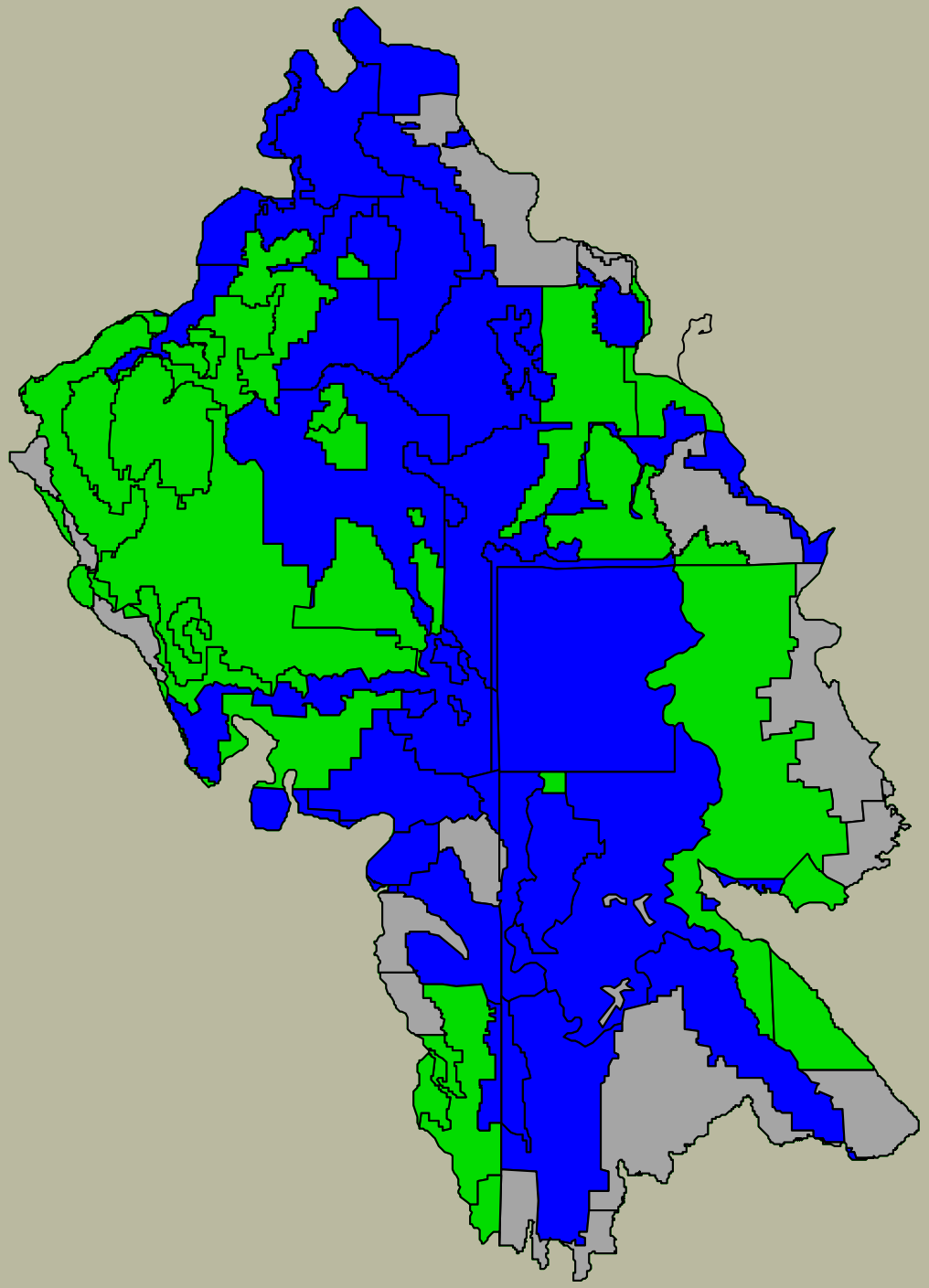
Pilot Project Objectives

- Data availability
- Feasibility
- A component of the final legend
- Seamless boundaries using “normalized join”
- Seamless boundaries using “boundary join”
- Use potential

INTERAGENCY SPATIAL ANALYSIS CENTER

Soil Survey Data In the GYA

- Blue= completed
- Green= on-going
- Gray= non-project



Methods: Correlation Table

GLCO lf unique values : Table

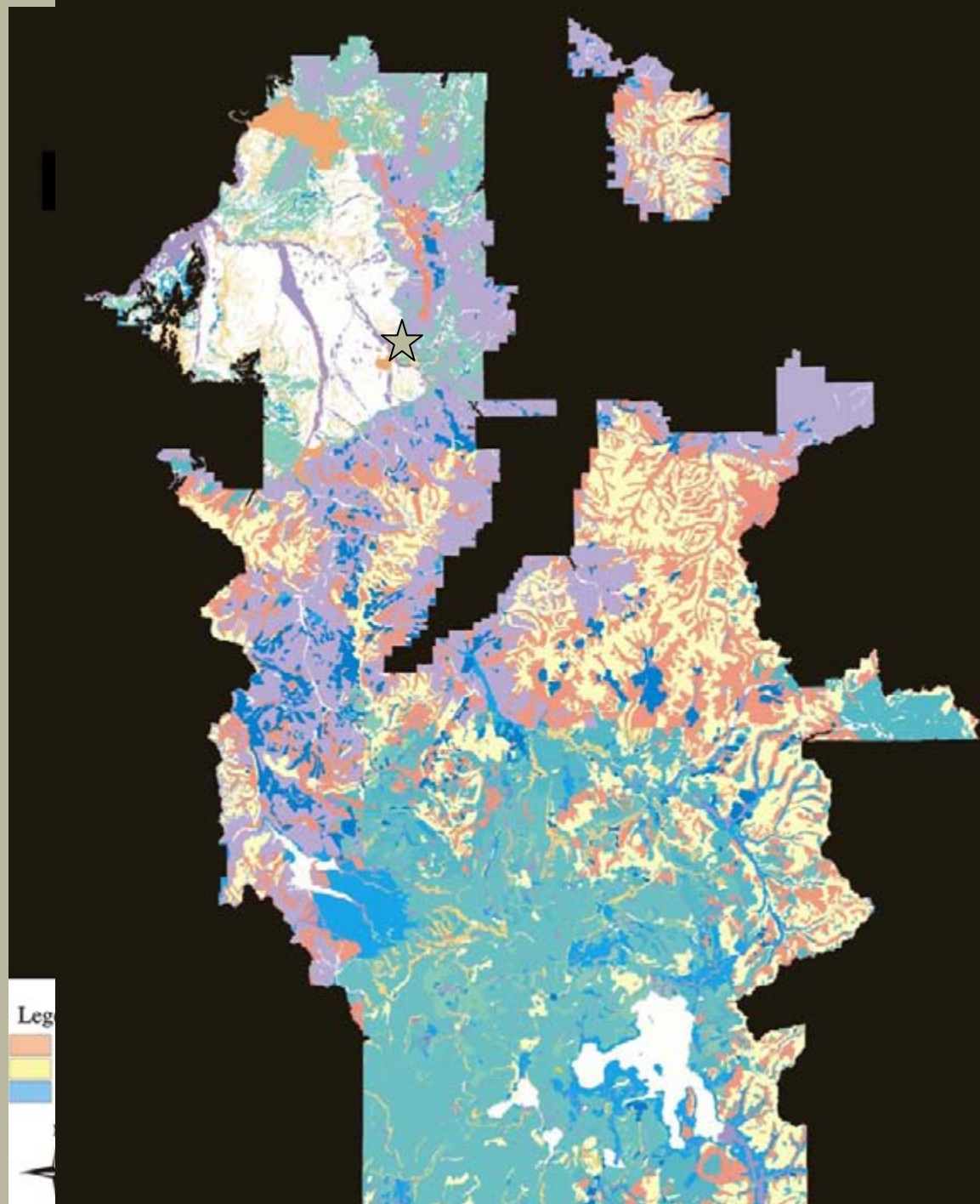
LandformSummary	GYALandformtext	GYALandform	GLCOCode
MOU; Mountains	mountainsides	2	12
DW; Drainageways	rolling hills	3	7
HI; Hills	rolling hills	3	11
AF; Alluvial fans	plains	4	1
SP; Sedimentary plains	plains	4	18
BFP; Bedrock-floored plains	plains	4	4
OP; Outwash plains	plains	4	13
CD; Closed depressions	stream floodplains	5	5
FP; Flood plains	stream floodplains	5	9
ESC; Escarpments	stream breaks	41	8
ST; Stream terraces	stream terraces	45	19
RST; Relict stream terraces	stream terraces	45	15
AFS; Alluvial fans and stream terraces	stream terraces	45	3
AFR; Relict stream terraces and alluvial fans	stream terraces	45	2
ROCK OUTCROP	other landforms	46	14
WATER, MISCELLANEOUS	other landforms	46	22
GRAVEL PIT	other landforms	46	10
WATER	other landforms	46	21
DENIED ACCESS	other landforms	46	6
SANITARY LANDFILL	other landforms	46	16
SLICKSPOTS	other landforms	46	17
URBAN LAND	other landforms	46	20
		0	(AutoNumber)

Example Join Legend

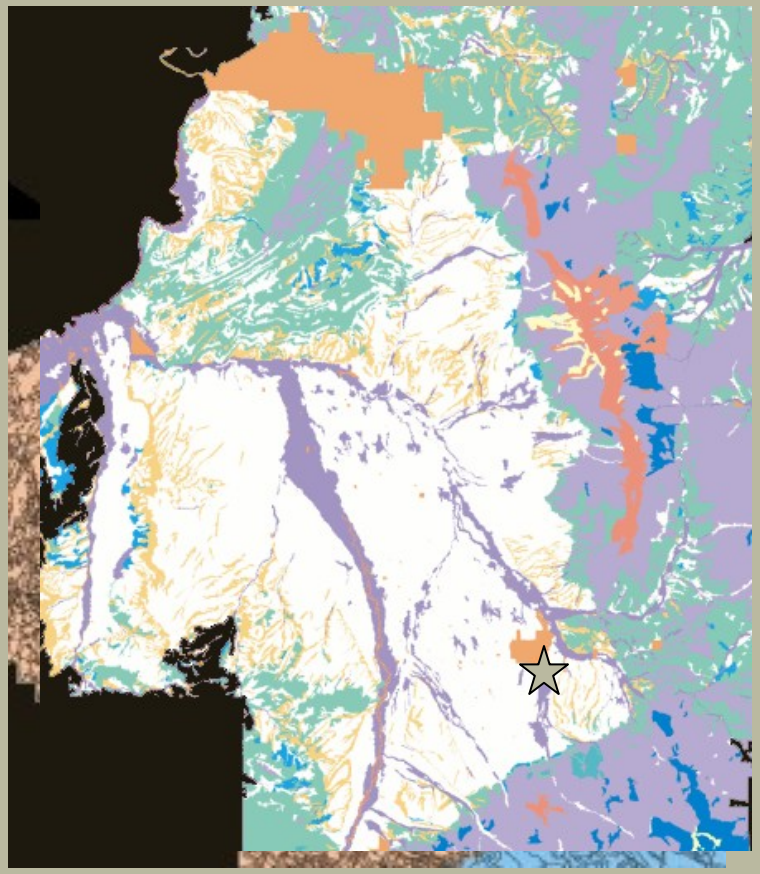
Allpilot

- glacial moraine in narrow trough valleys
- glacial moraine on broad uplands
- glacial troughwalls and cirques
- glaciated plateaus
- landslides
- mountainsides
- other landforms
- plains
- ridges
- rolling hills
- stream breaks
- stream floodplains
- stream terraces

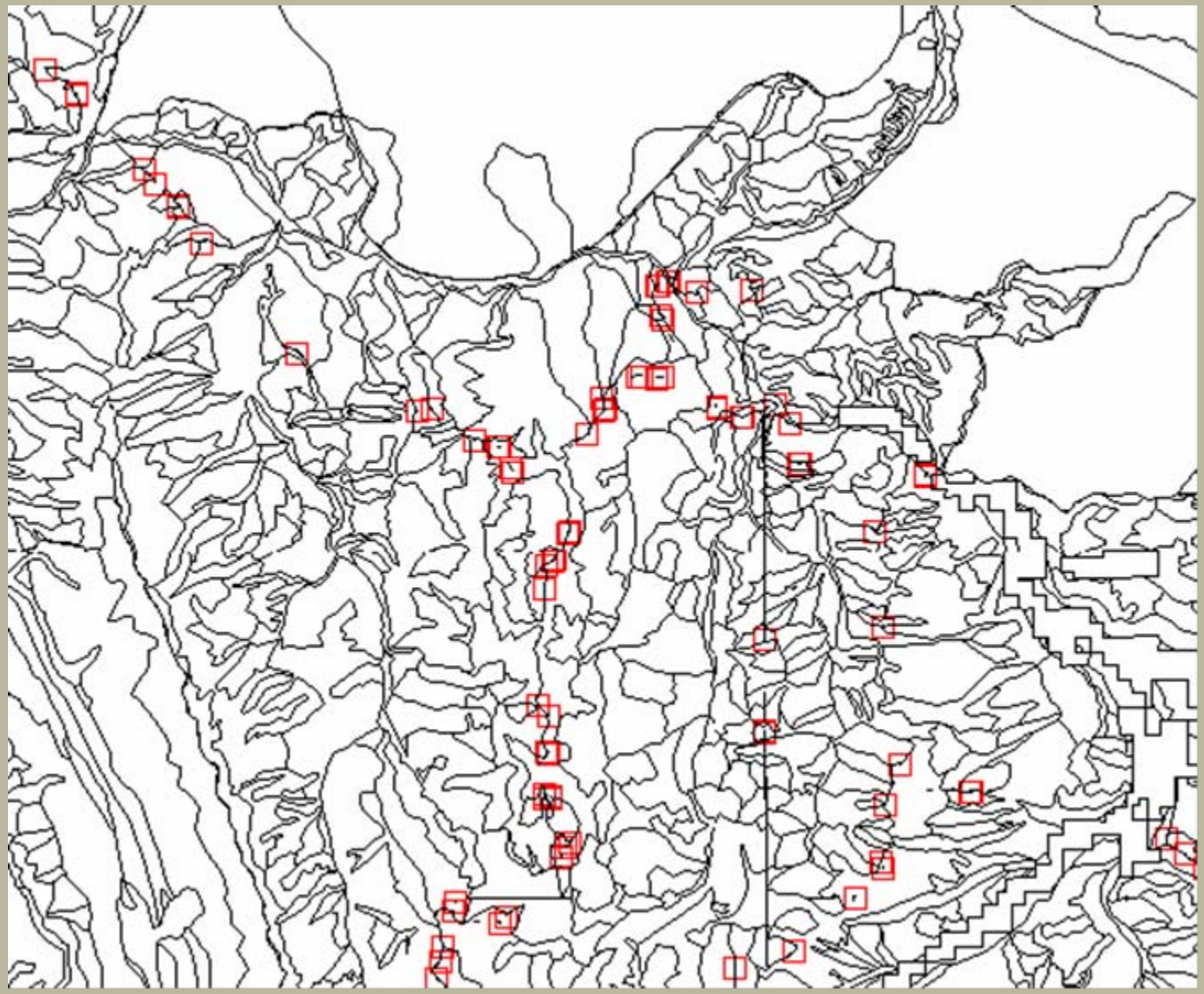
Original Data and the Resultant Seamless Layer



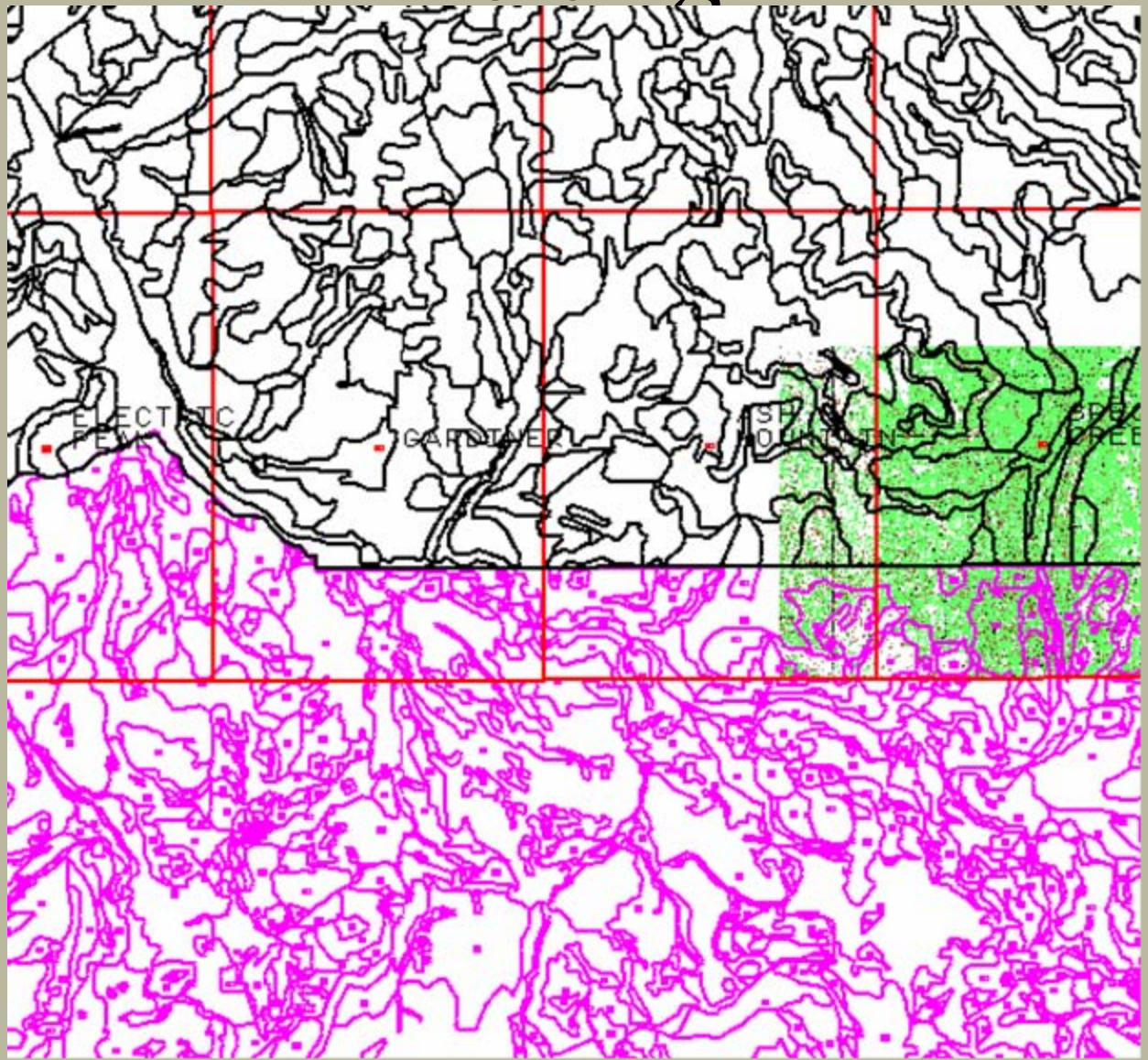
Seamless “Normalized Join” Layer Closeup- Two



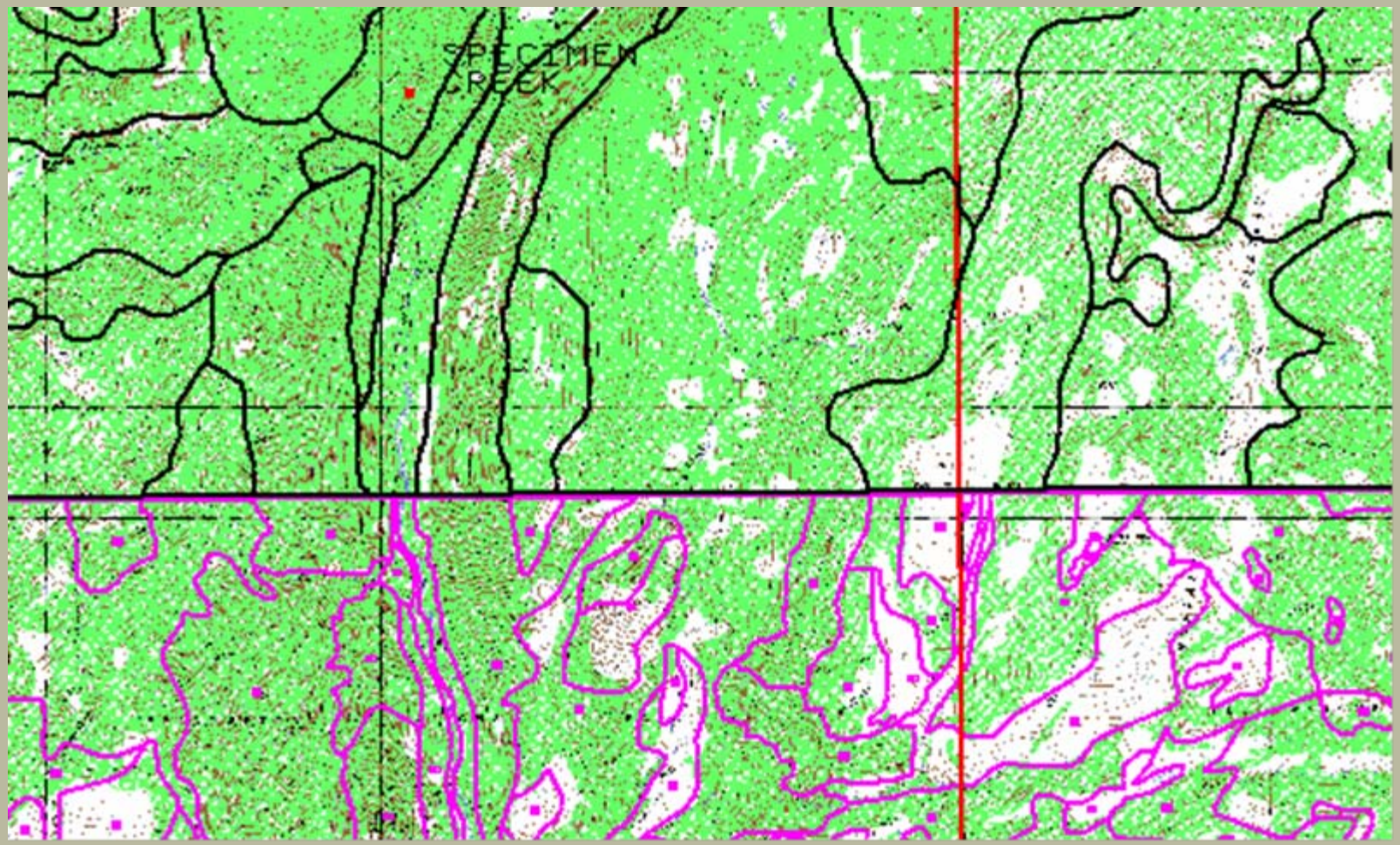
Digital Soil Survey Import



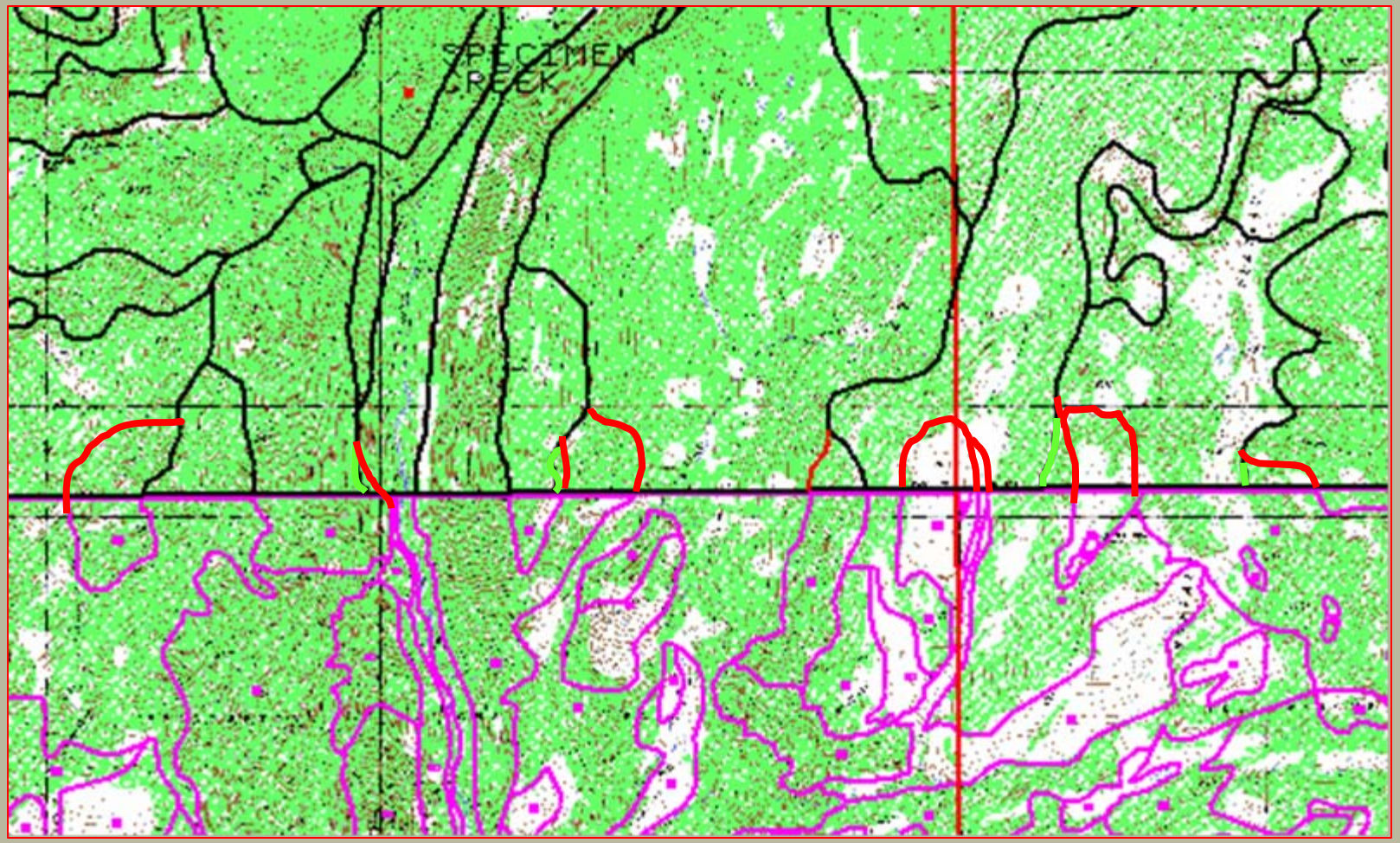
Digital-Based Soil Survey Editing



Before Boundary Joining



After Boundary Joining



In March

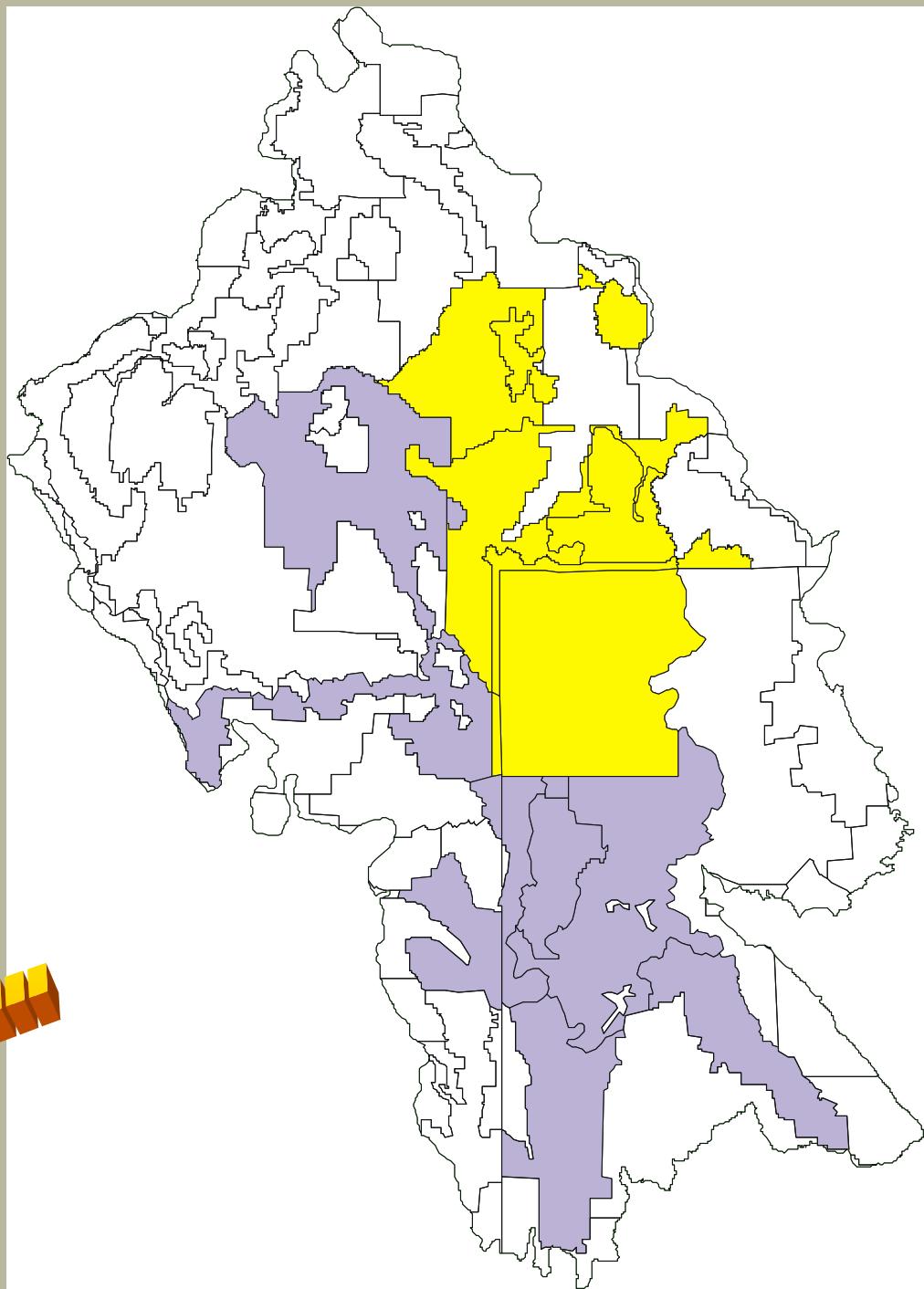
- Methods are developed and being applied
- 40% of data gathered
- 20% of data analyzed
- The funding search continues

