

Status Report on
Persistent sepal yellowcress
(*Rorippa calycina*)
in Wyoming

Prepared for the Bureau of Land Management
Wyoming State Office

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31 March 1998

Agreement # K910-A4-0011

Acknowledgements

We would like to thank the following individuals for their assistance with this project: Amy Roderick, graduate student from the University of Wyoming, for sharing location information from her 1997 floristic studies of central Wyoming, Bonnie Heidel of the Montana Natural Heritage Program for sharing information on the status of *Rorippa calycina* in Montana, Max Welp for general field assistance, and Jeff Carroll and Larry Apple of the BLM for their help in securing funding.

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I. INTRODUCTION

Rorippa calycina (Persistent sepal yellowcress) was first discovered by F.V. Hayden in 1854 along the banks of the Yellowstone River near the current site of Sheffield, Montana (Stuckey 1972). During the next 120 years, this species was observed only four times in Montana, North Dakota, and the Arctic coast of the Northwest Territories (Mulligan and Porsild 1966). The apparent scarcity of *R. calycina* prompted the Smithsonian Institution to recommend that it be listed as Threatened under the Endangered Species Act in 1975 and 1978 (Ayensu and DeFilipps 1978). Although it was not officially listed at that time, the species remained a candidate for listing on subsequent US Fish and Wildlife Service notices of review.

This species was not known from Wyoming until 1977, when it was discovered by Ron Schreibeis along the banks of Seminoe Reservoir. From 1979-1981, nine additional occurrences were discovered in Wyoming and one new population was located in Montana (Lichvar 1981). Despite its local abundance along reservoir margins, Lichvar (1981) considered *Rorippa calycina* to be highly threatened by potential changes in water management and herbicide use and recommended that it remain as a candidate for listing. For 15 years following Lichvar's study, additional populations of *R. calycina* continued to be discovered in Wyoming, but no state-wide review of its status and management needs was undertaken.

In 1997, the Bureau of Land Management (BLM) Wyoming State Office contracted with the Wyoming Natural Diversity Database (WYNDD) on a cost-share basis to conduct field surveys and evaluate the status of this taxon on BLM lands in Wyoming. The objective of this report is to summarize existing data on the biology, distribution, habitat, population size, and potential threats of *Rorippa calycina* to be used in determining its conservation status and potential management needs in Wyoming.

II. METHODS

Information on the habitat and distribution of *Rorippa calycina* was obtained from secondary sources, including WYNDD files and computer databases, specimens from the Rocky Mountain (RM) and Central Wyoming College (CWC) herbaria, scientific literature, and knowledgeable individuals. USGS topographic maps, geologic maps (Love and Christiansen 1985), and BLM land status maps were used to identify areas of potential habitat for ground survey.

Field surveys were conducted by the authors in late August 1997 (survey routes and collection sites are indicated in Appendix C). Data on the biology, habitat, population size, and management needs of this species were collected using WYNDD plant survey forms (Appendix B). Locations of occurrences were mapped on 7.5 minute USGS topographic maps. If populations were sufficiently large, voucher specimens were collected for deposit at the RM. Color photographs were taken of plants and their habitat at each site.

Information gathered in the field was entered into the computerized Element Occurrence database at WYNDD.

Permanent demographic monitoring plots were not established due to the ephemeral nature of subpopulations of this species. An alternative monitoring strategy that recognizes the dynamic and mobile nature of *Rorippa calycina* still needs to be developed. Such a strategy could involve yearly or biennial censuses of known habitat sites and permanent photo points to assess changes in habitat quality.

III. SPECIES INFORMATION

A. CLASSIFICATION

1. SCIENTIFIC NAME: *Rorippa calycina* (Engelm.) Rydb. (Rydberg 1900; Stuckey 1972). Lectotype specimen: USA: Montana: [Custer County]: sandy bottoms on Yellowstone [River] near Fort Sarpy [Fort Alexander Sarpie was near the present location of Sheffield], July 1854, E. V. Hayden s. n., MO.
2. SYNONYMS: *Nasturtium calycinum* Engelm. (Warren 1858).
3. COMMON NAMES: Persistent sepal yellowcress.
4. FAMILY: Brassicaceae or Cruciferae (mustard family).
5. SIZE OF GENUS: Rollins (1993) recognizes approximately 75 species in this genus worldwide, with 29 occurring in North America. Dorn (1992) lists 14 taxa in Wyoming (9 species and 5 additional varieties).
6. PHYLOGENETIC RELATIONSHIPS: *Rorippa calycina* is one of six species in Section *Sinuatae*, the most primitive group within the genus. Stuckey (1972) considered *R. calycina* to be most closely related to *R. columbiae* and *R. subumbellata*, two other localized endemics of the Columbia River and Lake Tahoe areas, respectively. According to Stuckey, all three represent old, relic species and the only survivors of a formerly more widespread and morphologically variable complex. Among Wyoming species, *R. calycina* is most closely related to *R. sinuata* (Stuckey 1972).

B. PRESENT LEGAL OR OTHER FORMAL STATUS:

1. NATIONAL:

- a. LEGAL STATUS: *Rorippa calycina* was formerly a C2 candidate for listing under the Endangered Species Act (US Fish and Wildlife Service 1993). The C2 list included species that might have warranted listing as Threatened or Endangered, but for which the USFWS lacked sufficient biological data to support a listing proposal. In February 1996, the USFWS revised its candidate policy and eliminated the C2 designation (US Fish and Wildlife Service 1996). As a result, *R. calycina* currently has no legal status.
- b. HERITAGE RANK: *Rorippa calycina* is ranked G3 by The Nature Conservancy's Natural Heritage network system. This indicates that the species is "rare or local throughout its range or found locally in a restricted range (21-100 occurrences)" (Fertig 1997).

2. STATE:

a. WYOMING

- i. LEGAL STATUS: None.
- ii. HERITAGE RANK: *Rorippa calycina* is ranked S3, indicating that it is rare or local throughout its range or found locally in a restricted range in the state of Wyoming (Fertig 1997).

b. Montana:

- i. LEGAL STATUS: None.
- ii. HERITAGE RANK: Ranked S1, indicating that this species is critically imperiled in Montana because of extreme rarity (5 or fewer extant occurrences, or very few remaining individuals) or because of some factor of its life history that makes it vulnerable to extinction (Heidel 1997).

c. North Dakota:

- i. LEGAL STATUS: None.
- ii. HERITAGE RANK: Ranked SH, indicating that this taxon is known only from historical records in North Dakota.

d. Northwest Territories:

i. LEGAL STATUS: None.

ii. HERITAGE RANK: *Rorippa calycina* is ranked S1 by the Natural Heritage network system, indicating that it is critically imperiled because of extreme rarity (5 or fewer extant occurrences) in the territory. The species is not, however, listed as a species of concern in Canada (Argus and Pryer 1990), perhaps due to past reports suggesting that it was introduced in Canada by humans (Mulligan and Porsild 1966).

