



Science in the Crown

International Cooperation for Ecological Restoration

Waterton Lakes National Park is an area of high conservation value with high diversity of species and habitats. Waterton and Glacier share a common boundary, many ecological communities, and management concerns. Recently, the two parks have worked together to share expertise and resources to accomplish management objectives that benefit both.

Past activities in Waterton have resulted in possible water and soil contamination. Parks Canada's mandate requires that contaminated sites be remediated. This remediation calls for the restoration of hydrology, soil, and vegetation to predisturbance conditions.

The Trade Waste Pit (TWP) in Waterton was identified as a high priority area. The grassland is predominated by rough fescue and oat grass, a community recognized in the Park Management Plan as an Ecologically Sensitive Area. The TWP was used as a dump site for many discarded materials (garbage, treated wood products, fuel, and scrap metal) for over 50 years. Restoration goals call for the restoration of native plant diversity and wildlife habitat and a reduction in the spread of invasive plants and the ecological footprint of park management activities.

In partnership with Dr. Anne Naeth, University of Alberta, and Glacier's Native Plant Program staff, Waterton biologists embarked on an aggressive program to restore TWP. Initial work included the installation of monitoring wells to provide ongoing soil and water contamination analysis, removal and burial of waste materials, the collection and propagation of native plant materials for restoration plantings, and weed



The Trade Waste Pit in Waterton Lakes National Park before (upper photo) and during (lower photo) plant restoration activities by Waterton biologists, Glacier Native Plant Program staff, and Dr. Naeth and graduate students from the University of Alberta.

eradication. For the past two years, crews from Glacier, volunteers, students, and community members assisted Waterton staff in the collection of native grass, forb, and shrub seeds. These collections were taken from ecosites in Waterton that were similar to TWP to insure that the material would be ecologically matched. This seed was cleaned, stored for future seeding, and used to grow nearly 4,000 plants in Glacier's Native Plant Nursery for planting into the site. Some seed was sent to the USDA, Natural Resources Conservation Service Plant Materials Center in Bridger, Montana for germination testing and seed increasing. Many lessons were learned in this process; the foremost was to insure that all paperwork was in place prior to moving

seeds and plants across the border.

In late fall 2006, the site was ready for planting after Waterton staff recontoured the site to resemble the adjacent landscape and added a temporary electric fencing along the entire perimeter to prevent ungulates from destroying the vegetation. Dr. Naeth and graduate students worked with Glacier's revegetation crew to plant over 3,600 plants in two days. Planting and seeding will continue next spring and fall. All plants were mapped by species and location; survival and growth will be monitored and the effectiveness of planting containerized

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USGS Scientist Assesses Fire Effects



Carl Key, a geographer at USGS Northern Rocky Mountain Science Center in Glacier NP

Carl Key, a geographer at the USGS Northern Rocky Mountain Science Center Glacier Field Station, currently studies post-fire severity through remote sensing and complementary field measures to understand the effects of wildland fire. During his 26 years with USGS and the NPS, his work also encompassed development of geographic information systems; studies of small mammals, plant ecology, and fire history; and the establishment of the Global Change Research Program at GNP. He has received several Special Achievement Awards from the NPS and the 2005 Science Excellence Award from the USGS.

Along with collaborators from the USGS Center for Earth Resources Observation and Science (EROS) and the NPS, Carl recently completed a national evaluation of remote sensing methods to

map fire severity. This effort, funded by the Joint Fire Sciences Program, included data from 2,600 field plots in 80 burns in 30 study regions of the U.S. Previously, Carl and Nate Benson, Fire Ecologist at the NPS Fire Management Program Center, were instrumental in creating a national burn severity mapping program for the NPS. Since 2002, EROS has routinely processed and provided fire perimeters and severity data for all parks (<http://burnseverity.cr.usgs.gov/>). These fire atlases were used for validation and as a scientific basis for the new National Interagency Monitoring Trends in Burn Severity (MTBS) program supported by the Wildland Fire Leadership Council (WFLC) under the National Fire Plan. MTBS is currently mapping all U.S. fires from 1984 to present and will map future fires over 1,000 acres in the west and 500 acres in the east. MTBS reports to WFLC on fire trends and supplies standard national databases on fire effects to all fire managers and scientists.

Many of the fundamental principles and practices underlying these national efforts were developed by Carl starting with the 1984 Crystal Creek and Napi Point fires, and continuing at other National Parks since 1998. Using Landsat satellite data, he worked out a spectral index of severity that is widely used today, called the differenced normalized burn ratio (dNBR). The dNBR provides maps at 30-meter resolution, showing how strongly a fire has altered an area compared to pre-fire conditions. Along with Nate Benson,

Carl also designed a field method, the Composite Burn Index, that summarizes multiple conditions over a site. It is widely used as an up-close measure of fire effects to validate and better understand the information provided by Landsat.