INTERAGENCY SPATIAL ANALYSIS CENTER

Data Development Status in March

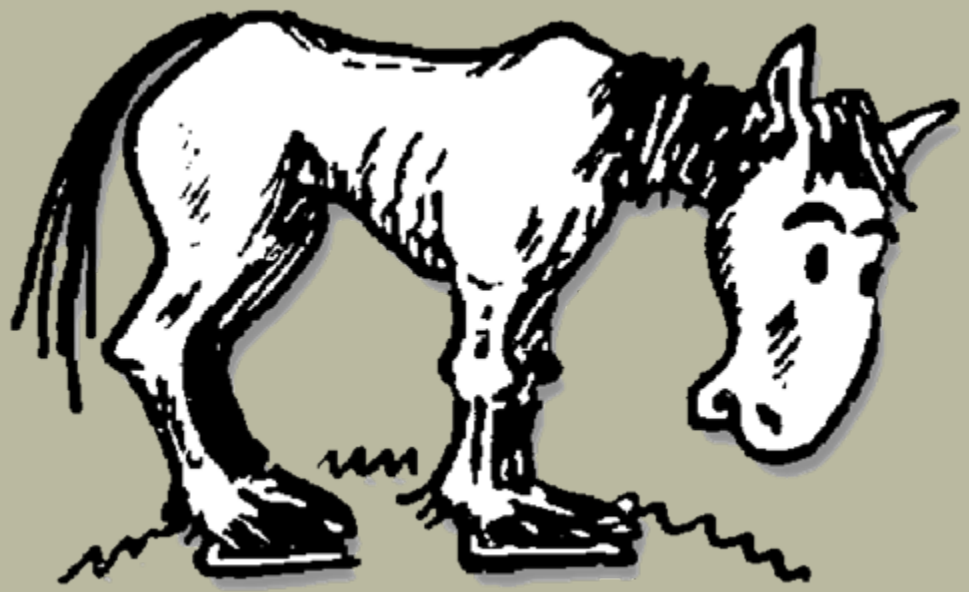
Yellow = boundary Joins

Violet = data acquired

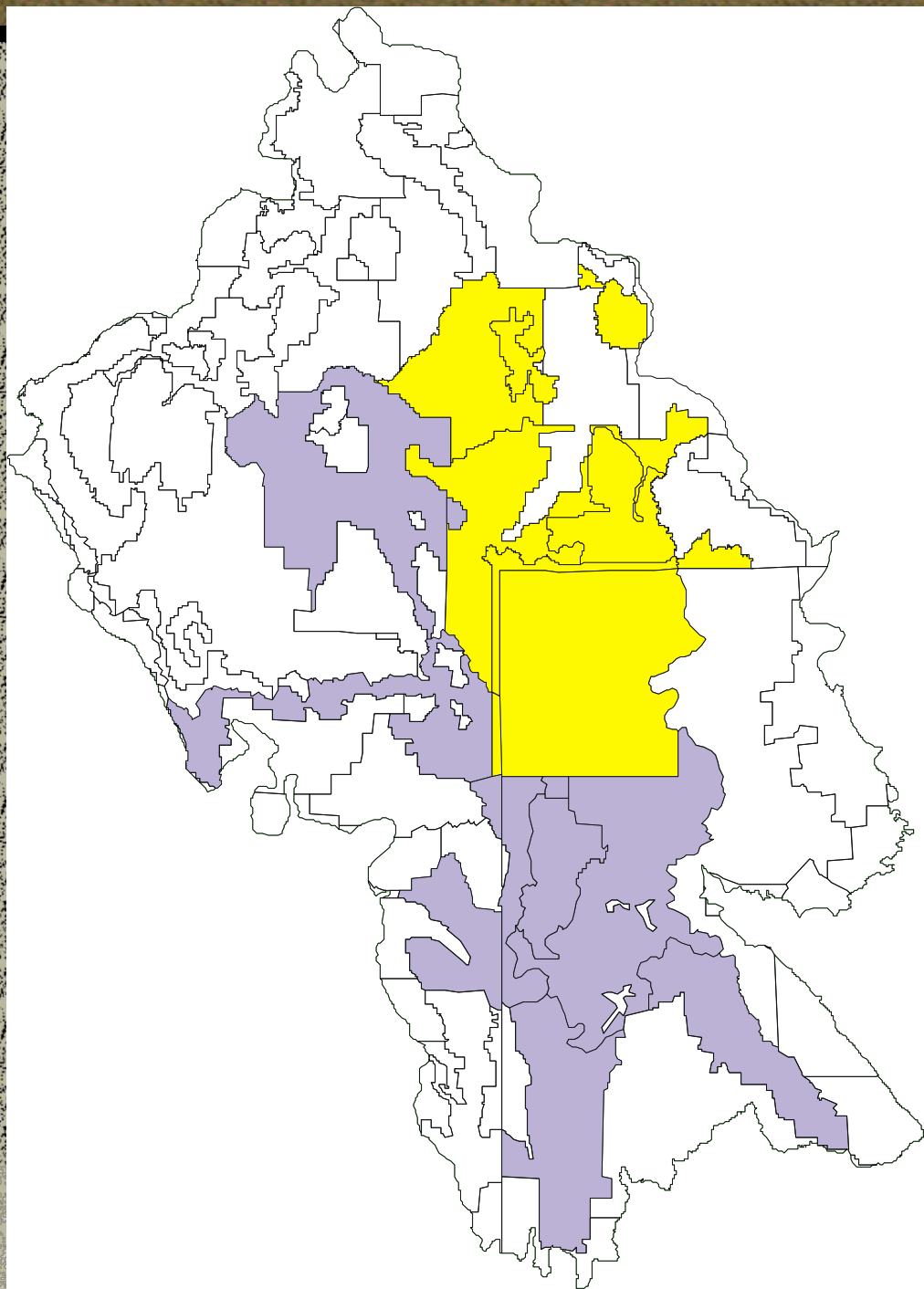


Since Then....

INTERAGENCY SPATIAL ANALYSIS CENTER



test



INTERAGENCY SPATIAL ANALYSIS CENTER

In June

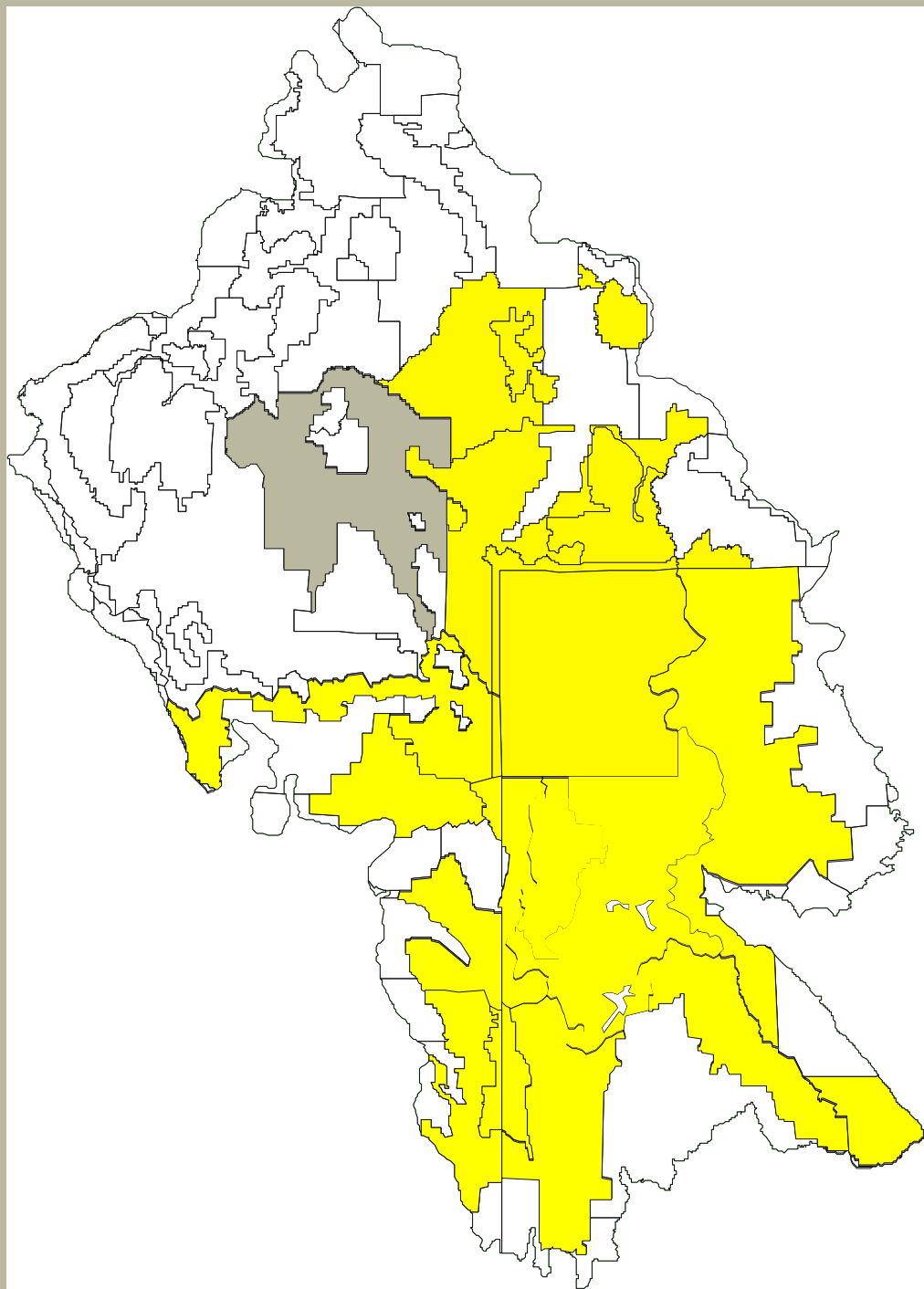
- 80% of data gathered
- 80% of data analyzed
- Funding search is over
- Project documentation and data delivery

INTERAGENCY SPATIAL ANALYSIS CENTER

Data Development Status in June

Yellow = boundary Joins

Violet = data acquired

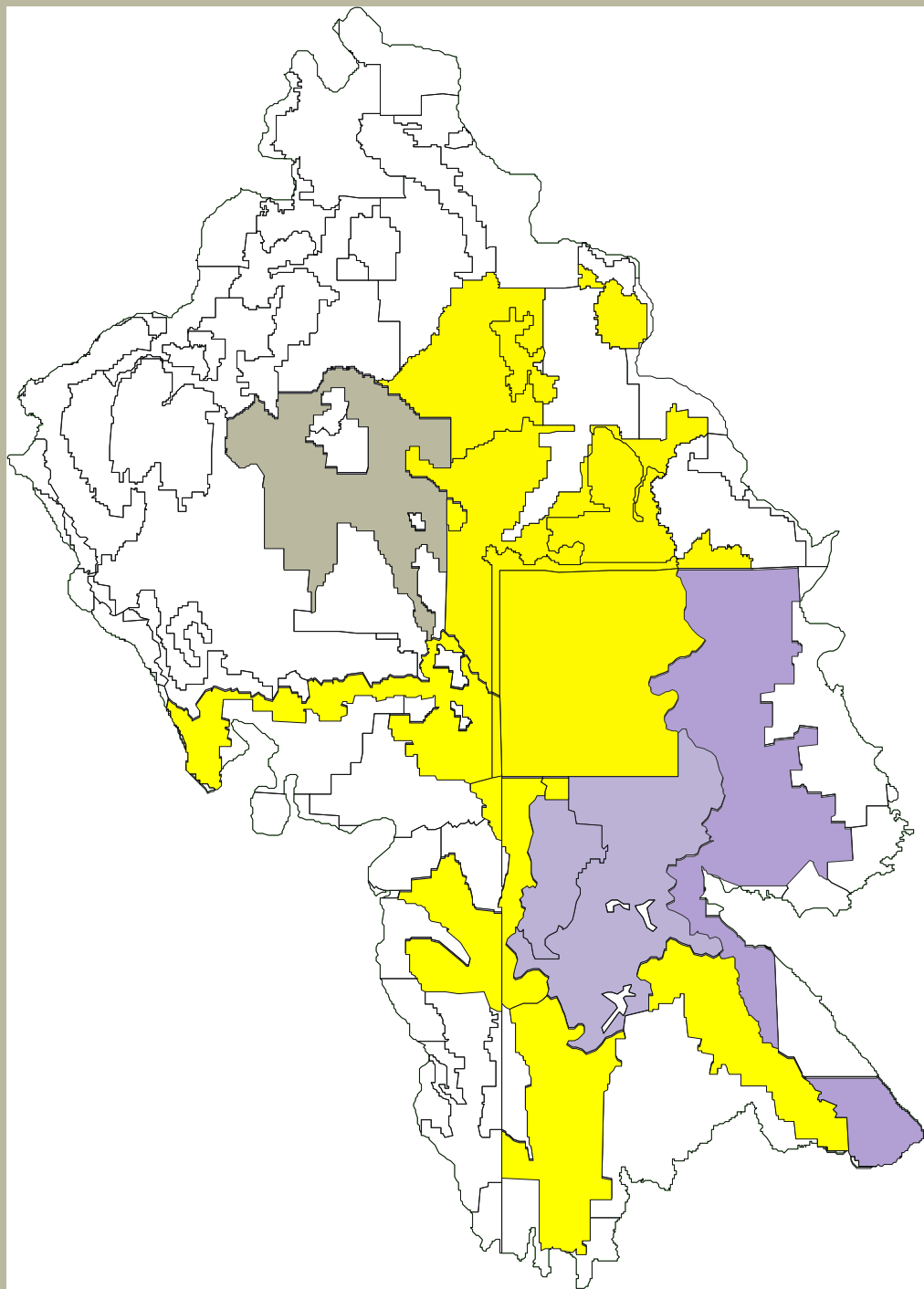


INTERAGENCY SPATIAL ANALYSIS CENTER

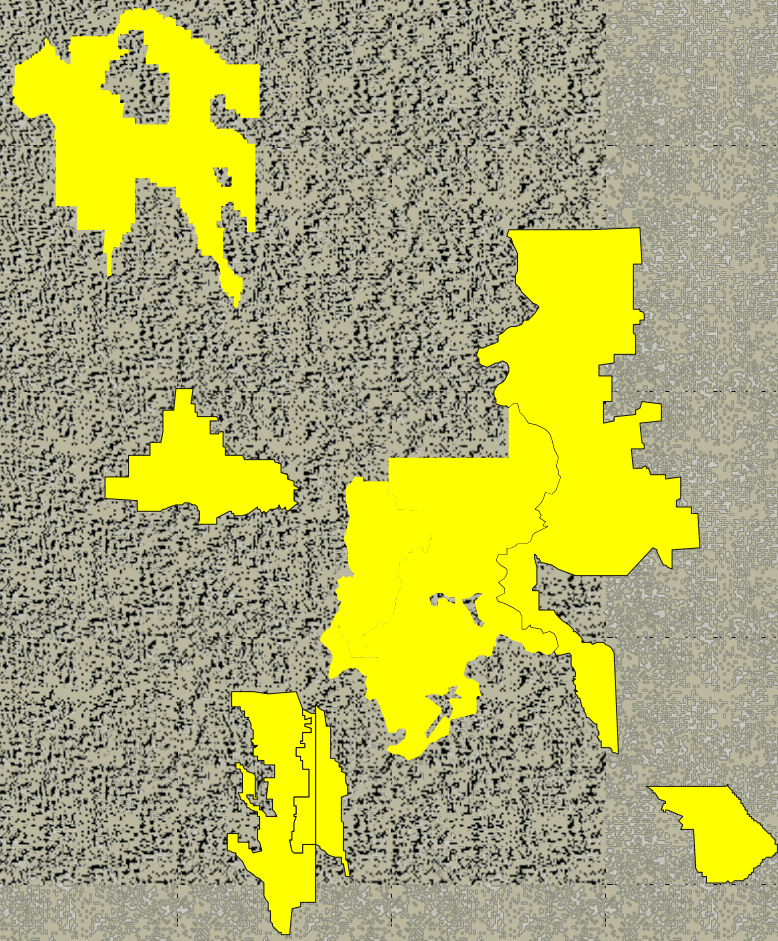
Test slide

Yellow = boundary Joins

Violet = data acquired



testanother



INTERAGENCY SPATIAL ANALYSIS CENTER

Results

- Boundary Join
  - Mapping concepts: soils, landtypes
  - Objectives
  - Legacies and Futures
- Normalized Join
  - Normalizing tables
  - Correlation Tables
  - Why we simplify
  - Why we don't simplify

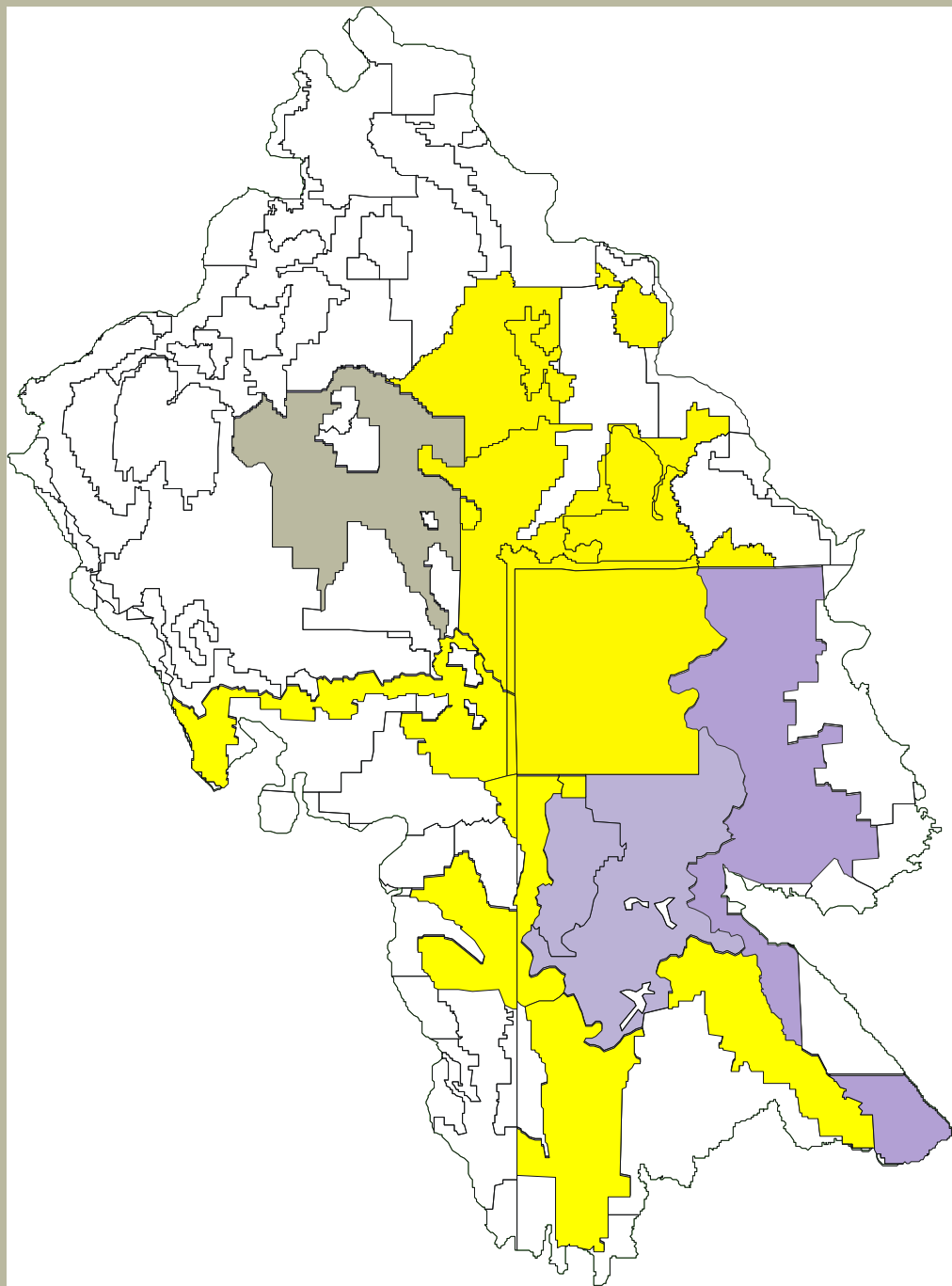
INTERAGENCY SPATIAL ANALYSIS CENTER

Uses to Date

- Parent Material for Landscape Study (three units)
- Soil Survey background and help in starting (three units)
- Upgrade Digital data to usable status (four units)
- Studies of higher ecological classes (two units)
- Joining Requirement for new Soil Surveys

INTERAGENCY SPATIAL ANALYSIS CENTER

June Status



INTERAGENCY SPATIAL ANALYSIS CENTER

The Landscape Model

- The integrated spatial database (30,000 polys)
- The common legend (1400 entries)
- The application engine
- The metadata
- The common terminology used throughout

INTERAGENCY SPATIAL ANALYSIS CENTER

The Application Engine

- Spatial data attribution
- Spatial Queries
- Legend attribution
- Legend Queries

INTERAGENCY SPATIAL ANALYSIS CENTER

The

s37VegetationExistingPotental	Text
s38VegetationTypeComponentOne%	Long Integer
s39VegetationTypeComponentTwo%	Long Integer
s40VegetationTypeComponentThree%	Long Integer
s41VegetationTypeOne	Memo
s42VegetationTypeTwo	Memo
s43VegetationTypeThree	Memo
s44HabitatTypeSummary	Memo
s45HabitatTypeSummaryNotes	Memo
s46HabitatTypeOne	Text
s47HabitatTypeTwo	Text
s48HabitatTypeThree	Text
s49HabitatTypeComponentOne%	Long Integer
s50HabitatTypeComponentTwo%	Long Integer
s51HabitatTypeComponentThree%	Long Integer
s52ElevationRangeLow	Long Integer
s53ElevationRangeHigh	Long Integer
s54SlopeRangeLow	Long Integer
s55SlopeRangeHigh	Long Integer
s56AspectSummary	Text
s57AspectNotes	Memo
s58GYALandform	Text
s59GYAParentMaterial	Text
s60GYAWetAreas	Text
s61GYASize	Long Integer
s62GYAslope	Text
s63GYASoilHorizon	Text
s64GYASoilTemp	Text
s65GYASoilTexture	Text
s66GYAVegetation	Text
s67GeneralForest%	Long Integer
s68GeneralNon-Forest%	Long Integer
s69GeneralRockOutcrop%	Long Integer

INTERAGENCY SPATIAL ANALYSIS CENTER

volcanic ash in soil : Update Query

Final 2000 GYA soil survey data

s64GYASoilTemp
s65GYASoilTexture
s66GYAVegetation
s67GeneralForest%
s68GeneralNon-Forest%

Field:	s25GYASoilTexture	s10SoilComponentOne	s11SoilComponentTwo	
Table:	Final 2000 GYA soil	Final 2000 GYA soil survey dat.	Final 2000 GYA soil survey data	
Update To:	"vitric properties"			
Criteria:		Like "*vitri*" Or Like "*vitra*"		
or:			Like "*vitri*" Or Like "*vitra*"	

INTERAGENCY SPATIAL ANALYSIS CENTER

```
Option Compare Database
Option Explicit


'-----------------------------------------------------------
Sub GYAParentMaterialClassification()
'This sub classifies the GYA standardized legend into parent material classes.  This does not include rock types.  Classes are pre-defined, but are taken
'from observation of the legend and objectives of the work.  First given parent material class is used in both summary and in components, as this is the usual
'dominant class (when mapped).
'H.Shovic
'5152000  version 1.1

'initialize and dimension
Dim GYAstandard, querytable, temptable As DAO.Recordset, temp, tablename As String, sql, pm As Variant, parentsummary As String
Dim dbs As Database, updates, totalrecords, totalunclass, GYAParentMaterial, mycheckparent, mycheckcomponent
Set dbs = CurrentDb
Set GYAstandard = dbs.OpenRecordset("Final 2000 GYA soil survey data")
Set temptable = dbs.OpenRecordset("temptable")
'Set querytable = dbs.OpenRecordset("temptable1")
GYAParentMaterial = " "


GYAstandard.MoveFirst

'delete records from temptable
Call EmptyTable_TSB("", "temptable")
updates = 0
totalrecords = 0
totalunclass = 0

nextrecord:

GYAstandard.Edit
GYAParentMaterial = " "
'delete records from temptable
tablename = "temptable"
Call EmptyTable_TSB("", tablename)


'IF statements for rules

'Named parent materials in parentmaterial summary ()
mycheckparent = IsNull(GYAstandard!s27ParentMaterialSummary)

If mycheckparent = True Then GoTo component
parentsummary = GYAstandard!s27ParentMaterialSummary
'find the start position for each parent material class words if it exists in the summary.



temptable.AddNew
temptable!Value = InStr(parentsummary, "alluvium")
temptable!NAME = "alluvium"
temptable.Update
```

Data Mining: Wordperfect Document

101 - Cumulic Cryoborolls, silty - Crubas - Tetonville Families complex, 0 to 5 percent slopes.

SETTING

The map unit consists of active floodplains of major drainages. Parent material is dominantly poorly to moderately sorted Quaternary alluvium derived from various sources. This material is highly variable within this map unit due to the relatively active meandering, braiding, and movement of the stream channel through its annual cycle. Elevation ranges from 6,000 to 8,500 feet. All aspects included. Average annual precipitation ranges from 35 to 60 inches. The stability rating is stable. This unit is mapped throughout the survey area.

VEGETATION

The map unit supports riparian vegetation. Willows are the dominant shrubs. Other common shrubs include mountain big sagebrush, silver sagebrush, gooseberry currant, and shrubby cinquefoil. Common forbs and graminoids include yarrow, sticky geranium, strawberry, goldenrod, western coneflower, Kentucky bluegrass, and elk sedge.

COMPONENTS

Cumulic Cryoborolls Family, silty, soils are approximately 30 percent of the map unit. The Crubas Family is approximately 30 percent of the map unit. The Tetonville Family is approximately 25 percent of the unit. The remaining 15 percent includes Gateview Family and Cryoborolls Family, loamy-skeletal, soils.

Cumulic Cryoborolls Family, silty, soils are very deep and poorly drained. Due to the variability of fluvial systems, these soils are found throughout the map unit. The surface layer is grayish brown and brown very fine sandy loam, 14 inches thick. The upper underlying material to a depth of 28 inches, is brown silt loam with common fine distinct reddish yellow mottles. The lower underlying material to a depth of 60 inches is pale brown extremely gravelly loamy sand. Reference Pedon: T56-78.

INTERAGENCY SPATIAL ANALYSIS CENTER

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'add a new temp document for individual map unit descriptions
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'open the interim table

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Set BTNFinitial = dbs.OpenRecordset("BTNF West Interim Soil Survey Data")


'initialize  start of range for doc beginning

pagecount = 0
currentstartpos = 0
' set range for  the page having map unit information
'make sure start at beginning of document
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nextmapunitdescription:

' add a blank record to the table

BTNFinitial.AddNew

'set range to start position and extending to end of document
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'beginning of selection is beginning of document
currentstartpos = 0
'find end character for this map unit description.

