



Upper Columbia Basin Network Natural Resources Report 2010

Big Hole National Battlefield

Natural Resource Report NPS/UCBN/NRR—2011/461



ON THE COVER

View of Horse Pasture at Big Hole National Battlefield
UCBN Photo

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Lisa K. Garrett
National Park Service
Upper Columbia Basin Network
105 East 2nd St. Suite #5
Moscow, ID 83843

Thomas J. Rodhouse
National Park Service
Upper Columbia Basin Network
20310 Empire Ave. Ste A100
Bend, OR 97701

Eric N. Starkey
National Park Service
Upper Columbia Basin Network
105 East 2nd St. Suite #7
Moscow, ID 83843

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2010 Summary

The concept of monitoring and reporting on the park's natural resources was initiated in 1999 as a part of the National Park Service's Natural Resources Challenge. Through the Challenge, 270 parks in the national park system were placed into 32 inventory and monitoring networks. The parks of the Upper Columbia Basin Inventory and Monitoring Network (UCBN) include Big Hole National Battlefield, City of Rocks National Reserve, Craters of the Moon National Monument and Preserve, Hagerman Fossil Beds National Monument, John Day Fossil Beds National Monument, Lake Roosevelt National Recreation Area, Nez Perce National Historical Park, and Whitman Mission National Historic Site.

In 2007, the UCBN prepared a monitoring plan and chose vital signs or key indicators to monitor in each park for the purpose of assessing the health of the park's natural resources. The vital signs chosen for monitoring at Big Hole National Battlefield (BIHO) were selected in collaboration with more than 40 scientists and managers who participated in identifying and prioritizing vital signs. Monitoring data currently available for many of these vital signs are too short-term to indicate trends or establish an appropriate standard or reference condition against which to compare the current condition. However, enough is known about four of the vital signs (camas, invasive weeds, macroinvertebrates, and water chemistry) to complete this first Natural Resources Report. The monitoring program will continue to track these vital signs so that this information can be integrated into the park manager's understanding of long-term changes in the park's natural resources. We have also included in this report information available on several other park resources, including climate and rare species.

This report is intended to be updated every three to five years and will report on the state of knowledge concerning the park's natural resources. This report will evolve based on user feedback and evaluation as our monitoring program continues to develop. As a first generation product, it brings into sharp focus several trends in the condition of the park's natural resources.

One notable concern for park managers is the lodgepole pines in the siege area at the Battlefield that have succumbed to infestations of bark beetles in recent years. Park managers are considering using prescribed fire to reduce the amount of woody debris in the forest with the long-term goal of reducing tree density along with mountain pine beetle infestations.

Increasing stream temperatures in the North Fork of the Big Hole River are also of management concern. Maximum temperatures in the river in the summer months in 2009 were close to the lethal temperature for cutthroat trout. A continuing upward trend in stream temperatures caused by climate change or decreasing summer flows could make the river inhospitable for trout and other coldwater fish species.

Water quality overall appears to be good to very good according to indices determined from macroinvertebrate data collected in 2009. Aquatic invaders such as New Zealand mud snail and whirling disease are of concern as they inhabit other streams and rivers in Montana. The best way to prevent the spread of aquatic invaders is for anglers to decontaminate (check, clean, dry) gear before entering park waters. It is recommended that signs be maintained at all park river access points to notify anglers of their responsibility in the prevention of the spread of aquatic invaders.

Invasive weeds have been, for the most part, kept out of the Battlefield. Some patches of spotted knapweed were encountered on Howitzer Hill in 2010 and park managers were immediately notified. The monitoring program has been an effective tool in detecting early invasions of exotic plants and notifying park managers so appropriate management actions could be undertaken.

Analysis of data from the camas monitoring program has assisted scientists in characterizing the baseline central tendency of camas abundance at Big Hole National Battlefield. According to data collected from 2006-2010 the density of camas lily on the Battlefield appears to be stable or increasing slightly.



Camas lily (*Camassia quamash*) blooming below the Visitor Center at Big Hole National Battlefield.

