AN ECOLOGICAL CHARACTERIZATION OF THE GREATER YELLOWSTONE AREA

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Northern Region, USDA Forest Service

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

Natural Resources Information Service (NRIS)
Montana State Library

Montana Natural Resource Information System

With Applications
Developed for
Demonstration Ecological Units

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OBJECTIVES

The goals of this 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.

The characterization of ecological units at the Section, Subsection and Landtype Association levels, along with the presentation and demonstration of appropriate applications for these units is a major objective of this project. Attributes of Sections and Subsections include geomorphic settings and landform morphometry, lithology, classified vegetation, land cover, mean annual precipitation ranges, soil moisture and temperature regimes.

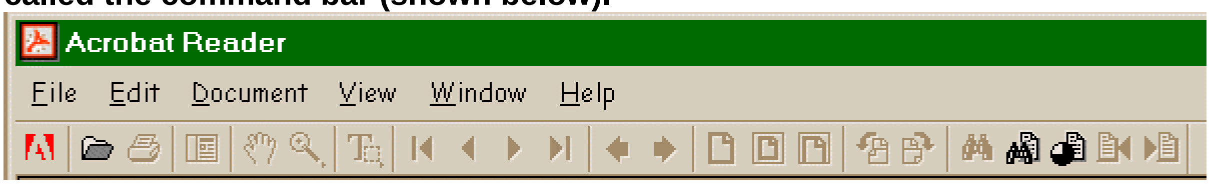
Constraints placed on this project included using only existing data sets that were readily available, at no cost, for all locations in the contiguous Greater Yellowstone Area. The effort also required using methods that could be easily duplicated for any landscape area within the United States.

The methods used in producing this information are designed to be portable and easily modified for the incorporation of additional data sets, and for use by others needing this level of ecological characterization. All geo-spatial products include, or provide references to Federal Geographic Data Committee (FGDC) compliant metadata for source map themes and project-generated themes, along with documentation of sources for data acquisition and methods of data assembly.

USING THIS DOCUMENT

This document is presented in Adobe PDF format and is viewed using Adobe Acrobat Reader. If you have Acrobat Reader you already know how handy it is for navigating portable document files (pdf's). So get started enjoying the Greater Yellowstone Area Ecological Characterization document. On each page are a number of invisible links to pages in the current document and the related documents. As you move the mouse cursor over a page, the cursor will change to a pointing hand indicating if you *click* in that location you will jump to a related page. The Table of Contents precedes this page, and contains links to each section listed. The title of each page will link back to the Table of Contents; the listing of DATA TABLES links to data summaries for each characterization theme. Under the listing DISPLAYS AND MAPS, selecting DISPLAYS will link to the 8.5"x11" page-size displays, and selecting MAPS will link to the full-size (34"x 34") maps which contain the full detail and accurate legends. Clicking on the title of a map will return you to the corresponding page in the document. These maps can be printed out at page-size, or if desired sent to a plotter to print the full-size map. The images and legends on pages that describe each of the characterization themes are for display purposes only, as are the page size (8.5"x11") maps. The listing REFERENCES will link to a document containing pertinent references. The listing SOURCES AND LINKS will open a document with a listing of relevant Internet web-site addresses.

Once the Adobe Reader is running you will find an area above the main windowpane, called the command bar (shown below).



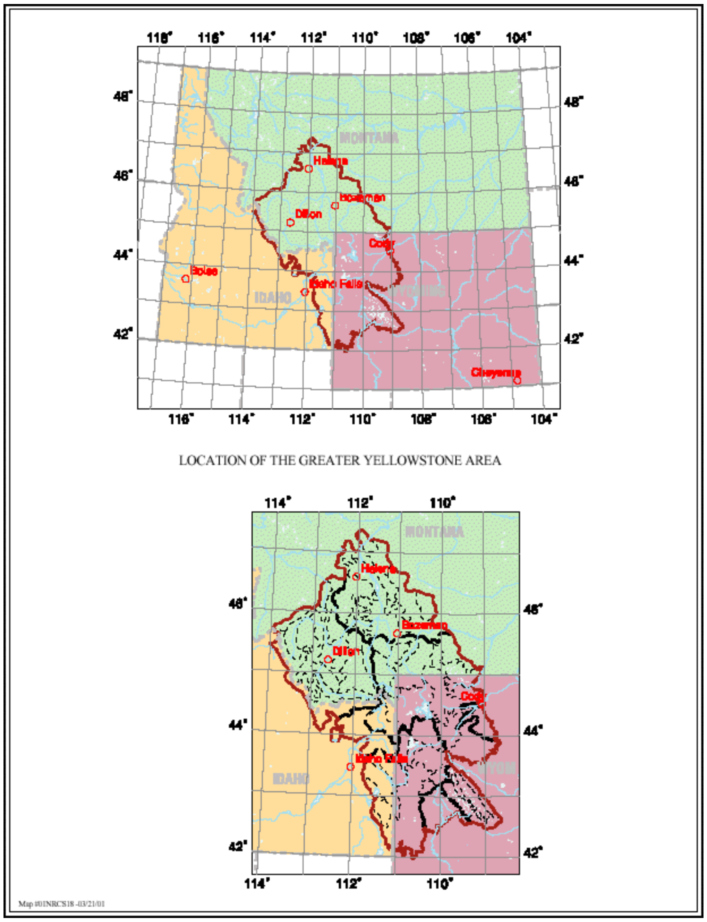
It contains navigation buttons, zoom buttons, search buttons and several other buttons. As you hesitate over a button, a text message will flash up with a short description of the button action. Left clicking on a button will perform the action or bring up a menu of options to modify the action to be performed (example: the binoculars button is find and will prompt you; Find What: ___________). This function allows you to search the document for a specific word or subject.

You will also find the hand button and the magnifying glass button on the command bar very useful. The magnifying glass button can be used to left click and drag a zoom in box, or once zoomed in if you hold down the ctrl key and left click to zoom out. If just left clicked it zooms in by a specific amount. The hand button functions to left click - hold - drag the view (panning), to move the document on the screen to a new position. When viewing the full-size map compositions these functions are very useful and will allow you to see the detail for specific locations, and the map legends.

There are many ways to adjust the page view. Play around. You can't hurt the files on this read-only CDROM.

GREATER YELLOWSTONE ECOLOGICAL CHARACTERIZATION

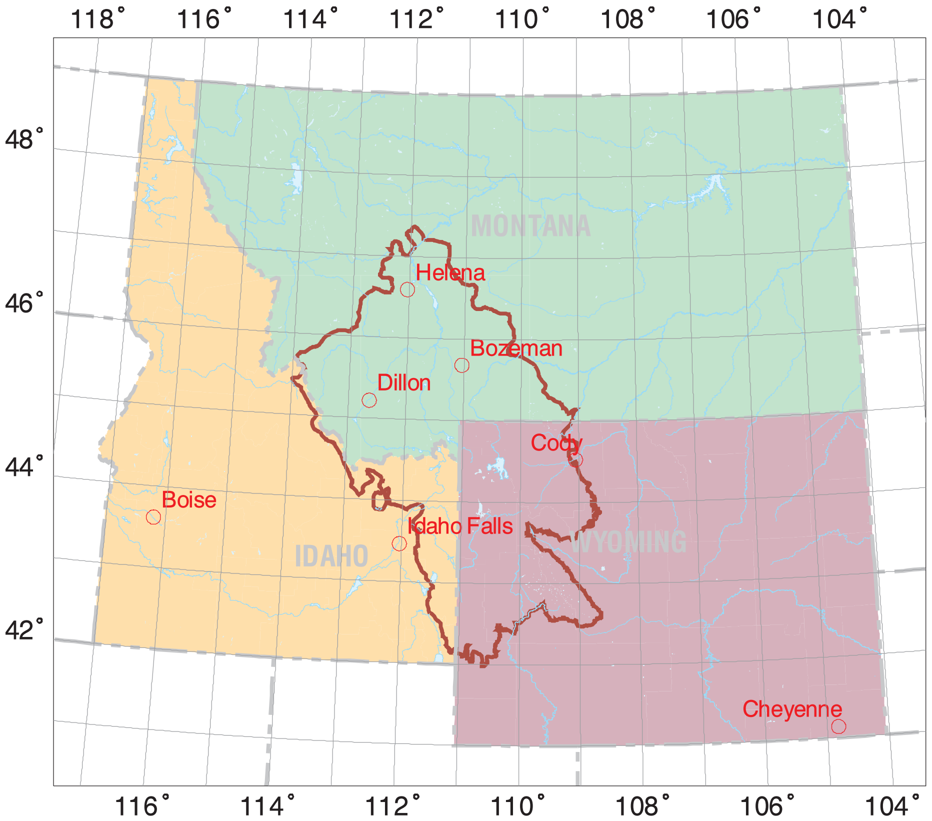
STUDY AREA



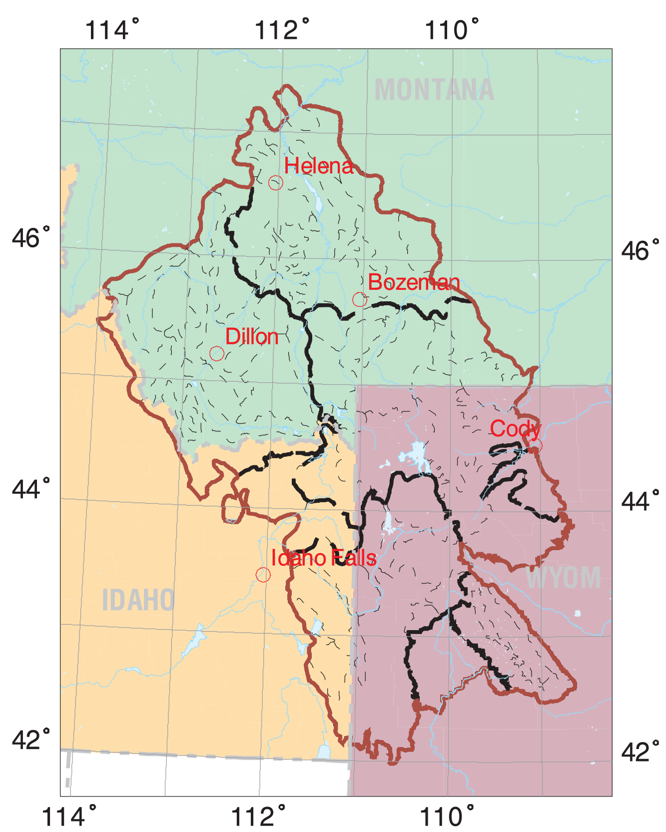
LOCATION OF THE GREATER YELLOWSTONE AREA

Our study area contains more than 31 million acres and includes areas not incorporated in other 'Greater Yellowstone Area' projects. For the purposes of this project, the outer perimeter of the study area was chosen to include, as concisely as possible, complete Ecological Units that have been previously published using nationally recognized ecological mapping methods, and whose attributes were considered critical to the structure and function of the GYA. *The selection of this boundary is in no way intended to make any political or management-related statements.*

There are many information sources for data about the physical area referred to as the Greater Yellowstone Area (GYA). Each of these sources will define a different perimeter around the locations they associate as being within the GYA. This effort does not attempt to be an all inclusive representation of available environmental data for the GYA. For example, general data regarding specific wildlife or plant populations, their habitats and distribution are not covered in this document.



LOCATION OF THE GREATER YELLOWSTONE AREA

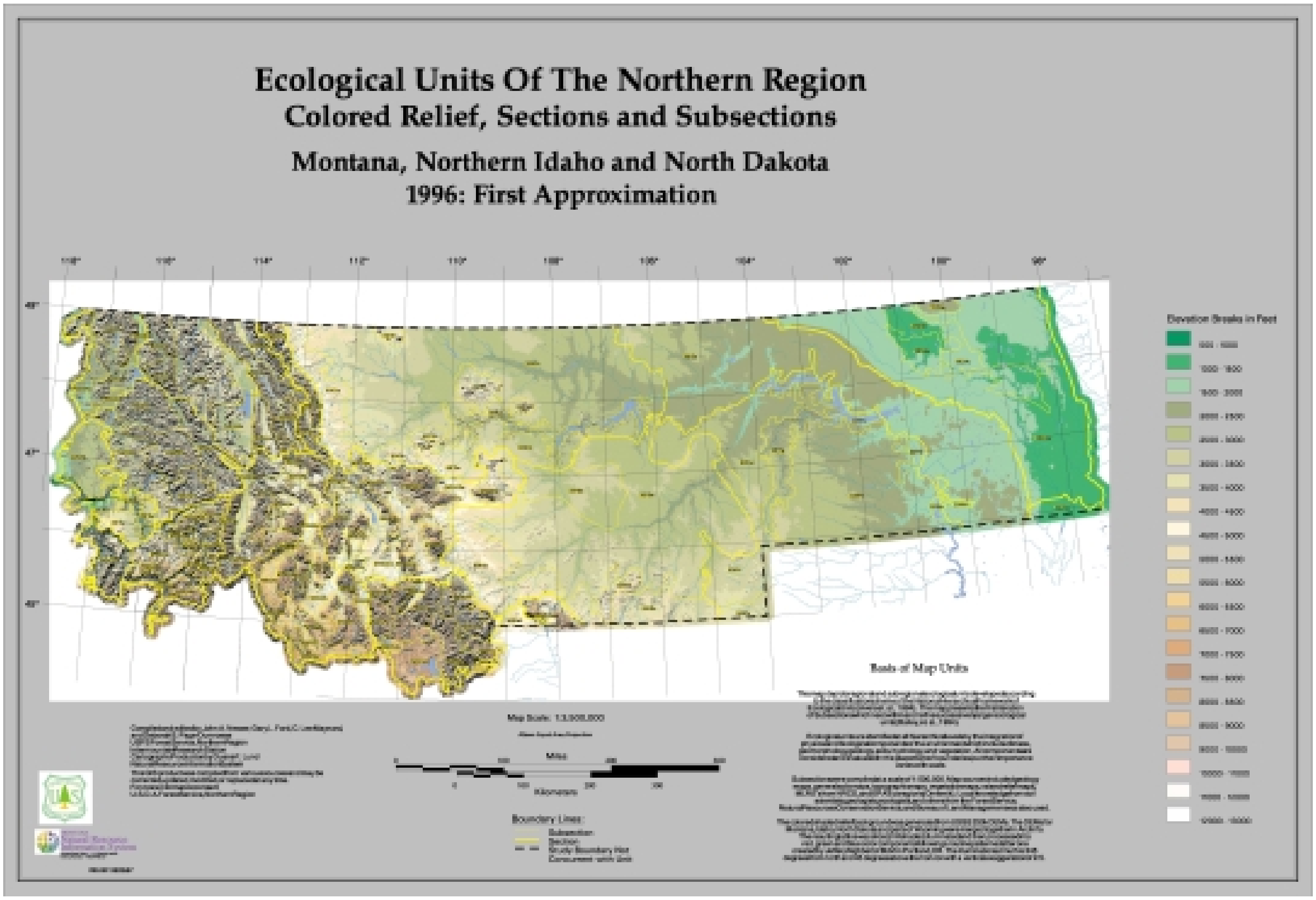


Map #01NRCS18 -10/24/00

<u>**THE NATIONAL HIERARCHICAL FRAMEWORK OF ECOLOGICAL UNITS**</u>

The National Hierarchical Framework of Ecological Units is a systematic, regionalized method for classifying and mapping areas of the Earth based on associations of ecological factors at different geographic scales.

Ecological types are classified, and ecological units are mapped based on associations of biotic and environmental factors that directly affect or indirectly express energy, moisture, and nutrient gradients which regulate the structure and function of ecosystems. These factors include climate, physiography, water, soils, air, hydrology, and potential natural communities. Ecological unit maps can be coupled with inventories of existing vegetation, air quality, aquatic systems, wildlife, and human elements to characterize complexes of life and environment, or ecosystems.



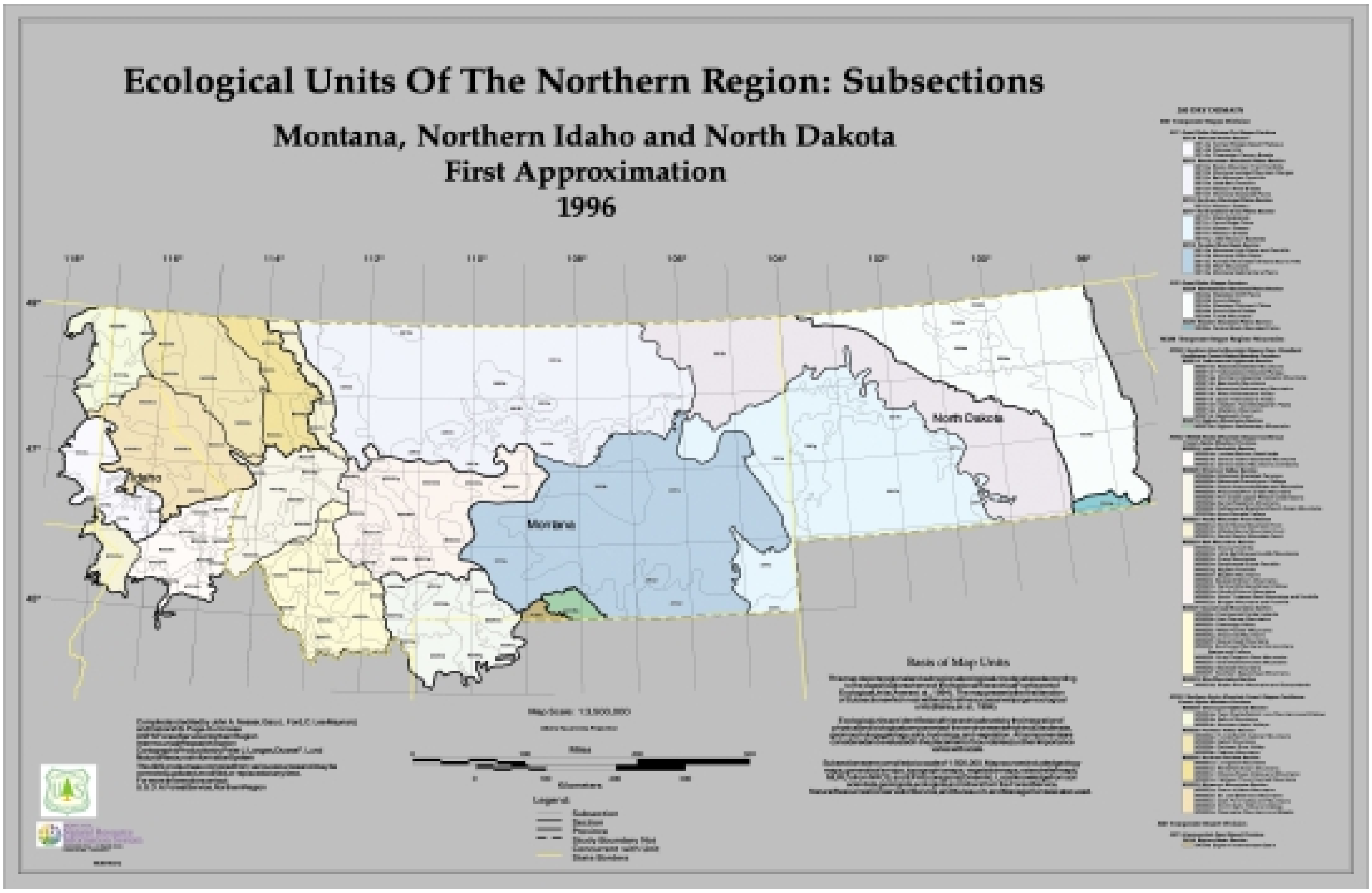
ECOLOGICAL UNIT DESIGN

The primary purpose for delineating ecological units is to display, at different levels of resolution, land and water areas that have similar capabilities and potentials for management. Ecological Units are designed to exhibit similar patterns in : (1) potential natural plant communities, (2) soils, (3) hydrologic function, (4) landform and topography, (5) lithology, (6) climate, (7) air quality, and (8) natural processes for cycling plant biomass and nutrients (e.g. succession, productivity, fire regimes) (Avers et al. 1994).

Climate, as modified by topography, is the dominant criteria at the upper levels of the hierarchy. Other factors, such as geomorphic processes, soils and potential natural plant communities take on equal or greater importance than climate at lower levels and more refined scales.

NORTHERN REGION ECOLOGICAL UNIT MAPPING

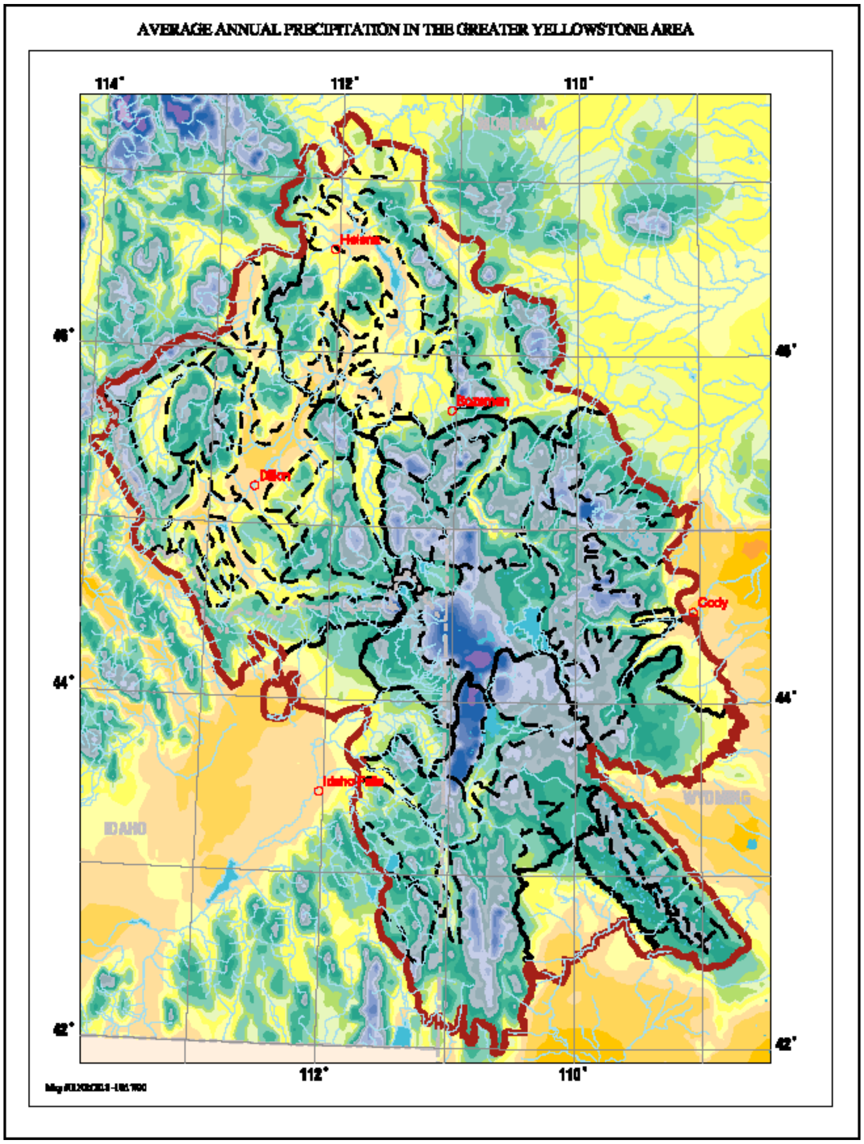
Subsection level ecological unit mapping was completed in the Northern Region, USDA Forest Service in 1996 and published in 1997. Ecological unit mapping at the Landtype Association level for the Northern Region was completed and published in 1997. Major Land Resource Area (MLRA) mapping compiled by the NRCS was used in developing both the mapping and characterization of these Ecological Units. Nationally, Ecological Unit mapping is coordinated by the USDA Forest Service. Currently, interagency efforts with the USDA NRCS and U.S. Department of Interior BLM to revise and modify existing mapping for greater consistency between agency delineations and to provide improved characterization of the map products are on-going.



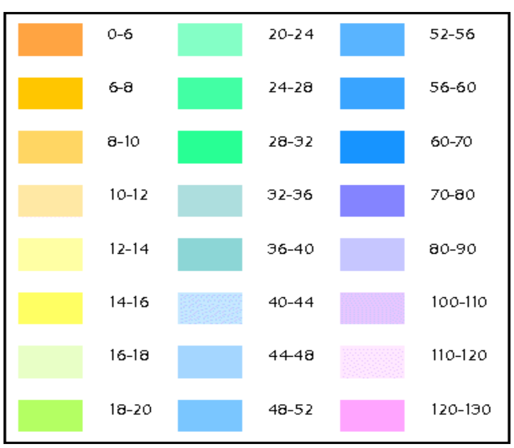
In a complimentary aspect of this project, significant progress has been made in developing a continuous edge-matched version of the SSURGO soils and Landtype (Order III) mapping for several of the 58 soil survey areas within the GYA (Shovic et al. 2000). This level of mapping is a pre-requisite for completion of the Landtype Association level of ecological unit mapping.

- **MAPS**
- **METADATA**
- **REFERENCES**
- **SOURCES AND LINKS**

CLIMATE



Precipitation Range (in inches)



PRECIPITATION

Regional and local precipitation and temperature patterns play a large role in determining the ecological features of any landscape. These patterns influence the formation of landforms, the development of soils, stream flow regimes, and on a more immediate temporal scale, the distribution of vegetation communities.

The information displayed here was generated using the PRISM model developed by Chris Daly of the Spatial Climate Analysis Service at Oregon State University. The PRISM model uses precipitation values collected from National Weather Service and NRCS SNOTEL data stations from 1961- 90 to create an extrapolated representation of ranges in precipitation for 2 kilometer resolution grid cells.

- **DATA TABLES**
- **DISPLAYS AND MAPS**
- **METADATA**
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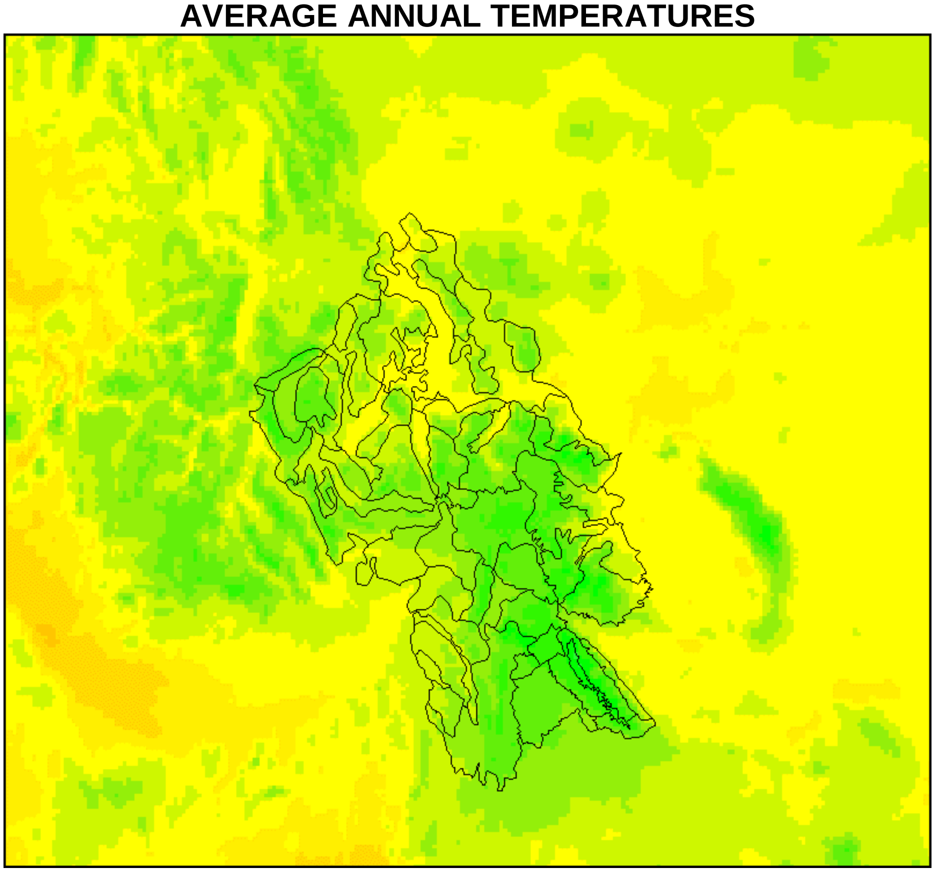
TEMPERATURE

This data set contains spatially gridded average monthly and annual mean temperature for the climatological period from1961-90. Distribution of the point measurements to a spatial grid for minimum and maximum temperature was accomplished using the PRISM model, developed by Chris Daly of SCAS/OSU.

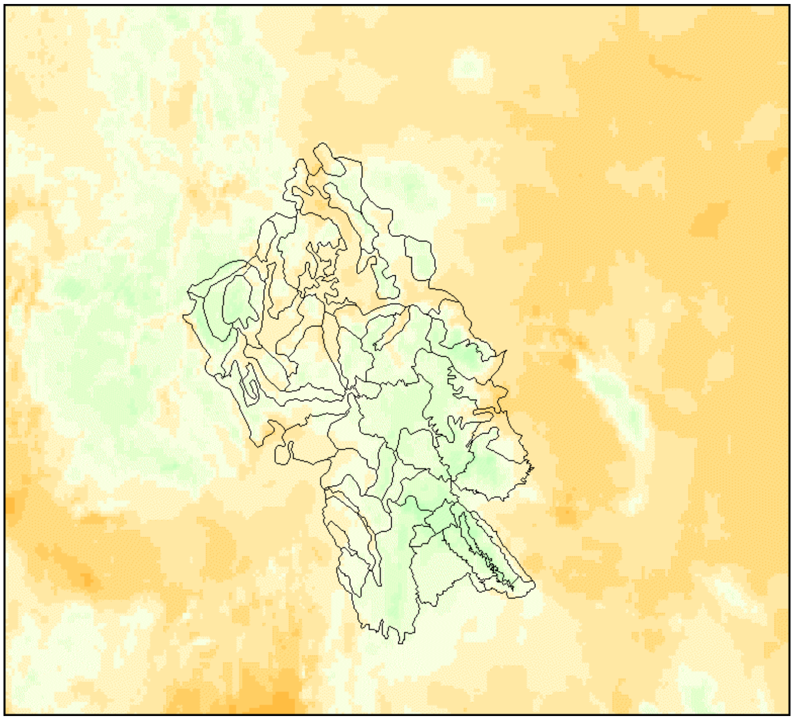
PRISM is an analytical model that uses point data and a digital elevation model (DEM) to generate gridded estimates of monthly and annual mean temperature (as well as other climatic parameters). PRISM has been described as being well suited for modeling temperature and precipitation in mountainous terrain, because it addresses the spatial scale and pattern of orographic processes.

The data generated from the PRISM is provided as monthly averages and mean minimum and maximum temperatures, and is provided for the entire U.S. as individual grids for each month. This national information was clipped to the Greater Yellowstone Area and summary information generated for Sections within the project area. For the purposes of this project five displays of temperature data within the Greater Yellowstone Area were developed from the PRISM data sets. These include a display of annual average temperatures and minimum and maximum average temperatures for July and January.