'find first " \"

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        .Wrap = wdFindStop
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        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
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'find next " \" for end of map unit description
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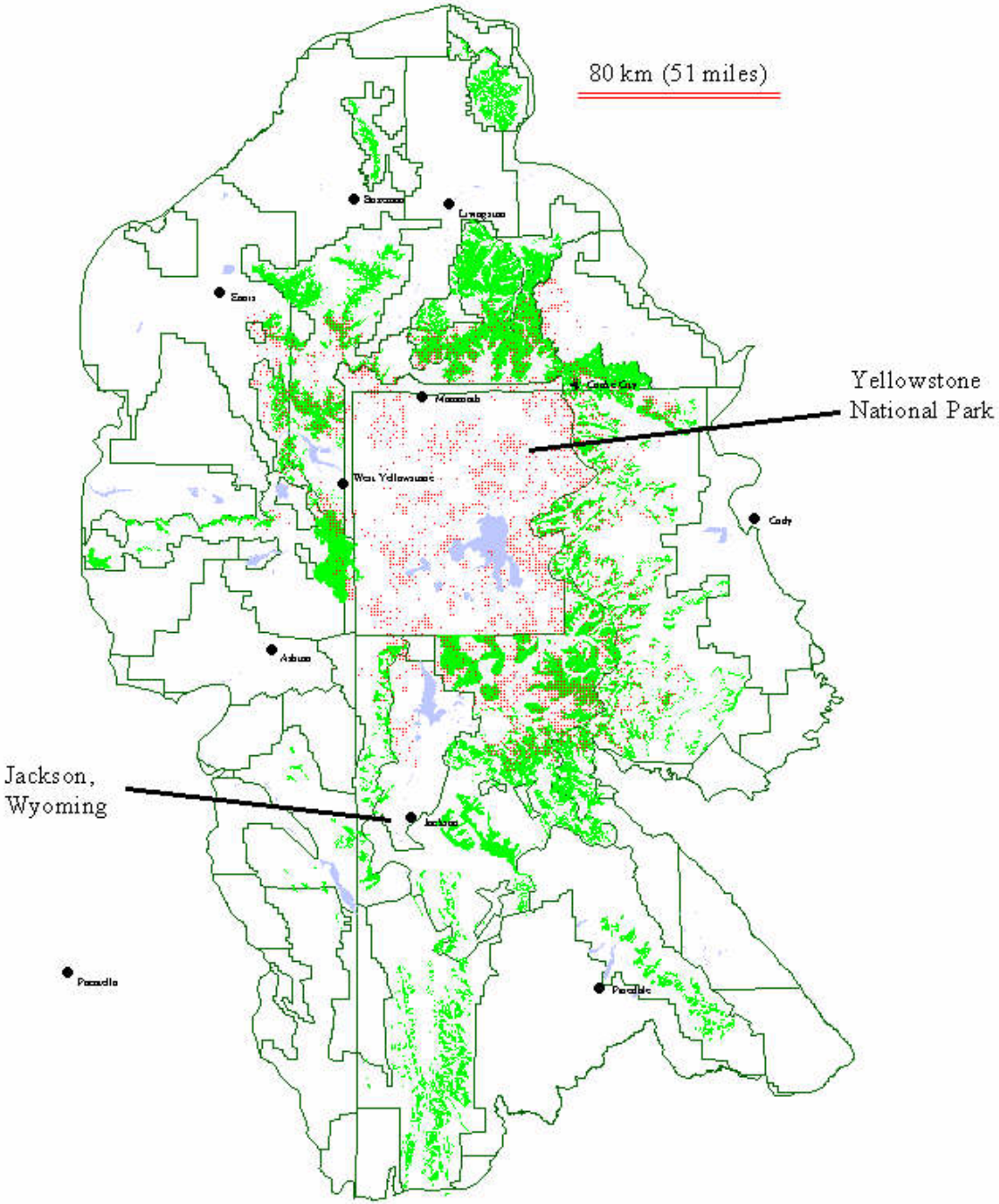
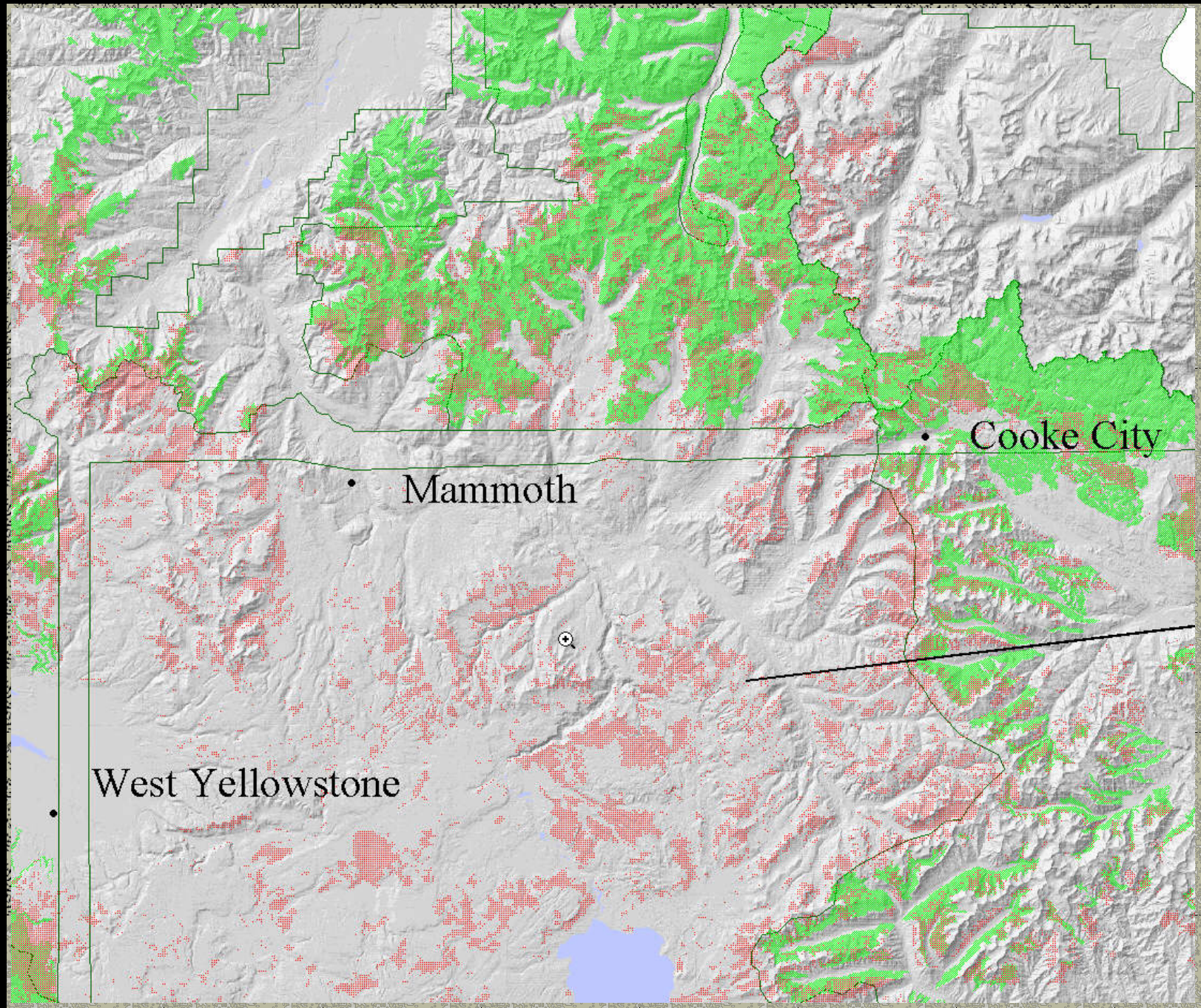
INTERAGENCY SPATIAL ANALYSIS CENTER

W



INTERAGENCY SPATIAL ANALYSIS CENTER



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Applications

- Concepts of Mapping Within Survey Areas
- Concepts of Mapping Between Survey Areas
- NASIS and use in these surveys
- Data mining in older surveys

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Conclusions

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Presented at Western Regional Soil Survey Conference
Hawaii June 26-30, 2000

Slide 1

Adding Value to Soil Surveys with a

Dynamic Soil Properties Database

Arlene J. Tugel
Soil Quality Institute

prepared by C. Ditzler, A. Tugel, L. Norfleet, C. Seybold, M. Hubbs

Slide 2

The "Next Generation":
A Challenge and an Opportunity

- Starting with an existing survey and a charge to "update and modernize".

Slide 3

What does this mean???

- Update classification?
- Draw new lines?
- Transects for map unit composition?
- Update yields?
- Describe to 2 meters, some deeper?
- Digitize for SSURGO?
- CD-Rom and web-based distribution?
- All are worthwhile goals.

Slide 4

Key is to:

Build on the existing product
so that modernized surveys are
BETTER
than the old ones, not just
DIFFERENT.

Slide 5

Two Views of Soil Properties

- **Inherent** - fixed, unlikely to change.
  - Texture, mineralogy, depth, color.
- **Dynamic** - respond to land use and management. (Especially in upper part of soil.)
  - **Organic matter, bulk density, pH, aggregation, organisms, CEC, permeability, infiltration.**

Slide 6

Soil Survey Considerations

- Soil Taxonomy purposely avoids consideration of dynamic properties to achieve consistent taxonomic placement.
- Soil Maps can not effectively show spatial distribution of dynamic soil properties.
- Soil Databases can be used to record this information.

Slide 7

Dynamic Soil Property Examples

- Management effects on cropland
  1. Milan, TN Exp. Station
  2. Silverton, OR farm
- Land use effects
  3. Auburn Univ. Exp. Farm, AL
  4. Eastern Nebraska farms
- Management effects on rangeland
  5. Las Cruces, NM

Slide 8

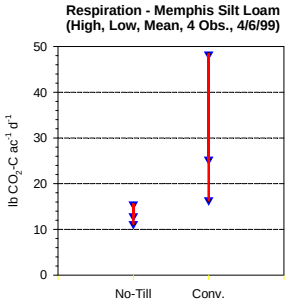
#1) Memphis silt loam - Milan, TN

- Fine-silty, mixed, active Typic Hapludalf
- Soil quality test kit used on experimental plots to compare effects of
  - no-till and
  - conventional tillage

Slide 9

Biological Activity

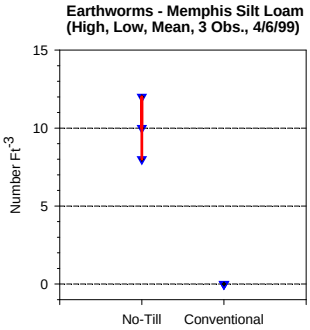
- CO_2 evolution within 6-inch ring.
- Generally higher and more variable on conventionally tilled area.
- Organic matter is being consumed.



Slide 10

Biological Activity

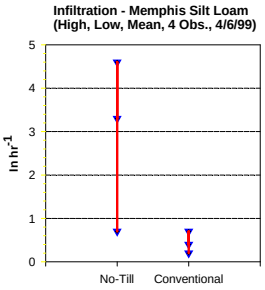
- No earthworms observed in the conventionally tilled plots.



Slide 11

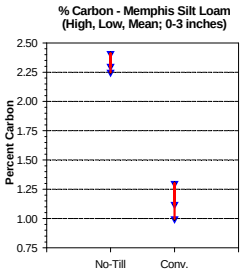
Water Movement Into Soil

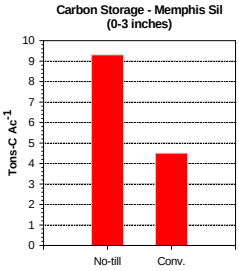
- Single 6-inch ring.
- Generally lower and less variable on conventionally tilled plots.
- Currently not in NASIS, but a good indicator of soil quality.



Slide 12

Carbon Content

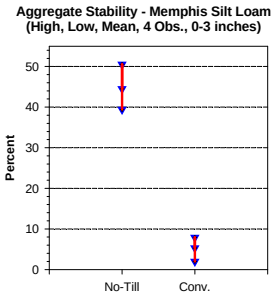




Slide 13

Stability of Peds

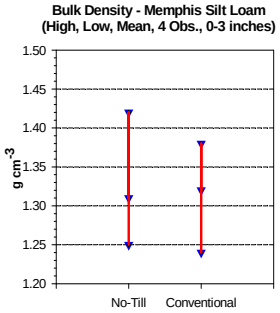
- Wet sieve procedure.
- Much greater aggregate stability under the no-till treatment.
- Currently not in NASIS, but a good indicator of soil quality.



Slide 14

Bulk Density

- 6-inch diameter core.
- Similar under both treatments.

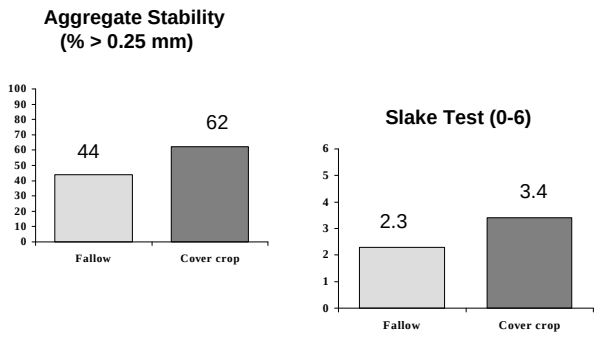


Slide 15

#2) <u>Amity silt loam - Silverton,OR</u>

- Fine-silty, mixed, mesic Argiaquic Xeric Argialbolls
- Soil quality test kit used to compare:
  - vegetable system with a winter cover crop (corn, annual ryegrass, cauliflower, barley, sweet corn)
  - vegetable system with no cover crop.

Slide 16



Silverton, OR (July 1998)

Slide 17

#3) <u>Compass loamy sand -</u>

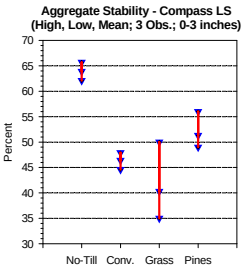
<u>Auburn, AL</u>

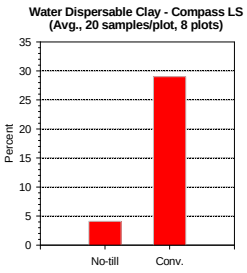
Coarse-loamy, siliceous, subactive, thermic Plinthic, Paleudult

- Auburn University Experimental Farm
- Comparisons:
  - Conventional-till
  - No-till
  - Grass
  - Planted Pines

Slide 18

Stability of Peds

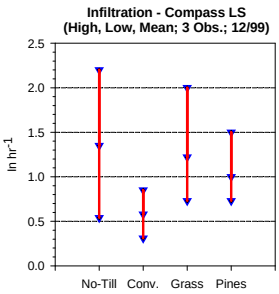




Slide 19

Water Movement (into soil)

- Cornell Infiltrometer.
- Slowest For Conventional Tillage.
- No-Till and Grass most variable.

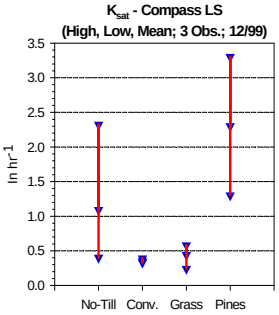


Slide 20

Water Movement (subsoil)

- Amoozemeter
- Slowest for conv. tillage and grass.
- Most variable for no-till and pines.

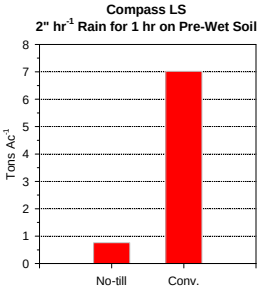
0.2-0.6 = mod. Slow
0.6-2.0 = moderate
2.0-6.0 = mod. rapid



Slide 21

Soil Erosion

- Dramatic soil loss reduction due to residue cover, more stable peds, higher OM, and increased infiltration.



Slide 22

#4) Eastern Nebraska

- **Aksarben** - Fine, smectitic, mesic Typic Argiudoll
- **Monona** - Fine-silty, mixed, superactive, mesic Typic Hapludoll

- Comparison of cropland and grassland

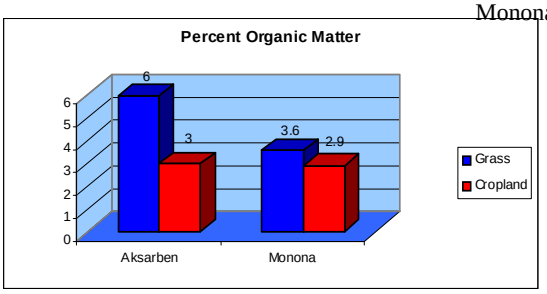
Slide 23

Organic Matter

Current Database

Aksarben 2-4

Monona 2-4



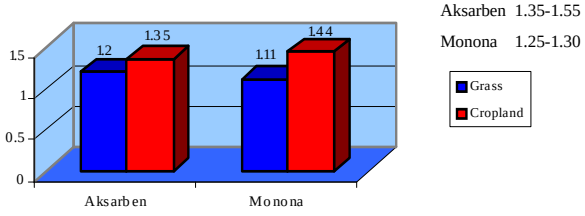
Slide 24

Bulk Density

Current Database

Aksarben 1.35-1.55

Monona 1.25-1.30



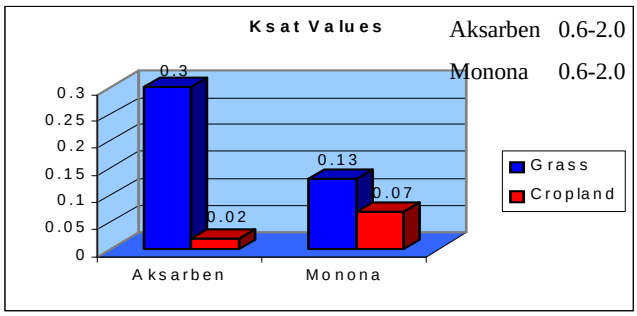
Slide 25

Hydraulic Conductivity

Current Database

Aksarben 0.6-2.0

Monona 0.6-2.0



Slide 26

#5) Simona loamy sand - Las Cruces, NM

- Loamy, mixed, thermic, shallow Typic Petrocalcids
- Two "states" within an Ecological Site are compared:
  - Black grama grassland and
  - Former grassland now invaded by mesquite.
- Contains 80-85% sand in 0-10cm layer

Slide 27

Shallow Sandy Ecological Site Southern Deserts MLRA 42

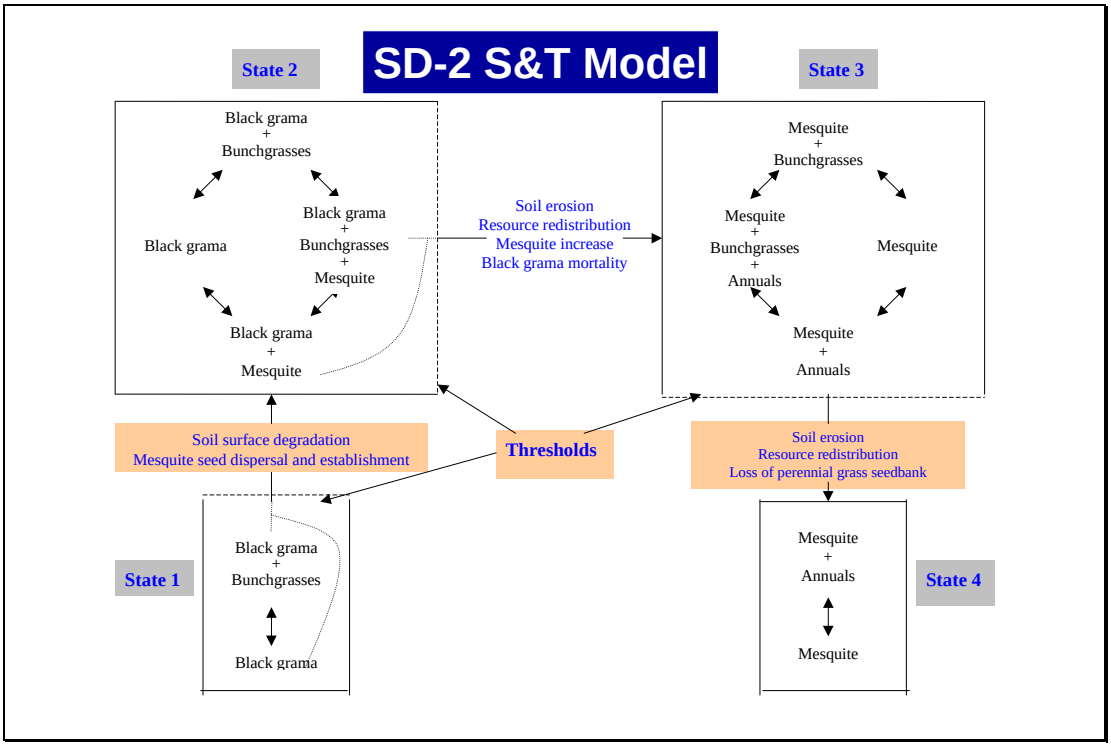
- 8-10.5" PPT
- 61 F MAAT
- Historic potential native plant community:
  - Open grassland dominated by black grama with dropseeds, threeawns, perennial and annual forbs, scattered shrubs and half-shrubs
- Very high soil blowing hazard

Slide 28

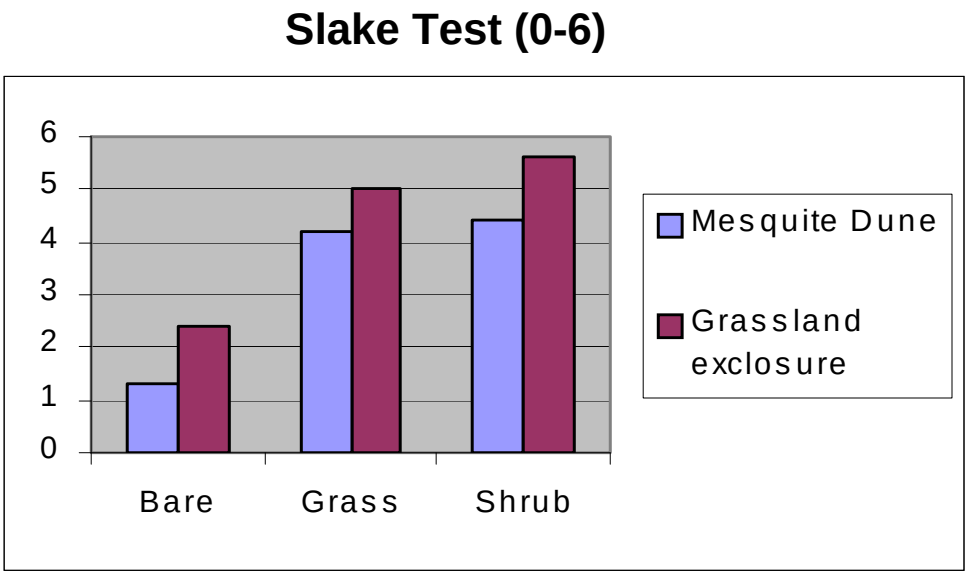
Vegetation change models

- Clementian
  - Linear model of succession
- State and Transition Models
  - Non-equilibrium dynamic ecological model

Slide 29

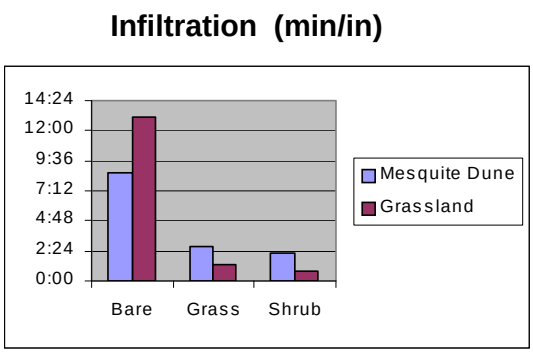


Slide 30



De Soyza, etal, 1977

Slide 31



Herrick, etal, 1999

Slide 32

Advantages of a Dynamic Properties Data Set

- Greater flexibility in interpretations.
- Improved derivative property information.
- Greater utility at the field, regional and national level.
- Fundamental to soil quality, rangeland health, watershed health.
- Essential for soil resistance and resilience.

Slide 33

More flexibility in making interpretations

Potential Pesticide Loss

Aksarban

	Leaching	Runoff
Grass	Low	Int.
Cropland	V. Low	High
Database	Int.	Int.

Slide 34

Improved Derivative Information

Hydrologic Group

	Aksarban	Monona
Grass	B	B
Cropland	D	C
Database	B	B

K factor

	Aksarban	Monona
Grass	.32	.27
Cropland	.44	.43
Database	.32	.32

Slide 35

Improved Value at the Field level

– "What is the potential for sequestering carbon in the soils on my farm?"

– "If I change to no-till, will it affect the potential for pesticides to enter my farm pond?"

– I need quantified values for rangeland health indicators."

Slide 36

Improved Watershed/Regional Assessment Capabilities

– "What are the current baseline carbon levels in the region?"

– "What effect would increasing no-till from 25% to 50% of the cropland in a watershed have on water quality and flooding?"

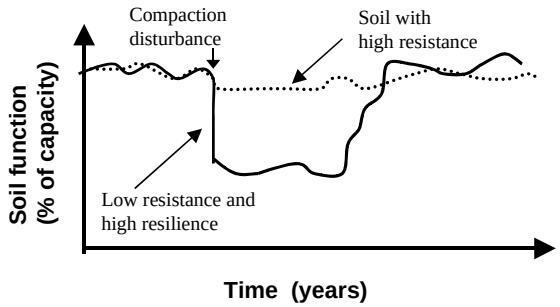
Slide 37

Fundamental to soil quality, rangeland health, watershed health

		Departure from ES Description				
	Indicators	Extreme	Mod to Extreme	Mod	Slight to Mod	None to Slight
1.	Rills					
2.	Water flow patterns					
3.	Pedestals and/or terracettes					
	Etc.					
17.	.					

Slide 38

Essential for soil resistance and resilience



Slide 39

Where do we go from here?

- Sample key soils under contrasting land use and management combinations.
- Extend information to similar soils.
- Evaluate ecological framework for database (S&T Models)
- Incorporate data in NASIS.
- Include information in soil survey reports and ecological site descriptions

Slide 40

Ecological Framework for Dynamic Soil Properties Database

Use

Rangeland	Cropland	Pasture	Forest
carbon	carbon	carbon	carbon
infiltration	infiltration	infiltration	infiltration

Ecosystem/Ecosite

State 1	State 2	State 3	State 4	State 5
Black grama	Mesquite	Irr row crop	Irr orchard	Irrig past
carbon	carbon	carbon	carbon	carbon
infiltration	infiltration	infiltration	infiltration	infiltration

Slide 41

NEXT STEPS

- Select a few pilot projects with states and MO's to work with NSSC & SQI in FY '01.
  - Preferably new updates with emphasis on data and interpretations.
- Work with specialists to identify properties to be included.
- Obtain equipment, provide training.

Thursday, June 29, 2000 8:45 – 9:15 a.m.

Hawaiian Hydrology, Pesticides and Soils: Understanding the Types and Interactions

From a lecture by Richard Green, Professor Emeritus, University of Hawaii at Manoa.
Presented by Chris Smith, NRCS, Hawaii

Ground Water can be generally defined as water in a reservoir below the land's surface that is generally renewable. Only in the last few decades have we thought of this resource as having the potential to be contaminated. Rachael Carson, in her writings in the 1960's was mostly concerned about surface water. As we didn't know much about ground water at the time. Surface water easily contaminated and more readily seen but is also more easily cleaned up by eliminating the contaminant source and allowing precipitation to refresh the system. Once ground water is contaminated, it is more difficult to decontaminate because water is more or less trapped in its aquifer.

About fifty percent of U.S. urban domestic water use and about 80% of rural domestic water use is from ground water.

The high islands of Hawaii are made up of shield volcanoes for the most part that are composed of porous basalt. In the older portions of the island chain still exhibiting volcanic landscapes, these shield volcanoes have been deeply incised by erosion but their original morphology can still be found by studying the interfluvs. In some cases, mass wasting has removed entire sides of these original volcanoes.

Water moves at differing rates through the layered a'a and pahoehoe. A'a is very porous in the clinker component and massive in the underlying "blue rock" component. P ahoehoe is relatively impervious. The strata also may contain buried ash deposits. So lateral and vertical movement both occur. The storage capacity of the system is about 10% of the rock volume.

The percent of the porosity in the rock above the aquifer that rapidly conducts water is only about 2% so a funneling action occurs and causes faster through flow than if all of the pores conducted water at an equal rate.

As seen on the attached diagram of the *water cycle*, orographic rainfall is an important component in freshwater recharge. Although there is only about 750 mm (30") precipitation over the nearby open ocean, precipitation levels may reach 6600 mm (260") on some mountains. There are freshwater lenses, due to pervious rock associated with impervious rock, and the high rainfall in highlands. On Oahu, we have the added water trapping advantage or having the ridge of the mountains perpendicular to the trade wind flow which maximizes trapping of clouds. Fresh displaces salt water because it is less dense allowing it to float above the sea water. This feature is called a Giben-Hertzberg lens and is typical of island hydrology even in coral atoll islands.

The Koolau mountains on Oahu have an extensive system of dikes as well that hold water within that system higher than the top of the water table. Ash or paleosols also perch water at

higher elevations. For each 1 meter of water above sea level, there are 40 meters below sea level.

Sediments have created a cap rock as deep as 300 meters off of the coast of Oahu (BI no cap rock) which prevents ground water from entering the ocean. This is because water saturates the pore space within the cap rock but the rock is relatively impervious and through flow is minimal.

Salt is actually then the most prevalent contaminant and active pumping has caused an increase in salinity in certain areas. Contaminants, aside from salt, include agricultural and industrial chemicals. Agriculture at the lower elevations is usually drier environments and so there is lower recharge. This results in less contamination than in upper elevation ground water.

Of all water consumed, ground water use ranges from 18% on Big Island to 85% for Oahu (1975). The Big Island is young and there is no cap rock, therefore the fresh water lens is thin.

Agricultural contaminants 0n Oahu include EDB, DBCP (nematicides in Pineapple), TCP (a component of DD), Atrazine (found in many wells), and Hexazinon. EDB was only found at one site in Kunia and was traced to a spill. DBCP and TCP were found in every well.

Industrial contaminants include TCE and PCE and are widespread through the Wahiawa aquifer.

Factors contributing to ground water contamination include: pesticide properties, soil properties, aquifer characteristics, and recharge characteristics.

Pesticide Properties

An important pesticide property is its sorption tendency with the solid surface of the soil. This surface is mainly that of organic matter (SOM). This is made up of a combination of adsorption and absorption. Non-polar molecules, when associated with organic matter, is miscible and is able to penetrates or combine with internal bonding sites. This is generally a reversible reaction. Non-polar molecules will desorb if the solution phase concentration is reduced. With time the reactions are less reversible.

Polar chemicals are not common. One, however, is paraquat, a well know defolient. It is cationic so highly reactive with negatively charged clays (adsorbed). A very few Ag chemicals are negatively charged. Examples include herbicides such as atrizine and amatrine if they are present under low soil pH conditions. Under low pH’s the carboxyl groups are hydrogenated.

Most chemicals, though, are non-ionic. They are slightly polar, polar, or non-polar. Non-polar chemicals associate with non-polar portions on SOM, polar portions associate with polar portions of SOM or clay minerals. Water is also polar and competes with the chemical

for sorption sites on the SOM. The more polar the molecule., the more likely it will not be sorbed and therefore be more mobile.

In Hawaii, many soils are classified as Andisols, Oxisols and Ultisols. Soil secondary minerals are leached of bases and silica, and are left with iron and aluminum oxyhydroxides that are not very active. Note that all Hawaiian soils are not of this nature. Molisols, some Inceptisols, and especially Vertisols are common in drier areas and contain variable amounts of 2:1 alumino-silicates. However in a majority of the agricultural areas, the soil's clays are relatively inactive (particularly at low pH) and so the active fraction is the SOM.

Some of the more common terminology relating to pesticide properties should be noted for reference here:

Kd or **Koc**: represents the partitioning of a chemical between soil and solution. A high coefficient means more of the chemical ends up associated with the soil.

Kd stands for distribution (between solid and solution or Kp (partitioned)

Kd = Amt. Sorbed/Amt. in Soln. = S/C = Kd (or Kp) S = mg/kg soil; C = mg/l

High Kd = more sorbed and so less leaching

Koc (organic carbon) = Kd/ foc foc = % fraction of organic carbon

Koc normalizes the Kd per percent organic carbon thereby making comparisons easier.

Degradation: is a rate term – In soil, degradation is mainly via microbial breakdown and secondarily by chemical redox reactions and hydrolysis. In the water below the soil layer, or in the vadose zone, hydrolysis is the main degradation method so depth to the ground water is important.

