SPECIES: Scientific [common]	*Botrychium crenulatum* [scalloped moonwort]
Forest:	Bridger-Teton National Forest
Forest Reviewer:	J.Irwin; R.Lehman; Trevor Bloom
Date of Review:	4/8/20; 1/13/20; 3/25/25
Forest concurrence (or recommendation if new) for inclusion of species on list of potential SCC: (Enter Yes or No)	Yes

FOREST REVIEW RESULTS:

1. The Forest concurs or recommends the species for inclusion on the list of potential SCC:
   Yes_X__ No___

2. Rationale for not concurring is based on (check all that apply):
   Species is not native to the plan area _____
   Species is not known to occur in the plan area _____
   Species persistence in the plan area is not of substantial concern _____

FOREST REVIEW INFORMATION:

1. Is the Species Native to the Plan Area? Yes_X__ No___

   If no, provide explanation and stop assessment.

2. Is the Species Known to Occur within the Planning Area? Yes_X__ No____

   If no, stop assessment.

Table 1. All Known Occurrences, Years, and Frequency within the Planning Area

Year Observed	Number of Individuals	Location of Observations (USFS District, Town, River, Road Intersection, HUC etc.)	Habitat Description	Source of Information[1]
8/04/2012	35	U.S.A., Wyoming, Sublette County: Wind River Range: spring along Forest Service Road 860, ca. 2 air miles southwest of Little Sheep Mountain. 43.293163° N, 109.948805° W	Small, flowing stream among open *Picea emgelmannii* and *Pinus contorta* forest; moist soil, with lush cover of short grasses, *Carex*, *Gentianopsis detonsa*, *Geum macrophyllum*, and *Fragaria virginiana*. Found in transition areas between wet and mesic soil.	Collector: Ben Legler 12460; EO #3 (Rocky Mountain Herbarium 2020, Consortium of Pacific Northwest Herbaria 2020; WYNDD 2025)

2023	8	Bridger-Teton National Forest: Found in the vicinity of Union Pass and FS Road 600, and the vicinity of FS Road 680 near Little Sheep Mountain		Collector: Ben Legler 12460 (Leger 2024).
2024	8	Lincoln. location: Bridger-Teton National Forest: Wyoming Range: Poison Meadows on W side of FS Rd 10138, in headwaters of Grays River 1 air mi N of Tri Basin Divide. elevation: 8469. elevation_unit: ft.	Moist meadow in opening among Salix tickets, bordering a small flowing stream, with Fragaria virginiana, Gentianopsis detonsa, Cirsium scariosum, Achillea millefolium, Deschampsia cespitosa, Carex spp.; meadow is actively being grazed by cattle.	Ben Legler, Rocky Mountain Herbarium. 2024 Surveys for Botrychium spp. (Moonworts) on the Bridger-Teton National Forest, Wyoming.

[1]SEINet was also searched, and no additional occurrences on the Bridger-Teton National Forest were found.

a. Are all Species Occurrences Only Accidental or Transient?

Yes___ No_X__

If yes, document source for determination and stop assessment.

b. For species with known occurrences on the Forest since 1990, based on the number of observations and/or year of last observation, can the species be presumed to be established or becoming established in the plan area?

Yes_X__ No__

If no, provide explanation and stop assessment

c. For species with known occurrences on the Forest predating 1990, does the weight of evidence suggest the species still occurs in the plan area?