C. DESCRIPTION

1. GENERAL NON-TECHNICAL DESCRIPTION: Persistent sepal yellowcress is a rhizome-bearing perennial herb with stems 10-40 cm tall (Figures 1-2). The stems and foliage are pubescent throughout with stiff, unbranched hairs. Stem leaves are pinnately divided or wavy-lobed, sessile, and 2.5-5 cm long. The flowers are borne in terminal and axillary inflorescences and have 4 yellow petals 3-5 mm long and 4 sepals that persist in fruit. Fruits are ovoid to nearly globose, 2-4 mm long and conspicuously pubescent with unbranched hairs that are broadest at the base. Styles in fruit are 1-2 mm long and glabrous (Stuckey 1972; Hitchcock et al. 1964; Clark and Dorn 1981; Dorn 1992; Rollins 1993; Fertig et al. 1994).
2. TECHNICAL DESCRIPTION: Perennial, spreading from underground roots, hirsute to nearly so throughout; trichomes needlelike and flaring toward base, especially those of the fruits; stems 1-4 dm long, usually somewhat weak (and decumbent or spreading) to erect, usually branched; leaves 3-7 cm long, sinuate to pinnately lobed, the lobes usually dentate, the lower petiolate, middle and upper sessile and mostly auriculate, segments ovate to oblong; pedicels divaricately ascending to erect and appressed, rarely slightly recurved, 2-4 mm long; sepals not saccate at base, tending to persist after anthesis, glabrous; petals light yellow, 2.5-3.7 mm long (up to 1 mm longer than the sepals); siliques ascending to erect, broadly oblong to nearly orbicular in outline, not compressed, 2-4 mm long, pubescent with short, stiff, \pm awl-shaped trichomes; styles glabrous, 1-1.5 mm long; stigmas entire, seeds cordiform, light tan, 0.6-0.7 mm in diameter, ca 20 per silique (modified from Stuckey 1972; Rollins, 1993).
3. LOCAL FIELD CHARACTERISTICS: *Rorippa calycina* can be recognized by its long, coarse hairs which are broadest at the base and narrow toward the tip, ovoid fruits, rhizomatous growth form, glabrous

Figure 1. Line drawing of *Rorippa calycina* from Dorn (1980). Illustration by Jane Dorn.

and persistent sepals, and yellow petals that exceed the sepals by 1 mm. Mature fruits are helpful for identification, but not required.

4. SIMILAR SPECIES: *Rorippa sinuata* is also a rhizomatous perennial, but has elongate, glabrous fruits over 5 mm long, deciduous sepals, and round, glassy, ball-like hairs on the leaves. *R. curvipes* often has white petals, finely hairy sepals, deeply pinnate leaves and glabrous to sparsely hairy fruits and leaves (hairs if present are of uniform thickness). All other Wyoming species of *Rorippa* are taprooted annuals or biennials with longer, more erect stems, and fruits that are either round or narrowly elongate. Seedling and vegetative individuals of *Rorippa calycina* may be difficult to distinguish from seedlings of other species. *Ambrosia tomentosa* seedlings differ in having fewer, wider leaves with darker upper surfaces and whitish-hairy undersides. Seedlings of annual species of *Oenothera* can be distinguished by their finely hairy leaves. Annual *Potentilla* species typically have 3-5 round-lobed leaflets.

D. GEOGRAPHICAL DISTRIBUTION

1. RANGE: *Rorippa calycina* is a regional endemic of south-central Montana, western North Dakota, and central Wyoming, with a disjunct population 2,500 miles to the north on the Arctic coast of Canada's Northwest Territories (Mulligan and Porsild 1966; Lesica and Shelly 1991; Fertig et al. 1994). In Wyoming (Figure 3), it is known from the Bighorn Basin, North Platte River drainage, and Great Divide, Green River, and Wind River basins in Albany, Big Horn, Carbon, Fremont, Park, Sweetwater, and Washakie counties (WYNDD records).
2. EXTANT SITES: This species is currently known from 23 occurrences in Wyoming, all of which have been located since 1977. These occurrences consist of 66 subpopulations and occupy a known area of approximately 105 acres (although this figure is probably very conservative). Since 1990, eight new occurrences have been discovered and 6 known sites have been relocated in surveys conducted by WYNDD and staff and affiliates of the Rocky Mountain Herbarium (Refsdal 1996; Welp et al. 1996).

Exact locations of extant populations are listed in Table 1. More detailed information is provided in the Element Occurrence Records and maps in Appendix A.

Figure 2 (page 11). *Rorippa calycina* at Horseshoe Bend on the Bighorn River in Bighorn Canyon National Recreation Area, Big Horn County, Wyoming. Plants can be recognized by their pinnately lobed leaves, yellow flowers, and round fruit. WYNDD photograph by W. Fertig, June 1994.

3. HISTORICAL SITES: No historical sites are known from Wyoming. Three of the five known occurrences in Montana are considered historical (Bonnie Heidel, Montana Natural Heritage Program, personal communication), as is the only known record from North Dakota (Stuckey 1972).
4. SITES WHERE PRESENT STATUS NOT KNOWN: Three occurrences of *Rorippa calycina* along Seminoe Reservoir reported by Lichvar (1981) could not be relocated in 1997 due to restricted access across intervening private lands (EO #s 001, 004, and 011). Likewise, the privately-owned Medicine Bow River population (EO # 005) was not resurveyed, although potential habitat was observed in the area from the adjacent highway. Several populations along Boysen Reservoir reported by Haines (1988) were also not resurveyed. Occurrence # 027 from Boysen Reservoir was surveyed, but could not be relocated due to high water levels. Nelson's population from the Big Horn/Washakie county line has not been resurveyed since 1981 (Lichvar 1981). Recent surveys along Red Canyon Creek have failed to relocate Richard Scott's 1986 population from The Nature Conservancy's Red Canyon Ranch (Fertig 1995).

In Montana, both of the populations discovered since 1980 have not been relocated in recent years and may be extirpated (Bonnie Heidel, personal communication). The current status of populations from the Northwest Territories is not known.

5. UNVERIFIED/UNDOCUMENTED REPORTS: None.
6. AREAS SURVEYED BUT SPECIES NOT LOCATED: The northeast side and south end of Boysen Reservoir were briefly surveyed for *Rorippa calycina* in 1997, but no additional populations were located. Recent WYNDD surveys at Alcova Reservoir (1993), the north end of Pathfinder Reservoir (1992), the Sweetwater River (1995), Flaming Gorge Reservoir (1994-95), and alkali lakes of the Laramie Basin (1994-97) have failed to uncover additional populations of this species. Lichvar (1981) searched unsuccessfully for *R. calycina* along the Platte and Powder rivers and at Alcova Reservoir.
7. AREAS OF UNSURVEYED POTENTIAL HABITAT: The west side of Boysen Reservoir has only been sporadically surveyed, and contains much potential habitat for *Rorippa calycina*. Additional habitat may also be found in the less accessible inlets of Seminoe, Pathfinder, Fontenelle, and Flaming Gorge reservoirs. Small stock ponds in the basins of western Wyoming may also have high potential for *R. calycina* habitat (B. Ernie Nelson, personal communication). Lichvar (1981) considered Guernsey and Glendo reservoirs in eastern Wyoming to be potential sites for this

Figure 3. Wyoming distribution of *Rorippa calycina*.

Table 1. Location information for known populations of *Rorippa calycina* in Wyoming.

1. North Platte River Valley

Occurrence # 001

County: Carbon.