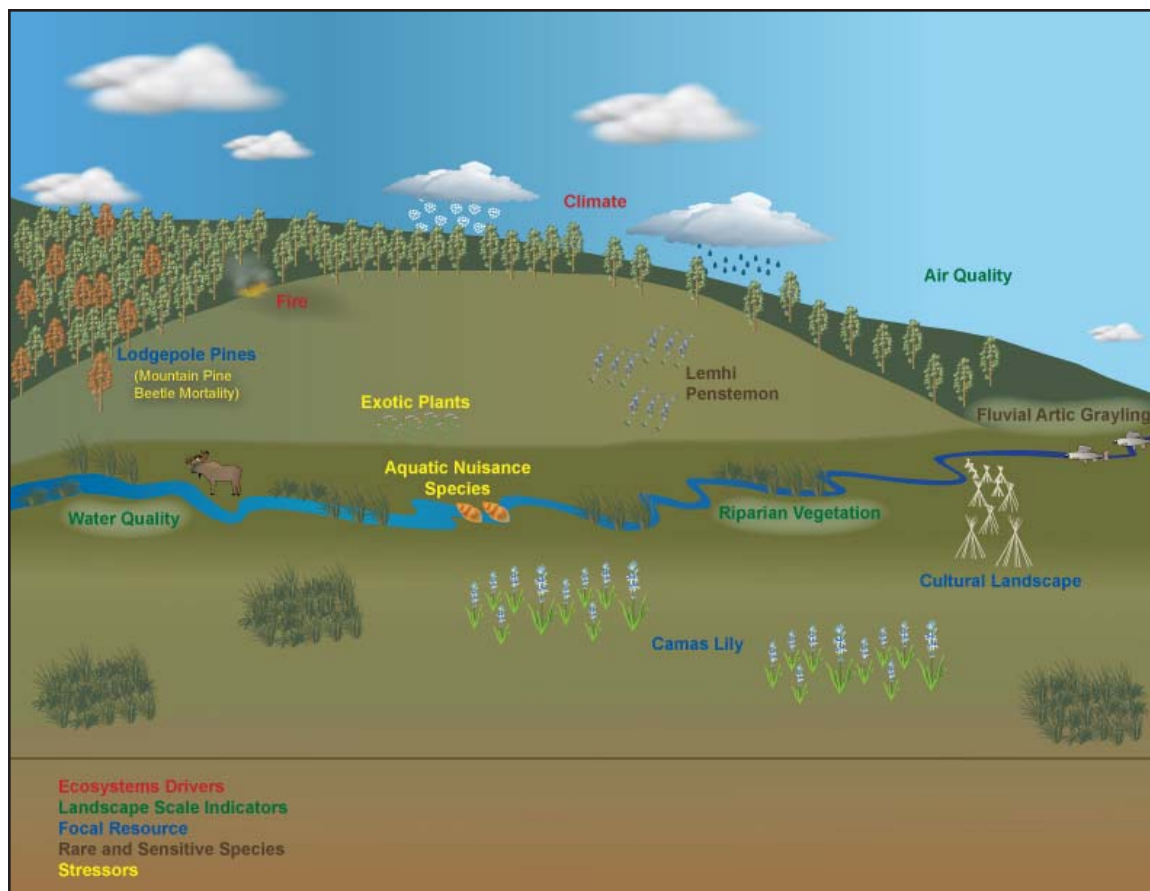
A rare plant inventory for Lemhi penstemon was conducted at Big Hole National Battlefield in 2010. Analysis of data collected during this inventory provided strong evidence that no fewer than 900 plants occur in the park, making this the largest known population for this narrow endemic species anywhere in its range. These results are very similar to results obtained from the 2009 inventory survey, providing added confidence in these findings and also insights into year-to-year variability that can inform future monitoring of this resource. The large size, natural habitat, and protection status of the Big Hole populations makes the park site globally significant and important to the long-term persistence of the species.

Baseline information such as distribution and abundance of Columbia spotted frogs in the park is important to determine long-term status and trend of amphibian populations. There are currently four recognized populations of Columbia spotted frogs: Northern, Great Basin, Wasatch, and West Desert. Columbia spotted frogs at Big Hole are classified in the Northern population and are considered abundant; however, the other three populations (Great Basin, Wasatch, and West Desert) are either declining or almost extirpated. The causes of decline are not fully understood, but as with most amphibians, a major threat is the destruction, fragmentation and degradation of wetlands. Other causes that contribute to the decline include the introduction of non-native predators such as bullfrogs, bass and predatory freshwater fish species. This is certainly a species that should be considered when additional funds become available for future monitoring.

Additional inventory information on fish species is desirable for park managers. Arctic grayling exist in the Big Hole River, but surveys have not been completed in the North Fork Big Hole River to determine whether the range of this species extends upstream into the park.

Long-term scientific monitoring is the key to documenting and understanding resource conditions and ecological health. Many stressors such as mountain pine beetle infestations and invasive weeds show that Big Hole's ecological system is being stressed by forces acting at larger scales than the boundary of the park. Partnerships between park and monitoring program staff, along with other federal, state, and private partners have been a successful model for addressing several issues at this scale. Existing partnerships need to be strengthened, and new partnerships formed, to address current issues and form the basis for effective stewardship of Big Hole National Battlefield's natural resources.

Thank you for reading this report. Please send comments to Monitoring Program Manager Lisa Garrett, 105 East 2nd St. Suite #5, Moscow, Idaho 83843.



This conceptual diagram of Big Hole National Battlefield depicts the complex interactions between natural resource vital signs.