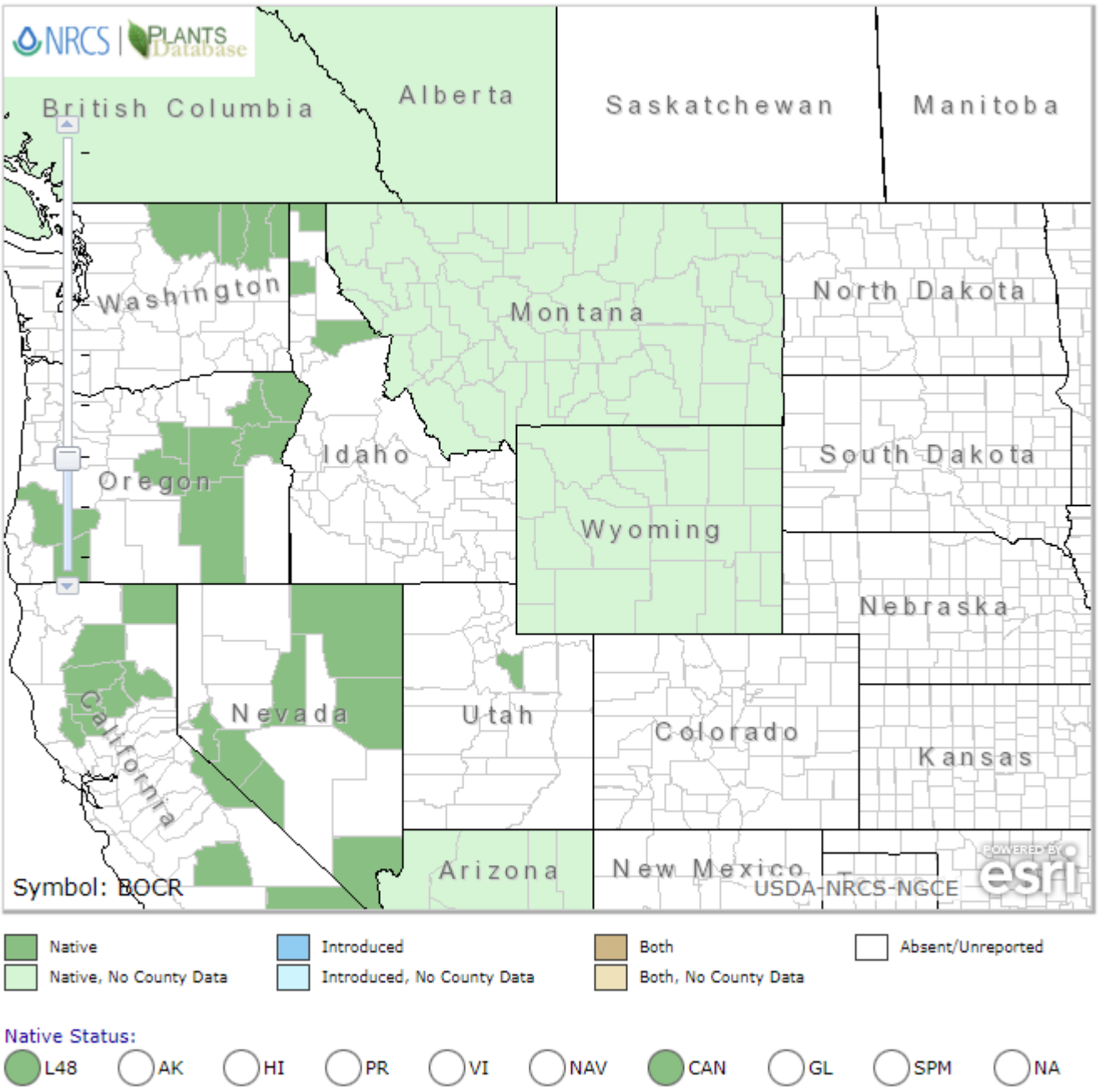
Yes___ No___

Provide explanation for determination

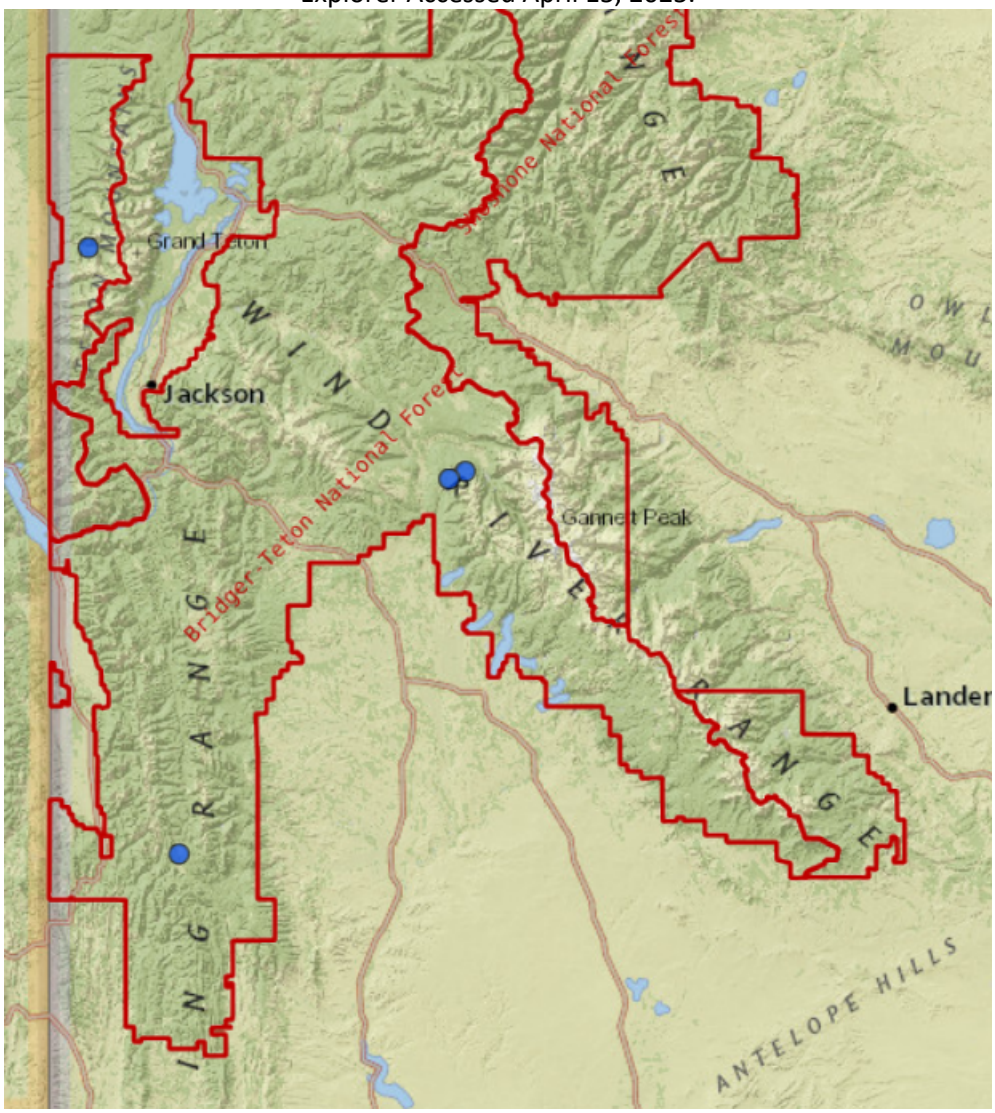
N/A–Occurrences have been documented since 1990.

If determination is no, stop assessment

Map 1, *Botrychium crenulatum* range in Wyoming and surrounding states (NRCS 2019).



Map 2: *Botrychium crenulatum* occurrences on the Bridger-Teton National Forest and surrounding region. WYNDD Date Explorer Accessed April 15, 2025.



3. Is There Substantial Concern for the Species' Capability to persist Over the Long-term in the Plan Area Based on Best Available Scientific Information?

Table 2. Status summary based on existing conservation assessments

Entity	Status/Rank (include definition)
NatureServe Global Status	**G4—Apparently Secure** At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors (apparently secure).
NatureServe State Status	**S1—Critically Imperiled** At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
WYNDD	**Plant Species of Concern** *Species vulnerable to extirpation at the global or state level due to:* *a. their rarity (e.g., restricted distribution, small population size, low population density)* *b. inherent vulnerability (e.g., specialized habitat requirements, restrictive life history)* *c. threats (e.g., significant loss of habitat, sensitivity to disturbances)*
USDA Forest Service	**Region 4: Sensitive Species** *Those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by* *a. Significant current or predicted downward trends in population numbers or density.* *b. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.* (FSM 2670.5 – Threatened, Endangered & Sensitive Species)
USDOI FWS	Not listed
USDOI BLM	Not listed
IUCN	Not listed

Sources: WYNDD 2025; Heidel 2018; USDA Forest Service Regions 2 and 4 Sensitive Species Lists; NatureServe 2019

Table 3. Status summary based on best available scientific information.