Legal Description: **T24N R84W S14** (SW4 of SE4); **S22** (NW4); **S23** (SE4), **S24** (SE4 of NW4), **S26** (NE4 of SW4), **S34** (SE4 & NW4); **T23N R84W S1** (W2 of NE4).

Latitude: 42° 01' 15" N (centrum).

North: 42° 02' 42" N.

South: 41° 59' 47" N.

Longitude: 106° 50' 15" W (centrum).

East: 106° 49' 02" W.

West: 106° 51' 55" W.

Elevation: 6400-6600 ft (1950-2010 m).

USGS 7.5' Quads: Seminole Dam SE and Pats Bottom.

Location: South end of Seminole Reservoir, near the confluence of the Medicine Bow and North Platte arms, 5-7 air miles east of County Highway 351.

Occurrence # 004

County: Carbon.

Legal Description: **T24N R84W S1** (SE4 of SE4).

Latitude: 42° 04' 29" N.

Longitude: 106° 49' 31" W.

Elevation: 6400 ft (1950 m).

USGS 7.5' Quad: Seminole Dam SE.

Location: Mouth of Big Draw on east shore of Seminole reservoir south of Horseshoe Ridge.

Occurrence # 007

County: Carbon.

Legal Description: **T24N R85W S13** (NW4 of SW4 of SW4, N2 of SE4); **S14** (SE4); **S27** (NW4 of SW4); **T24N R84W S4** (SW4).

Latitude: 42° 02' 50" N (centrum).

North: 42° 04' 50" N.

South: 42° 01' 35" N.

Longitude: 106° 56' 57" W (centrum).

East: 106° 52' 55" W.

West: 106° 58' 26" W.

Elevation: 6360-6400 ft (1940-1950 m).

USGS 7.5' Quad: Seminole Dam SW.

Location: West shore of Seminole Reservoir along the O'Brien arm, at mouth of O'Brien Creek, at old stockpond near Seminole Road, and north of Seminole Boat Club picnic area.

Occurrence # 008

County: Carbon.

Legal Description: **T25N R84W S16** (SW4 of NE4 of NW4); **S21** (NW4 of SE4).

Latitude: 42° 08' 25" N (centrum).

North: 42°08' 25" N.

South: 42°07' 17" N.

Longitude: 106° 53' 40" W (centrum).

East: 106° 53' 30" W.

West: 106° 53' 40" W.

Elevation: 6360 ft (1940 m).

USGS 7.5' Quads: Seminole Dam and Seminole Dam SW .

Location: Northwest shore of Seminole Reservoir, just north of North Red Hills Campground and at inlet south-southeast of Seminole Dam.

Occurrence # 009

County: Carbon.

Legal Description: **T27N R84W S20** (E2 of SW4); **S33** (NW4 of NE4)

Latitude: 42° 17' 33" N (centrum).

North: 42° 17' 33" N.

South: 42° 16' 18" N.

Longitude: 106° 54' 43" W (centrum).

East: 106° 53' 25" W.

West: 106° 54' 43" W.
Elevation: 5860-5900 ft (1785-1800 m).
USGS 7.5' Quad: Pathfinder Reservoir SW.
Location: Southeast shore of Pathfinder Reservoir on bank opposite Junk and Dewese Creeks and at mouth of Tye Draw, ca 38 air miles northeast of Sinclair.

Occurrence # 011
County: Carbon.
Legal Description: **T22N R84W S5** (NE4); **T22N R85W S1** (NW4), **S10** (N2); **T23N R84W S25** (NE4 of NE4), **S27** (SE4 of SE4).
Latitude: 41° 55' 39" N (centrum).
North: 41° 56' 21" N.
South: 41° 53' 40" N.
Longitude: 106° 51' 01" W (centrum).
East: 106° 48' 48" W.
West: 106° 58' 05" W.
Elevation: 6400 ft (1950 m).
USGS 7.5' Quads: Ferris Lake and Pats Bottom.
Location: North Platte River arm of Seminoe Reservoir, from the confluence of Dirtyman Draw and the North Platte River east-northeast ca 9 air miles to the mouth of the Big Ditch, ca 8-11 air miles north-northeast of Sinclair.

Occurrence # 014
County: Carbon.
Legal Description: **T24N R83W S26** (SW4 of SE4 of SW4, SW4 of NW4 of NW4, and SE4 of NE4 of NE4) **S29** (NW4).
Latitude: 42° 00' 53" N (centrum).
North: 42° 01' 38" N.
South: 42° 00' 53" N.
Longitude: 106° 43' 34" W (centrum).
East: 106° 42' 51" W.

West: 106° 47' 04" W.
Elevation: 6360-6400 ft (1940-1950 m).
USGS 7.5' Quad: Schneider Ridge.
Location: Medicine Bow River arm of Seminoe Reservoir, ca 3.5 miles south of the east end of Horseshoe Ridge and ca 3 air miles east-southeast of the confluence of the North Platte arm.

Occurrence # 031
County: Carbon.
Legal Description: **T21N R85W S31**.
Latitude: 41° 44' 45" N.
Longitude: 107° 01' 54" W.
Elevation: 6500 ft (1980 m).
USGS 7.5' Quad: Smith Draw East.
Location: Reservoir on the north side of Hogback Ridge, ca 1.2 miles east of Grenville Dome, south of Interstate 80.

Occurrence # 037
County: Carbon.
Legal Description: **T24N R84W S32**.
Latitude: 42° 00' 33" N.
Longitude: 106° 53' 55" W.
Elevation: 6600 ft (2101 m).
USGS 7.5' Quad: Seminoe Dam SW.
Location: 1.5 miles west of south end of Seminoe Reservoir, ca 4.25 air miles east of Seminoe Road, ca 18 air miles northeast of Sinclair.

2. Bighorn Basin

Occurrence # 003
County: Park.
Legal Description: **T52N R103W S15, S17; T52N R104W S12** (SW4), **S13** (NW4).
Latitude: 44° 29' 25" N (centrum).
North: 44° 29' 27" N.
South: 44° 28' 50" N.
Longitude: 109° 18' 34" W (centrum).
East: 109° 13' 58" W.
West: 109° 18' 40" W.

Elevation: 5350-5400 ft (1630-1645 m).
USGS 7.5' Quads: Castle Rock Creek
and Irma Flats
Location: North Fork Shoshone arm of
Buffalo Bill Reservoir, ca 12 road
miles
west of Cody.

Occurrence # 006
County: Big Horn.
Legal Description: **T58N R95W S36**
(SE4 of SW4).

Latitude: 44° 57' 30" N (centrum).
North: 44° 57' 33" N.
South: 44° 57' 27" N.
Longitude: 108°15' 53" W (centrum).
East: 108° 15' 47" W.
West: 108° 15' 59" W.
Elevation: 3660-3680 ft (1115-1120
m).

USGS 7.5' Quad: Sykes Spring.
Location: north end of Yellowtail
Reservoir, along inlet south and west
of the boat ramp near Horseshoe Bend
Campground, ca 9.5 air miles northeast
of Lovell.

