

FIELD INVESTIGATIONS OF  
BOTRYCHIUM SUBGENUS BOTRYCHIUM (MOONWORTS),  
ON THE IDAHO PANHANDLE NATIONAL FORESTS

by

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December 1990

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Purchase Order No. 53-0281-0-41

## ABSTRACT

A field survey for nine species of Botrychium subgenus Botrychium (moonworts) was conducted on the Idaho Panhandle National Forests during the summer of 1990 by the Idaho Department of Fish and Game's Natural Heritage Program. The investigation was a cooperative Challenge Cost Share project between the Department and the Idaho Panhandle National Forests.

Two species of moonwort are listed as Region 1 Sensitive Species, Botrychium minganense for Idaho and Montana, and B. paradoxum for Montana. Several additional moonworts are proposed for listing as Sensitive in Region 1 and three species, Botrychium ascendens, B. crenulatum, and B. paradoxum are federal Category 2 Candidate Species.

This investigation concentrated on extending our knowledge of moonworts in Idaho by conducting a survey for nine moonwort species on the Idaho Panhandle National Forests. Prior to 1990, four species of moonwort, Botrychium minganense, B. lanceolatum, B. pinnatum, and B. simplex, were documented from extant sites in Idaho. In addition, two historical collections have been tentatively identified as B. crenulatum. Most of the known Idaho locations of moonworts are on lands administered by the Forest Service.

This report documents eight new sightings of four species of moonwort from northern Idaho. One species is rather unusual and of uncertain identity and will be referred to as Botrychium sp. until correct identification is made. The majority of these new sightings support a single individual or a few scattered plants occurring in a variety of habitats including older roadsides, meadows, mature western red-cedar forest, and moist edges of ponds.

Detailed results of field surveys are presented and several recommendations are made relative to the long-term conservation of moonworts on lands administered by the Forest Service. This report will also document and describe the recent revisions and new taxonomic designations of Botrychium subgenus Botrychium.

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## INTRODUCTION

The National Forest Management Act of 1976 (16 U.S.C. 1600. Planning Regulations Section 219.19, Fish and Wildlife Resource) and Forest Service policy require that Forest Service land be managed to maintain populations of all existing native animal and plant species at or above the minimum viable population level (USDA Forest Service 1984). A minimum viable population consists of the number of individuals, adequately distributed throughout their range, necessary to perpetuate the existence of the species in natural, genetically stable, self-sustaining populations.

The Forest Service, along with other Federal and State agencies, has recognized the need for special planning considerations in order to protect the flora and fauna on the lands in public ownership. Species recognized by the Forest Service as needing such considerations are those that (1) are designated under the Endangered Species Act as endangered or threatened, (2) are under consideration for such designation, or (3) appear on a regional Forest Service Sensitive Species<sup>1</sup> list.

Botrychium subgenus Botrychium (moonworts) is composed of a number of rare and localized species. Distributions range from scattered disjunct populations throughout North America to regional endemic<sup>2</sup>. Botrychium manganense and B. paradoxum are listed as a Region 1 Sensitive Plant Species. Botrychium ascendens, B. crenulatum, and B. paradoxum are Category 2 Candidate species<sup>3</sup> with the U.S. Fish and Wildlife Service (USDI Fish and Wildlife Service 1990).

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<sup>1</sup> Sensitive Plant Species - a plant species, or recognized subspecies or variety, for which the Regional Forester has determined there is a concern for population viability, within a state, as evidenced by significant current or predicted downward trend in populations or habitat (USDA Forest Service 1984, 1988).

<sup>2</sup> A species confined naturally to a certain limited area or restricted locality. In this instance, confined to narrow river canyons in northern Idaho and far northeastern Oregon.

<sup>3</sup> Candidate Species - "those plant and animal species that, in the opinion of the Fish and Wildlife Service, may become endangered or threatened". Three types of candidate species exist, C1, C2 and 3C. Category 2 - "taxa for which information now in possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules" (USDI Fish and Wildlife Service 1985).

Little is known of the distribution and conservation status of the moonworts in the Pacific Northwest. Of the few documented populations in Idaho, most occur in the northern part of the state on the Idaho Panhandle National Forests. To increase our knowledge of this group, a survey for nine moonwort species was conducted on the Idaho Panhandle National Forests by the Idaho Department of Fish and Game's Natural Heritage Program through the Cooperative Challenge Cost Share Program during the 1990 field season.

This investigation concentrated on nine species of moonwort, documented or suspected to occur in Idaho. Most of these taxa are considered rare and localized and several are regional endemics to the Rocky Mountains. Heritage Program rare plant lists from Idaho and the adjacent states of Montana, Oregon, and Washington contain several or all of the following moonworts:

B. <u>ascendens</u>	B. <u>montanum</u>
B. <u>crenulatum</u>	B. <u>pedunculatum</u>
B. <u>lanceolatum</u>	B. <u>pinnatum</u>
B. <u>lunaria</u>	B. <u>simplex</u>
B. <u>minganense</u>	

The primary objectives of this investigation were as follows:

- 1) Relocate and survey known populations and historical collection sites of moonworts in northern Idaho.
- 2) Survey for potential habitats and new populations of moonworts on the Idaho Panhandle National Forests.
- 3) Acquire population data and characterize habitat conditions for known populations of moonworts.
- 4) Assess population numbers and threats to existing populations and make management recommendations to the forests based on these assessments.
- 5) Conduct a thorough literature search of Botrychium subgenus Botrychium and present information regarding recent taxonomic revisions of this group.

#### DISCUSSION:

The taxonomy of North American botrychiums still needs much research. Recent taxonomic revisions of the moonworts has resulted in the designation of a number of new taxa. Past confusion in species designations has resulted in many herbarium collections having undergone several annotations to reflect nomenclatural changes. Consequently, numerous misidentified



### Terminology:

Ferns are quite unique among vascular plants and thus have a distinct set of terminology. Although I have attempted to design this report in such a way that individuals with a variety of botanical backgrounds can use it, certain terms are essential towards properly describing and distinguishing these species. This section has been added to give a brief description of fern terminology, both for those individuals wishing to brush up on their terms and those who are unfamiliar with fern jargon. Although these terms are applicable to ferns in general, they are specifically related to the genus Botrychium (see also Appendix IV - Glossary).

Key to Species:

The subgenus Botrychium includes a number of closely related and often only subtly distinct taxa. This key to the moonworts include 14 taxa from western North America and incorporates information from Wagner and Wagner (1981, 1983a, 1990), Lellinger (1985), and Wagner and Devine (1989):

- 1a. Sterile leaf usually absent, transformed into a second, short fertile portion ..... B. paradoxum
- 1b. Sterile leaf always present, never transformed ..... 2
  - 2a. Sterile leaf evidently long-stalked, 1/3-1/2 as long as blade ..... 3
    - 3a. Common stalk with a conspicuous brown stripe below sterile leaf; sterile leaf attached above ground level, stalk 2.5-3 cm long; lower pinnae segments rhomboidal ..... B. pedunculatum
    - 3b. Common stalk without brown stripe; sterile leaf gen. attached near ground level (in our area); pinnae segments subflabellate to oblong; sterile leaf highly variable, broadly ternate with 3-main pinnate branches at maturity ..... B. simplex
  - 2b. Sterile leaf sessile or short stalked, generally less than 1/4 as long as blade ..... 4
    - 4a. Larger sterile pinnae distinctly pinnatifid, mostly oblong to lanceolate, pinnae margins entire ..... 5
    - 4b. Larger sterile pinnae not pinnatifid instead once-pinnate with spatulate, cuneate or flabellate pinnae; pinnae margins vary ..... 8
      - 5a. Sterile leaf broadly deltate (triangular) in outline, pinnae segments acute at apex, at least twice as long as wide, mostly lanceolate..... B. lanceolatum subsp. lanceolatum
      - 5b. Sterile leaf oblong to oblong-deltate in outline, pinnae segments rounded or truncated at apex, about as long as wide ..... 6
        - 6a. Pinnae and lobes well separated (no overlap), mostly parallel sided, linear to oblanceolate, pinnae tips pointed, basal pinnae usually deeply cleft into a single lower and larger upper projection, shiny green in life ..... B. echo
        - 6b. Pinnae lobes approximate or overlapping, larger pinnae oblong lanceolate to ovate to deltate; pinnae tips blunted or rounded, basal pinnae not cleft ..... 7
          - 7a. Pinnae with few lobes, these mainly on basal side, lowest pinnae exaggerated (up to times longer than adjacent one), ascending, strongly asymmetrical, sterile portion gray-green, dull in life ..... B. hesperium
          - 7b. Pinnae with numerous lobes of roughly equal number on both sides, lowest pinnae not exaggerated (equal or slightly larger