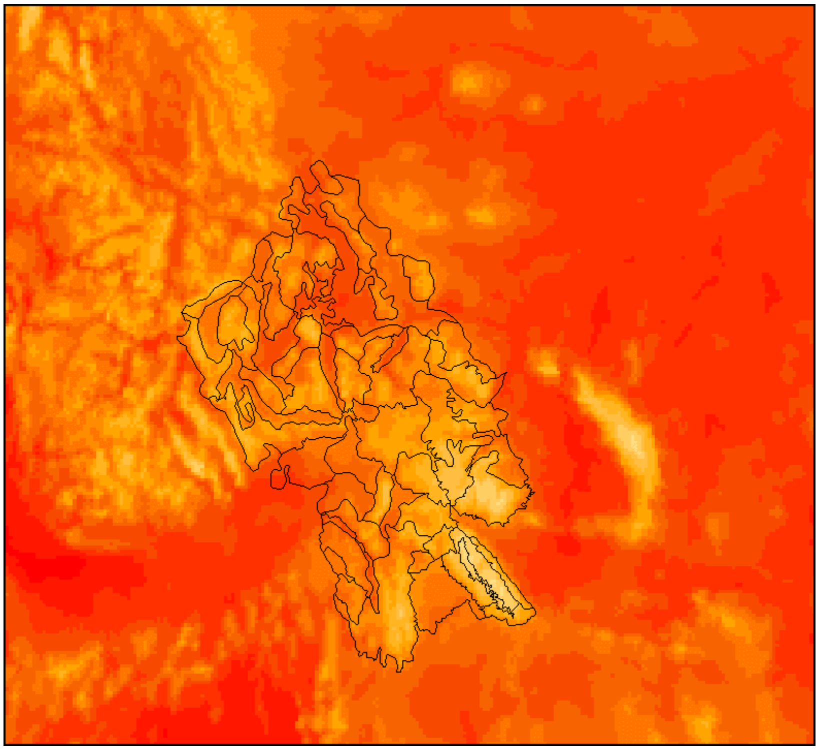
AVERAGE ANNUAL TEMPERATURES



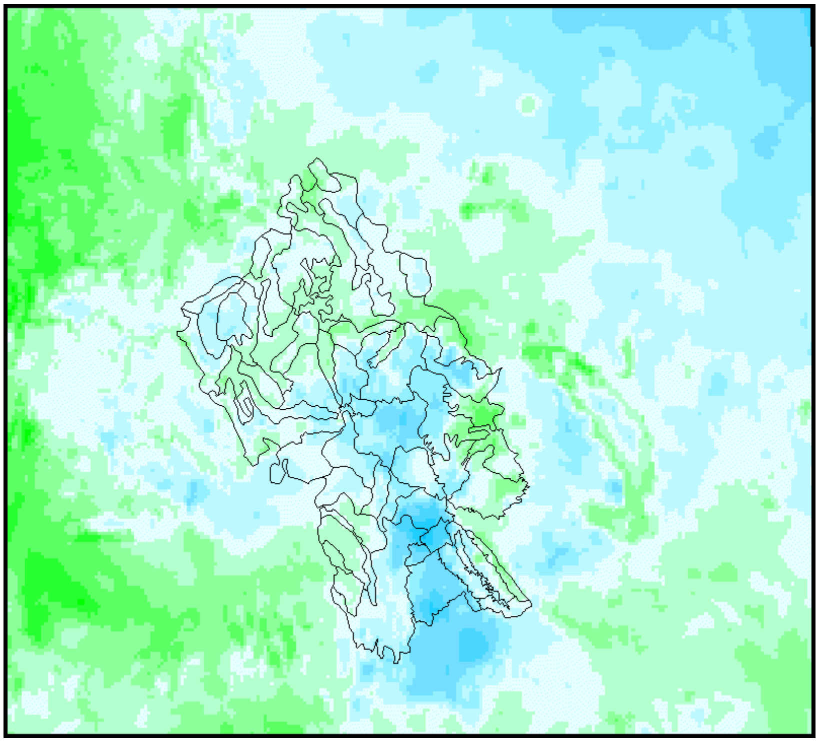
MEAN MINIMUM JULY TEMPERATURES



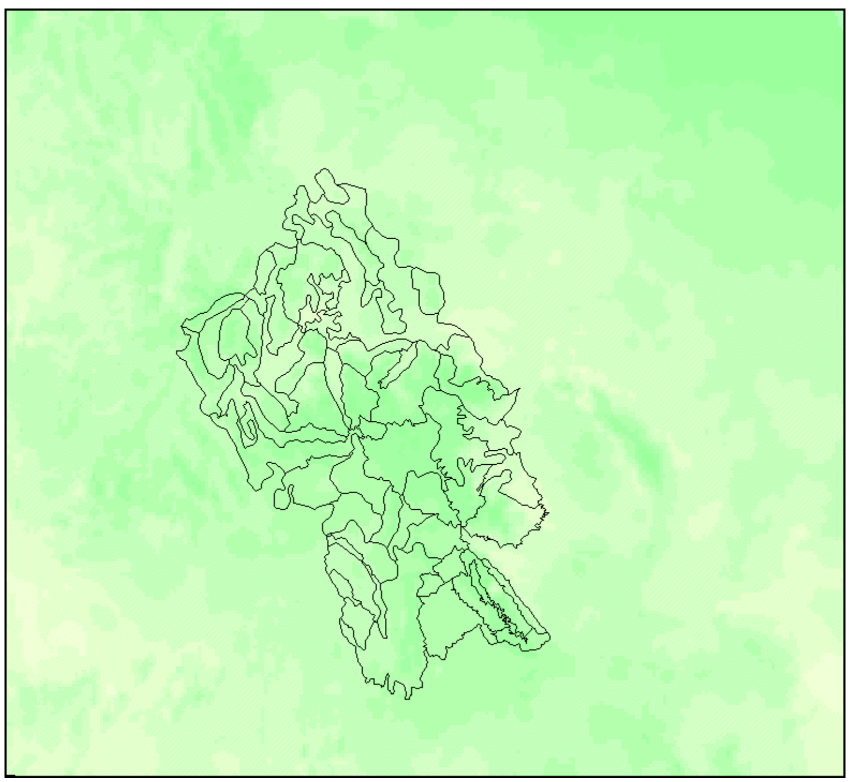
MEAN MAXIMUM JULY TEMPERATURES



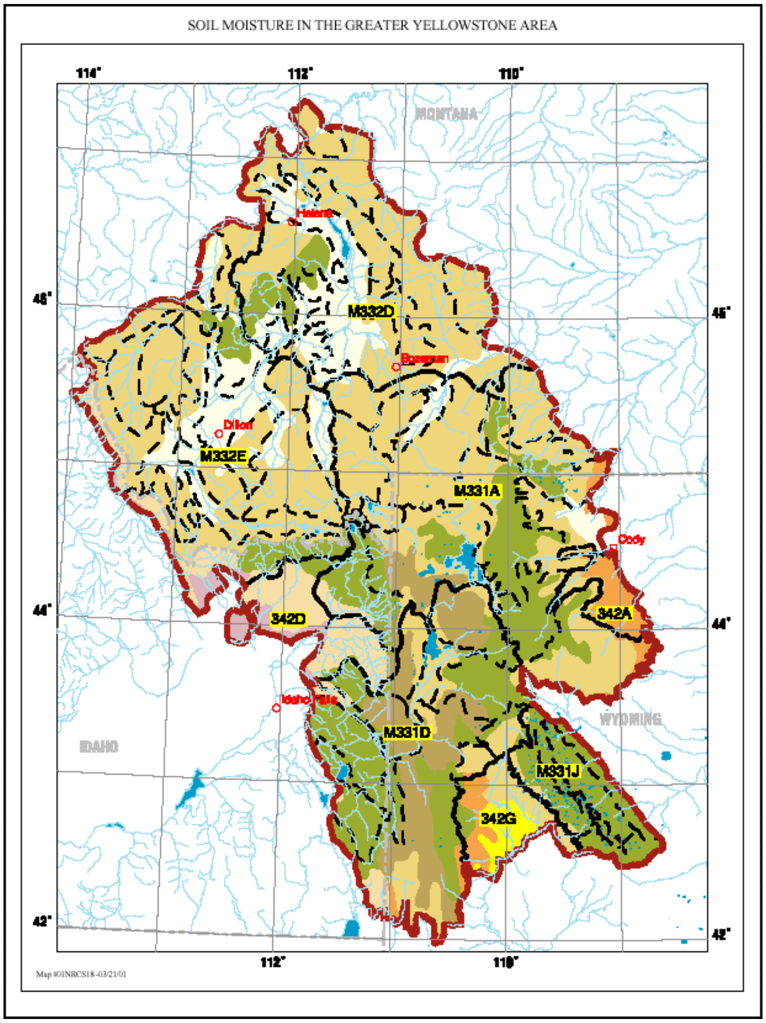
MEAN MINIMUM JANUARY TEMPERATURES



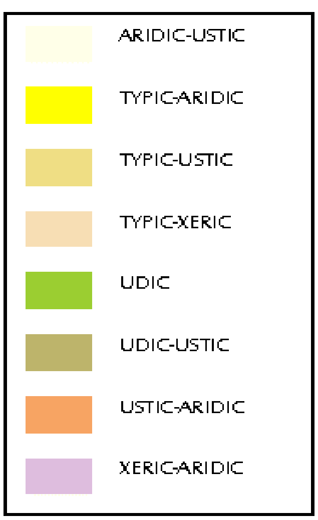
MEAN MAXIMUM JANUARY TEMPERATURES



SOIL MOISTURE AND TEMPERATURE REGIMES



SOIL MOISTURE LEGEND

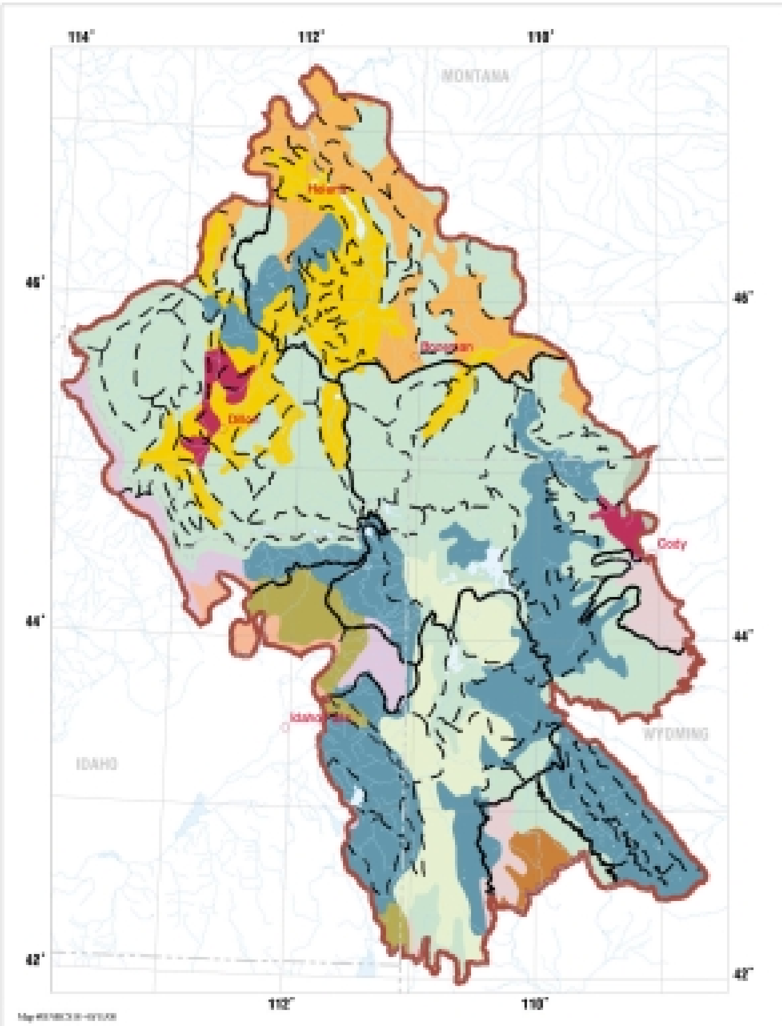


SOIL MOISTURE

Soil moisture and temperature regimes are a reflection of long-term regional climate patterns acting upon the parent material of any given site. The distribution of vegetation types is greatly influenced by these environmental parameters. The data presented here was developed for the publication, 'Soil Climate Regimes of the United States' produced by the National Soil Survey Center of the USDA Natural Resources Conservation Service. This digital theme was recoded and clipped to allow for separated display and evaluation of unique soil temperature and soil moisture categories within the project area.

- **DATA TABLES**
- **DISPLAYS AND MAPS**
- **REFERENCES**
- **SOURCES AND LINKS**

SOIL TEMPERATURE REGIMES IN THE GREATER YELLOWSTONE AREA



SOIL TEMPERATURE

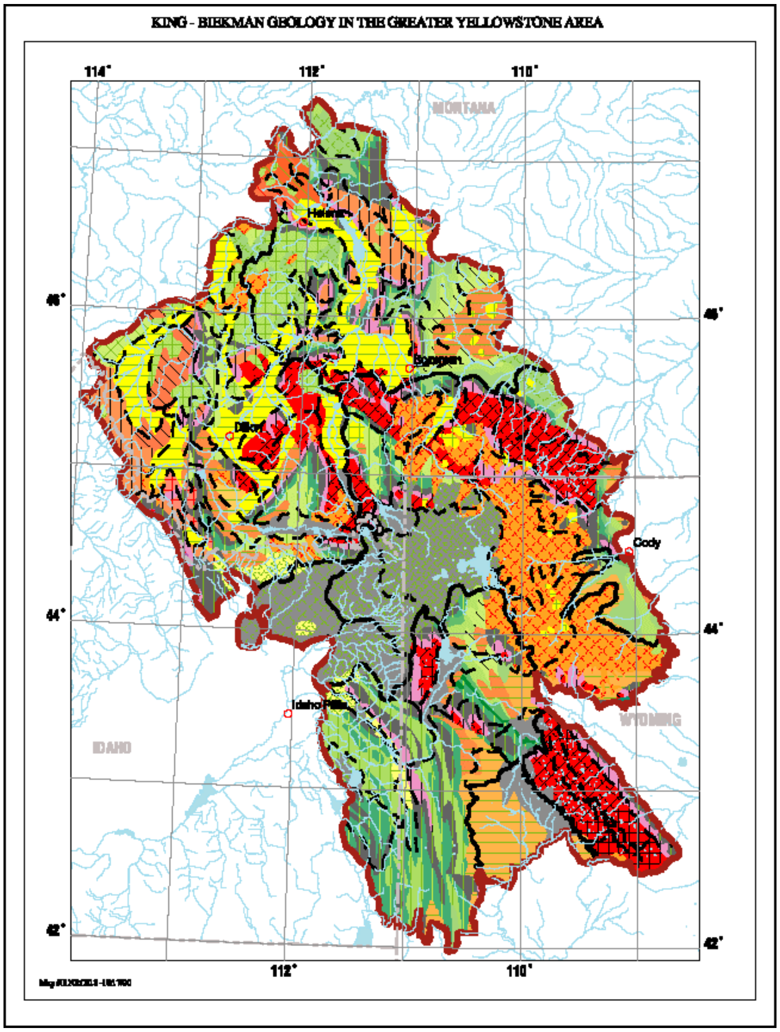
The temperature of a soil is an important property that influences soil formation, below ground ecosystem processes such as plant root growth, decomposition, the activity of soil biota, and above ground plant growth. Biological processes are largely controlled by soil moisture and temperature; below the freezing point, there is little or no biotic activity. Just as above ground temperatures fluctuate throughout the year, soils also have characteristic temperature regimes that can be measured and described.

- **DATA TABLES**
- **DISPLAYS AND MAPS**
- **REFERENCES**
- **SOURCES AND LINKS**

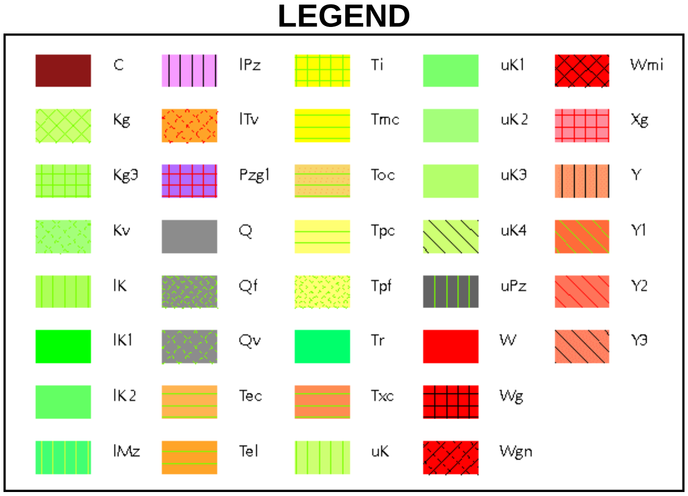
SOIL TEMPERATURE/MOISTURE LEGEND

CRYIC/ARIDIC USTIC	FRIGID/TYPIC USTIC
CRYIC/TYPIC USTIC	FRIGID/TYPIC XERIC
CRYIC/TYPIC XERIC	FRIGID/USTIC ARIDIC
CRYIC/UDIC	FRIGID/XERIC ARIDIC
CRYIC/UDIC USTIC	MESIC/TYPIC XERIC
CRYIC/XERIC ARIDIC	MESIC/USTIC ARIDIC
FRIGID/ARIDIC USTIC	MESIC/XERIC ARIDIC
FRIGID/TYPIC ARIDIC	WATER

GEOLOGY



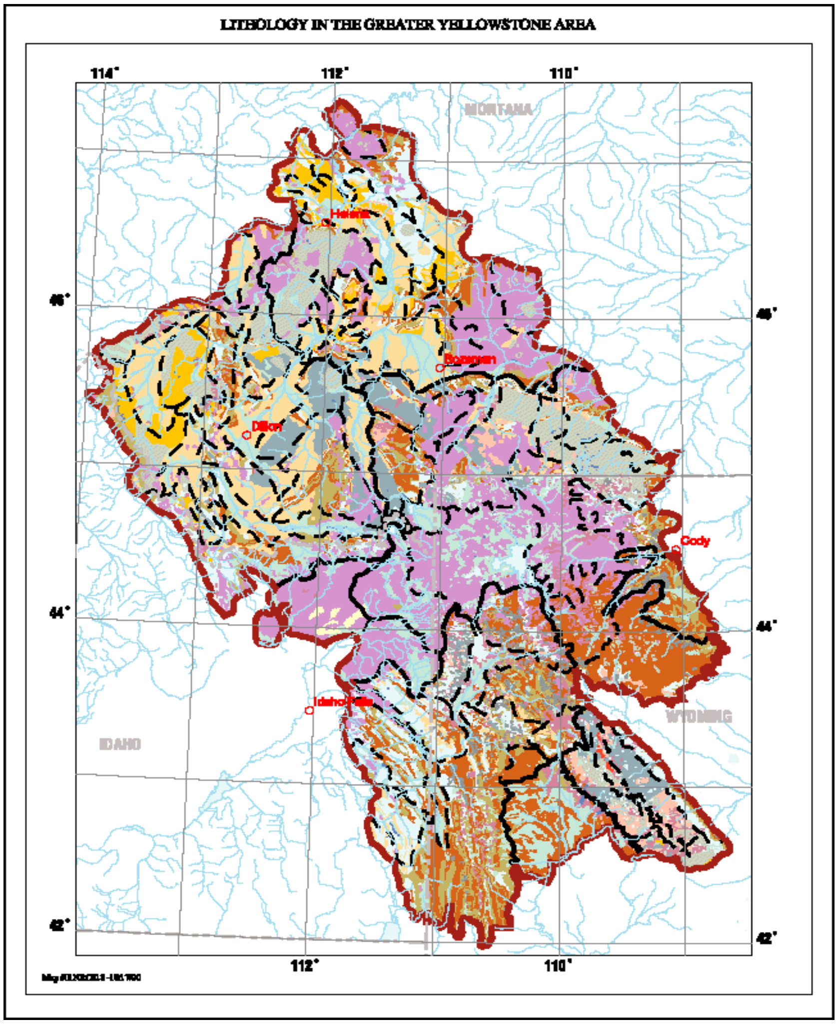
LEGEND



KING-BEIKMAN MAPPING

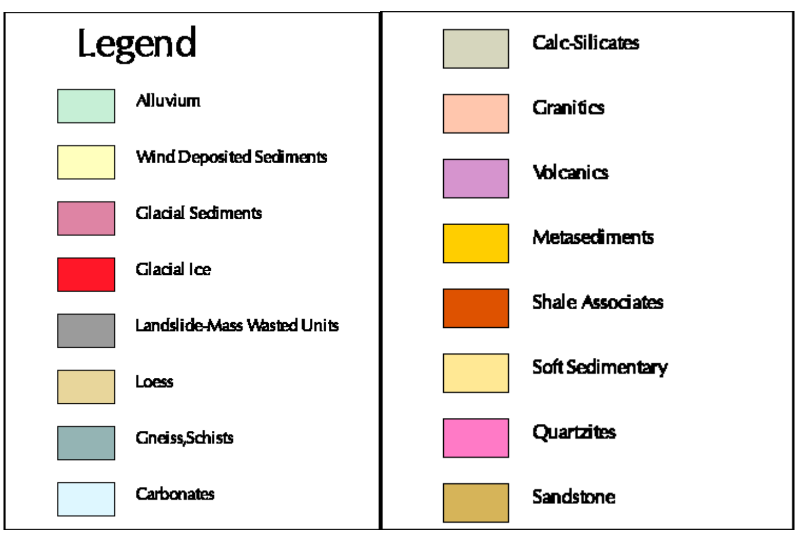
Geologic features of the GYA have been mapped and studied at various scales and levels of detail by numerous highly qualified individuals. Unfortunately few of these products are available in a consistent digital format for the entire study area. The geologic mapping represented here originated from the 'Geology of the Conterminous United States' developed by P.B. King and H.M. Beikman (U.S.Geological Survey Digital Data Series DDS-11).

- **DISPLAYS AND MAPS**
- **METADATA**
- **REFERENCES**
- **SOURCES AND LINKS**



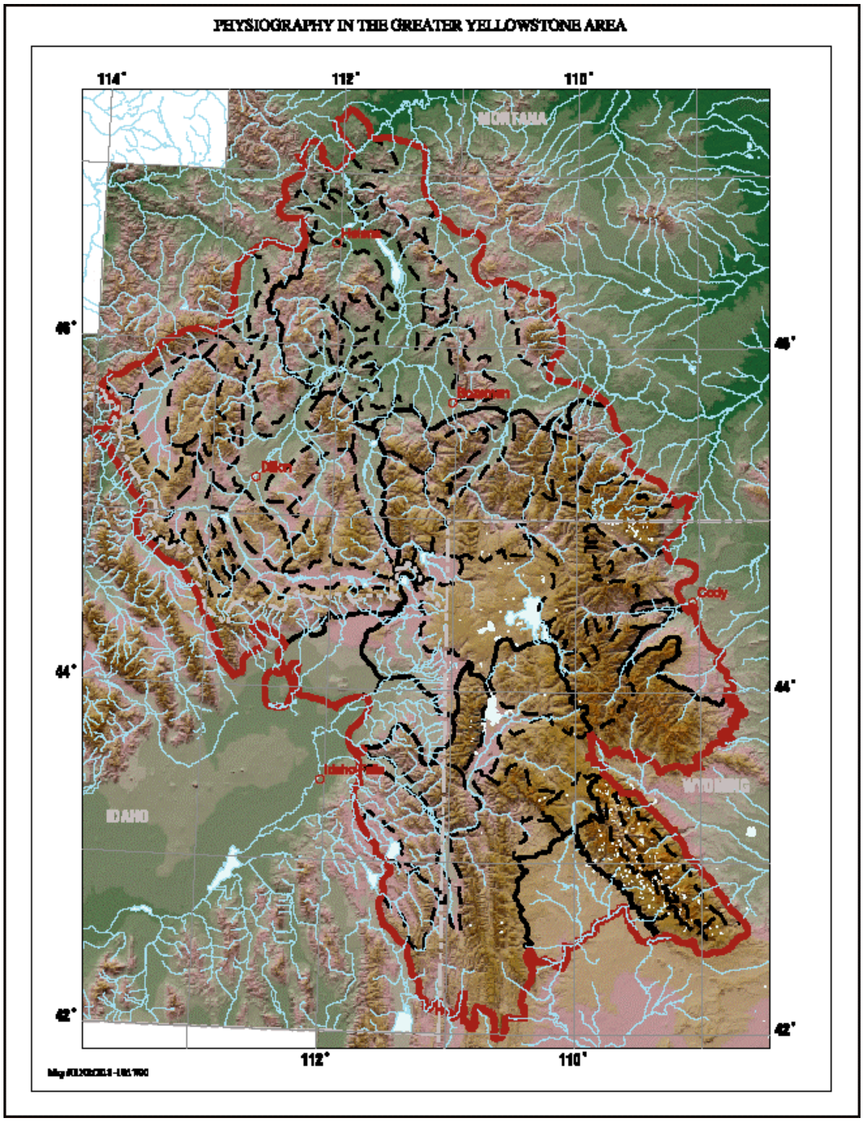
LITHOLOGY

This lithology of the Greater Yellowstone Area was compiled from existing maps at various scales and from various eras. It is based on modifications to several source maps at a variety of scales, including the 1974 USGS Geology of the Conterminous United States. The information displayed here was developed at a scale of 1: 500,000 and combined 59 lithologic units into 16 classes that were intended to correspond with those depicted in the Landtype Association mapping previously published for the Northern Region. These groupings are based on the collective judgement of the geologists involved and represent lithologies with similar erosional responses and residuum characteristics.



- **DATA TABLES**
- **DISPLAYS AND MAPS**

PHYSIOGRAPHY

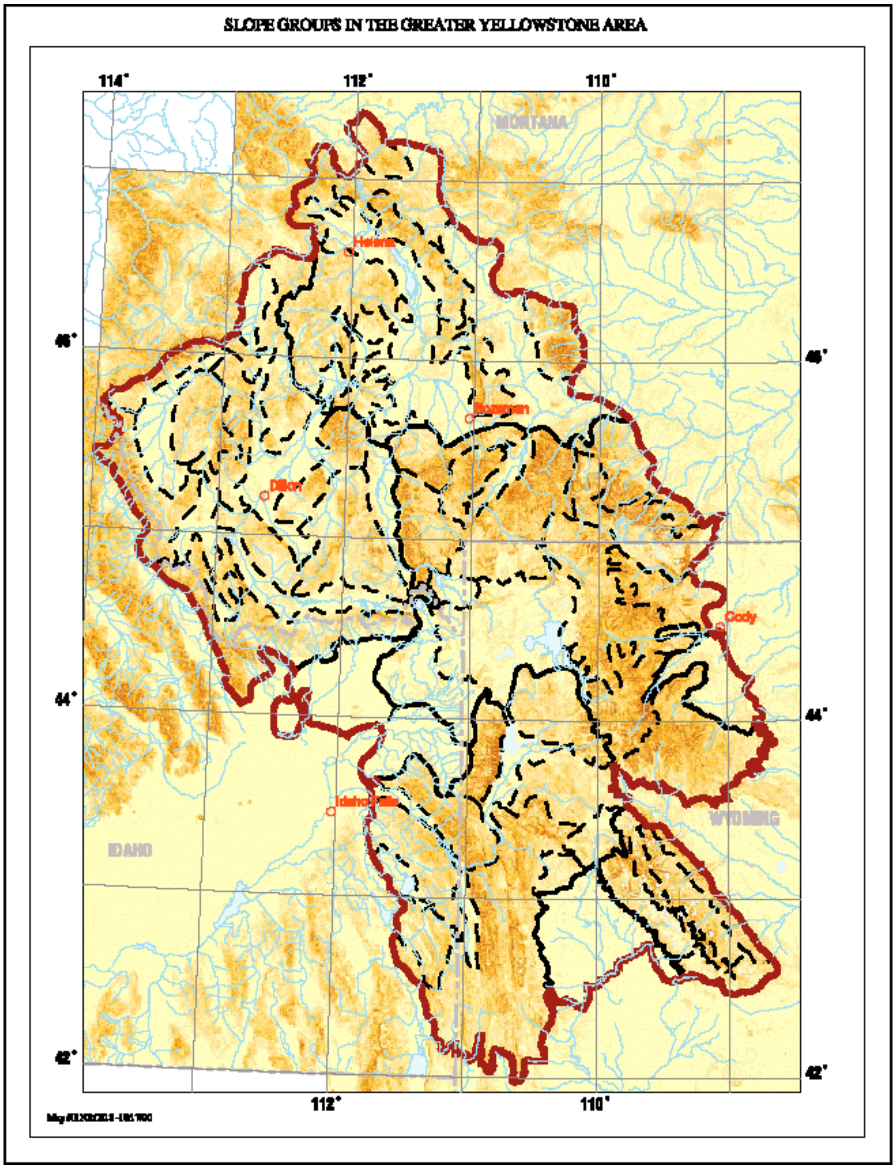


This physiographic display of the Greater Yellowstone Area was developed using 64 meter resolution Digital Elevation Models (DEMS) produced by the U.S. Geologic Survey (USGS). DEM's can be created from digital representations of contour information for each quadrangle or from scanning of National Aerial Photography Program (NAPP) photographs. From these products a grid of cells with each cell containing an x,y (geographic location) and z (elevation) value is generated. For this display the 1:250,000 scale quadrangles that make up the GYA were mosaiced together and clipped to the GYA boundary. The 30 meter resolution DEM's were used for developing the Section and Subsection level slope group mapping, the elevation and relief data, and as input into the erosion modeling. Relief for each ecological unit was measured as the difference between the maximum and minimum elevations divided by the area for the unit.

ELEVATIONS (in feet)

SECTION	MINIMUM	MAXIMUM	MEAN	RELIEF
M331A	3,960	12,988	7,967	10.4
M331D	4,996	12,529	7,780	12.8
M331J	5,797	13,618	9,694	29.6
M332D	3,399	11,177	5,406	14.2
M332E	3,799	11,397	6,893	12.6
342A	5,193	9,849	6,572	21.2
342D	4,780	8,966	5,664	12.4
342G	6,660	8,654	7,390	7.7

- DATA TABLES
- DISPLAYS AND MAPS
- METADATA
- SOURCES AND LINKS

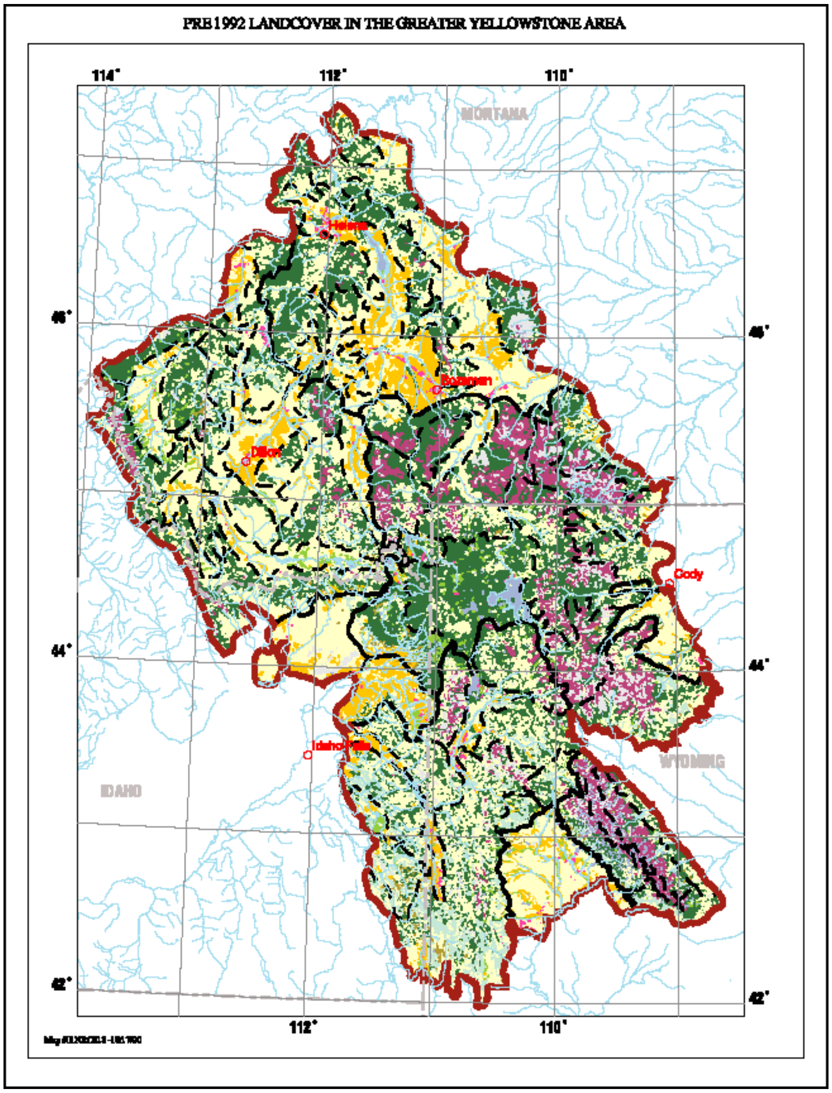


SLOPE GROUPS

Grouping the landscape into component categories based on slope steepness provides information that is useful in evaluating numerous ecological characteristics. In addition to a visual representation of landform patterns, the land slope is an important variable in predicting the potential for erosion and sediment deposition within landscape components. Slope categories and their associated aspects, elevations and climate regimes also relate to patterns of vegetation distribution and land use. The land slope information in this display was developed using the 64 meter resolution DEM's for which a grid is provided. Slope data provided for the Subsections was created from the 30 meter resolution DEM's.