Big Hole National Battlefield vital signs fall into five categories upon which the UCBN monitoring program is based: ecosystem drivers, landscape-scale indicators, rare and sensitive species, stressors, and focal resources. These vital signs encompass the suite of significant ecological resources of concern derived from the UCBN monitoring plan scoping process.

Ecosystem Drivers: Variability in weather and climatic patterns in the region are driven by changes in ocean circulation (Pacific Decadal Oscillation), changes in atmospheric composition (primarily water and CO₂), and elevation. This variability occurs across a broad range of spatiotemporal scales and, in concert with geology and landforms, exerts the most fundamental driving forces on the distribution, form, and function of UCBN ecosystems.

Landscape-scale Indicators: Landscape-scale indicators are monitored because changes they exhibit tell us something about the ecosystem or the landscape beyond their individual status or trends. Air quality, water chemistry, aquatic macroinvertebrates, stream channel characteristics, and riparian condition are vital signs

monitored at BIHO that are important to biological diversity and ecological processes such as water retention and nutrient cycling.

Rare and Sensitive Species: Rare and sensitive species are monitored not only because they are of high concern to both management and the public, but also because preserving native flora and fauna is core to the park's mission. Lemhi penstemon and arctic grayling are two species that fall into this category for BIHO.

Stressors: Like ecosystem drivers, stressors are agents of change. Stressors, such as exotic species, tend to reduce biodiversity and ecological integrity, and destabilize ecosystems.

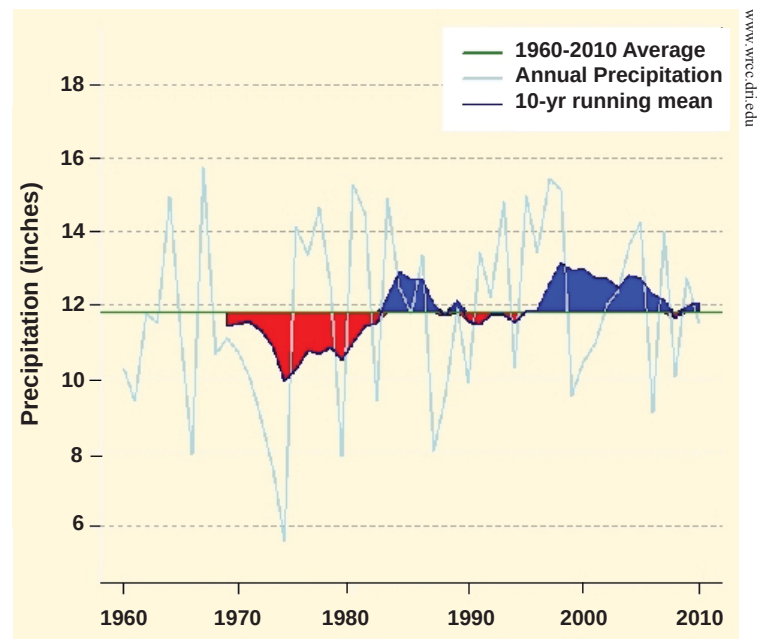
Focal Resources: These are resources that are of particular interest to management either because of concerns for that resource or because of how they might influence other resources. Camas was chosen because it is a focal resource of many of the significant historical events memorialized at the Battlefield. The battle at Big Hole in 1877 occurred at a traditional Nez Perce camas harvesting campsite.

Resource Category	UCBN Vital Sign	Measures	Current Condition	Reference Condition*	Within Reference Condition?	
Ecosystem Driver	Climate	Precipitation	slightly above average	50-yr. avg. (1960-2010)	Yes	
Landscape-scale Indicators	Water Chemistry	Temp (maximum daily average temperature)	17.1 °C	"A 1 °F [0.56 °C] maximum increase above naturally occurring water temperature is allowed"	TBD	
		Specific Conduct (mean)	54.5 µS/cm	Not designated	TBD	
		D.O. (mean daily min)	7.4 mg/L	Daily minimum > 8.0 mg/L, 7day mean >9.5 mg/L	No	
		pH (mean daily max)	7.4 pH Units	8.5 pH units, < 0.5 unit human induced change	Yes	
		pH (mean daily min)	7.1 pH Units	6.0 pH units, < 0.5 unit human induced change	Yes	
		Turbidity (mean daily max)	18.8 NTU	"No increase above natural turbidity is allowed"	TBD	
	Aquatic Macroinvertebrates	Species richness (mean)	71.2	TBD	TBD	
			EPT richness (mean)	21.2	TBD	TBD
			% EPT (mean)	39.8	TBD	TBD
			Hilsenhoff Biotic Index [HBI] (mean)	4.2	TBD	TBD
% predators (mean)			33.2	TBD	TBD	
% shredders (mean)			14.4	TBD	TBD	
% scrapers (mean)			12.2	TBD	TBD	
% gatherers (mean)			27.8	TBD	TBD	
MMI score (mean)			66.0	values ≥63 ("un-impaired")	Yes	
Stream Channel Characteristics / Riparian Condition			TBD	TBD	TBD	
Rare and Sensitive			Lemhi penstemon (Future project)	Total mature plants	1618	TBD
Stressors	Visitor use (Future project)	Number of visitors (2009)	49,822	average	Yes	
	Invasive Weeds	Spotted knapweed frequency in 100 m² plots in Howitzer Hill.	15%± 5%	0%	No	
Focal Resources	Camas Lily	Average stem density (plants/m2)	5.4	4.5	Yes	
		Avg. flowering density (flowering stems/m2)	0.6	TBD	TBD	
		Flowering ratio (flowering stems:plants)	0.1	TBD	TBD	
* Background color denotes the basis for the reference condition.						
		federal and state standards or NEPA process	scientific opinion	range or average	to be determined	