- than adjacent one) not ascending, nearly symmetrical, sterile portion bright to yellow-green, shiny in life . B. pinnatum
- 8a. Fertile portion of the laminae not much exceeding the sterile; plant gray-green, dull; lower portion of stem sheathed with dark brown remnants of previous years stems; known only in pumus soils of Crater Lake National Park and vicinity ..... B. pumicola
- 8b. Fertile portion of the laminae usually greatly exceeding the sterile; plants green or yellow-green; extensive ranges ..... 9
- 9a. Lower pinnae broadly fan-shaped (flabellate), with the upper and lower borders mostly at angles of  $120^{\circ}$  to  $180^{\circ}$  ..... 10
- 9b. Lower pinnae narrowly fan-shaped (subflabellate to cuneate), with the upper and lower borders mostly at angles of  $40^{\circ}$  to  $120^{\circ}$  ..... 11
- 10a. Plant slender and herbaceous, sterile leaf gen. less than 6 x 2 cm, 3-5 pairs of pinnae, remote and separate; margins commonly crenate to dentate ..... B. crenulatum
- 10b. Plant stout and fleshy; sterile leaf gen. more than 6 x 2 cm, 4-7 pairs of pinnae, approximate to overlapping; margins commonly entire to very shallowly crenulate ..... B. lunaria
- 11a. Plants with few, poorly developed segments, oblong to linear, pointed to squared apex with irregular toothed margins; laminae dull, bluish green (glaucous), and herbaceous ..... B. montanum
- 11b. Plants with well developed cuneate to flabellate segments, margins various; laminae green or yellowish green in color ..... 12
- 12a. Pinnae strongly ascending, distally angular; outer margins distinctly dentate-lacerate; lower pinnae cuneate, the margins mostly at angles of  $40^{\circ}$  to  $90^{\circ}$ ; basal pinnae often modified into sporangia ..... B. ascendens
- 12b. Pinnae only moderately ascending, remote with up to 8 pairs; margins entire to crenulate; lower pinnae cuneate to flabellate, the margins mostly at angles of  $80^{\circ}$  to  $120^{\circ}$ ; basal pinnae very rarely modified into sporangia ..... 13
- 13a. Sterile leaf narrowly oblong, firm herbaceous; pinnae cupped in life, suborbicular to subflabellate; lowest pinnae equal to or smaller than middle pinnae; margins entire to shallowly crenate ..... B. minganense
- 13b. Sterile leaf narrowly deltoid, leathery texture; pinnae often folded over the rachis in life, spatulate to flabellate; lowest pinnae larger than middle pinnae; margins entire to very coarsely and irregularly dentate ..... B. spathulatum

Known habitats and distributions of the fourteen taxa in the key (\* - indicates species included in this investigation):

- \* B. ascendens - grassy places; British Columbia, Alberta, and Montana to northern California and Nevada.
- \* B. crenulatum - damp meadows, boggy areas and marshy places at low elevation; Central and southern California to central Arizona and Montana.
- B. echo - roadsides, grassy slopes, and along the edges of lakes; Northern Arizona, northern Utah, and central Colorado.
- B. hesperium - exposed, dry fields and on roadsides, at high elevations; Southwestern Alberta, western Montana, and central Colorado.
- \* B. lanceolatum ssp. lanceolatum - wet to moist grassy and rocky slopes, meadows, woods, and roadsides in cold, mostly subacid soil; Alaska to Oregon; Colorado, Utah, New Mexico, and Arizona at higher elevations.
- \* B. lunaria - grassy or marshy meadows and on sandy or gravelly riverbanks, in acid to circumneutral soil; Labrador to Alaska south to Maine, Vermont, New York, Michigan, Minnesota, South Dakota, Colorado, northern New Mexico, Arizona, Nevada, and California.
- \* B. minganense - meadows, prairies, and woods and on sand dunes and riverbanks, in acid to circumneutral soil; practically all of Canada and Alaska, and ranging widely in the western United States mountains, south to Arizona.
- \* B. montanum - western redcedar forests and along grassy trail edges; British Columbia, Washington, Oregon, and Montana.
- B. paradoxum - sunny meadows and shady patches of Fireweed; Montana and Alberta.
- \* B. pedunculatum - roadsides and woods; Southern Saskatchewan to southern British Columbia. Disjunct to Wallowa Co., northeastern Oregon.
- \* B. pinnatum - grassy slopes, streambanks, roadsides and in mossy woods, in moist to wet soil; Alaska and Yukon Territory south at higher elevations in the mountains of eastern Montana, northern Nevada, and northeastern Oregon.
- B. pumicola - rocky, exposed summits, in pumice gravel; Crater Lake National Park and vicinity, Oregon.
- \* B. simplex - meadows, barrens, and woods in usually subacid soil; extensive range in North America from high elevation in southern California and North Carolina northward to Alaska and Newfoundland, and also widespread in the Old World.
- B. spathulatum - variety of habitats including open grassy fields, flats, and riverbanks. Also in woods, sand dunes and disturbed communities of old fields, spoils of abandoned coal mines, and near railroad tracks. Great

Lakes region including Michigan, Quebec, and Ontario, also in southern Alaska, Yukon and western Northwest Territories, and in the northern Rocky Mountains of Alberta and Montana.

#### Recommendations for Future Surveys:

It is well-known that most moonworts are very difficult to locate due to their inconspicuous nature and their tendency to grow in dense vegetation and be overtopped by forbs and graminoids. In fact, moonworts are so difficult to locate that most are considered "very rare" in local floras. Intensive searching is required before any specimens are found and, more often than not, one simply stumbles upon them in the field or fails to find them at all (Wagner and Devine 1989).

To add to the problem, habitats vary with each species and a single species often occurs in a variety of habitats, making accurate predictions of habitat for field surveys difficult. Moonworts are also very sensitive to drought and may not appear in very dry, hot years (Wagner and Devine 1989). Moreover, although moonworts often grow sympatrically, it is not uncommon to find only a single individual, even with much diligent searching. Based on the above facts, the vast amount of potential moonwort habitat found in northern Idaho, and the time-consuming surveying necessary to locate populations, it appears that site specific surveys for these species would be the most expeditious method.

Future surveyors should be forewarned that the differences between the taxa are often subtle, and there is often a high level of variability, even in single populations (Wagner and Wagner 1981). Differences can be difficult to detect even by the trained eye. Identification of a single, depauperate specimen can be particularly trying, if not impossible. Moreover, Botrychiums often form "genus communities" (Wagner and Wagner 1983b) where a number of different species can be found growing side-by-side. It is, therefore, necessary for all sighting to be EXTREMELY well documented and that all specimens be sent to qualified taxonomists for confirmation of identification.

Fortunately, collections of moonworts singly or in large quantities can be made without damaging the population (Wagner and Lord 1956). Several year's worth of leaf buds are pre-formed underground, therefore, removal of the current year's above ground growth, does the plant no permanent harm. When collecting, it is imperative that collected specimens be removed from the plant-press before they dry and that the leaf segments be spread out so all characters are clearly visible (Wagner and Lord 1956).

Problems in taxonomic interpretation and identification of botrychiums have also resulted from the fact that collected

material is often insufficient to represent the range of variation within a species at a given occurrence. Members of this group possess only a small number of comparative characters. Since most of the identification is based solely on the sterile portion of the frond, mass collections of "leaves only" is recommended, when appropriate (Wagner and Devine 1989, Wagner and Lord 1956).

Management Implications and Recommendations Recommendations and management implications are virtually the same for all of the taxa listed in this report. In each instance, very few moonwort populations are known for Idaho, however, what appears to be suitable habitat exists in a number of possible locations on the Idaho Panhandle National Forests. Moonwort species may occur in an area, but have been previously overlooked or as yet undiscovered. The Forest should carefully consider the impacts of its current and future management activities on the conservation of moonworts. Clearance surveys should be conducted for any projects in suitable habitat that may support Botrychium subgenus Botrychium populations.

Land managers and field personnel on the Idaho Panhandle National Forests should be informed of the possible occurrence of moonwort species in their area. Possible sightings should be documented by detailed location data and specimens (if the size of the population warrant collecting). Mass collection of the current year's above ground growth or the "leaves only" is recommended and can be done without harming the plant. Specimens should be sent to the University of Idaho Herbarium for confirmation. Confirmed sightings of moonworts should be reported to the Idaho Natural Heritage Program for entry into their permanent data base.

#### Data Included in this Report:

During the 1990 field surveys, new locations of four species of moonwort were discovered and tentatively identified as Botrychium lanceolatum ssp. lanceolatum, B. manganense, and B. pinnatum. The following report details this new information and briefly outlines two other species, Botrychium crenulatum and B. simplex, which are documented from Idaho (Moseley and Groves 1990). One specimen located during the 1990 field season is unusual and closely resembles the eastern species B. matricariifolium. It is suspected that this specimen may be an unusually dissected form of B. echo. If confirmed, this would be a new species record for the state of Idaho and would considerably extend the range of this taxon in the western United States, presently known only from Arizona, Colorado, and Utah. For this report this specimen will be referred to as Botrychium sp.

No specimens of B. ascendens, B. montanum, or B. pedunculatum are documented from Idaho and this report will not treat the conservation status of these taxa. However, since they could occur in Idaho, they have been included in the key to the various

species (see Page 5).



scalloped teeth along the margins (see Appendix I).

