UPDATE TO THE REPORT ON THE CONSERVATION STATUS OF
Arabis fecunda, A CANDIDATE THREATENED SPECIES

Taxon name: Arabis fecunda Rollins
Common name: Sapphire rockcress
Family: Brassicaceae (Cruciferae)
State where taxon occurs: U.S.A., Montana
Current Federal status: USFWS Notice of Review, Category 2
Recommended Federal status: USFWS Notice of Review, Category 2
Author of update: Lisa Ann Schassberger
Original date of report: November 15, 1985
Date of most recent revision: December 19, 1988

Individual to whom further information and comments should be sent:

J. Stephen Shelly
Montana Natural Heritage Program
State Library Building
1515 E. 6th Avenue
Helena, MT 59620
V. New Information


Note: Within the text, numbers in parentheses following site names refer to the three-digit occurrence numbers, see Table 1 (p. 4).

**I.1.D.**

**History and knowledge of taxon:** Since 1985, the sites in the foothills of the Sapphire Range in Ravalli County, Montana were resurveyed. Additional subpopulations were added to the three previously known sites and one new population was discovered. Additionally, eight new populations were located along the north and east flanks of the Pioneer Mountains, in Beaverhead and Silver Bow counties.

**I.2.B.1.D.**

**Other current formal status recommendations:**

The status of *Arabisc fecunda* will be changed to "endangered throughout range" (global rank = G2) by the Montana Natural Heritage Program.

**I.2.C.1.b.**

**Other current formal status recommendations:**

The status of *Arabisc fecunda* will be changed to "endangered" in Montana (state rank = S2) by the Montana Natural Heritage Program.

**I.3.E.**

**Photographs and line drawings:** The color slides (p.2) are duplicates of those taken at the sites indicated. Additional slides of *Arabisc fecunda* and its habitat are housed at the office of the Montana Natural Heritage Program, Helena, Montana.

**I.5.A.**

**Geographical range:** With the addition of nine new sites, *Arabisc fecunda* is now known to occur at elevations from 4,600-8,000 ft. A new site (1986) from the foothills of the Sapphire Range occurs along 3irch Creek in Ravalli County, Montana. The sites discovered in 1988 occur along the Big Hole
River, and in several smaller drainages on 
the north and east flanks of the Pioneer 
Mountains, including: Jerry Creek, Quartz 
Hill Gulch, Canyon Creek and Birch Creek. 
These sites fall within Beaverhead and Silver 
Bow counties, Montana. The new sites along 
the flanks of the Pioneer Mountains extend 
the range of this species ca. 75 miles to the 
southeast. The global distribution for this 
species is shown on Map 1, p. 4.

I.5.B.1. 

Populations currently known extant:

e. Montana: Populations are listed in 
Table 1, pp. 5-6; exact locations are 
provided on Maps 2-8, pp. 7-13. All 
technical extant populations are included 
in these tables and maps, as additional 
supersubpopulation were discovered for the 
three sites described in the original 
report.

I.6.A. 

Concise statement of general environment and 
habitat: Populations are now known to occur 
up to 8,000 ft. in elevation.


Regional macroclimate: The long-term weather 
station nearest to the newly discovered 
populations in the Pioneer Mountains is at 
Divide, approximately 11 miles east of the 
sites, at 5,395 ft. in elevation. For the 
period from 1951-1980, the July mean 
temperature was 63.3 °F, the January mean was 
19.1 °F, and the average annual precipitation 
was 12.39 in. (Department of Commerce, 1982).


Physiographic and topographic 
characteristics: The new sites along the 
flanks of the Pioneer Mountains occur on the 
Madison Limestone Formation, comprised of 
metamorphosed limestone and sandstones, and 
on the Threeforks Formation, comprised of 
grayish-brown argillaceous limestone 
(Richards and Pardee, 1925). These sites 
appear to be on substrates similar to those 
occupied by the Sapphire Range populations.

I.6.B.5. 

Edaphic factors: Arabis fecunda may be 
associated with cryptogamic soil crusts. The 
initial results of ongoing monitoring and 
ecological studies in Ravalli County are 
included in Appendix B, p. 36 (Lesica and
Map 1. Distribution of *Arabis fecunda* populations; the species is endemic to western Montana.

• = Extant populations.

Note: Numbers are used where more than one population is represented by a dot.
Table 1. Populations currently known extant.

<table>
<thead>
<tr>
<th>Occurrence number</th>
<th>Site name</th>
<th>County</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation</th>
<th>Township &amp; Range</th>
<th>Sections</th>
<th>USGS Quad</th>
<th>Size</th>
<th>Year of initial discovery</th>
<th>Date of most recent observation</th>
<th>Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>CHARLEYS GULCH</td>
<td>RAVALLI</td>
<td>41531</td>
<td>1140000</td>
<td>5000</td>
<td>006N019W</td>
<td>20, W; 19, S; 30, N</td>
<td>CORVALLIS, WILLOW MOUNTAIN</td>
<td>7.5 minute series</td>
<td>1975</td>
<td>1988-06-01</td>
<td>CHARLEYS GULCH, WEST SLOPE OF SAPPHIRE RANGE, ALONG CHARLEYS GULCH ROAD CA. 1.1-2.1 MILES FROM JUNCTION WITH PAVED COUNTY ROAD; ALSO NORTH AND SOUTH OF GULCH.</td>
</tr>
<tr>
<td>002</td>
<td>SPRING GULCH</td>
<td>RAVALLI</td>
<td>41452</td>
<td>1140109</td>
<td>4740</td>
<td>006N019W</td>
<td>30, S; 20, NEW</td>
<td>MOUNTAIN HOUSE</td>
<td>7.5 minute series</td>
<td>1985</td>
<td>1988-06-01</td>
<td>SPRING GULCH, WEST SLOPE OF SAPPHIRE RANGE; AT JCT. OF HWYS. 269 &amp; 380, 2.5 MI. E. TO WHERE 380 TURNS N.; E. 1.5 MI. TO CHARLEYS GULCH RD., 2 MI. TO CATTLEGUARD; SITES 1 MI. SW.</td>
</tr>
<tr>
<td>003</td>
<td>ROCK QUARRY GULCH</td>
<td>RAVALLI</td>
<td>41358</td>
<td>1140137</td>
<td>4850</td>
<td>006N019W</td>
<td>31, NW;S</td>
<td>MOUNTAIN HOUSE</td>
<td>7.5 minute series</td>
<td>1985</td>
<td>1988-06-01</td>
<td>ROCK QUARRY GULCH; FROM JCT. OF HWYS. 269 &amp; 380, GO 2.5 MI. E. TO CORNER WHERE 380 TURNS N.; GO E. 1.5 MI. TO CHARLEYS GULCH RD., &amp; 2 MI. TO CATTLEGUARD; SITE IS 2 MILES SW.</td>
</tr>
<tr>
<td>004</td>
<td>BIRCH CREEK BLUFFS</td>
<td>RAVALLI</td>
<td>42201</td>
<td>1135911</td>
<td>4700</td>
<td>007N019W</td>
<td>16, NW; 17, NE</td>
<td>WILLOW MOUNTAIN,CORVALLIS</td>
<td>7.5 minute series</td>
<td>1986</td>
<td>1988-06-01</td>
<td>WESTERN LOWER SLOPES OF SAPPHIRE MOUNTAINS, ALONG BIRCH CREEK AND TRIBUTARY NW. OF SCHOOLHOUSE BUTTE, CA. 7 AIR MILES ENE. OF CORVALLIS.</td>
</tr>
<tr>
<td>005</td>
<td>QUARTZ HILL</td>
<td>BEAVERHEAD</td>
<td>45424</td>
<td>1125421</td>
<td>8000</td>
<td>001S011W</td>
<td>36, center</td>
<td>VIRONDO PARK (15)</td>
<td>15 minute series</td>
<td>1986</td>
<td>1986-07-08</td>
<td>PIONEER MOUNTAINS, ECHO GULCH, SOUTHWEST BASE OF QUARTZ HILL.</td>
</tr>
<tr>
<td>006</td>
<td>MOUTH OF QUARTZ HILL GULCH</td>
<td>BEAVERHEAD</td>
<td>45608</td>
<td>1125126</td>
<td>5780</td>
<td>001S010W</td>
<td>8, E; 5, E; 17, NE</td>
<td>DEWEY</td>
<td>7.5 minute series</td>
<td>1988</td>
<td>1988-06-13</td>
<td>BEAVERHEAD NATIONAL FOREST. TRAVEL 0.25 MILE WEST OF DEWEY ON HIGHWAY 43, THEN SOUTH ON QUARTZ HILL GULCH, EAST AND WEST OF THE ROAD FOR 1.5 MILES.</td>
</tr>
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</table>
Table 1. (cont.).

