March 18, 2005

Dear Gardiner Basin Restoration Workshop Participant:

Thank you for agreeing to be a part of our workshop! Our goal is to develop recommended long-term restoration/ management plans for approximately 1200 acres of former agricultural fields within Yellowstone National Park and Gallatin National Forest.

By the end of the workshop we want to have written restoration recommendations, including feasibility, methodologies, timeframes and costs, which we can take to our agencies as recommended restoration plans.

We have assembled the enclosed information so that you can familiarize yourself with the challenges we face, and "hit" the ground running. We look forward to three days packed with productive and stimulating discussions.

Please contact us as you finalize your travel plans and as questions arise. And to those of you who have not sent us your biographical sketches—please do so and we will send everyone an updated version.

On behalf of the steering committee, thank you. We look forward to seeing you in April.

Mary M. Hektner
Chair, Steering Committee

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Invited Workshop Attendees, Steering Committee, and Facilitator

Invited Workshop Attendees

Jerry Benson
Restoration Specialist
BFI Native Seeds
1145 South Jefferson Ave.
Moses Lake, WA 98837
Phone 509-750-1789 (cell)
Jbenson @bfinativeseeds.com

Greg Eckert
Restoration Ecologist, National Park Service
Natural Resource Program Center
1201 Oak Ridge Drive, Suite 200
Ft. Collins, CO 80525
Phone: 970-225-3594; fax 970-225-3585
greg_Eckert@nps.gov

Reginald Hoff
Closed Mine Manager
Big Sky Coal Company
PO Box 97
Colstrip, MT 59323
Phone 406-748-2321 ext 5759
rhoff@peabodyenergy.com

Larry Holzworth
Plant Materials Specialist
Natural Resources Conservation Service
10 East Babcock Rm 443
Bozeman, MT 59715
Phone 406-587-6838; fax 406-587-6761
larry.holzworth@mt.nrcs.usda.gov

Jim Jacobs
Research Assistant Professor
Montana State University
Dept. of Land Resources & Env. Sciences
334 Leon Johnson Hall
Bozeman, MT 59717-3120
Phone 406-994-6749; fax 406-994-3933
jsjacobs@montana.edu

Dennis Neuman
Director, Reclamation Research Unit
Montana State University
Dept. of Land Resources & Env. Sciences
106 Linfield Hall
Bozeman, MT 59717
Phone 406-994-4822 ; fax 406-994-4876
dneuman@montana.edu

Roger Rosentreter
Botanist
Bureau Land Management
1387 South Vinnell Way
Boise, ID 83709
Phone 208-373-3824; fax 208-373-3964
roger_rosentreter@blm.gov

Jerry Schuman
Soil Scientist
High Plains Grasslands Research Station
8404 Hildreth Road
Cheyenne, WY 82009
Phone 307-772-2433 x 107, fax 307-637-6124
jerry.gschuman@ars.usda.gov

Tom Toman
Field Biologist
Rocky Mountain Elk Foundation
2291 W. Broadway
Missoula, MT 59808
Phone 406-523-3443
tom@rmef.org

Scott Westphal
Regional Director
Rocky Mountain Elk Foundation
192 Hwy 12 E. #17
Townsend, MT 59644
Phone 406-266-3042, cell 406-253-2432
swestphal@rmef.org

Steve Whisenant
Department Head & Professor, Ecological Restoration
2126 Texas A&M University
Dept. of Rangeland Ecology and Management
College Station, TX 77843
Phone 979-845-5579, Fax 979-845-6430
s-whisenant@tamu.edu

Cathy Zabinski
Assistant Professor
Montana State University
Dept. of Land Resources & Env. Sciences
334 Leon Johnson Hall
Bozeman, MT 59717-3120
Phone 406-994-4227, fax 406-994-3933
cathyz@montana.edu

Workshop Steering Committee

Lynn Burton
Rangeland Management Specialist
Gallatin National Forest
3710 Fallon St, Suite C
Bozeman, MT 59718
Phone 406-522-2540 or 406-222-1892
Fax: 406-222-2528
lburton@fs.fed.us

Roy Renkin
Vegetation Management Specialist
Yellowstone Center for Resources
P.O. Box 168
Yellowstone National Park, WY 82190
Phone 307-344-2161; fax 307-344-2211
roy_renkin@nps.gov

Mary Hektner
Vegetation Section Chief
Yellowstone Center for Resources
P.O. Box 168
Yellowstone National Park, WY 82190
Phone 307-344-2151; fax 307-344-2211
mary_hektner@nps.gov

PJ White
Ungulate Biologist
Yellowstone Center for Resources
P.O. Box 168
Yellowstone National Park, WY 82190
Phone 307-344-2442; fax 307-344-2211
pjwhite@nps.gov

Monica Pokorny
Restoration Program Coordinator
Center for Invasive Plant Management
Montana State University
334 Leon Johnson Hall
Bozeman, MT 59717-3120
Phone 406-994-6599; fax 406-994-1889
mpokorny@montana.edu

Workshop Facilitator

Will Murray
Facilitator
Conservation Impact, LLC
1792 Wynkoop Street, Suite 307
Denver, CO 80202
Phone 303-223-4886; fax 303-223-4886
will@conservationimpact.com
www.conservationimpact.com

Biographical Sketches of the Invited Workshop Attendees

Jerry Benson is a consultant for numerous agencies, private companies and non-profit organizations in the area of restoration and vegetation management. He was employed as a habitat restoration ecologist with the Washington Department of Fish and Wildlife for 30 years, while also operating a farming and specialty seed business. Jerry's undergraduate work was in botany at Central Washington State University, with graduate work in plant physiology.

Jerry has provided habitat investigations, directed wildlife habitat mitigation associated with hydroelectric projects, administered agricultural and grazing leases on public land, conducted weed management research, coordinated range re-vegetation following fire and abusive practices, and managed numerous weed control programs. Jerry's ESA projects are some of the most comprehensive native plant community restoration projects to be found in the Northwest. He also regularly provides herbicide training for staff recertification programs.

He is a member of the Washington State Weed Association, Director of Cal/West Seeds Co., past-president of the Mid-Columbia chapter of the Society for Range Management, was WDFW Employee of the year in 1997, and earned the Adams County Conservation District's Conservation Service Award in 1990. He resides at Moses Lake, Washington.

Greg Eckert is the Manager of Ecosystem Management and Restoration Programs for the NPS Natural Resources Washington Office. This office serves National Park Units across the country. Greg has over 20 years experience in scientific land management through work experiences with the US Peace Corps (fisheries extension), the US EPA (hazardous waste management and remediation) and The Nature Conservancy (conservation planning, management and restoration) and his doctoral program at the University of Georgia (ecosystem restoration, mycorrhizal and soil ecology). Greg's current duties include direct technical assistance to park s for specific restoration and ecosystem management questions, such as the topics below

- Assessment of ecological barriers to restoration in degraded lands
- Ecological restoration planning and implementation
- Ecological principles for management and restoration
  The role of grazing in parks
- Soil ecology (biogeochemical processes and biota sampling and data evaluation)
- Mycorrhizal ecology, assessment, inoculum development
- Identification of native plant material and restoration technology resources
- Ecosystem and landscape ecology
- Development of ecological indicators for restoration projects

Greg also works with parks and other NPS and non-NPS programs, such as hazardous waste management, weed control, fire management, landscape conservation and wildlife contaminants to integrate these into park restoration projects. Other duties are to develop technical policy for the National Park System. Greg hopes to use the Yellowstone workshop as an opportunity to apply Servicewide program direction and to also "test" draft management concepts and tools.

Reginald (Reg) Hoff is the Closed Mine Manger at Big Sky Coal Company owned by Peabody Energy in Colstrip, Montana. After graduating from Montana State University, Hoff was employed by the Montana Cooperative Extension Service for 6 years as a County Agricultural Extension Agent. In 1978 he went to work for Peabody Coal Co, as a reclamation and grading supervisor, later reclamation manager, currently Closed Mines Manager. Reg Hoff received the Reclamationist of the Year award in 2000 from the American Society of Mining and Reclamation. In addition to his reclamation work, he also operates a cow-calf ranch and irrigated farm north of Forsyth, Montana.