Occurrence # 020
Counties: Washakie and Big Horn.
Legal Description: **T48N R93W S6**
(NE4); **T49N R93W S32** (SE4 of
SW4).
Latitude: 44° 10' 06" N (centrum).
North: 44° 10' 09" N.
South: 44° 10' 03" N.
Longitude: 108° 03' 50" W (centrum).
East: 108° 03' 49" W.
West: 108° 03' 50" W.
Elevation: 4350 ft (1325 m).
USGS 7.5' Quad: Schuster Flats NE.
Location: Near the head of Sixmile
Creek, ca 11 air miles north-
northwest of Worland along the
Washakie-Big Horn county line.

Occurrence # 035
County: Park
Legal Description: **T56N R101W S29**
(SW4).

Latitude: 44° 48' 12" N.
Longitude: 109° 03' 24" W.
Elevation: 4520 ft (1375 m).
USGS 7.5' Quad: Badland Hills.
Location: Along south side of Sand
Coulee Road, ca 6 miles east of
Highway 120 in West Fork Big Sand
Coulee, south of the Badland Hills.

3. Laramie Basin

Occurrence # 005
County: Carbon.
Legal Description: **T22N R78W S5**
(NW4).
Latitude: 41° 54' 28" N.
Longitude: 106° 12' 22" W.
Elevation: 6800 ft (2075 m).
USGS 7.5' Quad: Medicine Bow.
Location: Medicine Bow River, ca 1.5
air miles north-northeast of Medicine
Bow.

Occurrence # 036
County: Albany.
Legal Description: **T21N R76W S12**.
Latitude: 41° 48' 28" N.
Longitude: 105° 53' 48" W.
Elevation: 6760 ft (2060 m).
USGS 7.5' Quad: Wilcox.
Location: Pond along Fetterman Road,
ca 1.2 air miles south of the confluence
of Rock Creek and Meiser Creek, ca.
6.4 air miles northeast of Rock River.

4. Wind River Basin

Occurrence # 012
County: Fremont.
Legal Description: **T3N R6E S10** (N2,
& SW4 of SW4), **S16** (NE4 of NE4),

S18 (SE4), **S21** (SW4).

Latitude: 43° 14' 50" N (centrum).
North: 43° 15' 04" N.
South: 43° 13' 25" N.
Longitude: 108° 09' 35" W (centrum).
East: 108° 08' 55" W.
West: 108° 12' 16" W.
Elevation: 4725-4760ft (1440-1450 m).
USGS 7.5' Quads: Hidden Valley and Bonneville SW.
Location: East and west banks of the south-central arm of Boysen Reservoir along the mouth of Poison Creek and Fivemile Creek and near the causeway of US Highway 26, 3-5 air miles west of Shoshoni.

Occurrence # 023
County: Fremont.
Legal Description: **T4N R5E S36; T4N R6E S32.**
Latitude: 43° 16' 46" N (centrum).
North: 43° 17' 05" N.
South: 43° 16' 45" N.
Longitude: 108° 11' 50" W (centrum).
East: 108° 11' 50" W.
West: 108° 13' 55" W.
Elevation: 4720 ft (1440 m).
USGS 7.5' Quad: Bonneville SW.
Location: West shore of Boysen Reservoir, ca 7.5 air miles northwest of Shoshoni and 0.5-1.5 air miles southeast of Lake Cameahwait.

Occurrence # 025
County: Fremont.
Legal Description: **T4N R5E S2; T4N R6E S7.**
Latitude: 43° 20' 15" N (centrum).
North: 43° 20' 45" N.
South: 43° 20' 15" N.
Longitude: 108° 12' 45" W (centrum).
East: 108° 12' 45" W.
West: 108° 15' 15" W.
Elevation: 4720-4730 ft (1440-1440 m).

USGS 7.5' Quads: Mexican Pass SE and Bonneville SW.
Location: Northwest shore of Boysen Reservoir, southwest end of Cottonwood Bay ca 23.5 air miles northeast of Riverton.

Occurrence # 027
County: Fremont.
Legal Description: **T4N R6E S33, 34.**
Latitude: 43° 16' 50" N.
Longitude: 108° 09' 50" W.
Elevation: 4725 ft (1440 m).
USGS 7.5' Quad: Bonneville SW.
Location: South side of bay on the east bank of Boysen Reservoir.

Occurrence # 034
County: Fremont.
Legal Description: **T39N R94W S17** (N2 of NW4), **S29** (NW4 of NE4); **T40N R94W S31** (SW4?).
Latitude: 43° 21' 08" N (centrum).
North: 43° 23' 18" N.
South: 43° 19' 28" N.
Longitude: 108° 08' 46" W (centrum).
East: 108° 08' 27" W.
West: 108° 09' 16" W.
Elevation: 4720 ft (1440 m).
USGS 7.5' Quads: Bonneville SW and Boysen.
Location: East side of Boysen Reservoir, ranging from 6-10 air miles north of Shoshoni.

5. East slope Wind River Range

Occurrence # 021
County: Fremont.
Legal Description: **T31N R99W S23** (W2).
Latitude: 42° 38' 30" N.
Longitude: 108° 38' 10" W.
Elevation: 6460 ft (1970 m).
USGS 7.5' Quad: Wolf Point.

Location: Red Canyon Creek,
south-southeast of Lander.

6. Great Divide Basin

Occurrence # 032

County: Sweetwater.

Legal Description: **T24N R95W S2**
(NW4), **S3** (NE4).

Latitude: 42° 05' 13" N.

Longitude: 108° 07' 22" W.

Elevation: 6620 ft (2105 m).

USGS 7.5' Quad: Eagles Nest Draw.

Location: Along Lost Creek below
Eagles Nest Spring, ca 30 air miles
north-northwest of Wamsutter.

7. Green River Basin

Occurrence # 033

County: Sweetwater.

Legal Description: **T15N R108W S13**
(SE4 and NW4).

Latitude: 41° 17' 18" N (centrum).

North: 41° 17' 18" N.

South: 41° 16' 38" N.

Longitude: 109° 32' 09" W (centrum).

East: 109° 31' 27" W.

West: 109° 32' 09" W.

Elevation: 6040 ft (1840 m).

USGS 7.5' Quad: Halfway Hollow East.

Location: Flaming Gorge Reservoir,
cove on east side of reservoir ca 1.5
miles below Blacks Fork, and on west
side of reservoir at confluence of
Blacks Fork and Green River, ca 17 air
miles south of Green River.

species, although recent floristic surveys in these areas have not documented any new locations.

E. HABITAT

1. ASSOCIATED VEGETATION: *Rorippa calycina* is found primarily along moist sandy to muddy banks of streams, stockponds, and man-made reservoirs near the high water line (Figures 4-5). It occurs mostly on semi-disturbed or recently flooded openings in small inlets or bays with scattered clumps of *Hordeum jubatum*, *Poa secunda*, *Elymus smithii*, and a variety of native and exotic early successional forbs. Occasional populations can also be found in openings in grassy stream banks, in barren patches among thickets of *Salix exigua* or *Tamarix chinensis*, and on the banks of small playa lakes. One atypical population is also known from a sandy roadcut, several miles from the nearest shoreline. Total vegetative cover at all sites averages 5-10% (but can reach 25% in some areas).

Figure 4 (page 19). Habitat of *Rorippa calycina* along Horseshoe Bend in Bighorn Canyon National Recreation Area (EO # 006). Plants occur on red clay mudflats in a sparsely vegetated community of scattered bunchgrasses and weedy forbs. WYNDD photograph by W. Fertig, June 1994.

