

***Botrychium campestre* W.H. Wagner & Farrar (Iowa moonwort)**

Species Conservation Assessment Update

Title of Assessment: *Botrychium campestre* W.H. Wagner & Farrar (Iowa moonwort): A Technical Conservation Assessment, USDA Forest Service, Rocky Mountain Region

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Date of Publication: November 18, 2003

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Date of Update: November 10, 2006

Update Summary: Since the publication of *this assessment in 2003*, there have been numerous new discoveries of populations of several moonwort taxa in Region 2 including *Botrychium campestre*. These discoveries are the result of intensive survey efforts, especially in 2005 and 2006, by many Region 2 botanists and by Dr. Don Farrar and his colleagues. This work has led to significant improvements in our understanding of the distribution, habitats, and threats to *B. campestre* and other moonworts.

Distribution: Seven occurrences have been discovered in South Dakota since the publication of the assessment, and one in Wyoming. Observers estimated that a total of over 1000 additional plants occur at these new sites (with the majority of them at a single site in Wind Cave National Park, South Dakota), bringing the total estimated population in Region 2 to over 1000. Additional distribution information for some of the nine previously known occurrences has also become available. Preliminary survey data gathered in 2006 do not provide estimates of occupied area. Five of the eight new occurrences are found on National Forest System land on the Black Hills National Forest. Material collected in the Guanella Pass area is currently being evaluated using molecular genetic analysis to determine whether it is *B. campestre*. Preliminary analysis suggests that this is *B. campestre*, which would represent the first verified record from the Rocky Mountains and would greatly broaden the range of habitats known for *B. campestre*. This site is on the Arapaho National Forest. If verified to be *B. campestre*, its presence in mountain habitats will impact planning activities on National Forest System land because it will broaden the range of habitats for which consideration must be given to *B. campestre*. Revised tables containing the new occurrence information are provided in this addendum, as well as a revised map of occurrences in Region 2.

Taxonomic Status: Recent surveys have led to the discovery of several *Botrychium* taxa new to science. A taxonomic realignment of *B. campestre*, *B. lineare*, and *B. 'bifurcatum'* (discovered in 2006) is pending, and a fourth taxa discovered in Idaho appears to be a hybrid with parentage involving *B. campestre* and *B. lineare*. Work on reassessing the phylogenetic relationships of these taxa is ongoing.

Agency Status: NA

Other: Change in subnational conservation status rank in South Dakota from S1 to S1S2.

Significance of Changes Relative to Original Assessment: The new information presented in this addendum represents a significant change to the number of known occurrences of *B. campestre* in Region 2. The newly available population and habitat information shows that the population size within the administrative boundary of Region 2 is considerably higher than previously believe although *Botrychium campestre* remains a species of conservation concern in Region 2.

The new occurrences and other information have not resulted in a change in agency status, but have resulted in a change to the subnational conservation status rank in South Dakota. The description of the range of the species presented in the assessment remains relevant because the new occurrences are within the range of the species as it was known at time the assessment was published. However, the possibility that *B. campestre* occurs in mountain habitats opens up the possibility that *B. campestre* remains to be discovered in other locations in the Rocky Mountains. The evaluation of threats presented in the assessment is still relevant and accurate, but other threats (resulting from road improvements) may become evident if it is confirmed that *B. campestre* occurs in the Guanella Pass area.

Because research is currently underway to make critical determinations of the distribution and taxonomic status of *Botrychium campestre*, a revision of this assessment is not warranted at this time. A revision will probably be needed in three to five years following the completion of ongoing research and survey efforts.

Positive Findings of New or Updated Information and Their Sources

(Note: The Table A checklist attached to this update provides a summary of all sources consulted)

Source 1

Farrar, Donald R. 2005. *Systematics of Western Moonworts Botrychium Subgenus Botrychium*. In: Popovich, Steve J. (ed.). United States Forest Service Moonwort Workshop. Arapaho-Roosevelt National Forests and Pawnee National Grassland, Fort Collins, Colorado, July 13-15, 2005. 31pp +10p key + 58p appendix with color plates and distribution maps + inserts. Spiral bound. Limited printing.

Summary of New Information

This Source includes a synopsis of the systematics, morphology and identification, genetic distinction, speciation and evolution, population genetics, and thorough species descriptions of members of the subgenus *Botrychium*, including *B. campestre*. A discussion of the phylogenetic relationship between *B. campestre* and *B. lineare* is included. Unpublished research involving the restriction of dispersal and lack of genetic variability within the genus are presented.