Crenulate moonwort is easily confused with *B. minganense* and *B. lunaria*. The nearest relative of crenulate moonwort is *B. lunaria* (moonwort), which is frequently found growing in the same habitat (Lellinger 1985, Wagner and Devine 1989). Small plants of *B. lunaria* can look very much like crenulate moonwort, however, crenulate moonwort has thin, pale yellow-green fronds, a distinctly stalked sterile leaf, and an average of three pairs of fan-shaped pinnae that are small and remote (generally not overlapping) with decidedly shallowly-scalloped outer margins (Wagner and Wagner 1981, Lellinger 1985). In comparison, *B. lunaria* is bluish-green with a fleshy texture, a sessile sterile leaf, and 4-7 pairs of very crowded, somewhat overlapping, flat pinnae with almost entire margins.

Crenulate moonwort can be distinguished from *B. minganense* based on the number and shape of the sterile leaf segments (pinnae), which are numerous and distinctly wedge-shaped and cupped or spoon-shaped in life for *B. minganense*. Comparatively, *B. crenulatum* has an average of three pairs of flat, fan-shaped pinnae (Wagner and Wagner 1981, Wagner and Devine 1989) (see Appendix I for line drawings and Page 5 for keys to species).

#### DISTRIBUTION

Range: Crenulate moonwort is very rare and local, but exhibits a rather extensive range. It is known to occur from as far north as Oregon, Montana, and Alberta, and as far east as Utah (Wagner and Devine 1989). Two historical sites in northern Idaho have been tentatively identified as *Botrychium crenulatum* from herbarium specimens at Washington State University, Pullman, WA. Both specimens has been annotated three times, in the following order:

- Ann #1 - *B. lunaria* var. *onondagense* DHW [Wagner], undated
- Ann #2 - *B. dusenii* (Christ) Alston W.H. Wagner, 1976
- Ann #3 - *B. crenulatum* Wagner R.K. Moseley, 1/11/89

For documentation these locations are:

J.H. Christ 18090 (Acc #261413). 25 July 1948. Idaho, Boundary County, 9 miles northeast of Naples; in deep duff in heavy cedar grove.

R.F. Daubenmire 47151. 11 July 1947. Idaho, Idaho County, 14 miles NNE of Pierce, near Washington Creek; climax forest dominated by *Thuja plicata*.

During the 1990 inventory survey in the Idaho Panhandle, the J.H. Christ collection from Boundary County was not relocated. The R.F. Daubenmire collection from Idaho County is located much further south in Idaho and was not part of this survey.

Habitat and Associated Species: Crenulate moonwort principally grows at low elevations in drier microsites of damp meadows, boggy areas, and marshes, either on hillsides or flat lands where there are wet banks or springy spots (Wagner and Wagner 1981, Lellinger 1985). The plants are generally rooted in tussocks or "rises" around isolated trees or shrubs, or in depressions that dry out during the summer, or at the edges of marshes. In California, plants have also been found on creekbanks, clearings, and in mixed conifer forests growing in more or less damp soil under sedges or on organic, mossy soil. They may occur either in sun or shade, but evidently prefer partial shade (Wagner and Wagner 1981, Wagner and Devine 1989).

#### STATUS

Ownership: The historical collection from Boundary County is probably on private land and the Idaho County collection is owned by the State or Potlatch Corporation.

Threats: Timber harvest and other habitat-altering activities such as road building or drainage of swampy habitats pose the most significant threats to crenulate moonwort in Idaho.

Management Implications: See Management Implications and Recommendations in the Introduction (Page 8).

#### ASSESSMENT AND RECOMMENDATIONS

Summary: Crenulate moonwort is a Category 2 Candidate for federal listing. Two historical collections, one from Boundary County and another from Idaho County have tentatively been identified as Botrychium crenulatum.

Although few collections have been documented, what seems to be suitable habitat, swampy areas in western redcedar forests, occurs in many places within the Idaho Panhandle National Forests. Crenulate moonwort is a rather inconspicuous plant that could easily be overlooked. It is quite conceivable that other populations are present, but have not yet been located.

Recommendations to the Idaho Panhandle National Forests: Since the two sightings of Botrychium crenulatum are tentative, species identification must first be confirmed. Should these specimens prove to be crenulate moonwort, it would be recommended that Botrychium crenulatum be added to the Region 1 Sensitive Species list for Idaho and the Kaniksu National Forest.

See also Management Implications and Recommendations in the Introduction (Page 8).

Botrychium lanceolatum (Gmel.) Angstr.  
ssp. lanceolatum

CURRENT STATUS            proposed USFS Region 1 Sensitive Species

TAXONOMY

Family:    Ophioglossaceae (Adder's-tongue)

Common Name:    lance-leaved moonwort

Citation:    Angstrom, Bot. Notiser 1854:58. 1854

Synonyms: Osmunda lanceolata Gmel.  
Botrychium lunaria var. lanceolatum Rupr.  
Botrychium rutaceum var. lanceolatum Moore  
Botrychium matricariaefolium var. lanceolatum Watt.

Technical Description: Plants mostly 0.5-3.5 dm tall, glabrous from the first; sterile blade sessile or nearly so, attached near the summit of the plant (the common stalk 3-14 cm long), deltoid in outline, as wide as or wider than long, commonly 1-6 cm long and 1-9 cm wide, rather openly bipinnatifid or subbipinnatifid, the pinnae and pinnules mostly longer than wide, entire margined with acute to round apices; fertile stalk mostly 1.5-8 cm long; sterile blade and fertile spike both completely reflexed in bud; bud glabrous, wholly concealed by the base of the common stalk (Cronquist 1969, Lellinger 1985, Wagner and Wagner 1983a).

Nontechnical Description: A rather fleshy perennial plant growing from 0.5-3.5 dm tall. Plants arise from a single stem that divides into a single fertile and sterile "leaf", both attached near the summit of the plant from a 3-14 cm long common stem. The sterile leaf is attached almost directly to the main stem (without a stalk), twice divided into lateral branches and has sharply pointed or rounded tips and a shiny dark green color. The fertile portion ranges from 1.5-8 cm long (see Appendix I for line drawings).

Distinguishing Features and Similar Species: As with all moonworts, lance-leaved moonwort is a rather inconspicuous species that must be searched for diligently. The species grows on wet to moist grassy slopes, roadsides, and edges of lakes generally at fairly high elevations. Within these habitats search for a small fern with a single fertile and sterile frond portion. The sterile frond is once or twice divided with pointed frond tips and a rather fleshy, shiny green appearance (see Appendix I).

Unlike most moonworts, lance-leaved moonwort is fairly easy to identify. It can, and frequently does, grow in the same habitat as B. hesperium, B. pinnatum, and B. echo (Wagner and Wagner 1983a). Lance-leaved moonwort can be distinguished from these

other taxa based on the shape of the sterile portion of the frond, which is broadly deltate (triangular) and nearly sessile in lance-leaved moonwort. The sterile leaf is ovate to oblong-deltate and subsessile to stalked in the other three species (Wagner and Wagner 1983a)(see Appendix I for line drawings and Page 5 for keys to species).

#### DISTRIBUTION

Range: Lance-leaved moonwort is rare and local, but exhibits a rather extensive range. It is known to occur from Alaska to Oregon and at higher elevations in Colorado, Utah, New Mexico, and Arizona. Four sites of lance-leaved moonwort are now documented for Idaho. The species was first recorded from Idaho in 1987 by Norm Trigoboff during a field survey for the Idaho Panhandle National Forests. He located a population in Boundary County near Spread Creek (occurrence #002)(Caicco 1987). Botrychium minganense also occurs with lance-leaved moonwort at this site.

In 1989, Robert Moseley discovered another population during a survey by the Idaho Natural Heritage Program in northern Idaho. This second site was located in a large meadow along Boulder Creek in Boundary County (occurrence #001). A collection was made from this second site and is deposited in the University of Idaho Herbarium (Moseley #1460).

During the 1990 survey, the Moseley collection was relocated. The Trigoboff collection from Spread Creek was inaccessible this year due to road failures. In addition, two new sites were discovered for lance-leaved moonwort. One site occurs along the eastern edge of the Selkirk Mountains in a small opening along the West Fork Smith Creek and Smith Creek Road (#281) in Boundary County (occurrence #003). The second site was located in Bonner County some 7.5 miles N of Nordman in a forest understory along the South Fork Granite Creek (occurrence #004). See Appendices II and III for location maps and demographic data.

Habitat and Associated Species: Lance-leaved moonwort grows in a wide variety of habitats including wet to moist grassy and rocky slopes, meadows, woods, roadsides, and edges of lakes generally at fairly high elevations (Wagner and Wagner 1983a, Lellinger 1985). Soils tend to be cold and mostly subacid in nature. In Idaho, plants have been documented from an open riparian meadow, shaded western redcedar forest floor, and a small fern opening along a road. Elevations are documented as 2950, 3800, 4120, and 4200 feet.

The Boulder Creek site (#001) was located in a large, well-drained meadow along Boulder Creek in Boundary County. This upland creekbottom occurs within the Abies lasiocarpa (subalpine fir) zone on a sandy, alluvial substrate at an elevation of 4120 feet. Some 50-100 individuals were discovered growing with Ligusticum

canbyi, Fragaria virginiana, Danthonia intermedia, Carex microptera, Bromus marginatus, Spiraea douglasii and scattered Pinus monticola. Also growing at this site were Botrychium pinnatum and B. multifidum.