Degradation results in the breakdown of the chemical to H+ and OH-. So **transformation** is an important step as oxidation products (such as in aldycarb and phonamophos) may be present 30 to 80 d. These intermediate products are more mobile than the parent chemical and are the forms that are actually responsible for killing nematodes. These are the species more able to move below the root zone to the aquifer.

Half life = t1/2 and is the degradation rate which usually follows 1st order kinetics

dC/dt = - kC where k = first order rate coefficient; C = 50% of the original concentration; and t = time (usually in days)

(2nd order degradation involves the activity of the organisms)

(t1/2 = 0.693/k is a conversion from natural logs of 0.5 (seen in literature))

Henry's partition coefficient = Kh = concentration of vapor in closed a atmosphere/concentration of the liquid = 10-5 to 10-8. If 10-1 or 10-2, the chemical is very volitalizable.

EDB for example has a high Henry's constant and was is assumed that not much would get into the ground water. However, not much is needed to be significant and sufficient quantities have been found. To provide a way to visualize how much is required to provide measureable amounts of chemical into the ground water: two hundred million gallons off water are used per day in Honolulu. One teaspoon of chemical = 6.6 ppt.

Half life = t1/2 and is the degradation rate which usually follows 1st order kinetics

dC/dt = **-** kC where k = first order rate coefficient; C = 50% of the original concentration; and t = time (usually in days)

Soil Properties

As noted above, **SOM** is one of the most important soil properties. SOM differs a great deal by soil. Andic materails may have up to 25% SOM; Oxisols contain 1 to 4%

SOM classically is highest in the surface layer and decreases regularly with depth. In alluvial soils and particularly in Andisols, SOM percentages vary with depth and may only decrease slightly from the surface. Accounting for deeper layer SOM can be important.

From a management standpoint, if top soil removed such as in homesite development, one usually loses the SOM richest layer. So it is important to recommend stockpiling and returning the material to areas that will be later landscaped.

Texture is more important to recognize in any modeling effort on themainland because textures are similar in our dominant areas of agriculture. Oxisols are either silty clay loam or silty clay and the Andisols are silt loam to silty clay loam (apparent field texture).

Clay mineralogy is important through the charge density, and whether the charge is negative and or positive kaolinite, goethite, and hematite are relatively inert but of pH dependent charge, smectite has high negative charge, and short range order minerals such as allophane and ferrihydrite can be of very low CEC at acid pH's or very high CEC at neutral pH's. There is also significant anion exchange capacity at low pH's.

Structure is also important. Our aggregates may be micro and have have micropores within aggregates. This results in low AWC but high 15 and 1/3 bar water contents. Chemicals can be drawn into these micopores within the microaggregates and later diffuse out into the soil solution.

The concentration with depth to say 100ft would provide a bell shaped pulse if one thinks chromatographically. This appears to have been observed at great depth at one moist climate

site during one sampling time) Most others appear like an SOM curve due to some diffusion from microaggregates which adds to the leachate. So structure is important in Oxidic soils.

Aquifer properties

In dry areas there appears to be no contamination below 20 ft so site climatic conditions are important. The amount of pumping important because contaminants can be drawn in from other areas.If recharge is high, the risk of contamination is higher.

The mechanism of movement in soils is mainly in water (not in vapor phase). Ununiform water movement occurs in some soils. Ash soils are poorly aggregated and contain 60-70% pore space so moves uniformly (there is mass flow but the rate is slower). Aggregates move water ununiformly and diffusion occurs.

The **depth to the aquifer** is important which allows time for redox reactions to occur.

Management: The better you know how and when to apply both chemicals and water, the better off one will be economically and environmentally.

As an example: Phonamophos (nemacure): If lable amounts are used, deep penetration occurs (>3m in one study). But if no more is used than thought needed (through experience) and careful irrigation practices are exercised, leaching occurs to < 1.2 m. So if one knows the system, application rates may be less and better than if lable instructions are followed.

Timing: don’t irrigate if rainfall is expected. Keep the chemical up in the upper part of the profile where microorganisms can degrade the material. Also, prevent point source contamination.

Conclusion: Offered here is a brief primer on pesticide/soil interactions with some consideration for environment and management.

Improvements can be made in the criteria (rules) that NRCS uses to rate soils for leaching of chemicals. Consideration of the above factors are possible within our database and should be exploited.

Kd or **Koc**: represents the partitioning of a chemical between soil and solution. A high coefficient means more of the chemical ends up associated with the soil.

Kd stands for distribution (between solid and solution or Kp (partitioned)

Kd = Amt. Sorbed/Amt. in Soln. = S/C = Kd (or Kp) S = mg/kg soil; C = mg/l

High Kd = more sorbed and so less leaching

Koc (organic carbon) = Kd/ foc
foc = % fraction of organic carbon

Koc normalizes the Kd per percent organic carbon thereby making comparisons easier.

Half life = t1/2 and is the degradation rate which usually follows 1st order kinetics

dC/dt = - kC where k = first order rate coefficient; C = 50% of the original concentration; and t = time (usually in days)

Henry's partition coefficient = Kh = concentration of vapor in closed a atmosphere/concentration of the liquid = 10-5 to 10-8. If 10-1 or 10-2, the chemical is very volitalizable.

June 29, 2000 – 8:45 – 9:15 a.m.

Soil Properties

SOM

Texture

Clay Mineralogy

Structure (porosity)

Soil Data Viewer

Soil Data Viewer Objectives

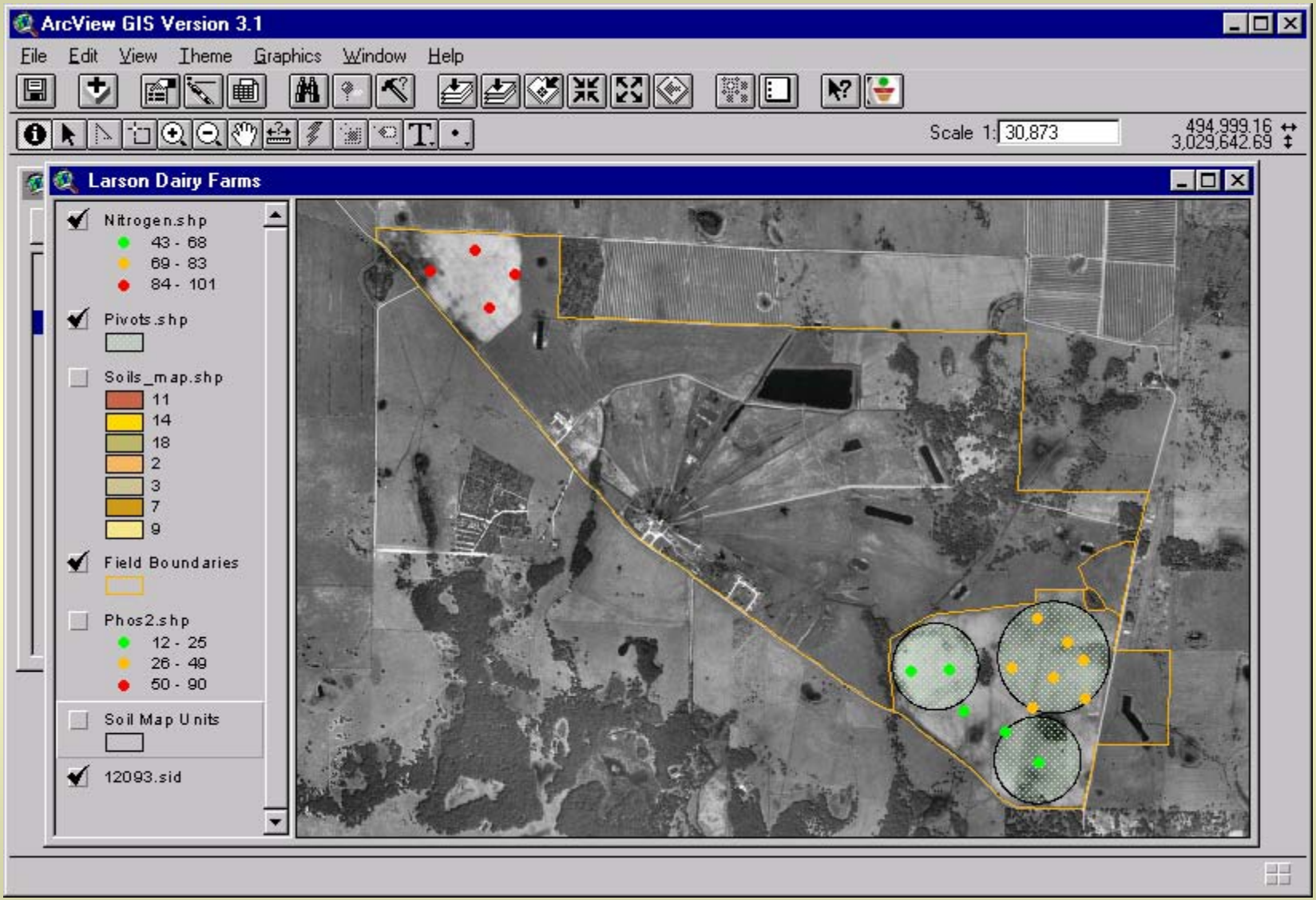
- Shield users and applications from the complexity of the soil database
- Encapsulate business rules for appropriate use of soil data
- Insulate users and applications from structural changes to the soil database
- Provide easy to use tool for analyzing and using soil data

Business Rule File

- MS Access database separate from the soil database
- Lists viewable interpretations and soil properties
- Defines valid methods of processing
- Defines tie breaker rules
- Stores SQL information: table, column, query

SDV Future Design

- Soil Data Viewer gets its business rules from metadata in the NASIS export
  - Analysis still needed on the requirements for the metadata
  - SDV interpretations and soil property choices are consistent with the soil database being used
- Soil Data Viewer is built as a component that can also be used in a Web application


ArcView GIS Version 3.1
File Edit View Theme Graphics Window Help
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Larson Dairy Farms
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Soil Map Units
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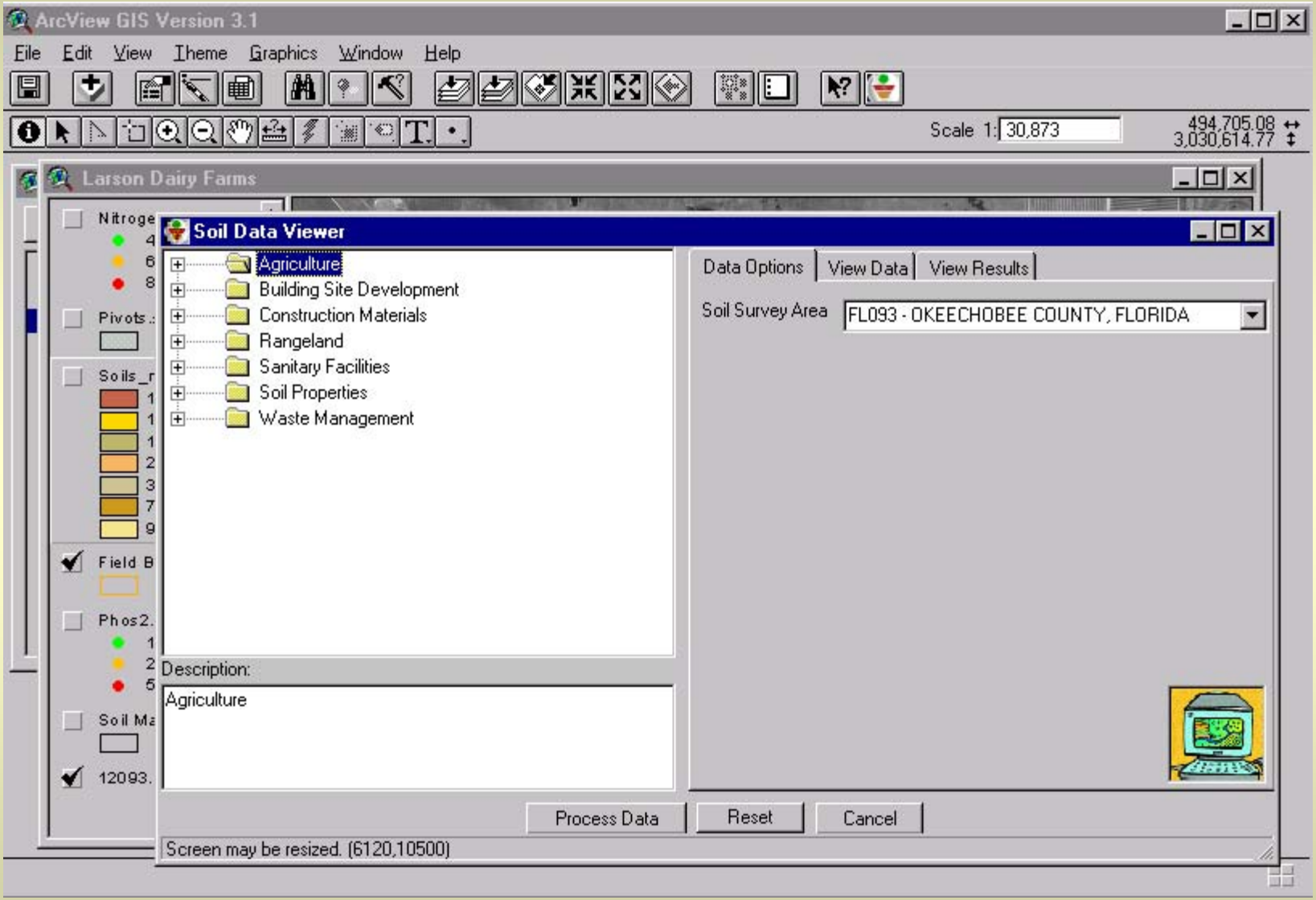
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Larson Dairy Farms
Soil Data Viewer
Agriculture
Building Site Development
Construction Materials
Rangeland
Sanitary Facilities
Soil Properties
Waste Management
Data Options
View Data
View Results
Soil Survey Area
FL093 - OKEECHOBEE COUNTY, FLORIDA
Description:
Agriculture
Process Data
Reset
Cancel
Screen may be resized. (6120,10500)

ArcView GIS Version 3.1

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Larson Dairy Farms

Soil Data Viewer

- Agriculture
- Building Site Development
- Construction Materials
- Rangeland
- Sanitary Facilities
- Soil Properties
- Waste Management
  - Irrigation Disposal of Wastewater
  - Land Application of Municipal Sewage Sludge
  - Manure and Food Processing Wastes
  - Overland Flow Process Treatment of Wastewa
  - Rapid Infiltration Disposal of Wastewater
  - Slow Rate Process Treatment of Wastewater

Description:

Manure is the excrement of livestock and poultry. The consistency of manure is labile. It changes in storage or treatment, and it depends upon the bedding used and upon whether the manure is diluted or allowed to dry. Food processing wastes

Data Options | View Data | View Results

Soil Survey Area: FL093 - OKEECHOBEE COUNTY, FLORIDA

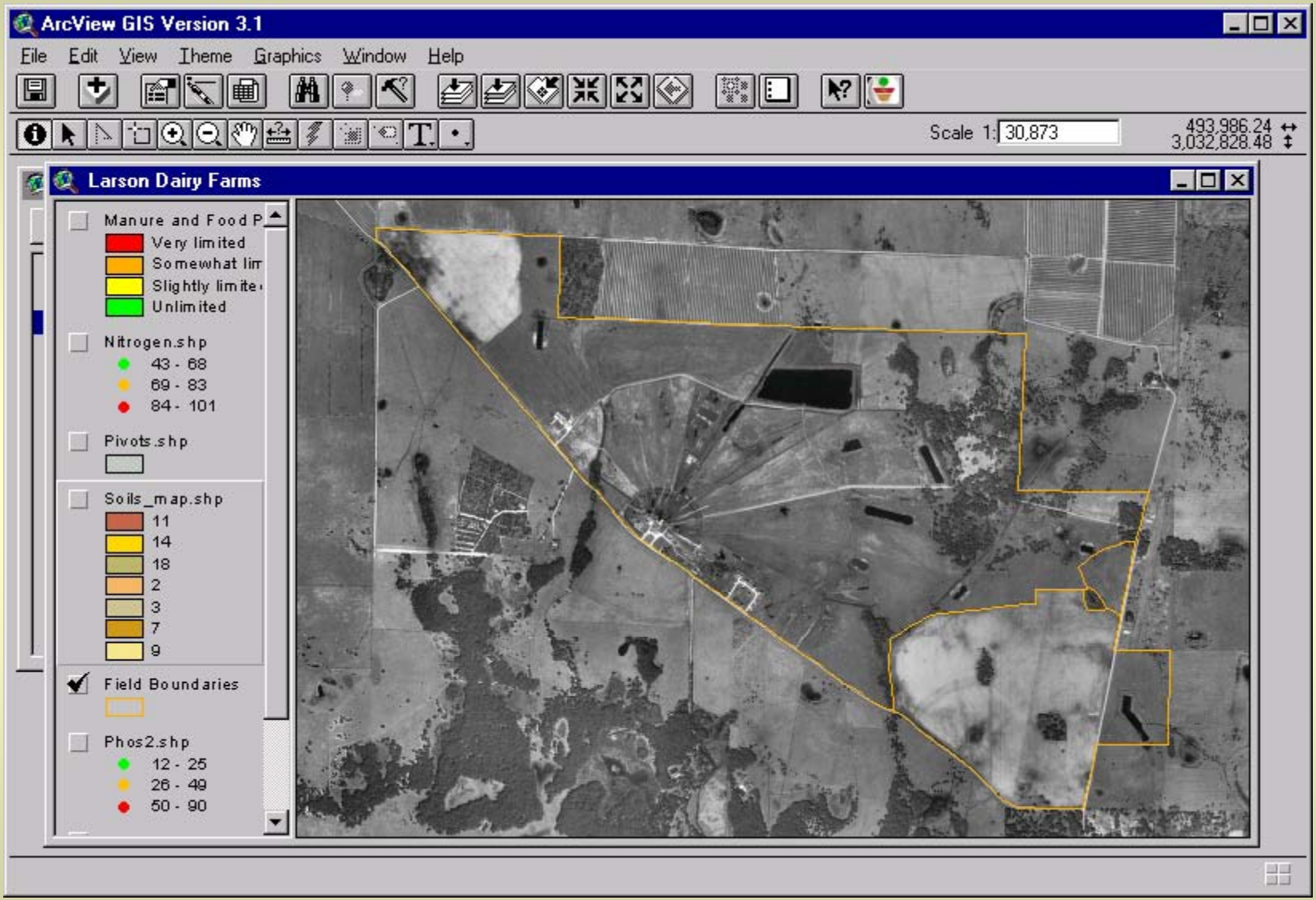
Column Name: ManureWDS

Data Filter Options

- Averages
- Most Limiting
- Least Limiting
- Dominant Soil
- Dominant Condition
- Absence/Presence

Process Data | Reset | Cancel

Screen may be resized. (6120,10500)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Field Boundaries
Phos2.shp
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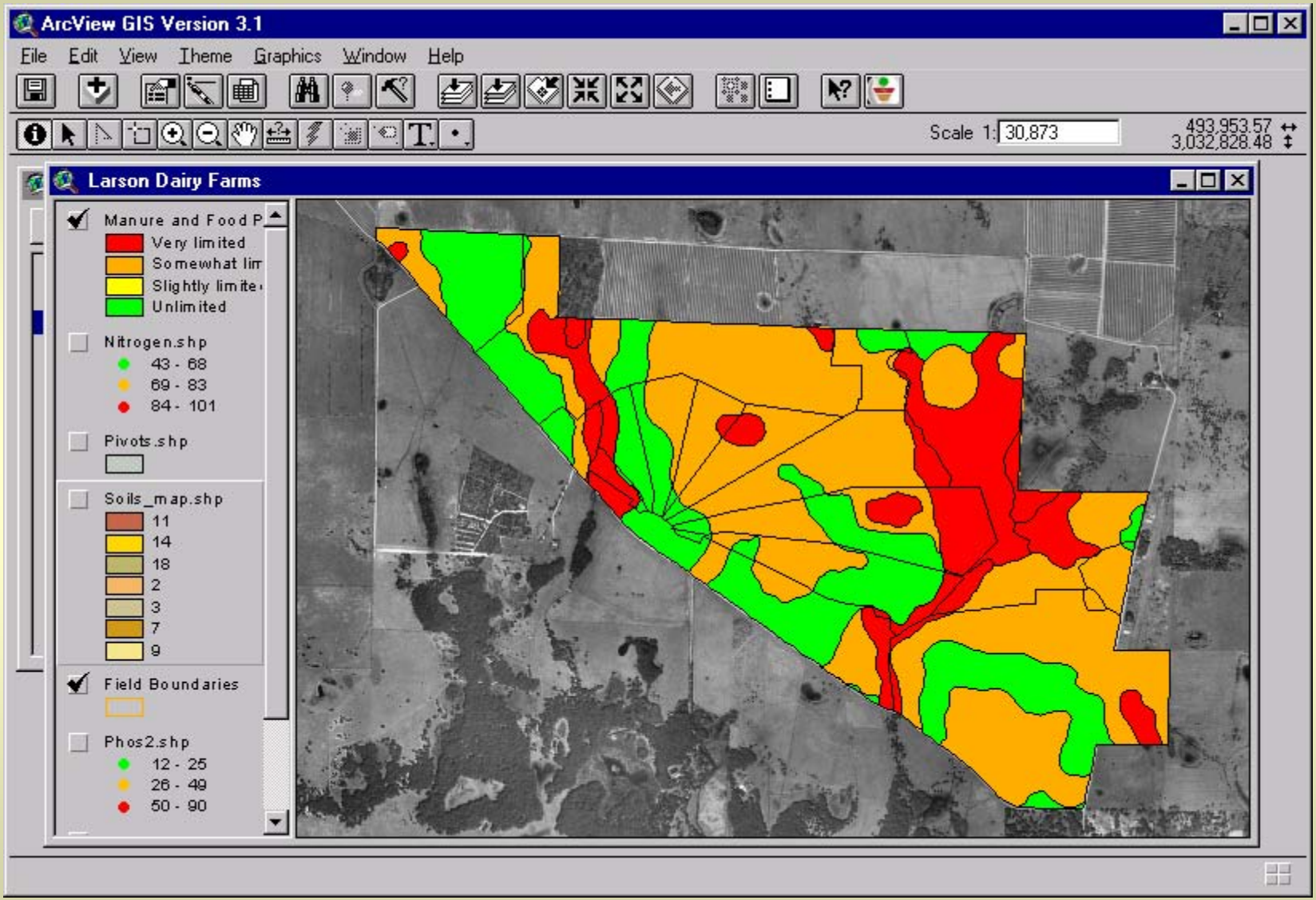
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Larson Dairy Farms

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Field Bour

Soil Data Viewer

- Agriculture
- Building Site Development
- Construction Materials
- Rangeland
- Sanitary Facilities
  - Septic Tank Absorption Fields
  - Sewage Lagoons
  - Sanitary Landfill (Area)
- Soil Properties
- Waste Management
  - Irrigation Disposal of Wastewater
  - Land Application of Municipal Sewage Sluc
  - Manure and Food Processing Wastes
  - Overland Flow Process Treatment of Waste
  - Rapid Infiltration Disposal of Wastewater

Description:

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are

Data Options | View Data | View Results

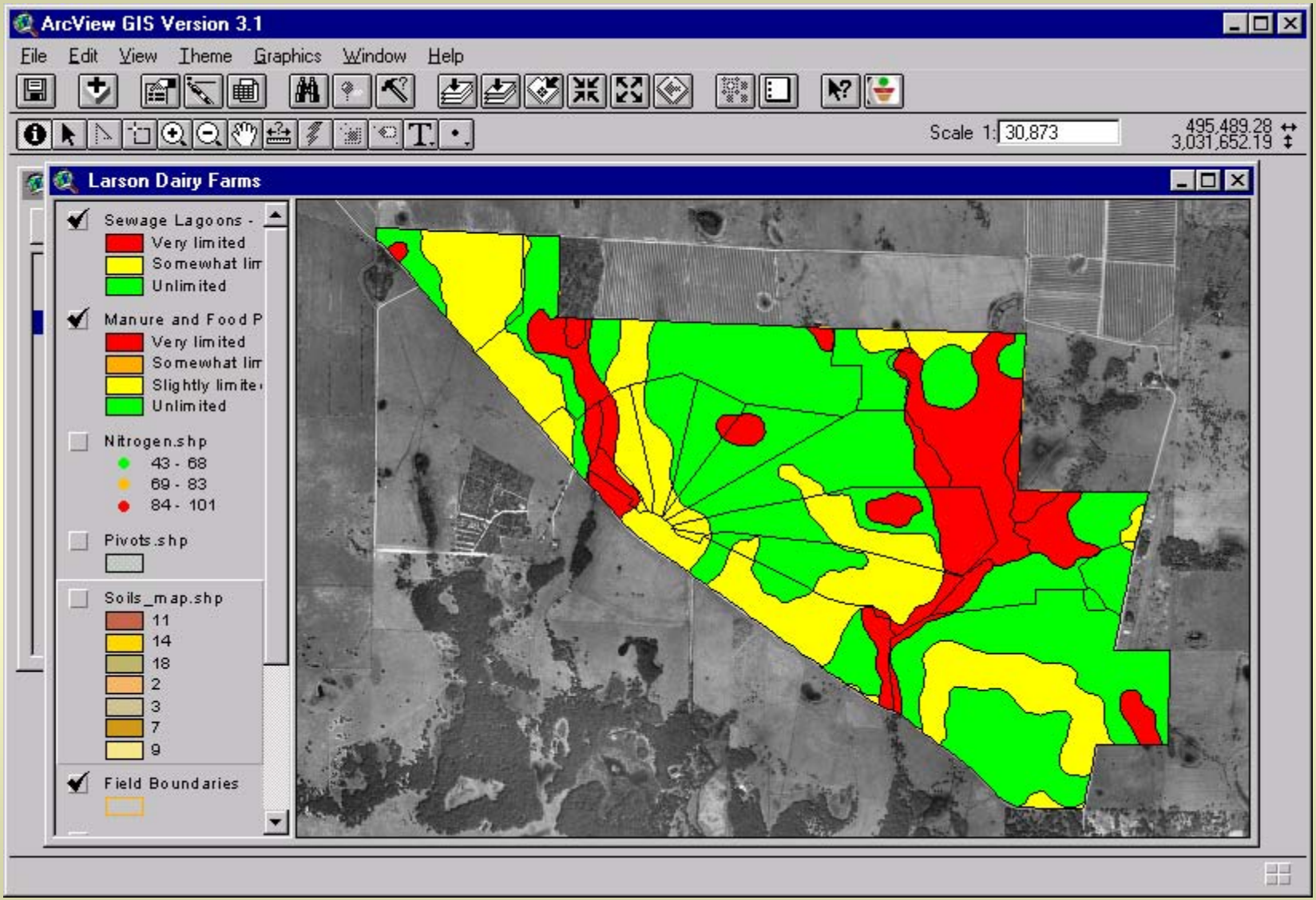
Soil Survey Area: FL093 - OKEECHOBEE COUNTY, FLORIDA

Column Name: sewageLL

Data Filter Options
- Averages
- Most Limiting
- Least Limiting
- Dominant Soil
- Dominant Condition
- Absence/Presence

Process Data | Reset | Cancel

Screen may be resized. (6120,10500)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Field Boundaries

ArcView GIS Version 3.1

File Edit Table Field Window Help

0 of 67 selected

Larson Dairy Farms

Attributes of Sewage Lagoons - Least Limiting

Parcelid	Localdata3	Clu_calcac	Fields_	Fields_id	ManureWDS	Sewagell
		15.33	128	90	Somewhat limited	Unlimited
		15.33	128	90	Very limited	Very limited
		15.33	128	90	Unlimited	Somewhat limited
		2.25	129	88	Somewhat limited	Unlimited
		270.31	130	89	Somewhat limited	Unlimited
		270.31	130	89	Very limited	Very limited
		270.31	130	89	Unlimited	Somewhat limited
		270.31	130	89	Very limited	Very limited
		270.31	130	89	Unlimited	Somewhat limited
		1010.62	127	83	Somewhat limited	Unlimited
		1010.62	127	83	Unlimited	Somewhat limited

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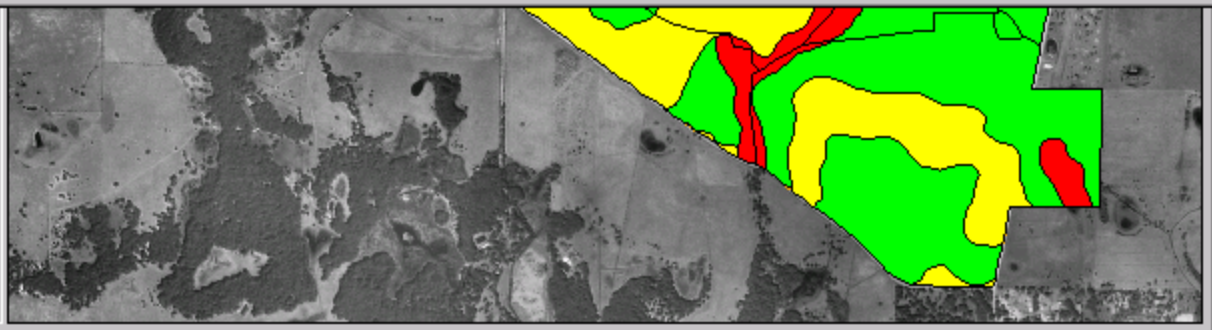
Field Boundaries



ArcView GIS Version 3.1

File Edit Table Field Window Help

24 of 67 selected

Larson Dairy Farms

Attributes of Sewage Lagoons - Least Limiting

Parcelid	Localdata3	Clu_calcac	Fields_	Fields_id	ManureWDS	Sewagell
		15.33	128	90	Unlimited	Somewhat limited
		2.25	129	88	Somewhat limited	Unlimited
		270.31	130	89	Somewhat limited	Unlimited
		270.31	130	89	Very limited	Very limited
						Somewhat limited
						Very limited
						Somewhat limited
						Unlimited
						Somewhat limited
						Very limited
						Unlimited

Attributes of Sewage Lagoons - Least Limiting

Fields

[Localdata3]
[Clu_calcac]
[Fields_]
[Fields_id]
[ManureWDS]
[Sewagell]