Relevant Sections of the Conservation Assessment Affected by the Updates

Reproductive Biology and Autecology, Classification and Description

Source 2

Farrar, D.R., C. Skelton, D. Reyher, A. King, and B. Burkhart. 2006. Black Hills National Forest *Botrychium* species study 2004 and 2005. Unpublished report. Iowa State University and Black Hills National Forest.

Summary of New Information

Three new occurrences of *Botrychium campestre* are documented from the 2005 surveys: Gobbler Pass, Wind Cave Road 5, and Boles Canyon.

One of these occurrences (Boles Canyon) is on National *Forest System land* on the Black Hills National Forest in South Dakota). Two (Wind Cave Road 5 and Gobbler Pass) are on National Park Service land (Wind Cave National Park in South Dakota).

The Gobbler Pass site was in high quality little bluestem/big bluestem prairie, on a west-facing slope, with 130 *Botrychium campestre*, *B. simplex* and *B. lineare*. It is assumed that approximately 1000 plants may be at this site, making this the largest known occurrence of *B. campestre* within the area administered by Region 2.

The Wind Cave Road 5 site was found on a steep, northeast-facing slope in dark red soil among sparse native prairie vegetation, with three *Botrychium campestre* individuals.

The Boles Canyon site was in a three acre patch of little bluestem in a ponderosa pine forest, with a total of 72 *Botrychium campestre* and *B. lineare* individuals occurring in areas of moisture/runoff concentration. The new occurrences do not expand the known range of the species, but fill gaps in distribution. New information for these occurrences is summarized in Tables 1 and 2.

Four additional suboccurrences were also found at Dugout Gulch. These consist of mixed populations of *Botrychium campestre* and *B. lineare*.

The similarities between *Botrychium campestre* and *B. lineare* are discussed, and the case for reducing *B. lineare* to a variety of *B. campestre* is presented. The rationale for demoting *B. lineare* to a variety of *B. campestre* is discussed in this Source. Additional associated species were documented in this Source; these are presented in Table 2.

Relevant Sections of the Conservation Assessment Affected by the Updates

Classification and Description, Community Ecology, Evidence of Populations in Region 2 at Risk

Table 1. Summary information on the newly discovered occurrences of *Botrychium campestre* in Region 2. Occurrences on National Forest System land are in bold.

State	Location	Last Observed	Land Ownership	Population Size	Notes
South Dakota	Custer County, Boles Canyon	May 28, 2006	USFS Black Hills NF	~50	Mixture of <i>B. campestre</i> and <i>B. lineare</i> , in 3 acre patch of little bluestem and snowberry grassland area.
	Custer County, Gobbler Pass	May 26, 2006	Wind Cave NP	combined total of 130 <i>B. campestre</i> , <i>B. simplex</i> , and <i>B. lineare</i> counted-estimate ~1000 <i>B. campestre</i> individuals at this site.	Mixture of <i>B. campestre</i> , <i>B. simplex</i> , and <i>B. lineare</i> in high quality little bluestem/big bluestem prairie.
	Custer County, Wind Cave Road 5	May 24, 2005	Wind Cave NP	3	In dark red soil among sparse native prairie vegetation.
	Custer County, north of Gobbler Ridge	Spring, 2006	Wind Cave NP	“two patches”	Little bluestem thatch.

State	Location	Last Observed	Land Ownership	Population Size	Notes
	Meade County, west of Blackhawk	May 27, 2006	USFS Black Hills NF	“at smallest occurrence”	Several <i>Botrychium</i> species, grassland with snowberry patches, ponderosa pine on edges, most found in big bluestem thatch.
	Custer County, Dead Horse Flats	May 28, 2006	USFS Black Hills NF	6	Burned in the Jasper Fire, 2000, in a swale with little bluestem and small snowberry plants, dead (burned) ponderosa pine within and on edges of grassland.
	Custer County, Witch Spring	May 28, 2006	USFS Black Hills NF	“a lot of similar habitat yet to be searched”	Mixture of <i>B. campestre</i> and <i>B. lineare</i> , little bluestem and snowberry patches and ponderosa pine.
Wyoming	Crook County, Sundance Trails	May 30, 2006	USFS Black Hills NF	2	Burned in Sundance Fire, ca 1940s, smooth brome, bluebunch wheatgrass, and a diversity of native forbs, few ponderosa pines have reestablished since the fire.