The newly discovered 1990 collections were found in two different habitats. The Smith Creek population (#003) supported a fair-sized population of some 50 individuals within an area of ca. 10 yds<sup>2</sup> at an elevation of 3800 feet. The habitat was a small fern opening along a road surrounded by a western redcedar-western hemlock forest that keyed to a Thuja plicata/Gymnocarpium dryopteris (western redcedar/oakfern) habitat type (Cooper et al. 1987). The actual microsite was slightly disturbed, on a slight eastern aspect, and fairly open with a wide mixture of forbs and shrubs. The existing vegetation indicated considerable moisture was present earlier in the year, but by July the humus was fairly dry. Species commonly found growing with lance-leaved moonwort at this location included Botrychium multifidum, Gymnocarpium dryopteris, Dryopteris filix-mas, Smilacina stellata, Rubus pedatus, Rubus parviflorus, Tiarella trifoliata, Epilobium angustifolium, Vaccinium globulare, Linnaea borealis, and Adenocaulon bicolor.

The population north of Nordman, along the South Fork Granite Creek and near the mouth of Packer Creek (#004), consisted of only three individuals. This site was along the edge of an undeveloped "campsite" pull-off along the creek at 2950 feet elevation. Plants were located within 15 feet of the creek edge in a filtered, moist, flat opening with a dense moss groundcover. The community keyed to a Thuja plicata/Gymnocarpium dryopteris (western redcedar/oakfern) habitat type (Cooper et al. 1987). Other species found growing at this location included Botrychium virginianum, Cornus stolonifera, Alnus sinuata, Gymnocarpium dryopteris, Ligusticum canbyi, Clintonia uniflora, Smilacina stellata, and Listera cordata.

#### STATUS

Ownership: All of the documented locations of lance-leaved moonwort in Idaho occur on land administered by the Kaniksu National Forest. Two locations, Boulder Creek Meadow (#001) and Smith Creek (#003) occur on the Bonners Ferry Ranger District and the other two sites, Spread Creek (#002) and Packer Creek West (#004), occur on the Priest Lake Ranger District.

Threats: Habitat-altering activities such as road building, grazing, and trampling pose threats to lance-leaved moonwort in Idaho. The Packer Creek West site (#004) could readily be disturbed by human trampling since it is between an undeveloped "campsite" and a creek. Trampling by elk or deer is already evident at the Smith Creek site (#003), which could also be threatened by road maintenance/construction or dust from heavy log

hauling. The Boulder Creek Meadows site (#001) received past cattle grazing, but the allotment has been closed since 1986 and the site is within the Cabinet Proposed Grizzly Bear Recovery Habitat area.

Management Implications: See Management Implications and Recommendations in the Introduction (Page 8).

#### ASSESSMENT AND RECOMMENDATIONS

Summary: Lance-leaved moonwort has been proposed for the Region 1 Sensitive Species list. Four extant locations of lance-leaved moonwort are now documented from Idaho. During the 1990 inventory, one previously known site was relocated and another was inaccessible due to road failures. Additionally, two new sites were discovered. All four occurrences are located on land administered by the Kaniksu National Forest.

Although few collections have been documented, what seems to be suitable habitat, occurs in many places within the Idaho Panhandle National Forests. Lance-leaved moonwort is a rather inconspicuous plant that could easily be overlooked. It is quite conceivable that other populations are present, but have not yet been located.

Recommendations to the Idaho Panhandle National Forests: All four known sightings of Botrychium lanceolatum ssp. lanceolatum in Idaho occur on the Kaniksu National Forest. Although, additional information is needed to correctly assess the conservation status of lance-leaved moonwort in Idaho, given the small number of known populations and the potential threat to the species habitat, it is recommended that Botrychium lanceolatum ssp. lanceolatum be added to the Region 1 Sensitive Species list for the Kaniksu National Forest. Documented populations presented in this report should be noted and protected by the Forest.

See also Management Implications and Recommendations in the Introduction (Page 8).

Botrychium minganense Vict.

CURRENT STATUS            proposed USFS Region 1 Sensitive Species

TAXONOMY

Family:    Ophioglossaceae (Adder's-tongue)

Common Name:    Mingan moonwort

Citation:    Victorin, F.M. 1927. Sur un Botrychium nouveau de la flore Americaine et ses rapports avec le B. lunaria et le B. simplex. Trans. Roy. Canad. Inst. Ser. 3,21(sect. 5):319-340.

Synonyms: Botrychium lunaria var. onondagense (Underw.) House

Technical Description: Plants mostly (3) 6-18 (22) cm tall, glabrous throughout; sterile blade on a short stalk about 5 mm long, attached near the summit of the plant (the common stalk 4-10 cm long), oblong and distinctly pinnate, with (2) 3-6 (7) pairs of pinnae, commonly 1.5-10 cm long by 0.5-2.5 cm wide, yellow-green in life; pinnae widely cuneate to subflabellate, the lower pinnae with upper and lower borders at angles of 50-100°, margins entire and rounded, or more frequently with one or more shallow incisions; sterile blade and fertile spike both completely reflexed in bud and wholly concealed by the base of the common stalk (Cronquist 1969, Wagner and Lord 1956, Wagner and Devine 1989).

Nontechnical Description: A small, inconspicuous, rather fleshy perennial growing from 3-22 cm tall. Plants arise from a single stem that produces a single fertile and sterile "leaf", both attached near the summit of the plant from a 3-13 cm long common stem. The sterile leaf is once divided into numerous well-developed wedge-shaped segments (pinnae). This sterile leaf is yellowish-green in color and is attached to the main stem by a small stalk often more than 5 mm long. Pinnae are rather remote, spoon-shaped or cupped rather than flat, and not notably wider than long. Outer margins of the pinnae are entire, but commonly with one or more shallow incisions. The fertile frond is 1.5-15 cm long. Plants emerge in late spring and release spores in summer (see Appendix I for line drawings).

Distinguishing Features and Similar Species: As with all moonworts, Mingan moonwort is a rather inconspicuous species that must be searched for diligently. The species grows in meadows, prairies, and woods and on sand dunes and riverbanks, in acid to circumneutral soils (Lellinger 1985). Within these habitats search for a small, yellow-green-colored fern with a single fertile and sterile frond. The sterile frond is once divided with numerous well-developed wedge-shaped segments, often with one or

several large incisions on the outer margin (see Appendix I).

For many years Mingan moonwort was confused with *B. lunaria* and was treated as a variety or form of that species. In 1956, Wagner and Lord (1956) presented a detailed comparison of the two taxa and found no less than 14 characters that distinguished them. They reaffirmed the status of *B. minganense* as a distinct taxon, confirming Victoran's (1927) original interpretation.

Mingan moonwort is still easily confused with *B. lunaria*, in addition to *B. crenulatum*. It can be distinguished from these taxa based on the shape of the sterile leaf, which is distinctly wedge-shaped and cupped or spoon-shaped in life. *B. lunaria* generally has very crowded, somewhat overlapping, flat, and mostly fan-shaped pinnae. *B. crenulatum* also has flat, fan-shaped pinnae, but they tend to be more remote and not overlapping (Wagner and Devine 1989) (see Appendix I for line drawings and Page 5 for keys to species).

#### DISTRIBUTION

Range: Mingan moonwort is rare, but is one of the most widespread North American species, occurring in practically all parts of Canada and Alaska, and ranging widely in the western United States mountains, south to Arizona (Wagner and Devine 1989). Five sites of Mingan moonwort are now documented for Idaho.

The species was first collected in Idaho under the name of *B. lunaria* in 1963 by Rex Daubenmire from Bonner County on the Priest River Experimental Forest. This historical site in northern Idaho is documented by a herbarium specimen at Washington State University, Pullman, WA. The specimen has been annotated three times, in the following order:

Ann #1 - *B. lunaria* var. *onondagense* DHW [Wagner], undated

Ann #2 - *B. dusenii* (Christ) Alston W.H. Wagner, 1976

Ann #3 - *B. minganense* Vict. R.K. Moseley, 1/11/89

For documentation this location is:

R. Daubenmire 5923. 13 August 1963. Idaho, Bonner County, South Ridge, east of Benton Springs; in an *Abies lasiocarpa*/*Pachistima* forest.

During a field survey on the Idaho Panhandle National Forests in 1987, Norm Trigoboff located a population that was identified as *B. lunaria* (Caicco 1987). This specimen was annotated to *B. minganense* by R.K. Moseley in 1989. The population was located in Boundary County near Spread Creek (occurrence #002). Growing with

Mingan moonwort was B. lanceolatum ssp. lanceolatum. A collection from this second site and is deposited in the University of Idaho Herbarium (Trigoboff - U of I accession #93673).

In 1989, the author discovered another population during a survey by the Idaho Natural Heritage Program on the Clearwater National Forest. This site was located in the understory of an old-growth western redcedar stand near Pollock Creek (see occurrence #003) in Clearwater County (Lorain 1989). A collection (Lorain #1991) was made from this site and will be deposited in the University of Idaho and University of Michigan herbaria.