Larry K. Holzworth earned a Bachelor of Science Degree in Agronomy from Colorado State University and postgraduate work in Agronomy at the University of Arizona. He has worked 33 years for the USDA-Natural Resources Conservation Service (NRCS). The mission of the NRCS is to provide leadership, in a partnership effort, to help people conserve, improve, and maintain our natural resources and environment. He has worked in three Colorado NRCS Field Offices as a Soil Conservationist assisting landowners with conservation plans. He has worked 30 years with the Plant Materials program, first as a Plant Materials Center Manager (6 years) and at his current position as a Plant Materials Specialist assisting NRCS Field Offices and landowners in Montana and Wyoming. The NRCS Plant Materials Program mission is to provide timely and effective vegetative solutions for identified resource needs. He serves as a technical coordinator for the Bridger, MT Plant Materials Program in Montana and Wyoming and his duties include: 1) on-farm research on plant performance and adaptation, demonstration plantings and promotional tours, 2) grass and legume seed production, 3) cultural and management technique studies, and 4) on-site technical assistance on landowner resource concerns. Larry has lead the Cooperative Evaluation of Western Hemisphere Grassland Germplasm project in Inner Mongolia (1991, 1993, and 1998), participated with the ARS National Plant Germplasm System on forage germplasm collection trips to Xinjiang (1997) and the Tibetan Plateau in Gansu and Sichuan Provinces (2000), and participated in a Scientific and Technical Exchange to Mongolia in 1996 and 2002. He has organized and hosted several Chinese and Mongolian scientist tours for observing Northern Great Plains grasslands, range management practices, pasture and hayland, reclamation, restoration and grass and legume seed production.

James (Jim) Jacobs is a Research Assistant Professor in the Department of Land Resources and Environmental Sciences at Montana State University, Bozeman, Montana. For the past 12 years Dr. Jacobs' research has focused on developing integrated management of invasive rangeland species, including various combinations of herbicides, grazing, prescribed burning, or biological control insects in revegetation and restoration of highly degraded sites. He takes an ecological approach incorporating concepts of succession, species interactions, limiting resources, ecosystem function, population, and community theories in his research. Dr. Jacobs is currently working on restoration and revegetation projects involving spotted knapweed/cheatgrass, Dalmatian toadflax, and leafy spurge invaded plant communities.

Dennis R. Neuman is Director and Research Scientist in the Reclamation Research Unit, and Adjunct Assistant professor in the Land Resources & Environmental Sciences

Department at Montana State University. For the past 30 years, he has been involved in land reclamation/restoration research and policy issues on drastically disturbed sites in Montana, Colorado, Idaho, Wyoming, and South Dakota. These lands include semi-arid areas strip mined for coal, historic hard rock mines, transportation corridors, and some of the nation's largest Superfund sites. Emphasis has been of ameliorating plant limiting conditions (acidity, phytotoxicity, and fertility), species selection, and monitoring vegetation and soil response variables. Soil column studies, greenhouse investigations, and large scale field studies have been conducted. Dr. Neuman has helped establish reclamation/restoration policy for state and federal land management (USFS, BLM) and risk management (USEPA) agencies. He is the Chairman and co-convener of the Billings Land Reclamation Symposium and is currently the chairman of the Western Coordinating Committee (USDA) on Revegetation and Stabilization of Deteriorated and Altered Lands.

Roger Rosentreter has been the Bureau of Land Management State Botanist for Idaho since 1985. Dr. Rosentreter is interested in sagebrush steppe habitats and in the role of biological soil crusts and weeds in the arid west. He is a trainer for the National Forest Health Monitoring Program and is interested in rangeland health monitoring methods. Since 1980, Roger has worked on mining and fire rehab projects, including several large post-fire rehab projects over 100,000 acres. He currently is an instructor for a BLM class on "Selecting Native Plant Materials to Meet Management Goals. He is also an avid kayaker and gardener.

Gerald (Jerry) E. Schuman is a Research Soil Scientist with the Rangeland Resources Research Unit, USDA, Agricultural Research Station at Cheyenne, Wyoming. Dr. Schuman's major research interests include soil organic carbon and nitrogen dynamics as affected by rangeland management, the role of grasslands in CO_2 sequestration, soil quality and rangeland health, waste utilization on rangelands, and land reclamation. He has served as a adjunct faculty member of the University of Wyoming, Department of Renewable Resources, for over 25 years and has guest lectured for classes in Restoration Ecology, Soil Microbiology, Reclamation of Drastically Disturbed Lands, and Forest and Range Soils. He is a member of the steering committee for the Wyoming Abandoned Coal Mine Land Research Program administered by of the Office of Research at the University of Wyoming. He also serves on the faculty at Colorado State University as a faculty affiliate in the Department of Soil and Crop Sciences.

Tom L. Toman is the Director of Conservation, Rocky Mountain Elk Foundation. Raised in Wyoming, Tom earned an Associate of Science degree in Zoology from Casper College as well as a bachelor's degree in Wildlife Management and Conservation from the University of Wyoming. Tom served for 24 years with the Wyoming Game and Fish Department, the last 18 years as the Regional Supervisor in Jackson, Wyoming. In this capacity, Tom was responsible for all terrestrial wildlife programs including non-game and watchable wildlife. He completed his master's degree in Public Administration from the University of Wyoming during his career with the department. Tom currently serves as the Rocky Mountain Elk Foundation staff biologist and coordinates projects in the habitat enhancement, wildlife management and wildlife research categories. He serves as a consultant and trainer to other wildlife biologists throughout the U. S. and Canada in habitat enhancement work. He also lends his expertise to wildlife professionals in the trapping, handling and transporting of elk to assist relocation and restoration efforts throughout North America. Tom is a Certified Wildlife Biologist.

Scott Westphal is the Regional Director of the Rocky Mountain Elk Foundation (RMEF) responsible for fundraising events for 11 chapters in Eastern Montana. Scott got involved with the Foundation in 1988 as a committee member on the Flathead Valley Chapter in Kalispell, Montana. He served on that committee for 11 years serving as its Chairman for two years and as a Habitat Partner Coordinator for four years. Scott became one of the first District Chairs for the RMEF and served in that capacity as a Development Team Leader for several years during the Royal Teton Ranch (RTR) acquisition. The team brainstormed and developed the first “Adopt a Project” plan that was instrumental in raising many funds for the RTR from across the whole country. Scott became the Montana State Chairman for two years as a voting member of the Montana Project Advisory Committee. He then became the Northwest Regional Chairman for Alaska, Washington, Oregon, Idaho, Montana, North Dakota, South Dakota, and Wyoming.

After a little over a year as the NW Regional Chairman Scott was asked to become the Lead Regional Chairman for all of the U.S. He sat on the Finance Committee of the Board of Directors for 2 years and also on the CEO Selection Committee. He has set up and facilitated many volunteers on projects in Montana, the largest being the annual Lost Trail National Wildlife Refuge-fence pull, west of Kalispell. Over the last four years the volunteers have dropped, rolled up and hauled out over 115 miles of barbed wire and removed around 2500 wooden post from the refuge. Scott also works with many agency folks for habitat enhancement and stewardship opportunities as well as conservation easements and acquisition possibilities.

Steven G. Whisenant is Professor and Department Head in the Department of Rangeland Ecology & Management at Texas A&M University, College Station, Texas. For over 25 years, Dr. Whisenant’s teachings, research, and consulting activities have addressed a wide range of ecological restoration and natural resource management issues. Dr. Whisenant’s restoration approach emphasizes 1) assessing and repairing primary processes (hydrology, nutrient cycling, and energy capture), 2) considering the restoration site within a landscape context, and 3) viewing the ‘repair’ process as a beginning of natural repair processes. He is a member of the Society for Ecological Restoration Board of Directors, and was recently awarded the Society for Range Management’s Outstanding Achievement Award. Steven Whisenant is author of Repairing Damaged Wildlands: a Process-Oriented, Landscape-Scale Approach. He works on restoration and management programs worldwide, including the United States, Kuwait, Syria, Jordan, Saudi Arabia, Iran, Turkey, Malaysia, Costa Rica, Poland, Spain, Argentina, China, Taiwan, Australia, and Niger.