Fire severity information is geared to resource management and science needs that extend beyond the period of active fire and incident management. Before fire, the pattern and extent of historical fires help update vegetation or fuels maps to guide risk assessment and prescription planning for future fires. After fire, burn severity is key to assessing post-fire hazards and economic impacts, and assists restoration efforts. Moreover, burn severity maps can be used as a reference for education and to evaluate past management practices. For research, severity data provides a way to test models and understand fire behavior, or to evaluate the status and trends of plants and animals that may either benefit or suffer from post-fire effects.

Carl continues to work on fire effects remote sensing and implementation at a national level, while maintaining close contact with park fire management staff on recent fires within the greater Glacier area and other ecosystems. He hopes to foster new studies on the landscape ecology of fire, and provide additional useful applications from Landsat-derived burn severity information.

Glacier Sabbatical: Assisting with Wildlife Projects

Dr. Don White, Associate Professor of Wildlife Ecology from the University of Arkansas, spent a six-month sabbatical in Glacier during summer and fall 2006. During his stay, Dr. White worked with park biologists on a range of wildlife-related research proposals, including a proposal to study mountain goat space use. Each of these studies will inform management decisions. He also worked with park managers on a wildlife management plan for army cutworm moth aggregation sites, which are important grizzly

bear feeding habitat. The plan may include suggestions for routing climbers around moth aggregation sites during July through September when grizzly bears are feeding on moths. In addition, he helped to create six Resource Bulletins through the Research Learning Center about black and grizzly bear biology and ecology. The bulletins will be utilized by the park to train seasonal interpretative staff. Dr. White's stay was supported by The Glacier National Park Fund.



Don White spent his sabbatical leave in Glacier NP.

Citizen Science on Common Loons



Volunteer loon observers are helping us corroborate the status of loons in Glacier.

Glacier NP has been collaborating with the state of Montana since 1986 to assess the status and trends of the Common Loon, a Montana Species of Special Concern. Surveys on Loon Day (a day in mid-July when all loon lakes in Montana are sampled annually) have been conducted by park staff and volunteers since 1988. Based on these counts, Glacier NP harbors 20% of the breeding loons in Montana and the reproductive rate appears to be lower than elsewhere in Montana and less than that needed to sustain the

population. During 2005 and 2006, the Crown of the Continent Research Learning Center (CCRLC) expanded the park's participation in the effort by developing a citizen science program that involves a broader number of volunteers and monitoring loons over a longer period of time than occurred previously. CCRLC staff developed a PowerPoint presentation describing the biology, identification, and management concerns about Common Loons, and methods for how to sample loons without disturbing them. The presentation was used to conduct training sessions and public lectures for park staff, citizen science volunteers, and partner organizations. In 2006, 77 Volunteer Loon Observers (including 25 staff members) conducted 474 surveys on 73 lakes. Special emphasis was put on 45 priority lakes that were each monitored three times (prior to, during, and after Loon Day). The 2006 Loon Day population estimate (our previous standard) was 36 adult loons, 9 pairs, and 4 chicks. These numbers are substantially different from the



Glacier has 20% of the loons in Montana but the reproductive rate is lower than elsewhere in Montana. (Photo taken by Daniel Poleschook, Jr. and Ginger Gumm in western Washington.)

season-long estimate of 45 adult loons, 16 pairs of loons, and 5 chicks in 3 broods. Current and historic data were entered into a statewide database. The loon work complemented national efforts. Partners included Flathead Audubon Society, Montana Loon Society, Montana Common Loon Working Group, and Montana's Department of Fish, Wildlife, and Parks. This program contributed to knowledge needed by park wildlife biologists. Support was provided by The Glacier National Park Fund and NPS VIP funds.

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material vs. seed, spring vs. fall timing, and several horticultural treatments (e.g., use of fertilizer) will be evaluated.

The benefits of this project are many. Foremost is the restoration of a functional native plant community. The restoration of TWP demonstrates Waterton's commitment to managing the impacts of park management and fostering sound stewardship practices. The restoration of this rough fescue ecosystem will advance knowledge of methods specific to grassland communities. The knowledge gained in this process will also enable both parks to pursue other restoration projects at much less cost and will be transferable to others. By involving students and other volunteers, we shared the importance of native ecosystems and methods for protecting public lands.