During the 1990 inventory survey, the historical collection from Benton Springs in Bonner County was not relocated. Additionally, the Trigoboff collection from Spread Creek was inaccessible this year due to road failures. However, three new sites tentatively identified as Botrychium minganense were discovered. One site was located by two botanists from BioSystems Analysis, Inc. (Taylor et al. 1990) who were conducting rare plant inventories along a proposed gas pipeline route. This population consisted of a single plant found on an alluvial terrace of the Moyie River about 2 miles north of Moyie Springs, Boundary County (see occurrence #004). A collection (Glen Clifton #21592) was made from this site and has been deposited at Pacific Union College.

The second site was discovered by Forest Service technicians while establishing monitoring plots for a successional study in the Coeur d'Alene River drainage. This population also consisted of a single individual located in the understory of an extremely dense brushfield some 2.7 miles N of Laverne Saddle near Hearse Creek (see occurrence #005) in Shoshone County. A collection (Lorain #2114) was made from this site and will be deposited in the University of Idaho Herbarium.

A third new population was discovered in Boundary County about 1 airmile south of Brush Lake along the edge of a small pond off Forest Service Rd #2205 (see occurrence #006). A collection (Lorain 2100) was made from this site and will be deposited at the University of Idaho Herbarium. See Appendices II and III for location maps and demographic data.

Habitat and Associated Species: Mingan moonwort grows in a wide variety of habitats including meadows, prairies, woods, sand dunes, and riverbanks. Soils tend to be acid to circumneutral in nature (Lellinger 1985). In Idaho, plants have been documented from the understory of an old-growth western redcedar forest, an extremely dense brushfield, a subalpine fir/pachistima habitat, and a disturbed lodgepole pine community. Elevations are documented as 2500, 2960, 3800, 4200, 4700, and 4800 feet.

The Pollock Creek population (#003) is within an isolated roadless area and consisted of five populations totaling some 500

individuals within a 1/4 section area. Scattered plants were found on a relatively flat bench at the confluence of two small creeks in a dense, shaded, old-growth Thuja plicata/Asarum caudatum (western redcedar/wild ginger) habitat type (Cooper *et al.* 1987). The old-growth stand of western redcedar is pristine and well over 500 years old with trees averaging >6 ft diameter. Plants were growing at an elevation between 4500 to 4900 feet in a moist, thick duff layer on 5-25% slopes with southeast and southwestern aspects. Understory vegetation is sparse and consisted of a few Clintonia uniflora, Smilacina stellata, Anemone piperi, and Adenocaulon bicolor.

The newly discovered 1990 collections were found in three different habitats. The Moyie Springs population consisted of one individual found on a well-drained alluvial terrace of the Moyie River in Boundary County (see occurrence #004). This site occurs at an elevation of 3200 feet on a flat, shaded terrace in a disturbed Pinus contorta/Vaccinium globulare community. Past logging activity was evident. Other associated plant species included Corylus cornuta, Betula papyrifera, Alnus incana, Shepherdia canadensis, Aralia nudicaulis, Linnaea borealis, and Ceanothus sanguineus.

The second population from Shoshone County, just N of Laverne Saddle near Hearse Creek (see occurrence #005), is located in an extremely dense brushfield habitat. Fortunately the technician that discovered this site mapped, flagged, and described this site in excellent detail, making relocation by the author possible. This site is within 150 feet uphill from Forest Service Road #409 on a steep NE slope. The community keyed to a Abies grandis/Clintonia uniflora (grand fir/queencup beadlily) habitat type (Cooper *et al.* 1987). Present vegetation consists of a very dense brushfield with a few pole-sized Pseudotsuga menziesii and young Abies grandis less than 6 feet tall. This community resulted from clearcutting and prescribed burning conducted some 30 years earlier. Other species found growing at this location included Ceanothus sanguineus, Rubus parviflorus, Pachistima myrsinites, Polystichum munitum, Lonicera utahensis, Salix scouleriana, Linnaea borealis, Coptis occidentalis and a few scattered Clintonia uniflora plants. A single plant of Botrychium echo (tentative identification) was also found at this site.

The third population from Boundary County, along FS Road #2205 (see occurrence #006), occurs at 2960 feet in a small, flat depression some 10-20 feet from the edge of a small pond. The area is quite moist, even in July, and undoubtedly experienced standing water earlier in the spring/summer. A thick moss layer covered the ground and filtered shade was produced by a canopy of Thuja plicata and Alnus incana trees. The microhabitat keyed to a Thuja plicata/Athyrium filix-femina (western redcedar/lady-fern) habitat type, with a surrounding vegetation of Thuja plicata/Clintonia uniflora (western redcedar/queencup beadlily)

habitat type (Cooper et al. 1987).

Species commonly found growing with Mingan moonwort at this location included Athyrium filix-femina, Dryopteris filix-mas, Smilacina stellata, Prunella vulgaris, Aralia nudicaule, Cornus stolonifera, Symphoricarpos albus, and thick mosses.

#### STATUS

Ownership: Five of the six documented locations of Mingan moonwort occur on land administered by the Forest Service and three of these are in the Idaho Panhandle National Forests. Three sites occur on the Kaniksu National Forest; the Spread Creek site (#002) on the Priest Lake Ranger District, the Bonner County historical site on the Priest River Experimental Forest, and the Road 2205 Pond site (#006) on the Bonners Ferry Ranger District. The Hearse Creek site (#005) is located on the Wallace Ranger District on the Coeur d'Alene National Forest and the Pipeline Moyie River Road site (#004) is found on private land in Boundary County. The last Idaho location of Mingan moonwort is the Pollock Creek site (#003) located on the North Fork Ranger District of the Clearwater National Forest (Lorain 1989).

Threats: Habitat-altering activities such as road building, timber harvesting, and drainage of swampy habitats pose threats to Mingan moonwort in Idaho. It appears that the species requires fairly dense shade and activities that would alter the overstory could threaten the species.

Management Implications: See Management Implications and Recommendations in the Introduction (Page 8).

#### ASSESSMENT AND RECOMMENDATIONS

Summary: Mingan moonwort is a Region 1 Sensitive Plant Species. Six known locations of Mingan moonwort are known from Idaho, four of which occur on land administered by the Idaho Panhandle National Forests. Three of these locations were discovered during this investigation. The Boundary County site on the Kaniksu National Forest is the second largest known population, supporting several hundred individuals. One historical site was not relocated and another site was inaccessible due to road failures. The final site was discovered by the author in 1989 from the Clearwater National Forest.

Although few collections have been documented, what seems to be suitable habitat, occurs in many places within the Idaho Panhandle National Forest. Mingan moonwort is a rather inconspicuous plant that could easily be overlooked. It is quite conceivable that other populations are present, but have not yet been located.

Recommendations to the Idaho Panhandle National Forests: Four of

the six sightings of Botrychium minganense occur on the Idaho Panhandle National Forests. Although, additional information is needed to correctly assess the conservation status of Mingan moonwort in Idaho, given the small number of known populations and the potential threat to the species habitat, it is recommended that Botrychium minganense be maintained on the Region 1 Sensitive Species list for the Kaniksu National Forests and be added to the Coeur d'Alene National Forest list. Documented populations presented in this report, especially the large population at Road 2205 Pond (#006) should be noted and protected by the Kaniksu and Coeur d'Alene National Forests.

See also Management Implications and Recommendations in the Introduction (Page 8).

Botrychium pinnatum H. St. John

CURRENT STATUS            proposed USFS Region 1 Sensitive Species

TAXONOMY

Family:    Ophioglossaceae (Adder's-tongue)

Common Name:    northern moonwort

Citation:    St. John, H. 1929. Notes on northwestern ferns.  
American Fern Journal 19:11-16.

Synonyms: Botrychium boreale var. obtusilobum Broun  
Botrychium boreale ssp. obtusilobum (Rupr.) Clausen

Although not really a synonym, the scientific name Botrychium boreale had been improperly used for North American plants until Wagner and Wagner (1983a) distinguished between this Eurasiatic species and B. pinnatum, the North American taxon.

Technical Description: Plants mostly 1-2 dm tall, glabrous from the first, a bright to yellow-green in color, shiny in life; sterile blade sessile or nearly so, attached near or more commonly above the middle of the plant (the common stalk 4-13 cm long), ovate or ovate-oblong in outline, mostly 1.5-7 cm long and 1-4.5 cm wide, somewhat fleshy, bipinnate or subbipinnate, the pinnae mostly 3-6 pairs, the ultimate segments blunt or rounded at apex, not much if at all longer than wide, entire margined with rounded apices, somewhat crowded, prominently veined with twice forked veins; pinnae in large plants pinnately cut and closely resembling the whole blade of a smaller plant; fertile stalk mostly 1.5-8 cm long; fertile stalk mostly 1-4 cm long, exceeding the sterile portion, fertile spike 1.5-6 cm long; sterile and fertile portions wholly concealed by the base of the common stalk (St. John 1929, Cronquist 1969, Lellinger 1985, Wagner and Wagner 1983a).