Cathy Zabinski is Assistant Professor in the Department of Land Resources and Environmental Sciences at Montana State University, Bozeman, Montana. Dr. Zabinski's research addresses both disturbed and undisturbed natural systems. She is interested in understanding how to better restored impacted areas. Her focus has been on the belowground ecology of weed-invaded systems, metal-contaminated sites, and recreation-impacted high elevations sites.

Purpose and Need

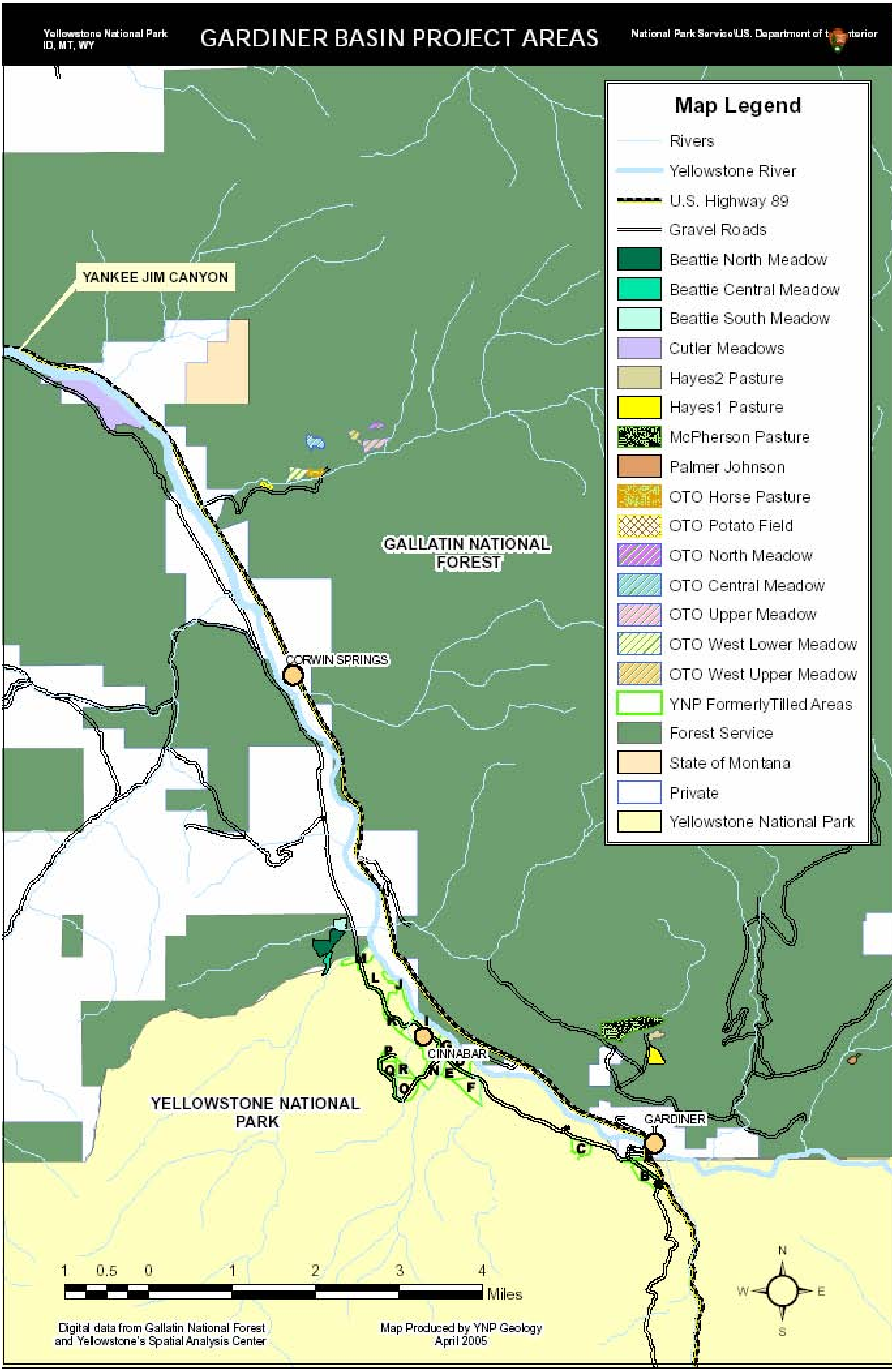
Yellowstone National Park and Gallatin National Forest both have land in the Gardiner Basin (defined as the Yellowstone river valley from Gardiner, Montana north to Yankee Jim Canyon) that was acquired for wildlife habitat. The lands are former agricultural fields dominated by exotic weeds and they provide poor forage for ungulates.

This area is especially important to Yellowstone's pronghorn herd, a herd that has dwindled from 600 animals in the early 1990's to around 200 animals today. A variety of attempts to reclaim portions of this park area to native vegetation communities have failed.

The soils and climate of the Gardiner Basin most closely approximate the Semi desert Ecological Province rather than the Southern Rocky Mountain Coniferous Forest Province more typical of Yellowstone and Gallatin NF. We lack in-depth knowledge of how to restore such an area to more pristine conditions. Areas dominated by crested wheatgrass, alyssum or Russian thistle have proven especially difficult to restore.

The purpose of this workshop is to bring together experts in arid land restoration to help the agencies develop recommended long-term restoration/ management plans for approximately 1200 acres of former agricultural fields within Yellowstone National Park and Gallatin National Forest.

By the end of the workshop we want to have written restoration recommendations, including feasibility, methodologies, timeframes and costs, which the agencies can as use as guidelines towards restoring ecologically sustainable native plant communities.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GARDINER BASIN PROJECT AREAS
National Park Service/U.S. Department of t
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Rivers
Yellowstone River
U.S. Highway 89
Gravel Roads
Beattie North Meadow
Beattie Central Meadow
Beattie South Meadow
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Hayes1 Pasture
McPherson Pasture
Palmer Johnson
OTO Horse Pasture
OTO Potato Field
OTO North Meadow
OTO Central Meadow
OTO Upper Meadow
OTO West Lower Meadow
OTO West Upper Meadow
YNP FormerlyTilled Areas
Forest Service
State of Montana
Private
Yellowstone National Park
YANKEE JIM CANYON
GALLATIN NATIONAL FOREST
CORWIN SPRINGS
CINNABAR
GARDINER
YELLOWSTONE NATIONAL PARK
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Digital data from Gallatin National Forest
and Yellowstone's Spatial Analysis Center
Map Produced by YNP Geology
April 2005

BRIEF VEGETATION AND LAND USE HISTORY IN THE BOUNDARY LANDS AREA OF YELLOWSTONE NATIONAL PARK

Historically, little is known about the character of the early vegetation communities in the Boundary Lands Area (BLA) of the park. As described and cited in Houston (1982), the BLA was variously described by early travelers as…"very rough and barren, has a little of the appearance of the Badlands of the Missouri River" and …"as passing from a dead alkali plain to a succession of plateaus covered with sterile soils", probably in reference to the mudflows.

The area inside the park was first settled by James Henderson by 1971, just SE of where the Stevens Creek Road leaves the county road. By 1875, at least one other homestead was settled in the area by George Reese. Both these families pastured stock on the open range, cultivated land, and built irrigation ditches in support of ranch operations (Henderson from Stevens Creek, Reese from Reese Creek). In the case of Reese, 2 acres of oats and vegetables and another acre of tame grass were cultivated on his 100-acre spread. Another nearby settler, James Clark, cultivated "6 or 7 acres".

Over the next decade, a series of complex land transactions and settlements took place: the mining town of Horr (later Electric) was established just outside park boundaries, the railroad began to claim lands or otherwise secure right-of-way passage, the railroad terminal town of Cinnabar (in field H) was established, and other claims established or land transfers were conveyed (Chadbourn, Pickering, Stevens, Huston, Keeney, Hobart). Hugo Hoppe, in an apparent land trade with Henderson, raised potatoes and oats on "30 acres", possibly nearby to his water rights claim on Wilson Creek at the head of Spring Creek inside park boundaries.