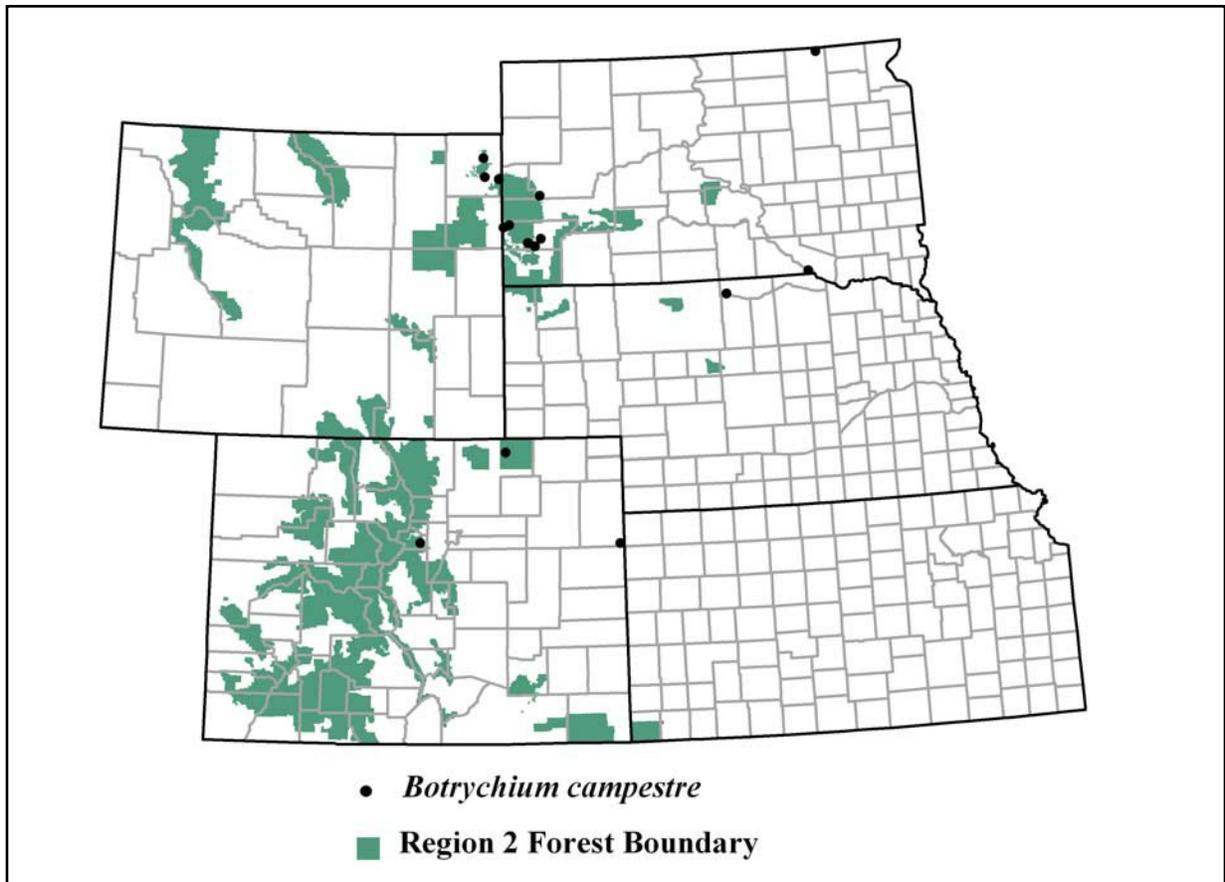


Figure 1. Distribution of all *Botrychium campestre* reports in the states of Region 2.

Table 2. Associated species that have been documented with *Botrychium campestre* at 13 of the 17 locations in the states of Region 2. DG = Dugout Gulch, WY; BC = Bearlodge Campground, WY; BP = Bonny Prairie, CO; NV = Niobrara Valley Preserve, NE; GC = Gregory County, SD; BO = Boles Canyon, SD; GP = Gobbler Pass, SD; R5 = Road 5, SD; NG = north of Gobbler Ridge, SD; BH = Blackhawk, SD; DH = Dead Horse, SD; WS = Witch Springs, SD; ST = Sundance Trails, WY. Designation: R = rare, E = exotic. Nomenclature follows that of Kartesz (1999).

Species	Dominant or common associate	Designation	DG	BC	BP	NV	GC	BO	GP	R5	NG	BH	DH	WS	ST
<i>Achillea millefolium</i>			X												
<i>Agoseris glauca</i>									X						
<i>Andropogon gerardii</i>									X	X		X			
<i>Anemone</i> sp.								X							
<i>Antennaria</i> spp.			X						X						
<i>Aristida purpurea</i>					X										