SLOPE LEGEND

- **DATA TABLES**
- **DISPLAYS AND MAPS**
- **SOURCES AND LINKS**

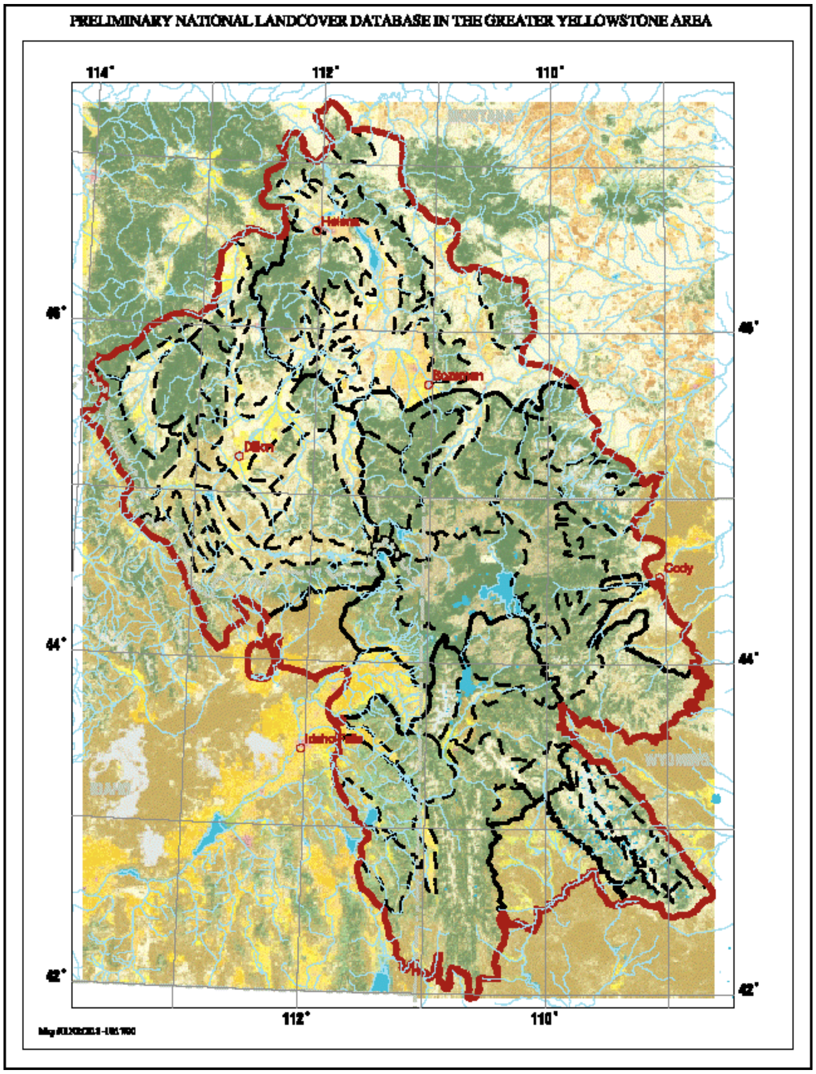


LAND COVER
1989-1992

Under Federal spatial data creation protocols, the U.S. Geological Survey is the federal agency responsible for publishing consistent land cover mapping for the nation. During the 1980's a mapping of land cover types was produced using NASA high elevation photos and 1:250,000 and 1:100,000 scale aerial photographic data as sources. One of the objectives of that effort was the development of landuse/landcover mapping that could be to provide nationwide information summaries. While this data is now being replaced by the National Land Cover Database, for major life form classes it still provides reliable and consistent information for comparative purposes.

- **DATA TABLES**
- **DISPLAYS AND MAPS**
- **METADATA**
- **REFERENCES**
- **SOURCES AND LINKS**

LANDUSE/LANDCOVER TYPE	% of GYA	ACRES IN GYA
Coniferous Forest	40.6	12,806,079
Rangeland	38.3	12,074,150
Agricultural Land	7.8	2,464,234
Alpine Areas	6.6	2,100,946
Mixed Conifer/Deciduous Forest	3.1	985,129
Wetlands	1.07	337,914
Water (not including all streams)	1.0	314,994
Exposed Rock or Barren Land	.67	213,646
Deciduous Forest	.33	127,463
Urban or Developed Areas	.26	85,018
Snow/Glaciers	.06	20,173



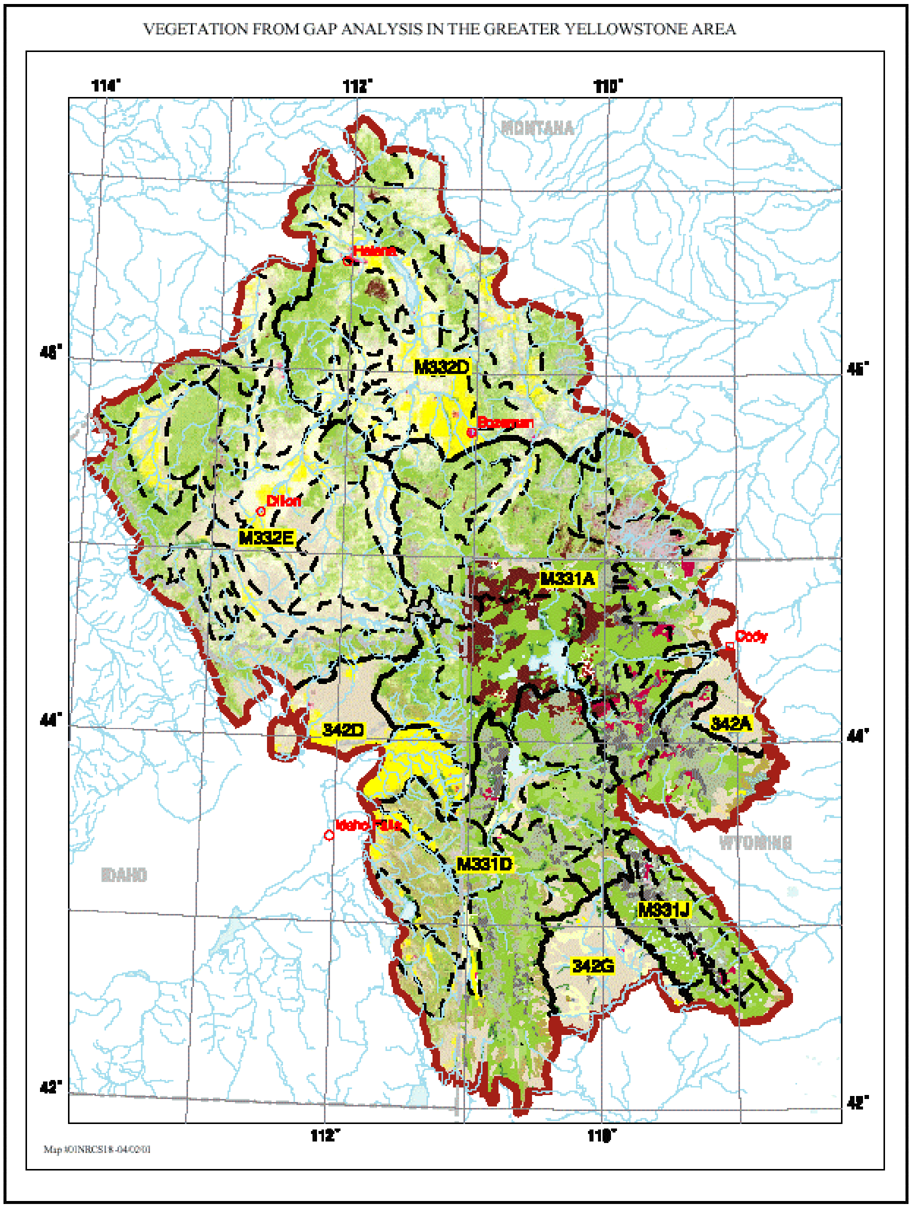
LAND COVER
1992-1996
NATIONAL LANDCOVER DATASET

U.S. Geologic Survey,
U.S. Environmental Protection Agency

This landcover data was developed from Landsat Thematic Mapper imagery taken primarily in the early to mid-1990s. Both leaves-off and leaves-on data sets were analyzed. Scientists also used a variety of supporting information in addition to the Landsat TM data, including topography, census, agricultural statistics, soil characteristics, other land cover maps, and wetlands data to determine and label the land cover types for each 30 meter pixel. Twenty-one classes of land cover are mapped, using consistent procedures for the entire U.S.

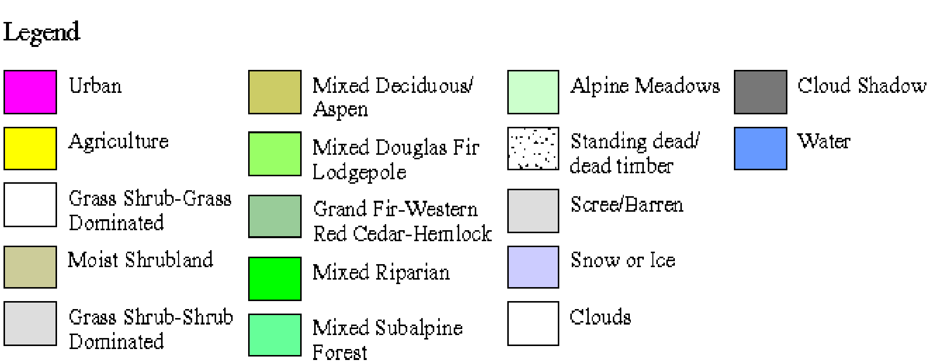
LANDCOVER TYPE	%of GYA	ACRES IN GYA
Coniferous Forest	34.05	10,735,259
Herbaceous Upland	29.02	9,149,797
Shrubland	20.72	6,531,698
Pasture/Hay	3.13	988,139
Barren/Transitional	2.98	940,471
Small Grains	2.3	724,509
Deciduous Forest	1.96	616,767
Open Water	1.2	379,298
Barren/Rock	1.08	339,264
Row Crops	.94	296,455
Woody Wetlands	.67	211,588
Herbaceous Wetlands	.61	192,522
Mixed Forest	.43	135,327
Fallow	.37	117,636
Perennial Ice/Snow	.33	104,958
Urban or Developed Areas	.17	55,231
Quarries/Mines	.03	10,982

- **DATA TABLES**
  Section-level Summaries
  Subsection-level Summaries
- **DISPLAYS AND MAPS**
- **METADATA**
- **SOURCES AND LINKS**



CLASSIFIED VEGETATION GAP PROJECT 1989-1994

The project that led to the development of this data set was initiated by the U.S. Department of Interior (USDI) and was intended to provide data for evaluating habitat available for native wildlife, fish and bird species. For each of the three states in the GYA (Idaho, Montana and Wyoming) LANDSAT TM satellite images (30 meter resolution) taken from 1989 to 1994 were used to develop vegetation classes and to characterize other vegetation attributes. The nature and complexity of the land cover class legends and other associated attributes are unique for each state. These data sets formed some of the foundation for the recently released National Land Cover Database (NLCD). Given the constraints of this project, the NLCD was used as an alternative to correlating legends for and spatially combining the original GAP data sets.



- **DISPLAYS AND MAPS**
- **METADATA**
- **REFERENCES**
- **SOURCES AND LINKS**

SATELLITE IMAGERY

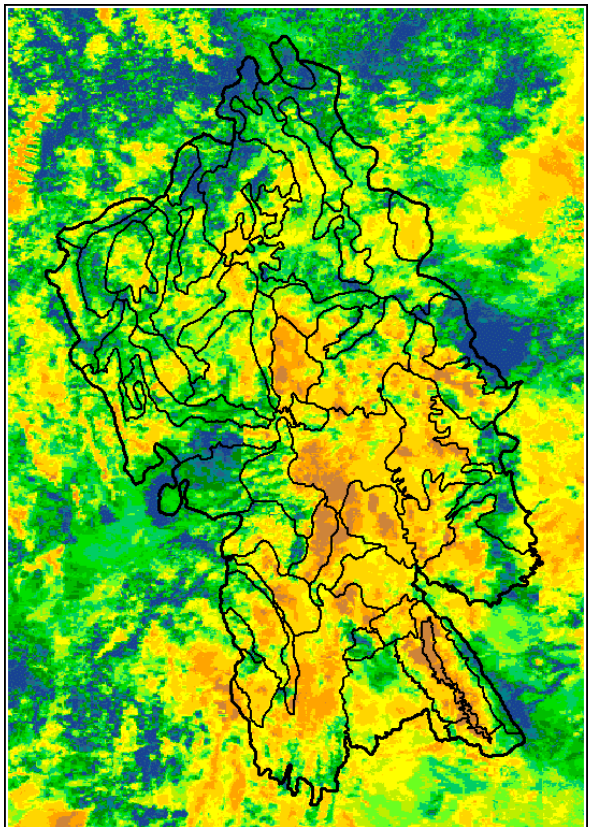
Beginning the in 1980's a variety of satellites with earth-observing sensors have been developed and launched, each intended to collect unique features from the earth's surface. As the technology has evolved, so has the capacity of these sensors to record, with higher levels of spectral, spatial, and temporal resolution, information that can be used to map and evaluate features such as geologic types, soils, and vegetation. While the availability of satellite imagery is more wide-spread than ever before, the incorporation of this information into the mapping and characterization of Ecological Units is extremely limited. It is likely that future projects such as this one will provide fully integrated use of satellite and other remotely sensed data sets.

Normalized Differential Vegetation Index

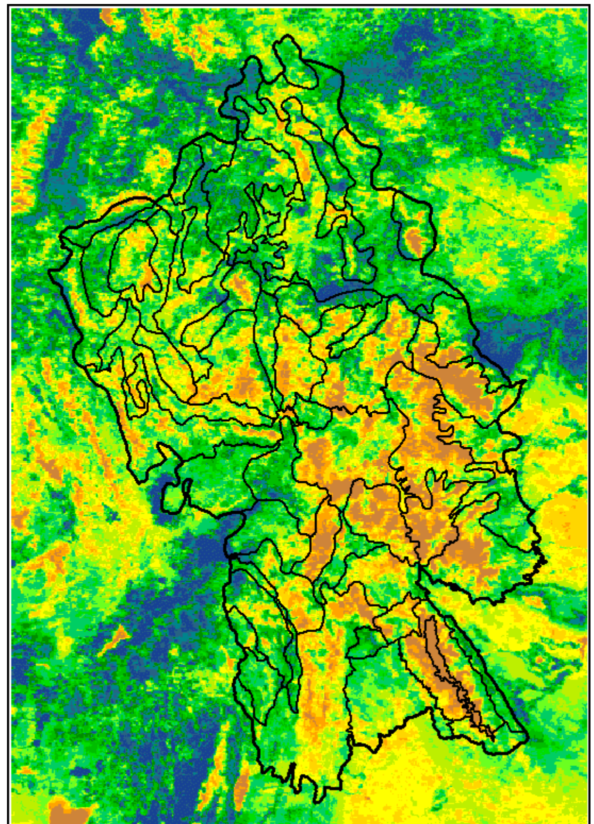
The 16 Normalized Differential Vegetation Index (NDVI) images presented here for the 2000 growing season were generated by the EROS Data Center from the 1-Km resolution Advanced Very High Resolution Radiometer (AVHRR) sensor that is onboard several polar orbiting spacecraft (Kidwell, 1991). From the AVHRR data, remote sensing scientists have developed a Normalized Difference Vegetation Index (NDVI) (Goward, et. al. 1991; Spanner, et. al. 1990; Tucker 1977; Tucker and Sellers 1986). This index is derived from a combined analysis of the visible and near infrared wavelengths from the AVHRR data, and is sensitive to the quantity of vegetation biomass that is actively photosynthesizing. Therefore it is used to provide an indication of the 'greeness' of vegetation in any given location. The NDVI data has also been used to represent vegetation patterns across the United States and elsewhere in the world (Loveland, et. al. 1991). The NDVI data is made available for the conterminous United States as weekly composites. For this project, these weekly composites were acquired from the internet web site supported by the Upper Midwest Aerospace Consortium (UMAC). Nationwide images were re-selected for portions of the three states surrounding the Greater Yellowstone study area.

- **MAPS**
- **SOURCES**
- **REFERENCES**

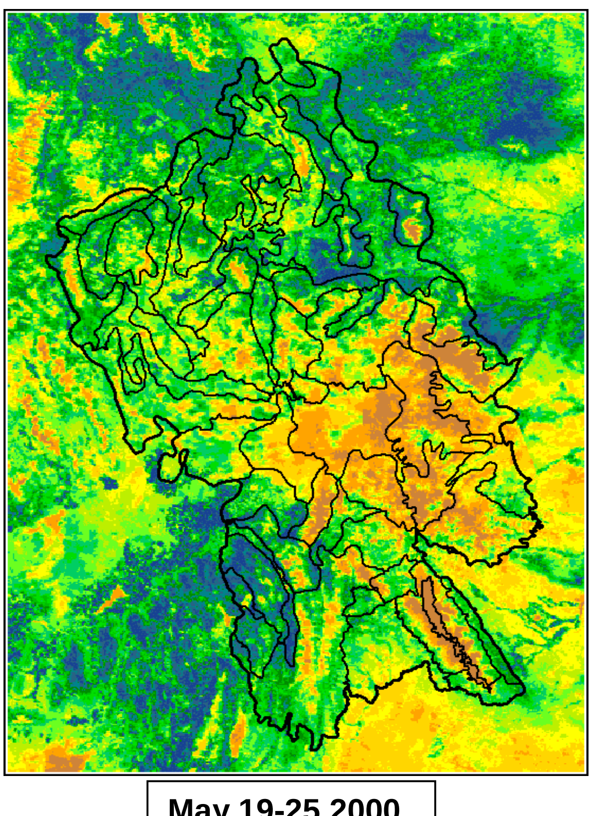
WEEKLY NDVI COMPOSITES 2000



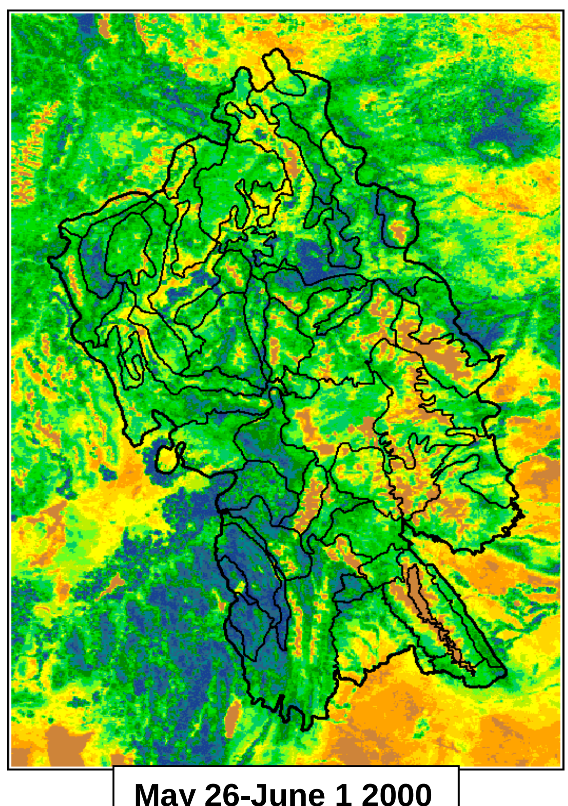
May 5 -11 2000



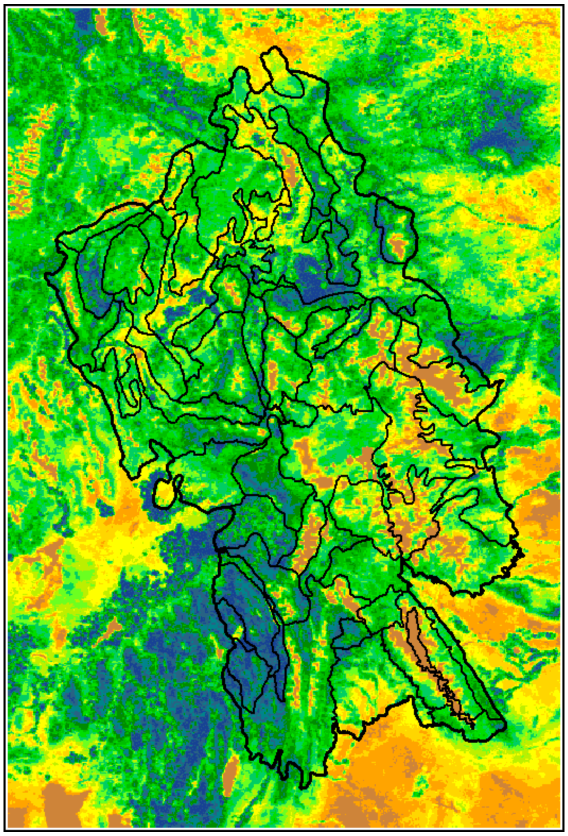
May 12-18 2000



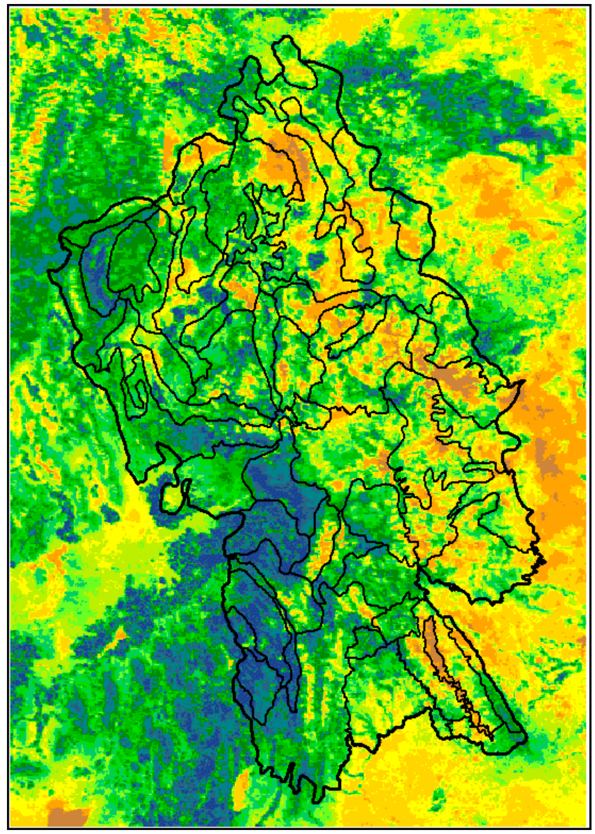
May 19-25 2000



May 26-June 1 2000



June 2 - 8 2000



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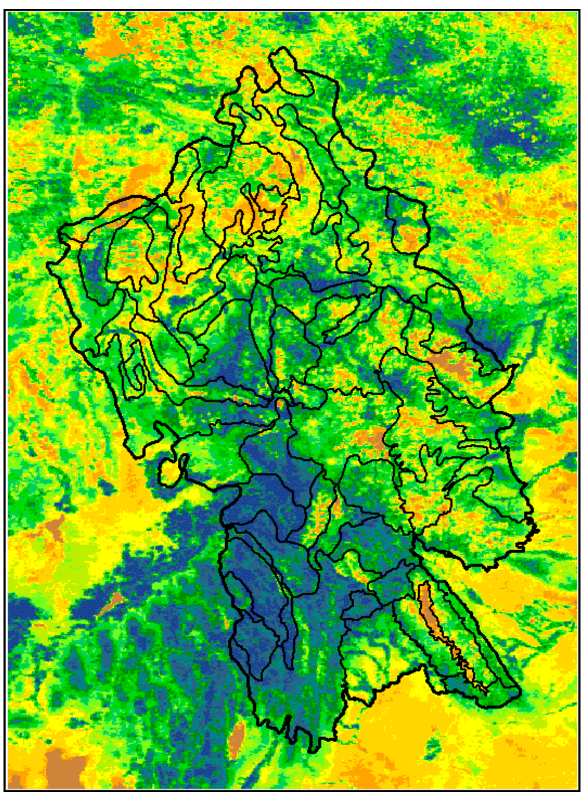
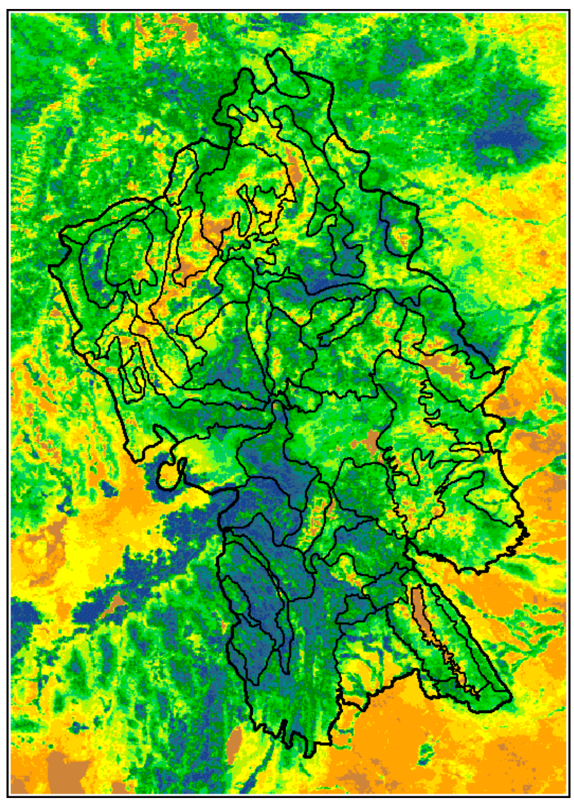
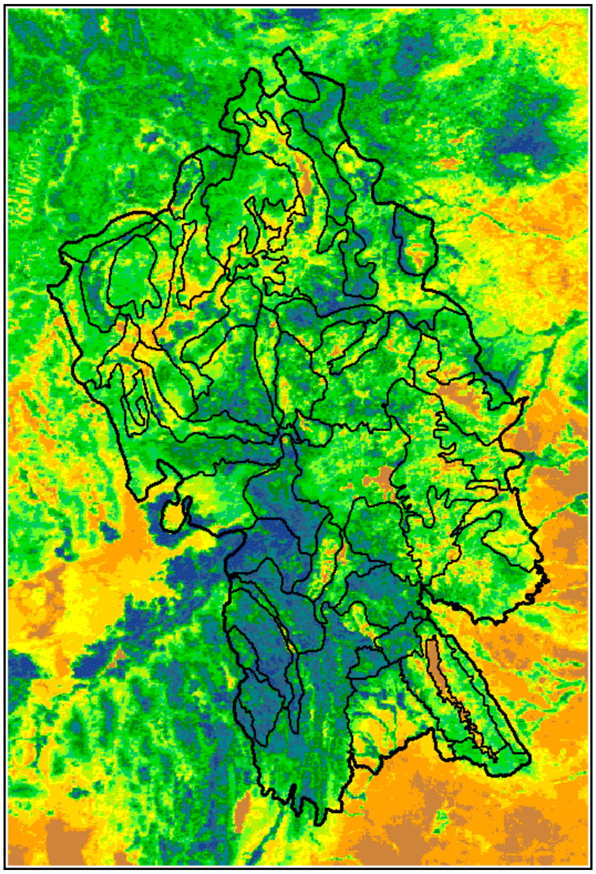