Criteria	Rationale
Distribution on the Bridger-Teton National Forest	*B. crenulatum* is known from three populations within the Bridger-Teton National Forest (**Table 1, Map 2**). The species' distribution in the Forest is likely sparse and isolated, although it is understudied and new populations were discovered in both 2023 and 2024.
Distribution outside the Bridger-Teton National Forest	*Botrychium crenulatum* occurs from British Columbia and Alberta south to California and Arizona, as well as Ontario and Minnesota. In Wyoming, it is known from the Big Horn, Teton and Wind River Ranges (Big Horn, Sheridan, Sublette, Teton and Washakie counties) (WYNDD 2025b). Populations are relatively small and occur in riparian, conifer-transition areas that are found at lower elevations (Beatty et al, 2003). This species can be found in Region 2 Forests and the upper north-western U.S. It was first discovered in Wyoming in 2008, where it is known from 6 extant occurrences, its distribution remains limited (Fertig, 2001). Previous reports were based on inference or on material later redetermined as *B. ascendens* (Fertig 2001).
Abundance on the Bridger-Teton National Forest	Three populations of species have been observed within the Bridger-Teton National Forest with 51 plants noted.
Population Trend on the Bridger-Teton National Forest	Population trends are difficult to estimate because of the limited amount of survey data for the species, but numbers suggest a struggling population (Beatty et al, 2003).
Habitat Trend on the Bridger-Teton National Forest	*Botrychium crenulatum* occupies wet habitats that include moist, open montane habitats, marshes, damp meadows, and riparian areas (Fertig, 2001). Populations in Wyoming have been observed near wet meadows. The species prefers areas that are early-succession, edges of trails, mossy openings in forest (Beatty et al, 2003). The observed forest population is located near the edge of a trail in a semi-dense forest area with surrounding meadows. The area has a small, flowing stream with moist soil and lush grasses (Legler, 2012). To analyze trends in habitat, aerial imagery and a USFS GIS database of existing grazing allotments, invasive plant populations, historical wildfires, trails, roads, Wilderness Areas, and Research Natural Areas (RNAs) was assessed at each occurrence (Rocky Mountain Herbarium 2020, SEINet 2020). The following summarizes identified disturbances for each occurrence in Bridger-Teton National Forest: Two of the three populations are found in the Upper Green Grazing Allotment. There is a high clearance seasonal forest service road (Moose/Gypsum) near the observed population, indicating that motorized travel (e.g., off-highway vehicles) could be a potential threat. The occurrence is within the Upper Green River grazing allotment and near a large mapped Canada thistle (*Cirsium arvense*) polygon. The third population discovered in 2024 in Poison Meadows in the West Zone of the Bridger-Teton is also in an active grazing

Criteria	Rationale
	allotment, and grazing has been listed as a potential threat to the species (USFS 2016; USFS 2018; CNDDB 2016; CNPS 2018; Montana Natural Heritage Program 2018; NatureServe Network Database as of November 2017). This analysis indicates that the Bridger-Teton National Forest occurrences are susceptible to anthropogenic disturbances and warrant special conservation measures.
Threats to the Species and its Habitat on the Bridger-Teton National Forest	*Botrychium crenulatum* is considered to be very rare, with few documented occurrences, small population abundances, and widely-disjunct occurrences within large ranges. Threatened most by logging and grazing; other threats include roads/trails, trampling, recreation, erosion, fuels reduction, ORVs, altered hydrology, soil compaction, invasive species, and climate change (CNDDB 2016; CNPS 2018; Montana Natural Heritage Program 2018; NatureServe Network Database as of November 2017; USFS 2016; USFS 2017). Disturbances and land management activities may create and maintain suitable habitat for this species or may negatively impact existing populations, depending on the disturbance intensity and frequency (Beatty et al. 2003). Climate change is a primary threat for riparian and wetland communities. Climate related effects and drying of wetlands could reduce habitat and viability for rare species. Warming temperatures and reduced snowpack may result in the loss of high-elevation riparian and wetland habitats, resulting in drier, less productive systems. With rising temperatures, frigid snow- and water-dependent ecosystems in the upper portions of watersheds will have very little room to move upslope. Elevating temperatures will increase competition from riparian species now occurring at lower elevations, and smaller snowpacks will increase competition from upland species that occupy drier sites. According to the Intermountain Adaption Partnership assessments, high-elevation riparian and wetland communities have a moderate to high sensitivity to climate change, a low to moderate adaptive capacity, and high vulnerability to climate change (Halofsky et al. 2018).
Life history and demographic characteristics of the species	*Botrychium crenulatum* is a perennial fern relative that grows to 10 cm or less tall with a singular leaf divided into two segments (Fertig, 2001). The plant has a vegetative segment that is yellow around 2 cm long and 1.2 wide divided pinnately in 3-5 years (Fertig, 2001). All *Botrychium* species are believed to be obligately dependent on mycorrhizal relationships (the symbiotic association of a fungus with the roots of a vascular plant) in all life stages; mycorrhizae are probably the most important limiting factor for Botrychium establishment, distribution, and abundance (Beatty et al. 2003). Plants release spores from July to August in Wyoming (Beatty et al, 2003). The reproductive biology of *Botrychium* has implications for the life history and strategies of these species, including (but not restricted to) issues related to dispersal, genetic variability, colonizing ability, habitat needs, distribution, and long-term persistence. The life history of ferns differs from flowering plants in that ferns have a distinct alternation of generations and reproduce by spores rather than seeds.