The heyday of Cinnabar lasted from 1883 with the arrival of the railroad until 1902, when the railroad line was completed to Gardiner. By 1903, the fortunes and activity of Cinnabar were in decline. The area reverted to "quiet ranch country", but the complex series of settlements, land swaps, purchases, and conveyances continued. At least the opportunity for new claims was slowed in 1917, when a presidential proclamation (by Woodrow Wilson) withdrew certain federal lands north of the park boundary from patentability "in aid of legislation". In 1919, another such proclamation closed all such federal lands from entry under the public lands law. That same year, park officials disseminated what was known as the Graves Nelson Report for the protection and perpetuation of the northern Yellowstone elk, antelope, and deer herds. The report contemplated and recommended the acquisition by the federal government of a great many small tracts of private land in the territory between Gardiner and Yankee Jim Canyon to the north. In following through with this vision, YNP Superintendent Horace Albright courted two New York businessmen, Thomas Cochran and George Pratt, into founding the Game Preservation Company in 1922. The intent of the Game Preservation Company was to purchase or acquire private lands for donation to the federal government, contingent upon legislation (finalized in 1926 and 1928) in support of such an endeavor and matching government funds to obligate towards land purchases.

Securing additional lands outside current park boundaries would contribute to wildlife and wildlife habitat management practices of the time. From park inception in 1872 until the 1930's, YNP management approach to wildlife along the northern park boundary was one of "protection"—from poaching inside park boundaries, from losses sustained by predators, and from winter migration beyond park boundaries where legalized but unregulated hunting could conceivably decimate the herds. Wildlife habitat management, therefore, consisted of supplying "adequate safe winter range", with attempts to supplement the winter diet of ungulates during extreme cold or drought conditions. To accomplish this, the park "farmed" certain areas into production of "hay"—mostly alfalfa and oats, later to include timothy, clover, and smooth brome. These ranches—in Lamar Valley, Slough Creek, Yancey's Hole, and inside the park boundary adjacent to the townsite of Gardiner (fields A and B)—were variously tilled, planted, irrigated, and harvested annually to provide a winter forage base as well as to "hold" animals within park boundaries. The Gardiner Ranch went into production in 1904.

One of the key parcels for acquisition north of the park belonged to Walter Hoppe (son of Hugo), who added to his estate by purchasing much of the area following the demise of Cinnabar as well as acquiring other parcels from family members. Because of the large wintering herds of ungulates, rangers were living on his ranch during the winters of 1922-23 and 1923-24 to keep elk out of his haystacks and mend damaged fences while performing their boundary patrol tasks. About 225 acres were irrigated and under cultivation, and the NPS bought oats from Hoppe to feed NPS horses. Some of Hoppe's stock were also grazing the ranch.

The Game Preservation Company bought out the Hoppe Ranch of nearly 1,000 acres in October of 1925, but was not able to accept title until 1931. During the interim, the ranch was placed at the disposal of the NPS for operation as a hay ranch for the feeding of elk, deer, and antelope, as well as government horses. The cultivated lands were plowed, seeded to hay, and irrigated, and all of Hoppe's stock (except for his personal horse) were required to be removed from the land. With the additional plowing/seeding of about 50 acres in 1926, some 300 acres were in hay cultivation by 1931. During this period, the ranch was known locally as the Game Preservation Ranch.

The Game Preservation Company continued to acquire private lands in the area for conveyance to the federal government (the Moseley, Stoll, Rife, and parts of the Hill and Armstrong ranches), which occurred in 1932-33. The ranchlands all contained cultivated fields for growing hay in support of stock operations and vegetables for storage/consumption. By 1932, some 530 acres of hay were under irrigation, and attempts were made to seed other disturbed portions of the ranches with "range grasses" (smooth brome, orchard grass, tall oat grass, timothy, meadow fescue) following acquisition. It was further noted that the hayfields were supporting populations of other problematic species including Canada thistle, tumbleweed, foxtail, field pennycress, whitetop, field bindweed, and mustards. But 1163 acres of private land still remained inside the boundary area added to the park (998 acres of Northern Pacific Railroad land, 20-acre Bassett-Ross ranch, 40-acre portion of the Armstrong Ranch, 100-acre Stermitz ranch, and the 5-acre portion of the Nichols-Childs ranch). The park continued to pursue title to the remaining lands, eventually acquiring the remaining parcels without assistance from private matching funds through outright purchase (Nichols-Child ranch in 1939, Bassett-Ross ranch in 1940) or “declaration of takings with just compensation” (Armstrong and Stermitz ranches in 1939). The Bassett-Ross lands were described as “arable but uncultivated” and the Nichols-Child and Armstrong properties were “without improvements”. Included in the Stermitz ranch were 51 acres of cultivated land, 12.5 acres of formerly cultivated land, and an apple/cherry tree orchard consisting of 26 trees. The railroad apparently had long-agreed to turn over its lands to the park, but did not do so until 1972, and the tracks removed from Livingston to Gardiner in 1975.

Haying operations for the purpose of winter wildlife feeding continued through 1935 at the Game Preservation and Gardiner ranches (except when harvests were interrupted by drought-related poor production in 1930-31), but the practice was being questioned. NPS Director Albright was beginning to succumb to recommendations by both NPS and independent biologists (as early as 1930) to abstain from the practice of winter feeding as means of encouraging ungulate migration out of the park. These biologists felt that winter feeding operations contributed to the overgrazing of native vegetation, which repeatedly surfaced in assessments of range condition. Albright offered that winter feeding should be used only as an “emergency” and to hold animals from migrating only “when deserved”. Such view represented a change in policy, and as early as 1936, some 300 acres of cultivated hayfields were targeted for revegetation, preferably with native range grasses. But in recognizing the lack of success in recent attempts to establish “range grasses” on portions of acquired lands, the appropriate species to plant for site conversion remained open. A September, 1936 letter from Leroy Moomaw, Superintendent of the USDA Agricultural Research Station in Dickinson, ND recommended the use of crested wheatgrass at a seeding rate of 10 lbs per acre because it was “aggressive, crowds out weeds, is drought resistant, undergoes an early green-up” and that it takes “20-25 years before native seeds would invade the crested wheatgrass fields”. Based on “successful” revegetation trials in arid western North Dakota lands, Moomaw further recommended that smooth brome and slender wheatgrass (*Agropyron tenerum= A. caninum*) be part of the seed mix with crested wheatgrass. Opposition, however, was voiced against the use of crested wheatgrass (by USDI-NPS Acting Chief of the Wildlife Victor Cahalane and botanist H.M. Jennison) because of its exotic nature and uncertainties of how the native grasses will be able to replace it over time. Nonetheless, YNP Superintendent Rodgers wrote Calahane that “crested wheatgrass will be used to reseed the Game Ranch Lands, and eventually lands will revert to native grasses”. Meanwhile, the park submitted an application to UDSI officials (in September 1936) for funds to support “the reseeding of 114 acres of formerly cultivated land plus 10 acres of virgin land from which the sagebrush has been removed and the original grasses have disappeared. Plowing, leveling, and reseeding will be by motorized equipment”.

Plans were drafted as early as 1935 for the proposed seeding of Game Ranch Lands. The proposed seed mix was dominated by crested wheatgrass, but included smooth brome, slender wheatgrass, seed oats, and in some cases tall oats and alsike clover. Apparently due to the hesitation surrounding the use of crested wheatgrass, the first fields were not seeded until 1936 and 1937, and more were scheduled for reseeding in 1938.

The NPS enlisted the services of Civilian Conservation Corps (CCC) crews in the tasks of seeding, irrigating, or otherwise tending to the project. The project fields seeded during this time were adjacent to the country and current Stevens Creek roads (fields F,E,N, and G), including the former townsite of Cinnabar (field H), and the field at the mouth of Stevens Creek (field 0). Some fields were deemed unsuccessful following seeding in 1937 (northwest portion of field N, and field P).

Even though hay operations for winter wildlife feeding in the area ceased by 1936, the remaining cultivated fields continued to be irrigated and apparently converted from alfalfa to crested wheatgrass over the course of the next decade, probably in relation to their acquisition. Successful conversion of the fields was not always immediately achieved, and various reseeding attempts on the fields continued into the in early 1940's, especially on the most recently acquired cultivated fields. In response to a consideration of producing hay on a commercial basis, Superintendent Rodgers wrote to the NPS Regional Director in 1943: "Since 1937, we have spent considerable sums of money and attempted in every possible way to restore drought resistant flora on the fields at Gardiner and the Game Ranch. Any program to produce hay on a commercial basis on these lands would constitute a complete reversal of policy in regards to their use and our past efforts to restore a self-sustaining flora would be entirely lost." It appears that all irrigation was continued as long as necessary to support conversion of the former agricultural fields, and was gradually phased out completely by the early 1950's.