= <> and
> >= or
< <= not
( )

Values

"Somewhat limited"
"Unlimited"
"Very limited"

Update Values

([ManureWDS] = "Unlimited") and ([Sewagell] = "Somewhat limited")

New Set

Add To Set

Select From Set

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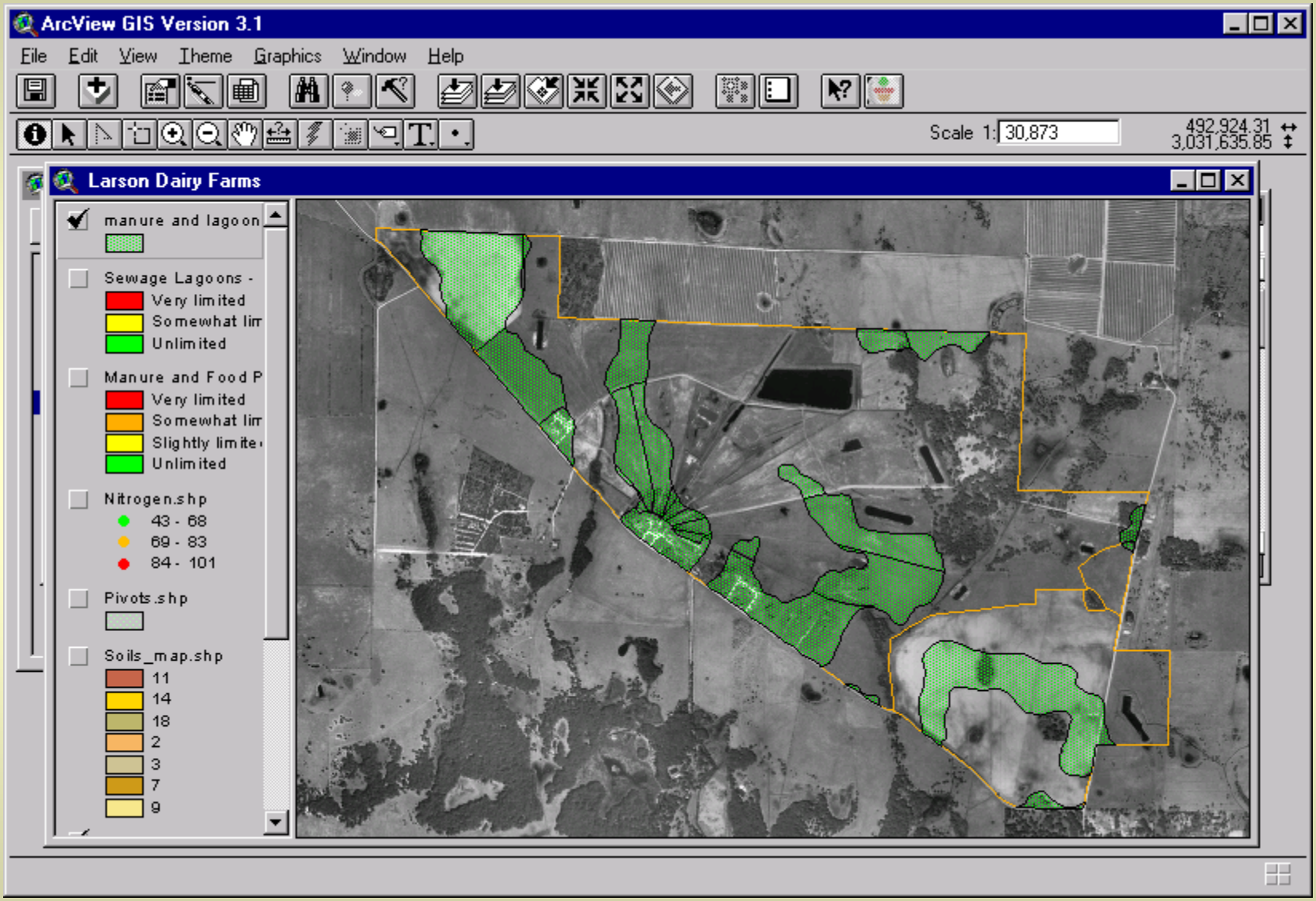
Field Boundaries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ArcView GIS Version 3.1

File Edit View Theme Graphics Window Help

Scale 1: 30,873

495,260.55
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Soil Data Viewer

- Agriculture
- Building Site Development
- Construction Materials
- Rangeland
- Sanitary Facilities
  - Septic Tank Absorption Fields
  - Sewage Lagoons
  - Sanitary Landfill (Area)
- Soil Properties
- Waste Management

Description:

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments

Data Options | View Data | View Results

	Mapunit Symbo	Mapunit Name	Kind	Status	legenc
1	10	FT. DRUM FINI	Consociation	Correlated	161
2	11	IMMOKALEE FI	Consociation	Correlated	161
3	12	UDORTHENTS	Consociation	Correlated	161
4	13	MANATEE, FLC	Undifferentiatec	Correlated	161
5	14	MYAKKA FINE	Consociation	Correlated	161
6	15	OKEELANTA M	Consociation	Correlated	161
7	17	ORSINO FINE S	Consociation	Correlated	161
8	18	PARKWOOD F	Consociation	Correlated	161
9	19	FLORIDANA, P	Undifferentiatec	Correlated	161
10	2	BASINGER FIN	Consociation	Correlated	161
11	20	POMELLO FINE	Consociation	Correlated	161
12	21	ADAMSVILLE F	Consociation	Correlated	161
13	23	ST. JOHNS FIN	Consociation	Correlated	161

	Component Nar	Comp % Repres	Kind	SIR phase
1	FLORIDANA	45	Series	[NULL]
2	PLACID	30	Series	[NULL]
3	OKEELANTA	25	Series	UNDRAINED

Process Data | Reset | Cancel

Screen may be resized. (6120,10500)

Larso

Man

Nitro

Pivo

Soils

Field

Phos

50 - 90

Commercial Software

Microsoft Access

Microsoft Outlook

Microsoft Excel

Desktop GIS Component

Customer Service Toolkit Express

FOCS Data Transfer

Customer Data Management

Conservation Reports

Local Options

Toolkit ArcView Extensions

Soil Data Viewer

Ortho Photos

NASIS Soils

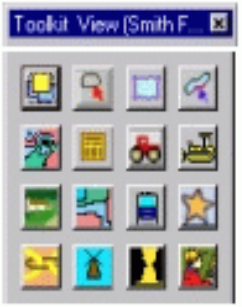
Digitized Land Units

Spatial Data

Toolkit with ArcView

- Customizable Toolbar with 16 features

Toolkit Tools



1 - 2 - 3 - 4

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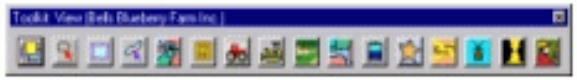
9 - 10 - 11 - 12

13 - 14 - 15 - 16

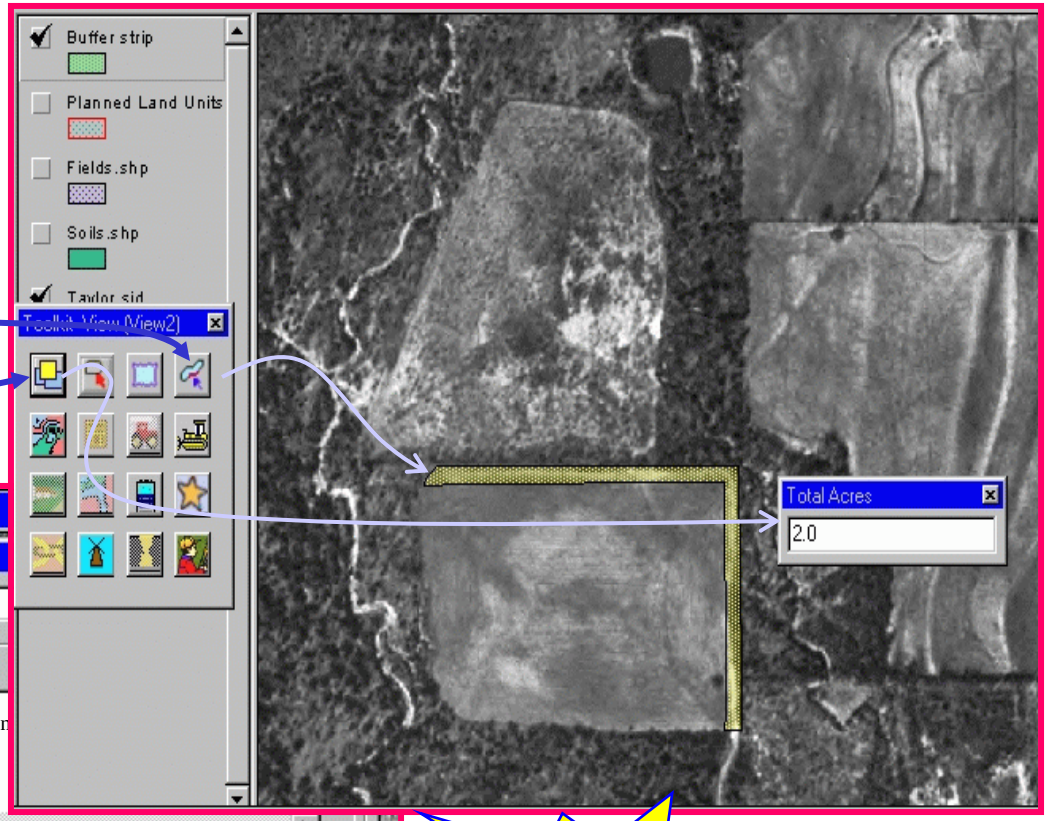
1. *Total Acres* to calculate the acres of one or more features such as fields, ponds, or easements.
2. *Graphic Acres* to draw a shape and automatically calculate acreage.
3. *Map Products* to create a header for your map with a title, your Service Center name and phone number, and other information.
4. *Buffer* to design a buffer inside or outside of an area, around a point or line, or as a boundary both inside and outside a polygon.
5. *Soils Map* to locate and size a soils map and legend for the customer's land units.
6. *Land Units* to add or edit data about land units.
7. *Practice Schedule* to add or edit information about planned or applied conservation practices.
8. *Structural Practice* to add or edit data on planned or applied structural practice features.
9. *Resource Inventory* to add or edit data for features such as soil samples, wells, drains, etc.
10. *Soils Inventory* to view acres of soil mapping units within a field.
11. *Import GPS Data* to import and view data collected using a global positioning unit.
12. *New Toolkit Theme* to create a new theme and add it to the view. Also to create a *Field Notes* theme to write notes or add graphics to a map.
13. *Land Unit and Conservation Practice Locator* to link mapped land units with unmapped land unit and conservation practice data.
14. *Map Symbol Loader* to select and use a set of map symbols.
15. *Owners and Operators* to view, add, or edit customer information for selected land units.
16. *Customer Service Toolkit Information* to display information about the current view.

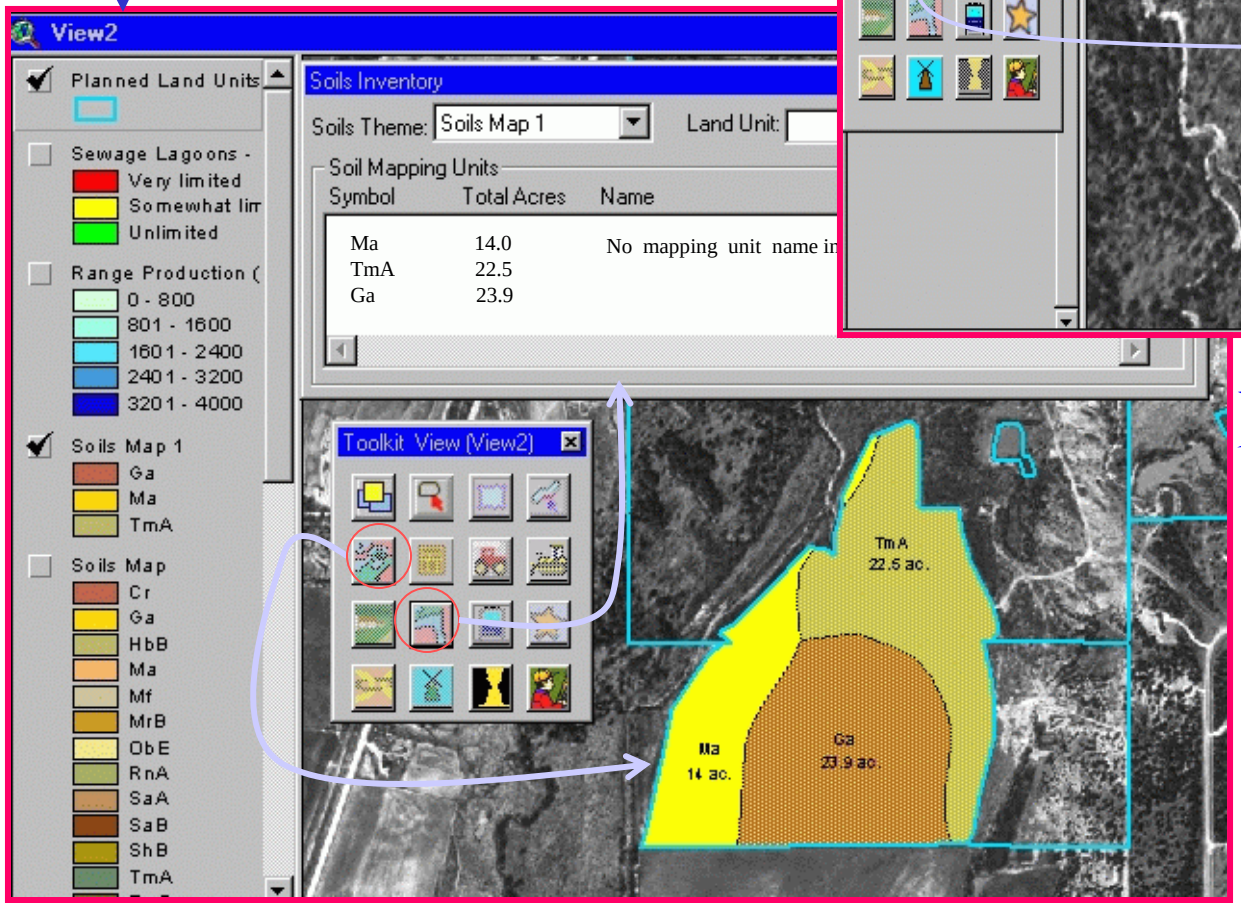


Toolkit ArcView Extensions

Conservation planning tools for ArcView

- Design buffers easily
- Calculate acres quickly
- Create custom soils maps
- Determine acres of soil polygons within a field



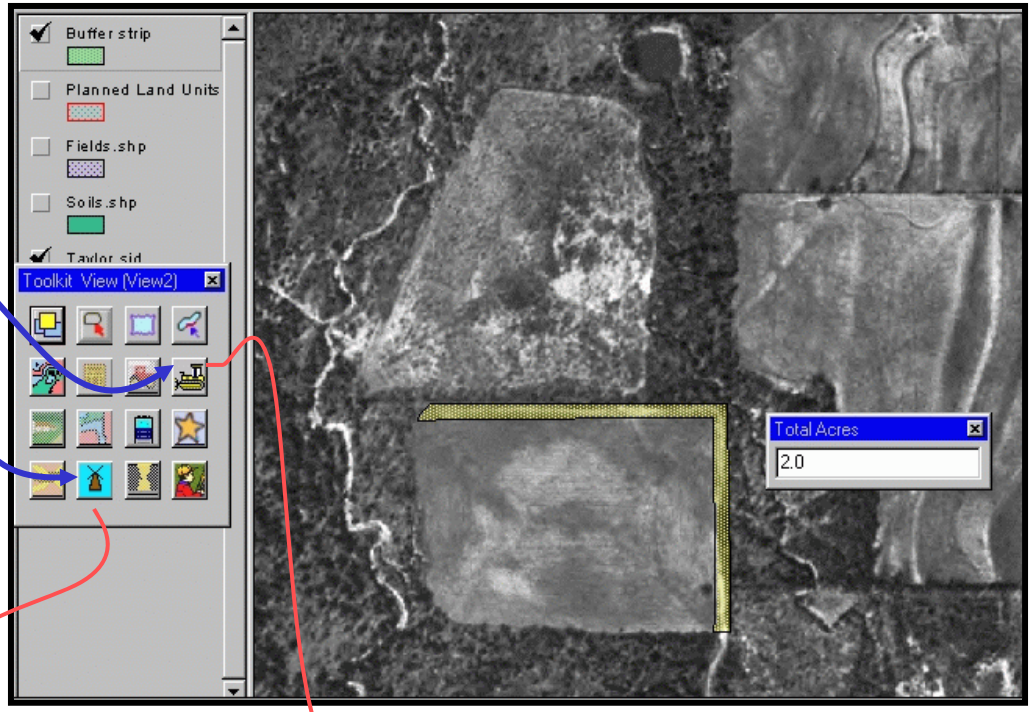


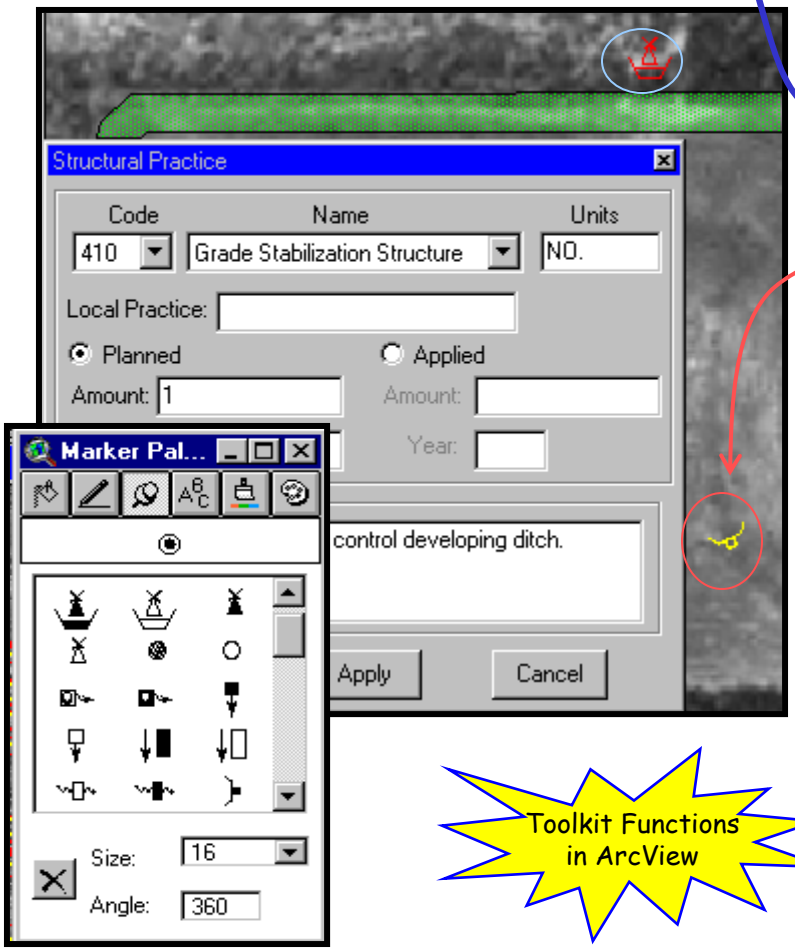
Toolkit Functions in ArcView

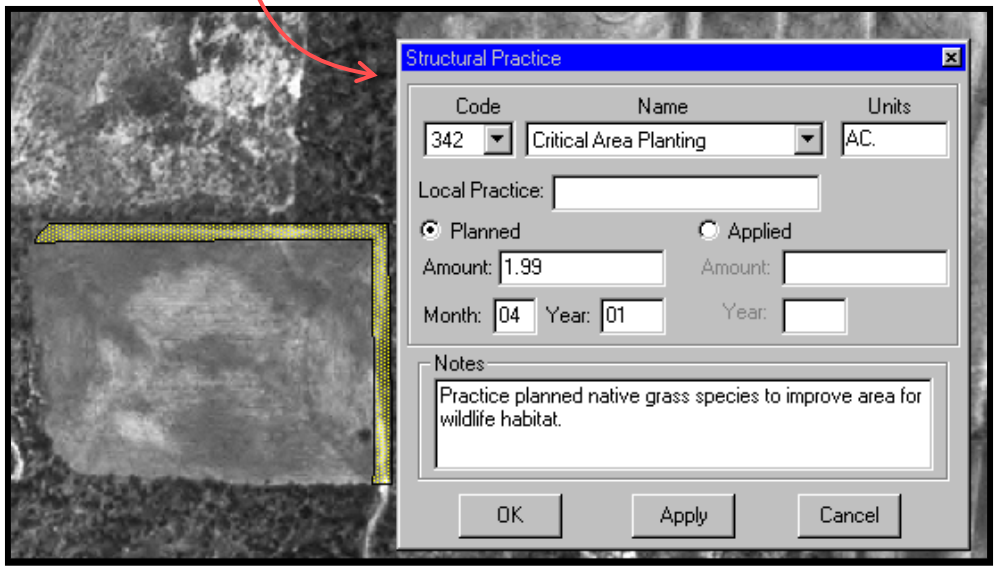
Toolkit ArcView Extensions cont'd

Conservation planning tools for ArcView

- Calculate acres quickly
- Design buffers easily
- Locate, size, and describe conservation practices
- Apply NRCS conservation planning map symbols





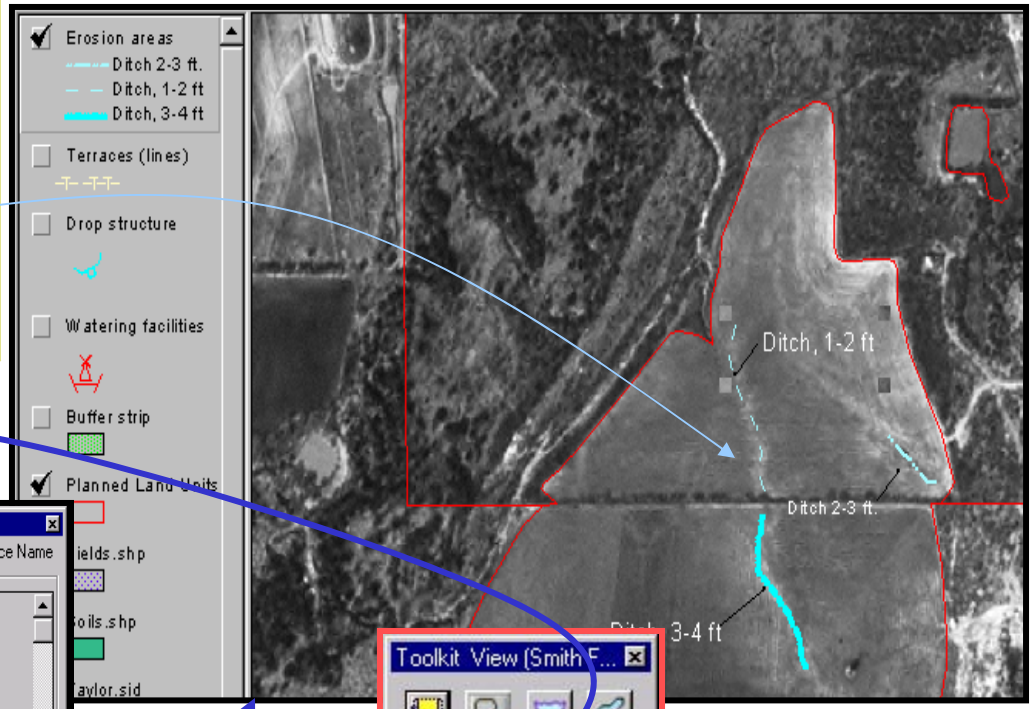


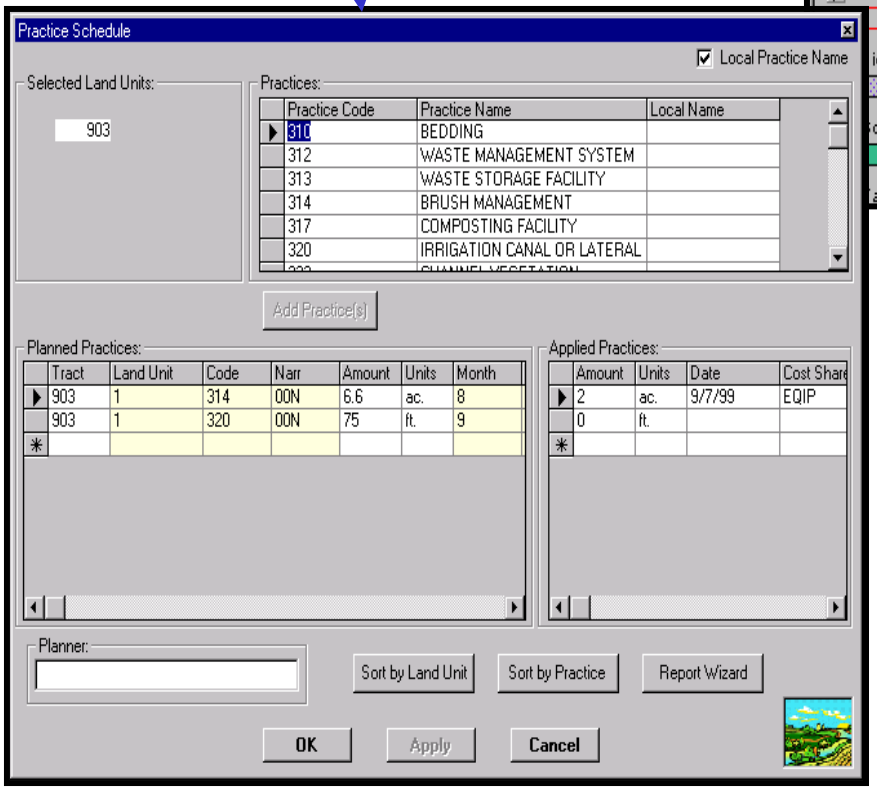
Toolkit Functions in ArcView

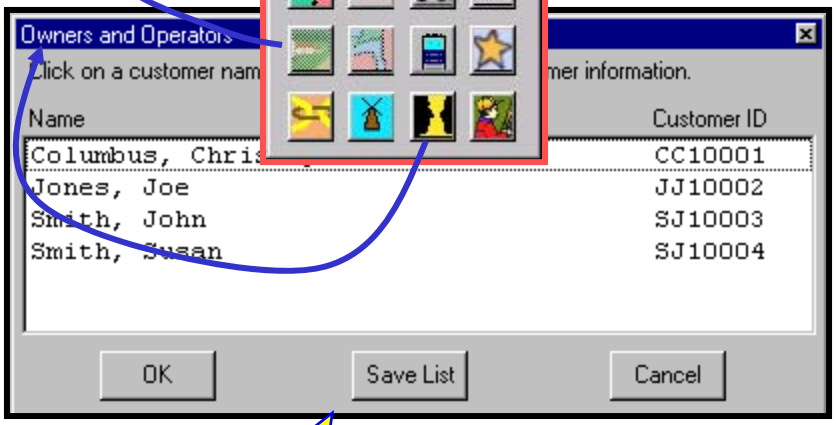
Toolkit ArcView Extensions cont'd

Conservation planning tools for ArcView

- Locate and describe site-specific resource inventory data
- Schedule conservation practices
- Identify owners and operators
- Produce quality map products with custom headers







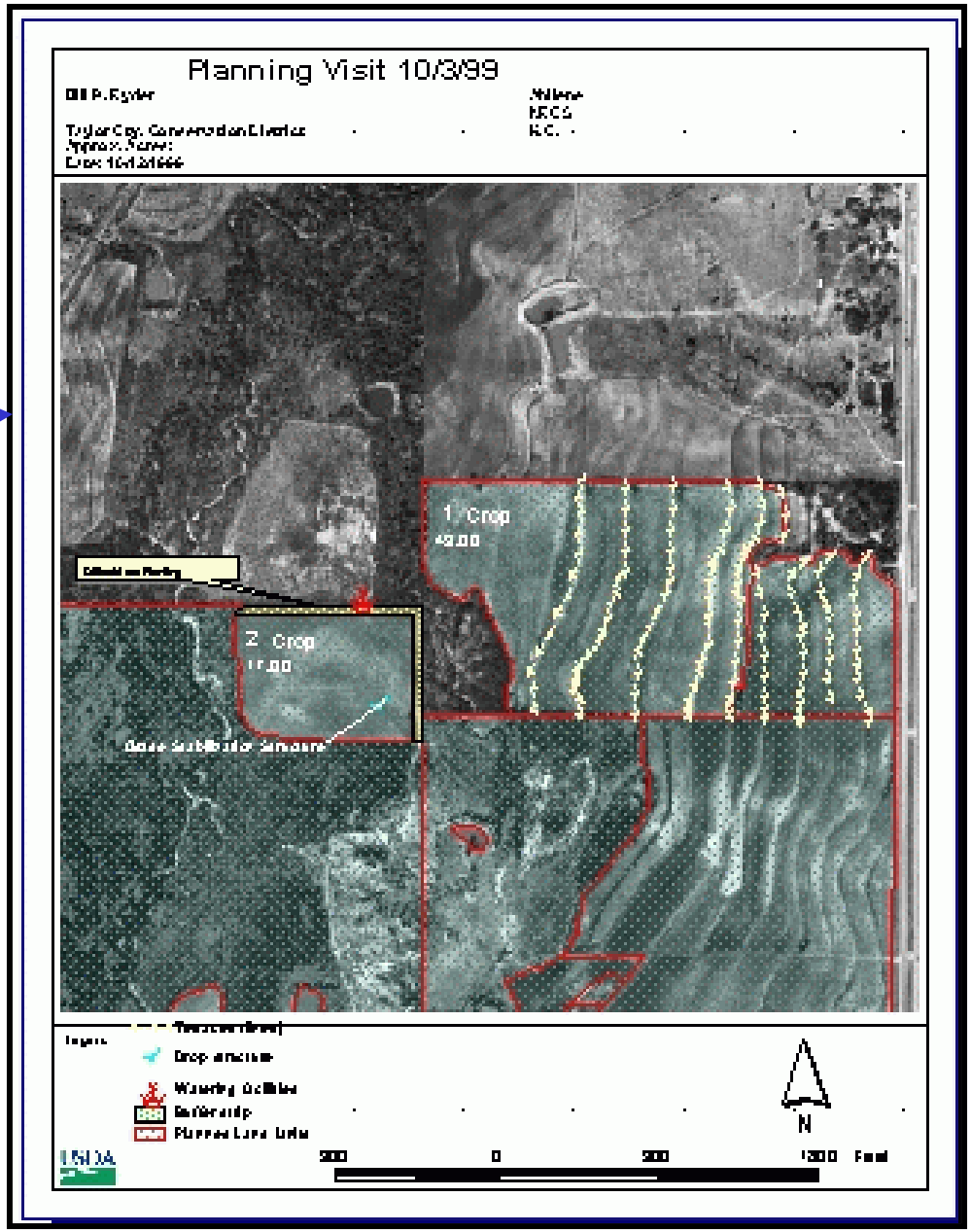
Toolkit Functions in ArcView

Toolkit ArcView Extensions cont'd

Conservation planning tools for ArcView

- Locate and describe site-specific resource inventory
- Schedule conservation practices
- Identify owners and operators
- Produce quality map products with custom headers

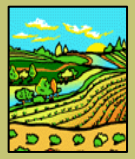
Toolkit Functions in ArcView



Many Toolkit Components DO NOT REQUIRE ArcView and Spatial Data!