2. FREQUENTLY ASSOCIATED SPECIES: Nearly all of the species commonly associated with *Rorippa calycina* are adapted to early successional or disturbed habitats. A number of these species are not native to North America and are indicated by a “!” in the following list:

Ambrosia tomentosa (Perennial bursage)
! *Atriplex heterosperma* (Two-seed orache)
Bidens cernua (Nodding beggarticks)
Chenopodium berlandieri (Pitseed goosefoot)
Chenopodium glaucum var. *salinum* (Oak-leaved goosefoot)
! *Cirsium arvense* (Canada thistle)
Elymus smithii (Western wheatgrass)
Grindelia squarrosa (Curly-cup gumweed)
Hordeum jubatum (Foxtail barley)
Iva axillaris (Poverty-weed)
Juncus balticus (Baltic rush)
! *Juncus compressus* (Compressed rush)
Machaeranthera canescens (Hoary aster)
Poa secunda (Sandberg bluegrass)
Polygonum aviculare (Common knotweed)
Potentilla anserina (Silverweed)
! *Potentilla norvegica* (Norwegian cinquefoil)
Potentilla paradoxa (Bushy cinquefoil)
Potentilla rivalis (Brook cinquefoil)
! *Rumex crispus* (Curly dock)
Rumex salicifolius var. *triangulivalvis* (Willow dock)
Rumex maritimus var. *fueginus* (Golden dock)
Salix exigua (Coyote or sandbar willow)
! *Salsola australis* (Russian-thistle)
! *Spergularia rubra* (Red sandspurry)
Suckleya suckleyana (Poison suckleya)
! *Tamarix chinensis* (Tamarisk)
Xanthium strumarium (Common cocklebur)

3. TOPOGRAPHY: Nearly all known Wyoming occurrences of *Rorippa calycina* are found on seasonally flooded mudflats or sandy beaches in small inlets of reservoirs or along the banks of ponds and small streams (Figure 6). These sites typically are flat or have slopes less than 1%.

Figure 5 (page 21). Two views of the habitat of *Rorippa calycina* along Boysen Reservoir. Upper photo: population of *R. calycina* in sandy habitat between water and rockier uplands. Note the line of seedlings along the high water mark. Lower photo: ORV tracks running through a *R. calycina* population near a campground. WYNDD photographs by Laura Welp, August 1997.

Figure 6. Topographic position of *Rorippa calycina* on the landscape. Top: sandy terraced banks of reservoir inlet, with stabilized and unflooded bunchgrass-shrub community above the seasonally flooded shore zone occupied by *R. calycina*. Middle: sandy-clay mud flats of gently sloping (0-3%) banks along an inlet channel. Bottom: Cross-section view showing typical location of colonies relative to high and low water marks in normal and high-water years. Illustrations by W. Fertig.

During high-water years, these mudflats may remain inundated throughout the growing season. Colonies are conspicuously absent from rocky shores or steep sandy to muddy banks (with slopes over 2-3%). Known occurrences range in elevation from 3660-6800 feet (1115-2075 meters).

4. SOIL RELATIONSHIPS: *Rorippa calycina* occurs on sandy or clay soils derived from 13 major Permian to Quaternary age formations. Occurrences along Seminoe Reservoir are found primarily on sand and clay soils derived from Cretaceous or Tertiary sandstones and shales of the Ferris, Hanna, and Medicine Bow formations. Colonies at Seminoe Reservoir may also occur on isolated outcrops of the Triassic Chugwater and Satanka formations, Cretaceous Lewis Shale, and Quaternary alluvial deposits. Populations along Boysen Reservoir occur on soils derived from variegated claystones and sandstones of the Tertiary Wind River Formation. Other scattered populations in the state are found on outcrops of the Permian Amsden Formation (Horseshoe member), Cretaceous Cody, Steele, and Niobrara shales, and the Tertiary Willwood and Green River formations (Love and Christiansen 1985). Soils in *R. calycina* habitat are typically loose-textured and non-alkaline (Lichvar 1981).

5. REGIONAL CLIMATE: In Wyoming, the average annual precipitation within the range of *Rorippa calycina* varies from 8 inches (20 cm) in the basins to 12 inches (30 cm) on the eastern foothills of the Absaroka Range (Martner, 1986). The average annual temperature ranges from 36° F (2.2° C) in the eastern foothills of the Wind River Range to 44° F (6.6° C) in the northern basins. Mean minimum and maximum temperatures in January are 4-12° (-15.5 to -11.1° C) and 26-32° (-3.3 to 0° C), while in July mean minimum and maximum temperatures are 48-54° (8.8 to 12.2° C) and 80-88° (26.6 to 31.1° C) (Martner, 1986).

6. LOCAL MICROCLIMATE: The open mudflats and beaches inhabited by *Rorippa calycina* may receive more direct sunlight than the surrounding, more highly vegetated, slopes and bluffs. Any localized increase in temperature, however, may be offset by the cooling effects of the adjacent watercourses.

F. POPULATION BIOLOGY AND DEMOGRAPHY

1. PHENOLOGY: *Rorippa calycina* typically flowers from late May to August, although the blooming season may extend into mid-October under favorable conditions. Fruit are produced from June to September. During high-water years, the onset of flowering may be delayed until later in the season, or may not occur at all.

2. POPULATION SIZE AND CONDITION: There are currently 23 known occurrences of *Rorippa calycina* in Wyoming, divided into 66 subpopulations. Approximately 4250-6820 individuals were observed at 27 subpopulations in 1997 (Table 2). Although current census figures are not available for the other known occurrences, the total population of this species is estimated at 15,000-25,000 plants in Wyoming. This figure is probably conservative, given the amount of unsurveyed (and often poorly accessible) potential habitat along reservoirs in the Wyoming basins.

Census data are not available for populations from the Northwest Territories. The two recent observations in Montana may no longer be extant (Bonnie Heidel, personal communication).

Individual colonies of *R. calycina* may range in size from 10-300 individuals in areas of 0.1-5 acres. This species occasionally is one of the dominant forb species present at a site. More often, populations consist of small clumps or widely scattered individuals that are restricted to suitable, and somewhat patchy microsites. Populations observed in 1997 usually consisted of a mix of size and age classes, including large flowering or fruiting plants, smaller vegetative individuals (often connected to their nearest neighbors by underground rhizomes), and first-year seedlings. Several of the smaller colonies on Boysen and Seminoe reservoirs, however, consisted entirely of vegetative plants or seedlings, perhaps indicating that the colonies were only recently established or exposed by the receding high water line.

Long-term trend data are not available for most Wyoming populations of *R. calycina*. One exception is the population along the southeast shore of Boysen Reservoir, near the highway rest area (EO # 012). In 1992, this site contained a population of several hundred flowering plants on extensive mud flats exposed by unusually low July water levels. The following year, the area was completely flooded by high water all summer long, and no *R. calycina* plants were observed. In 1994, water levels were lower (although not as low as in 1992), and a small population of approximately 50 flowering plants was observed. This population was also observed in flower in October 1996 (although no census was taken) and again in vegetative condition in August 1997. Although only semi-quantitative, these findings suggest that *R. calycina* populations exhibit annual fluctuations based on the amount of unflooded habitat available. The observations also suggest that populations are able to either recolonize exposed sites rapidly from an on-site or nearby seedbank, or able to persist as underground rhizomes until habitat conditions improve. If the latter is true, this species may possess unusual ecophysiological adaptations to flooding and low oxygen environments.