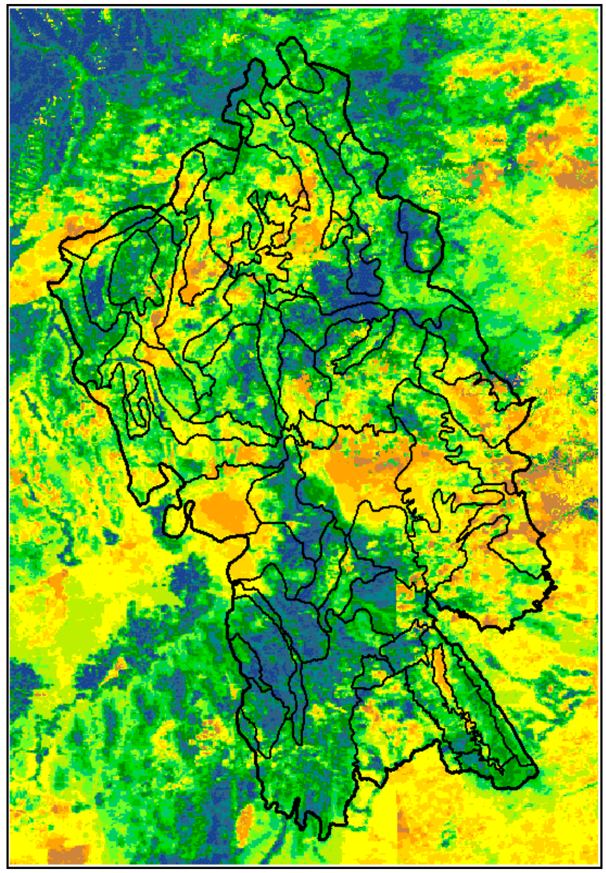
June 23 - 29



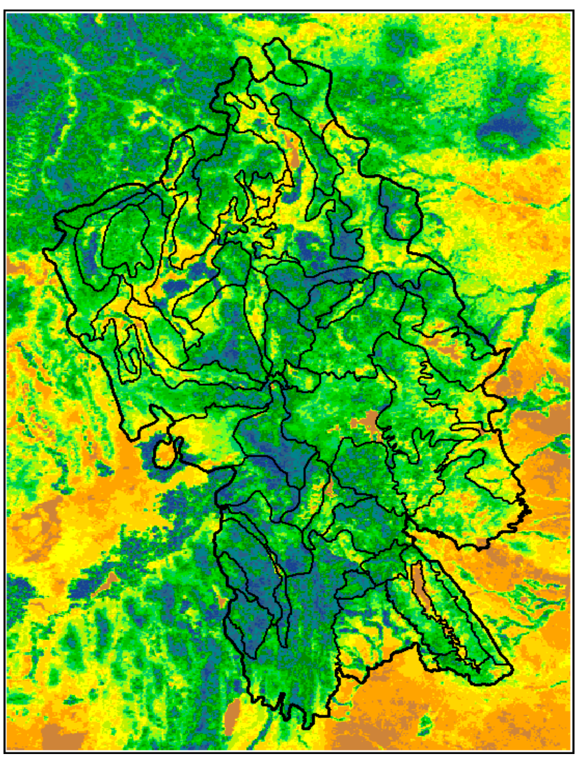
June 30 - July 6 2000



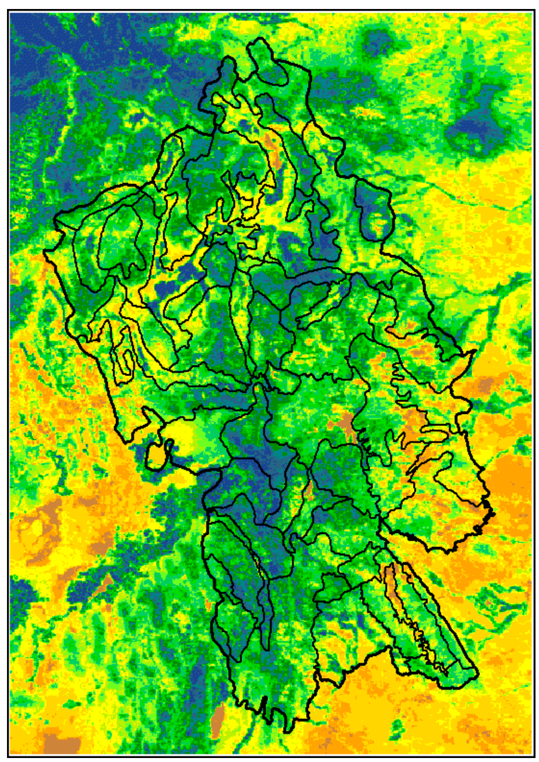
July 7 - 13 2000



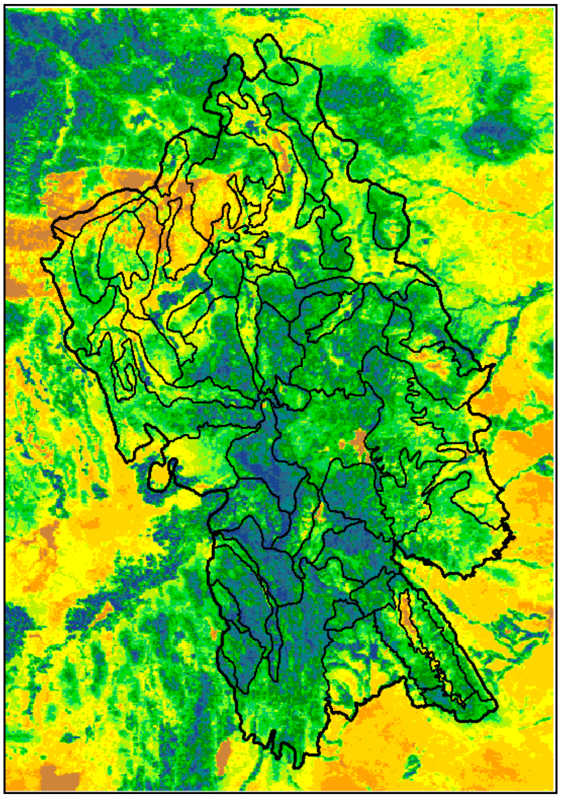
July 14 - 21 2000



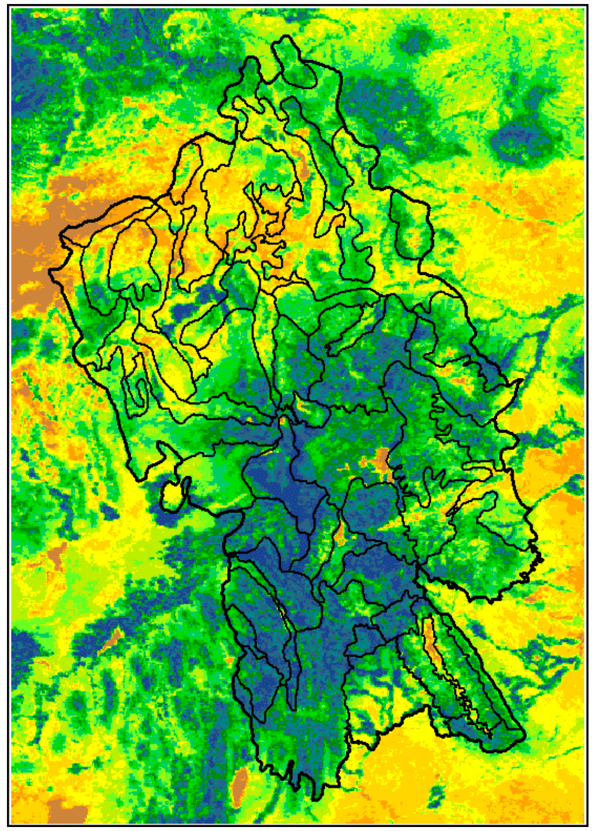
July 22 - 29



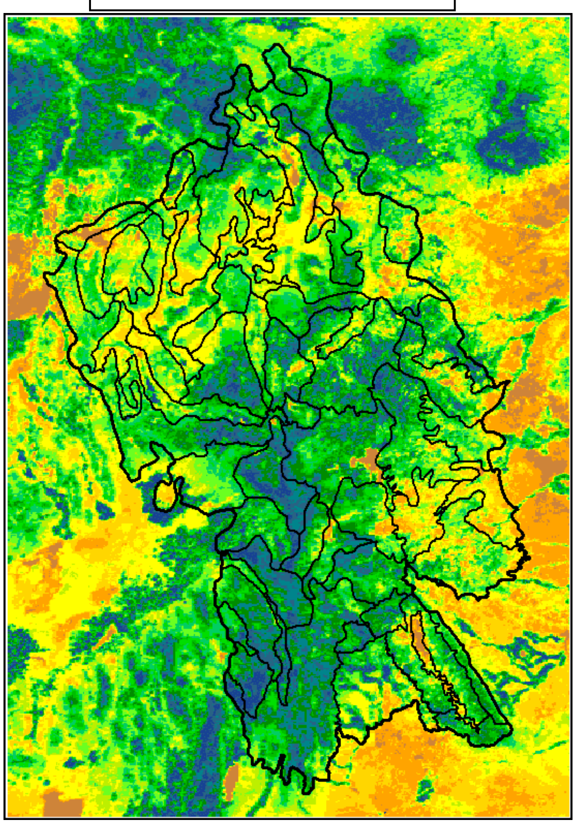
July 30 - August 5



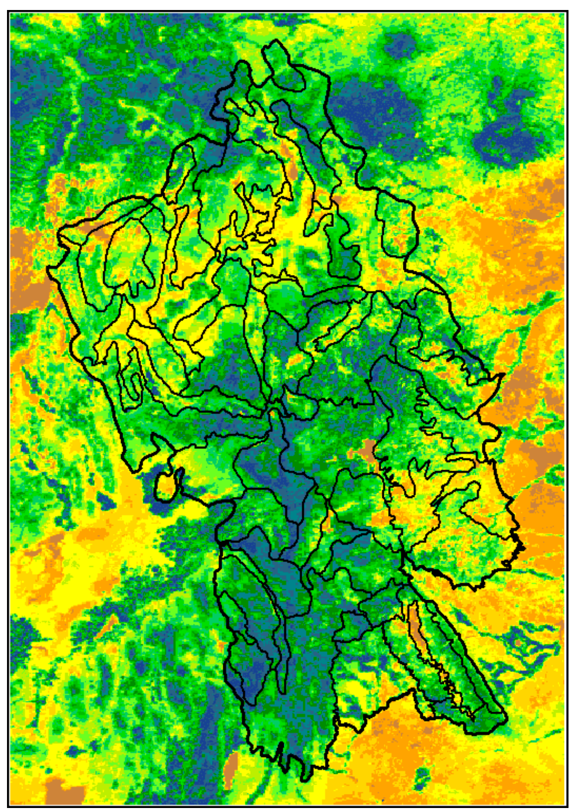
August 4 - 10 2000



August 11 - 17 2000



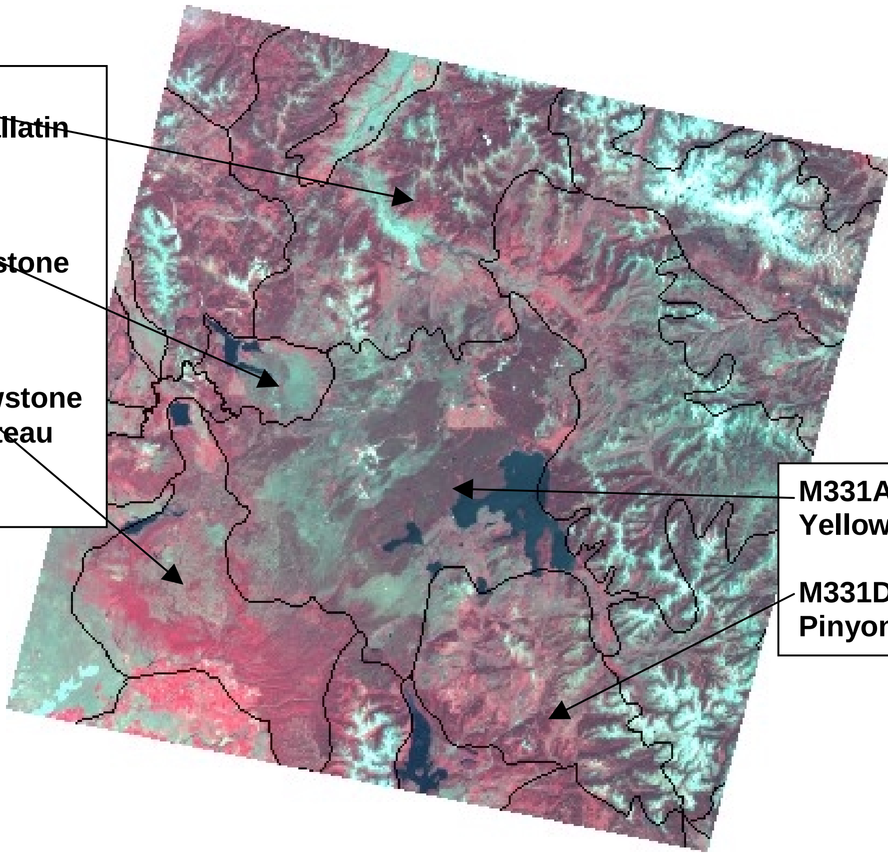
August 18 - 26 2000



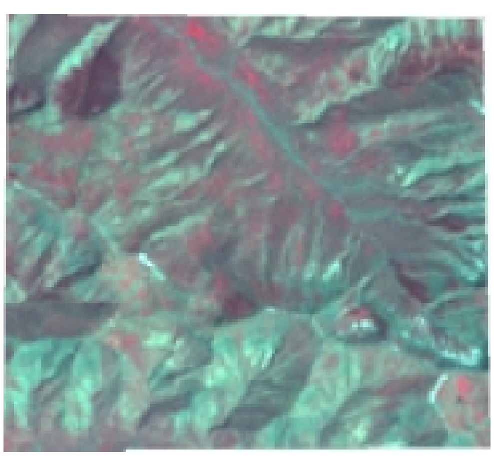
August 27 - September 2 2000

LANDSAT 7 SATELLITE IMAGERY

For over 25 years the Landsat Program has provided calibrated, high spatial resolution data of the Earth's surface, and represents the longest record of the Earth's continental surfaces as seen from space. Each Landsat 7 scene covers approximately 185 X 180 kilometers. Show below is a Landsat 7 scene from July 15, 2000 covering portions of the Greater Yellowstone Ecological Assessment project area.

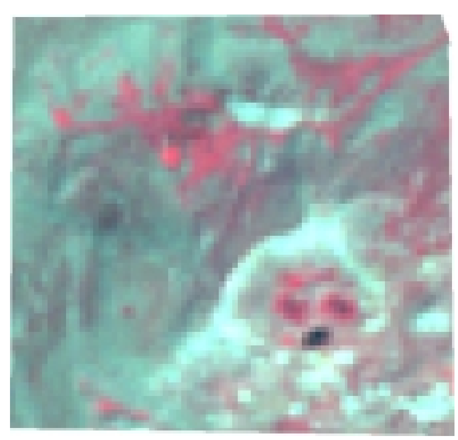


Data from the eight bands of Landsat-7 can be used to classify materials on the Earth's surface by evaluating variations in the amounts of emitted and reflected radiation and developing spectral signatures for groups of objects (such as vegetation types).



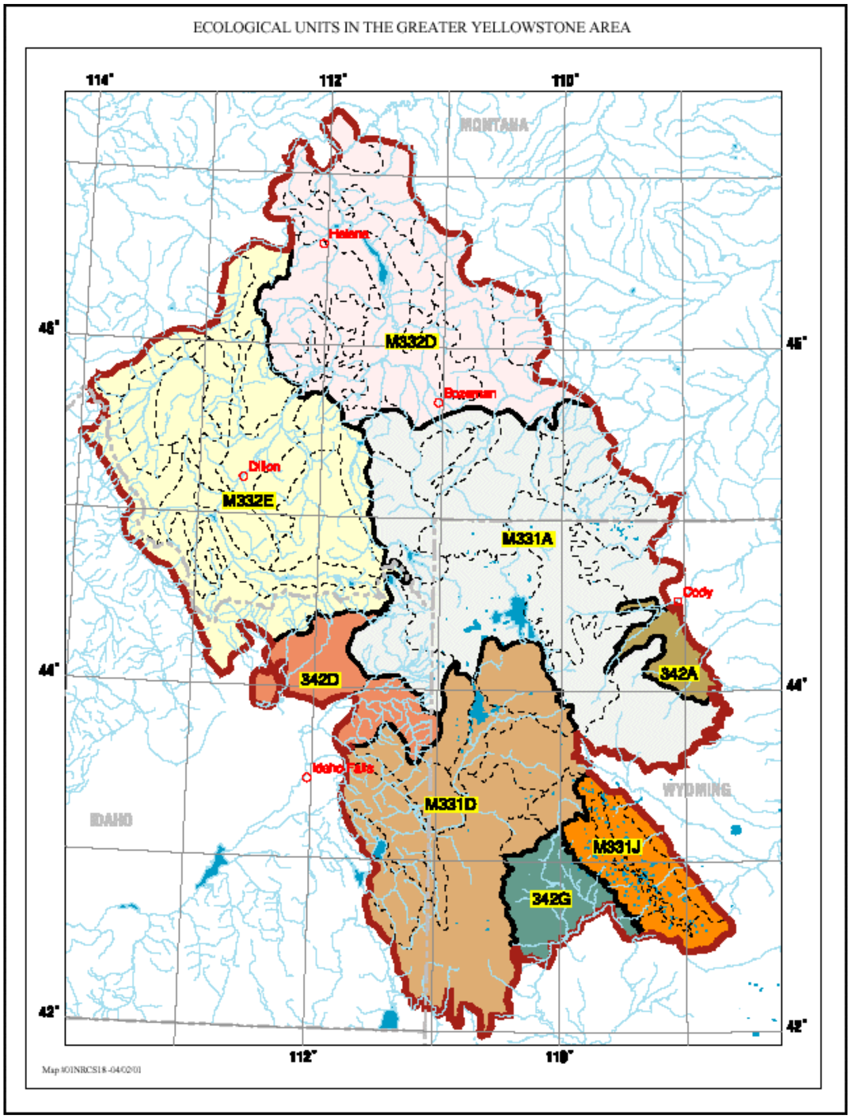
The Landsat-7 system collects seven bands of reflected energy and one band of emitted energy.

SOURCES AND LINKS



The 30 meter spatial resolution of Landsat-7 data provides a high level of detail for mapping and classifying landscape attributes.

CHARACTERISTICS OF THE GREATER YELLOWSTONE AREA



SECTIONS

At the Section level of ecological unit mapping, four major components

1) **The Yellowstone Highlands-Section M331A**
2) **The Beaverhead Mountains-Section M332E**
3) **The Overthrust Mountains-Section M331D and,**
4) **The Belt Mountains-Section M332D**

occupy 87% of the area. The Wind River Mountains-Section M331J, the Big Horn Basin-Section 342A, the Snake River Basalts-Section 342D and the Green River Basin-Section 342G influence the remainder of the area. At the Subsection level there are 54 unique map units in the study area.

- **DISPLAYS AND MAPS**
- **METADATA**
- **REFERENCES**
- **SOURCES AND LINKS**

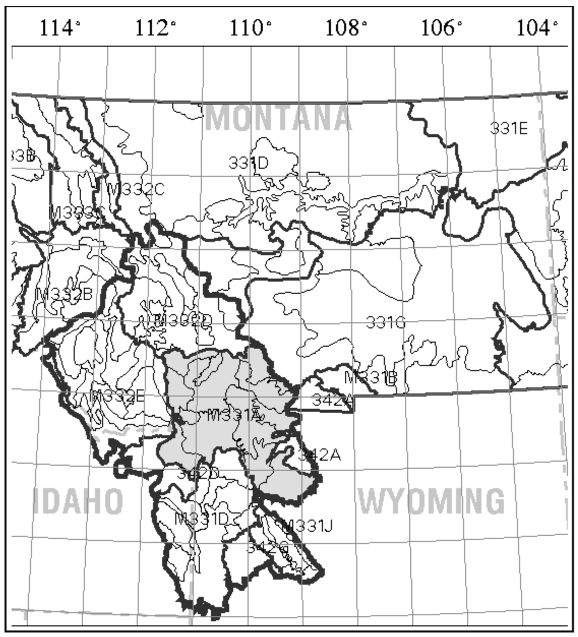
Ecological Units of the Greater Yellowstone Area

SECTION	NAME	AREA IN ACRES	% of GYA
342A	Big Horn Basin	509,514	1.62%
342D	Snake River Basalts	1,270,758	4.03%
342G	Green River Basin	972,065	3.08%
M331A	Yellowstone Highlands	8,423,315	26.72%
M331D	Overthrust Mountains	5,733,904	18.19%
M331J	Wind River Mountains	1,421,453	4.51%
M332D	Belt Mountains	5,898,882	18.71%
M332E	Beaverhead Mountains	7,300,018	23.15%
Total Area in GYA		31,529,913	

THE YELLOWSTONE HIGHLANDS

SECTION M331A

The Yellowstone Highlands Section encompasses the Yellowstone plateau, the Absaroka, Madison, and Beartooth mountain ranges, and is the central core of the GYA. This portion of the GYA landscape is predominantly steep, (over 30% slopes) glaciated mountains and high altitude plateaus underlain by Tertiary volcanic, Paleozoic sedimentary, and Precambrian metamorphic rocks. Elevations range from 4,000 to 13,000 feet with much of the landscape over 9,000 feet. Landcover is primarily coniferous forest interspersed with grass/shrub communities and alpine meadows. World-renowned geothermal features occur in Yellowstone National Park, which is found in the central part of this Section.



SUBSECTION	NAME	ACRES IN GYA
M331Aa	Absaroka / Gallatin Mountains	1,217,582
M331Ab	South Yellowstone Volcanic Plateau	620,810
M331Ac	Thorofare Plateau	517,654
M331Ad	Absaroka Range	973,237
M331Af	Yellowstone Volcanic Plateau	1,237,120
M331Ag	Northern Absaroka Volcanic Mountains	1,041,914
M331Ah	Beartooth Mountains	693,979
M331Ai	Absaroka Sedimentary Mountains	418,802
M331Ak	West Yellowstone Valley	132,483
M331Al	Upper Yellowstone Valley	178,627
M331Am	Gallatin Foothills / Spanish Peaks	392,923
M331Ap	Madison Mountains	473,661
M331Ar	Beartooth Front	524,482
	TOTAL ACRES IN GYA	8,423,274

MAPS

- **CLIMATE**

Precipitation
Soil Moisture
Soil Temperature

- **GEOLOGY**

Lithology

- **PHYSIOGRAPHY**

Elevation and Relief
Slope groups

- **LANDCOVER**

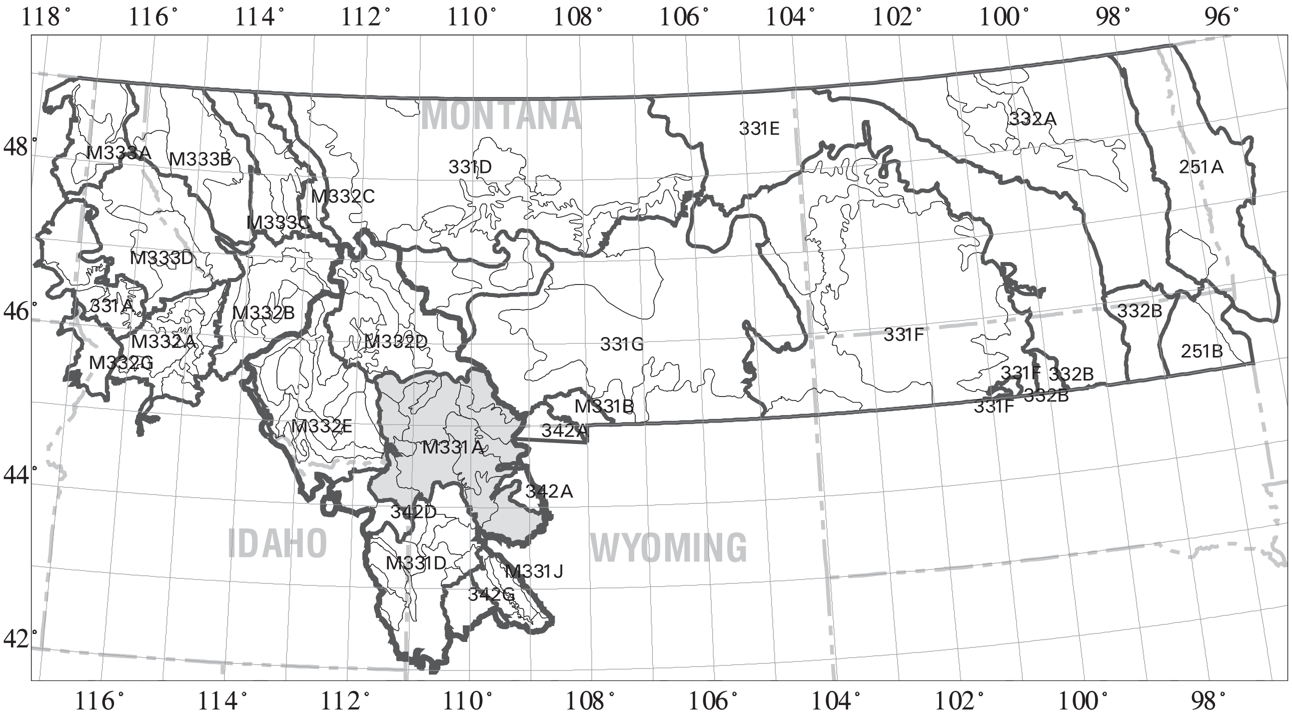
Pre-1990
NLCD

- **SUBSECTIONS**

DATA TABLES

Yellowstone Highlands

Section M331 A

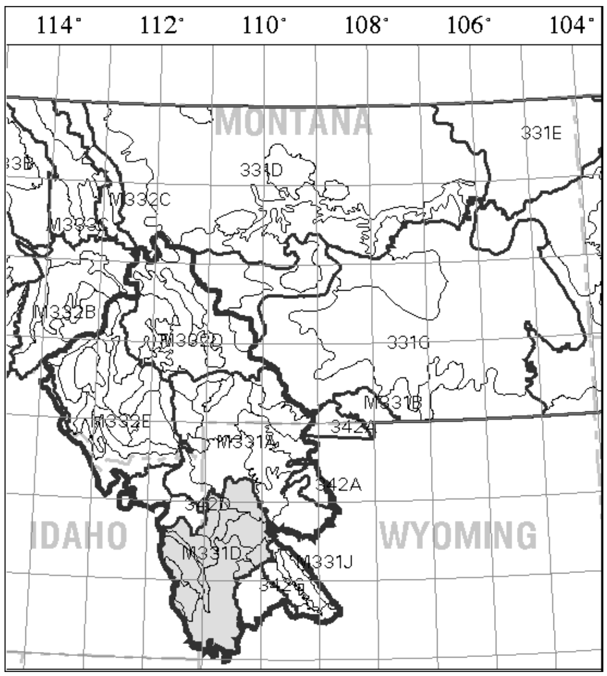


Subsections of Section M331 A

THE OVERTHRUST MOUNTAINS

SECTION M331D

Long, steep mountain chains that were glaciated at the higher elevations and broad to narrow linear valleys underlain by predominantly Paleozoic and Mesozoic sedimentary rocks characterize this portion of the GYA. This Section includes the Teton, Salt River, Gros Ventre, Wyoming and Caribou mountain ranges, along with the Jackson Hole valley. Elevations range from 5,000 to 12,500 feet . Over 20 percent of the land area has slopes in excess of 30 percent. Land cover is primarily forest with grass/shrub and agricultural lands in the valleys. Grand Teton National Park is within this Section.



SUBSECTION	NAME	ACRES
M331Da	Pinyon Peak Highlands	560,300
M331Db	Teton Range	294,909
M331Dc	Jackson Hole	269,164
M331Dd	Gros Ventre Range	533,678
M331Df	Wyoming / Salt River / Tunp Ranges	2,079,571
M331Dg	Hoback Basin	127,516
M331Dh	Union Pass Uplands	205,514
M331Di	Caribou Range	546,147
M331Dj	Star Valley	224,187
M331Dk	Big Hole / Snake River Ranges	472,082
M331Dm	Grays Lake Bottomlands	129,766
M331Dp	Webster Ridges and Valleys	291,077
TOTAL ACRES IN GYA		5,733,911

MAPS

- **CLIMATE**

Precipitation
Soil Moisture
Soil Temperature

- **GEOLOGY**

Lithology

- **PHYSIOGRAPHY**

Elevation and Relief
Slope groups

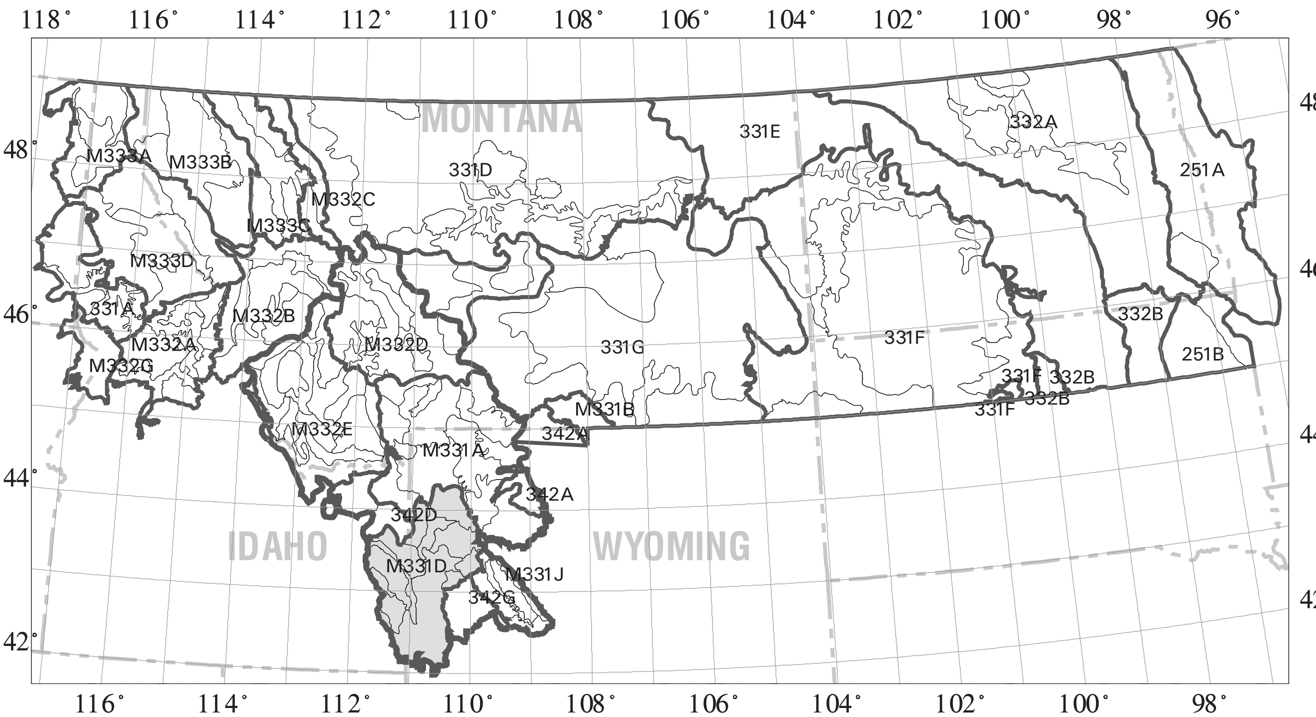
- **LANDCOVER**

Pre-1990
NLCD

- **SUBSECTIONS**
- **DATA TABLES**

Overthrust Mountains

Section M331D

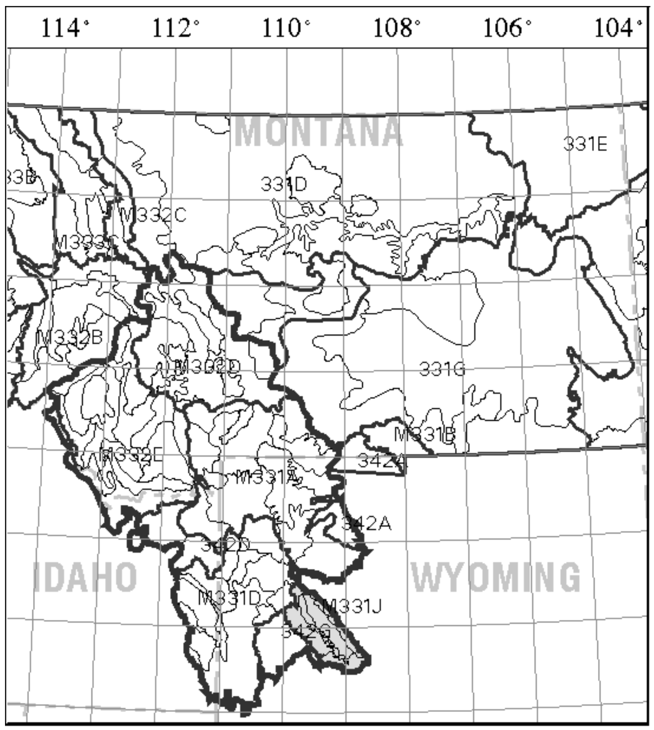


Subsections of Section M331D

THE WIND RIVER MOUNTAINS

SECTION M331J

This Section includes the heavily glaciated, linear Wind River mountain range which is underlain by Precambrian igneous and metamorphic rocks. Quaternary glacial deposits also occur in the valleys. Elevations range from 5,800 to 13,600 feet. More than 25 percent of the land is in excess of 30 percent slopes. Land cover is primarily coniferous forest and alpine meadows with limited areas of grassland. Numerous perennial lakes and streams occur in this Section.