Species	Dominant or common associate	Designation	DG	BC	BP	NV	GC	BO	GP	R5	NG	BH	DH	WS	ST
<i>Artemisia dracunculus</i>								X							
<i>Artemisia frigida</i>								X	X						
<i>Astragalus crassicaarpus</i>									X						
<i>Astragalus missouriensis</i>								X							
<i>Besseya wyomingensis</i>									X						
<i>Botrychium ascendens</i>		R	X												
<i>Botrychium lineare</i>		R						X	X						
<i>Botrychium pallidum</i>		R										X			
<i>Botrychium simplex</i>		R							X						
<i>Botrychium virginianum</i>		R	X												
<i>Bouteloua curtispindula</i>	X				X										
<i>Bouteloua gracilis</i>					X										
<i>Bromus inermis</i>															X
<i>Bromus tectorum</i>		E			X										
<i>Campanula rotundifolia</i>			X												
<i>Carex filifolia</i>								X	X						
<i>Carex inops</i>			X												
<i>Cirsium arvense</i>		E			X										
<i>Cirsium undulatum</i>								X	X						
<i>Corylus cornuta</i>			X												
<i>Crataegus chrysocarpa</i>			X												
<i>Dalea enneandra</i>					X										
<i>Erigeron spp.</i>			X												
<i>Erysimum asperum</i>					X										
<i>Erysimum capitatum</i>									X						
<i>Fragaria virginiana</i>			X												
<i>Geum triflorum</i>								X							
<i>Juniperus virginiana</i>	X					X	X								
<i>Lesquerella sp.</i>									X						
<i>Leucocrinum montanum</i>								X	X						
<i>Maianthemum canadense</i>			X												
<i>Maianthemum stellatum</i>			X												
<i>Medicago lupulina</i>	X	E	X												
<i>Melilotus alba</i>		E			X										
<i>Mertensia sp.</i>									X						
<i>Mertensia lanceolatum</i>								X							

Species	Dominant or common associate	Designation	DG	BC	BP	NV	GC	BO	GP	R5	NG	BH	DH	WS	ST
<i>Monarda fistulosa</i>			X												
<i>Nassella viridula</i>									X						
<i>Onosmodium molle</i>									X						
<i>Oxytropis sericea</i>									X						
<i>Phlox hoodii</i>								X	X						
<i>Pinus ponderosa</i>			X	X				X	X			X	X	X	X
<i>Poa</i> spp.	X		X												
<i>Polygala senega</i>			X												
<i>Populus tremuloides</i>				X											
<i>Potentilla</i> sp.									X						
<i>Pseudoroegneria spicata</i>															X
<i>Pulsatilla patens</i>									X						
<i>Quercus macrocarpa</i>			X			X									
<i>Ratibida columnifera</i>					X										
<i>Rhus trilobata</i>									X						
<i>Rosa</i> spp.			X					X	X						
<i>Schizachyrium scoparium</i>	X				X			X	X	X	X		X	X	
<i>Senecio integerrimus</i>									X						
<i>Sisyrinchium montanum</i>									X						
<i>Solidago</i> sp.								X	X						
<i>Sphaeralcea coccinea</i>					X				X						
<i>Stipa comata</i>					X										
<i>Symphoricarpos</i> spp.			X					X				X	X	X	
<i>Taraxacum</i> spp.			X												
<i>Tetrameuris acaulis</i>									X						
<i>Tragopogon dubius</i>									X						
<i>Trifolium repens</i>		E	X												
<i>Verbena stricta</i>					X										
<i>Verbascum thapsus</i>		E			X										
<i>Veronica</i> spp.			X												
<i>Vicia americana</i>								X							
<i>Zigadenus venenosus</i> var. <i>gramineus</i>								X							

Source 3

Farrar, D.R. 2005. Genetic and morphological analysis of Guanella Pass *Botrychium* plants. Unpublished report. Submitted to Arapaho-Roosevelt National Forest.

Summary of New Information

This Source summarizes the results of genetic and morphological analyses of *Botrychium* occurring near Guanella Pass, Colorado. Material analyzed is suspected of representing one or more new taxa to which *Botrychium campestre* may be closely related. Some of the plants collected at this site appear to be closely related and genetically and morphologically intermediate to *B. campestre* and *B. lineare*, and are possibly the result of hybridization events between them. Other plants at this site appear to be hybrids between a “new” taxon and another *Botrychium* species. Alternate hypotheses for the results of the electrophoresis are also proposed. It is stated that *B. campestre* and *B. lineare* are sister species.

Relevant Sections of the Conservation Assessment Affected by the Updates

Classification and Description, Hybridization

Source 4

Popovich, S.J. 2006a. Moonworts (*Botrychium*) – a “new species” found in Colorado? Unpublished report. Presented at Region 2 Botany Meeting.

Summary of New Information

This Source provides an overview of the discovery and diagnosis of the new taxa from the Guanella Pass area, Colorado (discussed in Source #3). The Guanella Pass corridor has been realigned to minimize impacts to moonwort populations in the area. The “new genetic entity” found in this area has alleles and attributes of both *B. campestre* and *B. lineare* and is believed to be a fertile diploid or allotetraploid. Other plants appear to be hybrids between the “new genetic entity” and other *Botrychium* species.