Operate WITHOUT ArcView & Spatial Data

Customer Data Management



Conservation Reports

FOCS Data Transfer

Local Options

Operate only WITH ArcView & Spatial Data

Toolkit ArcView Extensions

Soil Data Viewer

Toolkit Capabilities

WITH or WITHOUT ArcView & Spatial Data

1) Transfer FOCS clients & businesses to the Toolkit
2) Update current customer data
3) Transfer current plans & contracts to the Toolkit
4) Revise current plans & contracts
5) Add new customers
6) Edit current land unit data
7) Add new land units
8) Update the practice schedule
9) Create new plans & contracts
10) Create mailing lists from customer data

WITH ArcView & Spatial Data

All of the functionality in the adjacent list plus the following:

1) Query spatial land units to identify customers, then create a mailing list
2) Use Common Land Units if available
3) Develop plan maps with planning symbols
4) Insert maps into plans & contracts
5) Create soils inventory maps
6) Use spatial analysis to assess resources
7) Locate/size practices like buffers, fences, or waterways
8) Create soils interpretation maps
9) Create soil properties maps
10) Create a variety of custom maps

Within any State, there are several options for installation of Customer Service Toolkit, 2.0. The main difference is that one is <u>without</u> a Geospatial Component & Spatial data, the other <u>with</u> Geospatial Component and Spatial data. Each option presents a unique set of opportunities for training, support and implementation.

Research Agenda
National Cooperative Soil Survey

"What soils are out there?"

H. Curtis Monger
June 2000

In 1899, the National Cooperative Soil Survey was established (Gardner, 1957, p. 33). Its establishment at that time resulted because the Chief of the Division of Soils, Milton Whitney, saw that collaboration with university experiment stations and other local institutions would enable the Division of Soils to widen its sphere of field work, while at the same time provide cooperators with soil experts and shared expenses. The purpose of the National Cooperative Soil Survey (NCSS) was to gather information on soil characteristics, not by casual observation, but by systematic *survey*. During this early period, the dominant "Research Need," simply stated, was to answer the question: "What soils are out there?"

Just after World War I, aerial photography became available and greatly increased the soil mapper's ability to document what soils are out there. Concepts on how to classify soils by Curtis Marbut in the first half of the 20th century and Guy Smith and others in the second half of the 20th century, helped us comprehend (grasp mentally) what soils are out there. We now have 1:24,000 soil maps for most of the counties in the United States, a 1:15,000,000 map of the United States, and a 1:75,000,000 map of the Earth. So have we answered the question What soils are out there?" If we answer no, that much detail remains to be gathered, then what are the research needs that will augment our understanding of what soils are out there?

In the 1997, Research Agenda Report, co-chairs John Kimble and Larry Wilding, listed several research needs provided by members of the NCSS Research Agenda Standing Committee. From this list, they synthesized and ranked research needs into a list of the six most important:

1. Quantify Field Soil Water Regimes in a Landscape Setting. This issue recommended measuring the quality and movement of water to surface and groundwater sources, including wetland hydrology.

2. Develop Integrated Scaling of Research Using a Landscape Approach. This issue recommended developing methods for sampling, pedologic models, GIS techniques, and ways of conveying an understanding of soils to the public.

3. Develop Baseline Soil Survey Information to Assess Soil Quality/Soil Health Status. This issue recommended developing field and lab measurements of soil quality.

4. Quantify Biological Processes in Soil Systems. This issue recommended adding

microbial biomass to soil characterization data, identifying how biological processes can indicate soil quality, and measuring biotic and mineralogic interactions in soil.

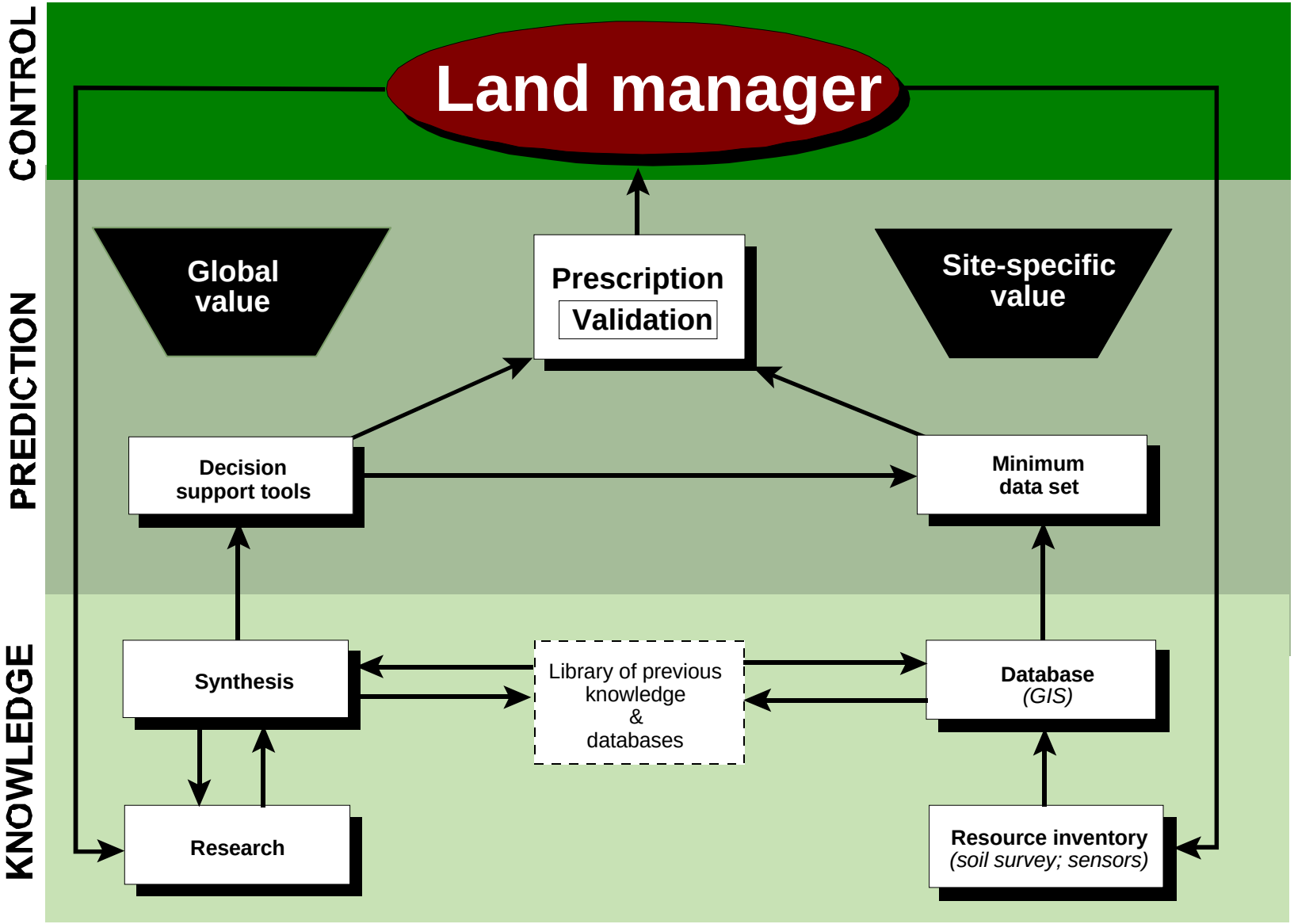
5. Quantify Paleo versus Modern Properties and Processes in Soil Systems. This issue recommended developing criteria that can be used to differentiate features that are the result of paleo-pedogenic processes from features that are the result of modern-pedogenic processes.

6. Develop New Methodologies and Techniques to Enhance Research Capabilities and Delivery of Soil Survey Services. This issue recommended placing recording instruments in soil and using satellite images to collect data, and using GIS to interpret data and display results.

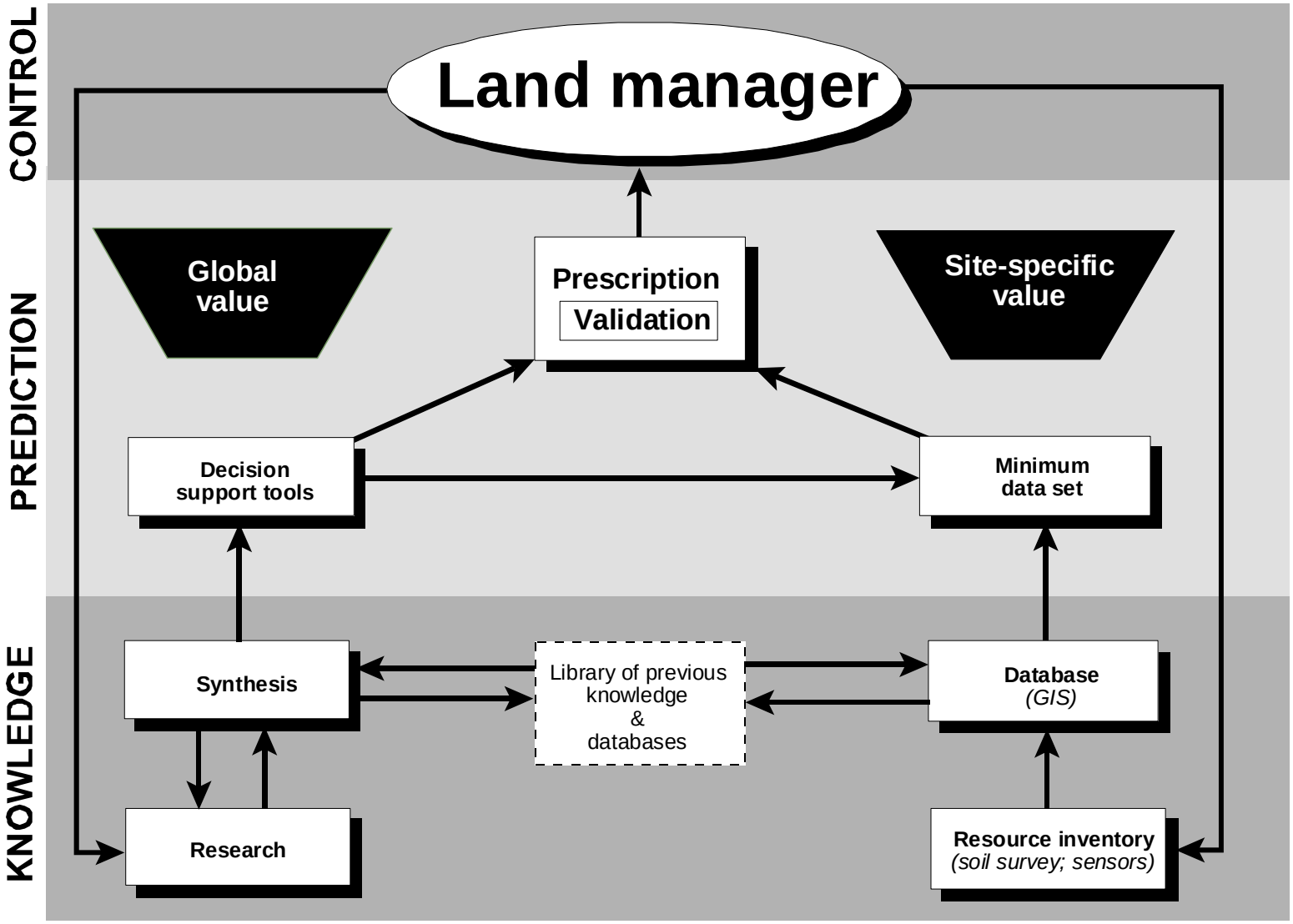
In the summer of 2001, the next Research Agenda report is due. This report, co-chaired by Curtis Monger and Rebecca Burt, will contain another survey of research needs. At this time, we will be able to compare the 1997 report with the 2001 report and determine if research needs have changed. We also need a way to determine if progress has been made on the research needs suggested in the 1997 report. Some of the suggested research, such as distinguishing paleo from modern processes, is by its nature vague. In contrast, maps of soils (i.e., determining what soils are out there) provide clear evidence of progress. These visual products might not only be the reason for past successes of the NCSS, but might also the key to future successes of the NCSS.

References

Gardner, David R. The National Cooperative Soil Survey of the United States. Thesis, Harvard University. 1957. (NRCS Historical Notes No. 7).



Research and resource inventory (e.g., soil survey and sensor data) knowledge is the basis for predictions that improve site-specific controls and outcomes for land managers such as grain producers. Schematic developed by G. Nielsen, Montana State University, with G. Uehara and others, Western NCSS Conference, Bozeman, MT, June, 1996.

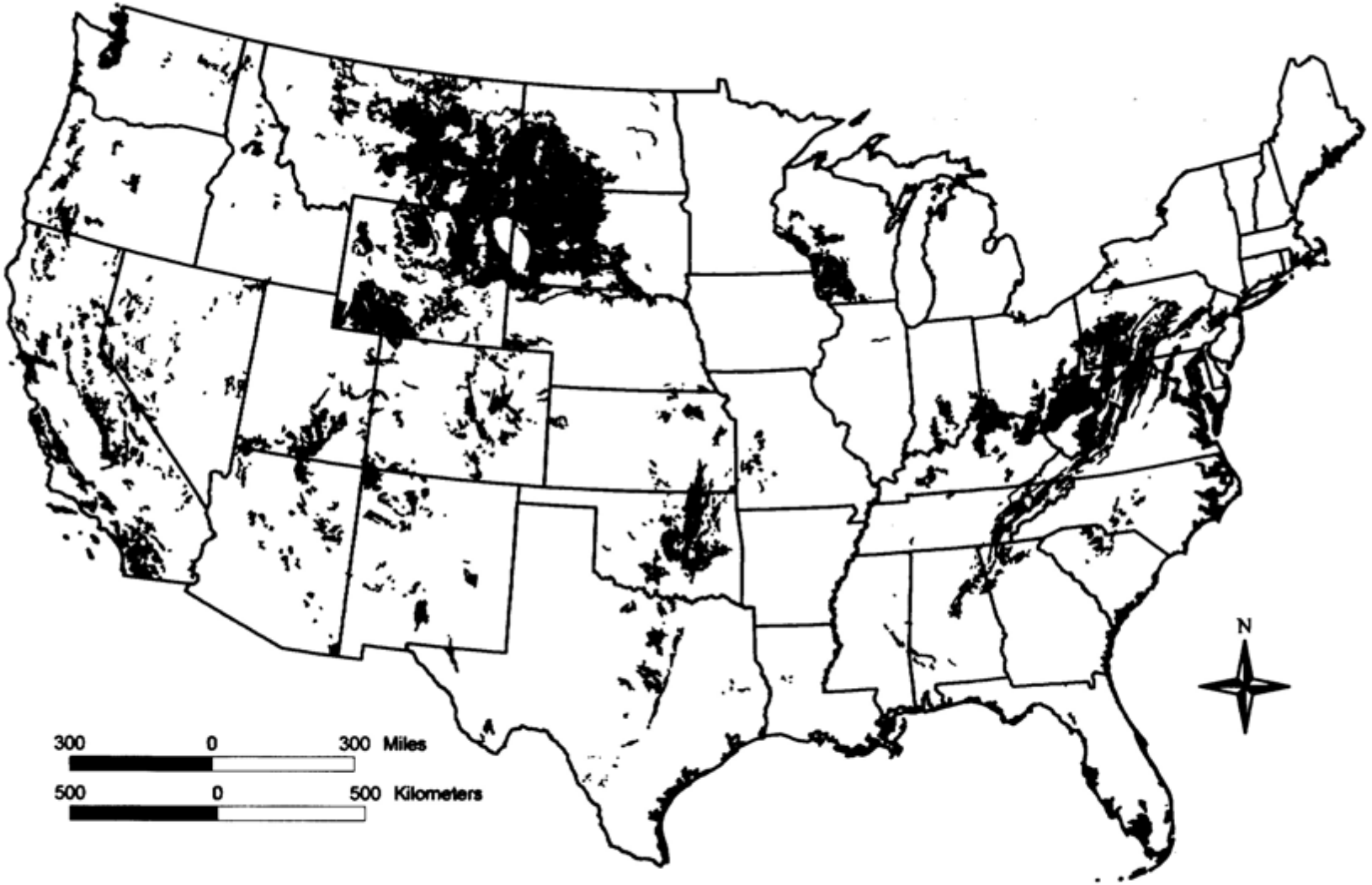


Research and resource inventory (e.g., soil survey and sensor data) knowledge is the basis for predictions that improve site-specific controls and outcomes for land managers such as grain producers. Schematic developed by G. Nielsen, Montana State University, with G. Uehara and others, Western NCSS Conference, Bozeman, MT, June, 1996.

DUST COMPOSITION, % weight

MINERAL	LOST HILLS (West Side) 10 m*	LOST HILLS (West Side) 150 m*	SHAFTER (East Side) 10 m*	SHAFTER (East Side) 150 m*
Biotite-like	35	37	49	59
Montmorillon	42	40	17	0
K-Spar	trace	trace	2	2
Plagioclase	7	7	25	33
Kaolinite	10	10	6	0
Quartz	5	6	trace	6

*downwind distance from dust-generating activity



Map showing the geographic distribution of weathered bedrock in the coterminous United States. (source:STATSGO)

West National Cooperative Soil Survey Conference
Western Coordinating Committee (WCC-093)
Western Region Soil Survey and Inventory
Kailuna-Kona, HI
June 26, 2000

Background

Historically, Experiment Station cooperators have been involved in almost all aspects of soil survey. Currently, Experiment Stations are subject to static or reduced funding, increasing demands for research productivity, and obtaining external grant funds, while still committed to providing quality soil survey, interpretations, and research assistance to the NCSS. At the same time, federal agencies involved in NCSS are subject to limited funds, organizational restructuring, and a changing clientele demanding new surveys and expanded data interpretation oriented toward ecosystem management and environmental quality.

The Western Coordinating Committee-93 and its predecessor, WRCC-30, have provided opportunity for western Experiment Station cooperators to meet with leaders of the NCSS in the western region and coordinate regional activities consistent with the goals of NCSS. Because of changing demands on all NCSS cooperators, WCC-93 continues to be essential for providing opportunity for Experiment Station personnel to be actively involved in planning of NCSS activities and coordination of research to support NCSS programs.

Activities

ARIZONA, David M. Hendricks, University of Arizona, Tucson

Kaibab Plateau: The Kaibab Plateau, the highest of several plateaus north of the Grand Canyon, is capped by the Kaibab formation (consisting of limestone and related calcareous sediments) and slopes downward toward the north. Five vegetation zones are identified extending from Engelmann spruce forest at the highest to a pinyon-juniper woodland at the lowest elevations. The soils on the nearly level plateau surfaces are deep, high or very high in clay, have strongly developed argillic horizons and are carbonate-free (except the lowest elevation soils that contain $CaC0_3$ at depths of about 80 to 100 cm). These soils have formed from the residue following the dissolution and removal of carbonates, plus any eolian input. This suggests that the geomorphic surfaces have been stable for a long time under conditions as humid or more humid than present. The study of this elevation sequence is nearly complete.

Volcanic soils in Arizona: We have studied soil formation on basaltic tephra from three areas: the Springerville Volcanic Field in east-central Arizona, the San Francisco Volcanic Field near Flagstaff, and the Mormon Mountain Volcanic Field

southwest of Flagstaff. Our current efforts are to determine the degree of eolian addition and admixture of dust and its influence on the evolution and properties of soils. For this study we are utilizing soils which have been previously characterized. Since these soils have formed in quartz-free (basaltic tephra) parent materials our emphasis is on characterizing the nature of the quartz. Quartz is considered to be a ubiquitous component of dust (except basaltic ash). Quartz is also very resistant to chemical weathering and will tend to persist in soils without undergoing appreciable change. Our approach is to isolate the quartz by selective dissolution and determine its particle size distribution (fine sand and silt fractions) using a laser optical particle size analyzer. Larger grains (fine sand and coarse silt) are also being analyzed by polarized light microscopy. Quartz grain surface features will also be examined by SEM to provide additional information about their history.

Volcanic soils in Hawaii: Work continues with Oliver Chadwick and others on soil formation in Hawaii, with efforts to determine the quantitative mineralogy of the soils.

Other: Other studies with graduate students include the use of different types and amounts of amendments to improve irrigation water infiltration and a study of the effect of soil properties (amount and type of clay, quantity of "free" iron oxides, etc) on the retention and movement of Cd. Teaching includes soil chemistry, soil genesis and half of a soil chemical analysis course. Don Post (now retired) is continuing to teach soil morphology, classification and survey.

CALIFORNIA

R.C. Graham, University of California, Riverside

The activity most directly related to NCSS is a project funded by USDA NRCS entitled "Hydrologic and Ecosystem Functions of Paralithic Materials" with NRCS collaborators Phil Schoeneberger and Sam Indorante.

There is growing recognition that the upper 2 meters of soil is not the whole subsurface story for ecosystems, hydrology, environmental quality, and other land management issues. On residual landscapes, deeply weathered bedrock (paralithic material) is often a large component of the regolith and it has many soil-like attributes.

The objective is to determine the spatial distribution and soil-like properties of paralithic materials in the coterminous United States. To accomplish this goal, we took advantage of the vast amounts of data stored in NRCS databases: STATSGO, Official Series Descriptions, Series Classification, and National Soil Characterization Lab.

Results: a) Paralithic materials underlie >10% of the land area. b) Water retention differences (between -33 and -1500 kPa) are similar to those of many soils, ranging from 0.10 to 0.22 cm/cm. They vary by lithology.

In comparison to watersheds underlain by hard rock, those underlain by paralithic materials supply water to plants longer into dry periods and have delayed drainage and surface runoff. Future needs include new strategies for investigating deep regoliths, consistent system of describing soft bedrock materials, and inclusion of deeper regoliths in NRCS investigations and databases.

Randal J. Southard, University of California, Davis

Research continues on the health effects of mineral particles on human lungs and on the characterization of dust from agricultural sources in the Central Valley. We are using soil survey information (SSURGO and STATSGO) to help identify soils most likely to produce PM-10 (particulate matter with aerodynamic diameters less the 10 microns) during crop management practices. Soil survey information also helps identify the sources of alluvium and allows us to predict how dust mineralogy will vary. The ultimate objective is to use mineralogy to help identify dust sources.

Our results indicate that PM-10 concentrations decrease rapidly within a few tens of meters downwind of the dust source during almond harvest. The PM –2.5 concentration is much lower than PM-10, but the smaller particles travel much greater distances and may be a significant part of ambient PM-10 downwind. Silt loam, silty clay loam, and silty clay surface textures produce more PM-10 than clay and sandy loam surface textures. PM-10 from soils derived from Coast Range alluvium is dominated by smectite and altered biotite, whereas the PM-10 from Sierran-derived alluvium is dominated by altered biotite and plagioclase.

We are just starting new projects using soil survey information to identify soils with high K-fixing capacity that are used for cotton production in the Central Valley and to estimate changes in C pools in agricultural and non-agricultural soils under various management and climatic schemes. These efforts will be STATSGO and SSURGO-based and will rely on field and lab studies to support GIS-aided predictions.

COLORADO, Eugene F. Kelly, Colorado State University, Fort Collins

Current Agricultural Experiment Station Activities directly related to NCSS

Colorado Agricultural Experiment Station, “ Building Soil Landscape Models for Soil Inventories and Precision Farming” $ 76,622. July 1, 1999 - June 30,2001.

USDA-ARS, “Delivery of GIS and Web Based Models of Soil Processes” $218,000. October 1, 1999 - September 30, 2001. (Co-PI’s, M. Schaffer, J. Cipra, B. Flynn)

National Park Service, “Soils resources in National Parks: Production of SSURGO data for use within the National Park System”, $54,000. June 1, 2000 - May 31, 2001

USDA, “Use of GIS to Determine Nematode Occurrence in Platte River Basin”. $170,00. January 1, 1998- December 31, 2000. (PI’s D. Wall, R. Niles)

Current Pedology and Biogeochemistry Research Projects

NSF-LTER, "Shortgrass Steppe." $3,195,850. October 1, 1996 - September 30, 2002. (Co-PI ‘s: W.K. Laurenroth, I.C. Burke; W. Parton; R. Pielke; B. Van Horne).

National Science Foundation “Aggregate Turnover Controls on Soil Organic Matter: The Influence of Management and Mineralogy”, $ 600,000. January 1, 2000 - September 1, 2002. (Co-PI’s K. Paustain, J. Six, E.T. Elliott)

National Science Foundation-Long Term Ecological Research. Supplemental Grant for Cross Site Comparisons. “Stable Si Isotope Geochemistry”, $ 49,310. (PI’s. O.A. Chadwick, W.K. Laurenroth, I.C. Burke)

Graduate Students Currently Enrolled in Pedology-Biogeochemistry Program

Elizabeth Sulzman, Ph.D. - Biogeochemistry
Richard Bachaand, Ph.D. - Forest Ecology
Suzanne Loadholt, M.S. - Soil Science/Biogeochemistry
John Benner, M.S. - Soil Science

Support Staff for Pedology Program at CSU

Caroline Yonker, Research Associate (Pedology)
Jan Cipra Research Associate (GIS)
Robert Flynn Research Associate (Programmer)
Dan Reuss Research Associate (Isotope Geochemistry)

MONTANA, Jerry Nielsen, Montana State University, Bozeman

Goals of related research are to provide economic and environmental benefits based on decision support tools and predictive models that merge knowledge of biological/agricultural processes with site-specific inventory knowledge of soil and microclimate attributes. Since soil water availability is the main driving variable in

predictions of yield and crop nutrient needs, an objective is to create and test a conceptual model that integrates soil map units and terrain indices. The model will be used to predict soil water distribution and delineate soil management areas (i.e., an order 1 soil survey) based on soil water-supplying capabilities. Long et al. demonstrated that wheat in areas with high predicted soil water and aerial evidence of nitrogen deficiency benefited from late season applications of nitrogen fertilizer that increased grain quality (protein) and yield valued at $20/acre after application costs. In activities by Decker et al., SSURGO soil survey data are combined with remote sensing, terrain, and field boundary data as on-farm GIS layers. A Montana water-driven model is used to predict crop yield by soil map unit component based on stored plant-available water and probability of rainfall during the growing season. Crop yield data from GPS-referenced monitors on crop harvesters are added to the GIS and compared with SSURGO-predicted yields. Two learning groups, composed of farmers and ranchers, and of industry, agency, and university participants, work together on site-specific research. The farmers learning group pursues GIS strategies for on-farm research and now uses the same GIS programs (SS Toolbox, Surfer) to share ideas, data, and solutions to computer-related problems.

Another goal is to link NCSS data products with current-condition data acquired from space satellites. This work is supported by NASA through the Upper Midwest Aerospace Consortium (member states include MT, ID, WY, ND, and SD) and its Public Access Resource Center (AgPARC), which provides site-specific (farm- or ranch-scale) remote sensing information for agriculture. We deliver current AVHRR NDVI and Landsat 7 (and future MODIS) images to a dozen farmer/rancher members of learning groups. The goal is to create low cost soil management maps and to monitor changes in crop and soil conditions (and indirectly, sequestered carbon) in ways that allow for scaling up and down. Earlier investigations demonstrated correlations between AVHRR NDVI and live-biomass (r^2=0.64) for six grassland areas where biomass was below 1800 kg/ha. When enhanced, this is a promising approach to tracking seasonal and yearly changes in forage biomass availability by soil map unit. A current project will allow rangeland managers to 1) evaluate the annual and seasonal productivity of their rangeland soil map units, 2) predict range readiness for timing and distribution of livestock use, and 3) assess automated tools on an ongoing basis for acquiring and analyzing soil survey and remotely sensed data that improve range management decisions.

Agroecosystems and land resources of the Northern Great Plains were mapped and characterized by Padbury et al. Major agroecosystems were described in terms of soil and landscape characteristics, with particular focus given to key climate parameters in relation to the new oil-seed, pulse and forage crops being introduced throughout the region.

NEW MEXICO, H. Curtis Monger, New Mexico State University, Las Cruces

1. Courses taught
   - Soil Genesis
   - Soil Morphology and Classification
   - Environmental Science

2. Research topics
   - Ca isotopes for distinguishing primary, pedo-atmogenic, and pedo-lithogenic carbonates
   - 13-C fractionation in microbial calcite
   - Links among landforms, soils, and vegetation in the Chihuahuan Desert

3. Funding sources
   - National Science Foundation (Long Term Ecological Research)
   - USDA-National Research Initiative Competitive Grants Program
   - International Arid Lands Consortium

4. National Cooperative Soil Survey Collaborations
   - Desert Project Tour (May 2000)
   - Field reviews
   - Soil temperature data collection for thermic boundary

UTAH, Janis L. Boettinger, Utah State University, Logan

Our first objective was to continue to monitor the physical and chemical dynamics in a soil catena affected by seepage from upslope irrigation canals in central Utah. The soils possess various degrees of saturation and salinity, ranging from a naturally dry analogue to a strongly saline and seasonally saturated soil to two soils that are slightly saline and saturated throughout the year. We manually measured water level, pH, EC, and temperature of solutions in piezometers biweekly during the growing season and monthly in winter. Dataloggers record redox potential, soil temperature, and water table at 30-cm depth every 2h. However, we removed pressure transducers and redox probes during the winter months to prevent equipment failure. This third year of data confirms our previous observations: the three soils affected by canal seepage were saturated and reduced within 30 cm of the soil surface during the microbial growing season and are hydric. Strongly expressed redoximorphic features can form in slightly saline soils in less than 110 years of artificial saturation. The strongly saline soil experiences microbial reduction in spite of poor expression of redoximorphic features. These results greatly improve our understanding of artificially wet soils, which are common in the western U.S., and of saline wetlands, which occur in naturally and artificially wet areas of semiarid, arid, and coastal regions.