Table 2. Demographic information for Wyoming populations of *Rorippa calycina*

1. North Platte River Valley

Occurrence # 001

Area: 8 acres (8 subpopulations).

Number of Plants: Population estimated in the thousands (Lichvar 1981); also described as “frequent” by R. Dorn.

Density: Not reported.

Evidence of Reproduction: Plants observed in flower and fruit in 1977 and 1979.

Evidence of Expansion/Contraction: Populations have been known from this site since 1977.

Occurrence # 004

Area: Not reported.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: Plants observed in flower and fruit in 1979 (Lichvar 1981).

Evidence of Expansion/Contraction: Not known. Population has not been revisited since 1979.

Occurrence # 007

Area: 15 acres (17 subpopulations).

Number of Plants: 11 colonies in Sec 4, total population estimated at 150-300 plants by W. Fertig; 5 colonies in Sec 13, total population estimated at 300 plants by W. Fertig on 21 August 1997.

Density: Populations are typically patchy.

Evidence of Reproduction: About 5% of the plants in Sec 4 were in flower or fruit, with 95 % vegetative or seedlings in 1997. The Sec 13 colonies were flowering, fruiting, and vegetative in

1997.

Evidence of Expansion/Contraction: Population has been known since 1981 (Lichvar 1981).

Occurrence # 008

Area: 0.25-0.5 acre (2 subpopulations).

Number of Plants: Sec 21 population was estimated at 20-30 vegetative genets (clusters of rosettes connected by a rhizome) by W. Fertig on 21 August 1997. Sec 16 population estimated at 25-40 vegetative plants by W. Fertig on 20 August 1997 and at 50-200 fruiting plants by R. Lichvar on 21 July 1981.

Density: Not reported.

Evidence of Reproduction: Vegetative rosettes observed in 1997 and fruiting plants observed in 1981 (Lichvar 1981).

Evidence of Expansion/Contraction: Populations known since 1981.

Occurrence # 009

Area: 2+ acres (2 subpopulations).

Number of Plants: Sec 20 colony estimated at 50-200 plants by R. Lichvar on 21 July 1981.

Density: Not reported.

Evidence of Reproduction: Both colonies observed in fruit and flower in 1981 and 1997.

Evidence of Expansion/Contraction: Population has been known since 1981. (Lichvar 1981).

Occurrence # 011

Area: 26 acres (5 subpopulations).

Number of Plants: Reported as abundant by A. Warren in 1981.

Density: Not reported.

Evidence of Reproduction: Populations in late flower and fruit in 1981

(Lichvar 1981).

Evidence of Expansion/Contraction: Not

known. Population has not been visited since 1981.

Occurrence # 014

Area: 5-6 acres (2 main subpopulations).

Number of Plants: Sec 26 NE4 colony estimated at 3000-5000 rosettes and Sec 26 NW4 estimated at 2500-3000 individuals by W. Fertig on 20 August 1997. Total population estimated at hundreds of individuals by R. Lichvar on 16 July 1981.

Density: Locally abundant in places, widely scattered and patchy where graminoid cover is high.

Evidence of Reproduction: Sec 26 NE4 population: 1% observed in fruit and flower and 99% first-year seedlings

or new vegetative shoots in 1997.

Large diversity of rosette size classes present. Sec 26 NW4 has 10-20% of population in flower or fruit and 80-90% first year seedlings in 1997.

Plants also observed in flower, fruit, and vegetative in 1981 (Lichvar 1981).

Evidence of Expansion/Contraction:

Population has been known since 1981.

Occurrence # 031

Area: Not reported.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: In flower in 1992.

Evidence of Expansion/Contraction: Not

known. Population has not been surveyed since 1992.

Occurrence # 037

Area: Not reported.

Number of Plants: Not reported.

Density: Reported as locally abundant by A. Roderick.

Evidence of Reproduction: In flower and fruit in 1997.

Evidence of Expansion/Contraction: Not

known. Population was just discovered in 1997.

2. Bighorn Basin

Occurrence # 003

Area: 10+ acres (at least four colonies).

Number of Plants: Plants in Sec 12 colony observed to be locally very abundant by W. Fertig, mostly of small rosettes and seedlings from seed germinated this summer; Sec 15, 17 colonies observed to be locally dominant by E. Evert; Sec 13 colony observed to be very abundant by E. Evert.

Density: Not reported.

Evidence of Reproduction: About 10% of plants observed in flower and almost none in fruit in 1984.

Evidence of Expansion/Contraction:

Populations have been known in this area since 1982.

Occurrence # 006

Area: 10+ acres.

Number of Plants: 1309 plants observed and 7000 estimated by W. Fertig and J. Whipple on 12 June 1994.

Density: Plants clustered near shore and more widely scattered upslope.

Evidence of Reproduction: Plants

observed in fruit and flower in 1983.
Evidence of Expansion/Contraction:
Population has been known since
1983.

Occurrence # 020

Area: Not reported.
Number of Plants: Not reported.
Density: Not reported.
Evidence of Reproduction: Not
reported.
Evidence of Expansion/Contraction:
Not
known. Population has not been
visited since 1981 (Lichvar 1981).

Occurrence # 035

Area: Not reported.
Number of Plants: Not reported.
Density: Not reported.
Evidence of Reproduction: In bud and
flower in 1990.
Evidence of Expansion/Contraction:
Not
known. Population has not been
visited since 1990.

3. Laramie Basin

Occurrence # 005

Area: Not reported, but probably less
than 2 acres.
Number of Plants: Not reported.
Density: Not reported.
Evidence of Reproduction: Plants were
in flower and fruit in July 1979.
Evidence of Expansion/Contraction:
Not
known; population has not been
resurveyed since 1979.

Occurrence # 036

Area: Not reported.
Number of Plants: Not reported.
Density: Not reported.

Evidence of Reproduction: In flower
and fruit in 1997.

Evidence of Expansion/Contraction:
Not
known. Population has only been
known since 1997.

4. Wind River Basin

Occurrence # 012

Area: 8 + acres (5 subpopulations).
Number of Plants: Total population
estimated by L. Welp at 550-850
individuals on 25 August 1997, with
individual colonies ranging in size
from
20-300 plants.
Density: Patchy to locally abundant and
clustered.
Evidence of Reproduction: Only
seedlings observed in 1997. Plants
observed in flower and fruit in 1996.
Population consisted mostly of rosettes
in 1994 (less than 15% in flower, and
5% in fruit). Also observed in flower
in
1992 and in fruit in 1988 and 1981.
Evidence of Expansion/Contraction:
Population has been known since 1981
and observed annually since 1992 at
Sec 21 site.
Abundance varies from year to year,
depending on water levels. During the
low-water year of 1992, hundreds of
individuals were observed, but none
were found the following year when
water levels were high. Low
population numbers were found in
1994 and 1997 when limited areas of
mud flats were exposed.

Occurrence # 023

Area: Not reported.
Number of Plants: Not reported.
Density: Not reported.

