**Species:** *Botrychium pinnatum* H. St. John  
Synonyms - *Botrychium boreale* Milde subsp. *obtusilobum* (Rupr.) R.T Clausen; *Botrychium boreale* Milde var. *obtusilobum* (RuPr.) Broun  
Common names – northern moonwort

**Status:** Table 1 summarizes the current status of this plant by various ranking entities and defines the meaning of the status.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Status</th>
<th>Status Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NatureServe</td>
<td>G4?</td>
<td>G4—Globally apparently secure –Uncommon but not rare, and usually widespread. Possible cause of long-term concern. Usually more than 100 occurrences and more than 10,000 individuals. ? - denotes inexact or uncertain numeric rank</td>
</tr>
<tr>
<td>Colorado Natural Heritage Program (CNHP)</td>
<td>S2</td>
<td>S2 – State imperiled - because of rarity or because of some factor(s) making it very vulnerable to extirpation or extinction. Typically 6 to 20 occurrences or between 1,000 and 3,000 remaining individuals.</td>
</tr>
<tr>
<td>USDA Forest Service</td>
<td>None</td>
<td>Not federally recognized under the Endangered Species Act (ESA) as endangered, threatened, proposed, or candidate species.</td>
</tr>
<tr>
<td>USDI Fish and Wildlife Service</td>
<td>Not listed</td>
<td>Not federally recognized under the Endangered Species Act (ESA) as endangered, threatened, proposed, or candidate species.</td>
</tr>
</tbody>
</table>

The 2012 U.S. Forest Service Planning Rule defines Species of Conservation Concern (SCC) as “a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area” (36 CFR 219.9). This overview was developed to summarize information relating to this species’ consideration to be listed as a SCC on the Rio Grande National Forest, and to aid in the development of plan components and monitoring objectives.

**Distribution, abundance, and population trend on the planning unit:**

NatureServe reports that *Botrychium pinnatum* is known from Canada, Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming (NatureServe 2015). According to the PLANTS database (USDA NRCS 2015) it is also known from New Mexico. Farrar
(2011) states *Botrychium pinnatum* occurs widely throughout western North America from high elevations in east-central and northern California, northern Nevada, northern Arizona, Utah and New Mexico to near sea level in Alaska and northwestern Canada. Although rare in the southern part of its range, it increases in occurrence and abundance from Oregon and Montana northward.

There are three CNHP element occurrence records of *Botrychium pinnatum* in the planning area. The reported occurrences range from one individual to an estimated 75 individuals. The occurrences were reported in 1996, 1998 and 2003; one of the sites was revisited in 2001 (CNHP 2015). The CNHP data indicates there are another eight occurrences outside the planning area in Colorado.

The taxon appears to be sufficiently abundant and secure to be viable in its primary range (as indicated by the G4? status); it appears to be much less secure in the southern part of its range, (as indicated by the S2 status in Colorado). Viability of the known occurrences on the planning area has not been assessed; the only potential risk identified in the element occurrence reports is potential road maintenance. *Botrychium* species remain underground for a large part of their life cycle, which appears to support continued population survival through periods of unfavorable conditions as long as the underground environment is not altered. Thus, even though this species is considered rare in Colorado, its identifiable aboveground presence indicates a stable population situation if the disturbance regime is stable (Burkhardt 2002).

**USFS Corporate Database Habitat Type Associated with the Species:**

It’s difficult to determine habitat types associated with this species; Farrar (2011) identifies a range of habitats including closed canopy forests, moist grassy sites in open forests and meadows. It often occurs near streams and other sites where soil moisture is constant. The known occurrences have been found in the Alpine Sedges and Forbs on Alpine Summits and Engelmann Spruce on Mountain Slopes Land Type Associations, however it is not possible to rule out other habitat types due to the species’ wide range of habitats.

**CNHP Ecological System of the Southern Rocky Mountains Ecoregion:**

There is not enough data to determine which CNHP Ecological Systems may support this species.

**Brief description of natural history and key ecological functions:**

It’s important to note that the life history of *Botrychium* species includes a distinct alternation of generations, represented by separate and unlike plants. The gametophytes, juvenile sporophytes, and gemmae are all belowground structures; only the adult sporophyte emerges above ground. The aboveground portion of the adult sporophyte is a mature leaf divided into two axes. One axis, bearing an expanded blade, is called the trophophore or sterile segment. The second axis bears numerous sporangia and is called the sporophore, or fertile segment. The trophophore and sporophore are joined into a common stalk, usually near the base of the expanded blade. Basically, the aboveground portion of *Botrychium pinnatum* is a small, single leaf that’s divided into a vegetative segment and a spore-producing segment. Johnson-Groh and others (2002, as reported in Beatty et al. 2003) discovered that the density of belowground structures greatly exceeded the aboveground population and that any individual plant may or may not produce the aboveground structure in any given year.