Relevant Sections of the Conservation Assessment Affected by the Updates

Classification and Description, Hybridization

Source 5

Burkhart, B. 2006. Trip report – 2006 *Botrychium* spp. survey on the Black Hills National Forest by Dr. Farrar/Chanda Skelton of Iowa State University with BHNH botanists and others. Unpublished report. Distributed to survey participants.

Summary of New Information

Four new occurrences of *Botrychium campestre* on National Forest lands, three in South Dakota: west of Blackhawk, Dead Horse Flats, and Witch Spring; and one in Wyoming at Sundance Trails, were documented in surveys conducted in 2006. An additional suboccurrence was also documented north of Gobbler Pass at Wind Cave NP, South Dakota. The new occurrences do not expand the known range of the species, but fill gaps in distribution. West of Blackhawk *B. campestre* was found with several *Botrychium* species in grassland with snowberry patches in ponderosa pine forest. Most of the approximately 139 *Botrychium* sporophytes were found in big bluestem thatch. Six *B. campestre* plants were found at Dead Horse Flats in a swale dominated by little bluestem and snowberry in an area burned in the Jasper Fire of 2000. The Witch Spring occurrence is on a large, north-facing hillside with little bluestem and snowberry. The occurrence was not thoroughly investigated due to weather conditions, but *B. campestre* and *B. lineare* were present. Sundance Trails had two *B. campestre* plants on a northwest-facing limestone slope among *Bromus inermis*, *Pseudoroegneria spicata*, and native forbs. The location north of Gobbler Pass was found by a Wind Cave volunteer in little bluestem thatch on a south-facing slope and another area near the

ridge top. *Botrychium campestre* and *B. gallicomontanum* were found together at this location. The above information is incorporated into the new Tables 1 and 2.

Relevant Sections of the Conservation Assessment Affected by the Updates

Management Status, Evidence of Populations in Region 2 at Risk sections, Community Ecology

Source 6

Ode, D. 2006. Personal communication regarding change of South Dakota State ranking of *Botrychium campestre*.

Summary of New Information

The subnational conservation status rank was changed from S1 to S1S2 in South Dakota based on 2005 surveys (Source #2). The rank change is supported by the discovery of large occurrences at Gobbler Pass and Boles Canyon, and the increased likelihood of finding the taxon with further survey effort. Information obtained in 2006 (Source #5) did not warrant another change in the subnational conservation status rank. Ode suspects that *B. campestre* is likely to occur in the eastern part of South Dakota.

Relevant Sections of the Conservation Assessment Affected by the Updates

The updated field ranking information should be added to the Management status section.

Source 7

Anderson, D.G. 2006. Personal communication regarding search for *Botrychium campestre* in Pawnee National Grassland.

Summary of New Information

The spring of 2006 was extremely dry, and no moonworts were found during this survey, conducted on April 20-22. Seasonal dormancy may have been occurring. On the Pawnee National Grassland, *Botrychium campestre* is likely to be found on moist slopes or toeslopes where forb diversity is high. The presence of *Stipa comata*, *Schizachyrium scoparium*, *Koeleria macrantha*, a diversity of forbs, and moss species in such sites is indicative of possible *B. campestre* habitat. Areas were identified and searched where Dr. Farrar indicated that the presence of *B. campestre* was very likely. Previous reports of moonworts from the Pawnee National Grassland are from sites described as buffalo wallows or playas, but such sites are more likely to support *B. simplex*. Moist swales dominated by *Buchlœe dactyloides* were searched, where Dr. Farrar indicated that *B. simplex* would be very likely to occur in more favorable (wetter) years.

Relevant Sections of the Conservation Assessment Affected by the Updates

Distribution and Abundance, Habitat

Source 8

Kurzel, B. 2006. Personal communication regarding search for *Botrychium campestre* in Bonny Prairie Natural Area.

Summary of New Information

Extreme drought conditions were occurring during this survey on April 29, 2006. No moonworts were observed in suitable habitat at this location where up to six *B. campestre* sporophytes have been observed previously. The relatively intact loess prairie habitat at this site was searched by two people on April 29, 2006. Seasonal dormancy may have been occurring. Soil samples were collected in the area where *B. campestre* was previously observed and will be sent to Cindy Johnson-Groh to search for gemmae and gametophytes.