ECOSYSTEM DRIVERS

Climate

According to recordings from the Wisdom weather station located 250 feet below and 10 miles east of the park, precipitation in the upper Big Hole valley was slightly above the 50-year average. In 2010, winter precipitation and snowpack was slightly below average, but this was quickly eclipsed by a very wet spring and summer. Rainfall in June was twice the amount of the recent 10-year average, and the wettest on record since 1993. Above-average rainfall continued throughout the rest of 2010. Monthly average temperatures for 2010 were at or slightly below the 50-year average. 10-year monthly temperature averages ending in 2010 were approximately the same as long-term monthly averages, and no discernible climate trends over the period of record beginning in 1923 is detectable. However, slight decreases in regional winter precipitation, and increases in summer precipitation and in average temperatures for western Montana have been noted over the last several decades.



Upper Big Hole Valley (Wisdom, Montana) precipitation, 1960-2010.
Data from Western Regional Climate Center archives

LANDSCAPE SCALE INDICATORS

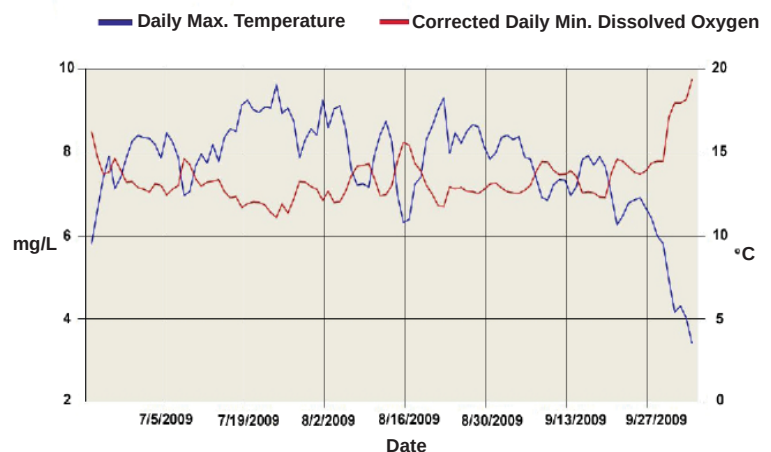
Water Chemistry

In 2009, all but one of the core parameters (Temperature, pH, Specific Conductance, Dissolved Oxygen, and Turbidity) monitored by the UCBN fell within state standards. Dissolved oxygen levels fell below the regulatory threshold (8.0 mg/L) on 97 of the 106 monitoring days (92% exceedance). While the North Fork Big Hole River is not on the 303(d) list for dissolved oxygen impairment, our monitoring suggests that the North Fork Big Hole River was below the total maximum daily load (TMDL) established by Montana Department of Environmental Quality (DEQ) for most of the sample period.

Dissolved oxygen indicates the amount of oxygen available for fish and aquatic macroinvertebrates. Low dissolved oxygen levels can have a negative influence on the aquatic macroinvertebrate and vertebrate assemblages and community composition. The amount of dissolved oxygen decreases in response to increasing water temperature and stream eutrophication.

Water temperatures did not technically exceed the state threshold; although, maximum temperatures in late July were close to the upper lethal temperatures for cutthroat trout ($\approx 19.5^{\circ}\text{C}$), and exceeded optimum growth temperatures $13\text{--}15^{\circ}\text{C}$ on a regular basis. Projected climate change could exacerbate the problem by decreasing summer stream flow and increasing peak temperatures.