Nontechnical Description: A rather fleshy perennial plant growing from 1-2 dm tall. Plants arise from a single stem that divides into a single fertile and sterile "leaf", with the sterile leaf commonly attached above the middle of the plant from a 4-13 cm long common stem. The sterile leaf is attached almost directly to the main stem (without a stalk), once or twice divided into numerous somewhat overlapping lobes with rounded tips and a shiny bright to yellow-green color. The fertile portion ranges from 1.5-8 cm long (see Appendix I for line drawings).

Distinguishing Features and Similar Species: As with all moonworts, northern moonwort is a rather inconspicuous species that must be searched for diligently. The species grows on wet to moist grassy slopes, streambanks, roadsides, and in mossy woods

generally in the mountains. Within these habitats search for a small bright- to yellow-green-colored fern with a single fertile and sterile frond portion. The sterile frond is once or twice divided with rounded frond tips, rather fleshy, and has somewhat crowded pinnae (see Appendix I).

Northern moonwort is relatively distinct, for a moonwort. It can, and frequently does, grow in the same habitat as *B. hesperium* and *B. lanceolatum* (Wagner and Wagner 1983a; Lorain pers. obs.). Northern moonwort can be distinguished from these other taxa based on the shape of the sterile portion of the frond, which is lance-shaped to ovate in outline, bright to yellow-green in color with numerous, fleshy, somewhat overlapping lobes in northern moonwort. Additionally, the pinnae are nearly symmetrical, not ascending or clasping, and blunt to rounded at the apex. *Botrychium hesperium* is quite similar to northern moonwort, however, *B. hesperium* is a dull, gray-green in color with few pinnae lobes and the lowest lobe is exaggerated, strongly asymmetrical, ascending, and somewhat clasping. The sterile leaf in *B. lanceolatum* is distinctly triangular, shiny dark green in color with narrow, pointed pinnae (Wagner and Wagner 1983a)(see Appendix I for line drawings and Page 5 for keys to species).

#### DISTRIBUTION

Range: Northern moonwort is rare and local, but exhibits a rather extensive range. It is known to occur in Alaska and the Yukon Territory, south at higher elevations in the mountains of eastern Montana, northern Nevada, and northeastern Oregon. Three sites of northern moonwort are now documented for Idaho. The species was first recorded from Idaho in 1989 by Robert Moseley during a survey by the Idaho Natural Heritage Program in northern Idaho. This site is located in a large meadow along Boulder Creek in Boundary County (see occurrence #001). A collection was made from this site and is deposited in the University of Michigan Herbarium (Moseley #1461). *B. lanceolatum* ssp. *lanceolatum* was found growing in this same meadow. During the 1990 survey, the Moseley collection from Boundary County was relocated and a more thorough investigation of this large meadow revealed that this populations consists of some 50 plants versus the single plant originally found.

In addition, three new sites were discovered for northern moonwort in 1990. One site was discovered by the author while trying to relocate a historical collection of *B. minganense* near Benton Springs in the Priest River Experimental Forest, Bonner County (see occurrence #002). Another population is located about 1 airmile south of Brush Lake along the edge of a small pond off Forest Service Rd #2205 (see occurrence #004). A collection (Lorain 2100a) was made from this site and will be deposited in the University of Idaho Herbarium. The third site was located in Idaho County along the Indian Hill Road (#290) in the Nez Perce

National Forest (occurrence #003). See Appendices II and III for location maps and demographic data.

Habitat and Associated Species: Northern moonwort grows in a wide variety of habitats including wet to moist grassy slopes, streambanks, roadsides, and in mossy woods, generally in the mountains (Wagner and Wagner 1983a, Lellinger 1985). In Idaho, plants have been documented from an open riparian meadow, shaded western redcedar forest floor, and a shrubby roadside. Elevations are documented as 4150, 4800, and 6400 feet.

The Boulder Creek site (#001) was located at 4150 feet in a large, well-drained meadow along Boulder Creek in Boundary County. This upland creekbottom occurs within the Abies lasiocarpa (subalpine fir) zone on a sandy, alluvium substrate. Some 50 individuals were discovered growing with Ligusticum canbyi, Fragaria virginiana, Danthonia intermedia, Carex microptera, Bromus marginatus, Spiraea douglasii and scattered Pinus monticola. Also growing at this site were Botrychium lanceolatum ssp. lanceolatum and B. multifidum.

The newly discovered 1990 collections were found in three different habitats, all of which supported less than ten individuals. The Benton Springs population (#002) is located at 4800 feet on a 8-15% slope with a western aspect and near a small spring within the Abies lasiocarpa zone. The moister microsite community keyed to a Thuja plicata/Asarum caudatum (western redcedar/wild ginger) habitat type surrounded by an Abies lasiocarpa/Clintonia uniflora (subalpine fir/queencup beadleily) habitat type (Cooper et al. 1987). The plant occurred in a small concavity at the base of a large western redcedar tree. Existing vegetation indicated considerable moisture was present earlier in the year, but by July the humus was fairly dry. Species commonly found growing with northern moonwort at this location included Clintonia uniflora, Smilacina stellata, S. racemosa, Pachistima myrsinites, Arnica cordifolia, Acer glabrum, and Viola glabella.

The second newly discovered 1990 collection from Idaho occurs at 2960 feet in a small, flat depression some 10-20 feet from the edge of a small pond (#004). The area was quite moist, even in July, and undoubtedly experienced standing water earlier in the spring/summer. A thick moss layer covered the ground and filtered shade was produced by a canopy of Thuja plicata and Alnus incana trees. The microhabitat keyed to a Thuja plicata/Athyrium filix-femina (western redcedar/lady-fern) habitat type, with a surrounding vegetation of Thuja plicata/Clintonia uniflora (western redcedar/queencup beadleily) habitat type (Cooper et al. 1987). Species commonly found growing with northern moonwort at this location included another moonwort, Botrychium minganense, in addition to Athyrium filix-femina, Dryopteris filix-mas, Smilacina stellata, Prunella vulgaris, Aralia nudicaule, Cornus stolonifera, Symphoricarpos albus, and thick mosses.

Another 1990 location for northern moonwort, Indian Hill (#003) from Idaho County, occurs much farther south and in a different type of habitat. This population also consisted of a single individual and occurs on a partially shaded western slope at some 6400 feet in elevation. The microsite is on a steep westerly-facing roadcut within a surrounding Abies grandis/Clintonia uniflora (grand fir/queencup beadlily) habitat type (Cooper *et al.* 1987). The substrate consists of rather dry mineral soils that supports Arnica cordifolia, Valeriana sitchensis, Pedicularis bracteosa, Xerophyllum tenax and nearby shrubs of Acer glabrum, Sorbus sitchensis, and Menziesii ferruginea.

#### STATUS

Ownership: All of the documented locations of northern moonwort in Idaho occur on land administered by the Kaniksu or Nez Perce National Forests. Three populations, Boulder Creek Meadow (#001), Benton Springs (#002), and Road 2205 Pond (#004), occur in the Kaniksu National Forest on the Bonners Ferry and Priest Lake Ranger Districts, respectively. The other site, Indian Hill (#003) occurs on the Selway Ranger District of the Nez Perce National Forest.

Threats: Habitat-altering activities such as road construction/maintenance, drainage of swampy areas, grazing, and trampling pose threats to northern moonwort in Idaho. Both the Benton Springs (#002) and Indian Hill (#003) sites are within 5 feet of a Forest Service Road and could readily be disturbed by road work or heavy dust. In fact, recent and extensive flagging was seen along the Indian Hill road, indicating anticipated road improvements. The northern moonwort plant discovered this year fell within this flagged zone. Trampling by elk, deer or humans is quite possible at the Boulder Creek site (#001). This meadow received past cattle grazing, but the allotment has been closed since 1986 and the site is within the Cabinet Proposed Grizzly Bear Recovery Habitat area.

Management Implications: See Management Implications and Recommendations in the Introduction (Page 8).

#### ASSESSMENT AND RECOMMENDATIONS

Summary: Northern moonwort has been proposed for the Region 1 Sensitive Species list. Three extant locations of northern moonwort are now documented from Idaho. During the 1990 inventory, one previously known population was relocated and expanded in size. Additionally, three new sites of northern moonwort were discovered. Two occurrences are located on land administered by the Kaniksu National Forest and one is found on the Nez Perce National Forest.

Although few collections have been documented, what seems to be

suitable habitat, occurs in many places within the Idaho Panhandle National Forest. Northern moonwort is a rather inconspicuous plant that could easily be overlooked. It is quite conceivable that other populations are present, but have not yet been located.

Recommendations to the Idaho Panhandle National Forests: Two of the three known sightings of Botrychium pinnatum in Idaho occur on the Idaho Panhandle National Forests. Although, additional information is needed to correctly assess the conservation status of northern moonwort in Idaho, given the small number of known populations and the potential threat to the species habitat, it is recommended that Botrychium pinnatum be added to the Region 1 Sensitive Species list for the Kaniksu and Nez Perce National Forests. Documented populations presented in this report should be noted and protected by the Kaniksu National Forest.

See also Management Implications and Recommendations in the Introduction (Page 8).