Joint NPS/USFS/GNHA internships



Dawn LaFleur, Invasive Plant Biologist, teaches Jame Troyer, Cory Ravetto, Lori Ortley (teacher), and Rosemary Till how to identify noxious weeds.

The Crown of the Continent Research Learning Center collaborated with the Flathead National Forest and Glacier Natural History Association (GNHA) to create student internships on weed inventory and monitoring on agency lands. After a week of training by park and forest exotic plant management specialists on weed identification, three local high school students and their advisor monitored weeds on Flathead National Forest and

in Glacier National Park for five weeks. They scouted for 16 state-listed invasive plant species along secondary roads and trails in conifer forests, burned forests, and riparian areas. They mapped plant locations and entered them into a GIS system. At the end of the five weeks, they gave a presentation to forest and park managers. The forest and park gained valuable data on weed locations. The students and teacher learned how to identify and monitor weed populations, how to use GPS and GIS technology, about the complexity of managing invasive plants, and how it is a joint problem that requires working together across jurisdictions. The program also allowed the students to explore a potential natural resources career and gave them a better understanding of natural resource management. This project was funded by the US Forest Service (USFS) and The Glacier National Park Fund.

Glacier National Park Wolverine Study



The habits of the elusive wolverine are being discovered in Glacier NP. (Photo by Chris Peterson.)

The wolverine is one of the least studied and least understood mammals in North America. Its alpine habitat and wide-ranging movements make studying this animal difficult and expensive. It's no wonder that the ecology of this species has been shrouded in mystery. Now, researchers with the USFS Rocky Mountain Research Station are starting to lift that shroud from over Glacier National Park. Biologists Jeff Copeland and Rick Yates began studying wolverines in 2002 with

funding from a 3-year National Park Service grant. Since then, they have captured and radio-marked 22 wolverines. The resulting location coordinates (over 3,000 of them) provide a rare glimpse into the lives of these fascinating animals. They have also documented the reproductive den sites of 3 adult females thus doubling the total number of wolverine dens ever found in the continental U.S. Six young wolverines, called kits, were captured and marked leading to the documentation of 17 rendezvous sites (locations where family groups congregate). In 2005, the researchers began deploying experimental Global Positioning System collars that can closely track wolverine movements across the landscape. The resulting data, collected at up to 5 minute intervals, has provided an unprecedented look at how wolverines move through Glacier's precipitous terrain.

Wolverine reproductive den sites have, so far, occurred primarily in sparse timber beneath

downed, woody debris at high elevations, while rendezvous sites occurred primarily in boulder talus and cliff areas. Kits separate from their mother at 6-7 months-of-age in late September. Their survival to adulthood has been low; 5 of 6 kits died during their first year. GPS results suggest that wolverines traverse the landscape indifferent to topographic features. Two males had movement rates averaging 4 kilometers per hour, and movements exceeding 10 kilometers were common and generally interspersed with localization periods of approximately 20 hrs.

Wolverine home ranges averaged 496 km² for males and 141 km² for females. DNA analysis for 20 individuals suggests less genetic structure than expected with relatedness contained by 2 distinct genotypic groups within the study population.

The 3-year study period provided by the Natural Resources Protection Program grant ended in early 2004. Current funding goes through 2007.

International VIP Supports Monitoring & Restoration

Alex Hof, a biology student from the University of Marburg, Germany, served as an International Volunteer in the Park for 6.5 weeks during summer 2006 to locate and monitor wildlife and vegetative species for park managers. Alex participated in four resource monitoring projects: 1) native plant restoration from disturbance; 2) whitebark pine restoration; 3) monitoring nests of harlequin ducks; and 4) identifying and monitoring activities of black and grizzly bears along the Going-to-the-Sun Road (GTSR) corridor. Glacier's Native Plant Restoration Program aims to reestablish indigenous vegetation to disturbed areas and to preserve genetic integrity and diversity, reduce invasion by non-native plants, and reduce habitat fragmentation. Alex assisted park biologists in restoring native plants in two locations along the GTSR, Logan Pass and Oberlin Bend; both sites had undergone disturbance from road reconstruction and had degraded native vegetation. Whitebark pine is a keystone species in subalpine environments of the

western United States and Canada that provides shelter and food to other species and serves as a moisture retainer at treeline, which lengthens the snow melt period. Dramatic declines of whitebark pine populations over the last decades are being combated at Glacier with an integrated restoration program. Efforts in 2006 included cultivation and planting of disease-resistant seedlings and documenting survival rates from previous years' plantings at 38 plots on Flattop Mountain. The Harlequin duck, a small sea duck that migrates inland from the coast to reproduce, occurs only on a limited number of cold, fast-flowing mountain streams in western Montana. Some streams in Glacier NP, such as upper Lake McDonald Creek, are prime habitat. Because nests are built very close to the stream edge, they are sensitive to a number of environmental perturbations, including flash floods and river recreation. The sites along upper McDonald are also close to the GTSR and could potentially be impacted by renovation efforts underway along that section of the road.