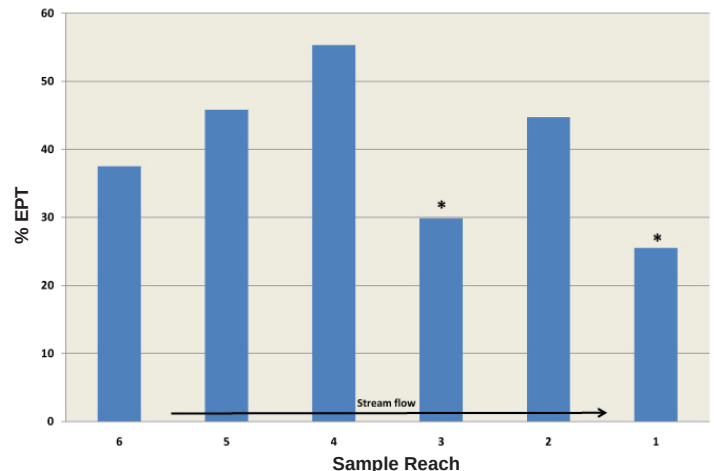
Corrected Daily Minimum Dissolved Oxygen and Daily Maximum Temperature
North Fork Big Hole River, June-October 2009



Aquatic Macroinvertebrates

In 2009, benthic macroinvertebrates were collected from 6 sites on the North Fork Big Hole River as part of the UCBN's integrated water quality protocol. A multi-metric index (MMI) score was calculated according to methods outlined by Montana DEQ. Results for 2006 indicate that 4 of the 6 sample reaches were "un-impaired" (values ≥ 63), while 2 reaches were between 62 and 29 and had "moderate impairment" (MT DEQ 2006). The mean MMI score for all sample reaches was 66, which indicates that the segment of the North Fork Big Hole River within the park is "un-impaired." Average species richness was 71.2 and EPT richness was 21.2. The Hilsenhoff Biotic Index (HBI) values ranged from 3.59 to 5.39 indicating that water quality is "good" to "very good".

% EPT in the North Fork Big Hole River - BIHO 2009



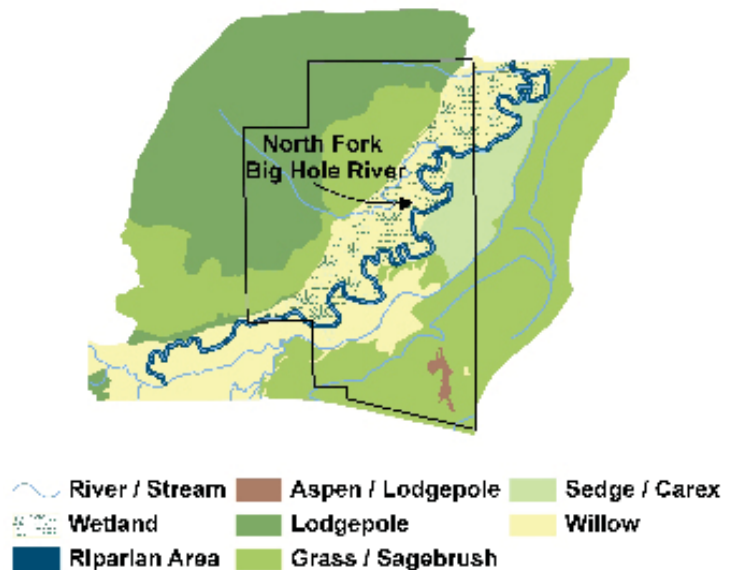
* Denotes impaired sample reaches (e.g. low multi-metric index [MMI] score)

LANDSCAPE SCALE INDICATORS (cont.)

Stream Channel Characteristics / Riparian Condition

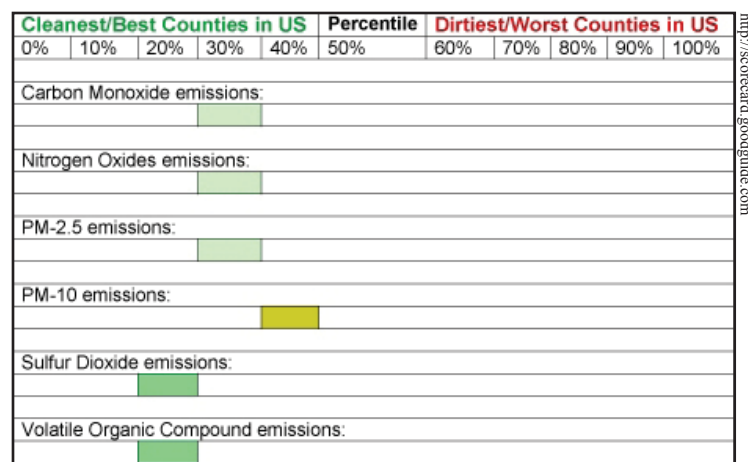
In summer 2012 the UCBN will implement stream channel characteristics and riparian condition monitoring in the North Fork Big Hole River.