<table>
<thead>
<tr>
<th>Occurrence number:</th>
<th>Site name:</th>
<th>County:</th>
<th>USGS Quad:</th>
<th>Size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>007</td>
<td>JERRY CREEK</td>
<td>SILVER BOW</td>
<td>WISE RIVER</td>
<td>7.5 minute series</td>
</tr>
<tr>
<td>008</td>
<td>UPPER QUARTZ HILL GULCH</td>
<td>BEAVERHEAD</td>
<td>VIPOND PARK</td>
<td>15 minute series</td>
</tr>
<tr>
<td>009</td>
<td>SPRING GULCH II</td>
<td>BEAVERHEAD</td>
<td>WISE RIVER, DEWEY</td>
<td>7.5 minute series</td>
</tr>
<tr>
<td>010</td>
<td>BIG HOLE RIVER</td>
<td>SILVER BOW</td>
<td>WISE RIVER, DEWEY</td>
<td>7.5 minute series</td>
</tr>
<tr>
<td>011</td>
<td>VIPOND PARK</td>
<td>BEAVERHEAD</td>
<td>VIPOND PARK</td>
<td>15 minute series</td>
</tr>
<tr>
<td>012</td>
<td>LIME GULCH</td>
<td>BEAVERHEAD</td>
<td>TWIN ADAMS MOUNTAIN</td>
<td>7.5 minute series</td>
</tr>
</tbody>
</table>

- **Occurrence number**: 007, Site name: JERRY CREEK, County: SILVER BOW
  - Latitude: 45.4718, Longitude: 112.5402, Elevation: 5700
  - Township & Range: 001N010W, Sections: 31, SW
  - USGS Quad: WISE RIVER, Size: 7.5 minute series
  - Year of initial discovery: 1988
  - Date of most recent observation: 1988-06-07
  - Directions: CA. 1.5 MILES EAST OF WISE RIVER ON HIGHWAY 43, NE ON JERRY CREEK ROAD 0.3 MILE; HILLSIDES AND OUTCROPS EAST OF ROAD.

- **Occurrence number**: 008, Site name: UPPER QUARTZ HILL GULCH, County: BEAVERHEAD
  - Latitude: 45.4345, Longitude: 112.5242, Elevation: 7500
  - Township & Range: 001S010W, Sections: 19, SE; 20, SW; 29, SW; 30, SE
  - USGS Quad: VIPOND PARK, Size: 15 minute series
  - Year of initial discovery: 1988
  - Date of most recent observation: 1988-06-07
  - Directions: CA. 3.75 MILES S. OF DEWEY ON QUARTZ HILL GULCH ROAD, CA. 0.2 MILE SW OF ROAD.

- **Occurrence number**: 009, Site name: SPRING GULCH II, County: BEAVERHEAD
  - Latitude: 45.4643, Longitude: 112.5354, Elevation: 5600
  - Township & Range: 001S011W, Section: 1, SE
  - USGS Quad: WISE RIVER, Size: 7.5 minute series
  - Year of initial discovery: 1988
  - Date of most recent observation: 1988-06-07
  - Directions: CA. 2.2 MILES EAST OF WISE RIVER ON HIGHWAY 43. AT BEND, 0.20 MILE SOUTH OF ROAD ATOP STEEP CLIFFS.

- **Occurrence number**: 010, Site name: BIG HOLE RIVER, County: SILVER BOW
  - Latitude: 45.4709, Longitude: 112.5230, Elevation: 5600
  - Township & Range: 001S010W, Sections: 6, NE, NW, E, W
  - USGS Quad: WISE RIVER, DEWEY, Size: 7.5 minute series
  - Year of initial discovery: 1988
  - Date of most recent observation: 1988-06-07
  - Directions: 1.0 MILE WEST OF DEWEY ON HIGHWAY 43, 0.33 MILE NORTH OF ROAD ON THE NORTH SIDE OF BIG HOLE RIVER.

- **Occurrence number**: 011, Site name: VIPOND PARK, County: BEAVERHEAD
  - Latitude: 45.4059, Longitude: 112.5213, Elevation: 7200
  - Township & Range: 002S010W, Sections: 8, W; 7, NE; 5, S
  - USGS Quad: VIPOND PARK, Size: 15 minute series
  - Year of initial discovery: 1988
  - Date of most recent observation: 1988-06-13
  - Directions: FROM MELROSE, CA. 12.5 MILES WEST, UP CANYON CREEK ROAD, AT CORNER OVERLOOKING KILNS.

- **Occurrence number**: 012, Site name: LIME GULCH, County: BEAVERHEAD
  - Latitude: 45.2352, Longitude: 112.4844, Elevation: 6200
  - Township & Range: 005S010W, Sections: 14, W; 15, SE
  - USGS Quad: TWIN ADAMS MOUNTAIN, Size: 7.5 minute series
  - Year of initial discovery: 1988
  - Date of most recent observation: 1988-06-15
  - Directions: 5 MILES WEST OF INTERSTATE-15, UP BIRCH CREEK ROAD. NORTH OF ROAD ON EAST AND WEST FACES OF LIME GULCH.
USGS Corvallis (left) and Willow Mountain (right) (7.5') quadrangles.

Charleys Gulch (001)
USGS Mountain House (7.5') Quadrangle.

Spring Gulch (002)
Rock Quarry Gulch (003)
USGS Corvallis (left) and Willow Mountian (right) (7.5') quadrangles.

Birch Creek Bluffs (004)
USGS Vipond Park (15') Quadrangle.
Quartz Hill (005)
Upper Quartz Hill Gulch (008)
Vipond Park (011)
USGS Dewy (7.5') Quadrangle.

Mouth of Quartz Hill Gulch (006)
USGS Wise River (left) and Dewy (right) (7.5') quadrangles.

Mouth of Jerry Creek (007)
Spring Gulch (009)
Wise River (010)
USGS Twin Adams Mountain (7.5') Quadrangle.

Lime Gulch (012)
Shelly, 1988). This report details the possible influence of soil crust on this species.

I.6.C.1. Vegetation, physiognomy and community structure: Sites in the Pioneer Mountain drainages are often under a very sparse overstory of Juniperus scopulorum (Rocky Mountain juniper), Pseudotsuga menziesii (Douglas fir) and Pinus ponderosa (ponderosa pine). The dominant shrubs are Cercocarpus ledifolius (curly-leaf mountain mahogany) or Artemisia tridentata (big sagebrush). The associated species at the new site in the foothills of the Sapphire Range, Birch Creek Bluffs (004), are similar to those previously reported from that area.

I.6.C.6. Dependence on dynamic aspects of biotic associations and ecosystem features: Arabis fecunda may be influenced by the presence and abundance of Centaurea maculosa (spotted knapweed) at the sites along the eastern edge of the Sapphire Mountains. A report on detailed studies of these effects is included in Appendix B, p. 36 (Lesica and Shelly, 1988).

I.7.A. GENERAL SUMMARY: Additional subpopulations and/or numbers of plants were recorded for the three sites in the original report. Charleys Gulch (001) now includes thirteen subpopulations and contains approximately 8,000-10,000 plants. Spring Gulch (002) now includes four subpopulations containing approximately 1,000-1,500 plants. Rock Quarry Gulch (003) still consists of only one population, but additional plants were recorded for this site, bringing the total number to approximately 800-1,000. The new Birch Creek Bluffs (004) population has six subpopulations, with approximately 10,000+ plants, within a radius of 3/4 mile.

Populations and subpopulations in the Pioneer Mountain drainages consist of from 75-10,000 plants. These populations are within a radius of ca. 16 miles of one another. The largest distance separating all known populations is ca. 95 miles (between the Lime Gulch (012) site in the Pioneer Mountains, and the Sapphire Mountain populations).
I.7.B.1. **KNOWN POPULATIONS:** Nine new populations of *Arabis fecunda* have been discovered since 1985; the total number is now twelve. Eight of these populations occur along the north and east flanks of the Pioneer Mountains and one additional population was found in the foothills of the Sapphire Range. The Element Occurrence records for each of these populations is found in Appendix A, p. 23.

I.7.B.2. a. **Charleys Gulch**
1. Area: Thirteen subpopulations covering a total area of ca. 700 acres.
2. Number and size of plants: ca. 8,000-10,000+ plants.
3. Density: Plant density is often high in localized areas within the site.
5. Evidence of reproduction: Presence of flowering and fruiting plants.
6. Evidence of expansion/contraction: None.

b. **Spring Gulch**
1. Area: Four subpopulations covering a total area of ca. 160 acres.
2. Number and size of plants: ca. 1,000-1,500 individual plants.
3. Density: Plants sparsely distributed within the site.
5. Evidence of reproduction: Presence of flowering and fruiting plants.
6. Evidence of expansion/contraction: None.

c. **Rock Quarry Gulch**
1. Area: One population covering a total area of ca. 5 acres.
2. Number and size of plants: ca. 800-1,000+ individual plants.
3. Density: Plant density intermediate within the site.
5. Evidence of reproduction: Presence of flowering and fruiting plants.
6. Evidence of expansion/contraction: None.

d. **Birch Creek Bluffs**
1. Area: Six subpopulations covering a total area of ca. 200 acres.
2. **Number and size of plants:** ca. 10,000+ individual plants, ca. 60% in flower and 20% in fruit in 1986.

3. **Density:** *Arabis fecunda* frequent in some areas within the site.

4. **Presence of dispersed seed:** Unknown.

5. **Evidence of reproduction:** Presence of flowering and fruiting plants.

6. **Evidence of expansion/contraction:** None.

e. **Quartz Hill**

1. **Area:** One population with scattered individuals. Total area occupied by *Arabis fecunda* is ca. 5 acres.

2. **Number and size of plants:** No estimate of population size available.

3. **Density:** Scattered individual plants.

4. **Presence of dispersed seed:** Unknown.

5. **Evidence of reproduction:** Presence of plants with mature fruits.

6. **Evidence of expansion/contraction:** None.

f. **Mouth of Quartz Hill Gulch**

1. **Area:** Eight subpopulations, over ca. 100 acres.