Relevant Sections of the Conservation Assessment Affected by the Updates

Distribution and Abundance

Source 9

Distribution and Abundance

Summary of New Information

A thorough description of the first collection/discovery of *Botrychium campestre* is provided in this reference. In 1982, University of South Dakota botanist Ted Van Bruggen found a small grapefern on the recently burned grassland while hiking in the loess hills of the Missouri River Breaks of Iowa and Nebraska. Iowa botanist Larry Eilers tried to identify the specimen, and returned to the prairie to collect some more. Eilers sent the specimens to Iowa State University fern expert Don Farrar, and he and University of Michigan fern expert W. Herb Wagner authored the new taxon, *B. campestre*, in 1986.

Relevant Sections of the Conservation Assessment Affected by the Updates

Classification and Description

Source 10

Popovich, S.J. 2006b. Review of Moonworts (*Botrychium* spp. subgenus *Botrychium*) Located within the Corridor of the Guanella Pass Road Improvement Project, Arapaho National Forest, Colorado. Arapaho-Roosevelt National Forests & Pawnee National Grassland, Fort Collins, CO.

Summary of New Information

This is a brief preliminary report summarizing the current thinking on the taxonomic and conservation status of moonwort taxa observed thus far in the Guanella Pass area.

Preliminary electrophoretic analysis of material collected within the project area at Guanella Pass indicates that two plants collected are *Botrychium campestre*. This determination was made based on preliminary electrophoretic analysis of two loci by Dr. Donald Farrar. An analysis is pending for all loci that will increase the confidence in this assessment; this analysis will be conducted in the winter of 2006-2007. If this is confirmed, this will be the first verified report of *B. campestre* from the Rocky Mountains. This would greatly broaden the range of elevation and habitat types known to be occupied by this species.

There is a site near the entrance station on the Mt. Evans road on the Arapaho National Forest that is either *Botrychium campestre* or *B. lineare*, but collected material made one year in the past has become too old to perform genetic analysis. If the presence of *B. campestre* is confirmed on Guanella Pass, this would also bring the designation of the Echo Lake collection as the characteristically montane *B. lineare* back into question since the specimen is morphologically closer to *B. campestre*. This site has been searched every year between 2003 and 2006 but similar plants have not been observed. Until presence of *B. campestre* is confirmed from another mountain locality, Dr. Farrar feels that the site at Mt. Evans is probably best treated as *B. lineare* based on elevation and habitat.

Although *Botrychium campestre* has been discovered at many new sites in 2005 and 2006, it still appears to be rare and thus remains of viability concern in Region 2.

Dr. Farrar is currently working on a taxonomic revision of what is now being referred to as “the *Botrychium campestre* complex.” In this new treatment, Dr. Farrar will probably reduce two taxa to the rank of infraspecies (either subspecies or variety) under *B. campestre*. The two taxa to be subsumed are *B. ‘bifurcatum’* (which may end up being called ‘*furcatum*’ because some individuals do not have bifurcate pinnae) and *B. lineare*. This will result in the circumscription of three new taxa: *Botrychium campestre* subspecies/variety *campestre*, *B. campestre* subspecies/variety *lineare*, and *B. campestre* subspecies/variety ‘*bifurcatum*’ or ‘*furcatum*.’ A fourth undescribed entity that appears to be a stable hybrid of *B. campestre* and *B. lineare* (currently known only from a single large population in the Boulder-White Clouds Mountains of the Sawtooth National Forest in south-central Idaho outside Region 2), will also be described, but its phylogenetic relationship

with these taxa remains unclear at present.

A status report on the moonworts of Colorado by Popovich is pending, following confirmation of material from the Guanella Pass site.

Relevant Sections of the Conservation Assessment Affected by the Updates

Classification and Description, Distribution and Abundance, Hybridization; if confirmed, the Guanella Pass site will be discussed in Distribution and Abundance and Threats.

Additional Unabstracted Sources – *pre*-Assessment

(citations pre-dating Assessment publication that were not referenced in it).

None.

Additional Unabstracted Sources – *post*-Assessment

(citations post-dating Assessment publication that refer to the target genus but were determined by the reviewer to contain no information requiring an update of the original assessment)

We considered but did not abstract one environmental assessment for West Red Pine, Hiawatha National Forest, in which *Botrychium campestre* was named as a species of interest:

Chase, T. 2005. Environmental Assessment, West Red Pine, Hiawatha National Forest. Munising Ranger District. USDA Forest Service. Available on the Web at: http://www.fs.fed.us/r9/hiawatha/west_red_pine/final_EA.pdf.

We considered but did not abstract one environmental impact statement for proposed Spring Creek Land Exchange, prepared for the town of Canmore, [Alberta], in which *Botrychium campestre* was named as a species of interest:

Matrix Planning in association with Wildlife & Company. 2003. Environmental impact statement for proposed Spring Creek Land Exchange, prepared for the town of Canmore, [Alberta]. Available on the Web at: <http://www.biosphereinstitute.org/docs/Final-Spring-Creek-Volume-II-EIS-Appendices.pdf>.