The UCBN stream channel and riparian condition monitoring protocols use an existing monitoring protocol developed by the United States Forest Service (USFS) PACFISH/INFISH Effectiveness Monitoring (PIBO-EM) Program. In addition to the use of existing protocols, the UCBN has formed an interagency agreement with the USFS, for the PIBO-EM program to use their monitoring teams to collect stream channel and riparian condition monitoring data in UCBN parks, ensuring consistency and enhancing efficiency. Using the PIBO protocols will provide a unique opportunity to examine park stream channel and riparian condition resources relative to other streams in the Pacific Northwest.



Air Quality

Air quality in Wisdom, Montana is 99 on a scale to 100 (higher is better). This is based on ozone alert days and number of pollutants in the air, as reported by the EPA. Big Hole National Battlefield is in compliance with federal air quality standards for human health in regards to carbon monoxide, nitrogen oxide, sulfur and other emissions. A natural resource assessment completed in 2007 by the National Parks Conservation Association stated that air quality is excellent, and attributed this rating to the park's location. The park is buffered by Beaverhead National Forest and agricultural and ranch lands, which contribute to expansive scenic vistas.



Rankings of Beaverhead county relative to the entire U.S. The Environmental Protection Agency has designated Beaverhead County as an *attainment* area, meaning that there is no ozone pollution problem.

RARE AND SENSITIVE

Lemhi Penstemon

The 2010 survey confirmed that Big Hole National Battlefield is home to the largest reported population of Lemhi penstemon, making the park a globally significant conservation area for this rare endemic species. In 2010 the population was estimated to contain 1618 ± 644 established plants (excluding seedlings), a remarkably similar estimate to the one obtained in 2009. In contrast, all but 3 reported populations from elsewhere in the species' range contain fewer than 30 plants. In the Battlefield, the population is concentrated on the two east-facing slopes overlooking the river – the Howitzer Hill and the Horse Pasture. The species is known to require bare soil microsites for germination, including roadcuts, and the old roadcut at the base of the Howitzer Hill appears to support a particularly large concentration of plants. In 2011, a small subpopulation thought to have been extirpated was rediscovered below the visitor center along the eroded canal bank. Thirty-three plants were counted in this area.



A large showy Lemhi Penstemon (*Penstemon lemhiensis*) at Big Hole National Battlefield.

Amphibians

An amphibian survey in 2002 confirmed the presence of Columbia spotted frog (*Rana luteiventris*) and Western toad (*Bufo boreas*) at Big Hole National Battlefield. As a result of this survey the Columbia spotted frog was classified as abundant and the Western toad as rare in the park. Incidental observations in 2009 by field personnel collecting data for the Natural Resource Condition Assessment Project and Integrated Water Quality Protocol also observed Columbia spotted frogs. The state of Montana ranks this species as a S4 indicating that they are apparently secure across their range. Hydrological fluctuations change the extent and location of wetland sites at the park annually, which may result in year-to-year variation in amphibian reproduction. Baseline information such as distribution and abundance of spotted frogs in the park has not been determined so acquiring this information should be considered a priority for the park.



A Columbia Spotted Frog (*Rana luteiventris*).

RARE AND SENSITIVE (cont.)

Arctic Grayling

The last remaining population of fluvial arctic grayling (*Thymallus arcticus*) in the lower 48 states exists in the Big Hole River (east of Big Hole National Battlefield approximately 15 km). Historically arctic grayling likely inhabited the North Fork Big Hole River within the park. Recently, arctic grayling have only been documented downstream of the park near the confluence of the North Fork with the Big Hole River.

Decline of grayling populations have been attributed to habitat degradation, introduction of non-native salmonids, climate change and recreational angling. Non-native salmonids in the North Fork Big Hole River include brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*). In Montana, arctic grayling are designated as a “species of concern” by Montana Fish, Wildlife and Parks. Restoration of grayling habitat is underway within the Big Hole basin with reintroduction efforts in the Sun and Ruby Rivers.



Arctic grayling (*Thymallus arcticus*).