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. The identity of the
mycorrhizal fungi forming associations with *Botrychium* species has not been determined, but they are most likely a group of common fungi belonging to relatively few species that are broadly non-specific with regard to their associated plant species (Beatty et al. 2003).

**Overview of ecological conditions for recovery, conservation, and viability:**

*Botrychium pinnatum* is a small plant, often hidden under grasses and sedges, making it difficult to find. It is also morphologically similar to other species of *Botrychium* subgenus *Botrychium* and thus difficult to identify in the field. It is possible that its rarity in the planning area is reflective of how difficult it is to find the plants rather than its true distribution.

The lack of information about this species makes it difficult to determine ecological conditions need for recovery, conservation and viability. It is known that it is highly dependent on soil mycorrhizal health, although the identity of the mycorrhizal fungi is still unknown. Possible key conservation elements includes surveying for new populations of the species, protecting and buffering the known occurrences from direct damage, documenting and monitoring the effects of current management activities, and studying the mycorrhizal relationships.

Disturbance dynamics are relatively unknown for all *Botrychium* species; researchers have noted that disturbances may be important factors for the establishment and persistence of *Botrychium* species (Beatty et al. 2003); however, the optimal disturbance regime is still largely unknown.

Overall, based on current information, threats to *Botrychium pinnatum* are considered relatively low. However, this should be tempered with the high number of unknowns for this species.

**Key ecosystem characteristics and ecological conditions for recovery, conservation, and viability:**

The three known occurrences of *Botrychium pinnatum* in the planning area need to be protected from direct damage, with effects of current management monitored. Presently, most threats appear to be at a relatively low and manageable level. Global climate change will likely affect all plant communities to an unknown degree over time. How this species will cope with this potential change is unknown, but, it is assumed that any drying of the soil will impact the mycorrhizal relationship that is critical for the species.

**Key uncertainties and information needs/gaps:**

There are a large number of information gaps and research needs for this species. Re-visiting the known occurrences, estimating current abundance, assessing imminent threats, measuring demographic parameters, studying the mycorrhizal relationships, and determining ecological needs and limitations are of primary importance to further the understanding of *Botrychium pinnatum*. The following suggestions are ordered from inventory activities (to determine the current status) to more complex biological studies (to help understand the species):

- Re-visiting and detailed mapping of the known occurrences
- Surveying for new occurrences
- Addressing any imminent threats to the known occurrences
- Defining and measuring microhabitat characteristics
• Measuring demographic parameters using long-term monitoring plots
• Conducting studies related to reaction to various disturbance regimes and mycorrhizal associations.

The following is an outline of a monitoring approach that could be used to inform the development of the RGNF Forest Plan revision’s monitoring plan. Additionally, areas of research opportunity (beyond the scope of the Forest Plan revision) are suggested below based on key uncertainties about this species.

1) Monitoring: monitoring priority is a judgment determination based on number of occurrences, potential threats, and conservation status. The priority for this species is thought to be moderate. This is primarily due to the status being G4?S2 (see Table 1), and its limited known occurrence on the RGNF. Existing management practices are not known to be causing detrimental impact. Only limited search effort and monitoring have been conducted so individual occurrences may be vulnerable to unforeseen impacts. Thus, monitoring is suggested as follows:

   a. Search for and document new occurrences found on the Forest. Ensure that additional occurrences, as well as negative search results, are recorded in the appropriate electronic database. Finding additional occurrences helps inform whether additional monitoring is needed and at what intensity.

   b. Monitor known element occurrences to document presence or absence. Evaluate each occurrence based on appropriate database protocols. Visually document the same populations every 5-7 years (twice in a planning cycle). Consider enlisting an organization such as CNHP to help develop a rapid monitoring technique that is meaningful for trend analysis but is easy to establish and simple to evaluate.

   c. Make visual observations to assess if any impacts are occurring to the known occurrence. Assess the type, source, frequency, and magnitude of the impact. Develop a strategy at the appropriate time for mitigating impacts (eliminate, move, delay, or reduce the impact).

2) Research:

   a. Disturbance - there are unknowns about the role and types of disturbance and their possible effects on *Botrychium pinnatum*.

   b. Mycorrhizal relationships

**Key literature:**


Map of Known Occurrences:

[Map of Botrychium pinnatum occurrences on the RGNF]

Figure 1. *Botrychium pinnatum* on the RGNF.