SUBSECTION	NAME	ACRES IN GYA
M331Ja	Wind River Alpine Crest	171,607
M331Jb	Wind River Glaciated Mountains	806,942
M331Jc	Southeastern Wind River Mountains	219,697
M331Jd	Wind River Sedimentary Mountains	223,200
	TOTAL ACRES IN GYA	1,421,446

MAPS

- **CLIMATE**

Precipitation
Soil Moisture
Soil Temperature

- **GEOLOGY**

Lithology

- **PHYSIOGRAPHY**

Elevation and Relief
Slope groups

- **LANDCOVER**

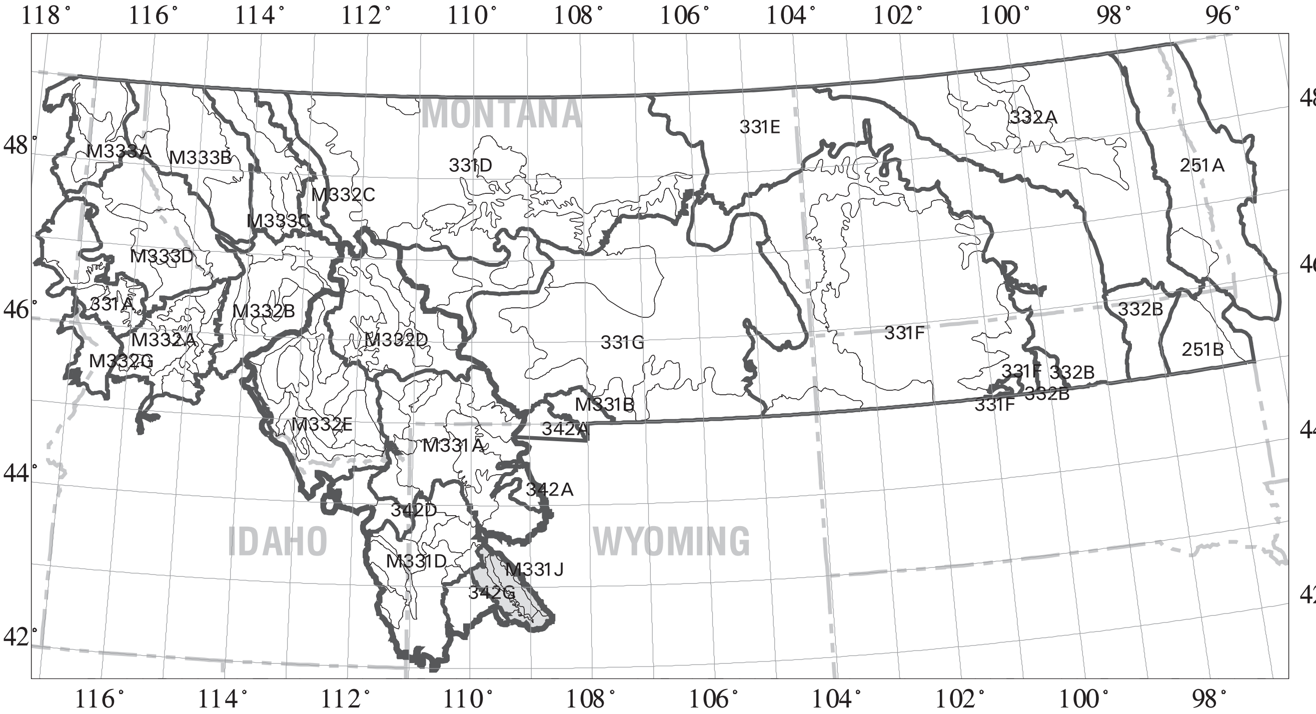
Pre-1990
NLCD

- **SUBSECTIONS**

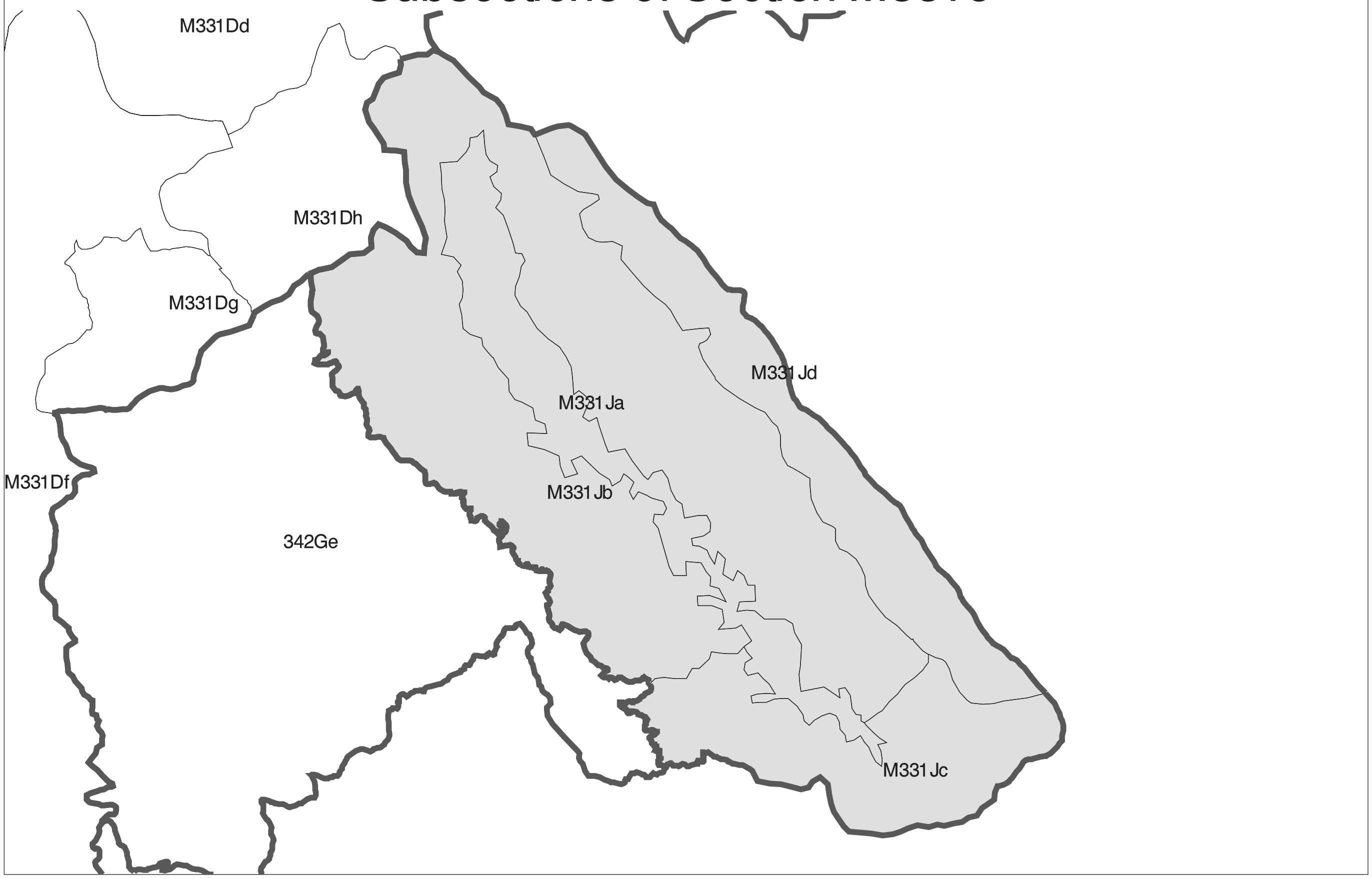
DATA TABLES

Wind River Mountains

Section M331J



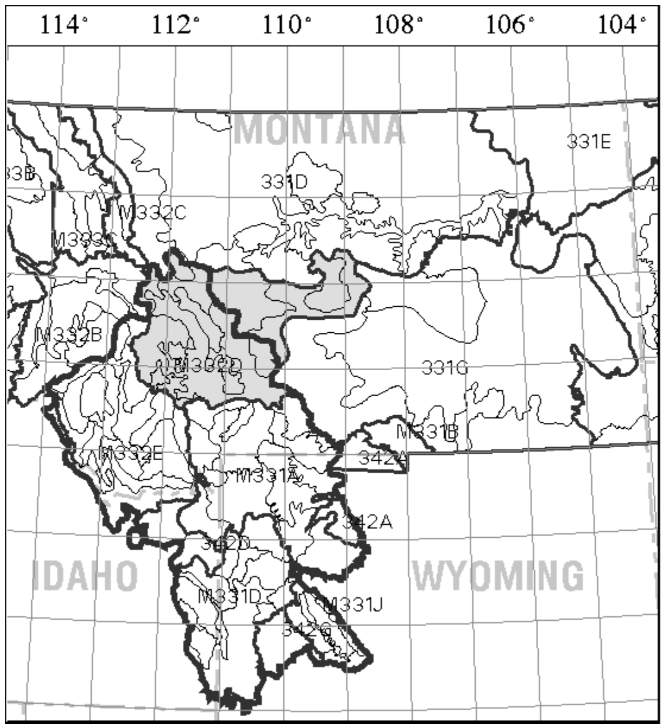
Subsections of Section M331J



THE BELT MOUNTAINS

SECTION M332D

This Section includes isolated island mountains surrounded by rolling hills and broad valleys underlain by Precambrian and Paleozoic metamorphic, Tertiary volcanic, and Cretaceous sedimentary rocks. The Crazy, Bridger, Elkhorn and Big Belt Mountain ranges are included in this area. Elevations range from 3,400 to 11,200 feet. The land is level to rolling with over half having slopes less than 10%. Land cover is over 50% grassland-and agricultural in the valleys with coniferous forests in the mountains.



SUBSECTION	NAME	ACRES IN GYA
M332Dc	Crazy Mountains	332,143
M332De	Continental Divide Foothills	433,261
M332Dg	Big Belt Foothills	516,302
M332Dh	Big Belt Mountains	378,383
M332Dj	Boulder / Elkhorn Mountains	883,608
M332Dk	Central Montana Broad Valleys	2,646,321
M332Dm	South Elkhorn Mountains	170,881
M332Dn	North Tobacco Root Mountains and Foothills	224,837
M332Dp	Bridger Mountains and Foothills	313,075
	TOTAL ACRES IN GYA	5,848,811

MAPS

- **CLIMATE**

Precipitation
Soil Moisture
Soil Temperature

- **GEOLOGY**

Lithology

- **PHYSIOGRAPHY**

Elevation and Relief
Slope groups

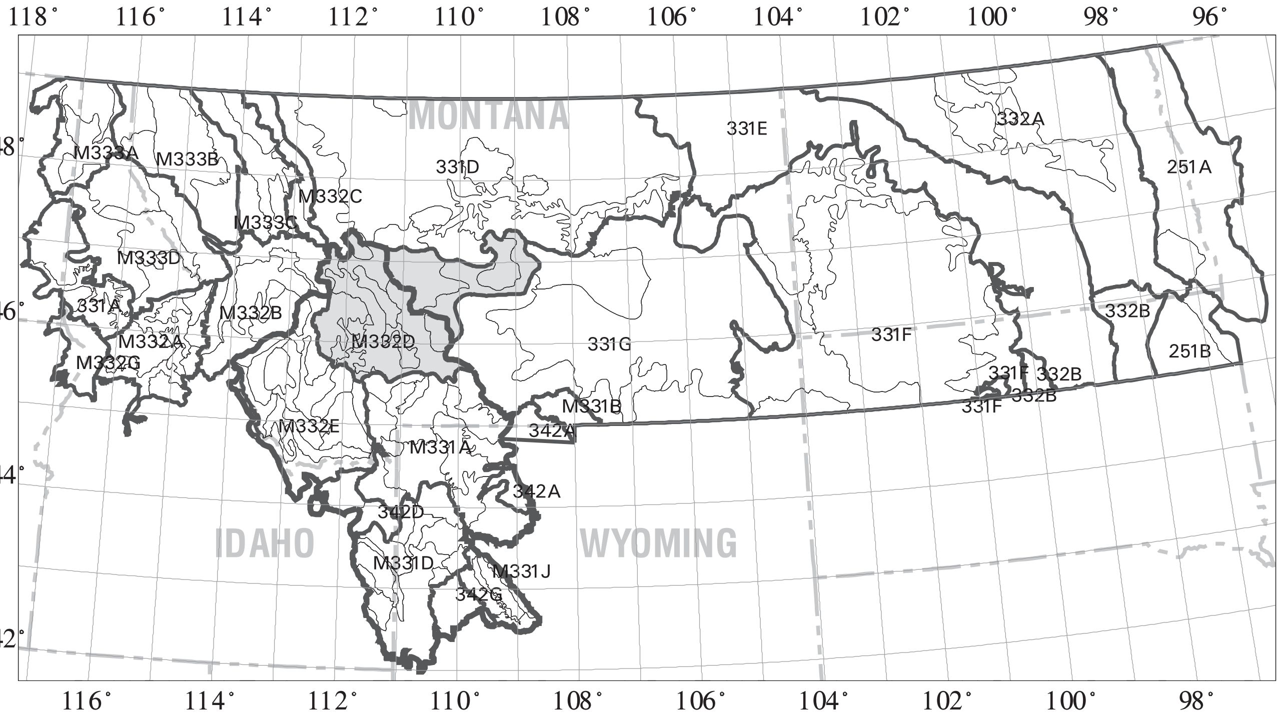
- **LANDCOVER**

Pre-1990
NLCD

- **SUBSECTIONS**
- **DATA TABLES**

Belt Mountains

Section M332D

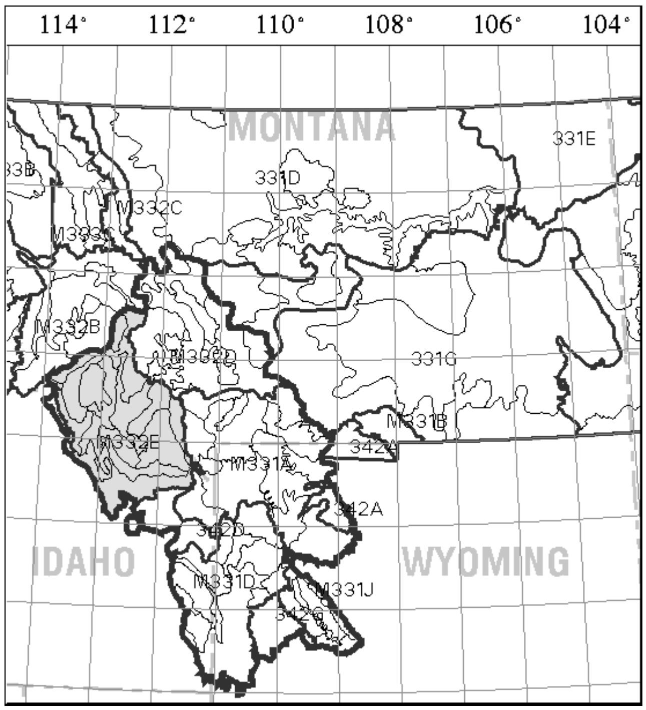


Subsections of Section M332D

THE BEAVERHEAD MOUNTAINS

SECTION M332E

The Beaverhead Mountains Section is a complex of linear mountain and large gravel filled basins with terraces underlain by Tertiary volcanic and sedimentary rocks and Paleozoic metamorphic rocks. This area includes the Pioneer, Beaverhead, Ruby, Tobacco Root, Gravelly, and Snowcrest mountain ranges. Elevations range from 3,800 to 11,400 feet. Land cover is predominantly grassland and coniferous forest.



SUBSECTION NAME	ACRES IN GYA
M332Ea Continental Divide Uplands	**672,020**
M332Eb East Pioneer Mountains	**390,736**
M332Ec Deerlodge Valley	**176,146**
M332Ee West Pioneer Mountains	**430,624**
M332Eg Anaconda Mountains	**225,886**
M332Eh Beaverhead Mountains	**552,080**
M332Ej Southwest Montana Intermontane Basins	**2,097,829**
M332Ek Ruby / Tobacco Root Mountains	**412,255**
M332En Gravelly / Snowcrest Mountains	**809,775**
M332Ep Blacktail Mountains	**312,068**
M332Er Southern Beaverhead Mountains	**1,220,567**
TOTAL ACRES IN GYA	**7,299,986**

MAPS

- **CLIMATE**

Precipitation
Soil Moisture
Soil Temperature

- **GEOLOGY**

Lithology

- **PHYSIOGRAPHY**

Elevation and Relief
Slope groups

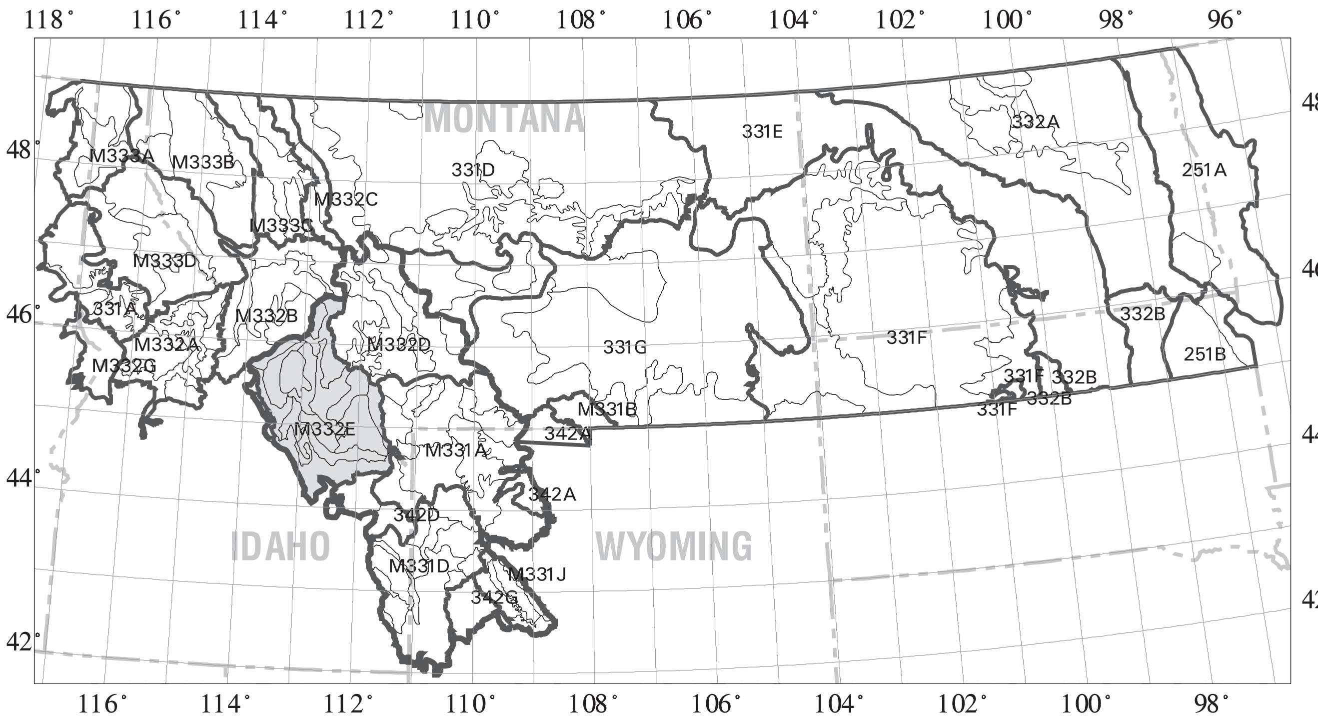
- **LANDCOVER**

Pre-1990
NLCD

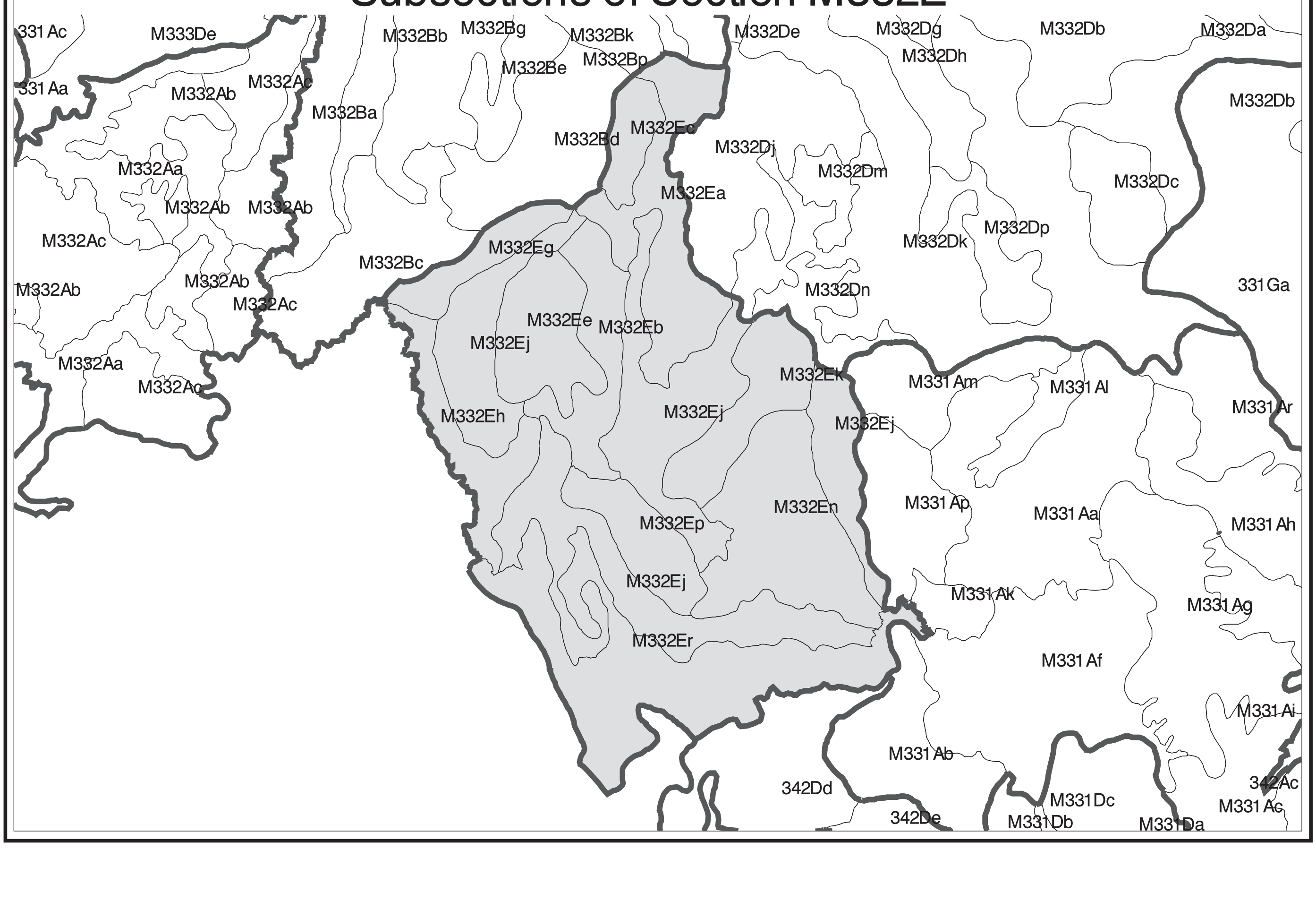
- **SUBSECTIONS**
- **DATA TABLES**

Beaverhead Mountains

Section M332E



Subsections of Section M332E

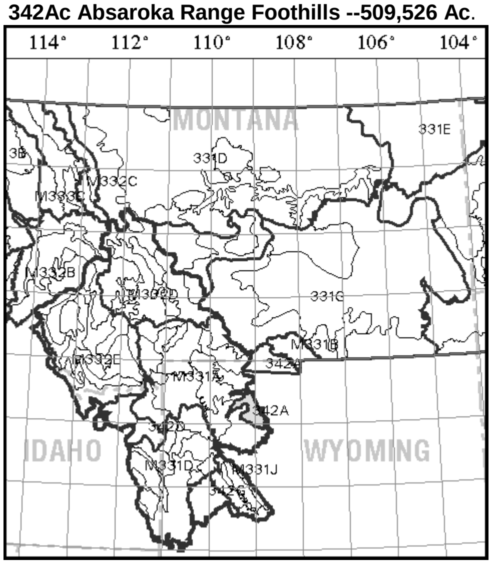


MINOR COMPONENT ECOLOGICAL UNITS

Parts of the Bighorn Basin (342A), Snake River Basalts (342D) , and Green River Basin (342G) Sections were also included in this GYA study area. These areas 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. Land cover is mostly grassland with significant amounts devoted to agriculture. Tabular summaries of characterization data are included for these minor components, however the full suite of map products provided for major Sections is not.

THE BIGHORN BASIN
SECTION 342A

342Ac Absaroka Range Foothills --509,526 Ac.



- **DATA TABLES**
- **MAPS**

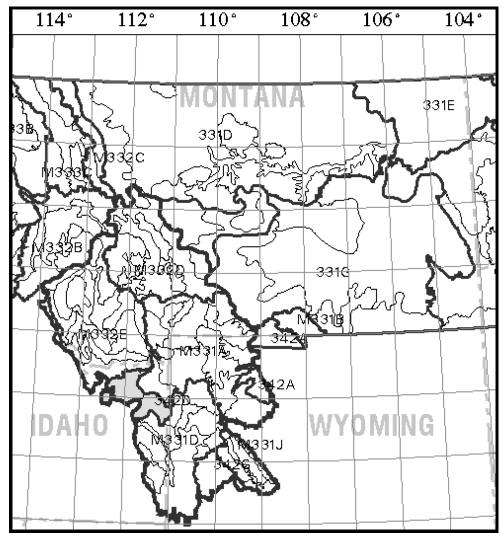
LANDCOVER
- **Section 342A**
- **Section 342D**
- **Section 342G**

LITHOLOGY
- **Section 342A**
- **Section 342D**
- **Section 342G**

SOIL TEMPERATURE
- **Section 342A**
- **Section 342D**
- **Section 342G**

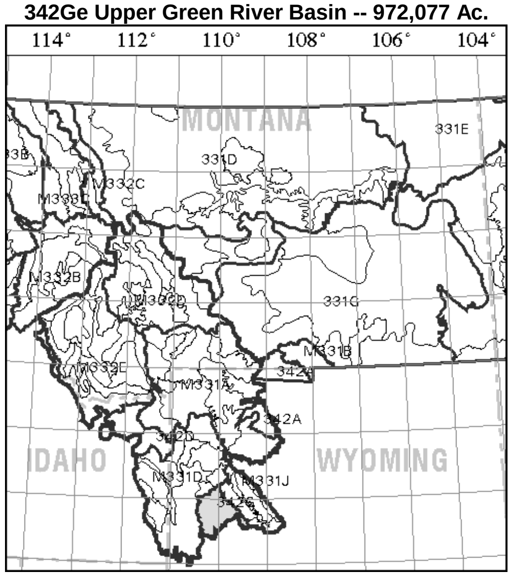
THE SNAKE RIVER BASALTS
SECTION 342D

342Dd Eastern Idaho Plateau - - 745,079 Ac.
342De Dissected Plateaus, Teton Basin -- 525,636 Ac.



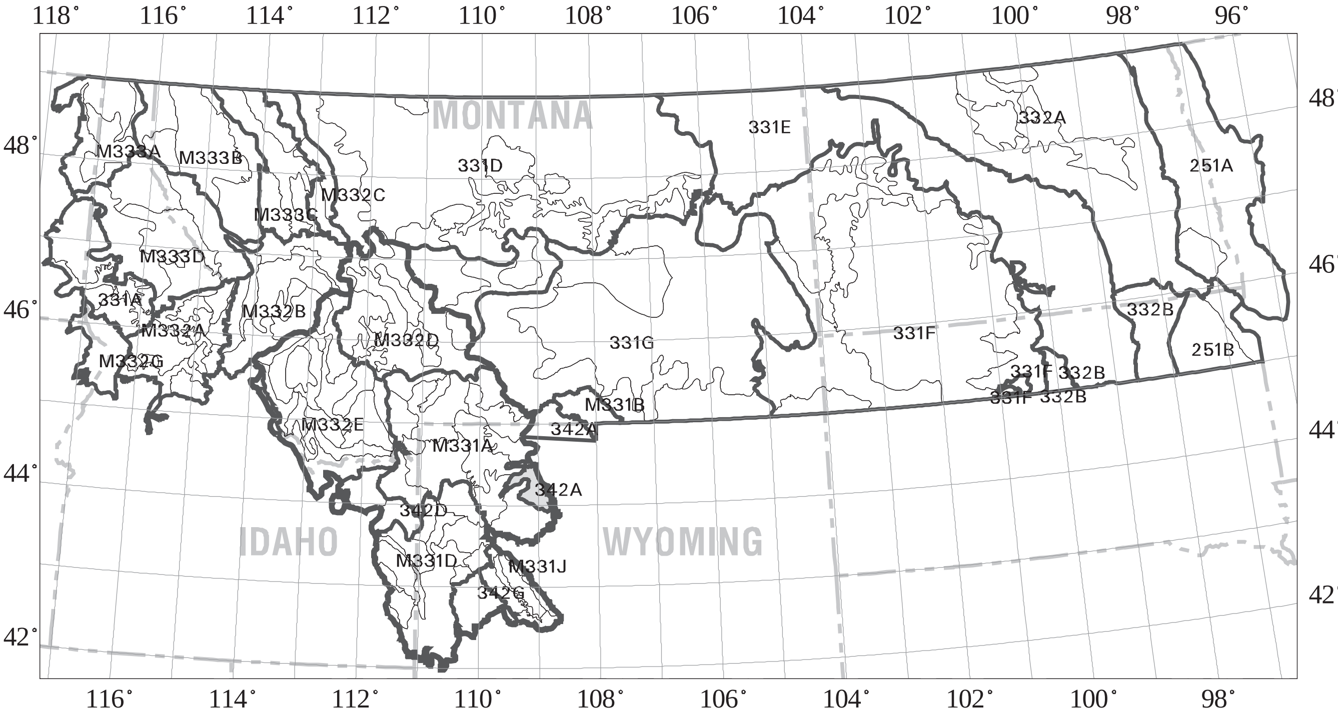
SECTION 342G
GREEN RIVER BASIN

342Ge Upper Green River Basin -- 972,077 Ac.