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STRESSORS

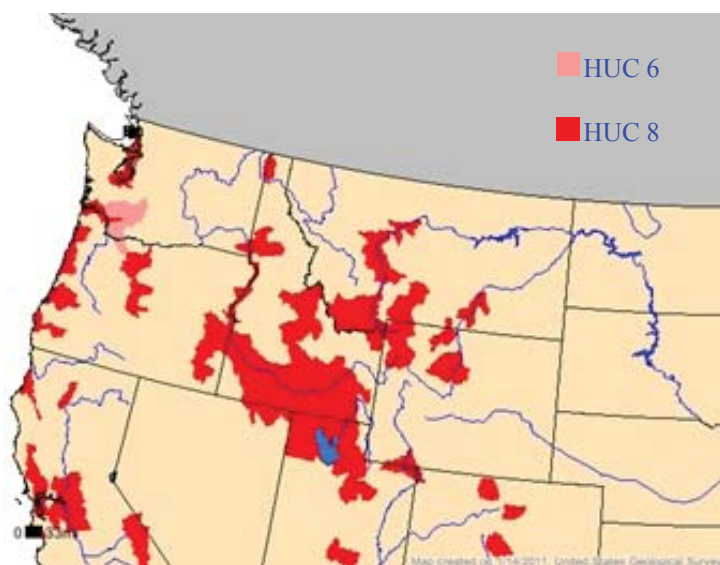
Aquatic Nuisance Species

Aquatic nuisance species (ANS) are a threat to water resources and visitor use within the park. In Montana, the primary vector for introduction and transport of aquatic invasive species (AIS) is recreational anglers and boat users. Given the yearly influx of anglers to the Big Hole River and North Fork Big Hole River the odds of ANS introduction to the park is relatively high. Montana ANS Technical Committee lists the following two species as “present and established in Montana and have the potential to spread”: New Zealand mud snail (*Potamopyrgus antipodarum*), and whirling disease (*Myxobolus cerebralis*). New Zealand mud snails have no natural predators in the U.S. and can reach high densities. At high concentrations they alter benthic macroinvertebrate communities and restrict food available to native trout. Whirling disease is caused by a parasite which damages spinal cartilage in trout. Infected trout swim erratically and are unable to feed and avoid predators.

Another nuisance species of concern in Montana is “Didymo” algae (*Didymosphenia geminata*). Didymo is a diatom capable of forming thick mats which smother benthic organisms. Didymo grows well in clean, clear flowing rivers such as the North Fork Big Hole River. The UCBN’s integrated water quality and stream channel characteristics monitoring protocols provide a means of detecting these invaders, but the best way to prevent them is for anglers to decontaminate (check, clean, dry) gear before entering park waters.



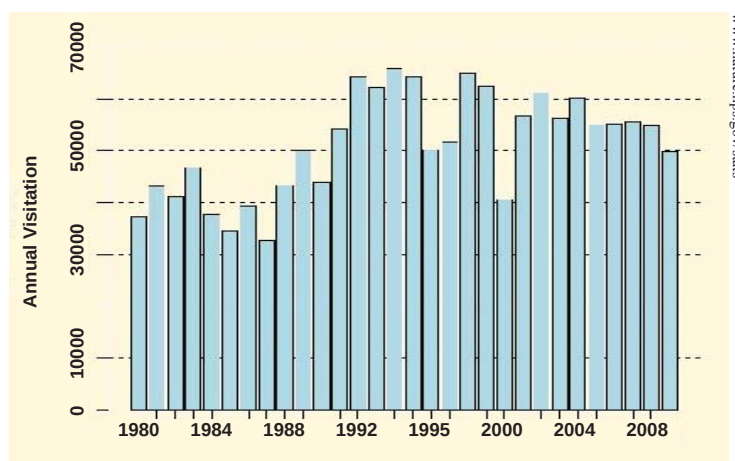
New Zealand mud snails (*Potamopyrgus antipodarum*).



Distribution of New Zealand mud snails.

Visitor Use

Annual visitation at Big Hole passed 60,000 people for the first time in 1992; since then, it has remained relatively stable, ranging from 40,000 to 60,000 annually. Most visitation occurs during the summer; use typically peaks in July. Fall visitation comprises approximately 20% of annual use. Winter visitation has never been more than 3% of the annual count. Since 2003, recreational visitors fluctuated between 49,000 and 60,000 with an overall downward trend. In 2009 it was 49,822.

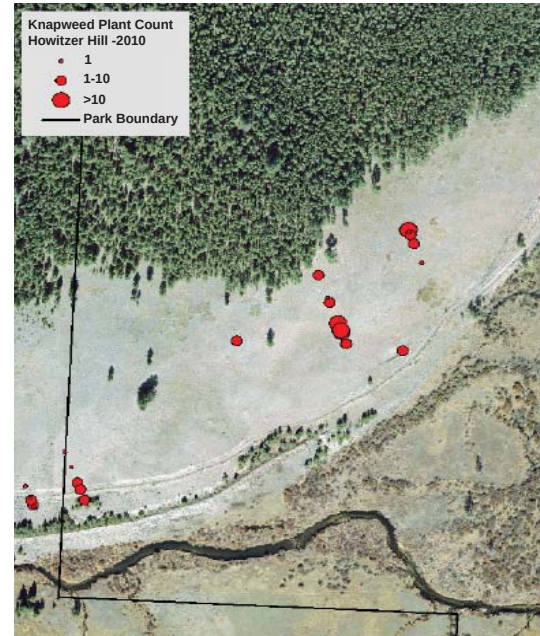


Visitation at Big Hole National Battlefield from 1980-2008.

STRESSORS (cont.)