2. **Number and size of plants:** ca. 7,300 plants, ca. 25% in flower and 15% in fruit in 1988.

3. **Density:** Density of *Arabis fecunda* high in some areas within the largest subpopulations; otherwise, individual plants were scattered.

4. **Presence of dispersed seed:** Unknown.

5. **Evidence of reproduction:** Presence of mature fruits.

6. **Evidence of expansion/contraction:** None.

g. **Jerry Creek**

1. **Area:** Two subpopulations over ca. 40 acres.

2. **Number and size of plants:** ca. 5,000 plants, ca. 50% with mature fruit in 1988.

3. **Density:** Plant density fairly high in the largest subpopulation, with ca. 20% total cover of *Arabis fecunda* in some areas; remaining plants scattered.

4. **Presence of dispersed seed:** Unknown.
6. Evidence of expansion/contraction: None.

h. Upper Quartz Hill Gulch
1. Area: One population on ca. 40 acres.
2. Number and size of plants: ca. 75-100 plants, ca. 15% in fruit and 25% in flower in 1988.
6. Evidence of expansion/contraction: None.

i. Spring Gulch II
1. Area: One population scattered over ca. 2 acres.
2. Number and size of plants: ca. 100-200 plants, most in fruit in 1988.
6. Evidence of expansion/contraction: None.

j. Big Hole River
1. Area: One population scattered over 1 acre.
2. Number and size of plants: ca. 100 plants, 90% in fruit in 1988.
6. Evidence of expansion/contraction: None.

k. Vipond Park
1. Area: Two subpopulations, covering 100 acres.
2. Number and size of plants: ca. 10,000 plants, ca. 15% in flower and 60% in fruit in 1988.
3. Density: Very dense cover of Arabis fecunda occurs in portions of the site.
5. **Evidence of reproduction:** Presence of mature fruit.
6. **Evidence of expansion/contraction:** None.

1. **Lime Gulch**
   1. **Area:** One large population covering 80 acres.
   2. **Number and size of plants:** ca. 10,000 plants, ca. 90% in fruit in 1988.
   3. **Density:** Greater than 20% cover of *Arabis fecunda* within parts of the site.
   4. **Presence of dispersed seed:** Unknown.
   5. **Evidence of reproduction:** Presence of mature fruit.
   6. **Evidence of expansion/contraction:** None.

**I.7.C.**

1. **Patterns:** The Pioneer Mountain sites were first visited in early July of 1988. At that time, five of the eight populations were still partially in flower. These high elevation sites extend the flowering dates for the known populations into early July, and fruiting is likely to occur through mid- or late July.

**I.7.D.4.**

Seed biology

a. **Amount and variation of seed production:** There appears to be some variation with respect to yearly seed production by *Arabis fecunda* at some sites. See Appendix B, p. 36 (Lesica and Shelly, 1988) for detailed information.

**I.7.D.6.**

**Survival and mortality:** Mortality and recruitment appear to be nearly equal in some populations of *Arabis fecunda*; however, disturbance by livestock may have an influence on these processes at some sites. See Appendix B, p. 36 (Lesica and Shelly, 1988) for detailed information.

**I.8.C.2.**

b. **Interspecific:** The exotic weed *Centaurea maculosa* (spotted knapweed) may have an influence on populations of *Arabis fecunda*. A report from an ongoing study of the interactions between these two species, from sites
near the Sapphire Range, is contained in Appendix B, p. 36.


I.9.B. Specific landowners:

1. USDA Forest Service
   Beaverhead National Forest
   610 N. Montana Street
   Dillon, MT  59725

2. USDI Bureau of Land Management
   Headwaters Resource Area
   P.O. Box 3388
   Butte, MT  59702

3. Montana Department of State Lands
   1625 11th Avenue
   Helena, MT  59620

4. Several sites are partially or wholly privately owned. These include:
   - Charleys Gulch (001)
   - Spring Gulch (002)
   - Rock Quarry Gulch (003)
   - Birch Creek Bluffs (004)
   - Wise River (010)

I.9.C. Management responsibility: Same as ownership.

I.9.D. Easements, conservation restrictions, etc.:
A portion of the Charleys Gulch Site is registered with The Nature Conservancy by the owner (George Frost). Although such registry is not legally binding, the owner agrees to preserve the populations present, and to inform The Nature Conservancy of any proposed land management changes.

I.11.A.1. Present or threatened destruction, modification, or curtailment of habitat or range: The Birch Creek Bluffs population (004) may be threatened by weed invasion by Centaurea maculosa (spotted knapweed). The Mouth of Quartz Hill Gulch subpopulation (006) closest to the road is threatened by gravel removal from the base of the hill.
The Jerry Creek population (007) is threatened by grazing and trampling by cattle. The lower portion of the hill where this population occurs was heavily trailed and disturbed.

II.12. General assessment of vigor, trends and status: Arabis fecunda is now known from twelve populations, within a radius of ca. 47 miles. Centaurea maculosa (spotted knapweed) is currently not a threat to populations along the flanks of the Pioneer Range, but may pose a threat to the Birch Creek Bluffs site in the foothills of the Sapphire Range. Reproductive output and vigor of Arabis fecunda appears to be normal at the newly discovered sites.

II.13.A. Recommendation to U.S. Fish and Wildlife Service: Peter Lesica submitted a petition to list Arabis fecunda just prior to the discovery of the new populations along the flanks of the Pioneer Mountains. Subsequent to these discoveries the petition was retracted. It is recommended that Arabis fecunda be retained in Category 2 until further distribution and ecological studies can be conducted.

II.13.B. U.S. Forest Service: Arabis fecunda is now known to occur on lands administered by the U.S. Forest Service. Thus, it should be placed on the list of sensitive species in Region 1 for Montana.

II.15.A. 1. Recommendations regarding present or anticipated activities: The effects of mining or increased grazing in areas supporting populations of Arabis fecunda should be assessed before any of these activities are implemented.

2. Areas recommended for protection: The Vipond Park site (011) is a large, representative population of Arabis fecunda on Forest Service lands, and should be proposed for special designation. The Quartz Hill site (005), although not yet thoroughly surveyed, is recommended for protection because of its close proximity to two other rare plant populations (Penstemon lemhiensis (Lemhi penstemon) and Claytonia lanceolata var. flava (yellow springbeauty)). Both of these
are USFWS Category 2 taxa and USFS Region 1 sensitive species.

II.16  **Interested parties:**

Lisa Ann Schassberger  
Montana Natural Heritage Program  
State Library Building  
1515 E. 6th Ave  
Helena, MT  59620

III.17.C.  1. **Surveys:**

Steve Shelly, Montana Natural Heritage Program  
8 May 1986 (001; Charleys Gulch)  
19-20 May 1987  
19-20 May 1988  
1-3 June 1988

Peter Lesica, The Nature Conservancy  
8 May 1986 (001; Charleys Gulch)  
27-30 May 1986  
19-20 May 1987  
19-20 May 1988

Lisa A. Schassberger, Montana Natural Heritage Program  
1-3 June 1988  
6-7 June 1988  
13-15 June 1988

III.17.D.  **Knowledgeable individuals:**

Lisa Schassberger  
Montana Natural Heritage Program  
State Library Building  
1515 E. 6th Ave.  
Helena, MT  59620

III.18.  **Summary of materials on file:** All detailed field forms, maps and color slides are on file at the office of the Montana Natural Heritage Program. Herbarium vouchers for Montana populations will be deposited at the University of Montana Herbarium (MONTU).


APPENDIX A
ELEMENT OCCURRENCE RECORD

EICODE: PDBRA06290.001
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGNUM: 1 TEMEN: 10,10 IDENT: Y EORANK: B
SURVEYSITE: CHARLEYS GULCH
EORANKCOMM: LARGE POPULATION, BUT AREA IMPACTED BY WEEDS AND GRAZING.
SRANK: 82 STATE: MT COUNTYNAME: MTRA
QUADCDE: 4611431 4611338
QUADNAME: CORVALLIS, WILLOW MOUNTAIN
TOWNRANGE: 006N019W SECTION: 20 MERIDIAN: PR TRSCOMM: W2,W2NE4,1195
2:129NW4+
PHYSPROV: NR WATERSHED: 17010205 RIVERREACH:
DIRECTIONS: ALSO 30 N2. CHARLEYS GULCH, WEST SLOPE OF SAPPHIRE RANGE,
ALONG CHARLEYS GULCH ROAD CA. 1.1-2.1 MILES FROM JUNCTION
WITH PAVED COUNTY ROAD; ALSO NORTH AND SOUTH OF GULCH.

GENDESC: ON STEEP, W- AND SW-FACING SLOPES, ON LIGHT-COLORED LIMESTONE OUTCROPS,
IN SAGEBRUSH GRASSLAND WITH CHRYSOPSIS VILLOSA, GILIA SPICATA, PHYSARIA GEYERI, AYLOSSUM ALYSSOIDES.

ELEV: 5000 SIZE: 700
EODATA: CA. 8000-10000+ PLANTS, IN 13 SUBPOPULATIONS; EVIDENCE OF
DISTURBANCE BY CATTLE; WEED INVASION BY SPOTTED KNAPEWEE
(CENTAUREA MACULOSA) A SERIOUS THREAT.