IVIP Alex Hof monitoring native plant restoration at Logan Pass.

Monitoring efforts give managers specific information about Harlequin nesting behavior so that road reconstruction can be scheduled to minimize impacts to ducks reproductive success. The main goal in monitoring bear use of the GTSR corridor is also to inform the reconstruction schedule. This includes preventing bears from becoming habituated to humans, ensuring no bear ever gets a food reward, and minimizing disturbance to bears' critical travel and foraging areas during important movement times.

Rare Plant Population Surveys in 2005 & 2006



Glacier pygmy poppy is endemic to the Waterton-Glacier area.

Rare plant populations are an important component of the park's biodiversity and may be sensitive indicators of environmental changes that could threaten the health of park vegetation communities. In 2005 and 2006, park staff conducted surveys of rare plant populations in Glacier NP. Peter Lesica, a consulting ecologist, was contracted to help monitor rare plants in wetlands. Objectives included: to ground-truth data on rare plant populations; to document size, vigor, and habitat of populations; and to create an accurate GIS layer. First, existing information on rare plant populations was compiled from the

Montana Natural Heritage Program and park sources. Next, field crews surveyed more than 90 rare plant populations, collected habitat data, and mapped the extent of populations with GPS. Once the field crews got a sense of typical habitats where rare plants are found, they also searched new areas fitting those habitat descriptions. Alpine limestone fellfields provided particularly good search areas for several rare plant species. More than a dozen new rare plant populations were documented, including ones for glacier pygmy poppy, one-flowered cinquefoil, and Jones' columbine. The data are being submitted to the Montana Natural Heritage Program. The Rocky Mountain Inventory & Monitoring Network is developing a relational database for storing all verified data.

The project was even more successful than we anticipated. Not only were we able to accurately map many rare plant populations for the first time, we also discovered several new populations and were able to relocate some historic records.

Because we have a better understanding of the extent and status of these populations, we have already been able to make management decisions to better protect them. Examples include: trail crews were informed of populations growing immediately adjacent to trails so they could minimize impacts during trail maintenance; a climbing route has been re-directed with new signage to protect lens-fruited sedge; protocols are in place to delay mowing and selectively spot spray for weeds in the vicinity of the slender moonwort populations; and a proposal to create a bypass lane near the west entrance station was eliminated thereby preserving velvetleaf blueberry populations. We have also improved information about the extent and status of rock harlequin. We have used the new information to develop a rare plant field guide. We now have the information needed to develop an accurate and consolidated database for future tracking of these data. Rare plant surveys were supported by NPS Intermountain Region Natural Resource Fund and the Glacier National Park Fund.

Climate Change Communication

The Crown of the Continent Research Learning Center collaborated with the Division of Interpretation & Education and the Air Resource Division to develop a climate change communication strategy to carry the message of global climate change forward to the public visiting the park. To carry the message at Glacier, we developed three wayside exhibits and a site bulletin that tell the story of the disappearing glaciers as well as the longer range implications of the changes that are triggering that event. The first wayside is located along a highly traveled walkway near the Many Glacier Hotel. The panel uses global climate change as a backdrop to depict disappearing glaciers (you can currently see four glaciers from this one location), but it makes the larger point that not just the glaciers, but the entire landscape will be different in the future. The second wayside is located near the Grinnell Glacier Trailhead. The Grinnell Glacier is one of the most prominent and well known glaciers in



Grinnell Glacier, shown in middle foreground, has retreated dramatically in recent years and has split off from Salamander Glacier, on upper right. The smaller Gem Glacier, in upper left, is also still visible.

the park and is one of the most popular hikes; literally hundreds of people depart daily for Glacier's backcountry at this spot. The panel features Grinnell Glacier with repeat photographs that graphically demonstrate the rapid pace at which climate change is changing the face of park scenery. The third panel is located at the Jackson Glacier Overlook pull-out along the Going to the Sun Road. This panel combines

some of the strongest elements of the other two regarding global climate change and our changing landscape and features descriptions of how climate change is affecting the water cycle and aquatic organisms. The site bulletin conveys many of the key messages conveyed at the waysides with a little more detail. The bulletins will be available beginning in the 2007 season at all NPS public distribution points in the park. In addition, at the beginning of the 2006 season, Leigh Welling, Research Learning Center Director, gave 3 training sessions to park staff and concessioners, who are on the front line with park visitors, on climate change and park impacts. The park receives numerous inquiries about melting glaciers but few visitors are aware of the broader resource impacts of climate change. This effort, along with a series of training sessions for park employees and concessioners, will help to remedy this lack of knowledge about a complex and critical issue.