Big Horn Basin

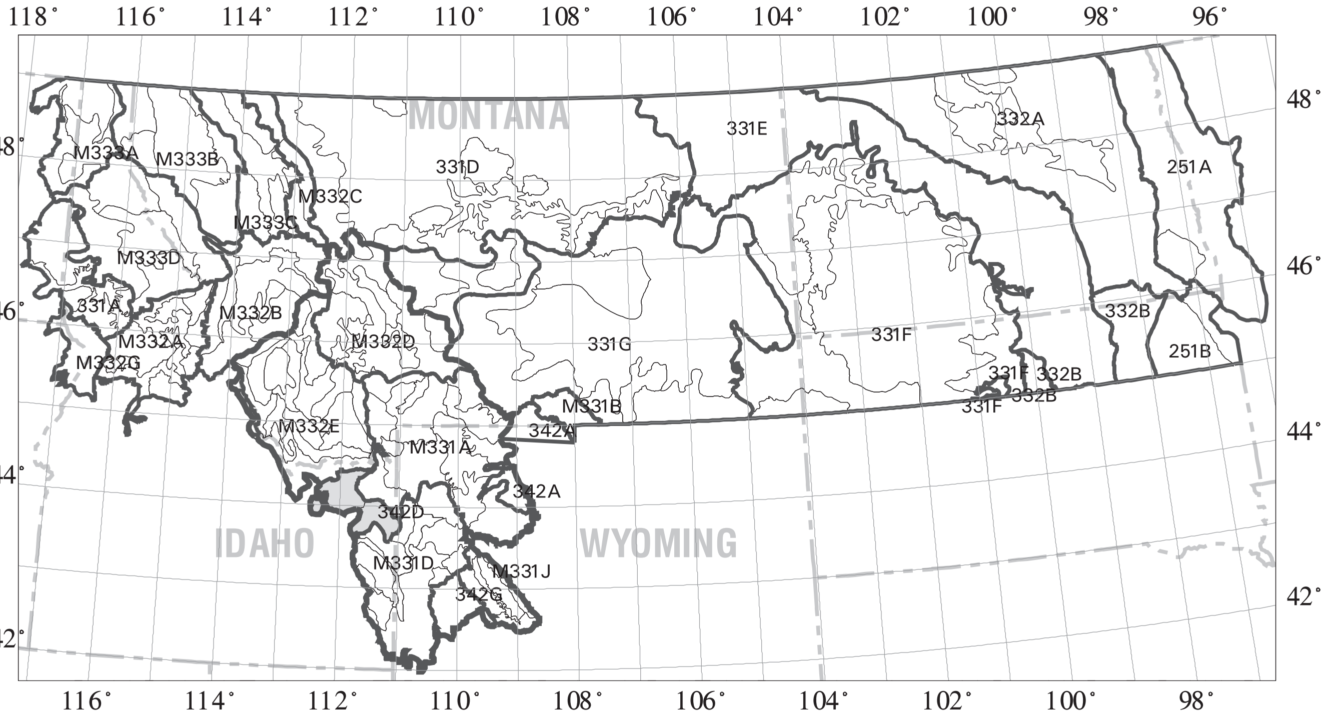
Section 342A



Subsections of Section 342A

Snake River Basalts

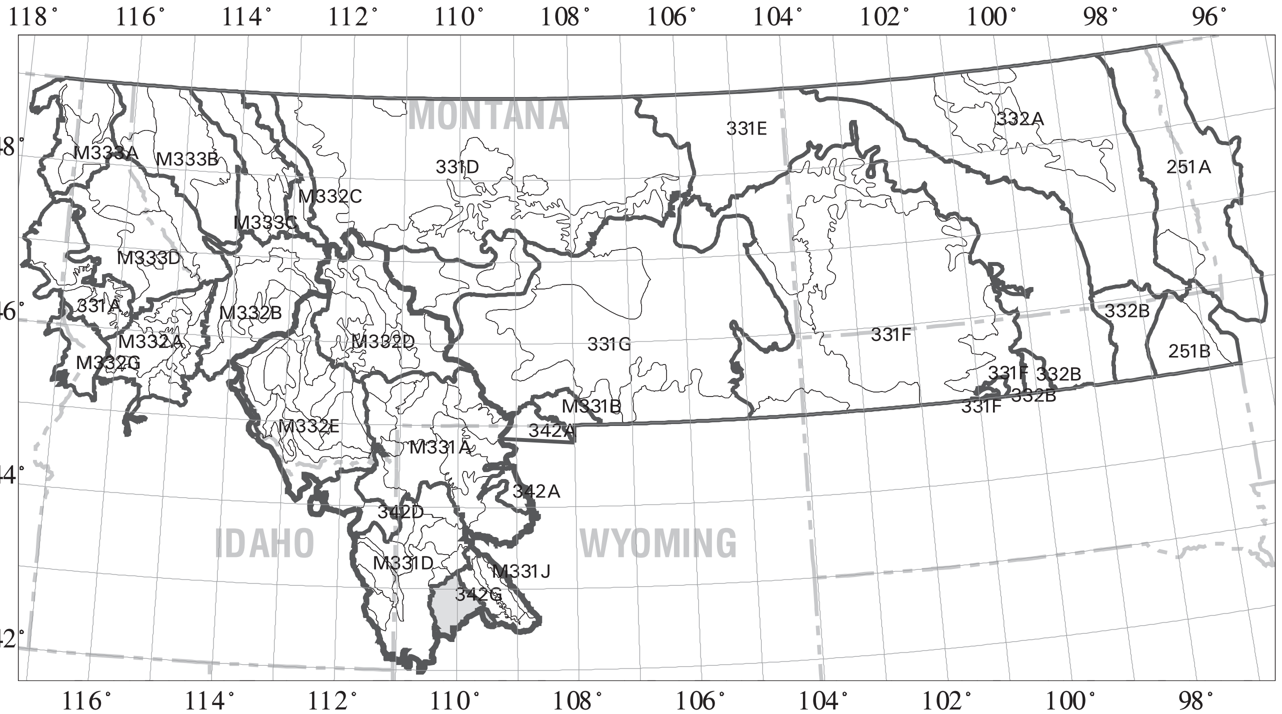
Section 342D



Subsections of Section 342D

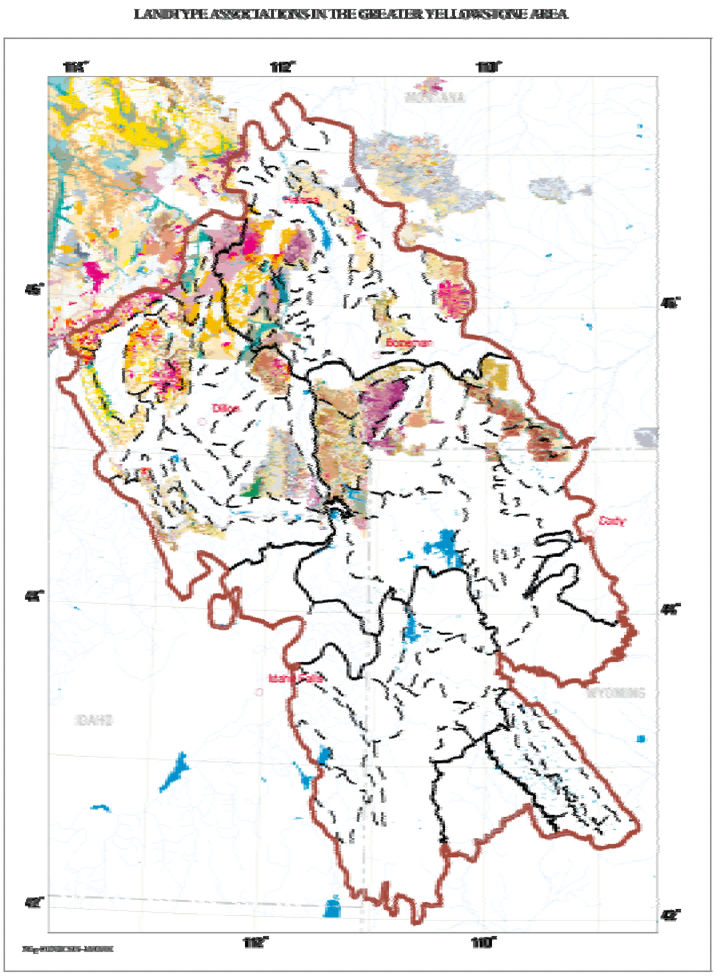
Green River Basin

Section 342G



Subsections of Section 342G

LANDTYPE ASSOCIATION MAPPING



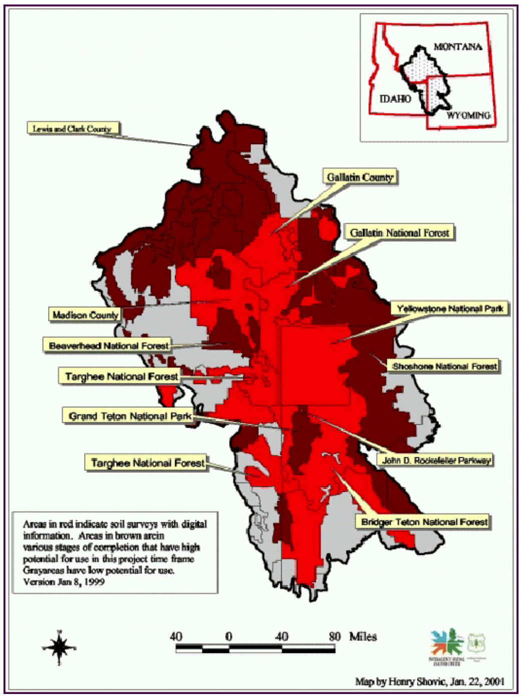
Landtype Associations (LTA'S) are defined by general topography, geomorphic process, surficial geology, associations of soil families, vegetation and local climates. These factors affect biotic distributions, hydrologic functions, natural disturbance regimes, and general land use. Local landform patterns become apparent at this level in the ecological hierarchy and differences among units are usually obvious to on-the-ground observers. These terrestrial features and processes also have a strong influence on the ecological characteristics of aquatic habitats.

The mapping of Landtype Associations was completed in 1997 for the Northern Region, USDA Forest Service (Ford et al 1997). Landtype Association mapping is not yet available for those parts of the Greater Yellowstone Area that are not in the Northern Region. Coincident with this project, the development of a seamless, electronic soils map layer of the GYA was undertaken. From that data we intended to develop LTA's for the entire Greater Yellowstone Area. A lack of funding did not permit the completion of this effort. Consequently, only areas within the GYA which had previously developed LTA mapping were available to be used for demonstration purposes.

- DISPLAYS AND MAPS
- METADATA
- REFERENCES
- LTA LEGEND

GREATER YELLOWSTONE AREA LANDTYPE LEVEL MAPPING

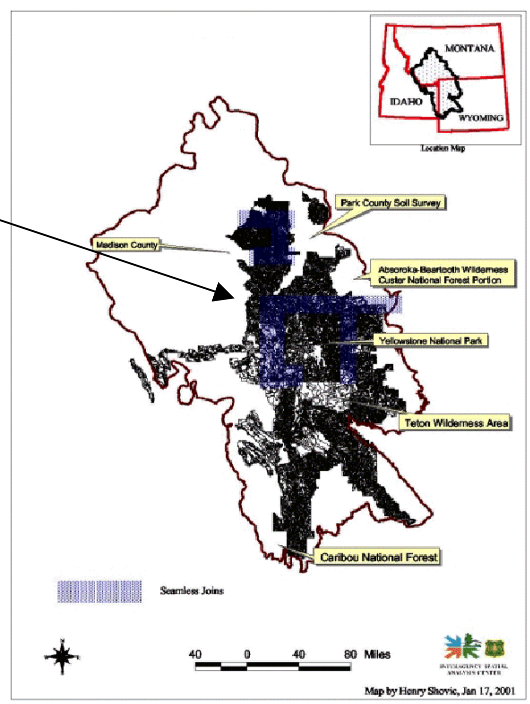
The development of Landtype level mapping within the Greater Yellowstone Area is the subject of a recently published report that was completed as a companion project to this broad and mid-scale ecological characterization of the GYA. This effort utilized digitally available soil survey mapping for portions of the study area to develop demonstration methods for providing a seamless map theme with associated attributes. Of the 58 soil survey areas in the GYA, the methods for combining surveys were applied to ten individual inventories in seven administrative units (Shovic et al., 2000).



Soil Survey Areas included in Landtype Model:

Gallatin National Forest
Gallatin County
Yellowstone National Park
Grand Teton National Park
Teton County
Shoshone National Forest
Targhee portion of Caribou-Targhee National Forest
Bridger-Teton National Forest
Teton, Bridger-East, (combined)
Bridger-West, John D. Rockerfeller Parkway (combined)

Area of Landtype level seamless combination of digital Soil Survey data within the Greater Yellowstone ecological characterization study area.

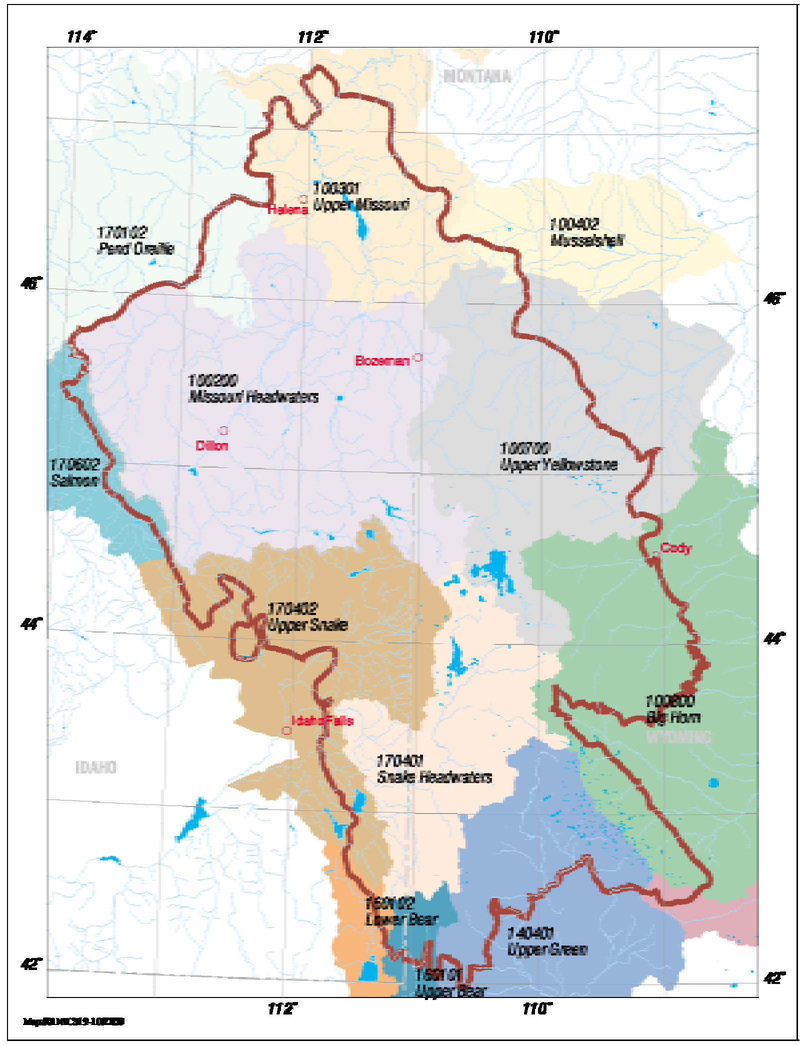


- **REFERENCES**
- **LINKS**

WATERSHEDS IN THE GREATER YELLOWSTONE AREA

Nationally, watershed mapping is primarily done at four unique scales-the Basin (1:500,000), the Sub-basin (1:250,000), the Watershed (1:100,000) and Sub-watershed (1:24,000) levels. For areas included in the GYA, watershed mapping at the watershed and sub-watershed scales is ongoing; the basin and sub-basin levels of mapping have been completed and published the USGS. Under Federal guidelines, watershed mapping efforts are coordinated by the NRCS with final approval and publication the responsibility of the USGS Water Resources Division. Major watersheds found in the GYA include the Upper Missouri, Missouri Headwaters, the Upper Yellowstone, the Big Hole, the Upper Snake and Snake Headwaters, and portions of the Upper Green and Lower Bear Basins.

MAJOR BASINS IN THE GREATER YELLOWSTONE AREA

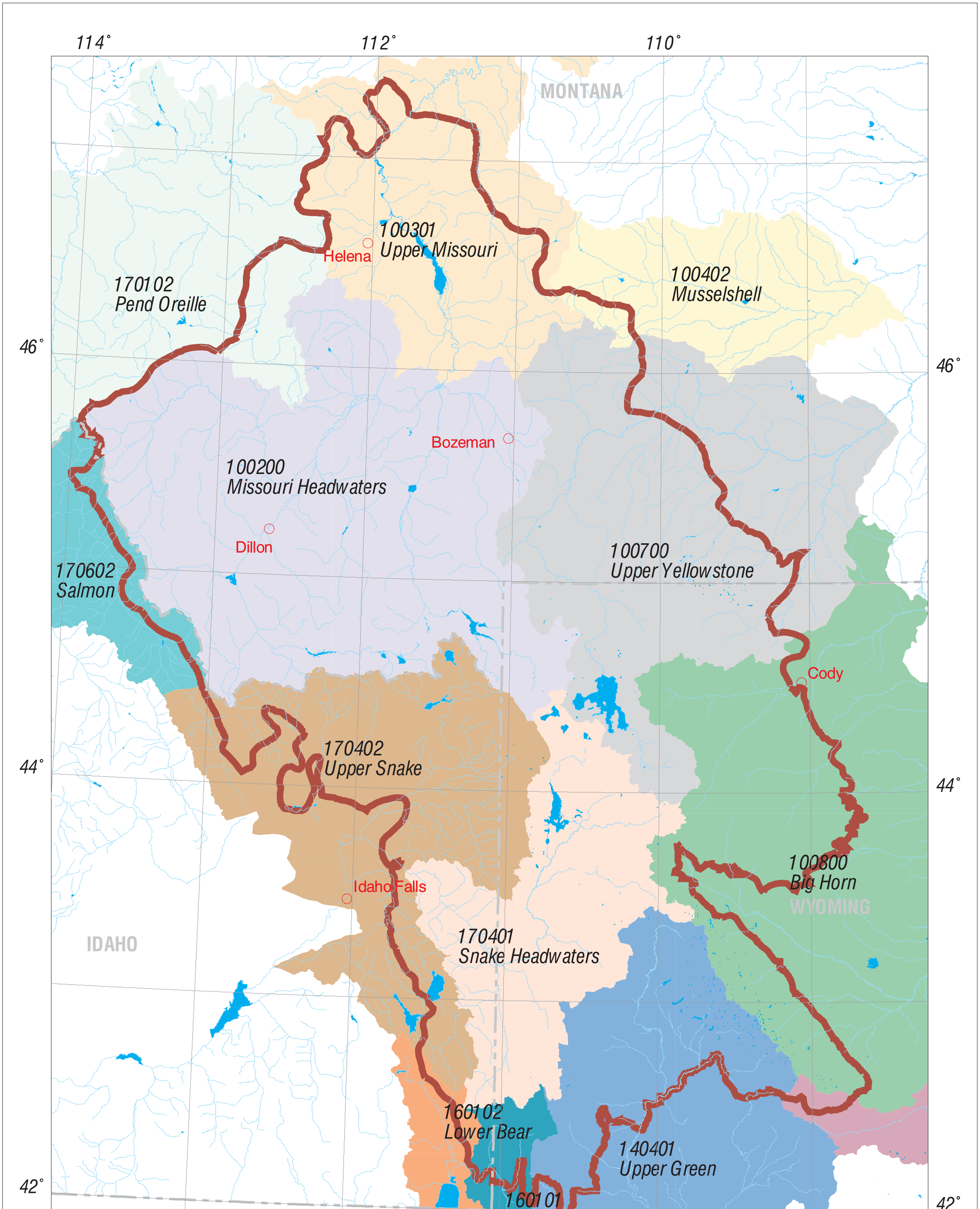


- **DATA TABLES**
  Sub-Basins by Section
  Sub-Basins by Subsection
- **REFERENCES**
- **SOURCES AND LINKS**

DISPLAYS AND MAPS

Basins in the GYA
Basins and Ecological Units
Sub-Basins and Ecological Units
Section M331A
Section M331D
Section M331J
Section M332D
Section M332E
Section 342A
Section 342D
Section 342G

MAJOR BASINS IN THE GREATER YELLOWSTONE AREA



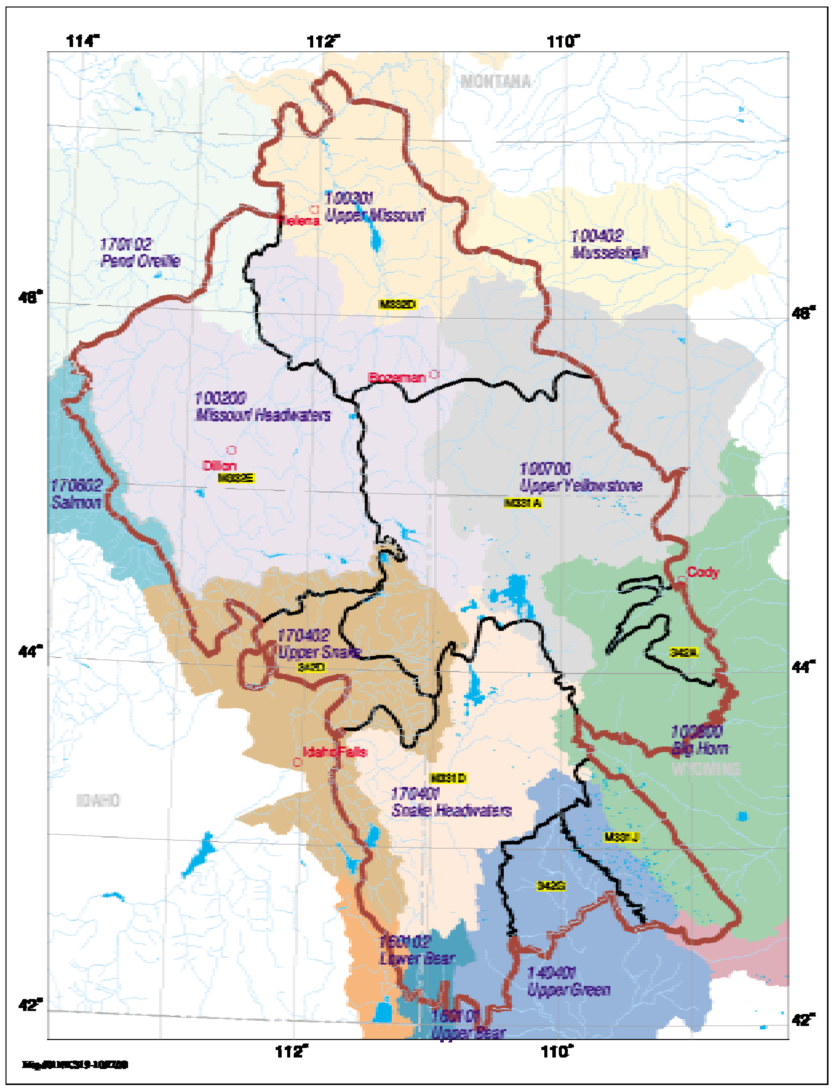
Map #01 NRCS19 -10/27/00

WATERSHEDS AND ECOLOGICAL UNITS

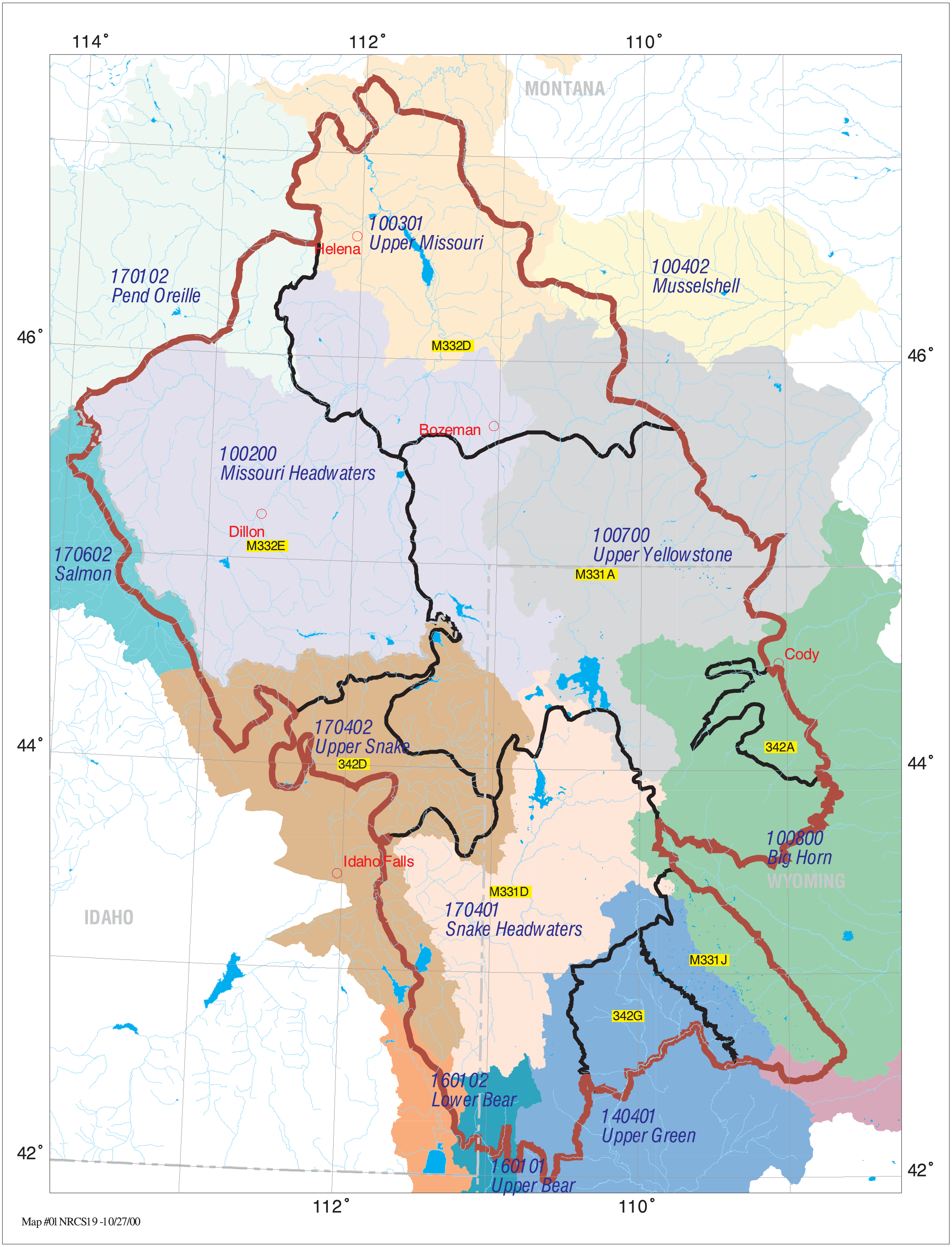
The inherent nature of, and delineation criteria for, ecological units and watersheds are distinctly different. The hydrologic unit or watershed is defined by a drainage basin and it's contributing tributaries; whereas the various scales of ecological units represent increasingly more refined environmental factors that influence and define unique landscapes and their components. Consequently, at the Section and Subsection level, ecological units commonly contain portions of one or more basins, three or more sub-basins, and several watersheds. While watersheds can be appropriately used to describe drainage patterns and stream properties, watersheds are not synonymous with ecological units so comparisons between watersheds must take into account the composition of ecological units and their attributes. The ecological characterization of any given watershed can be described at various scales depending upon the information needs.

Ecological units provide a spatial framework for ecosystem assessment, monitoring, and management. These units delimit areas within which ecological properties reoccur in predictable and repeating patterns. These predictable and repeating patterns make ecological units an extrapolation mechanism. Watersheds provide a spatial framework for the study of the effects of natural and anthropogenic phenomena on water quality and quantity. However, effective extrapolation of watershed data requires knowledge of the ecological units in which they occur. Watersheds by themselves form study units: ecological units provide the extrapolation mechanism (Omernick and Bailey, 1997). It should also be noted that hydrologic units (HUCs) are not necessarily watersheds. Ecological units and watersheds can be complimentary tools if the uses of each are understood and the misuses avoided.

MAJOR BASINS IN SECTIONS OF THE GREATER YELLOWSTONE AREA



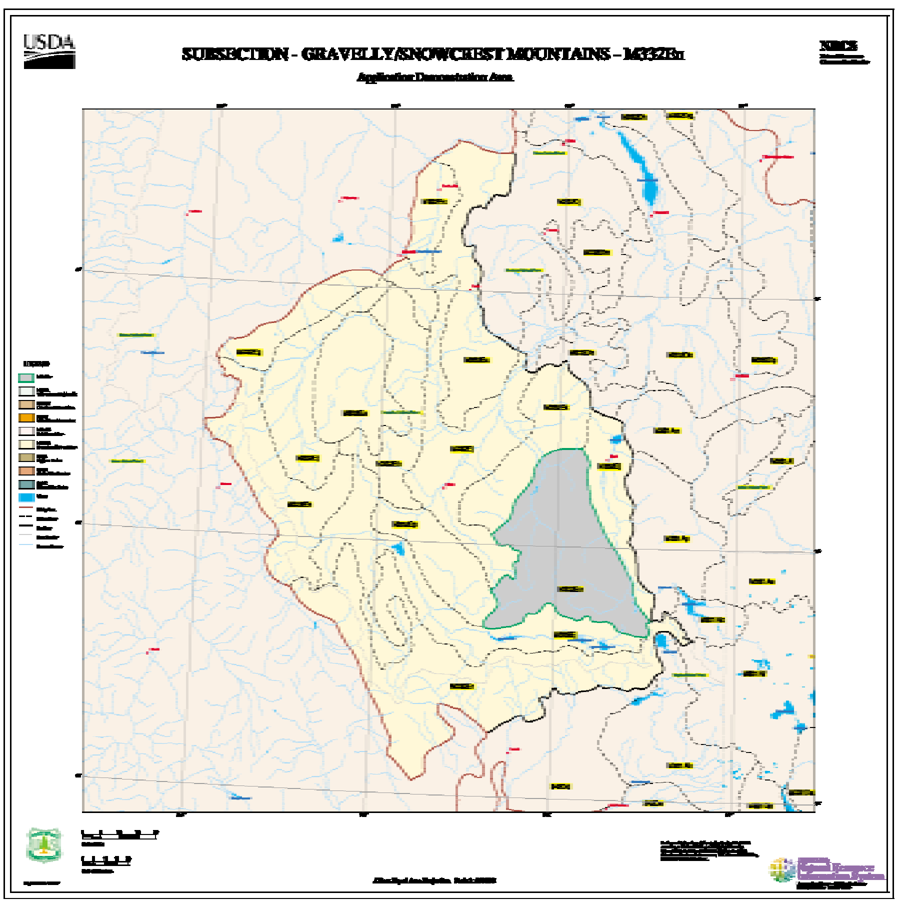
MAJOR BASINS IN SECTIONS OF THE GREATER YELLOWSTONE AREA



Map #01 NRCS19 -10/27/00

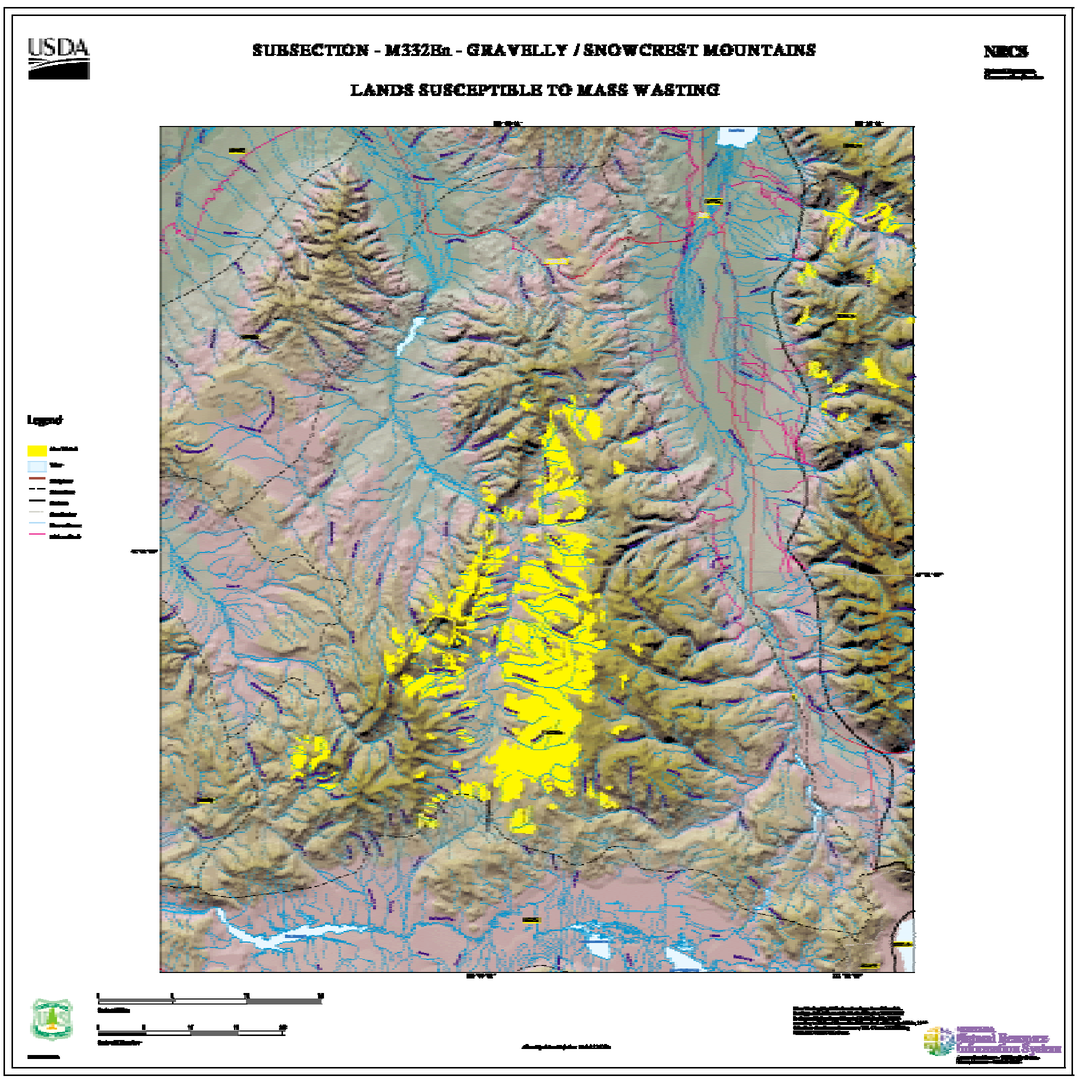
LANDTYPE ASSOCIATIONS: APPLICATIONS

Landscape scale application development includes interpretations related to those characteristics portrayed by Landtype Associations. Developing landscape scale applications requires extensive manipulation of, and familiarity with the features and limitations of each of the base resource themes. Erosional characteristics including parent material erodability (developed for entire GYA), surface erosion potential and mass movement (for demonstration area only), are presented. The FSWEPP model was used to predict surface erosion at the landscape and watershed scales. The relationship between valley floor environments as characterized by dominant site features and stream types and their component Landtype Associations is also presented. For the purposes of this project these applications are presented on a demonstration basis, however they can be applied anywhere that Landtype Association and other ecological unit mapping is available. Further development of these and additional applications, including site productivity relationships, and vulnerability/resiliency interpretations were dropped due to funding and time constraints.



MASS WASTING

This representation of lands susceptible to mass wasting within the Gravelly and Snowcrest Mountains was developed from Landtype Association mapping. Within this Subsection, 73,061 acres are classified as mass wasted slopes or landflows. These areas occur in both glaciated and non-glaciated environments in colluvium from various parent materials. They are characterized by undulating or steep micro-relief and indications of recent movement such as slip scars, cracks or leaning trees. These landflows have many seeps, springs and depressions. Small ponds and boggy areas are common. In addition, hydrothermal alteration, over-steepening, and alternating deposits of flow materials and ash in conjunction with seismic events make bedrock failures a notable contribution to mass wasting in the Greater Yellowstone Area. Mass wasting interpretations can also be made by evaluating factors such as lithology, slope, precipitation and other more site specific attributes. Ratings of mass wasting potential or hazard based on such evaluations vary, depending on locale and the type of mass wasting event, and are most appropriately developed using site level investigations. Various geo-technical models are also available and are highly recommended for site level investigations.