Ever since conversion of the hayfields to created wheatgrass, various range and wildlife biologists have recommended the desirability of re-establishing native vegetation. The 1963 Soil Conservation Service report on the northern Yellowstone elk range recommended the planting of western wheatgrass, bluebunch wheatgrass, green needlegrass, and basin wild rye. YNP ungulate biologist Doug Houston, in 1982, recommended converting these fields to needle and thread and bluebunch wheatgrass. A 2002 interagency/interdisciplinary working group addressing pronghorn biology and management in Yellowstone strongly recommended using state-of-the art restoration techniques to convert the former agricultural fields to native plant communities. A 2002 report of the National Research Council similarly suggested that improving the quality of winter range for pronghorn would positively influence their production and survivorship. Very few efforts, however, have addressed the feasibility or methodology of successful revegetation or the plant species offering the greatest probability of success (see the annotated vegetation bibliography section). While such efforts have been small scale and of varying design, they have nonetheless met with very limited success. Experimental plant communities quickly revert back to exotic-dominated communities when the study sites are discontinued or abandoned. Furthermore, many of the perennial crested wheatgrass sites have since been replaced by the exotic annual *Alyssum desertorum.* over the past 15 years.

A few other noteworthy vegetation and land-use practices occurred in the Boundary Lands Area over time, but are not addressed here. Those would include the evolution of the Stevens Creek NPS administrative site and corral operations, the nursery and former garden sites, and the reclaimed former Gardiner dump site. None of these areas are under consideration for revegetation efforts.

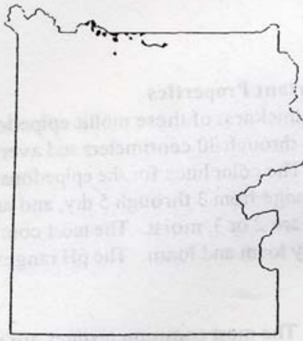
Geology of the Gardiner Basin

About three billion years of geologic history can be seen within the Gardiner Basin area. Mountain building about 70 million years ago exposed Precambrian metamorphic rocks (gneiss, schist) as well as a variety of Paleozoic and Mesozoic sediments (limestones, shales, conglomerates and sandstones). Volcanic activity about 50 million years ago also resulted in buildup of volcanic rocks. During the last two million years, the Gardiner Basin area experienced volcanic eruptions of rhyolite and basalt, glaciations, glacial floods, and landslides. Within the valley of the Gardiner Basin it is glacial activity, floods, and landslides that have profoundly influenced the current landscape, its soils, and vegetation. In particular, damming of the Yellowstone River about 10,000 years ago (Ken Pierce, written comm., 2005), inundated the floor of the Gardiner Basin with water and formed a temporary lake. The clay-rich sediments deposited within this lake are responsible for the lowest parts of the broad flat valley-floor within the Gardiner Basin.

Bedrock Geology: Bedrock includes Cretaceous (~ 100 million years) shales and sands as well as Tertiary (~ 50 million years) mostly intermediate-composition volcanic and volcaniclastic rocks. Cretaceous sediments include sandstones and shales of the following formations:- Landslide Creek formation, Everts Formation, Eagle Sandstone, Telegraph Creek Formation, Cody shale and Frontier sandstone.

Surficial Geology: Alluvial, lacustrine and glacial surficial geologic deposits overlie the bedrock. Surficial geologic deposits on the floor of the of the Gardiner Basin area include glacial flood deposits, fan alluvium, glacial till, landslide deposits and lake beds. Latest Pleistocene-Holocene alluvial fan deposits are poorly sorted, crudely bedded, angular sands and clay approximately 5-50 feet thick. Glacial flood deposits from the Pinedale Glaciation are poorly to moderately sorted boulder-rich gravels and sand approximately 10-50 feet and include gneiss and basalt boulders greater than three feet in diameter. Glacial gravels are tan to gray, subangular to surrounded, moderately sorted and stratified. Lake beds reach an altitude of about 5,200 feet and were dammed by a landslide in Yankee Jin Canyon about 10,000 years ago (Ken Pierce, written comm., 2005) and are brown to tan beds of silt and clay. The fan deposits are the most common surficial geologic deposit amongst the tilled areas. The Gardiner basin surficial geology is in a constant state of flux, as the area is subject to landslides and high winds.

Soils Information taken from Soils of Yellowstone National Park



295F Pesowyo Family-Sawbuck Family-Beartooth Family Complex

Summary

This complex forms under a frigid temperature regime on concave glaciated uplands and glaciofluvial flood bars and terraces. Slopes are commonly less than 25 percent. The main surficial deposits are glacial till, glaciofluvial alluvium, and flood alluvium derived from a variety of rock types. The flood deposits contain a large proportion of cobbles, stones, and boulders. Small areas of fan alluvium and colluvium are also included. This is a nonforested map unit composed mainly of the ARTR/AGSP and ARTR/FEID habitat types. Small areas of AGSP/POSA habitat types and forested Douglas fir habitat types are also included. Areas of bedrock outcrop occur within the map unit, but not in every delineation. The main soils are skeletal Mollisols without argillic horizons, skeletal Mollisols with argillic horizons, and nonskeletal Mollisols with argillic horizons.

Components

45% *Pesowyo family* and similar inclusions (Roundup and Greyback families)
20% *Sawbuck family*
20% *Beartooth family*

15% *Dissimilar inclusions* (Bedrock outcrops and Eaglewing family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 14)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Pesowyo family	56	18	>100	70 - 100	28
Similar inclusions	22 - 55	18 - 24	>100	70 - 100	22 - 29
Sawbuck family	45	28	>100	90 - 100	19
Beartooth family	15	26	>100	90 - 100	31

Pesowyo family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. Some of these soils are enriched in calcium carbonate. They form throughout the map unit under nonforested habitat types in glacial till, glaciofluvial alluvium, and flood alluvium.

Typical profile: Loamy-skeletal, mixed, superactive Typic Haploboroll (pedon 109). All colors are for moist conditions.

0 to 17 cm: very dark grayish brown (10YR 3/2) very gravelly loam; mildly alkaline (pH 7.8).

17 to 63 cm: dark brown (10YR 3/3) extremely stony sandy loam; moderately alkaline (pH 8.3); strongly effervescent.

63 to 100 cm: dark grayish brown (10YR 4/2) very stony sandy loam; moderately alkaline (pH 8.0); slightly effervescent.

Sawbuck family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. The subsoil layers are enriched in calcium carbonate. They form under nonforested habitat types in glacial till and flood alluvium.

Typical profile: Loamy-skeletal, mixed, superactive Typic Argiboroll (pedon 107). All colors are for moist conditions.

- 0 to 6 cm: dark brown (10YR 3/3) loam; slightly alkaline (pH 7.7).
- 9 to 26 cm: dark brown (10YR 3/3) very bouldery sandy clay loam; common, distinct clay films lining pores; slightly alkaline (pH 7.4).
- 26 to 62 cm: very dark grayish brown (10YR 3/2) very gravelly sandy loam; moderately alkaline (pH 7.9); strongly effervescent.
- 62 to 100 cm: dark grayish brown (10YR 4/2) very gravelly sandy loam; slightly alkaline (pH 7.4).

Beartooth family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. The subsoil layers are enriched in calcium carbonate. They form under nonforested habitat types in glacial till and fan alluvium.

Typical profile: Fine-loamy, mixed, superactive Typic Argiboroll (pedon 142). All colors are for moist conditions.

- 0 to 9 cm: dark brown (10YR 3/3) cobbly sandy loam; mildly alkaline (pH 7.8).
- 9 to 39 cm: brown (10YR 4/3) cobbly loam; common, distinct clay films on ped faces; mildly alkaline (pH 7.8).
- 39 to 61 cm: brown (10YR 4/3) very cobbly sandy loam; moderately alkaline (pH 8.0); violently effervescent.
- 61 to 100 cm: brown (10YR 5/3) sandy loam; moderately alkaline (pH 8.0); violently effervescent.