Botrychium simplex E. Hitchc.

CURRENT STATUS            proposed USFS Region 1 Sensitive Species

TAXONOMY

Family:     Ophioglossaceae (Adder's-tongue)

Common Name:     least moonwort

Citation:     Hitchcock, E. 1823. Am. Journ. of Science 6:103.

Synonyms:     Botrychium virginicum var. simplex Gray  
                  Botrychium lunaria var. simplex Watt  
                  Botrychium kannenbergii f. compositum Lasch  
                  Botrychium simplex var. compositum Milde

Technical Description: Plants mostly 3-13 cm tall, glabrous from the first; sterile blade with an evident, sometimes sheathing petiole, gen. 1.0-3.5 cm long, attached from ground level (common in our area) to high on the common stalk, which is seldom more than 2.5 cm long; sterile leaf highly variable from simple to broadly ternate with 3-main pinnate branches each with 2-4 pairs of pinnae at maturity; pinnae segments subflabellate to oblong, the lowest one commonly larger than the others, margins generally entire with rounded apices, flat, often approximate; fertile stalk mostly 2-8 cm long; sterile blade and fertile spike both erect or nearly so in bud; bud glabrous, wholly concealed by the base of the common stalk (Cronquist 1969, Lellinger 1985, Wagner and Devine 1989).

Nontechnical Description: A small, somewhat fleshy, perennial growing from 3-13 cm tall. Plants arise from a single stem that divides into a single fertile and sterile "leaf", attached to a common stem seldom more than 2.5 cm long. The sterile leaf is attached from ground level (common in our area) to high on the common stalk and is highly variable in shape and size. The sterile leaf can be simple or more commonly divided into three main branches (ternate), each with 2-4 pairs of pinnae, the lowest generally the largest. Pinnae fan-shaped, flat, slightly overlapping with entire, rounded outer margins. The fertile portion ranges from 2-8 cm long (see Appendix I for line drawings).

Distinguishing Features and Similar Species: As with all moonworts, least moonwort is a rather inconspicuous species that must be searched for diligently. It grows on moist to rather dry open, grassy meadows and woods in deep shade and duff. Within these habitats search for a small, somewhat fleshy fern with a single fertile and sterile frond portion. The sterile frond is long-stalked, often attached at ground level and variable from simple to three main branches with fan-shaped segments that

slightly overlap (see Appendix I).

Larger, mature plants of least moonwort are difficult to confuse, since no other species in this area has a sterile leaf that is divided into three main branches. Smaller plants, however, could be confused with Botrychium crenulatum or B. lunaria. Least moonwort can be distinguished from these taxa based on the shape of the sterile portion of the frond, which is generally attached near ground level (our area) and has few fan-shaped pinnae that somewhat overlap. In contrast, B. lunaria and B. crenulatum have once pinnate sterile leaves that attach to a distinct common stalk and both species have broadly fan-shaped pinnae.

Additionally, B. lunaria is fleshy, bluish-green in color with 4-7 pairs of very crowded pinnae that overlap and B. crenulatum is herbaceous, yellow-green in color with an average of three pairs of separate pinnae that do not overlap and have distinctly crenate margins (Wagner and Devine 1989; Cronquist 1969)(see Appendix I for line drawings and Page 5 for keys to species).

#### DISTRIBUTION

Range: Least moonwort is regarded as rare and local, but has an enormous range in North America and is probably much more common than usually assumed (Wagner and Devine 1989). It is known to occur from high elevations in southern California and North Carolina northward to Alaska and Newfoundland, and is also widespread in the Old World (Wagner and Devine 1989). Four sites of least moonwort are now documented for Idaho, one of which occurs in northern Idaho and the other three are in central and southern Idaho from Custer, Valley, and Blaine Counties. The northern Idaho population occurs on the Palouse Ranger District of the St. Joe National Forest; land administered by the Clearwater National Forest.

The species was first recorded from northern Idaho in 1987 by Robert Moseley. This site was located in the understory of an old-growth western redcedar grove in Clearwater County (see occurrence #001). A collection (Moseley #769) was made from this site and is deposited in the University of Idaho Herbarium. See Appendices II and III for location maps and demographic data.

Habitat and Associated Species: Least moonwort grows in a wide variety of habitats including meadows, barrens, and woods in usually subacid soil (Lellinger 1985). The small northern Idaho population occurs in the understory of a shaded Thuja plicata/Gymnocarpium dryopteris (western redcedar/oakfern) habitat type (Cooper et al. 1987). The thick duff layer also supported Clintonia uniflora, Pachistima myrsinites, Coptis occidentalis, Goodyera oblongifolia, Taxus brevifolia, and Asarum caudatum.

## STATUS

Ownership: This single northern Idaho population of least moonwort occurs on the Palouse Ranger District of the St. Joe National Forest; land administered by the Clearwater National Forest.

Threats: At present, no significant threats exist to this northern Idaho population of least moonwort. The site is located within the Morris Creek Cedar Grove Botanical Area. Potential natural threats might include windthrow or trampling by large game animals.

## ASSESSMENT AND RECOMMENDATIONS

Summary: Least moonwort has been proposed for the Region 1 Sensitive Species list. Four sites are documented from Idaho, one from the Palouse Ranger District of the St. Joe National Forest. No new sites for least moonwort were located during this investigation and none are known to occur on lands administered by the Idaho Panhandle National Forests.

Although few collections have been documented, what seems to be suitable habitat occurs in many places within the Idaho Panhandle National Forest. Least moonwort is a rather inconspicuous plant that could easily be overlooked. It is quite conceivable that other populations are present, but have not yet been located.

### Recommendations to the Idaho Panhandle National Forests:

Although no sites for least moonwort are documented from land administered by the Idaho Panhandle National Forests, significant suitable habitat occurs on the Forests. Additional information is needed to correctly assess the conservation status of least moonwort in Idaho and clearance surveys on the Idaho Panhandle National Forests in suitable potential habitat should include Botrychium simplex.

See also Management Implications and Recommendations in the Introduction (Page 8).

Botrychium sp.

During the course of this field investigation one specimen of moonwort was discovered on the Wallace Ranger District of the Coeur d'Alene National Forest that closely resembles the eastern species B. matricariifolium. It is suspected that this specimen may be an unusually dissected form of B. echo. If confirmed, this would be a new species record for the state of Idaho and would considerably extend the range of this taxon in the western United States, presently known only from Arizona, Colorado, and Utah.

Habitat and Associated Species: This site was discovered by Forest Service technicians while establishing monitoring plots for a successional study. Fortunately the technician mapped, flagged, and described this site in excellent detail, making relocation by the author possible. The population consisted of a single individual located some 2.7 miles N of Laverne Saddle near Hearse Creek (see occurrence #001) in Shoshone County. The site is within 150 feet uphill from Forest Service Road #409 on a steep NE slope within a seral Abies grandis/Clintonia uniflora (grand fir/queencup beadleily) habitat type (Cooper et al. 1987). Present vegetation consists of an extremely dense brushfield with a few pole-sized Pseudotsuga menziesii and young Abies grandis less than six feet tall. This community resulted from clearcutting and prescribed burning conducted some 30 years earlier. Other species found growing at this location included Ceanothus sanguineus, Rubus parviflorus, Pachistima myrsinites, Polystichum munitum, Lonicera utahensis, Salix scouleriana, Linnaea borealis, Coptis occidentalis and a few scattered Clintonia uniflora plants. A single plant of Botrychium minganense was also found at this site. A collection (Lorain #2113) was made from this site and will be deposited in the University of Idaho Herbarium. See Appendices II and III for location maps and demographic data.

Recommendations to the Idaho Panhandle National Forests: Since this sighting is tentative, species identification must first be confirmed. Specimens have been sent to Warren H. Wagner (Botrychium specialist, University of Michigan, Ann Arbor). Should this specimen prove to be Botrychium echo, it would be recommended for addition to the Region 1 Sensitive Species list for the Coeur d'Alene National Forest. The documented population presented in this report should be noted and protected by the Forest.

See also Management Implications and Recommendations in the Introduction (Page 8).

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APPENDIX I

Line drawings of Botrychium subgenus Botrychium species.

(from Wagner and Lord 1956; Cronquist 1969;  
Wagner and Wagner 1981, 1983; Wagner and Devine 1989)

APPENDIX II

Maps of precise occurrences of Botrychium subgenus Botrychium  
in northern Idaho

Botrychium sp.  
(tentative identification B. echo)

Map A. Portion of Bumblebee Peak 7.5' quadrangle

Botrychium lanceolatum ssp. lanceolatum

Map B. Portion of Clifty Mountain 7.5' quadrangle  
Map C. Portion of Continental Mountain 7.5' quadrangle  
Map D. Portion of Shorty Peak 7.5' quadrangle  
Map E. Portion of Orwig Hump 7.5' quadrangle

Botrychium minganense

Map F. Portion of Continental Mountain 7.5' quadrangle  
Map G. Portion of Bruin Hill 7.5' quadrangle  
Map H. Portion of Meadow Creek 7.5' quadrangle  
Map I. Portion of Bumblebee Peak 15' quadrangle  
Map J. Portion of Ritz 7.5' quadrangle

Botrychium pinnatum

Map K. Portion of Clifty Mountain 7.5' quadrangle  
Map L. Portion of Prater Mountain 7.5' quadrangle  
Map M. Portion of Selway Falls 7.5' quadrangle  
Map N. Portion of Ritz 7.5' quadrangle

Botrychium simplex

Map O. Portion of Elk River 7.5' quadrangle

APPENDIX III

Demographic data for extant Botrychium subgenus Botrychium  
sites in northern Idaho.