COMMENTS: CENTRUM IS THE TYPE LOCALITY; MONITORING TRANSCECTS ESTAB-
LISHED BY LESICA AND SHELLY, 87-05-19.
MACODE1: PRIVATEOWNMTUS CONTAINED1: N MACODE2: SSL6GXXXX1MTUS CONTAINED2:
N
MACODE3: MOREMGMT: Z SITECODE:
CONTAINED3: ADLMAS: MORELAN: MOREPROT:
SITENAME:
OWNER: SEE UBSLES01MTUS,ELEMENT FILE.
OWNERCMM:
PROTCOMM:
MGMTCOMM: BITTERROOT N.F. PARCEL HAS BEEN TRADED.

MONITOR: MONITORNUM: -
BESTSOURCE: SHELLY, J.S. 1988. FIELD SURVEYS IN RAVALLI COUNTY OF 19-20
MAY, 1-3 JUNE.
SOURCECODE: F88SHE02MTUS PNSHSHE01MTUS A84ROL01MTUS PNSCH02MTUS UBSLES01MTUS
S76CORU0M7MTUS SBSLES02M7MTUS UBSLES02MTUS PNSLES01MTUS
DATEGNS: N BOUNDARIES: PHOTOS: N OWNERINFO:
TRANSCRIBER: B6-01-21 JSS CDREV: Y MAPPER: B6-01-21 JSS QC:
UPDATE: 88-09-02 JSS
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA06290.002
NAME: ARABIS FUCUNDA
COMNAME: SAPPHIRE ROCKCRESS

MARGINUM: 1
TENTEN: 9,1
IDENT: Y
EORANK: BC

SURVEYSITE: SPRING GULCH
EORANKCOMM: MODERATE-SIZED POPULATION, SOME IMPACTS FROM GRAZING.
SURVEYDATE: 1988-06-01
LASTOBS: 1988-06-01
FIRSTOBS: 1985
GRANK: G2
SRANK: S2
STATE: MT
COUNTYNAME: MTRAVA

QUADCODE: 4611421
QUADNAME: MOUNTAIN HOUSE

LAT: 461452
LONG: 1140109
S: 461421
N: 461454
E: 1140044
W: 1140126
TOWNRANGE: 006N019W
SECTION: 30
MERIDIAN: PR
TRSCOMM: 52,31NE4NW4

PHYSPROV: NR
WATERSHED: 17010205
RIVERREACH:
DIRECTIONS: SPRING GULCH, WEST SLOPE OF SAPPHIRE RANGE; AT JCT. OF HWYS. 269 & 380, 2.5 MI. E. TO WHERE 300 TURNS N.; E. 1.5 MI. TO CHARLEYS GULCH RD., 2 MI. TO CATTLEGUARD; SITES 1 MI. SW.

GENDESC: ON LIGHT-COLORED GRANITIC AND CALCAREOUS ROCK OUTCROPS, ON STEEP, S-FACING SLOPES; SAGEBRUSH GRASSLAND WITH PINUS PONDEROSA, HAPLOPAPPUS ARMERIOIDES, GILIA SPICATA, CRYPTANTHIA.

ELEV: 4740
SIZE: 160
EODATA: CA. 1000-1500 PLANTS, 4 SUBPOPULATIONS; EVIDENCE OF DISTURBANCE BY CATTLE; SITES THREATENED BY WEEDY SPECIES (ESP. CENATUEARA MACULOSA); REMOTE AREA.

COMMENTS: VOUCHER-LESICA, P. (3339), 1985, MONTU.

MACODE1: PRIVATEOWNMTUS
MACODE3:
MOREMGMT: Z
SITECODE:
CONTAINED3: ADLMA:
MORELAN:
MOREPROT:

OWNER: BITTERROOT STOCK FARM, INC.
OWNERCOMM: C. BRESEE, P.O. BOX 271, HAMILTON, MT 59840

BESTSOURCE: SHELLY, J.S. 1986. FIELD SURVEYS IN RAVALLI COUNTY OF 19-20 MAY, 1-3 JUNE.

SOURCECODE: F00SHE02MTUS S05LESUMMTUS A04ROL01MTUS U05LES01MTUS PNDCOR01MTUS U05LES02MTUS PNDLES01MTUS PNDTAY01MTUS

DATASENS: N
BOUNDARIES: Y
PHOTOS: Y
OWNERINF:
TRANSCRIBER: 86-01-21 JSS
CDREV: Y
MAPPER: 86-01-21 JSS
QC: Y
UPDATE: 88-10-13 JSS
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA0392.003
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGINUM: 2 TENTEN: 8,2 IDENT: Y EORDRANK: B
SURVEYSITE: ROCK QUARRY GULCH
EORDRANKCOMM: FAIRLY LARGE POPULATION, HABITAT NOT HEAVILY DISTURBED.
SRANK: 52 STATE: MT COUNTYNAME: MTRAVA
QUADCODE: 4611421 QUADNAME: MOUNTAIN HOUSE PRECISION: SC
TOWNRANGE: 006N019W SECTION: 31 MERIDIAN: PR TRSCOMM: NW4SW4
PHYSPROV: NR WATERSHED: 17010205 RIVERREACH:
DIRECTIONS: ROCK QUARRY GULCH: FROM JCT. OF HWYS. 269 & 380, GO 2.5 MI.
E. TO CORNER WHERE 380 TURNS N.; GO E. 1.5 MI. TO CHARLEYS
GULCH RD., & 2 MI. TO CATTLE GUARD; SITE IS 2 MILES SW.
GENDESC: ON LIGHT-COLORED ROCK OUTCROPS ON OPEN, S-FACING SLOPES; IN
SAGEBRUSH GRASSLAND NEAR LOWER TREELINE, W/ SCATTERED PINUS
PONDEROSA, AGROPYRON SPICATUM, HAPLOPAPPUS AMERI OIDES.
ELEV: 4850 SIZE: 5
EODATA: CA. 800-1000+ PLANTS, ONE POPULATION; EVIDENCE OF LIGHT
DISTURBANCE BY CATTLE; POPULATION THREATENED BY KNAPEWED
(CENTAUREA SP.) INVASION, BUT SITE NOT AS WEEDY AS OTHERS IN
AREA.
COMMENTS: VOUCHER-LESICA, P. (3340), 1985, MONTU; RECENTLY DESCRIBED
MACODE1: PRIVATEOWNMTUS CONTAINED1: Y MACODE2:
MACODE3: PRIVATEOWNMTUS CONTAINED2: CONTAINED3:
MOREMGMT: Z SITECODE:
SITENAME:
OWNER: BITTERROOT STOCK FARM, INC.
OWNERCOMM: C. BRESEE, P.O. BOX 271, HAMILTON, MT 59840.
PROTCOMM:
MGMTCOMM:
MONITOR:
BESTSOURCE: SHELLY, J.S. 1988. FIELD SURVEYS IN RAVALLI COUNTY OF 19-20
MAY, 1-3 JUNE.
SOURCECODE: FBBSHE02MTUS PDNSHE01MTUS A84ROL01MTUS U85LES01MTUS PNDCOR01MTUS
U85LES02MTUS PNDLES01MTUS S85LESUMMTUS
DATASENS: N BOUNDARIES: Y PHOTOS: N OWNERINF:
UPDATE: 88-09-12 JSS
ELEMENT OCCURRENCE RECORD

ECODE: PDBRA0290.004
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGINUM: 2 TENTEN: 1,1 IDENT: Y EORANK: AB
SURVEYSITE: BIRCH CREEK BLUFFS
EORANKCOMM: VERY LARGE POPULATION, SOME AREAS IN GOOD CONDITION.
SRANK: S2 STATE: MT COUNTYNAME: MTAVA
QUADCODE: 461133E 4611431
QUADNAME: WILLOW MOUNTAIN, CORVALLIS
TOWNRANGE: 007N019W SECTION: 16 MERIDIAN: PR TRSCOMM: NW4,17,18NE4
PHYSPROV: NR WATERSHED: 17010205 RIVERREACH:
DIRECTIONS: WESTERN LOWER SLOPES OF SAPPHIRE MOUNTAINS, ALONG BIRCH CREEK AND TRIBUTARY NW. OF SCHOOLHOUSE BUTTE, CA. 7 AIR MILES ENE. OF CORVALLIS.
GENDESC: WHITE, HIGHLY CALCAROUS, ERODING SLOPES OF METAMORPHOSED CALC-SILICATES, WITH PINUS PONDEROSA, JUNIPERUS SCOPULORUM, HAPLOPAPPUS ARMERIOIDES, LESQUERELLA ALPINA, POA SECUNDA.
ELEV: 4700 SIZE: 200
EODATA: 10,000+ INDIVIDUALS, CA. SIX SUBPOPULATIONS; SLOPES ARE TERRACED FROM LIVESTOCK GRAZING, AND WEEDS (CENTAUREA MACULOSA, Bromus tectorum, Alyssum) ARE ABUNDANT; ALSO WITH AGROPYRON SPICATUM, OXYTROPIS BESSEYI, SENECIO CANUS.
MACODE1: SSLGNXXX01MTUS CONTAINED1: N MACODE2: PRIVATEOWNMTUS CONTAINED2: N
MACODE3: CONTAINED3: ADLMAS: MORELAN: MOREPROT:
MOREMGMT: Z SITECODE:
SITENAME: BIRCH CREEK BLUFFS
OWNER: DOUBLE FORK LAND CO.
OWNERCOMM: 1953 EASTSIDE HWY, CORVALLIS, MT 59828.
PROTCOMM:
MGMTCOMM:
MONITOR:
MONITORNUM:
BESTSOURCE: SHELBY, J.S. 1988. FIELD SURVEYS IN RAVALLI COUNTY OF 19-20 MAY, 1-3 JUNE.
SOURCECODE: FBSHE02MTUS S6LESUMMTUS A04ROL01MTUS PND01MTUS PNDESE01MTUS SBSHEUMMTUS
DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANSBIBR: 86-06-06 JSS CDREV: Y MAPPER: 86-06-06 JSS QC: Y
UPDATE: 86-10-13 JSS
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA06290.005
NAME: ARABIS FECUNDA
COMMONAME: SAPPHIRE ROCKCRESS
MARGINUM: 15 TENTEN: 4,2 IDENT: Y EORANK: BC
SURVEYSITE: QUARTZ HILL
EORANK.COMM: SMALL POPULATION, BUT AREA NOT THOROUGHLY SURVEYED.
SRANK: S2 STATE: MT COUNTYNAME: MTBEAV
QUADCODE: 4511260
QUADNAME: VIPOND PARK (15) PRECISION: SC
LAT: 454224 LONG: 1125421 S: 0 N: 0 E: 0 W: 0
TOWNRANGE: 0015001W SECTION: 36 MERIDIAN: PR TRSCOMM: CENTER