Criteria	Rationale
	The diploid sporophyte stage of Botrychium, which is the familiar, visible portion consisting of the aboveground structures, produces spores in sporangia borne on specialized portions of the Botrychium frond. These spores are dispersed, filter into the soil, germinate underground, and develop into the haploid gametophyte stage. This underground gametophyte bears rhizoids and sexual structures producing sperm and eggs. When mature, sperm are released and swim to an egg with which they fuse to create a zygote and to initiate the next sporophyte (diploid) generation. The juvenile sporophytes of Botrychium are also underground structures, bearing a short rhizome, a leaf-producing bud, and mycorrhizal roots. It may take several years for the single leaf of the juvenile sporophyte to develop and emerge aboveground (Beatty et al. 2003).
Date: March 25, 2020 Reviewer: Julie Remp and Clayton McGee Updated: Trevor Bloom 4/16/2025	

Summary and Recommendations

Species (Scientific and Common Name): *Botrychium crenulatum* (Scalloped moonwort)

Botrychium crenulatum is listed as S1 (critically imperiled) and G4 (apparently secure) globally. It occurs from British Columbia and Alberta south to California and Arizona, as well as Ontario and Minnesota. In Wyoming, it is known from six populations across the Big Horn, Teton and Wind River Ranges (WYNDD 2025b). Populations are relatively small and occur in early-successional micro-sites with soils derived from glacial till. Such habitats include meadow or mossy openings in riparian areas, wetlands, marshes and montane forest. The Bridger-Teton Forest has three occurrences, with 51 reproductive plants observed across the Wyoming and Wind River Range.

One of the challenges with locating and counting populations of *B. crenulatum* is that the plants spend much of their life cycle below ground, dependent on mycorrhizal interactions. On a given year, a portion of an existing population will produce above ground reproductive parts – essential for detection and identification by survey. Plants may be detectable for only a few weeks in from late July through August, influenced by seasonal hydrology and snowpack. For these reasons, species occurrences and populations sizes are generally sparse across its entire distribution. The lack of information regarding the dispersal and colonizing ability, mycorrhizal relationships, adaptability to changing environmental conditions, reproductive potential, or genetic variability of these species makes it difficult to predict their long-term vulnerability (Beatty et al. 2003)

All three occurrences fall within active grazing allotments. Two of the three populations located in the Upper Green are found near a large mapped Canada thistle (*Cirsium arvense*) polygon. There is also a high clearance seasonal forest service road (Moose/Gypsum) nearby, indicating that motorized travel (e.g., off-highway vehicles) could be a potential threat. Climate related effects and drying of wetlands could reduce habitat and viability for rare species. Warming temperatures and reduced snowpack may result in the loss of high-elevation riparian and wetland habitats, resulting in drier, less productive systems. Disturbances and land management activities may actually create and maintain suitable habitat for this species or may negatively impact existing populations, depending on the disturbance intensity and frequency (Beatty et al. 2003).

It is likely that more populations occur on the forest but that their detection remains confounded by the species' life history traits and difficulty to find and identify. The three known populations are exposed to several potential threats including grazing and invasive species and little is understood regarding its response to varying types and intensity of disturbance. It is therefore recommended that *Botrychium crenulatum* be included as a SCC.

Evaluator: Jessica Irwin & Rose Lehman Date: 5/14/20; 1/13/21

Updated: Trevor Bloom Date 4/16/2025

References

Beatty, B., Jennings, W., Rawlinson, 2003. *Botrychium ascendens* W.H. Wagner (trianglelobe moonwort), *Botrychium crenulatum* W.H. Wagner (scalloped moonwort), and *Botrychium lineare* W.H. Wagner (narrowleaf grapefern): A Technical Conservation Assessment. Prepared for the USDA Forest Service, Rocky Mountain Region, Species Conservation Project. Denver, Colorado.