Dissimilar inclusions: Eaglewing family soils have ochric epipedons and nonskeletal subsoil layers. Bedrock outcrops are mainly composed of sedimentary rocks.

PESOWYO FAMILY

The Pesowyo family soils have mollic epipedons and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in colluvium and glacial till derived from a variety of rock types. These soils form under various Douglas fir habitat types and the nonforested, AGSP/POSA habitat type.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Haploborolls

Typical Pedon

Location: Near Crevice Creek, Ash Mountain 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 533610E/4985090N. Pedon 521.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 27 cm; very dark grayish brown (10YR 3/2) very gravelly fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; soft, very friable, nonsticky and slightly plastic; 35 percent gravel and 5 percent cobbles; 13 percent clay; neutral (pH 6.6); gradual smooth boundary.

Bw1 27 to 58 cm; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky parting to moderate medium granular structure; soft, very friable, nonsticky and slightly plastic; 60 percent gravel and 15 percent cobbles; 10 percent clay; neutral (pH 6.6); gradual smooth boundary.

Bw2 58 to 100 cm; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, friable, nonsticky and slightly plastic; 50 percent gravel and 20 percent cobbles; 10 percent clay; slightly acid (pH 6.5).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 30 centimeters and averages 20 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 3 moist. Chromas are 2 or 3, moist. The most common textures are sandy loam and loam. The pH ranges from 6.4 through 8.0.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 10 through 27 percent, and averages 19 percent. The weighted average rock fragment content ranges from 60 through 85 percent, and averages 72 percent for all pedons. The pH ranges from 6.3 through 8.0.

Base saturation: The range for all horizons in all pedons is 75 through 100 percent. The average for all pedons is 84 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: In soils forming near the North Entrance of the park, it is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 centimeters.

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*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Pesowyo Family

The Pesowyo family soils have mollic epipedons and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in colluvium and glacial till derived from a variety of rock types. These soils form under various Douglas fir habitat types and the nonforested, AGSP/POSA habitat type.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Haploborolls

Typical Pedon
Location: Near Crevice Creek, Ash Mountain 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 533610E/4985090N. Pedon 521.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 27 cm; very dark grayish brown (10YR 3/2) very gravelly fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; soft, very friable, nonsticky and slightly plastic; 35 percent gravel and 5 percent cobbles; 13 percent clay; neutral (pH 6.6); gradual smooth boundary.

Bw1 27 to 58 cm; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky parting to moderate medium granular structure; soft, very friable, nonsticky and slightly plastic; 60 percent gravel and 15 percent cobbles; 10 percent clay; neutral (pH 6.6); gradual smooth boundary.

Bw2 58 to 100 cm; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, friable, nonsticky and slightly plastic; 50 percent gravel and 20 percent cobbles; 10 percent clay; slightly acid (pH 6.5).

Range of Important Properties
Epipedon: The thickness of these mollic epipedons ranges from 18* through 30 centimeters and averages 20 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 3 moist. Chromas are 2 or 3, moist. The most common textures are sandy loam and loam. The pH ranges from 6.4 through 8.0.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 10 through 27 percent, and averages 19 percent. The weighted average rock fragment content ranges from 60 through 85 percent, and averages 72 percent for all pedons. The pH ranges from 6.3 through 8.0.

Base saturation: The range for all horizons in all pedons is 75 through 100 percent. The average for all pedons is 84 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: In soils forming near the North Entrance of the park, it is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 centimeters.

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*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Beartooth Family

The Beartooth family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine to medium textures. They are greater than 100 centimeters deep. These soils form in fan alluvium, stream alluvium, earthflow debris, and glacial till derived from a mixture of rock types. They form under the nonforested ARTR/AGSP and ARTR/FEID habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Argiborolls

Typical Pedon
Location: Near Reese Creek, Electric Peak 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 516570E/4988710N. Pedon 142.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 9 cm; dark brown (10YR 3/3) cobbly sandy loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent gravel, 20 percent cobbles; 15 percent clay; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bt 9 to 39 cm; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 12 percent gravel, 15 percent cobbles; 25 percent clay; common, distinct clay films on ped faces and lining pores; slightly alkaline (pH 7.8); gradual smooth boundary.

Bk1 39 to 61 cm; brown (10YR 4/3) very cobbly sandy loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 20 percent gravel, 20 percent cobbles; 10 percent clay; moderately alkaline (pH 8.0); accumulation of lime in pores; violently effervescent; abrupt smooth boundary.

Bk 261 to 100 cm; brown (10YR 5/3) sandy loam, light gray (10YR 7/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 6 percent gravel, 5 percent cobbles; moderately alkaline (pH 8.0); accumulation of lime in pores; violently effervescent.

Range of Important Properties
Epipedon: The thickness of these mollic epipedons ranges from 18* through 39 centimeters and averages 28 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and are 2 or 3 moist. Chromas are 2 or 3 moist. The most common textures are loam and sandy loam. The pH ranges from 7.5 through 8.0.

Control section: The most common textures are loam and clay loam. The weighted average clay content ranges from 19 through 27 percent, and averages 22 percent. The weighted average rock fragment content ranges from 2 through 27 percent, and averages 16 percent. The pH ranges from 7.8 through 8.2.

Base saturation: The range for all horizons in all pedons is 90 through 100 percent. The average of all pedons is 98 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 30 centimeters. In soils weathering from earthflow debris, calcium carbonates may also accumulate in surface layers.

Salinity and Sodicity: When these soils weather from earthflow debris, they often have an accumulation of sodium salts, with ESPs of 30 to 40 percent, in the subsoil layers. These same layers are slightly to moderately saline with EC measurements of 4 to 13 mmhos/cm.

* After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

1721F Gateson Family-Pesowyo Family-Eaglewing Family Complex

Summary

This complex forms on alluvial fans under a frigid temperature regime. Drainage channels and stream courses dissect these fans. Some stream bottoms are also included. Slopes are commonly between 5 and 20 percent. The main surficial deposit is fan alluvium derived from sedimentary rock types. Small areas of glaciofluvial alluvium, glacial till, and stream alluvium are also included. This is a nonforested map unit dominated by the AGSP/POSA, ARTR/AGSP, and ARTR/FEID habitat types. Small areas of soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are nonskeletal Alfisols, nonskeletal Inceptisols, and skeletal Mollisols.

Components

35% *Gateson family*

35% *Eaglewing family* and similar inclusions (Lamedeer family)

25% *Pesowyo family* and similar inclusions (Lolo and Roundup families)

10% *Dissimilar inclusions* (Beartooth family and soils with aquic conditions)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 14)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Gateson family	14	28	>100	100	0
Eaglewing family	2	25	>100	100	3
Similar inclusions	37	20	>100	90 - 100	1
Pesowyo family	73	21	>100	80 - 100	20
Similar inclusions	20 - 60	20 - 25	>100	80 - 100	25 - 45

Gateson family: These soils have argillic horizons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. Some of these soils are enriched in calcium carbonate and sodium. They form under warm, dry nonforested habitat types in alluvial fan deposits.

Typical profile: Fine-loamy, mixed, superactive Typic Eutroboralf (pedon 112) All colors are for moist conditions.

0 to 10 cm: dark grayish brown (10YR 4/2) loam; moderately alkaline (pH 8.0); strongly effervescent.

10 to 20 cm: dark grayish brown (10YR 4/2) clay loam; few, thin clay films lining pores; moderately alkaline (pH 8.0); violently effervescent.

20 to 100 cm: dark grayish brown (10YR 4/2) clay loam; common, thin clay films lining pores and ped faces; moderately alkaline (pH 8.0); violently effervescent.

Eaglewing family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit these soils are fine to medium textured. These soils are often enriched in calcium carbonate. They form under warm, dry nonforested habitat types in fan alluvium, stream alluvium, and glaciofluvial kame deposits.

Typical Profile: Fine-loamy, mixed, superactive, frigid Typic Ustochrept (pedon 140) All colors are for moist conditions.

0 to 9 cm: dark brown (10YR 3/3) sandy clay; moderately alkaline (pH 8.0).
9 to 23 cm: very dark grayish brown (10YR 3/2) sandy clay; slightly alkaline (pH 7.5).
23 to 61 cm: brown (10YR 4/3) clay loam; slightly alkaline (pH 7.5); slightly effervescent.
61 to 100 cm: brown (10YR 4/3) sandy clay loam; slightly alkaline (pH 7.8).