PHYSPROV: NR WATERSHED: 10020004 RIVERREACH: 1002000415700.00
DIRECTIONS: PIONEER MOUNTAINS, ECHO GULCH, SOUTHWEST BASE OF QUARTZ HILL

GENDESC: ON OPEN GRAVELLY LIMESTONE SLOPE, IN PINUS CONTORTA ZONE.

ELEV: 8000 SIZE: 5 EODATA: SCATTERED.

COMMENTS:

MACODE1: FFSNBEBAV2MTUS CONTAINED1: Y MACODE2: CONTAINED2:
MACODE3: CONTAINED3: ADLMAS MORELAN MOREPROT:
MOREMGMT: Z SITECODE:
SITENAME:
OWNER: BEAVERHEAD NATIONAL FOREST
OwNCOMM:
PROTCOMM:
MGTCOMM:
MONITOR:

SOURCECODE: PNDSE01MTUS 899SHEUMMTUS

DATASENS: N BOUNDARIES: N PHOTOS: N OWNERINFO:
UPDATE: 88-09-02 MEZ
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA06290.006
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGNUM: 2 TENTEN: 2.9 IDENT: Y EORANK: AB
SURVEYSITE: MOUTH OF QUARTZ HILL GULCH
EDRANKCOMM: EXCELLENT SITE, BUT CLOSE TO ROAD.
SRANK: S2 STATE: MT COUNTNAME: MTBEAV
QUADCODE: 4511277 QUADNAME: DEWEY PRECISION: SC
TOWNRANGE: 001S010W SECTION: 08 MERIDIAN: PR TRSCOMM: E2; S5; S2; S1
7; NE4
PHYSPROV: NR WATERSHED: 10020004 RIVERREACH:
DIRECTIONS: BEAVERHEAD NATIONAL FOREST. TRAVEL 0.25 MILE WEST OF DEWEY
ON HIGHWAY 43, THEN SOUTH ON QUARTZ HILL GULCH, EAST AND
WEST OF THE ROAD FOR 1.5 MILES.
GENDESC: CALC-SILICATE ROCKY OUTCROPS AND HILLSIDES; BENEATH JUNIP-
ERUS SCOPULORUM AND PSEUDOTSUGA MENZIESII, WITH CERCOCARPUS
LEDFOLIUS AND DRABA NIVALIS.
ELEV: 5780 SIZE: 100
EODATA: CA. 7,300 PLANTS IN 8 SUBPOPULATIONS; FRUITING.

COMMENTS: VOUCHER, SCHASSBERGER (205). 1988. MONTU. SEE GMF FOR BASE
MAP SHOWING SUBPOPULATIONS.
MACODE1: FFSNFBEAV2MTUS CONTAINED1: Y MACODE2: CONTAINED2:
MACODE3: CONTAINED3: ADLMAS: MORELAN: MOREPROT:
MOREMGMT: Z SITECODE:
SITENAME:
OWNER: BEAVERHEAD NATIONAL FOREST
OWNERCMP:
PROTCMM:
MGMTCOMM:
MONITOR:
BESTSOURCE: SCHASSBERGER, L.A. 1988. FIELD SURVEY, SOUTHWEST MONTANA,
SOURCECODE: F80SCH02MTUS PNSCH02MTUS S00SCHUMTMUS
DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANSRBR: 88-08-03 LAS CDREV: Y MAPPER: 88-10-05 LAS QC: Y
UPDATE: 88-12-20 LAS
ELEMENT OCCURRENCE RECORD

ECODE:  PDBRA06290.007
NAME:  ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGINUM:  4  TENTEN:  8,7  IDENT:  Y  EORANK:  B
SURVEYSITE: JERRY CREEK
EORANKCOMM: LARGE POPULATION BUT HEAVY GRAZING NEARBY.
SRANK:  S2  STATE:  MT  COUNTRYNAME:  MT5ILY
QUADCODE:  4511278
QUADNAME: WISE RIVER
LAT:  45°47'18"  LONG:  112°54'02"  S:  45°47'15"  N:  45°47'31"
TOWNRANGE:  001N010W  SECTION:  31  MERIDIAN:  PR  TRSCOMM:  SW4,R11W:S36,
PRECISION:  SE4
PHYSPROV:  MB  WATERSHED:  10020004  RIVERREACH:  
DIRECTIONS: CA. 1.5 MILES EAST OF WISE RIVER ON HIGHWAY 43, NE ON JERRY
CREEK ROAD 0.3 MILE; HILLSIDES AND OUTCROPS EAST OF ROAD.

GENDESC:  CALC-SILICATE OUTCROPS & HILLSIDES IN OPEN SOILS, BENEATH
JUNIPERUS SCOPULORUM AND PSEUDOTSUGA MENZIESII, WITH CER- C
OCARUS LEDIFOLIUS AND ERIGERON COMPOSITUS.
ELEV:  5700  SIZE:  30
EDDATA: CA. 5,050 PLANTS IN 2 SUBPOPULATIONS, FLOWERING AND FRUIT-
ING; THREATENED BY OVER-GRAZING.

COMMENTS:  VOUCHER - SCHASSBERGER (207). 1988. MONTU.  SEE GMF FOR BASE
MAP SHOWING SUBPOPULATIONS.
MACODE1:  FBDLOBUTF1MTUS  CONTAINED1:  N  MACODE2:  SSLGNXXX1MTUS  CONTAINED2:
MACODE3:  CONTAINED3:  ADLMAS:  MORELAN:  MOREPROT:
MOREMGT:  Z  SITECODE:
SITENAME:  
OWNER:  BLM/STATE OF MONTANA
OWNERCOMM:  
PROTCOMM:  
MGMTCOMM:  
MONITOR:  
BESTSOURCE: SCHASSBERGER, L.A. 1988. FIELD SURVEY IN SOUTHWEST MONTANA,
SOURCECODE:  F88SCH02MTUS PNDSC02MTUS 888SCHUMMTUS

DATASENS:  N  BOUNDARIES:  Y  PHOTOS:  Y  OWNERINFO:  
UPDATE:  88-12-20 LAS
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA06290.008
NAME: ARABIS FECUNDA
COMMONAME: SAPPHIRE ROCKCRESS
MARGINUM: 16 TENTEN: 5.1 IDENT: Y EORANK: AB
SURVEYSITE: UPPER QUARTZ HILL GULCH
EORANKCOMM: PAST MINING DISTURBANCES; SMALL POPULATION.
SRANK: S2 STATE: MT COUNTYNAME: MTBEAV
QUADCIDE: 4511257
QUADNAME: VIPOND PARK
SW41+
PHYSPROV: MB WATERSHED: 1002404 RIVERREACH:
DIRECTIONS: 30SE4. CA. 3.75 MILES SOUTH OF DEWEY ON QUARTZ HILL GULCH R
ROAD, CA. 0.2 MILE SW OF ROAD ON ROCKY OUTCROPS AND SOILS.

GENDESC: CALC-SILICATE ROCKY OUTCROPS AND HILLSIDES; BENEATH PSEUDO-
TSUGA MENZIESII, WITH CERCOCARPUS LEDIFOLIUS AND DRABA NIV-
ALIS.

ELEV: 7500 SIZE: 40
EODATA: CA. 75-100 PLANTS, FLOWERING AND FRUITING. SCATTERED
PLANTS, USUALLY ON EXPOSED OUTCROPS.