Our second objective was to assess whether remotely sensed satellite data can facilitate soil inventory and interpretation in difficult-to-access areas of the Grand Staircase Escalante National Monument, in which a cooperative soil survey is ongoing. The study focuses on the Circle Cliffs, which spans a well-defined section of middle and lower Mesozoic and upper Paleozoic sedimentary rocks and a climate that ranges from ustic aridic to typic aridic. Soil mapping units were developed using traditional survey methods and typical pedons were sampled for National Soil Survey Laboratory analysis. Due to repeatedly delayed launch of NASA's Terra satellite, which carries the new ASTER sensor that shows great promise for sensing surface soil properties, we are investigating alternative methods for facilitating soil inventory such as Landsat 7 remotely sensed data and digital terrain analysis. With reduced budgets and personnel, it is essential that we improve the efficiency and accuracy of soil inventory and interpretation, especially in the vast and remote areas of the western U.S.

Our results greatly improve the understanding of the origin, properties, and functions of artificial wetlands, which are common in irrigated areas, and of saline wetlands, which are a rapidly dwindling resource in the western U.S. Soil survey methods can be improved using new remote sensing and GIS technologies, making soil inventory and interpretation more accurate and efficient.

The landscape of the artificially wet catena in Mancos shale near Castle Dale Utah is attached as a .jpg file. The cliffs of the Wasatch plateau are in the distance to the west. The trees in the background mark the line of the Bluecut ditch (the nearest of three upslope irrigation canals). The four small fenced areas mark each of the monitoring sites, left to right: 1) dry analogue (Torriorthent -- Chipeta/Hanksville series, sparse greasewood and shadscale), 2) strongly saline and saturated within 30 cm in the summer only (Halaquept [not quite saline enough for the Aquisalid], Libbings series-like, saltgrass and greasewood), 3) slightly saline on slope with throughflow of water, saturated w/in 30-cm most of year (Endoaquept -- Rafael series?, Juncus spp.), 4) slightly saline in small depression, saturated w/in 30-cm throughout the year (Endoaquept –Rafael series, Juncus spp.).

WASHINGTON, Alan J. Busacca, Washington State University, Pullman

Modeling soils of the Sawtooth and Pasayten Wilderness areas, North Cascades, using terrain analysis, field studies, and GIS.

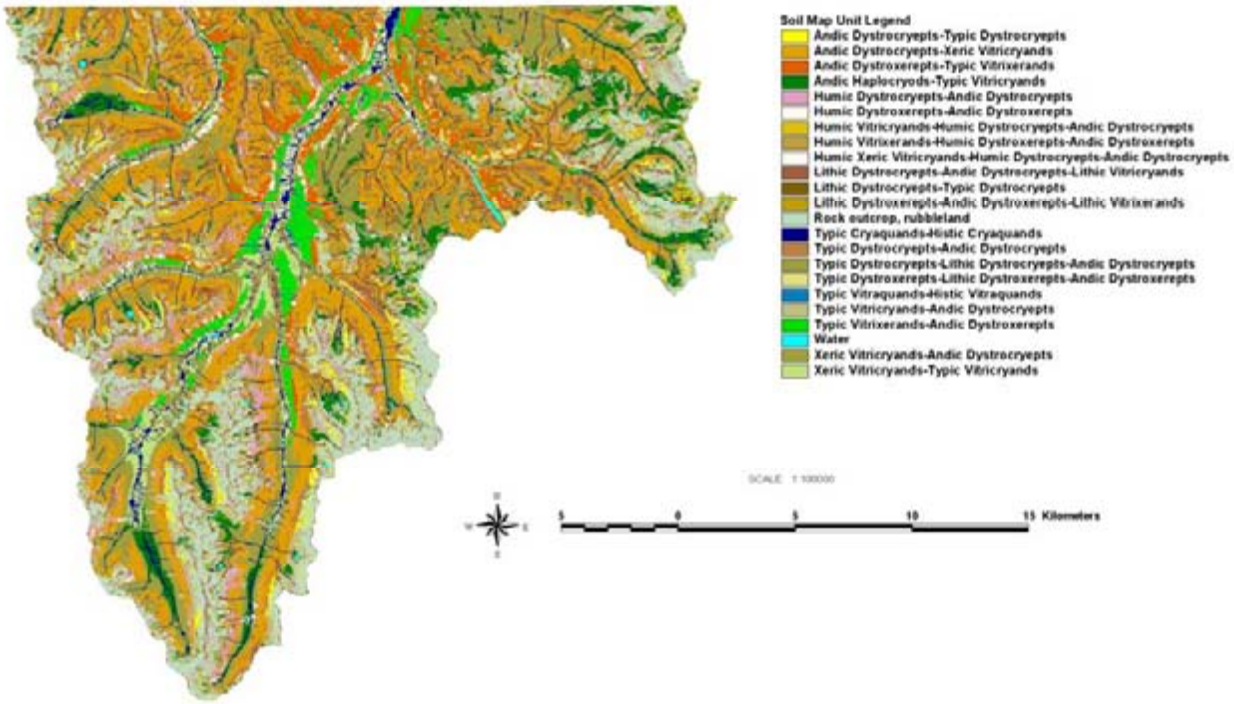
A three-year cooperative project among Washington State University (WSU), the USDA-Forest Service, and the USDA-Natural Resources Conservation Service was started in 1998 to map the soils of the Sawtooth Wilderness Area and a portion of the Pasayten Wilderness Area at a fourth-order level using novel techniques. The project area is about 220,000 acres in size. WSU is providing the personnel and developing the methods used. The purpose is to obtain a resource inventory at modest cost for wilderness-type areas. More than 150 reference pedons were

described during two field seasons in 1998 and 1999. Representative pedon descriptions are being prepared for integration into the national soils database. Sampling and mapping procedures were facilitated with the use of a GPS unit to capture site locations for later manipulation in a GIS. Since the 1999 field season, soil-landscape models in the GIS have been improved and tested. A decision-tree model to predict soil distribution is based on derived climate indices, potential natural vegetation, and primary and secondary terrain attributes such as slope and wetness index respectively. Additional digital information regarding bedrock geology, when it becomes available, will allow more precise modeling. Preliminary maps have been produced at 1:100,000 scale; components of mapping units are defined at the Subgroup level of Soil Taxonomy. Parallel studies are underway to define the volcanic eruptions that have added tephra to these alpine landscapes and to define the critical factors controlling spodic horizon development in andic materials. Initial results were presented at the 1999 SSSA meetings in Salt Lake City: Indicators of albic horizon development in Spodosols of the North Cascade Range, Washington.

Other NCSS activities include technical field assistance by Alan Busacca for the Spokane County soil survey. Mr. Chris Miller of NRCS assisted Alan Busacca for a 3-day field trip for Busacca's Pedology class. Topics covered included genesis, morphology, and classification of Andisols, Alfisols, Vertisols, Mollisols, and Spodosols of the Cascade Range and Mount St. Helens area. Ms. Eva Muller of NRCS discussed career development in soil science, careers with Federal agencies, and how a soil survey project is organized and conducted with students in Busacca's Pedology course.

Future Plans

The WCC-093 was recently approved for a three-year term extension through September 2002. The committee meets with the Western Soil Survey Conference during even-numbered years, and on its own in other years. Tentative plans for 2001 include a meeting with the Western Society of Soil Science at the University of California, Irvine, in June.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SOIL TAXONOMY
Bob Engel

The Keys to Soil Taxonomy were published in 1998 and the Second edition of Soil Taxonomy was published in 1999. Since then we have made no revisions to these documents. We have had, in effect, an unofficial moratorium for the past two years. We have, however corrected some errors. The corrected documents along with a listing of the errata are posted on the NSSC web site.

During the last two years we concentrated on updating the soil classification database. Many of the pedons with laboratory data (SOI-8 forms) and of the official series descriptions (OSD's) have been updated. Many of the MO areas have most or all of the classifications updated. This project is continuing, but has slowed this year because of limited travel funds.

During that period many requests for improvements to Soil Taxonomy have been received. We are planning to start sending these requests out for review. The staff dedicated to working on taxonomy at the National Soil Survey Center is now down to one person. Until the staff is increased the preparation and distribution of amendments for review and finalization of amendments will be slower than in the past.

Taxonomy updates awaiting action:

The Bismarck, North Dakota MO staff requests these additions.

> A proposal to add several subgroups that were used in the great group of Borolls prior to the great group being deleted. Some of these subgroups were added to Udolls, but not Ustolls.
>
> The great group Dystrustepts is of larger extent than expected. The great group needs several new subgroups for use in the Bismarck, North Dakota MO.
>
> A proposal to add udic subgroups to several frigid Ustolls, mostly in South Dakota, that were Udic Borrolls.
>
> A proposal to change the color criteria of aquic Hapludolls.

A proposal from the Northeast and MO 14 to add subaquic subgroups to several great groups of Entisols, mostly in Maryland, that are permanently under water. Similar taxa also are being considered in Texas.

A proposal from St. Paul, Minnesota on changing the keying order of the aquic, oxyaquic, and pachic subgroups. The keying order of these subgroups is inconsistent among the great groups of Mollisols. The order in the more recently added great groups is aquic, oxyaquic, and pachic in that order. Originally pachic was keyed first. When the

oxyaquic subgroups were added the hope was that they would identify all soils with a water table within a meter of the surface that failed other aquic criteria.

The following proposals are from the MO office in Indianapolis, Indiana.

> Travis Neely provided documentation showing that several soil series that were classified as spodic subgroups failed to meet the new criteria. They recommend the spodic subgroup criteria be changed
>
> The addition of an Arenic Oxyaquic subgroups to Hapludalfs.
>
> From Don Franzmeier, Purdue University
>
> In Indiana and other states dense glacial till, usually designated as Cd horizons, qualifies as a fragipan according to the current definition. The two kinds of horizons differ significantly, however. To separate the two kinds of horizons, Don proposes that the definition of a fragipan include the clause, "It has a neutral or acid reaction (pH <7.3)"
> [Don has agreed to change the proposal to “It is not effervescent”.]

Stephen Gourley sent a detailed report of a Northeast Fragipan Study. His proposal concludes that the definition of evidence of pedogenesis in the fragipan definition is too broad. He asks that structure and redox features be removed from the evidence of pedogenesis.

Tom Hahn MO 6, Lakewood, Colorado, called our attention to the fact that Cryepts could be less than 25 cm deep. Thus we propose to add the underlined text to the definition of Eutrocryepts.

KCA. Cryepts that have one or both of the following:

1. Free carbonates within the soil; or

2. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons between 25 and 75 cm from the mineral soil surface <u>or immediately above a root limiting layer if at a shallower depth.</u>
Eutrocryepts, p.

Del Fanning, Maryland and MO 14 Raleigh, North Carolina proposed revisions to the glauconitic mineralogy family.

MO 9, Temple, Texas proposed adding a Crd horizon designation for bedrock that slakes in water (densic material).

Joe Chiaretti MO 3, Reno, Nevada proposes adding an oxyaquic subgroup to Torripsamments.

A proposal from MO 13 Morgantown, West Virginia to change the name of the andic subgroups in the Appalachian Mountains to amorphic subgroups.

The following class was requested by Hari Eswaren for use in Thailand. No supporting information was provided.

FAA. Aquerts that have within 100 cm of the mineral soil surface: either

A sulfuric horizon; or Sulfidic materials.
Sulfaquerts, p. 245

Sulfaquerts

These are the acid sulfate Aquerts (cat clays). They are extremely acid and toxic to most plants if have been drained and oxidized. They are mostly dark gray and have straw-colored mottles of iron sulfate (jarosite) within 100 cm of the soil surface. They are mainly in coastal marshes near the mouths of rivers that carry sediments that are free of carbonates or have low carbonate content. They generally contain an appreciable amount of organic carbon. They are only known to occur in Thailand. Most of these soils support a sparse stand of acid and water tolerant plants. A few areas are used for rice production.

SELECTED BENCHMARK SOIL DATASETS
TO TEST THE VALIDITY OF
ALGORITHMS AND EXISTING SOIL PROPERTIES IN NASIS
June, 2000

ISSUE:

Some key soil properties of map unit components, which are used to generate soil interpretations in the National Soil Information System (NASIS), are not yet populated in the database. Many soil property values that do exist in NASIS are *estimated values* that were not validated during the data conversion from the former State Soil Survey Database structure to the current NASIS data structure. In an effort to populate empty data fields and validate existing data, the National Soil Survey Center (NSSC) is developing algorithms from statistical analyses of National Soil Survey Laboratory data.

In order to improve the accuracy of our soil survey interpretations, ***standard (control) test* datasets** could be assembled and used to test the validity of data entries in NASIS.

OBJECTIVE and USES:

Identify criteria and assemble a ***standard laboratory dataset*** and a ***standard component dataset***. The datasets will be representative of diverse soil taxa, but not so large as to make the validity-testing phase excessively time-consuming.

- The standard laboratory dataset will be compared to the standard component dataset in order to test the validity of:
  - ✓ existing soil property values in NASIS and
  - ✓ soil property values derived from algorithms.
- These datasets also will be used for validating soil survey interpretations.

CRITERIA USED TO DEVELOP THE DATASET LIST:

- Benchmark series of large extent with:
  - ✓ high data-completeness indexes (DCI) and
  - ✓ high pedon counts
- At least one benchmark series per state will be selected
- Taxonomic diversity
- Acceptable geographic distribution

COMPLETED BUSINESS:

- standard laboratory dataset, 1st approximation (see attachments)
  - ✓ Sorted by taxonomic classification
  - ✓ Sorted by state

REMAINING BUSINESS:

- NCSS peer review of the ***standard laboratory dataset***
  - ✓ Anticipate adding more series to deal with taxonomic gaps
  - ✓ Anticipate adding series with complete lab data stored at state universities
- Need to assemble the ***standard component dataset***, i.e. a map unit identification legend containing components of the selected benchmark series.

OTHER POTENTIAL APPLICATIONS:

- Serve as a standard dataset to test models

Please send any questions, comments, and suggestions to
HUtestdataset@nssc.nrcs.usda.govU

UTest Dataset Team Members

Sponsor – Berman Hudson, National Leader, Soil Survey Interpretations

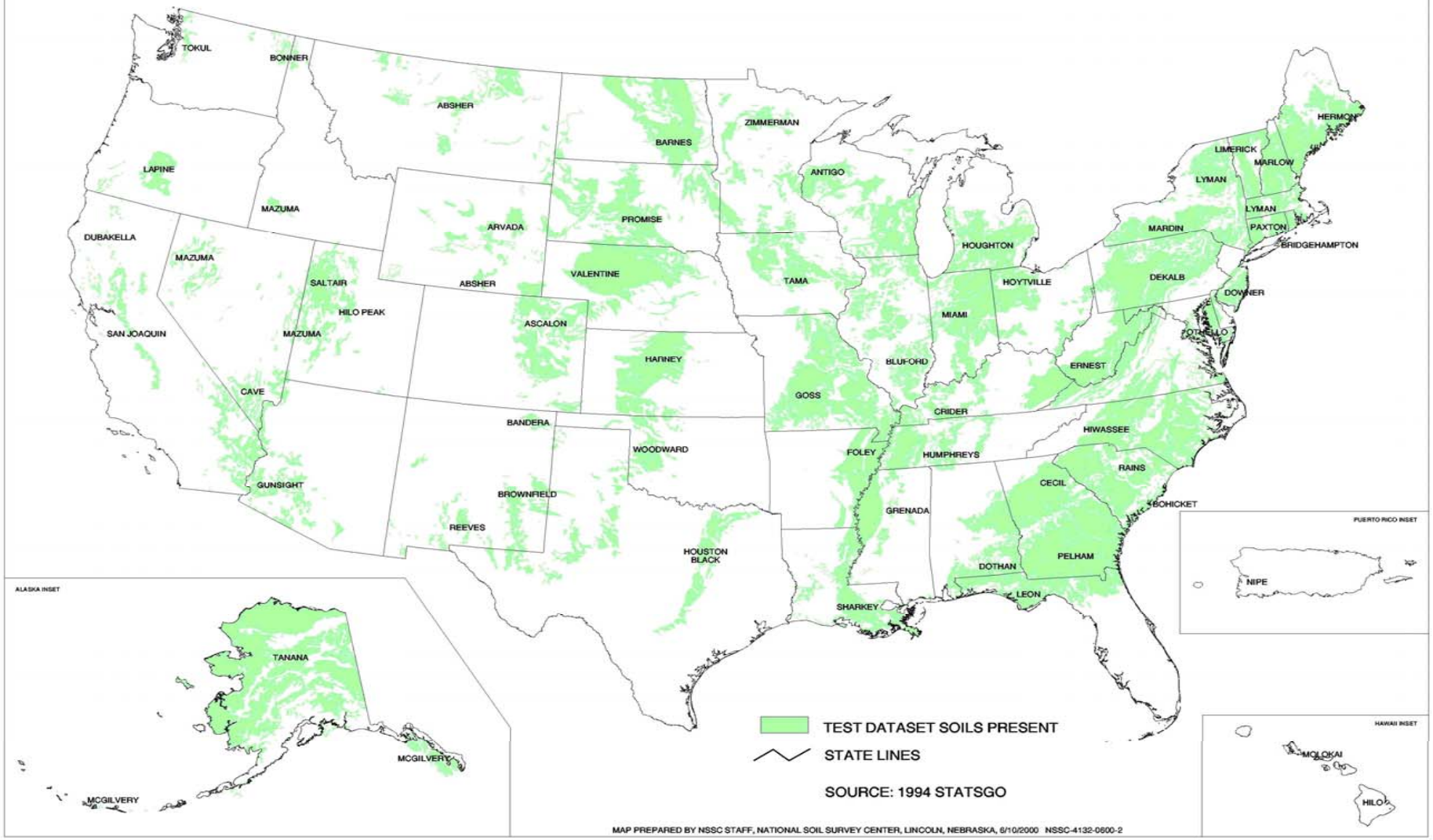
Rick Bigler, Soil Scientist
Jim Culver, National Leader, Technical Soil Services
Bob Engel, Soil Scientist
Tom Reedy, Soil Scientist
Adrian Smith, GIS Specialist

UNITED STATES DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE - SOIL SURVEY DIVISION

SELECTED BENCHMARK SOIL DATASETS

DRAFT MAP FOR TEST DATASET TEAM, JUNE 2000



MAP PREPARED BY NSSC STAFF, NATIONAL SOIL SURVEY CENTER, LINCOLN, NEBRASKA, 6/10/2000 NSSC-4132-0600-2

Standard Lab Test Dataset, Sorted by Soil Order

UClassification	*Series Name*	*State*
CLAYEY-SKELETAL, MAGNESIC, MESIC MOLLIC HAPLOXERALFS	DUBAKELLA	CA
CLAYEY-SKELETAL, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS	GOSS	MO
COARSE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, SUPERACTIVE, FRIGID HAPLIC GLOSSUDALFS	ANTIGO	WI
FINE, ILLITIC, MESIC MOLLIC EPIAQUALFS	HOYTVILLE	OH
FINE, MIXED, ACTIVE, THERMIC ABRUPTIC DURIXERALFS	SAN JOAQUIN	CA
FINE, SMECTITIC, FRIGID LEPTIC TORRERTIC NATRUSTALFS	ABSHER	MT
FINE, SMECTITIC, MESIC AERIC CHROMIC VERTIC EPIAQUALFS	BLUFORD	IL
FINE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC HAPLUDALFS	MIAMI	IN
FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS	CRIDER	KY
FINE-SILTY, MIXED, ACTIVE, THERMIC ALBIC GLOSSIC NATRAQUALFS	FOLEY	AR
FINE-SILTY, MIXED, ACTIVE, THERMIC GLOSSIC FRAGIUDALFS	GRENADA	MS
LOAMY, MIXED, SUPERACTIVE, THERMIC ARENIC ARIDIC PALEUSTALFS	BROWNFIELD	TX
ASHY OVER SANDY OR SANDY-SKELETAL, MIXED, FRIGID TYPIC VITRIXERANDS	BONNER	ID
ASHY-PUMICEOUS, GLASSY XERIC VITRICRYANDS	LAPINE	OR
MEDIAL, AMORPHIC, MESIC AQUIC VITRIXERANDS	TOKUL	WA
FINE, SMECTITIC, MESIC USTIC NATRARGIDS	ARVADA	WY
FINE-LOAMY, GYPSIC, THERMIC USTIC CALCIGYPSIDS	REEVES	NM
FINE-SILTY, MIXED, MESIC TYPIC SALORTHIDS	SALTAIR	UT
LOAMY, MIXED, SUPERACTIVE, THERMIC, SHALLOW TYPIC PETROCALCIDS	CAVE	AZ
LOAMY-SKELETAL, MIXED, MESIC XERIC HAPLOCALCIDS	HIKO PEAK	UT
LOAMY-SKELETAL, MIXED, SUPERACTIVE, HYPERTHERMIC TYPIC HAPLOCALCIDS	GUNSIGHT	AZ
COARSE-SILTY, MIXED, SUPERACTIVE, SUBGELIC TYPIC AQUITURBELS	TANANA	AK
COARSE-LOAMY, MIXED, SUPERACTIVE, CALCAREOUS, MESIC TYPIC TORRIORTHENTS	MAZUMA	NV
COARSE-SILTY, MIXED, ACTIVE, NONACID, MESIC TYPIC FLUVAQUENTS	LIMERICK	VT
FINE, MIXED, SUPERACTIVE, NONACID, THERMIC TYPIC SULFAQUENTS	BOHICKET	SC
MIXED, FRIGID ARGIC UDIPSAMMENTS	ZIMMERMAN	MN
MIXED, MESIC TYPIC USTIPSAMMENTS	VALENTINE	NE
DYSIC SPHAGNIC BOROFIBRISTS	SALAMATOF	AK
DYSIC LITHIC CRYOFOLISTS	MCGILVERY	AK
EUIC, MESIC TYPIC HAPLOSAPRISTS	HOUGHTON	MI

Classification	Series Name	State
COARSE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC DYSTRUDEPTS	PAXTON	CT
COARSE-LOAMY, MIXED, ACTIVE, MESIC TYPIC FRAGIUDEPTS	MARDIN	NY
COARSE-SILTY, MIXED, MESIC TYPIC DYSTROCHREPTS	BRIDGEHAMPTON	RI
COARSE-SILTY, MIXED, SUPERACTIVE, THERMIC TYPIC HAPLUSTEPTS	WOODWARD	OK
LOAMY-SKELETAL, SILICEOUS, SUBACTIVE, MESIC TYPIC DYSTROCHREPTS	DEKALB	PA
THIXOTROPIC, ISOHYPERTHERMIC TYPIC HYDRANDEPTS	HILO	HI
FINE, SMECTITIC, MESIC TYPIC ARGIUSTOLLS	HARNEY	KS
FINE-LOAMY, MIXED, SUPERACTIVE, FRIGID CALCIC HAPLUDOLLS	BARNES	ND
FINE-LOAMY, MIXED, SUPERACTIVE, MESIC ARIDIC ARGIUSTOLLS	ASCALON	CO
FINE-SILTY, MIXED, MESIC TYPIC ARGIUDOLLS	TAMA	IA
LOAMY-SKELETAL OVER FRAGMENTAL, MIXED ENTIC HAPLOBOROLLS	BANDERA	NM
FINE, SESQUIC, ISOHYPERTHERMIC ANIONIC ACRUDOX	NIPE	PR
VERY-FINE, KAOLINITIC, ISOHYPERTHERMIC RHODIC EUTRUSTOX	MOLOKAI	HI
COARSE-LOAMY, ISOTIC, FRIGID OXYAQUIC HAPLORTHODS	MARLOW	NH
LOAMY, ISOTIC, FRIGID LITHIC HAPLORTHODS	LYMAN	MA
SANDY, SILICEOUS, THERMIC AERIC ALAQUODS	LEON	FL
SANDY-SKELETAL, MIXED, FRIGID TYPIC HAPLORTHODS	HERMON	ME
COARSE-LOAMY, SILICEOUS, SEMIACTIVE, MESIC TYPIC HAPLUDULTS	DOWNER	NJ
FINE, KAOLINITIC, THERMIC TYPIC KANHAPLUDULTS	CECIL	NC
FINE, KAOLINITIC, THERMIC TYPIC RHODUDULTS	HIWASSEE	VA
FINE-LOAMY, KAOLINITIC, THERMIC PLINTHIC KANDIUDULTS	DOTHAN	AL
FINE-LOAMY, MIXED, SUPERACTIVE, MESIC AQUIC FRAGIUDULTS	ERNEST	WV
FINE-LOAMY, SILICEOUS, SEMIACTIVE, THERMIC HUMIC HAPLUDULTS	HUMPHREYS	TN
FINE-LOAMY, SILICEOUS, SEMIACTIVE, THERMIC TYPIC PALEAQUULTS	RAINS	SC
FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC ENDOAQUULTS	OTHELLO	MD
LOAMY, SILICEOUS, SUBACTIVE, THERMIC ARENIC PALEAQUULTS	PELHAM	GA
FINE, SMECTITIC, THERMIC UDIC HAPLUSTERTS	HOUSTON BLACK	TX
VERY-FINE, SMECTITIC, MESIC TYPIC HAPLUSTERTS	PROMISE	SD
VERY-FINE, SMECTITIC, THERMIC CHROMIC EPIAQUERTS	SHARKEY	LA

Standard Lab Test Dataset, Sorted by State

State	*Series Name*	*Classification*
AK	MCGILVERY	DYSIC LITHIC CRYOFOLISTS
AK	SALAMATOF	DYSIC SPHAGNIC BOROFIBRISTS
AK	TANANA	COARSE-SILTY, MIXED, SUPERACTIVE, SUBGELIC TYPIC AQUORTHELS
AL	DOTHAN	FINE-LOAMY, KAOLINITIC, THERMIC PLINTHIC KANDIUDULTS
AR	FOLEY	FINE-SILTY, MIXED, ACTIVE, THERMIC ALBIC GLOSSIC NATRAQUALFS
AZ	CAVE	LOAMY, MIXED, SUPERACTIVE, THERMIC, SHALLOW TYPIC PETROCALCIDS
AZ	GUNSIGHT	LOAMY-SKELETAL, MIXED, SUPERACTIVE, HYPERTHERMIC TYPIC HAPLOCALCIDS
CA	DUBAKELLA	CLAYEY-SKELETAL, MAGNESIC, MESIC MOLLIC HAPLOXERALFS
CA	SAN JOAQUIN	FINE, MIXED, ACTIVE, THERMIC ABRUPTIC DURIXERALFS
CO	ASCALON	FINE-LOAMY, MIXED, SUPERACTIVE, MESIC ARIDIC ARGIUSTOLLS
CT	PAXTON	COARSE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC DYSTRUDEPTS
FL	LEON	SANDY, SILICEOUS, THERMIC AERIC ALAQUODS
GA	PELHAM	LOAMY, SILICEOUS, SUBACTIVE, THERMIC ARENIC PALEAQUULTS
HI	HILO	THIXOTROPIC, ISOHYPERTHERMIC TYPIC HYDRANDEPTS
HI	MOLOKAI	VERY-FINE, KAOLINITIC, ISOHYPERTHERMIC RHODIC EUTRUSTOX
IA	TAMA	FINE-SILTY, MIXED, MESIC TYPIC ARGIUDOLLS
ID	BONNER	ASHY OVER SANDY OR SANDY-SKELETAL, MIXED, FRIGID TYPIC VITRIXERANDS
IL	BLUFORD	FINE, SMECTITIC, MESIC AERIC CHROMIC VERTIC EPIAQUALFS
IN	MIAMI	FINE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC HAPLUDALFS
KS	HARNEY	FINE, SMECTITIC, MESIC TYPIC ARGIUSTOLLS
KY	CRIDER	FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS
LA	SHARKEY	VERY-FINE, SMECTITIC, THERMIC CHROMIC EPIAQUERTS
MA	LYMAN	LOAMY, ISOTIC, FRIGID LITHIC HAPLORTHODS
MD	OTHELLO	FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC ENDOAQUULTS
ME	HERMON	SANDY-SKELETAL, MIXED, FRIGID TYPIC HAPLORTHODS
MI	HOUGHTON	EUIC, MESIC TYPIC HAPLOSAPRISTS
MN	ZIMMERMAN	MIXED, FRIGID ARGIC UDIPSAMMENTS
MO	GOSS	CLAYEY-SKELETAL, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS
MS	GRENADA	FINE-SILTY, MIXED, ACTIVE, THERMIC GLOSSIC FRAGIUDALFS
MT	ABSHER	FINE, SMECTITIC, FRIGID LEPTIC TORRERTIC NATRUSTALFS
NC	CECIL	FINE, KAOLINITIC, THERMIC TYPIC KANHAPLUDULTS
ND	BARNES	FINE-LOAMY, MIXED, SUPERACTIVE, FRIGID CALCIC HAPLUDOLLS