Bald and Golden Eagle Nest Monitoring in Glacier



Nests of Bald Eagles are closely monitored in Glacier NP to determine whether immature Bald Eagles such as this one fledge.

Glacier National Park staff monitor eagle nests because knowing about nesting activity and the production of young helps the park understand the status and health of eagle populations.

Occupancy of Bald Eagle nesting territories and early nesting activity at backcountry sites is usually checked during a fixed-wing aircraft survey in March or April. Other more accessible nests are monitored from the ground during this early period, and all nests are monitored from the ground throughout the rest of the nesting season. New nests may go undiscovered for a year or more, but most if not all nests are eventually located due to eagle activity in the nest area, and the predictability of nest sites near lakes and rivers. Some Bald Eagle pairs have more than one nest within their breeding territories, with only one nest used in a given year. Not all

breeding territories are active every year, and some active nests fail to produce young to flight-stage. For example, during 2006, 6 nests produced young; 1 nest was active but failed to produce any young; and 6 nesting territories were inactive, with no apparent attempt to lay eggs.

Regular monitoring for nesting behavior and nesting success began in 1981, when only one chick was produced. The number of known Bald Eagle nesting territories increased from 3 in 1981 to 13 in 2006. Park-wide Bald Eagle productivity has varied annually but has increased from an average of 2.3 young per year during the 1980s to 8.3 young per year during the last 10 years, with high counts of 13 during 1999 and 2003. Seven eaglets were produced from 7 active nests during 2006. The increase in Bald Eagle nesting territories in Glacier has paralleled the increase statewide; the number of known breeding pairs in Montana increased from about 190 pairs in 1993 to over 300 pairs in 2005.

Monitoring of Golden Eagle nests has been more limited: park-wide surveys to locate Golden Eagle nests and other cliff-nesting raptors were undertaken during 1989-1991 and 1998-1999.

The productivity of Golden Eagle nests along the Going-to-the-Sun Road has been monitored since

1999. Due to the lack of parkwide, season-long monitoring of nest location and productivity, the number of active nests and young produced each year in the park is unknown. Unlike Bald Eagles that nest in trees, Golden Eagles are cliff-nesters in Glacier, and their nests are more difficult to locate and monitor. Observations of Golden Eagle nests are made from the ground, usually with a telescope from pullouts along the Sun Road. Over 50 nests have been located in the park; some are alternate nests of a single territorial pair, and many are inactive or in disrepair. Ten nests have been documented from the Sun Road, representing 4-6 pairs. During 2006, two nests were active along the road corridor, each producing 1 young.

Monitoring the distribution, status and trends of Glacier's wildlife populations is necessary to fulfill the park's mission to protect wildlife and other natural resources for present and future generations. Knowing the general distribution, relative numbers, and long-term trend for each species of wildlife will help managers anticipate potential problems and provide information on wildlife to the public. Unfortunately, the Bald Eagle and Common Loon are the only wildlife species with long-term, parkwide information indicating population status and trend.



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Research Learning Centers increase the effectiveness and communication of research and science results in the national parks.

Upcoming Projects & Events

Jerry O'Neal National Park Service Student Fellowship

The Crown of the Continent Research Learning Center, in collaboration with the Rocky Mountain CESU, created a new student fellowship to support research in Glacier National Park, Grant-Kohrs Ranch National Historic Site, and Little Bighorn Battlefield National Monument. The first awards are going to: David McKenzie (University of Wyoming), Erich Peitzsch (Montana State University), and Sarah Wilson (University of Montana).

Crown of the Continent Invasive Plant Guide

In concert with representatives from 20 agencies and organizations, many of whom are members of the Crown of the Continent Managers Partnership (www.rockies.ca/cmp/), the Research Learning Center and Glacier's Integrated Pest Management Biologist are designing and developing a Crown of the Continent Invasive Plant Guide. The guide will be printed in 2008.

Waterton-Glacier Science and History Day

Waterton-Glacier International Peace Park will hold its 4th Annual Science and History Day on Thursday, July 26, at Lake McDonald Lodge at Glacier National Park, from 8:30 a.m. until 4:30 p.m.