COMMENTS: VOUCHER - SCHASSBERGER (205) 1988. MONTU. SEE GMF FOR BASE
MAP SHOWING POPULATION.
MACODE1: FFSNFBEAV2MTUS CONTAINED1: Y MACODE2: CONTAINED2:

MACODE3: CONTAINED3: ADLMAS: MORELAN: MOREPROT:
SITENAME:
OWNER: BEAVERHEAD NATIONAL FOREST
OWNERCORE: PROTCORE:
MGMTCORE: MONITOR:
BESTSOURCE: SCHASSBERGER, L.A. 1988. FIELD SURVEY OF SOUTHWESTERN MON-
SOURCECODE: F88SCH02MTUS PNDSC02MTUS S88SCHUMTUS

DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANScriber: 88-08-03 LAS CDREV: Y MAPPER: 88-10-05 LAS QC: Y
UPDATE: 88-11-03 MEZ
ELEMENT OCCURRENCE RECORD

EICODE: PBRA06290.009
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MAGNUM: 5 TENTEN: 8,8 IDENT: Y EORANK: AB
SURVEYSITE: SPRING GULCH
EORANKCOMM: SMALLER POPULATION, NATURALLY PROTECTED.
SRANK: S2 STATE: MT COUNTYNAME: MTBEAV
QUACODE: 4511278
QUADNAME: WISE RIVER PRECISION: SC
TOWNRANGE: 00150011W SECTION: 01 MERIDIAN: PR TRSCOMM: SE4

PHYSPROV: NR WATERSHED: 10020004 RIVERREACH:
DIRECTIONS: CA. 2.2 MILES EAST OF WISE RIVER ON HIGHWAY 43. AT BEND,
0.20 MILE SOUTH OF ROAD ATOP STEEP CLIFFS.

GENDESC: ON CALC-SILICATE ROCKY OUTCROPS BENEATH JUNIPERUS SCOPULOR-
UM AND PSEUDOTSUGA MENZIESII, WITH CERCOCARPUS LEDIFOLIUS.

ELEV: 5600 SIZE: 10 EODATA: CA. 100-200 PLANTS, FRUITING; SPARSELY DISTRIBUTED.

COMMENTS: VOUCHER - SCHASSBERGER (207). 1988. MONTU. SEE GMF FOR BASE
MAP SHOWING POPULATION.
MACODE1: FBLDOBUTT2MTUS CONTAINED1: Y MACODE2: CONTAINED2:
MACODE3: MOREMGMT: Z SITECODE:
SITENAME: OWNER: BLM
OWNERCOMM: PROTCOMM: MGMTCOMM:
MONITOR:
BESTSOURCE: SCHASSBERGER, L.A. 1988. FIELD SURVEY, SOUTHWEST MONTANA,
SOURCEDATE: F88SCH02MTUS PNSCH02MTUS S88SCHUMMTUS

DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANSCRIBR: 88-09-03 LAS CDREV: Y MAPPER: 88-10-05 LAS QC: Y
UPDATE: 88-12-20 LAS
ELEMENT OCCURRENCE RECORD

ECODE: PDBR96298.010
NAME: ARABIS FECUNDICA
COMNAME: SAPPHIRE ROCKCRESS
MARGINUM: 6 TENTEN: 10,7 IDENT: Y EDRANK: AB
SURVEYSITE: WISE RIVER EDRANKCOMM: AREA IS GRAZED.
SRANK: S2 STATE: MT COUNTYNAME: MT SILV
QUADCODE: 4511278 4511277 PRECISION: SC
QUADNAME: WISE RIVER, DEWEY
TOWN RANGE: 001S010W SECTION: 06 MERIDIAN: PR TRS COMM: NE4NE4,5NW4N
W4 PHYSPROV: NR WATERSHED: 10020004 RIVERRREACH:
DIRECTIONS: 1.0 MILE WEST OF DEWEY ON HIGHWAY 43, 0.33 MILE NORTH OF ROAD ON THE NORTH SIDE OF WISE RIVER.
GENDESC: ON CALC-SILICATE ROCKY OUTCROPS AND SOILS, BENEATH JUNIPERUS SCOPULORUM AND PSEUDOTSUGA MENZIESII, WITH CERCOCARPUS LEDIFOLIUS.
ELEV: 5600 SIZE: 1
EODATA: CA. 100+ PLANTS, FRUITING.

COMMENTS: VOUCHER - SCHASSBERGER (207). 1988. MONTU. SEE GMF FOR BASE MAP SHOWING POPULATION.
MACODE1: FBDLOBUT4MTUS CONTAINED1: N MACODE2: PRIVATEWMTUS CONTAINED2:
MACODE3: MOREMGMT: Z SITECODE: CONTAINED3: ADLMAS: MORELAN: MOREPROT:
SITENAME: OWNER: BLM / PRIVATE
OWNERCOMM: PROTCOMM: MGMTCOMM: MONITOR: MONITORNUM:
SOURCECODE: FBBCH02MTUS PNSCH02MTUS 5858CHUMMTUS
DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANSCIBER: 88-08-03 LAS CDREV: Y MAPPER: 88-10-05 LAS QC: Y
UPDATE: 88-12-20 LAS
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA06290.011
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGINUM: 17 TENTEN: 5 3 IDENT: Y EDRANK: AA
SURVEYSITE: VIPOND PARK
EDRANKCOMM: EXCELLENT SITE, LARGE POPULATION.
QUADCODE: 4511257

PHYSPROV: NR WATERSHED: 10020004 RIVERREACH:
DIRECTIONS: FROM MELROSE, CA. 12.5 MILES WEST, UP CANYON CREEK ROAD, AT CORNER LOOKING OVER KILNS.

GENDESC: ON CALC-SILICATE ROCKY SOILS AND HILLSIDES, BENEATH PINUS FLEXILIS/PSEUDOTSUGA MENZIESII, WITH ARTEMISIA TRIDENTATA, A. FRIGIDA AND ERIGERON COMPOSITUS.
ELEV: 7200 SIZE: 100 EDDATA: CA. 10,000 FLOWERING PLANTS IN 2 SUBPOPULATIONS; FLOWERING AND FRUITING OVER A LARGE AREA.

COMMENTS: VOUCHER - SCHASSBERGER (211). 1988. MONTU. SEE GMF FOR BASE MAP SHOWING SUBPOPULATIONS.
MACODE1: FFSNFB4EAV2MTUS CONTAINED1: Y MACODE2: CONTAINED2:
MACODE3: FFSNFB4EAV2MTUS CONTAINED3: ADLMAS: MCRELAN: MOREPRT:
MOREMGMT: Z SITECODE:
SITENAME:
OWNER: BEAVERHEAD NATIONAL FOREST
OWNERCOMM:
PROTCOMM:
MGMTCOM:
MONITOR:
SOURCECODE: F88SCH02MTUS PNSCH02MTUS S88SCH0MTUS

DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANSCHR: 88-08-03 LAS COREV: Y MAPPER: 88-10-05 LAS QC: Y UPDATE: 88-12-20 LAS
ELEMENT OCCURRENCE RECORD

EOCODE: PDBRA06290.012
NAME: ARABIS FECUNDA
COMNAME: SAPPHIRE ROCKCRESS
MARGINUM: 2 TENTEN: 5,9 IDENT: Y ECRANK: AB
SURVEYSITE: LIME GULCH
EDRANKCOMM: GOOD SITE BUT CLOSE TO ROAD.
SRANK: G2 STATE: MT COUNTYNAME: MTBEAV
QUADCODE: 4511247
QUADNAME: TWIN ADAMS MOUNTAIN PRECISION: SC
TOWNRANGE: 005S010W SECTION: 14 MERIDIAN: PR TRSCOMM: W2,155E4
PHYSPROV: NR WATERSHED: 10020004 RIVERREACH:
DIRECTIONS: 5 MILES WEST OF INTERSTATE-15, UP BIRCH CREEK ROAD. NORTH
OF ROAD ON EAST AND WEST FACES OF LIME GULCH.
GENDESC: CALC-SILICATE ROCK OUTCROPS AND HILLSIDES, BENEATH JUNIPERUS
SCOPULORUM, WITH CERCOCARPUS LEDIFOLIUS, SENECIO CANUS AND
ERIGERON COMPOSITUS.
ELEV: 6200 SIZE: 80
EODATA: CA. 10,000+ PLANTS, FRUITING. OLD MINING ACTIVITY IN AREA.

MAP SHOWING POPULATION.
MACODE1: FFSNFBEAV2MTUS CONTAINED1: Y MACODE2:
CONTAINED2:
MACODE3: CONTAINED3: ADLMAS: MORELAN: MOREPROT:
MOREMGMT: Z SITECODE:
SITENAME:
OWNER: BEAVERHEAD NATIONAL FOREST
OWNERCOMM:
PROTCOMM:
MGMTCOMM:
MONITOR:
BESTSOURCE: SCHASSBERG, L.A. 1988. FIELD SURVEY, SOUTHWEST MONTANA,
SOURCECODE: F88SCH02MTUS PNDSCH02MTUS S88SCHUMMTUS
DATASENS: N BOUNDARIES: Y PHOTOS: Y OWNERINFO:
TRANSCHR: 88-08-03 LAS CDREV: Y MAPPER: 88-10-05 LAS QC: Y
UPDATE: 88-12-20 LAS
THE ECOLOGY OF *Arabis fecunda*:
LONG-TERM MONITORING, KNAPWEED REMOVAL,
AND SOIL CRUST ECOLOGY STUDIES.
1988 PROGRESS REPORT

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and

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Montana Natural Heritage Program
\[ State Library Building \]
1515 E. 6th Avenue
Helena, MT 59620

December 1988
INTRODUCTION

In order to adequately protect populations of an organism, it is necessary to understand its life history and population dynamics (Massey and Whitson 1980; Sutter 1986; Palmer 1987). In addition, many rare species are threatened by interactions with non-native species that have been introduced into their habitat (Drake 1988). It is important to understand the nature of these interactions in order to protect populations of rare species from extinction.