State	Series Name	Classification
NE	VALENTINE	MIXED, MESIC TYPIC USTIPSAMMENTS
NH	MARLOW	COARSE-LOAMY, ISOTIC, FRIGID OXYAQUIC HAPLORTHODS
NJ	DOWNER	COARSE-LOAMY, SILICEOUS, SEMIACTIVE, MESIC TYPIC HAPLUDULTS
NM	BANDERA	LOAMY-SKELETAL OVER FRAGMENTAL, MIXED ENTIC HAPLOBOROLLS
NM	REEVES	FINE-LOAMY, GYPSIC, THERMIC USTIC CALCIGYPSIDS
NV	MAZUMA	COARSE-LOAMY, MIXED, SUPERACTIVE, CALCAREOUS, MESIC TYPIC TORRIORTHENTS
NY	MARDIN	COARSE-LOAMY, MIXED, ACTIVE, MESIC TYPIC FRAGIUDEPTS
OH	HOYTVILLE	FINE, ILLITIC, MESIC MOLLIC EPIAQUALFS
OK	WOODWARD	COARSE-SILTY, MIXED, SUPERACTIVE, THERMIC TYPIC HAPLUSTEPTS
OR	LAPINE	ASHY-PUMICEOUS, GLASSY XERIC VITRICRYANDS
PA	DEKALB	LOAMY-SKELETAL, SILICEOUS, SUBACTIVE, MESIC TYPIC DYSTROCHREPTS
PR	NIPE	FINE, SESQUIC, ISOHYPERTHERMIC ANIONIC ACRUDOX
RI	BRIDGEHAMPTON	COARSE-SILTY, MIXED, MESIC TYPIC DYSTROCHREPTS
SC	BOHICKET	FINE, MIXED, SUPERACTIVE, NONACID, THERMIC TYPIC SULFAQUENTS
SC	RAINS	FINE-LOAMY, SILICEOUS, SEMIACTIVE, THERMIC TYPIC PALEAQUULTS
SD	PROMISE	VERY-FINE, SMECTITIC, MESIC TYPIC HAPLUSTERTS
TN	HUMPHREYS	FINE-LOAMY, SILICEOUS, SEMIACTIVE, THERMIC HUMIC HAPLUDULTS
TX	BROWNFIELD	LOAMY, MIXED, SUPERACTIVE, THERMIC ARENIC ARIDIC PALEUSTALFS
TX	HOUSTON BLACK	FINE, SMECTITIC, THERMIC UDIC HAPLUSTERTS
UT	HIKO PEAK	LOAMY-SKELETAL, MIXED, MESIC XERIC HAPLOCALCIDS
UT	SALTAIR	FINE-SILTY, MIXED, MESIC TYPIC SALORTHIDS
VA	HIWASSEE	FINE, KAOLINITIC, THERMIC TYPIC RHODUDULTS
VT	LIMERICK	COARSE-SILTY, MIXED, ACTIVE, NONACID, MESIC TYPIC FLUVAQUENTS
WA	TOKUL	MEDIAL, AMORPHIC, MESIC AQUIC VITRIXERANDS
WI	ANTIGO	COARSE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, SUPERACTIVE, FRIGID HAPLIC GLOSSUDALFS
WV	ERNEST	FINE-LOAMY, MIXED, SUPERACTIVE, MESIC AQUIC FRAGIUDULTS
WY	ARVADA	FINE, SMECTITIC, MESIC USTIC NATRARGIDS

Selected Benchmark Soil Datasets to Test the Validity of Algorithms and Existing Soil Properties in NASIS

Standard Lab Test Dataset, Sorted by Soil Order

Classification	Series Name	State
CLAYEY-SKELETAL, MAGNESIC, MESIC MOLLIC HAPLOXERALFS	DUBAKELLA	CA
CLAYEY-SKELETAL, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS	GOSS	MO
COARSE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, SUPERACTIVE, FRIGID HAPLIC GLOSSUDALFS	ANTIGO	WI
FINE, ILLITIC, MESIC MOLLIC EPIAQUALFS	HOYTVILLE	OH
FINE, MIXED, ACTIVE, THERMIC ABRUPTIC DURIXERALFS	SAN JOAQUIN	CA
FINE, SMECTITIC, FRIGID LEPTIC TORRERTIC NATRUSTALFS	ABSHER	MT
FINE, SMECTITIC, MESIC AERIC CHROMIC VERTIC EPIAQUALFS	BLUFORD	IL
FINE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC HAPLUDALFS	MIAMI	IN
FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS	CRIDER	KY
FINE-SILTY, MIXED, ACTIVE, THERMIC ALBIC GLOSSIC NATRAQUALFS	FOLEY	AR
FINE-SILTY, MIXED, ACTIVE, THERMIC GLOSSIC FRAGIUDALFS	GRENADA	MS
LOAMY, MIXED, SUPERACTIVE, THERMIC ARENIC ARIDIC PALEUSTALFS	BROWNFIELD	TX
ASHY OVER SANDY OR SANDY-SKELETAL, MIXED, FRIGID TYPIC VITRIXERANDS	BONNER	ID
ASHY-PUMICEOUS, GLASSY XERIC VITRICRYANDS	LAPINE	OR
MEDIAL, AMORPHIC, MESIC AQUIC VITRIXERANDS	TOKUL	WA
FINE, SMECTITIC, MESIC USTIC NATRARGIDS	ARVADA	WY
FINE-LOAMY, GYPSIC, THERMIC USTIC CALCIGYPSIDS	REEVES	NM
FINE-SILTY, MIXED, MESIC TYPIC SALORTHIDS	SALTAIR	UT
LOAMY, MIXED, SUPERACTIVE, THERMIC, SHALLOW TYPIC PETROCALCIDS	CAVE	AZ
LOAMY-SKELETAL, MIXED, MESIC XERIC HAPLOCALCIDS	HIKO PEAK	UT
LOAMY-SKELETAL, MIXED, SUPERACTIVE, HYPERTHERMIC TYPIC HAPLOCALCIDS	GUNSIGHT	AZ
COARSE-SILTY, MIXED, SUPERACTIVE, SUBGELIC TYPIC AQUORTHELS	TANANA	AK
COARSE-LOAMY, MIXED, SUPERACTIVE, CALCAREOUS, MESIC TYPIC TORRIORTHENTS	MAZUMA	NV
COARSE-SILTY, MIXED, ACTIVE, NONACID, MESIC TYPIC FLUVAQUENTS	LIMERICK	VT
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MIXED, FRIGID ARGIC UDIPSAMMENTS	ZIMMERMAN	MN
MIXED, MESIC TYPIC USTIPSAMMENTS	VALENTINE	NE
DYSIC SPHAGNIC BOROFIBRISTS	SALAMATOF	AK
DYSIC LITHIC CRYOFOLISTS	MCGILVERY	AK
EUIC, MESIC TYPIC HAPLOSAPRISTS	HOUGHTON	MI
COARSE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC DYSTRUDEPTS	PAXTON	CT
COARSE-LOAMY, MIXED, ACTIVE, MESIC TYPIC FRAGIUDEPTS	MARDIN	NY
COARSE-SILTY, MIXED, MESIC TYPIC DYSTROCHREPTS	BRIDGEHAMPTON	RI
COARSE-SILTY, MIXED, SUPERACTIVE, THERMIC TYPIC HAPLUSTEPTS	WOODWARD	OK
LOAMY-SKELETAL, SILICEOUS, SUBACTIVE, MESIC TYPIC DYSTROCHREPTS	DEKALB	PA
THIXOTROPIC, ISOHYPERTHERMIC TYPIC HYDRANDEPTS	HILO	HI
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FINE-LOAMY, MIXED, SUPERACTIVE, MESIC ARIDIC ARGIUSTOLLS	ASCALON	CO
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LOAMY, SILICEOUS, SUBACTIVE, THERMIC ARENIC PALEAQUULTS	PELHAM	GA
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VERY-FINE, SMECTITIC, MESIC TYPIC HAPLUSTERTS	PROMISE	SD
VERY-FINE, SMECTITIC, THERMIC CHROMIC EPIAQUERTS	SHARKEY	LA

Test Dataset Team, National Soil Survey Center, Lincoln, Nebraska

Issue

Some key soil properties of map unit components, which are used to generate soil interpretations in the National Soil Information System (NASIS), are not yet populated in the database. Many soil property values that exist in NASIS are *estimated values* that were not validated during the data conversion from the former State Soil Survey Database structure to the current NASIS data structure. In an effort to populate empty data fields and validate existing data, the National Soil Survey Center (NSSC) is developing algorithms from statistical analyses of National Soil Survey Laboratory data.

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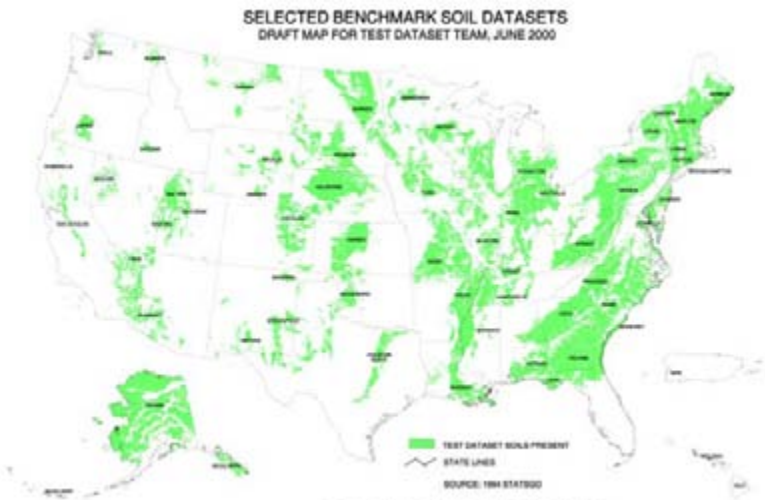

Criteria Used to Develop the Dataset List

- Benchmark series of large extent with:
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- At least one benchmark series per state will be selected
- Taxonomic diversity
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Completed Business

- Standard laboratory dataset, 1st approximation (see charts)
  - ✓ Sorted by soil order
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  - ✓ Anticipate adding more series to deal with taxonomic gaps
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Other Potential Applications

- Serve as a standard dataset to test models

Please send any questions, comments, and suggestions to:
testdataset@nssc.nrcs.usda.gov

Test Dataset Team Members

Sponsor – Berman Hudson, National Leader, Soil Survey Interpretations

Rick Bigler, Soil Scientist

Jim Culver, National Leader, Technical Soil Services

Bob Engel, Soil Scientist

Tom Reedy, Soil Scientist

Adrian Smith, GIS Specialist

USDA NRCS Natural Resources Conservation Service

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Standard Lab Test Dataset, Sorted by State

State	Series Name	Classification
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AZ	GUNSIGHT	LOAMY-SKELETAL, MIXED, SUPERACTIVE, HYPERTHERMIC TYPIC HAPLOCALCIDS
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CO	ASCALON	FINE-LOAMY, MIXED, SUPERACTIVE, MESIC ARIDIC ARGIUSTOLLS
CT	PAXTON	COARSE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC DYSTRUDEPTS
FL	LEON	SANDY, SILICEOUS, THERMIC AERIC ALAQUODS
GA	PELHAM	LOAMY, SILICEOUS, SUBACTIVE, THERMIC ARENIC PALEAQUULTS
HI	HILO	THIXOTROPIC, ISOHYPERTHERMIC TYPIC HYDRANDEPTS
HI	MOLOKAI	VERY-FINE, KAOLINITIC, ISOHYPERTHERMIC RHODIC EUTRUSTOX
IA	TAMA	FINE-SILTY, MIXED, MESIC TYPIC ARGIUDOLLS
ID	BONNER	ASHY OVER SANDY OR SANDY-SKELETAL, MIXED, FRIGID TYPIC VITRIXERANDS
IL	BLUFORD	FINE, SMECTITIC, MESIC AERIC CHROMIC VERTIC EPIAQUALFS
IN	MIAMI	FINE-LOAMY, MIXED, ACTIVE, MESIC OXYAQUIC HAPLUDALFS
KS	HARNEY	FINE, SMECTITIC, MESIC TYPIC ARGIUSTOLLS
KY	CRIDER	FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS
LA	SHARKEY	VERY-FINE, SMECTITIC, THERMIC CHROMIC EPIAQUERTS
MA	LYMAN	LOAMY, ISOTIC, FRIGID LITHIC HAPLORTHODS
MD	OTHELLO	FINE-SILTY, MIXED, ACTIVE, MESIC TYPIC ENDOAQUULTS
ME	HERMON	SANDY-SKELETAL, MIXED, FRIGID TYPIC HAPLORTHODS
MI	HOUGHTON	EUIC, MESIC TYPIC HAPLOSAPRISTS
MN	ZIMMERMAN	MIXED, FRIGID ARGIC UDIPSAMMENTS
MO	GOSS	CLAYEY-SKELETAL, MIXED, ACTIVE, MESIC TYPIC PALEUDALFS
MS	GRENADA	FINE-SILTY, MIXED, ACTIVE, THERMIC GLOSSIC FRAGIUDALFS
MT	ABSHER	FINE, SMECTITIC, FRIGID LEPTIC TORRERTIC NATRUSTALFS
NC	CECIL	FINE, KAOLINITIC, THERMIC TYPIC KANHAPLUDULTS
ND	BARNES	FINE-LOAMY, MIXED, SUPERACTIVE, FRIGID CALCIC HAPLUDOLLS
NE	VALENTINE	MIXED, MESIC TYPIC USTIPSAMMENTS
NH	MARLOW	COARSE-LOAMY, ISOTIC, FRIGID OXYAQUIC HAPLORTHODS
NJ	DOWNER	COARSE-LOAMY, SILICEOUS, SEMIACTIVE, MESIC TYPIC HAPLUDULTS
NM	BANDERA	LOAMY-SKELETAL OVER FRAGMENTAL, MIXED ENTIC HAPLOBOROLLS
NM	REEVES	FINE-LOAMY, GYPSIC, THERMIC USTIC CALCIGYPSIDS
NV	MAZUMA	COARSE-LOAMY, MIXED, SUPERACTIVE, CALCAREOUS, MESIC TYPIC TORRIORTHENTS
NY	MARDIN	COARSE-LOAMY, MIXED, ACTIVE, MESIC TYPIC FRAGIUDEPTS
OH	HOYTVILLE	FINE, ILLITIC, MESIC MOLLIC EPIAQUALFS
OK	WOODWARD	COARSE-SILTY, MIXED, SUPERACTIVE, THERMIC TYPIC HAPLUSTEPTS
OR	LAPINE	ASHY-PUMICEOUS, GLASSY XERIC VITRICRYANDS
PA	DEKALB	LOAMY-SKELETAL, SILICEOUS, SUBACTIVE, MESIC TYPIC DYSTROCHREPTS
PR	NIPE	FINE, SESQUIC, ISOHYPERTHERMIC ANIONIC ACRUDOX
RI	BRIDGEHAMPTON	COARSE-SILTY, MIXED, MESIC TYPIC DYSTROCHREPTS
SC	BOHICKET	FINE, MIXED, SUPERACTIVE, NONACID, THERMIC TYPIC SULFAQUENTS
SC	RAINS	FINE-LOAMY, SILICEOUS, SEMIACTIVE, THERMIC TYPIC PALEAQUULTS
SD	PROMISE	VERY-FINE, SMECTITIC, MESIC TYPIC HAPLUSTERTS
TN	HUMPHREYS	FINE-LOAMY, SILICEOUS, SEMIACTIVE, THERMIC HUMIC HAPLUDULTS
TX	BROWNFIELD	LOAMY, MIXED, SUPERACTIVE, THERMIC ARENIC ARIDIC PALEUSTALFS
TX	HOUSTON BLACK	FINE, SMECTITIC, THERMIC UDIC HAPLUSTERTS
UT	HIKO PEAK	LOAMY-SKELETAL, MIXED, MESIC XERIC HAPLOCALCIDS
UT	SALTAIR	FINE-SILTY, MIXED, MESIC TYPIC SALORTHIDS
VA	HIWASSEE	FINE, KAOLINITIC, THERMIC TYPIC RHODUDULTS
VT	LIMERICK	COARSE-SILTY, MIXED, ACTIVE, NONACID, MESIC TYPIC FLUVAQUENTS
WA	TOKUL	MEDIAL, AMORPHIC, MESIC AQUIC VITRIXERANDS
WI	ANTIGO	COARSE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, SUPERACTIVE, FRIGID HAPLIC GLOSSUDALFS
WV	ERNEST	FINE-LOAMY, MIXED, SUPERACTIVE, MESIC AQUIC FRAGIUDULTS
WY	ARVADA	FINE, SMECTITIC, MESIC USTIC NATRARGIDS

WEST REGION HYDRIC SOILS COMMITTEE REPORT

I would like to extend my apologies for not being able to be with you to present this report.

The committee has since two years ago has lost (at least temporally) one member and that is Chris Noble who is on a detail to the Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi.

There hasn't been much activity at the committee level per say, although nationally there have been some changes in the hydric soil area that effect the west region.

The first is that the hydric soil criteria is in the process of being changed (up dated) to include the Histels in the hydric soil criteria. The task that now remains is to publish this in the Federal Register. We may still have a problem with the growing season as it relates to the Gelisols.

The second is that we are now able to search the NASSIS data base to produce a up to date hydric soils list.

Dave Clausnitzer, Dr. Herb Huddleston's PhD student has completed his study on the playas of eastern Oregon and we are awaiting his final report. Which may help us in the western playas.

WETLAND SCIENCE INSTITUTE

This has not been a good year for either the Institutes, Centers, or the agency it's self. The Wetland Science Institute this year has just about enough money in its budget to cover employee salaries and benefits and minimal support. All of the research projects we have been funding were cancelled or put on hold for at least a year. We hope to have a better funding outlook next year. The problem with that is that next year never gets here.

TRAINING

One of the main duties of at least the Wetland Science Institute has been training, except for this year. National Employee Development Center has almost nothing to provide for training. The classes I have taught this year have been funded either by other federal agencies or state agencies. At least someone sees the value of training.

This will end my report.

ALOHA

Russ Pringle
Soil Scientist

BY-LAWS
OF THE
WESTERN REGIONAL
COOPERATIVE
SOIL SURVEY CONFERENCE

Updated July 2000

ARTICLE I - NAME

Section 1.0 Conference Name

The name of the conference shall be the Western Regional Cooperative Soil Survey Conference. It is formed of and represents the area within the state boundaries of the following thirteen western states and U S Territory: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Nevada, New Mexico, Montana, Oregon, Pacific Basin, Utah, Washington, and Wyoming.

ARTICLE II - OBJECTIVES

Section 2.0 Objectives and Purposes

The objectives and purposes of the Western Regional Cooperative Soil Survey Conference are to bring together Western States representatives of the National Cooperative Soil Survey for discussion of technical and scientific questions. Through the actions of committees and conference discussions, experience is summarized and clarified for the benefit of all; new areas explored; procedures are synthesized; and ideas are exchanged and disseminated. The conference also functions as a clearinghouse for recommendations and proposals received from individual members and State Conferences for transmittal to the National Cooperative Soil Survey Conference. The conference promotes the use of soil resource information by others and develops recommendations for courses of action, including national policies and procedures, that relate to making soil surveys and using soil resource data and information.

ARTICLE III - MEMBERSHIP AND PARTICIPANTS

Section 3.0 Permanent Membership

Permanent membership of the conference shall consist of:

1. National Leader for Soil Taxonomy and Standards who serves as Executive Secretary for Conference Steering Committee

2. NRCS State Soil Scientists/MLRA Leaders
3. Representatives from Western State Experiment Stations and Land Grant Universities
4. Regional Soil Scientists from the 7 Western U S Forest Service Regions – Northern Region, Rocky Mountain Region, Southwest Region, Intermountain Region, Pacific Southwest Region, Pacific Northwest Region, and Alaska Region
5. USDI, Bureau of Land Management (BLM) State Soil Scientist or State Soil Liaison from 11 Western States (Alaska, Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon/Washington, Utah, and Wyoming)
6. Representatives from 7 Western Regions of USDI, Bureau of Indian Affairs (BIA) Regions – Alaska Region, Navajo Region, Northwest Region, Pacific Region, Rocky Mountain Region, Southwest Region, and Western Region.
7. NCSS Representative from the USDI National Park Service (NPS)
8. President-elect or delegated representative from the National Society of Consulting Soil Scientists (NSCSS)
9. A representative from the National Congress of American Indians
10. Program Manager for Land Suitability and Water Quality, USDI, Bureau of Reclamation (BOR)
11. A Representative from USDI Corps of Engineers (COE)

Section 3.1 Associate Membership

Invitations may be extended to a number of other individuals to participate in committee work or for a specific conference or conferences. A representative from the NRCS National Cartographic and Geospatial Center (NCGC) and a representative from the NRCS Information Technology Center (ITC) shall be associate conference members. Any soil scientist, technical specialist, or other individual of any local, state, or federal agency or interest group whose participation will benefit particular objectives or projects of the conference may be invited to participate. Any permanent member of the conference may invite one additional participant. If a permanent member wishes to invite more than one guest (or associate member), the request should be cleared through the Chair or Vice-Chair of the conference, or the Chair of the Steering Committee. Names of all associate members of a specific conference should be provided to the conference Chair.

ARTICLE IV - CONFERENCE OFFICERS

Section 4.0 Conference Officers

A Chair, Vice-Chair and Secretary of the conference are elected to serve for a two-year term. Their tenure runs from the end of a conference to the end of the following conference. Elections are held during the biennial business meeting. Conference officers shall be from the state hosting the next conference. Officers rotate among the agencies. That is to say, the Chair-elect must represent a different agency than the past Chair. Similarly, the Vice-Chair and Secretary must be of different agencies than their predecessors.

Section 4.0.1 Responsibilities of the Chair (specific tasks may be delegated to the Vice-Chair):

1. Plans and manages the biennial conference.
2. Serves as a steering committee member.
3. Presides at the conference business meeting.
4. Issues conference announcements and invitations.
5. Organizes the conference program.
6. Selects presiding Chair for the various sessions.
7. Develops the conference agenda, and has copies of the agenda prepared and distributed.
8. Make necessary arrangements for lodging accommodations for conference participants, for food functions, if any, for meeting rooms (including committee rooms), for a field trip, and for local transport for other official functions.
9. Assembles, reproduces, and distributes the Conference Proceedings.
10. Provides for appropriate conference publicity.
11. Arranges for conference guest speakers.
12. Presides over the conference business meeting.

Section 4.0.2 Responsibilities of the Vice-Chair

1. Serves as a steering committee member.
2. Acts for the Conference Chair in the Chair's absence or disability.
3. Assists the Conference Chair in carrying out his/her responsibilities, and performs other duties as assigned by the Conference Chair.
4. Compiles and maintains the conference mailing list.

Section 4.0.3 Responsibilities of the Secretary

1. Maintains conference business meetings minutes and other conference meetings minutes as assigned by the Conference Chair.
2. Obtains copies of all committee reports and papers presented at the conference and makes copies available to all conference members.
3. Compiles the conference proceedings and assists the Chair in their duplication and distribution.

ARTICLE V - MEETINGS

Section 5.0 Time of Meetings

The conference convenes every two years, in even numbered years. It convenes the third week in June, unless a different date is agreed to by a majority of permanent conference members at the previous conference.

Section 5.1 Location of Meetings

The conference will be held on a rotational basis throughout the region according to the following schedule. States may trade years to host the conference for good cause and upon approval by a majority vote of the conference members at the business meeting preceding the next conference.

Year	Host State
2000	Hawaii
2002	Colorado
2004	Alaska
2006	Arizona
2008	Utah
2010	Washington
2012	California
2014	Oregon
2016	Nevada
2018	Montana
2020	New Mexico
2022	Wyoming
2024	Idaho
2026	Return to Hawaii (repeat rotation)

ARTICLE VI - COMMITTEES

Section 6.0 Kinds and functions of Committees

The conference will have permanent standing, ad hoc, and special task force committees. Duly constituted official committees accomplish most conference work. The kinds of committees and their charges are determined by the Steering Committee, based on the recommendations of the conference members. Committee members are appointed by the Steering Committee after first determining the interests of conference members. Each committee shall make an official report at the designated time at each biennial conference. Committee reports shall be duplicated and copies distributed as follows:

1. One copy to each permanent member (whether present or not) and to each participant in the conference.
2. One final copy to the Conference Secretary for inclusion in the conference proceedings. This copy will include all revisions approved by the conference.

Much of the work of committees will, of necessity, be conducted by correspondence during the interval between conferences.

Section 6.1 Committee Structure

Each committee has a Chair. A Secretary, or recorder, may be elected by the committee or appointed by the Chair, if necessary. Committee Chairs are selected by the Steering Committee or are elected by the conference. The Committee Chairs are responsible for prompt submission of their reports to the Chair of the Steering Committee who will duplicate and distribute the reports. This should be done prior to the beginning of the conference.

Section 6.1.1 Committee Chair Responsibilities

Committee Chairs are charged with the responsibility of initiating and carrying forward this work. They shall provide their committee members with the charges as directed by the Steering Committee and with additional instructions they deem necessary to complete the committee charge(s). Committee Chairs should initiate committee work at the earliest possible date to assure completion by the next scheduled conference.

Committee Chairs shall also give a verbal summary of committee actions/recommendations at designated times during the conference.

Section 6.2 Permanent Standing Committees

Permanent standing committees are established by the By-laws of the National Cooperative Soil Survey Conference as contained in the NSSH Part 602.00 and Exhibit 602-1.

Section 6.2.1 Conference Steering Committee

The Conference Chair will also serve as the Chair of the Conference Steering Committee. The National Leader for Soil Classification and Standards will serve as the permanent Executive Secretary of the Steering Committee. The Steering Committee formulates policy on conference membership and participation. Final approval or disapproval of policy changes is by vote, during the biennial business meeting of the conference. The Steering Committee will assure that there is a balance among states and among agencies or each committee - that is to say that no one state or agency will dominate any single committee. The Conference Steering Committee shall consist consists of the following five (5) members:

1. Conference Chair
2. Conference Vice-Chair.
3. Conference Secretary
4. Executive Secretary
5. Past conference Chair

Section 6.2.2 Responsibilities of the Conference Steering Committee:

Conference Steering Committee responsibilities include but are not limited to:

1. Steering Committee Chair will call a meeting of the committee about 1 year prior to the conference to plan the meeting agenda and establish Conference Committees and develop committee charges
2. Formulate statements of conference policy
3. Formulate committee charges as recommended by the conference.
4. Select committee Chair and committee members as recommended by the conference.
5. Review conference activities and develop an executive summary of conference recommendations.
6. Send applicable conference recommendations to the Steering Committee Chair of the National Cooperative Soil Survey Conference.
7. Send applicable conference recommendations to the soil survey leaders of appropriate agencies for consideration and possible implementation.
8. Establish and maintain liaisons between the conference and:
   - The National and other Regional Conferences
   - State Conservationists of 13 Western States and Pacific Basin
   - West Regional Soil Consortium
   - Directors of the Western Experiment Stations
   - National Congress of American Indians
   - State, Regional, and National Offices of NRCS, US Forest Service, Bureau of Indian Affairs, Bureau of Land Management, National Park Service, American Indian Tribes, and National Society of Consulting Soil Scientists
   - NRCS Institutes and Centers
   - Other committees or work groups associated with the conference
   - Others as identified by the Steering Committee
9. Shall meet immediately after the conference to summarize recommendations and propose actions to be taken.

At least sixty percent of the Conference Steering Committee shall constitute a quorum for the transaction of business. Items shall be passed by a majority of members present. The Chair does not vote except in the case of a tie vote.

Section 6.3 Ad hoc Committees

Ad hoc committees may be established by the Steering Committee as needed to meet specific needs and/or goals.

Section 6.4 Special Task Force Committees

Special task force committees may be established by the Steering committee as needed to meet specific needs and/or goals.

ARTICLE VII - CONFERENCE ADVISORS

Section 7.0 **Conference Advisors**

Conference advisors are invited to the conference and shall act in an advisory capacity to assist in items related to agency line and policy. Advisors to the conference are the State Conservationist (STC) of the host state, or as selected by the conference, the Experiment Station Director for the host state, or as selected by the conference, a Forest Service Regional Forester and a BLM State Director as selected by the conference.

ARTICLE VII - HISTORICAL RECORDS

Section 8.0 **Conference Historical Records**

The Executive Secretary of the Conference Steering Committee will maintain a permanent, cumulative file of conference programs, correspondence, committee reports, proceedings, by-laws and other material generated by or related to the conference..

ARTICLE VIII - AMENDMENTS

Section 9.0 **Amendments**

Any part of these by-laws may be amended for purposes, policy, and procedures at any time by ballot with a majority vote of the permanent membership. An amendment shall, unless otherwise provided therein, be effective immediately upon adoption and shall remain in effect until changed or deleted.

These amended Western Regional Cooperative Soil Survey Conference By-Laws were accepted and passed by unanimous vote of conference members on June 30, 2000 in Kona, HI.

KARL W. HIPPLE CPSSc
Chairman, WRCSSC By-Laws Committee

West Region Cooperative Soil Survey Conference
June 25 to 30, 2000

NRCS – Breakout Session

Discussion Issue:
Develop a process to transfer new technologies for the west region, i.e. information dissemination to field personnel, between states, and soil survey cooperators.

Issue Moderator:
William D. Broderson

Background Discussion:
Information that relates to new technology development is not disseminated within NRCS and partners efficiently and some not at all. It is the view of the West Region State Soil Scientists that the agency needs to adopt a central internet site to communicate soil survey issues from new technology advances to methods of information display and customer training. We also discussed limits needed to the kinds of information, and a need for archiving information with a geographic component and key word links for quick reference.

The West Region NRCS group discussed the potential for expanding an existing internet site called "Forums" to include the archiving of new technology developed to new techniques that were a success in use of soil survey information. A central internet site seemed to be the preferred medium by the group for information dissemination.

Summary and Recommendation:
The West Region NRCS recommends expanding the current "Forums" internet site to include a new technologies library. It is recommended that the new internet site be renamed to strengthen the notion that the site will include soil survey technology and development information, such as "New Technologies and Soil Survey Forums."

The following recommended items would also help to strengthen the ease and understanding of this site:

1. Categories on the current forums page, such as Interpretations or Technical Soil Services is a good start. Allow the categories to have a geographic component. Most of the group thought that information grouped by region would be sufficient.
2. Develop a search engine, such as key words that link to the literature. For example, "Thematic Maps" to bring up the creation protocols for special soil interpretive maps and a link to an example of the thematic map.
3. All soil survey information developed and peer reviewed within a state or region and posted to the site needs to be archived and reviewed. The information need to be reviewed periodically, perhaps every two years to remove out dated information.