Botrychium lanceolatum ssp. lanceolatum

Botrychium minganense

Botrychium pinnatum

Botrychium simplex

Botrychium sp. (tentatively identified as B. echo)

(\* - previously known and documented population)

Categories follow those on the Idaho Natural Heritage Program's Special Plant Survey Form. The categories breakdown as follows:

<u>Pop. Size</u>	-	actual #	<u>Pop. Area</u>	-	1yd <sup>2</sup>
		estimated #			1-5 yds <sup>2</sup>
		1-10			5-10 yds <sup>2</sup>
		11-50			10-100 yds <sup>2</sup>
		51-100			100 yds <sup>2</sup> - 2 ac
		101-1000			2 ac+
		1001-10,000			actual area
		10K+			(if known)

Botrychium lanceolatum ssp. lanceolatum

- \* 1. Boulder Creek Meadows (001)
  - a. Location:
  - b. Area: 2+ acres
  - c. Number of plants: 51-100 plants in 1989
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- \* 2. Spread Creek (002)
  - a. Location:
  - b. Area: 5-10 yd<sup>2</sup>
  - c. Number of plants: "fourteen individuals of B. manganense were found growing with B. lanceolatum" (Caicco 1987) in 1987
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- 3. Smith Creek 1st Clearcut (003)
  - a. Location:
  - b. Area: 5-10 yds<sup>2</sup>
  - c. Number of plants: 11-50 plants in 1990
  - d. Density: Moderate
  - e. Evidence of expansion/contraction: No evidence
  
- 4. Packer Creek West (004)
  - a. Location:
  - b. Area: <1 yd<sup>2</sup>
  - c. Number of plants: 3 plants in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence

Botrychium minganense

- \* 1. Spread Creek (002)
  - a. Location:
  - b. Area: 5-10 yd<sup>2</sup>
  - c. Number of plants: "fourteen individuals of B. minganense were found" (Caicco 1987) in 1987
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- \* 2. Pollock Creek (003)
  - a. Location:
  - b. Area: 2+ acres (scattered in a 1/4 section)
  - c. Number of plants: 5 populations totaling 101-1000 plants in 1989
  - d. Density: Moderate
  - e. Evidence of expansion/contraction: No evidence
  
- 3. Pipeline Moyie River Road (004)
  - a. Location:
  - b. Area: <1 yd<sup>2</sup>
  - c. Number of plants: single plant in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- 4. Hearse Creek South (005)
  - a. Location:
  - b. Area: <1 yd<sup>2</sup>
  - c. Number of plants: single plant in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- 5. Road 2205 Pond (006)
  - a. Location:
  - b. Area: 10-100 yd<sup>2</sup>
  - c. Number of plants: 101-200 plants in 1990
  - d. Density: locally dense
  - e. Evidence of expansion/contraction: No evidence

Botrychium pinnatum

- \* 1. Boulder Creek Meadows (001)
  - a. Location:
  - b. Area: 10-100 yds<sup>2</sup>
  - c. Number of plants: 11-50 plants in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: single plant seen in 1989, further survey of meadow in 1990 revealed ca. 50 plants.
  
- 2. Benton Springs (002)
  - a. Location:
  - b. Area: < 1 yd<sup>2</sup>
  - c. Number of plants: 1 plant in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- 3. Indian Hill (003)
  - a. Location:
  - b. Area: <1 yd<sup>2</sup>
  - c. Number of plants: 1 plant in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence
  
- 4. Road 2205 Pond (004)
  - a. Location:
  - b. Area: 5-10 yd<sup>2</sup>
  - c. Number of plants: <10 plants in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence

Botrychium simplex

- \* 1. Morris Creek Cedar Grove (001)
  - a. Location:
  - b. Area: 5-10 yds<sup>2</sup>
  - c. Number of plants: few plants in 1986
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence

Three additional collections are recorded from central and southern Idaho in Valley, Blaine and Custer Counties (see Idaho Natural Heritage Program data records).

Botrychium sp. (tentatively identified as B. echo)

- 1. Hearse Creek South (001)
  - a. Location:
  - b. Area: <1 yd<sup>2</sup>
  - c. Number of plants: single plant in 1990
  - d. Density: Low
  - e. Evidence of expansion/contraction: No evidence

APPENDIX IV

Glossary

(Figures from Lellinger 1985)

acute - sharp-pointed, with more or less straight margins which form an angle of less than  $90^{\circ}$  at the tip.

apex - terminal portion of a structure (generally refers to leaves).

approximate - similar parts that are close together and often overlapping or touching at the edges. Antonym - distant

ascending - inclined upward.

asymmetrical - having a different outline on each side of a central axis.

axis - the central line or structure along which parts or organs are attaches. Plural Axes.

bipinnate or twice-pinnate - twice pinnate, the pinnae again pinnate; divided into pinnae bearing pinnules (see Figure 1).

clasping - attached directly and usually somewhat surrounding.

cleft - cut about half way to the base; deeply lobed.

crenate - shallowly-scalloped, with rounded teeth (see Figure 2).

crenulate - minutely crenate (see Figure 2).

cuneate - wedge-shaped or triangular, with the narrow end at the point of attachment; forming an angle of  $30-45^{\circ}$  with the two sides straight.

deltate - broadly triangular with an obtuse apex (see Figure 3).

deltoid - shaped more or less like an equilateral triangle, with one of the sides as the base (see Figure 3).

dentate - bearing spreading, pointed teeth; directed outward from margin rather than forward (see Figure 2).

distant - similar parts that are well separated and not overlapping or touching at the edges. Antonym - approximate

elongate - much longer than wide.

entire - an even or smooth margin, not toothed or lobed.

fertile - bearing sporangia (spore cases). Antonym - sterile

flabellate - fan-shaped (see Figure 3).

frond - the leaf of a fern (see Page 4).

glabrous - lacking glands, hairs, and scales.

herbaceous - a plant with stems that die back to the ground at the end of the growing season; not woody.

imbricate - having similar parts that overlap.

incised - deeply and sharply cut.

lacerate or laciniate - cut into narrow and usually unequal segments (see Figure 2).

lamina - the expanded portion of a frond, the leaf blade of a fern (see Page 4). Plural laminae.

lanceolate - lance-shaped, with a long, tapered apex and a short-tapered base (see Figure 3).

linear - long, narrow, and of uniform or nearly uniform width (see Figure 3).

lobe - a projecting segment of an organ.

lunate - shaped like a small crescent or half-moon (see Figure 3).

margin - an edge of a flat structure, usually a lamina or pinnae.

medial, median - pertaining to the middle.

oblanceolate - the inverse of lanceolate; gradually narrowed toward the base and widest at the apex (see Figure 3).

oblong - longer than wide with the long sides mostly parallel; shaped more or less like a geometric rectangle (see Figure 3).

obtuse - forming an angle of  $90^{\circ}$  or more with the 2 sides straight or slightly convex.

orbiculate - circular in outline, or nearly so.

ovate - having the outline of a longitudinal section of a hen's egg; similar to elliptic except broadest towards the base, rather than at the middle (see Figure 3).

pinna - a stalked or sessile, primary division of a compound lamina that is narrowed at the base (see Page 4). Plural - pinnae. See segment.

pinnate or once-pinnate - with 2 rows of lateral branches or appendages, or parts along an axis, like barbs on a feather; once divided into pinnae (see Figure 1).

pinnatifid - deeply lobed, but not cut to the axis, and the lobes not contracted at their base (see Figure 1).

recurved - curved backward or downward.

remote - see distant.

rhomboidal - diamond-shaped, often much longer than wide (see Figure 3).

segment - a portion of a lamina, pinna, or pinnule that is fully attached and with a deep sinus on each side that extends more than half way from the segment apex to the axis that the segment is attached to (see Page 4).

sessile - attached directly without a stipe or stalk.

spatulate - shaped like a spatula, rounded above and narrowed to the base.

stalk - a short, supporting axis, as the petiolule of a segment or pinna (see Page 4).

sterile - lacking sporangia (spore cases). Antonym - fertile

stipe - the stalk of a frond from the base of the lamina to the point of attachment to the rhizome; the petiole of a fern leaf (see Page 4).

sub- - a prefix indicating a lesser degree of a characteristic; meaning under, almost or not quite.

symmetrical - having a similar outline on both sides of a central axis. Antonym - asymmetrical

truncate - appearing as if cut off perpendicular to the axis.

ternate - divided into 3 equal or subequal parts.

ultimate - of the lowest order; the smallest division.

venation - the type or kind of vein pattern.

#### APPENDIX V

Slides of Botrychium subgenus Botrychium species  
and their habitats.