Arabis fecunda Rollins (Sapphire rockcress) is a rosette-forming perennial in the mustard family (Brassicaceae). This recently described species (Rollins 1984) is endemic to highly calcareous, azonal soils in the foothills of the Sapphire and Pioneer mountains in Ravalli, Beaverhead and Silver Bow counties, Montana (Lesica 1985; Schassberger 1988). Arabis fecunda occurs on eroding slopes with low vascular plant density but a relatively high cover of cryptogamic soil crust. Populations of A. fecunda are thought to be threatened by livestock grazing and encroachment by Centaurea maculosa Lam. (spotted knapweed), an aggressive exotic weed (Lesica 1985; Schassberger 1988).

This paper is a progress report on three studies being conducted on populations of A. fecunda in Ravalli County. The studies and their purposes are:

1. Long-term monitoring of A. fecunda populations in order to determine important life history attributes and trends in overall recruitment and mortality.

2. Spotted knapweed removal study, in order to determine the effects of knapweed competition on the performance of A. fecunda.

3. Soil crust ecology study, in order to assess the importance of soil crust to the establishment and survival of A. fecunda plants.

METHODS

Study Areas

Studies were conducted at two Arabis fecunda sites in Ravalli County, Montana: Charleys Gulch and Birch Creek. The Charleys Gulch site is on a steep, eroding, southwest-facing slope along the drainage at an elevation of ca. 1524 m. (5000 ft.) (T6N R19W S29, NW1/4). The Birch Creek site is on a steep, eroding, southeast-facing slope above the creek at an elevation of ca. 1433 m. (4700 ft.) (T7N R19W S16, NW1/4). Complete descriptions of the study sites can be found in Lesica (1985) and Schassberger (1988).
Long-term Monitoring Study

In May, 1987, we established permanent belt transects of 12 adjacent 1 m² plots at both sites following the methods outlined in Lesica (1987). Individual A. fecunda plants were mapped and recorded using the following system:

\[ S = \text{seedling} \]
\[ R = \text{the number of rosettes per plant} \]
\[ I = \text{the total number of inflorescences (stems) per plant} \]
\[ F = \text{the total number of fruits produced by the plant} \]

Thus, a plant with two rosettes, three stems and a total of nine fruits would be recorded as R1-I3-F9. Seedlings were recognized by their small size and the absence of leaves from the previous year. In addition, we noted the presence of recently disturbed soil and evidence of livestock trampling. We did not record seedlings at the Birch Creek site in 1987. The transects were read on May 19-20, 1987 and 1988.

Knapweed Removal Study

In May, 1987, we established permanent belt transects consisting of 10 adjacent 1 m² plots at each of the study sites following the methods of Lesica (1987). Transects were placed in areas with relatively heavy knapweed infestations. Individual A. fecunda plants were mapped and recorded as in the long-term monitoring study. For each transect, we removed the knapweed from five randomly selected plots by carefully cutting the plants below the root crown with a sharp knife. Knapweed was removed from plots 2, 4, 5, 8, and 9 at Birch Creek and from plots 1, 4, 5, 8, and 9 at Charleys Gulch. We did not record seedlings at the Birch Creek site in 1987. The transects were read on May 19-20, 1987 and 1988.

Soil Crust Ecology Study

In order to determine whether there is an association between intact cryptogamic soil crust and the distribution of A. fecunda, we estimated cover of soil crust and bare ground in belt transects consisting of adjacent 1 m² plots. These transects were chosen to be representative of the steep, highly erodible slopes where A. fecunda is most frequent. We measured cover of bare ground and soil crust using a point-frequency frame (Mueller-Dombois and Ellenberg 1974, p. 86). The frame was 1 X 1 m with 20 equally-spaced pins. In each plot, the pins were dropped to the surface and the number of hits on bare soil and soil crust was recorded. Hits on exposed rock were not included in subsequent analyses. The diameter of the pins was approximately equal to the diameter of a taproot of A. fecunda (ca. 0.1 in). In addition, we recorded the number of A. fecunda plants rooted in the soil crust and the total number of A.
**fecunda** plants in each 1 m² plot. At Charleys Gulch, we read two transects (10 and 12 plots), and at Birch Creek, we read one transect (22 plots). All of the transects were located in areas subject to livestock grazing. Transects were read on May 19-20, 1988.

**RESULTS AND DISCUSSION**

Long Term Monitoring Study

A summary of the data from two years of the long-term monitoring study is presented in Table 1. At both sites the density of plants was slightly lower in 1988 than in 1987. In addition, the number and percentage of fruiting plants was appreciably lower in 1988 than in 1987. At both sites, however, the total number of fruits per fertile plant, and the number of fruits per inflorescence, was greater in 1988. These results probably indicate various stress responses to the drought conditions that began in 1987 and continued into 1988.

Size and fecundity data for individual *Arabis fecunda* plants over the two-year period are presented in Appendix A. These data are summarized in Table 2. It is too early in the study to determine whether these populations are stable, growing or declining; nonetheless, it is worth noting some trends. At Charleys Gulch, where only one plant was lost to apparent soil slumping, recruitment and adult mortality were approximately equal in both years. At Birch Creek, where 15 plants were lost to soil slumping, adult mortality was appreciably higher than recruitment. In most cases of soil slumping at Birch Creek, we observed hoof prints of cattle in the slumped areas. If these 15 plants had not been lost, mortality and recruitment would have been approximately equal. At Charleys Gulch, apparent seedling survival was greater than seedling mortality. However, these results have limited meaning because appreciable seedling mortality may have occurred prior to reading the transects in late May.

Knapweed Removal Study

One year after removing spotted knapweed plants from the experimental plots, its cover was approximately equal to that in the control plots (Table 3). This result can be explained in part by new recruitment of seedlings and in part by a failure to completely eradicate all plants in 1987. Nonetheless, the competitive ability of knapweed in the removal plots should have been reduced during at least part of the 1987 growing season.

<table>
<thead>
<tr>
<th></th>
<th>Birch Creek</th>
<th>Charleys Gulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (plants/m²)</td>
<td>1987: 5.0</td>
<td>1987: 6.3</td>
</tr>
<tr>
<td></td>
<td>1988: 4.6</td>
<td>1988: 5.2</td>
</tr>
<tr>
<td># plants fruiting</td>
<td>1987: 17</td>
<td>1988: 26</td>
</tr>
<tr>
<td></td>
<td>1988: 7</td>
<td>1988: 10</td>
</tr>
<tr>
<td>% plants fruiting</td>
<td>1987: 34%</td>
<td>1987: 41%</td>
</tr>
<tr>
<td></td>
<td>1988: 11%</td>
<td>1988: 14%</td>
</tr>
<tr>
<td># fruits per</td>
<td>1987: 3.8</td>
<td>1988: 5.7</td>
</tr>
<tr>
<td># fruits per</td>
<td>1987: 2.3</td>
<td>1987: 2.3</td>
</tr>
<tr>
<td>inflorescence</td>
<td>1988: 5.2</td>
<td>1988: 4.3</td>
</tr>
<tr>
<td>% plants with more</td>
<td>1987: 11%</td>
<td>1987: 22%</td>
</tr>
<tr>
<td>than one rosette</td>
<td>1988: 7%</td>
<td>1988: 29%</td>
</tr>
<tr>
<td>% one-rosette plants</td>
<td>1987: 25%</td>
<td>1987: 37%</td>
</tr>
<tr>
<td>with fruit</td>
<td>1988: 13%</td>
<td>1988: 24%</td>
</tr>
<tr>
<td>% multi-rosette plants</td>
<td>1987: 83%</td>
<td>1987: 67%</td>
</tr>
<tr>
<td>with fruit</td>
<td>1988: 0%</td>
<td>1988: 13%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Birch Creek</th>
<th>Charleys Gulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants first observed in 1988</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>1987 plants not observed in 1988</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Number of plants with a greater number of rosettes in 1988</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Number of plants with a smaller number of rosettes in 1988</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Plants with the same number of rosettes in 1987 and 1988</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>Plants with increased fecundity in 1988</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Plants with decreased fecundity in 1988</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Seedling survival</td>
<td>--</td>
<td>64%</td>
</tr>
</tbody>
</table>
Table 3. Percent canopy cover of knapweed (Centaurea maculosa) in removal transects in 1987 and 1988 (before knapweed removal). An asterisk (*) indicates plots from which knapweed was removed; remaining plots are controls.

**Charleys Gulch #2**

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Control Mean</th>
<th>Removal Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>5</td>
<td>20</td>
<td>28</td>
<td>15</td>
<td>18</td>
<td>30</td>
<td>25</td>
<td>23</td>
<td>18</td>
<td>35</td>
<td>28</td>
<td>16</td>
</tr>
</tbody>
</table>

**Birch Creek #2**

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Control Mean</th>
<th>Removal Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>30</td>
<td>33</td>
<td>38</td>
<td>28</td>
<td>23</td>
<td>23</td>
<td>28</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>1988</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>15</td>
<td>30</td>
<td>30</td>
<td>20</td>
<td>25</td>
<td>26</td>
</tr>
</tbody>
</table>
Density and fecundity data for plants of *A. fecunda* in removal and control plots are presented in Table 4. In general, these data show the same trends as found in the long-term monitoring study: a drastic reduction in number and percent of plants fruiting and an increase in the average number of fruits per inflorescence and per fruiting plant in 1988 (see above for discussion). Density of *A. fecunda* plants at Charley's Gulch showed no increase in 1988 in either the control plots or the removal plots. At Birch Creek, while control plots showed no appreciable increase in density of *A. fecunda* plants in 1988, there was a more than three-fold increase in the removal plots. The density of *A. fecunda* in individual removal and control plots in 1987 and 1988 at Birch Creek are presented in Table 5. Between 1987 and 1988, density decreased slightly in all but one of the control plots, while density increased in all but one of the knapweed removal plots. Our notes from 1987 indicate that there were large numbers of seedlings in plots 8, 9, and 10. Many of these survived in the removal plots (plots 8 and 9), but few survived in the control plot (plot 10). These results suggest that *A. fecunda* recruitment may be curtailed by the presence of knapweed.