Pesowyo family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. Some of these soils are enriched in calcium carbonate. They form under nonforested habitat types in alluvial fan and glaciofluvial kame deposits. These soils are likely to occur close to drainage channels and apex areas of the fans.

Typical profile: Loamy-skeletal, mixed, superactive Typic Haploboroll (pedon 3376) All colors are for moist conditions.

4 to 0 cm: litter layer.
0 to 9 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; neutral (pH 6.6).
9 to 24 cm: dark brown (10YR 3/3) extremely cobbly sandy loam; neutral (pH 6.6).
24 to 100 cm: olive brown (2.5Y 4/4) and extremely gravelly coarse sandy loam; slightly acid (pH 6.5).

Dissimilar inclusions: Beartooth family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers. Soils with aquic conditions, occurring near stream channels and within small depressions, make up approximately 3 percent of this map unit.

SOIL DESCRIPTION 111 - Typic Eutroboralf; fine-loamy, mixed, calcareous

Pedon Description: (Colors are for dry soil unless otherwise stated.)

A (0-8 cm) Light grayish brown (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure breaking to moderate fine granular structure; soft, very friable, nonsticky, nonplastic; many very fine and fine roots, and common medium roots; moderately alkaline (pH 7.9); abrupt smooth boundary.

Bk (8-17 cm) Light gray (10YR 7/2) loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure breaking to moderate fine subangular blocky structure; soft, friable, slightly sticky, nonplastic; many very fine and fine roots; moderately alkaline (pH 8.2); strongly effervescent; abrupt smooth boundary.

Btk (17-50 cm) Light gray (10YR 7/2) loam, dark grayish brown (10YR 4/2) moist; weak coarse angular blocky structure; slightly hard, friable, sticky, slightly plastic; common very fine and fine roots, and few medium roots; moderately alkaline (pH 8.3); strongly effervescent; diffuse smooth boundary.

Bn (50-70 cm) Light gray (10YR 7/2) loam, dark grayish brown (10YR 4/2) moist; weak coarse angular blocky structure; slightly hard, very friable, slightly sticky, nonplastic; few very fine and fine roots; mildly alkaline (pH 7.8); strongly effervescent.

Location and Topography: Southwestern Montana, Yellowstone National Park, UTM 524570 east 4983030 north. The pedon has formed in fan deposits derived from sedimentary bedrock. The slope is 2 %. Aspect is southwest. Elevation is 1800 m. The habitat type is bluebunch wheatgrass/Sandberg bluegrass (AGSP/POSA) with 60 % vegetative cover.

Notes: Rock fragments make up 1 % of the soil surface. Soil described by Ann Rodman and Liz Colvard on 7/19/88.

Soil data is on file at Division of Research, Yellowstone National Park, Box 168, Mammoth, WY 82190.

Gateson Family

The Gateson family soils have ochric epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine textures. The soils are greater than 100 centimeters deep. Soils in this family form in fan alluvium and glacial till derived from sedimentary rocks or rhyolite. They form under the nonforested AGSP/POSA, ARTR/AGSP, and SAVE/AGSM habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Eutroboralfs

Typical Pedon
Location: West slope of Mt. Everts; Mammoth 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 524840E/4982530N. Pedon 112.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 10 cm; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; strong fine granular structure parting to moderate coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; 5 percent gravel; 22 percent clay; moderately alkaline (pH 8.0); violently effervescent; clear smooth boundary.

Btk1 10 to 30 cm; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, sticky and plastic; 10 percent gravel; 34 percent clay; few, distinct clay films lining tubular and interstitial pores; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent; diffuse smooth boundary.

Btk2 30 to 100 cm; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; hard, friable, sticky and slightly plastic; 10 percent gravel; 34 percent clay; few, distinct clay films on ped faces and lining tubular and interstitial pores; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent.

Range of Important Properties
Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 5 or 6 dry, and 3 or 4 moist. Chromas are 2 or 3 moist. The most common texture is loam. The pH ranges from 7.0 through 8.0.

Control section: The most common texture is clay loam. The weighted average clay content ranges from 25 through 34 percent, and averages 30 percent. The weighted average rock fragment content ranges from 5 through 20 percent, averages 14 percent. The pH ranges from 7.3 through 8.6.

Base saturation: The range for all horizons in all pedons is 90 through 100 percent. The average for all pedons is 99 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 centimeters. In some soils, calcium carbonates also accumulate in surface layers.

Salinity: Soils forming in fan alluvium derived from sedimentary rocks are very slightly to slightly saline, with EC measurements of 2 to 5 mmhos/cm, at depths greater than 50 centimeters.

rom:

odman, A., H.F. Shovic, and D. Thoma. 1996. Soils of Yellowstone National Park. Yellowstone for Resources. Yellowstone National Park, Wyoming. YCR-NRSR-96-2.

GATESON FAMILY

The Gateson family soils have ochric epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine textures. The soils are greater than 100 centimeters deep. Soils in this family form in fan alluvium and glacial till derived from sedimentary rocks or rhyolite. They form under the nonforested AGSP/POSA, ARTR/AGSP, and SAVE/AGSM habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Eutroboralfs

Typical Pedon
Location: West slope of Mt. Everts; Mammoth 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 524840E/4982530N. Pedon 112.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 10 cm; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; strong fine granular structure parting to moderate coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; 5 percent gravel; 22 percent clay; moderately alkaline (pH 8.0); violently effervescent; clear smooth boundary.

Btk1 10 to 30 cm; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, sticky and plastic; 10 percent gravel; 34 percent clay; few, distinct clay films lining tubular and interstitial pores; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent; diffuse smooth boundary.

Btk2 30 to 100 cm; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; hard, friable, sticky and slightly plastic; 10 percent gravel; 34 percent clay; few, distinct clay films on ped faces and lining tubular and interstitial pores; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent.

Range of Important Properties
Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 5 or 6 dry, and 3 or 4 moist. Chromas are 2 or 3 moist. The most common texture is loam. The pH ranges from 7.0 through 8.0.

Control section: The most common texture is clay loam. The weighted average clay content ranges from 25 through 34 percent, and averages 30 percent. The weighted average rock fragment content ranges from 5 through 20 percent, averages 14 percent. The pH ranges from 7.3 through 8.6.

Base saturation: The range for all horizons in all pedons is 90 through 100 percent. The average for all pedons is 99 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 centimeters. In some soils, calcium carbonates also accumulate in surface layers.

Salinity: Soils forming in fan alluvium derived from sedimentary rocks are very slightly to slightly saline, with EC measurements of 2 to 5 mmhos/cm, at depths greater than 50 centimeters.

rom:

odman, A., H.F. Shovic, and D. Thoma. 1996. Soils of Yellowstone National Park. Yellowstone for Resources. Yellowstone National Park, Wyoming. YCR-NRSR-96-2.

References

Berg, R.B., Lonn, J.D., and Locke, W.W., 1999, Geologic Map of the Gardiner 30’ x 60’ quadrangle, south-central Montana; Montana Bureau of Mines and Geology Open File Report MBMG 387, scale 1:100,000.

Pierce, K.L., 1973. Surficial geologic map of the Mount Holmes quadrangle and parts of the Tepee Creek, Crown Butte, and Miner quadrangles, Yellowstone National Park and Montana: U.S. Geological Survey miscellaneous geologic investigations Map I-640, Scale 1: 62,500.

Pierce, K.L., 1973. Surficial geologic map of the Mammoth quadrangle and part of the Gardiner quadrangle, Yellowstone National Park, Wyoming and Montana. U.S. Geological Survey Miscellaneous Geologic Investigations Map I-641 1:62,500.