We considered but did not abstract one biological evaluation (flora) for the Kinsey Hunt salvage project on the Huron-Manistee National Forests, Oscoda County, Michigan, in which *Botrychium campestre* was named as a species of interest:

Schmidt, G., Botanist – Huron National Forest. 2005. Biological evaluation (flora) for the Kinsey Hunt salvage project on the Huron-Manistee National Forests, Oscoda County, Michigan. USDA Forest Service. Available on the Web at: http://www.fs.fed.us/r9/hmnf/pdf_files/Kinsey_Hunt/BE_Kinsey_Hunt_Salvage-plants-0103.pdf.

We considered but did not abstract application to the Minnesota Environmental Quality Board for a route permit, in which *Botrychium campestre* was named as a species of interest:

Xcel Energy. 2004. Xcel Energy application to the Minnesota Environmental Quality Board for a route permit, Buffalo Ridge – White 115 KV transmission line and the Yankee Substation. EQB Docket No. 04-84-TR-XCEL. Available on the Web at: <http://scholar.google.com/scholar?hl=en&lr=&q=cache:zmoi4q5YQFkJ:www.eqb.state.mn.us/pdf/FileRegister/buffaloridgewhite/buffalowwhite.pdf+%22xcel+energy+application+%22+%22buffalo+ridge%22>.

We considered but did not abstract a focus area strategic plan, prepared by Rocky Mountain Bird Observatory and the Prairie and Wetlands Focus Area Committee, in which *Botrychium campestre* was named as a species of interest:

Rocky Mountain Bird Observatory and the Prairie and Wetlands Focus Area Committee. 2004. Prairie and wetlands focus area strategic plan. Funded by Colorado Division of Wildlife Playa Lakes Joint Venture. Available on the Web at: <http://wildlife.state.co.us/NR/rdonlyres/>

95B311B1-A001-4846-BF26-F0F8FB8A5113/0/stratplanPrairie1204.pdf.

We considered but did not abstract an economic valuation of ecosystem services, in which *Botrychium campestre* was named as a species of interest:

Hawkins, K. 2003. Economic valuation of ecosystem services. University of Minnesota. Available on the Web at: http://www.frc.state.mn.us/Landscp/econ_lit_search_1003.pdf.

We considered but did not abstract a list of Wyoming plant and animal species of concern, in which *Botrychium campestre* was named as a species of interest:

Keinath, D., B. Heidel and G.P. Beauvais. 2003. Wyoming Plant and Animal Species of Concern. Prepared by WYNDD, Laramie, WY. Available on the Web at: http://uwadmnweb.uwyo.edu/WYNDD/SOC/2003_WYNDD_SOC.pdf

We considered but did not abstract a provisional list of vascular plants for the Southern Rocky Mountain Interactive Flora, in which *Botrychium campestre* was named as a species of interest:

Snow, N., J. W. Brasher. February 2004. Provisional Checklist of Vascular Plants for the Southern Rocky Mountain Interactive Flora (SRMIF). University of Northern Colorado, Greeley. Available on the Web at: <http://scholar.google.com/scholar?hl=en&lr=&q=cache:7ocCvIjrxxAJ:www.unco.edu/nhs/biology/SRMIF/SRMIFChecklistFeb04.pdf+provisional+list+of+vascular+plants+for+the+Southern+Rocky+Mountain+Interactive+Flora>.

We considered but did not abstract a New York Natural Heritage Program rare plant status list, in which *Botrychium campestre* was named as a species of interest:

Young, Stephen M. and Troy W. Weldy. 2004. New York Rare Plant Status List. New York Natural Heritage Program, Albany NY. May 2004. 90 pages. Available on the Web at: <http://www.dot.state.ny.us/eab/epm/4-1-h.pdf> or <http://www.nynhp.org/>.

We considered but did not abstract an aquatic integrity areas report for the Upper Columbia River Basin, in which *Botrychium campestre* was named as a species of interest:

Oechsli, L. and C. Frissell. 2003. Aquatic integrity areas: Upper Columbia River Basin. A joint project of American Wildlands, Pacific Rivers Council, Yellowstone to Yukon Conservation Initiative. Available on the Web at: http://www.wildlands.org/AIA_ucpaper_final.pdf

We considered but did not abstract a report on developing rare and exotic plant geographic information systems databases, in which *Botrychium campestre* was named as a species of interest:

Pavlovic, N.B., K.M. Quinlan, and T Ford. 2005. Developing rare and exotic plant geographic information systems databases for Indiana Dunes and Sleeping Bear Dunes National Lakeshores. USGS, Biological Resources Discipline, Great Lakes Science Center, Lake Michigan Ecological Research Station. Available on the Web at: [http://www1.nature.nps.gov/im/units/glkn/INDU%20and%20SLBE%20rare%20and%20exotic%20plants%20\(publicwithExotics\).pdf](http://www1.nature.nps.gov/im/units/glkn/INDU%20and%20SLBE%20rare%20and%20exotic%20plants%20(publicwithExotics).pdf)

We considered but did not abstract literature on other members of the genus that did not have clear relevance.