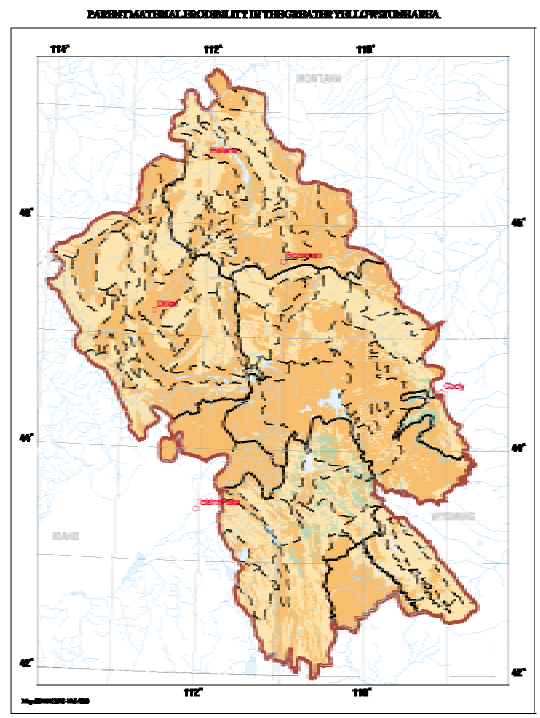
LINK TO FULL SIZE MAP

CHARACTERIZING AND MODELING SURFACE EROSION

Due to the nature of the variables that influence erosion potential (i.e. soil surface texture, hillslope steepness and length, amount and type of vegetative cover, climate as reflected by rainfall intensity, and type of site disturbance) modeling this complex phenomenon requires very detailed, site specific data. Consistent information at the appropriate scale required by erosion prediction models is not currently available for all ecological units of the GYA. A limited number of climate data stations are maintained throughout the area. Available mapping of vegetation types does not provide sufficient spatial resolution with regard to surface biomass and cover percentages. The Landtype and SSURGO soils levels of mapping, which contain much of the background data necessary to develop reliable spatial models for predicting erosion and sediment delivery potential are in various stages of completion for locations in the GYA. In short, while methods for predicting and modeling erosion and sediment production and transport are improving in accuracy and scope (RUSLE v. 1.6; WEPP v. 99.5; FS WEPP) consistent, reliable data sets with the properties and scale required to support these modeling programs are extremely limited in availability.

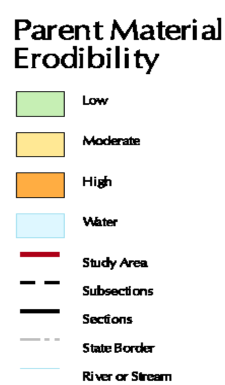
PARENT MATERIAL ERODABILITY

Over the years numerous methods have been developed to evaluate and predict the potential rate of erosion for any given hillslope. Most of these methods were developed prior to the introduction of computerized geo-spatial analysis capabilities that are now available. For this display soil parent material was rated for its inherent water erosion potential based on coefficients established from research findings and further refined by Northern Region soil scientists. This rating does not use measured slope gradient or length, rainfall intensity, or vegetative cover. It is only a rating of inherent soil properties that affect the detachment and transport of soil particles. To develop this display, the previously developed coefficients were applied to lithologic units and landform categories and generalized into groups. Maps of the resulting ratings were then prepared for each of the Sections within the GYA study area.



- MAPS

Section M331A
Section M331D
Section M331J
Section M332D
Section M332E
Section 342A
Section 342D
Section 342G



THE WEPP EROSION PREDICTION MODEL

The USDA - Water Erosion Prediction Project (WEPP) model is geared to users of Universal Soil Loss Equation and incorporates a series of erosion prediction models, which both require and deliver more sophisticated input and output. (Wischmeier and Smith, 1978). As the WEPP model is process-based, it can be extrapolated to a broad range of conditions. The current version is available from the National Soil Erosion Research Laboratory located at Purdue University.

The FS WEPP interface was developed by the Soil and Water Engineering group of the U.S. Forest Service Rocky Mountain Research Station, Bill Elliot, Project Leader. FS WEPP is the Forest Service Interface to the WEPP model. Both WEPP and FSWEPP are process-based, distributed parameter, continuous simulation, erosion prediction models for use on personal computers.

As it is currently designed, the FS WEPP model provides tabular output of predicted erosion and sediment production for generalized surface texture groups on slopes of selected gradient and length for specific vegetative cover and disturbance scenarios. For the purposes of this project our intent was to explore methods for incorporating geo-referenced spatial data inputs for slope gradient and soil surface texture classes to all model outputs to be displayed for the demonstration area. This objective required several preliminary GIS analysis steps. The LTA map units in the demonstration area served as the information source for general soil surface texture classes which were spatially associated to a 30 meter resolution grid with cells that had been previously reclassified into five major slope group categories. The resulting grid contained 48 possible slope class/surface texture combinations. Each of these combinations were then iteratively entered as input criteria into the FS WEPP model for four example vegetative cover/ disturbance scenarios. To demonstrate a range of possible simulations, the model was run for: 95% 20-year-old forest cover; 60% tall grass cover; 30% cover, low intensity fire; 8% cover, high intensity fire. All scenarios used a five year climate simulation as input. The FS WEPP tabular output results of predicted erosion for each scenario were then related back to the 30 meter grid and displays were created to portray the distribution and extent of the range of predicted erosion across the landscape. The following graphics display the results for a sample location.

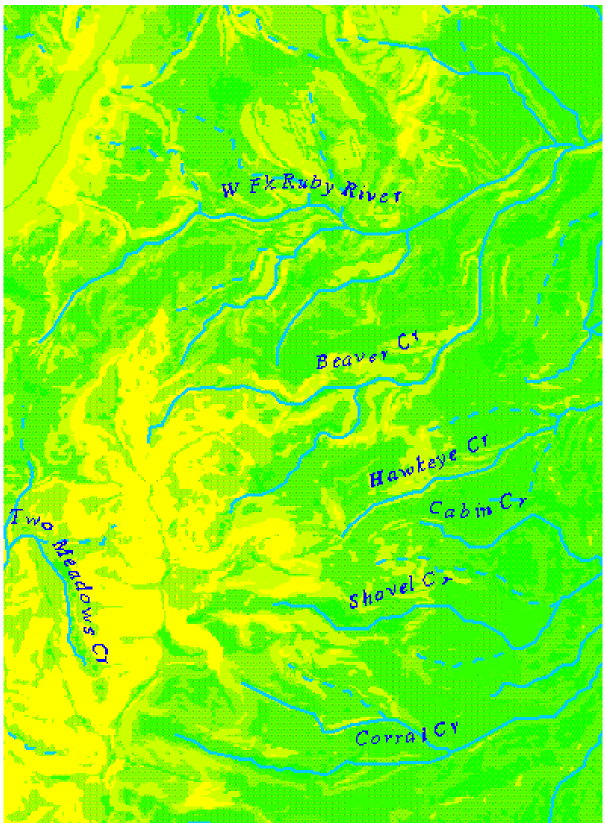
This generalized approach is in no way intended to provide site specific interpretations of erosion potential, nor to substitute for the input of location specific soil surface texture, climatic data, vegetative cover, slope length and gradient measurements. The purpose is simply to demonstrate information that can be generated with currently existing data sets, process models and geographic information system (GIS) technology; and to reinforce awareness for the importance of continuing support for site level soils and vegetation mapping efforts.

- **MAPS**
  8% Cover, High Intensity Fire
  30% Cover, Low Intensity Fire
  60% Cover, No Fire

- **REFERENCES**
- **SOURCES AND LINKS**

PREDICTED EROSION - FS WEPP MODEL

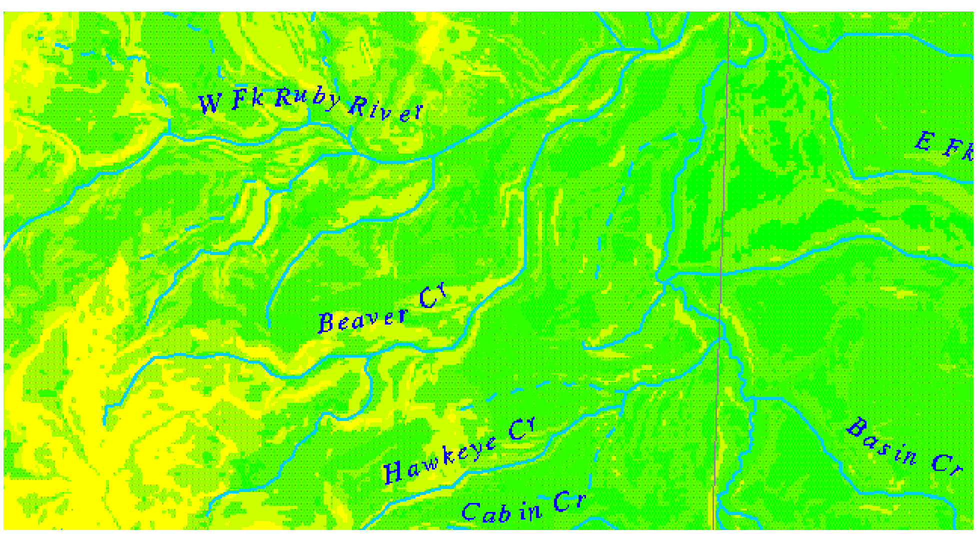
60 PERCENT TALL GRASS COVER
FIVE YEAR CLIMATE SIMULATION



PREDICTED EROSION

TONS PER ACRE PER YEAR

0.13	1.47
0.14	1.74
0.16	1.82
0.34	2.15
0.81	2.24
0.89	2.56
0.93	3.07
1.43	

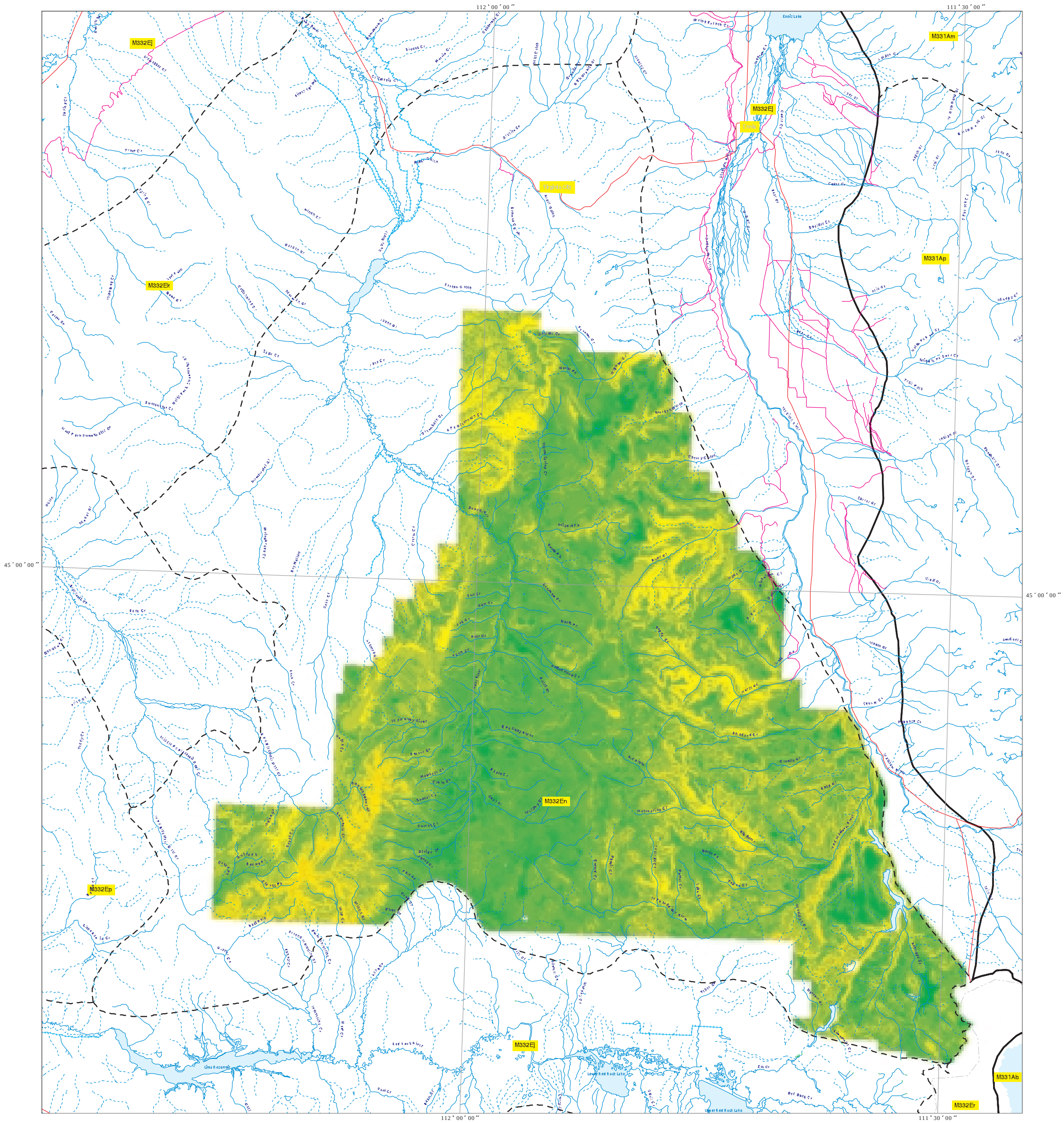


USDA

Gravelly / Snowcrest Mountains - Subsection M332En
Beaverhead Mountains - Section M332E
Predicted Erosion - WEPP Model
No Fire - 60 Percent Tall Grass Cover

NRCS

Natural Resources
Conservation Service



Erosion Prediction
Tons per Acre/Yr.

- 0.13
- 0.14
- 0.16
- 0.34
- 0.81
- 0.89
- 0.93
- 1.43
- 1.47
- 1.74
- 1.82
- 2.15
- 2.24
- 2.56
- 3.07
- Water
- Study Area
- Subsections
- Sections
- State Border
- River or Stream

0 5 10 15

Scale of Miles

0 5 10 15 20

Scale of Kilometers

Albers Equal Area Projection Scale 1:136000

The FS WEPP interface to the WEPP model was developed by the Soil and Water Engineering group of the U.S. Forest Service Rocky Mountain Research Station, Bill Elliot, Project Leader. Section and Subsections delineated by Region One USFS according to National Ecological Mapping Heirarchy Other base data from various source; U.S. Census TIGER files, ESRI ARCUSA 1:2M cdrom.

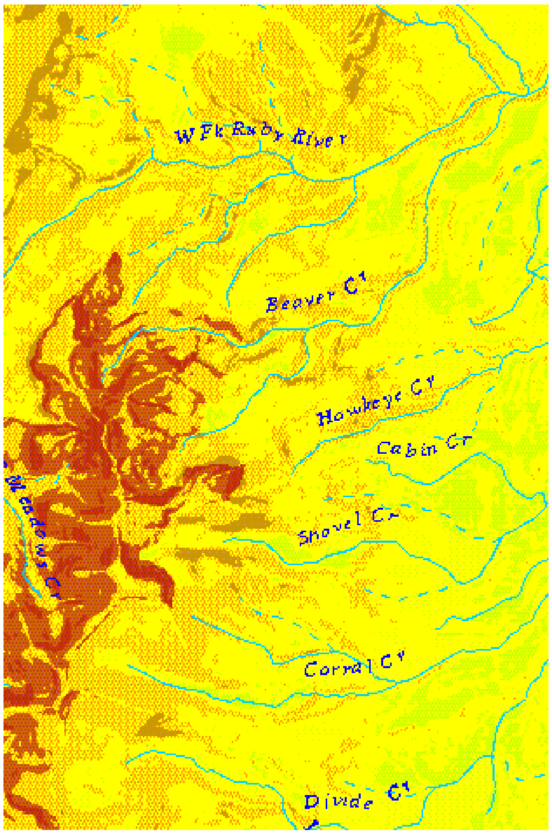
MONTANA
Natural Resource
Information System

Montana State Library – 1515 East 6th Avenue
Helena, Montana – (406) 444-5357

Map#NRCS25-022101

PREDICTED EROSION - FS WEPP MODEL

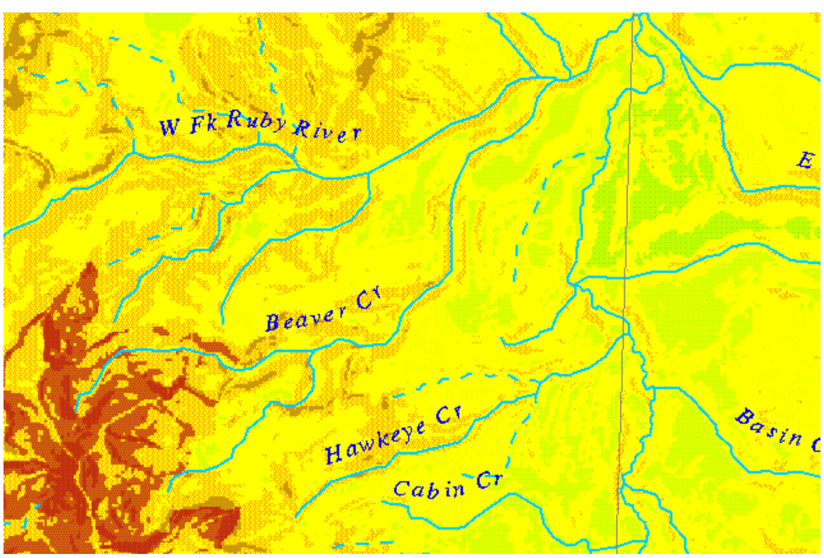
LOW INTENSITY FIRE - 30 PERCENT TALL GRASS COVER
FIVE YEAR CLIMATE SIMULATION



PREDICTED EROSION

TONS PER ACRE PER YEAR

1.71	10.25
1.96	10.95
2.03	11.92
3.28	12.14
6.46	13.26
6.48	14.27
7.21	15.36
9.70	18.16

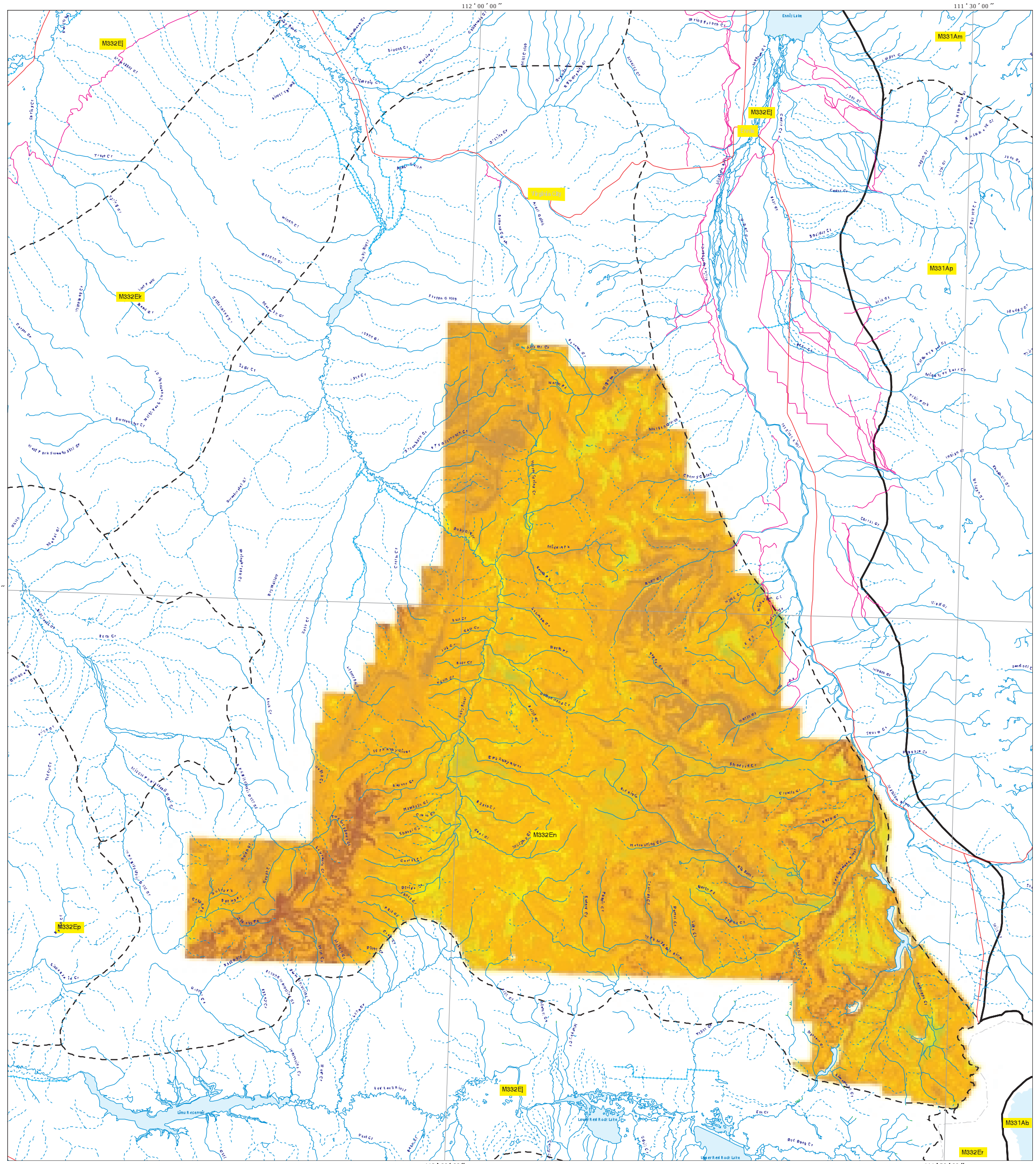


USDA

Gravelly / Snowcrest Mountains - Subsection M332En
Beaverhead Mountains - Section M332E
Predicted Erosion - WEPP Model
Low Intensity Fire - 30 Percent Cover

NRCS

Natural Resources
Conservation Service



Erosion Prediction
Tons per Acre/Yr.

- 1.71
- 1.96
- 2.03
- 3.28
- 6.46
- 6.48
- 7.21
- 9.70
- 10.25
- 10.95
- 11.92
- 12.14
- 13.26
- 14.27
- 15.36
- 18.16
- Water
- Study Area
- Subsections
- Sections
- State Border
- River or Stream

Scale of Miles: 0 5 10 15

Scale of Kilometers: 0 5 10 15 20

Albers Equal Area Projection Scale 1:136000

The FS WEPP interface to the WEPP model was developed by the Soil and Water Engineering group of the U.S. Forest Service Rocky Mountain Research Station, Bill Elliot, Project Leader. Section and Subsections delineated by Region One USFS according to National Ecological Mapping Heirarchy Other base data from various source; U.S. Census TIGER files, ESRI ARCUSA 1:2M cdrom.

Map#01NRCS25-022101

MONTANA
Natural Resource
Information System
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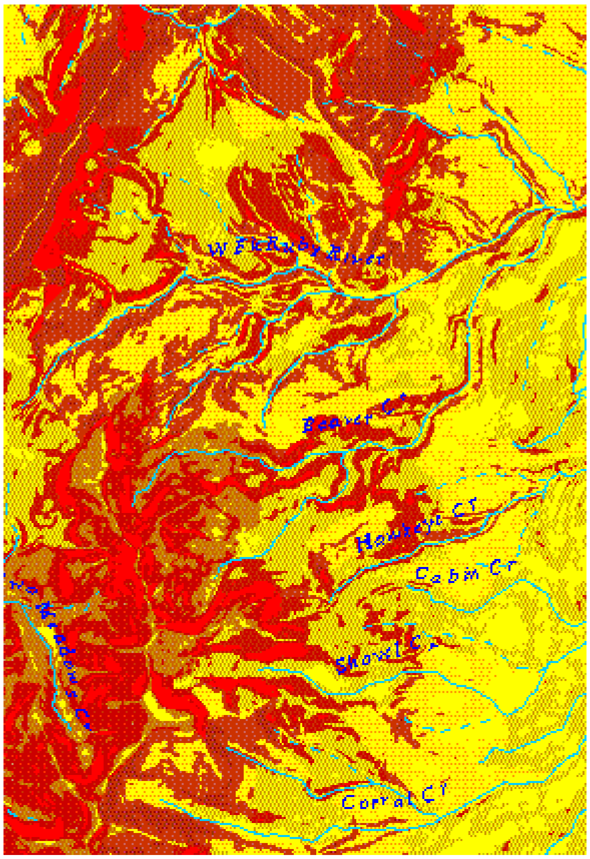
Helena, Montana – (406) 444-5357

PREDICTED EROSION - FS WEPP MODEL

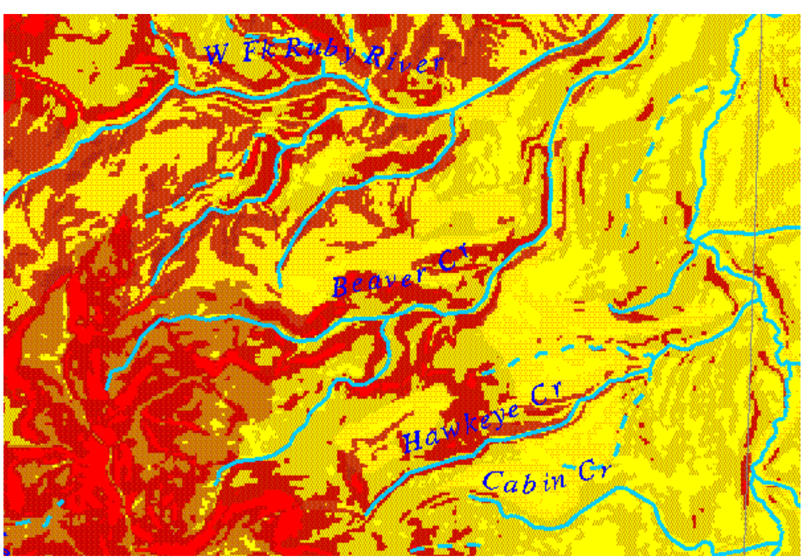
HIGH INTENSITY FIRE - 8 PERCENT COVER
FIVE YEAR CLIMATE SIMULATION



PREDICTED EROSION

TONS PER ACRE PER YEAR

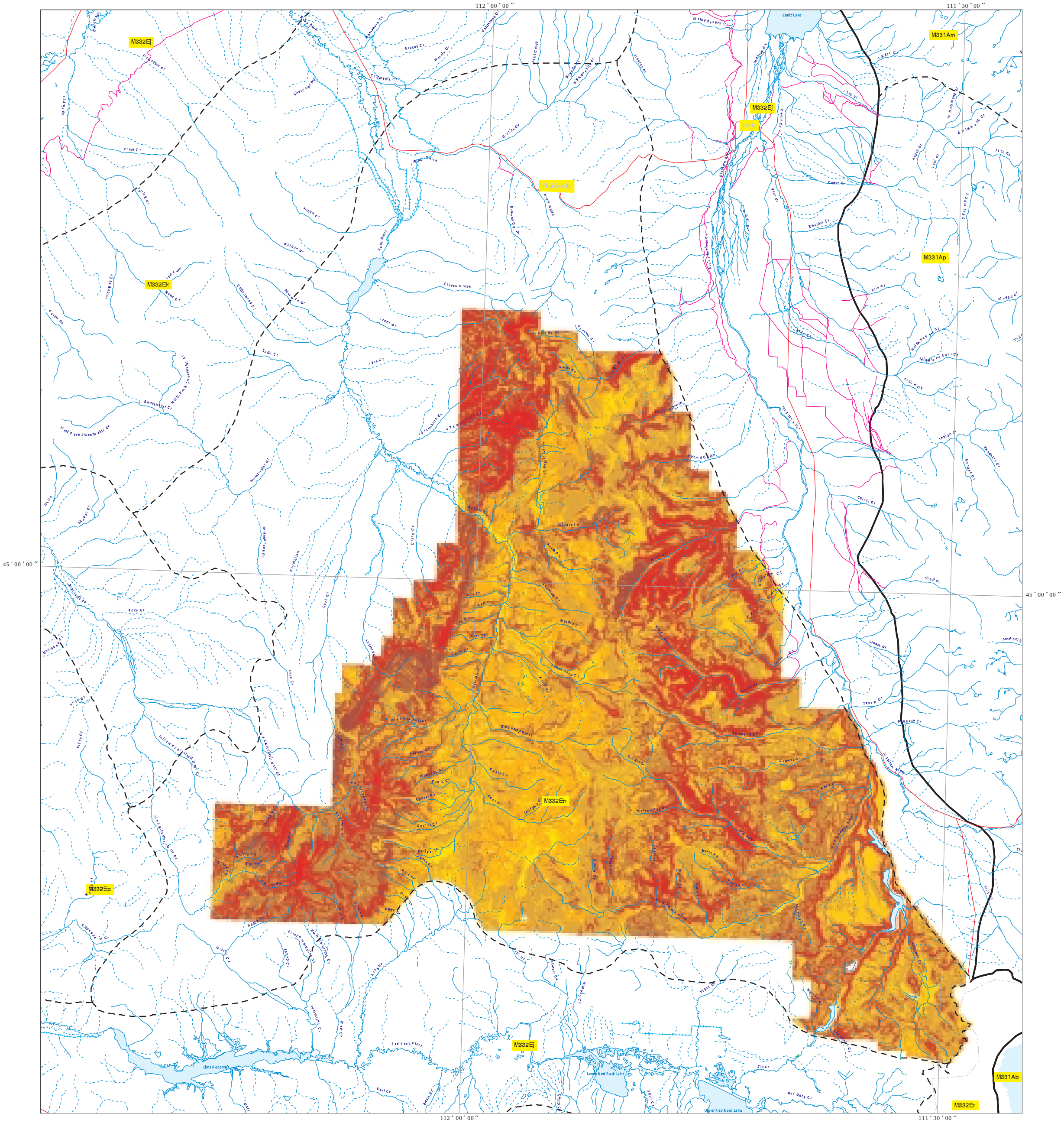
2.92	15.50
3.20	18.41
3.44	20.81
4.96	21.25
9.59	23.63
12.26	25.30
12.90	25.35
15.02	28.17



Gravelly / Snowcrest Mountains - Subsection M332En
Beaverhead Mountains - Section M332E
Predicted Erosion - WEPP Model
High Intensity Fire - 8 Percent Cover

USDA

NRCS
Natural Resources
Conservation Service



Erosion Prediction
Tons per Acre/Yr.

- 2.92
- 3.20
- 3.44
- 4.96
- 9.59
- 12.26
- 12.90
- 15.02
- 15.50
- 18.41
- 20.81
- 21.25
- 23.63
- 25.30
- 25.35
- 28.17
- Water
- Study Area
- Subsections
- Sections
- State Border
- River or Stream

Scale of Miles: 0 5 10 15

Scale of Kilometers: 0 5 10 15 20

Albers Equal Area Projection Scale 1:136000

The FS WEPP interface to the WEPP model was developed by the Soil and Water Engineering group of the U.S. Forest Service Rocky Mountain Research Station, Bill Elliot, Project Leader. Section and Subsections delineated by Region One USFS according to National Ecological Mapping Heirarchy Other base data from various source; U.S. Census TIGER files, ESRI ARCUSA 1:2M cdrom.

MONTANA Natural Resource Information System
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Helena, Montana – (406) 444-5357

PREDICTING VALLEY FLOOR AND STREAM CHANNEL CHARACTERISTICS

Within the National Hierarchical Framework of Ecological Units, valley segments are mapped as unique Landtypes, Landtype phases, SSURGO soil map units, or map unit components, and may be delineated as either polygons or line segments. Valley segments can be used to assess riparian vegetation patterns, hydrologic function, fluvial processes, and aquatic habitat potential for major portions of a stream network. Classes of valley segment types can be used to describe and interpret these properties within the spatial context of the river continuum and floodplain environments. The stratification of landscape components using ecological units that represent inherent site potential makes it possible to characterize the riparian and stream channel properties of any given valley segment and to summarize and interpret this information in an ecosystem or watershed context.