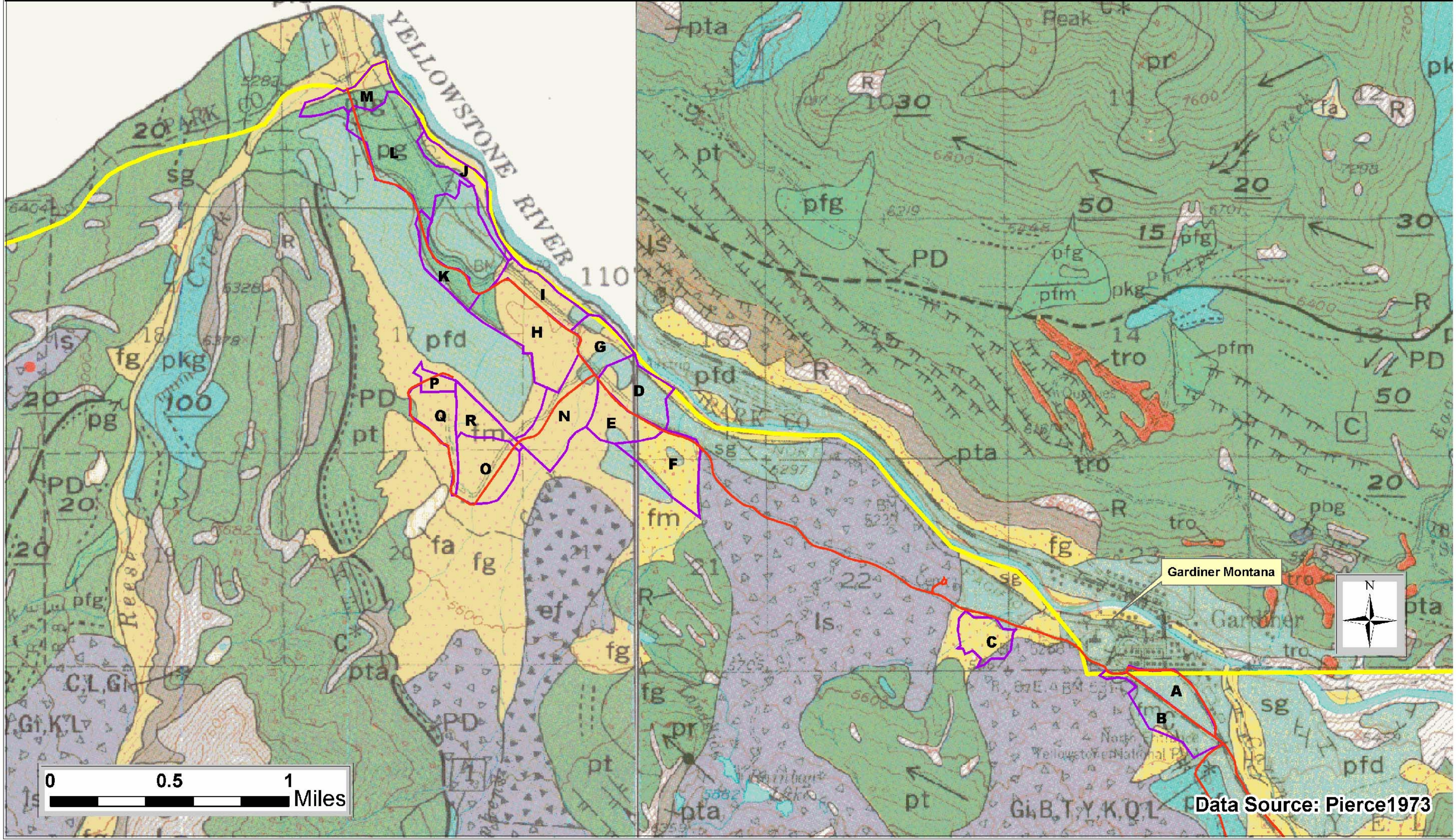
Rodman, A., Shovic, H., and Thoma, D., 1996. Soils of Yellowstone National Park. Yellowstone National Park, WY p. 1-324.

United States Geologic Survey, 1972. Geologic map of Yellowstone National Park. U. S. Geologic Survey miscellaneous geologic investigation, Map I-711 1:125,000.

Yellowstone National Park
ID, MT, WY

Surficial Geology

National Park Service
U.S. Department of the Interior



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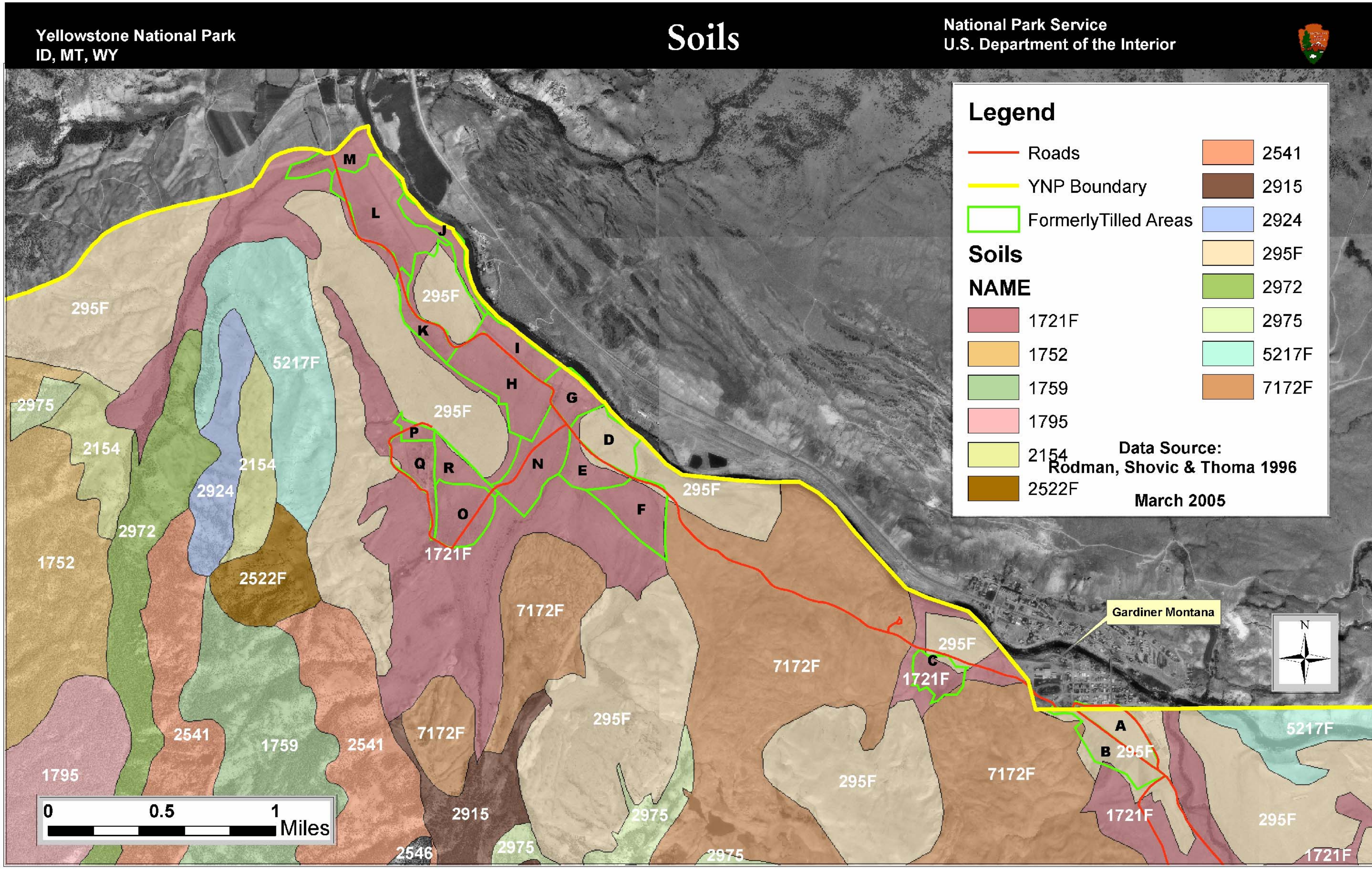

Yellowstone National Park
ID, MT, WY
Soils
National Park Service
U.S. Department of the Interior
Legend
Roads
YNP Boundary
FormerlyTilled Areas
Soils
NAME
1721F
1752
1759
1795
2154
2522F
2541
2915
2924
295F
2972
2975
5217F
7172F
Data Source:
Rodman, Shovic & Thoma 1996
March 2005
Gardiner Montana
N
0
0.5
1
Miles