Davis, C.C., W.R. Anderson, and K.J. Wurdack. 2005. Gene transfer from a parasitic flowering plant to a fern. *Proceedings of the Royal Society Biological Sciences Series B* 272 (1578): 2237-2242.

Small, R.L., E.B. Lickey, J. Shaw, and W.D. Hauk. 2005. Amplification of noncoding chloroplast DNA for phylogenetic studies in lycophytes and monilophytes with a comparative example of relative phylogenetic utility from Ophioglossaceae. *Molecular Phylogenetics and Evolution* 36:509-522.

Checklist of Sources Consulted for Updates to *Botrychium campestre* Conservation Assessment

Guidelines for Producing Updates

Sources of information relevant to review of this Technical Conservation Assessment for updates include Sources of information consulted in reviewing this Technical Conservation Assessment. Sources include databases, experts, personal communications, published and unpublished literature. Positive results are discussed in detail in the Summary of Addendum to the Technical Conservation Assessment.

Internet Literature Searches: The minimal search for each update consists of Google Scholar, Federal Register, plus a minimum of three other available online literature databases. Search terms include at a minimum: species common name, genus, and recent synonyms. Other keywords will be used at the discretion of the updater (e.g., passerine, wetland, rodent). Searches will be constrained to the time beginning two years prior to publication of the Technical Conservation Assessment to the present.

Two attempts were made to contact experts and agency personnel.

Table A. Sources of information consulted for updates to the Species Conservation Assessment.

Source Category	Source/ Name	Date	Results
Internet based literature databases	Google Scholar	6/22/2006	Twelve new sources for the search term " <i>Botrychium campestre</i> ". Cited but not reviewed.
	Federal Register	6/22/2006	No new sources for search term: " <i>Botrychium campestre</i> "
	Scopus	6/22/2006	No new sources for search term: " <i>Botrychium campestre</i> "
	Web of Science/Web of Knowledge	6/22/2006	No new sources for search term: " <i>Botrychium campestre</i> "
	Biological Abstracts	2/23/2006	Two new sources identified for search term " <i>Botrychium</i> ". Cited but not reviewed.
	WorldCat	6/22/2006	No new sources for search term: " <i>Botrychium campestre</i> "
Reports	Farrar, D.R.	6/27/2006	Moonwort workshop notebook. See Source #1
	Farrar, D.R., C. Skelton, D. Reyher, A. King, and B. Burkhart. 2006	6/22/2006	New records representing 2004, 2005 field results. See Source #2.
	Farrar, D.R. 2005	9/12/2005	Suspected new taxa. See Source #3
	Popovich, S. 2006	1/31/2006	Suspected new taxon. See Source #4, #10
	Burkhart, B. 2006.	7/31/2006	2006 field results. See Source #5
NatureServe affiliate program databases and personnel	Dave Ode, South Dakota Game, Fish and Parks Wildlife Diversity Program	6/20/2006	Personal communication regarding South Dakota species ranking See Source #6
State Agency Personnel			
Federal Agency Personnel	Steve Popovich, Arapaho & Roosevelt NF and Pawnee NG	7/12/2006	Personal communication regarding unpublished reports. See Sources #3 and 4
Federal Agency Personnel	Steve Popovich, Arapaho & Roosevelt NF and Pawnee NG	10/16/2006	Personal communication regarding new localities, new taxa, and forthcoming status report. See Source #10
Federal Agency Personnel	Beth Burkhart, Black Hills National Forest		Personal communication regarding 2006 survey data. See Source #5

Source Category	Source/ Name	Date	Results
Internal USFS Intranet search			
Original Author	David G. Anderson	5/24/2006	Personal communication regarding search for taxon in Pawnee NG. See Source #7
Colorado Natural Areas Program	Brian Kurzel	3/15/2006	Personal communication regarding search for taxon in Bonny Prairie Natural Area. See Source #8
Books	Dave Ode, Author	8/28/2006	Dakota Flora, includes a thorough description of the first collection/discovery of <i>B. campestre</i> . See Source #9

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