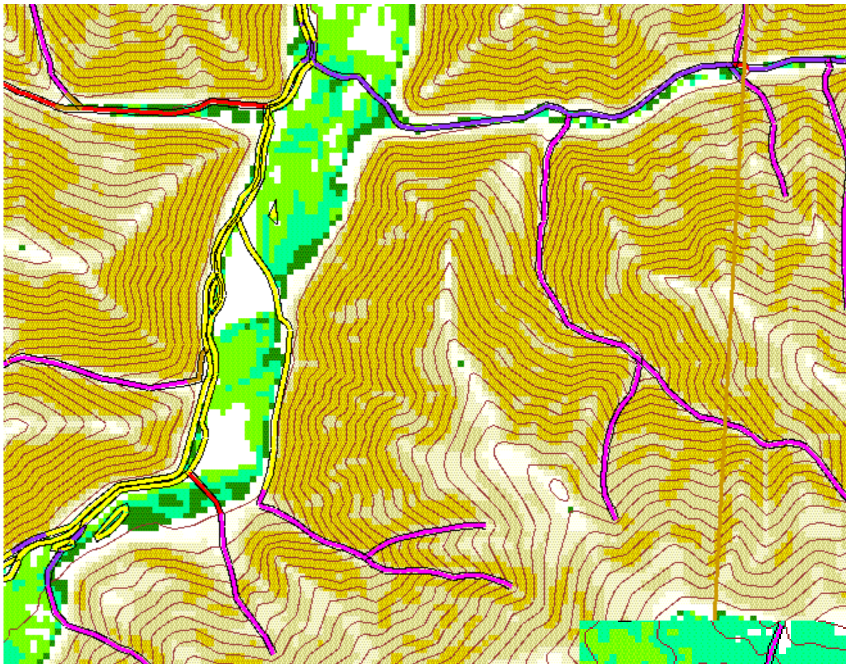
A limited set of stream reach types are nested within any given valley segment. These reach types commonly break where there are changes in adjacent geo-climatic or geomorphic land units, and reflect corresponding changes in valley confinement, width/depth ratios, stream gradient and sinuosity, pool-riffle ratios and in-channel particle size distribution. Landscape geomorphology, basin morphometrics and hydrographic properties influence sediment production and delivery, stream flow regimes, and stream energy processes that affect channel response to natural or human induced disturbances. Characterization of valley segment types facilitates classifying the stream network into major functional components that define broad similarities in fluvial processes, sediment transport regimes, and riparian interactions.

The capacity of a Geographic Information System (GIS) to associate the attributes of numerous geo-referenced data sets one with another and spatially evaluate and display these attributes has added greatly to our ability to model and evaluate the occurrence and distribution of valley-floor types, their associated riparian habitats and unique stream channel features. For watersheds within the demonstration ecological unit in the GYA, digital themes of geo-referenced valley segment maps were produced to identify these predictable and repeatable patterns in valley segment and stream channel categories. This information was generated using a stream classification model developed for Region One of the U.S. Forest Service. Summary data tables and maps representing the model outputs are included for demonstration purposes.

As with other aspects of this project, this information is not intended to serve as a definitive work on the characterization of valley and stream types, but rather to present information derived from some of the currently available data sets and analysis methods.

MODELING VALLEY AND STREAM PHYSIOGRAPHIC FEATURES

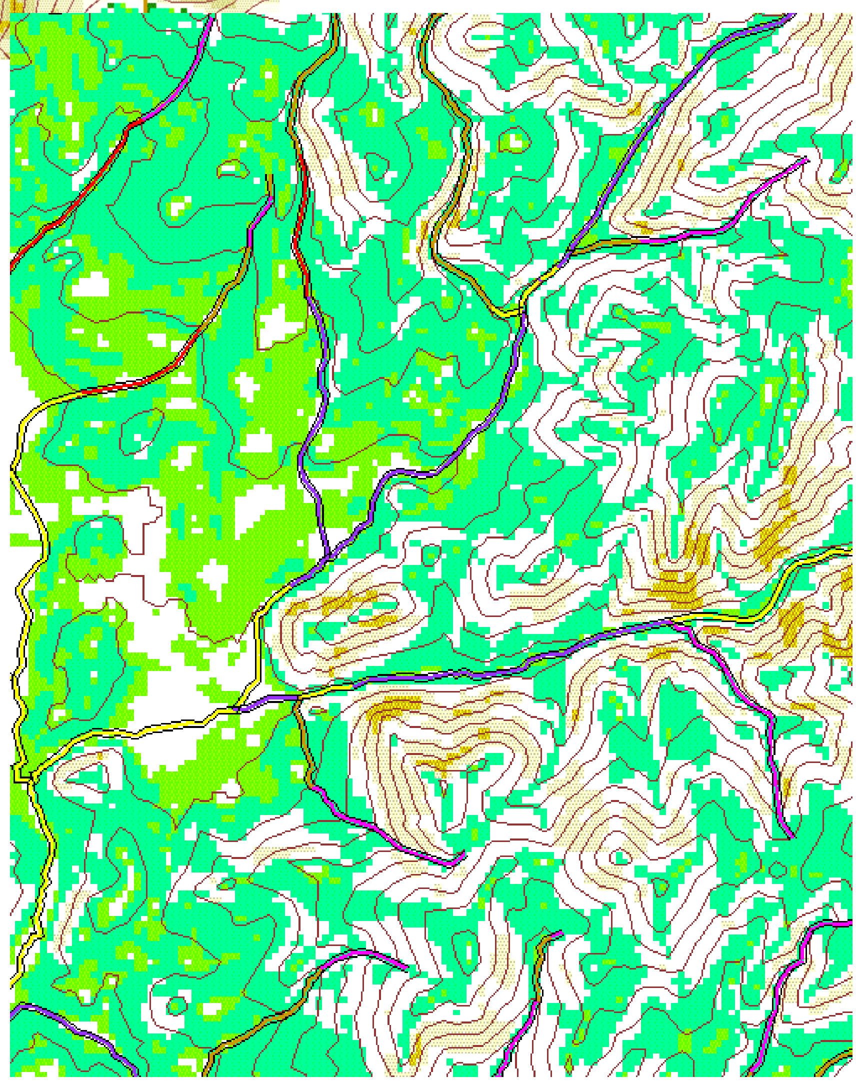
Thirty meter resolution DEM's (Digital Elevation Models) are used to associate elevation, slope and aspect attributes to Ecological Units and hydrography.



Gradient and sinuosity are calculated for, and attributed to stream segments of user defined lengths.

Stream Gradient Key

- Gradient 0 to less than 2
- Gradient 2 to less than 4
- Gradient 4 to less than 6
- Gradient 6 to less than 10
- Gradient greater than or equals 10



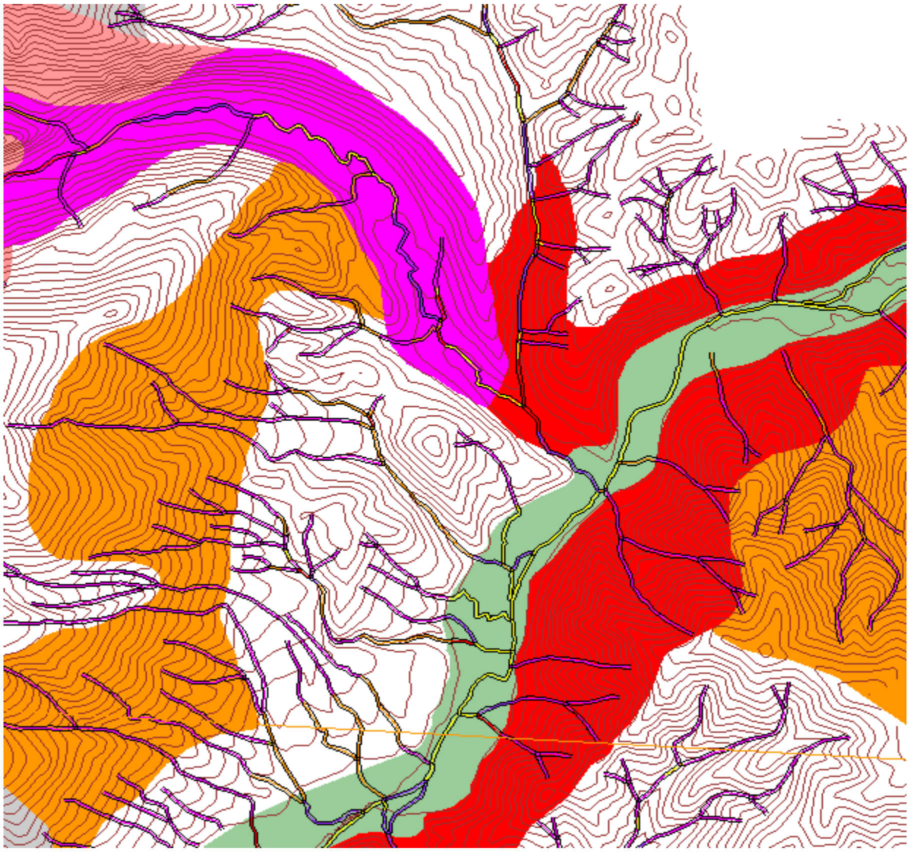
Slope Key

- Slope 0 to less than 2
- Slope 2 to less than 4
- Slope 4 to less than 6
- Slope 6 to less than 10
- Slope 10 to less than 15
- Slope 15 to less than 30
- Slope 30 to less than 45
- Slope 45 to less than 60
- Slope greater than or equal 60

Slope group classes at appropriate intervals for the level of analysis are developed from the DEM's , and associated with ecological map units and the hydrographic theme.

GEOMORPHIC ENVIRONMENTS:
A PREDICTIVE TOOL FOR STREAM CLASSIFICATION

Landscape geomorphology greatly influences basin morphometrics and hydrographic properties which in turn determine stream flow regimes, sediment production and delivery, and stream energy processes that affect stream channel characteristics.



PARENT MATERIAL AND LANDFORMS OCCUR IN PREDICTABLE AND REPEATABLE PATTERNS and have….

CONSISTENT RELATIONSHIPS WITH BASIN MORPHOMETRICS AND RIPARIAN ENVIRONMENTS
And are…

Stream Gradient Key

- Gradient 0 to less than 2
- Gradient 2 to less than 4
- Gradient 4 to less than 6
- Gradient 6 to less than 10
- Gradient greater than or equals 10

RELATED TO:

STREAM GRADIENT
SINUOSITY

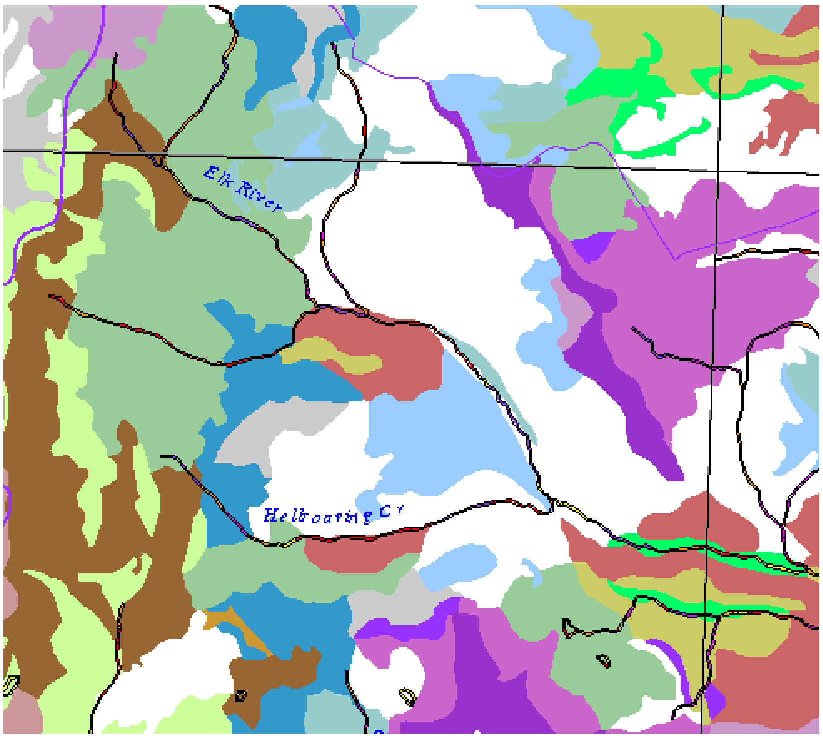
VALLEY WIDTH
STREAM WIDTH/ DEPTH RATIOS

POOL / RIFFLE RATIOS

IN-STREAM PARTICLE SIZE DISTRIBUTION

DEVELOPING A CLASSIFICATION OF VALLEY AND STREAM TYPES

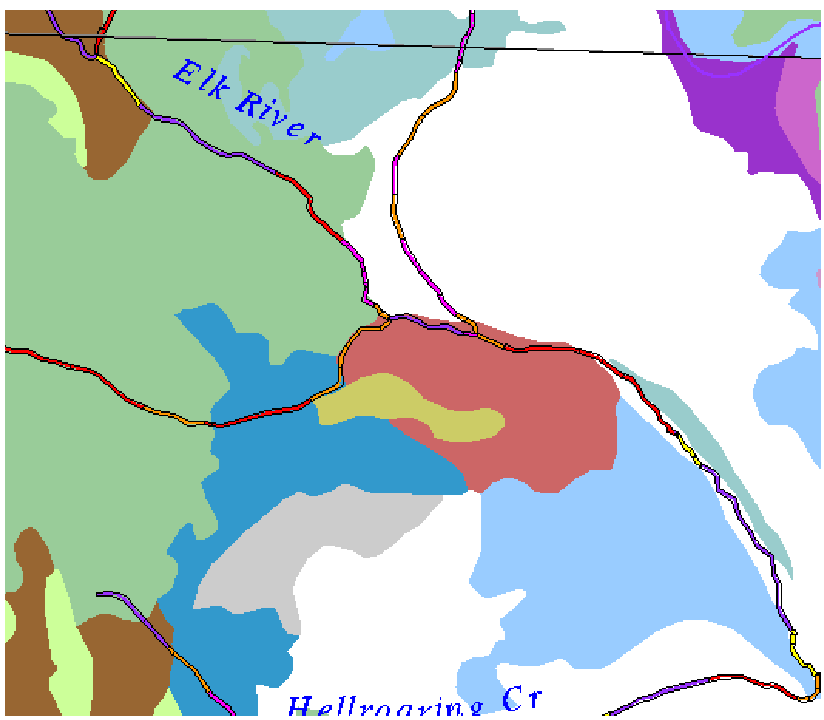
By combining ecological and physiographic attributes for the environment surrounding a stream and associating that information to the hydrographic theme, the unique features of stream segments can be analyzed and a classification of streams based on similar types can be developed. This system can then be applied to classify and compare watersheds of similar composition.



The ecological unit (i.e. Section, Subsection, Landtype Association, Landtype, soil map unit), landform, parent material and physiographic attributes of valleys through which streams flow, when associated with hydrography aids in characterizing unique stream segment types. Summarizing the occurrence of these categories within watersheds and planning units, can assist in assessing the potential impacts of management activities.

- **MODEL DOCUMENTATION**
- **EXAMPLE MAPS by Watershed**
  LTA/Stream Class
  10020004100
  10020008030
  10020007090

  Physiography/Stream Class
  10020004100
  10020008030
  10020007090
- **EXAMPLE ATTRIBUTE DATA**
- **SOURCES**



FISHERIES HABITAT POTENTIAL

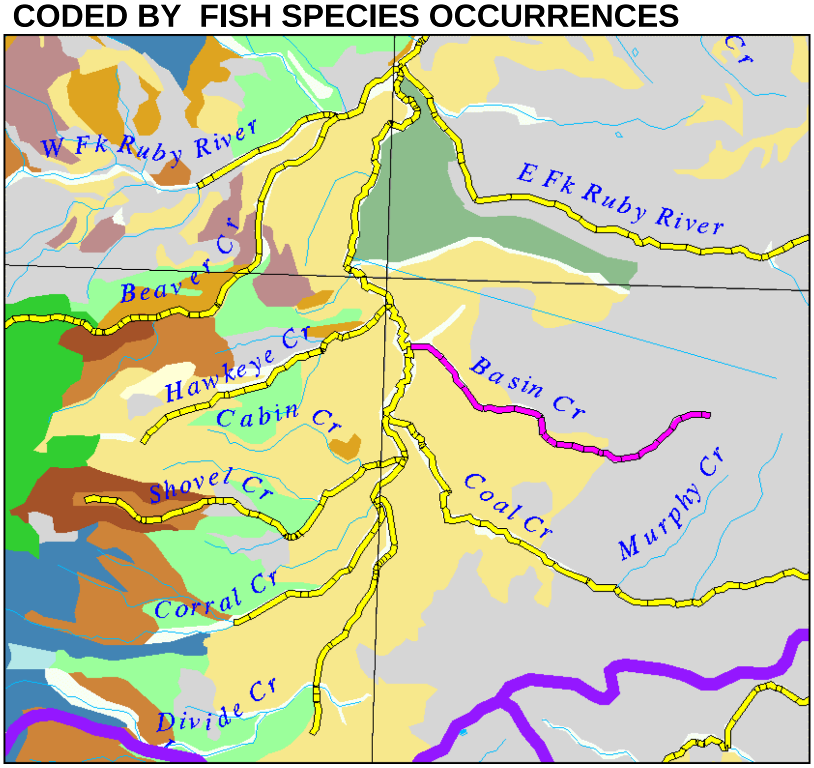
The final application that has been developed for this study of the Greater Yellowstone Area is an investigation into the relationships between the Landtype Association level ecological units and the occurrence of fish species for selected locations within the demonstration ecological unit M332En.

The Montana Department of Fish, Wildlife and Parks maintains an extensive tabular database of information collected by fisheries biologists in which field survey results are recorded for all fish species located in any surveyed stream segment. Stream segments are coded by reach and watershed. Fisheries data from this database were selected for streams within the Madison and Ruby watersheds that occur within Section M332En- the Gravelly Snowcrest Mountains, and for which Landtype Association mapping was available.

Within this demonstration area, 346 miles of stream with LTA information had been surveyed and contained one or more species of fish. The fisheries data from these stream segments were associated with a hydrography theme developed from the stream classification modeling procedures, which had been spatially associated with LTA and other ecological unit attributes, in addition to stream gradient and sinuosity classes. The following charts display the miles of stream occupied by selected fish species within the groups of Landtype Associations found within the demonstration area.

Due to time constraints, the appropriate level of statistical analysis necessary to adequately evaluate this information for any significant relationships was not completed. However, as with other aspects of this project, the spatial analysis methods developed are intended to provide a template and prototype for more intensive investigations, and a context for interpretations.

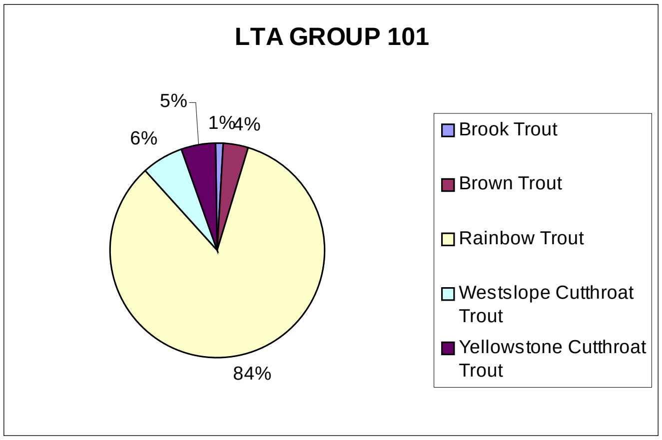
EXAMPLE OF STREAMS
CODED BY FISH SPECIES OCCURRENCES



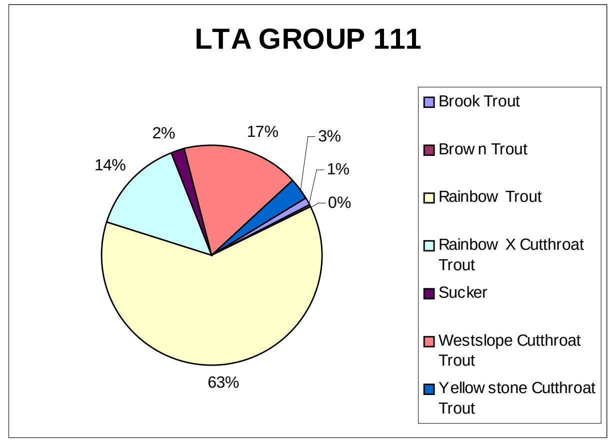
MAP

SOURCES AND LINKS

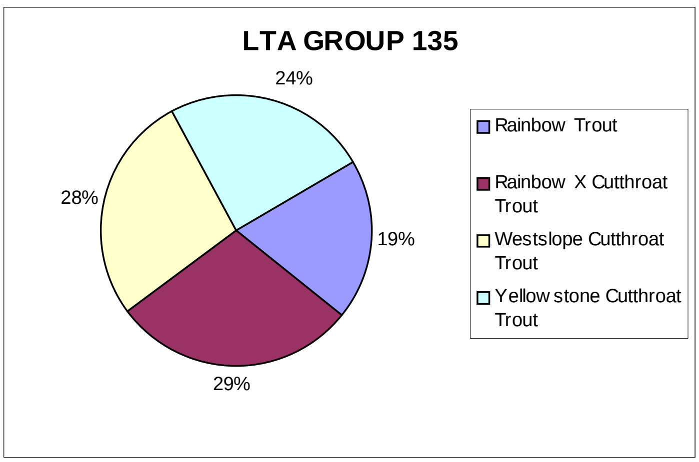
FISH SPECIES OCCURRENCES WITHIN LANDTYPE ASSOCIATION GROUPS
(NOTE: Color codes on charts are not consistent by species)



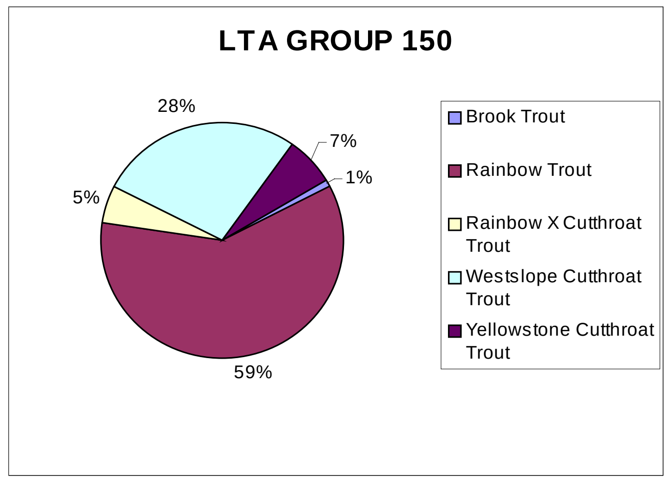
101-- Alluvial Valley and Tertiary Sediments, coarse
LTA's 10, 12, 69



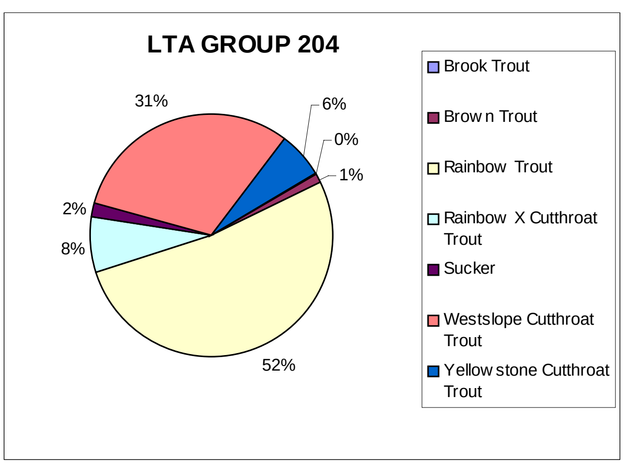
111 -- Alluvial Valleys and Tertiary Glacial Sediments, fine
LTA's 11, 13, 14, 17, 83



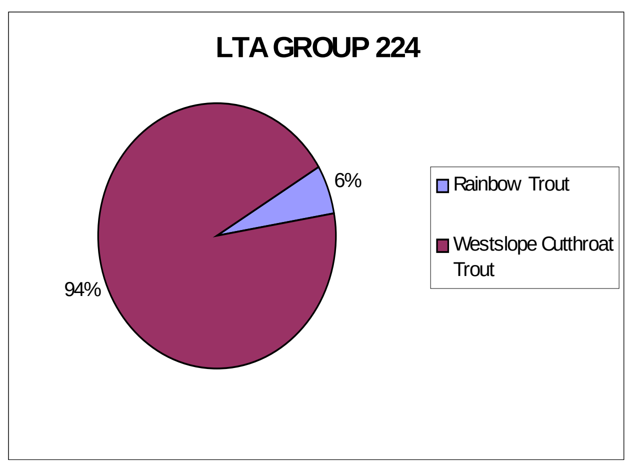
135 -- Rolling Hills, loess/ash surface
LTA's 80, 82, 84, 85



150 -- Mass Wasted and Colluvial Slopes, mixed
LTA's 90, 92

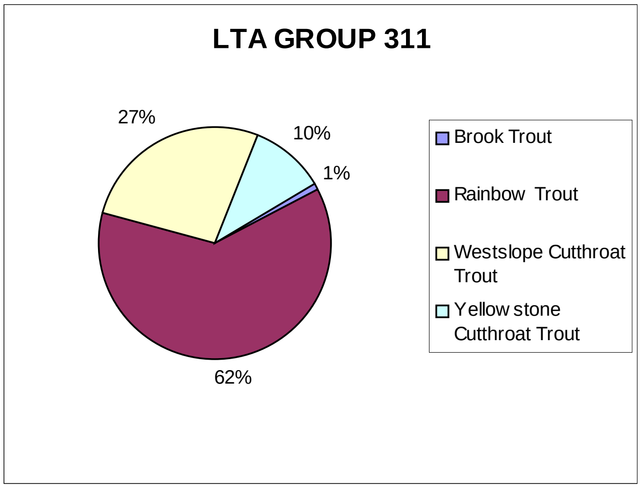


204 -- Steep Mountain Slopes and Breaks, mixed
LTA's 20, 24, 25, 28, 34, 36, 39, 40

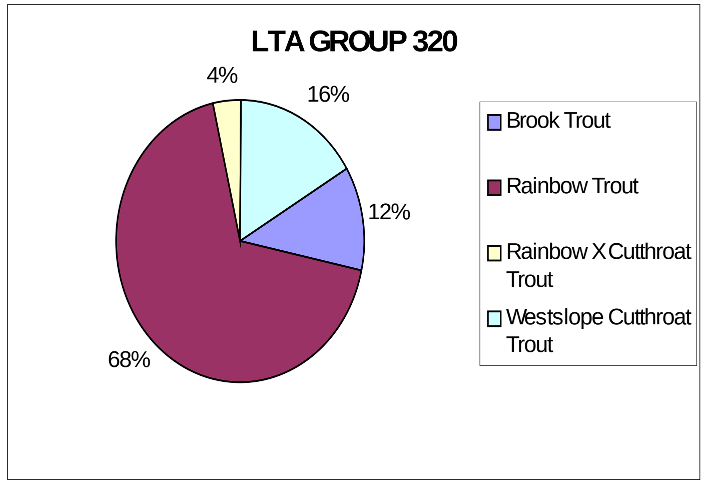


224 -- Steep Mountain Slopes and Breaks, Granitics
LTA's 21, 22, 41, 46

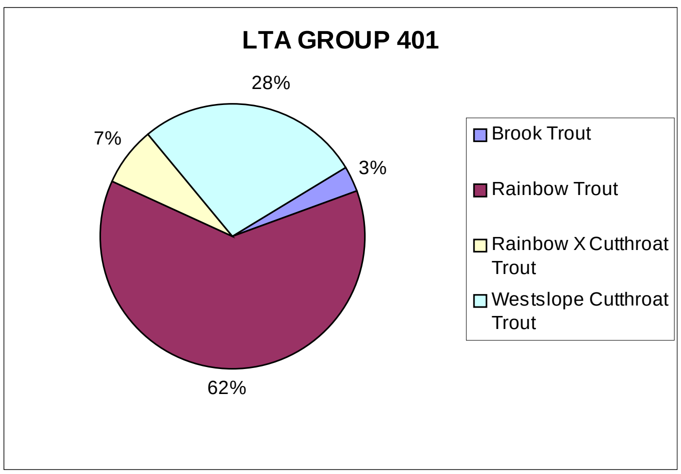
FISH SPECIES OCCURRENCES WITHIN LTA GROUPS (cont.)



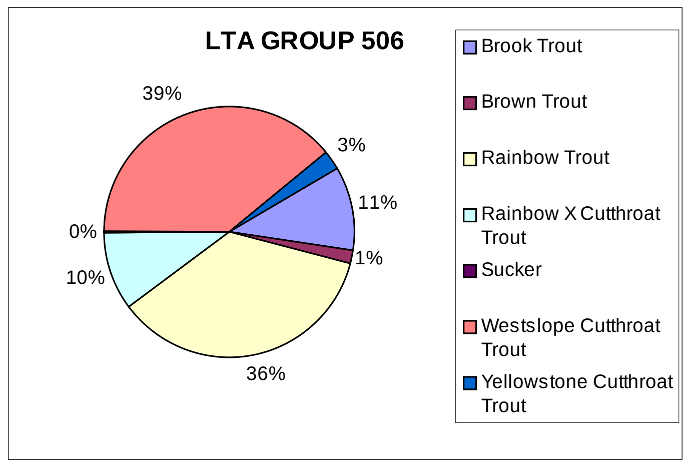
311 -- Glacial Till, medium
LTA's 50, 51, 54



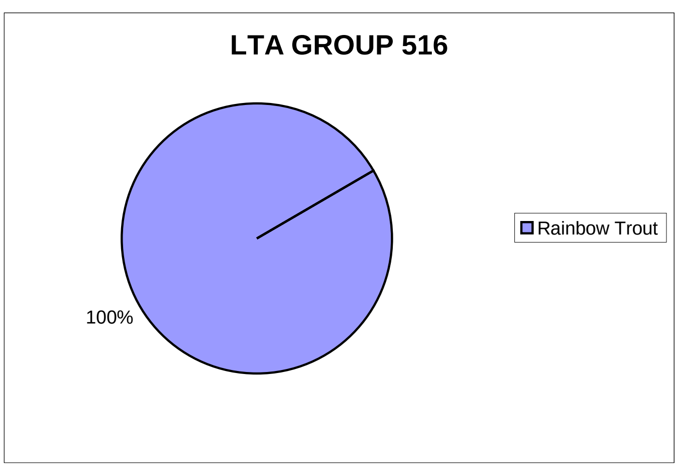
320 -- Glacial Till, fine
LTA's 53, 58



401 -- Mountain Ridgetops, mixed
LTA's 35, 45, 70, 71, 72, 73, 74, 75



506 -- Mountain Slopes, mixed
LTA's 23, 26, 27, 29, 37, 43, 57, 59



516 -- Mountain Slopes, granitic
LTA's 61, 62, 81

DOCUMENT SUMMARY

The information presented in this document has been developed with the intention or providing land managers, and other interested individuals, examples of the type and extent of data sets and analysis methods that are currently available for characterizing the natural features of landscapes within the United States. As is mentioned throughout the document, this set of information is by no means comprehensive. One of the primary objectives was to demonstrate methods for ecological characterization and analysis, and to provide a set of templates for future efforts of this nature. In order to develop what has been summarized on this CDROM, numerous GIS programs and tabular data analysis applications have been written; and a wealth of more extensive spatial and tabular data sets for the Greater Yellowstone Area now exist. We encourage those who find this document useful to explore the use of these analysis methods for providing ecological characterizations of other locations of interest. We also encourage land managers, both private and public, to incorporate this, and like information and tools in their planning efforts. Finally, we hope to have demonstrated the importance of readily available, high quality environmental data, and the necessity of supporting the efforts of scientists who map, analyze and characterize our natural environment.

ACKNOWLEDGMENTS

The information that we have presented here represents the collective work of individuals from the USDA Natural Resources Conservation Service, Region One of the U.S. Forest Service, and the Montana State Library Natural Resource Information System (NRIS). We would like to thank the countless other individuals whose specialized work over the years has resulted in the wealth of environmental data sets we were able to incorporate. Many thanks also to our supervisors, colleagues, friends and families for their patience and support.