**Soil Crust Ecology Study**

In this study, the null hypothesis is that within the three belt transects *Arabis fecunda* plants are distributed at random, i.e., without respect to the presence of soil crusts. The results of a chi-square analysis of the data are presented in Table 6. The null hypothesis was strongly rejected in all three cases, indicating that the distribution of *A. fecunda* is not random. The data show that *A. fecunda* is associated more often with soil crusts than bare soil within the transects. There are two possible explanations for these results: (1) *A. fecunda* is able to establish and survive better in soil crusts, and/or (2) *A. fecunda* is able to establish and survive with equal success in bare soil and soil crusts; however, perturbations caused by livestock destroy not only the *A. fecunda* plants growing in bare soil and soil crust, but also the soil crust itself. This would result in an increase in the amount of bare soil without *A. fecunda*. These two explanations are not mutually exclusive.

If the first explanation is correct, *A. fecunda* may be dependent on the presence of soil crusts to maintain viable population levels within these transects. Grazing by livestock has been shown to reduce the cover of soil crusts (St. Clair et al. 1984), thus reducing the availability of microsites which are important for seedling establishment and survival. If the second explanation is correct, livestock grazing is destroying *A. fecunda* plants in these transects regardless of whether they are rooted in bare soil or soil crusts. Under either interpretation, our results indicate that livestock grazing is detrimental to populations of *A. fecunda* on the steep, highly erodible slopes in these transects.
Table 4. Density and fecundity data for *Arabidopsis fecunda* in knapweed removal transects.

<table>
<thead>
<tr>
<th></th>
<th>Birch Creek</th>
<th></th>
<th>Charley's Gulch</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Removal</td>
<td>Control</td>
<td>Removal</td>
<td>Control</td>
</tr>
<tr>
<td><strong>Density (plants/m²)</strong></td>
<td>1987</td>
<td>16.0</td>
<td>21.4</td>
<td>12.8</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>54.6</td>
<td>24.0</td>
<td>14.2</td>
</tr>
<tr>
<td><strong># plants fruiting</strong></td>
<td>1987</td>
<td>44</td>
<td>41</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>6</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td><strong>% plants fruiting</strong></td>
<td>1987</td>
<td>55%</td>
<td>38%</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>2%</td>
<td>6%</td>
<td>3%</td>
</tr>
<tr>
<td><strong># fruits per fruiting plant</strong></td>
<td>1987</td>
<td>6.3</td>
<td>4.8</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>15.2</td>
<td>5.7</td>
<td>11.5</td>
</tr>
<tr>
<td><strong># fruits per inflorescence</strong></td>
<td>1987</td>
<td>2.5</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>5.1</td>
<td>3.6</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>% plants with more than one rosette</strong></td>
<td>1987</td>
<td>19%</td>
<td>36%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>7%</td>
<td>17%</td>
<td>13%</td>
</tr>
<tr>
<td><strong>% one-rosette plants with fruit</strong></td>
<td>1987</td>
<td>51%</td>
<td>55%</td>
<td>47%</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>2%</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td><strong>% multi-rosette plants with fruit</strong></td>
<td>1987</td>
<td>73%</td>
<td>66%</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Table 5. Density of *Arabis fecunda* plants in individual knapweed removal and control plots at the Birch Creek site in 1987 and 1988.

<table>
<thead>
<tr>
<th>Plot #</th>
<th>1987</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>7</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>10</td>
<td>27</td>
<td>29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plot #</th>
<th>1987</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>145</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>69</td>
</tr>
</tbody>
</table>
Table 6. Density of bare soil and soil crust and the number of *Arabis fecunda* plants growing in each type of substrate in three belt transects.

<table>
<thead>
<tr>
<th>Site</th>
<th># point hits on soil crust</th>
<th># point hits on bare soil</th>
<th># of <em>A. fecunda</em> in soil crust</th>
<th># of <em>A. fecunda</em> in bare soil</th>
<th>$x^2$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birch Creek</td>
<td>97</td>
<td>289</td>
<td>81</td>
<td>48</td>
<td>61</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Charleys Gulch West</td>
<td>83</td>
<td>117</td>
<td>100</td>
<td>27</td>
<td>44</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Charleys Gulch</td>
<td>78</td>
<td>147</td>
<td>52</td>
<td>21</td>
<td>30</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
CONCLUSIONS

All of the studies reported on are still in progress, and any conclusions must be considered tentative until more data has been collected. Nonetheless, several trends are apparent and are worthy of comment. Results of the long-term monitoring and soil crust ecology studies suggest that livestock grazing on the steep highly erodible slopes, where the transects were located, is destructive, and is probably detrimental to the long-term viability of *Arabis fecunda* populations. Results of the knapweed removal study suggest that, under certain circumstances, spotted knapweed may be inhibiting recruitment of *Arabis fecunda* seedlings. Thus, both livestock grazing and knapweed encroachment may pose a threat to populations of *Arabis fecunda*. 
LITERATURE CITED


Appendix A. Performance of individual *Arabis fecunda* plants in permanent monitoring transects in 1987 and 1988. Seedlings were not recorded at Birch Creek in 1987. An asterisk (*) indicates a plant lost due to slumping soil.

**Birch Creek**

<table>
<thead>
<tr>
<th>Plot #</th>
<th>1987</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R1</td>
<td>R1</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>R1</td>
</tr>
<tr>
<td></td>
<td>R3</td>
<td>R4</td>
</tr>
<tr>
<td></td>
<td>R2-I3-F6</td>
<td>R2</td>
</tr>
<tr>
<td>2</td>
<td>R1</td>
<td>---*</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>---*</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>---*</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>---*</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>---*</td>
</tr>
<tr>
<td></td>
<td>R1-I1-F3</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>R1</td>
</tr>
<tr>
<td></td>
<td>R1</td>
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<td></td>
<td>R1</td>
<td>R1</td>
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<tr>
<td></td>
<td>R1-I2-F3</td>
<td>---*</td>
</tr>
<tr>
<td>3</td>
<td>R1-I1-F1</td>
<td>---*</td>
</tr>
<tr>
<td></td>
<td>R1-I2-F4</td>
<td>---*</td>
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<tr>
<td></td>
<td>R1</td>
<td>---*</td>
</tr>
<tr>
<td>4</td>
<td>R2</td>
<td>---*</td>
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<tr>
<td></td>
<td>R1</td>
<td>R1</td>
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<td></td>
<td>R1</td>
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</tr>
<tr>
<td>6</td>
<td>R1</td>
<td>R2</td>
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<td>R1</td>
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<td>R1-I2-F6</td>
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<td>R1-I3-F9</td>
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<td>R2-I2-F5</td>
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</tr>
<tr>
<td></td>
<td>R1</td>
<td>R1</td>
</tr>
<tr>
<td></td>
<td>--</td>
<td>R1</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>R1-I2-F12</td>
</tr>
</tbody>
</table>
7. R1-I1-F3  R1
   R1  --
   R1-I2-F2  R1
   R1  --

8. R1-I1-F3  R3
   R1  R1
   R1-I2-F4  R1
   R1  R1
   R1  R1

9. R2-I2-F5  --*
   R1-I3-F6  --*
   R1-I1-F5  --*
   R1  --*
   R2-I1-F2  --*

10. --  S
    --  S

11. R1  R1
    R1  --
    R1  --
    R1  R1
    R1  R1-I1-F3
    --  R1
    --  R1
    --  R1

12. R1-I3-F7  R1
    R1  R1
    R1  --
    R1  R1
    R1-I1-F1  --
    R1  R1
    R1-I2-F3  R1
    R1  --
    R1  R1
    --  R1
    --  R1
    --  S
    --  S
    --  S
    --  R1
    --  R1

13. NOT RECORDED  R1
    R1
    R1-I1-F5
    R1
    R1
    R1-I5-F22
14. NOT
RECORDED
R1-I5-F34
R1
R1
R1
R1-I2-F13

Charleys Gulch

1. S
R1-I1-F2
R1-I1-F3
S
R2
S
R1
R1-I4-F15
R1-I5-F23

2. S
R1-I1-F6

3. NO PLANTS

4. R1-I3-F5
R2-I4-F11
R2-I1-F5

5. S
R1-I5-F15
--
R1-I2-F5

6. S
R1-I1-F4
R1-I5-F13
R1-I2-F12
--
R2
--
S
--
S
S
R1

7. R1-I5-F11
R1-I1-F2
R2
R1-I1-F2
--*
S
S
R2
R1-I3-F1
R1-I4-F17

8. NO PLANTS

9. NO PLANTS

10. R2
R1-I3-F6
R1
R1
R1
R1
R2-I2-F5
R2
S
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S
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R1-I6-F0
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VI. SLIDES OF MONITORING TRANSECTS AND LOCATIONS