California Native Plant Society (CNPS). 2018. Inventory of Rare and Endangered Plants (online edition, v8-03 0.39). California Native Plant Society, Sacramento, CA. Online. Available: http://www.rareplants.cnps.org (accessed 2018).

California Natural Diversity Database (CNDDB). 2016. RareFind Version 5.1.1. California Department of Fish and Game, Sacramento.

Montana Natural Heritage Program. 2025. Montana Field Guide. Online. Available: http://fieldguide.mt.gov (Accessed 2025).

Consortium of Pacific Northwest Herbaria. 2019. Specimen data search. Available at: http://pnwherbaria.org.

Fertig, W. 2001. *Botrychium crenulatum* (Crenulate moonwort) State Species Account. Wyoming Natural Diversity Database. Updated by Joy Handley and Bonnie Heidel 2008-11-13 and 2015-03-03. Retrieved from http://www.uwyo.edu/wyndd/_files/docs/reports/speciesabstracts/botrychium_crenulatum.pdf

Google Earth Pro, 2020. Aerial photo and mapping analysis. Software version 7.3.2.5776 (64-bit).

Halofsky, Jessica E.; Peterson, David L.; Ho, Joanne J.; Little, Natalie, J.; Joyce, Linda A., eds. 2018. Climate change vulnerability and adaptation in the Intermountain Region. Gen. Tech. Rep. RMRS-GTR-375. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Part 1. pp. 1–197.

Heidel, B. 2012. Sensitive and rare plant species inventory in the Salt River and Wyoming Ranges, Bridger-Teton National Forest. Wyoming Natural Diversity Database. Laramie, WY.

Heidel, B. 2018. Wyoming plant species of concern, March 2018. Wyoming Natural Diversity Database, Laramie, WY. Accompanied by Wyoming plant species of potential concern, with tables of additions and deletions.

Legler, Ben. 2025. Surveys for Botrychium spp. (Moonworts) on the Bridger-Teton National Forest, Wyoming. 2024. Survey Results. Report prepared for the USDA Forest Service Region 4 and Wyoming Natural Diversity Database by the Rocky Mountain Herbarium.

Legler, Ben. 2024. Surveys for Botrychium spp. (Moonworts) on the Bridger-Teton National Forest, Wyoming. 2023. Survey Results. Report prepared for the USDA Forest Service Region 4 and Wyoming Natural Diversity Database by the Rocky Mountain Herbarium.

Natural Resources Conservation Service. 2019. USDA. Botrychium crenulatum W.H. WagnerShow Tabs scalloped moonwort. Retrieved from https://plants.sc.egov.usda.gov/core/profile?symbol=BOCR

NatureServe. 2025. NatureServe Explorer: An online encyclopedia of life [web application]. Botrychium crenulatum. Version 7.1. NatureServe, Arlington, Virginia. Internet website: http://explorer.natureserve.org. Accessed 4/16/2025.

Rocky Mountain Herbarium Specimen Database. 2020 University of Wyoming, Department of Botany. Laramie, WY. Internet website: http://rmh.uwyo.edu/data/search.php. Accessed on January 21, 2020.

SEINet. 2020. SEINet data portal. Available at: http://swbiodiversity.org/seinet/collections/index.php.

USDA, National Resources Conservation Service (NRCS). NRCS. 2020. The PLANTS Database. Available at http://plants.usda.gov. National Plant Data Team, Greensboro, NC 27401-4901 USA.

U.S. Forest Service. 2016. Species of Conservation Concern List for the Helena - Lewis and Clark National Forests with supporting documentation and rationale. USDA Forest Service, Northern Region, Missoula. MT.

Wyoming Natural Diversity Database (WYNND). 2025. Wyoming Natural Diversity Database; Data Explorer. Laramie, WY: University of Wyoming.

WYNND 2025b. *Botrychium crenulatum*- . Wyoming Field Guide. Laramie, WY: University of Wyoming. Retrieved on 1/29/2020, from http://fieldguide.wyndd.org/

WYNND GIS 2019. GIS data of Wyoming Natural Diversity Database. Bridger Teton National Forest, U.S Forest Service. Department of Agriculture. Data received April 25, 2019.