Invasive Weeds

The full extent of weed invasion in the Battlefield is not known, but believed to be relatively low. No noxious weeds have been reported from camas monitoring plots in the floodplain along the river. On the Howitzer Hill, spotted knapweed has been encountered during Lemhi penstemon surveys. In 2010, the frequency of knapweed in 100 m² plots was 15% ± 5%, and counts of knapweed plants in those plots ranged from 1 to 42. Four large patches were encountered on the Howitzer Hill with >10 plants, and these are particularly worrisome infestations. Our data were used to guide herbicide application in some areas. Fortunately, spotted knapweed has not been encountered while surveying for penstemon on the Horse Pasture, a trend that we hope will continue.



Patches of spotted knapweed (red dots), scaled proportional to the number of plants counted. The park boundary is illustrated with the black line. Data from 2010 Lemhi penstemon survey conducted by Network and park staff.

Mountain Pine Beetle

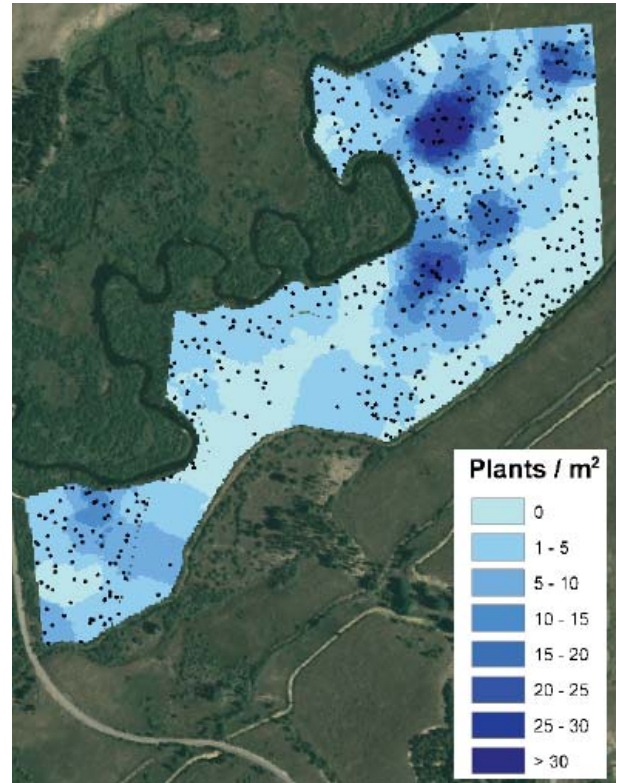
The long-term health of the forest at Big Hole is of concern, in part, because historic fire patterns have been altered. A century of fire suppression has led to densities of lodgepole pine (*Pinus contorta*) that could be fire hazards. In addition to management concern with stand density is the infestations of bark beetles that are occurring in Big Hole National Battlefield and throughout much of Montana. These infestations by bark beetles, native to western forests, are causing the most widespread tree mortality in recorded history. Evidence suggests that warming temperatures have intensified outbreaks of mountain pine beetle (*Dendroctonus ponderosae*) by enabling the beetles to survive the winter even at higher elevations. Earlier snowmelt and warmer temperatures also stress many tree species making them more vulnerable to attack by beetles and more vulnerable to wildfire.



Lodgepole pine tree mortality due to infestation of mountain pine beetle at Big Hole National Battlefield.

Camas Lily

Annual camas surveys since 2006 have found a stable to slightly increasing trend of $\leq 2\%$ per year in the median number of established plants per m^2 (camas density excluding seedlings). The estimated annual average number of established plants per m^2 ranged from a low of 4.2 in 2006 to a high of 5.8 in 2009. The 2010 average was estimated to be 5.4 plants per m^2 . Below-average winter and spring precipitation in 2005 and again in 2006 may have contributed to this pattern although there is no clear statistical relationship detectable at this time. The camas population in the Battlefield is characterized by high spatial variation, with discrete patches of very high density (e.g., >20 plants per m^2) concentrated in the northern portion of the study area near the encampment. Below-average density along the eastern border of the study area adjacent to the irrigation canal is suggestive of a possible connection to altered down-slope surface and subsurface runoff. High spring runoff and flooding of the meadow that occurred in the winter and spring of 2010 may invigorate camas populations, and we anticipate a continued increasing trend in camas density in 2011.



Estimated camas density (established plants per m^2) patterns in the floodplain below the visitor center. Data from 2006-2010 Upper Columbia Basin Network monitoring

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Climate

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Landscape-Scale Indicators:

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Landscape-Scale Indicators (cont.):

Stream Channel Characteristics/Riparian Condition

Starkey, E. N., T. J. Rodhouse, G. H. Dicus, L. K. Garrett, K. M. Irvine, and E. K. Archer. 2011. Upper Columbia Basin Network stream channel characteristics monitoring protocol: Narrative version 1.0. Natural Resource Report NPS/UCBN/NRR—2011/340. National Park Service, Fort Collins, Colorado.

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Rare and Sensitive:

Lemhi penstemon

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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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