Evidence of Reproduction: In bud, flower, and fruit in 1985 (Haines 1988).

Evidence of Expansion/Contraction:

Not

known. Population has not been surveyed since 1985.

Occurrence # 025

Area: Not reported.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: In flower and fruit in 1985 (Haines 1988).

Evidence of Expansion/Contraction:

Not

known. Population has not been surveyed since 1985.

Occurrence # 027

Area: Not reported.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: In flower and fruit in 1985 (Haines 1988).

Evidence of Expansion/Contraction: Not

known. This population could not be relocated in 1997 due to high water levels.

Occurrence # 034

Area: 0.1 acres.

Number of Plants: Total population estimated by L. Welp at 210-320 plants. Sec 17 population has ca 100 seedlings; Sec 29 population has 100-200 seedlings; Sec 31 population has 10-20 plants.

Density: Patchy.

Evidence of Reproduction: Only seedlings observed in 1997.

Evidence of Expansion/Contraction: Not

known. Population has only been known since 1997.

5. East slope Wind River Range

Occurrence # 021

Area: Not reported, but probably less than 1 acre.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: In flower and fruit in 1986 (Fertig 1995).

Evidence of Expansion/Contraction: Not

known. Population could not be relocated in surveys from 1993-95 (Fertig 1995).

6. Great Divide Basin

Occurrence # 032

Area: Not reported, but probably less than 1 acre.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: In fruit and flower in 1994 (Welp et al. 1996).

Evidence of Expansion/Contraction: Not

known. Population has not been revisited since being discovered in 1994.

7. Green River Basin

Occurrence # 033

Area: Not reported, but probably less than 2 acres.

Number of Plants: Not reported.

Density: Not reported.

Evidence of Reproduction: In flower and fruit in 1995 (Refsdal, 1996).

Evidence of Expansion/Contraction: Not

known. Population has not been revisited since being discovered in 1995.

Lichvar (1981) conservatively estimated the total population of this species to be 21,000 based on surveys of 19 subpopulations from 1979-81.

Current estimates are comparable to Lichvar's estimates, although they are based on a larger number of locations. While apparently stable at present, long-term trends suggest that *R. calycina* is increasing, at least in Wyoming (Rollins 1993). The scarcity of collections in the United States from 1854-1977 suggests that this species may have been extremely uncommon during the era of early European exploration and settlement. The proliferation of man-made reservoirs and stock ponds in Wyoming during the 20th Century has probably greatly increased the amount of habitat available to this species and resulted in a population increase (Lichvar 1981).

3. REPRODUCTIVE BIOLOGY:

- a. TYPE OF REPRODUCTION: *Rorippa calycina* reproduces sexually by seed and asexually from elongating, perennial rhizomes. Mulligan and Porsild (1966) report that it is self-compatible.
- b. POLLINATION BIOLOGY: No detailed information is known about the pollinators of *Rorippa calycina*. Small bees were observed visiting flowers on Yellowtail Reservoir (EO # 006) in 1994.
- c. SEED DISPERSAL AND BIOLOGY: *Rorippa calycina* produces an average of 20 seeds per fruit (Stuckey 1972). These seeds are probably dispersed by muddy waterfowl (Rollins 1993). Transport by migrating waterfowl may explain the unusual bipolar geographic distribution of this species (Lichvar 1981). Mulligan and Porsild (1966) found that seeds could germinate within 2 days, suggesting that establishment at a site may be rapid. It is not known whether *R. calycina* is able to maintain a seedbank, especially at sites that are alternately flooded or exposed from year to year. The perennial growth habit of this species would suggest that seedlings established during the summer are capable of overwintering. It is not known if seedlings are capable of flowering in their first year, although observations of undersized flowering individuals in 1997 suggest that this may occasionally occur.

G. POPULATION ECOLOGY:

1. GENERAL SUMMARY: Populations of *Rorippa calycina* are typically found on moist, sandy beaches or mudflats along the margins of man-made reservoirs, small ponds and streams. Topographic features and water levels appear to be more important than geologic substrates in determining where this species becomes established. *R. calycina* habitats are usually sparsely vegetated with bunchgrasses, early-successional or weedy forbs, and scattered shrubs. Population size and density varies from sparse to locally abundant depending on seasonal flooding, the amount of competing

vegetative cover, and disturbance. Colonies are most abundant during years with low water levels, but appear to be able to persist during periods of flooding due to perennating rhizomes or a seedbank. High seed production, asexual reproduction, and self-compatibility are adaptations possessed by *R. calycina* that allow it to colonize bare ground.

2. COMPETITION: *Rorippa calycina* is typically found on seasonally flooded sites with low vegetative cover (often under 25%). It appears to be absent from sites that are not periodically disturbed and does not tolerate shading. Populations may be in decline in areas where the disturbance-adapted vegetation is being replaced by *Tamarix* or other shrubs.
3. HERBIVORY: In general, there is little evidence of herbivory on this species by large ungulates or domestic livestock. Fruits and inflorescences may be grazed by insects or small rodents.
4. HYBRIDIZATION: There is no evidence of hybridization between this and other species of *Rorippa*.

H. LAND OWNERSHIP (Table 3)

1. BLM: All or part of 14 occurrences of *Rorippa calycina* in Wyoming are found on lands managed by the BLM. Two populations are managed by the Worland District (Bighorn Basin and Cody resource areas). The remaining populations are on lands managed by the Rawlins District (Great Divide and Lander resource areas). One of these occurrences may be located within the Red Canyon Management Unit ACEC.
2. NATIONAL PARK SERVICE: One population is found along the banks of Horseshoe Bend in Bighorn Canyon National Recreation Area.
3. US FOREST SERVICE: One occurrence is found in Flaming Gorge National Recreation Area, managed by Ashley National Forest.
4. U.S. FISH AND WILDLIFE SERVICE: One population on Pathfinder Reservoir occurs within Pathfinder National Wildlife Refuge.
5. BUREAU OF RECLAMATION: Portions of six populations occur within the Bureau of Reclamation withdrawal along Seminoe Reservoir.

Table 3. Land management status of known occurrences of *Rorippa calycina* in Wyoming.

1. Bureau of Land Management	4. US Fish and Wildlife Service
A. Rawlins District	Pathfinder National Wildlife Refuge
Great Divide Resource Area	EO# 009 (in part)
EO# 001 (in part)	
EO# 004 (in part)	5. Bureau of Reclamation
EO# 007 (in part)	EO# 001 (in part)
EO# 009 (in part)	EO# 004 (in part)
EO# 011 (in part)	EO# 007 (in part)
EO# 014 (in part)	EO# 008 (in part)
EO# 031	EO# 009 (in part)
EO# 032	EO# 011 (in part)
EO# 036	EO# 014 (in part)
EO# 037	
Lander Resource Area	6. State of Wyoming
EO# 021 (in part)	A. Boysen State Park
B. Worland District	EO# 012
Bighorn Basin Resource Area	EO# 023
EO# 020	EO# 025
Cody Resource Area	EO# 027
EO# 035	EO# 034
2. National Park Service	B. Buffalo Bill State park
Bighorn Canyon NRA	EO# 003
EO# 006	C. Seminoe State Park
3. US Forest Service	EO# 007 (in part)
Flaming Gorge NRA (Ashley National Forest)	EO# 008 (in part)
EO# 033	7. Private
	EO# 005
	EO# 021 (in part) TNC Red Canyon Ranch

6. STATE OF WYOMING: One occurrence of *R. calycina* is found in Buffalo Bill State Park and five are known from Boysen State Park. Portions of two other populations are found in Seminoe State Park.
7. PRIVATE: All or part of two Wyoming populations are on private lands, including The Nature Conservancy's Red Canyon Ranch preserve.

II. ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

A. POTENTIAL THREATS TO CURRENTLY KNOWN POPULATIONS: A small geographic range, high habitat specificity, and dependence on periodic disturbance makes this species potentially vulnerable to extirpation. The following potential threats were observed in 1997 field surveys or have been reported in the literature:

1. WATER MANAGEMENT: Increasing water storage capacity may be the primary threat to populations of *Rorippa calycina* along man-made reservoirs in central and western Wyoming (R. Lichvar, unpublished data).

Raising water levels could permanently inundate lower-lying colonies of this species, preventing the germination of existing seedbanks. Although the loss of low-lying sites could be offset by the creation of similar habitats on newly flooded, higher banks, migration of *R. calycina* to these new sites would require an off-site seed source since the existing seed bank would be flooded. Colonization of new habitat might be very slow unless augmented by human release of *R. calycina* seed. Water levels at Seminoe Reservoir would have been permanently raised at Seminoe Reservoir under the proposed Stage III project in the mid-1980s.

Maintaining reservoirs at a constant level may also be a potential problem for this species in that it would encourage later successional species to become established and crowd out populations of disturbance-adapted plants like *R. calycina*. Current management, in which water levels fluctuate annually, appears to be ideal for periodically creating new microsites favorable for *R. calycina* colonization.

2. RECREATION: 15 of the 23 known occurrences of *Rorippa calycina* in

Wyoming are found along the shores of reservoirs near popular campgrounds, boat ramps, and other high-use recreation areas. Impacts from fishing, swimming, boating, hiking, and other non-motorized activities appear to be minimal at these sites. Off-road vehicle (ORV) use, however, may result in significant soil compaction or uprooting of plants in beach areas (Figure 5).

3. EXOTIC PLANTS/WEED CONTROL: Competition from exotic species may impact population recruitment. Many sandy beaches along reservoirs are becoming infested with *Tamarix chinensis*, which could stabilize the substrate over time and reduce the amount of disturbed habitat available for *Rorippa calycina*. The increased shade may also have adverse effects on the population. Additionally, the Bureau of Reclamation uses pesticides for weed control around the reservoirs, which may affect plants that come into contact with the pesticide (George Neuberger, Bureau of Reclamation, personal communication).

4. GRAZING: Little evidence of herbivory on leaves or stems of *Rorippa calycina* was observed during 1997 surveys. Clark and Dorn (1981) also report that this species does not appear to be impacted by normal levels of grazing. Construction of stock ponds in the Bighorn Basin and North Platte River Valley may have actually increased the amount of habitat available for this plant. However, some beach sites, such as the O'Brien Creek arm of Seminoe Reservoir (EO # 007), may become heavily trampled and less suited for *R. calycina* habitat if livestock use is high.

5. MINERAL DEVELOPMENT: Large coal deposits are mined south of Seminoe Reservoir, but no mining is currently occurring within occupied *R. calycina* habitat. Potential impacts from air pollution or surface runoff are not known.

6. OTHER: Populations of *R. calycina* in small inlets of Seminoe Reservoir may receive high use by wildlife species, especially deer and raccoons. It is not known if trampling or herbivory by wildlife is a potential threat to this species.

B. MANAGEMENT PRACTICES AND RESPONSE: *Rorippa calycina* appears to be pre-adapted to colonize periodically exposed reservoir and pond banks. Its present distribution and abundance is strongly linked with man-made water bodies, and thus the plant's continued survival may be strongly related to management activities at these sites. Continued maintenance of fluctuating water levels may be necessary for the long-term survival of this species. Additional research is needed to determine the possible impacts of competition from *Tamarix* and effects of herbicides on populations of *R. calycina*.

C. CONSERVATION RECOMMENDATIONS:

1. RECOMMENDATIONS REGARDING PRESENT OR ANTICIPATED ACTIVITIES: Current management of water levels at the state's larger reservoirs appears to be conducive to the establishment and maintenance of colonies of *Rorippa calycina*. Changes in management could have a major impact on this species if low-lying colonies are permanently inundated and

the seed source for new colonization of higher mudflat sites is lost. The spread of *Tamarix* may negatively impact shoreline populations of *R. calycina* and may require a control program. The application of herbicides, however, may itself be a threat to *R. calycina*. Alternative methods of pest management, such as biological controls, should be investigated. ORV use may need to be restricted in some sensitive shoreline habitats occupied by *R. calycina*.

2. AREAS RECOMMENDED FOR PROTECTION: Eleven of the 23 known occurrences of *Rorippa calycina* are on lands with some special management status. Of these, 9 are in National Park Service or state park areas with a management emphasis on recreation (Bighorn Canyon NRA and Boysen, Buffalo Bill, and Seminoe state parks). One occurrence is protected within Pathfinder National Wildlife Refuge and another is protected at the Red Canyon ACEC and adjacent Red Canyon Ranch preserve (managed by The Nature Conservancy). This latter population, however, has not been relocated since 1986 and is in fairly marginal habitat (Fertig 1995). All other populations on BLM, Forest Service, or private lands are managed for recreation, livestock grazing, and water storage. Existing protective areas may be adequate for the survival of *R. calycina* provided that managers take into greater account the plant's management needs. Areas of pristine wetland habitat should be sought for this species and, if found, provided adequate protection.

D. STATUS RECOMMENDATIONS: The discovery of 23 occurrences of *Rorippa calycina* in Wyoming since 1977 indicates that this species is not in imminent danger of extinction and does not warrant being listed under the Endangered Species Act at the present time. Surveys in 1997 suggest that the overall population of this species is relatively stable, although annual fluctuations are likely depending on summer water levels. Nevertheless, *R. calycina* remains in potential jeopardy from changes in watershed management, competition from late successional or exotic species (especially *Tamarix chinensis*), high recreation use, and herbicides over its relatively small geographic range. The BLM Wyoming State Office should list *R. calycina* as a "watch list" species and develop appropriate management strategies to ensure that actions by the agency do not contribute to future endangerment of the species and subsequent listing under the Endangered Species Act.

V. SUMMARY: *Rorippa calycina* is a regional endemic of south-central Montana, western North Dakota, and central Wyoming, with a disjunct population center on the Arctic coast of the Northwest Territories (a distance of 2500 miles). It was formerly a candidate for listing under the Endangered Species Act until the candidate program was revised in 1996. Surveys since 1977 have documented 23 occurrences (composed of 66 subpopulations) in Wyoming, most of which are associated with artificial reservoirs or stock ponds in the North Platte River Valley, and Wind River, Bighorn, Great Divide, Green River, and Laramie basins. Based on surveys in 1997, the statewide population is conservatively estimated at 15,000-25,000 plants. This figure is approximately equal to the

population estimate of Lichvar (1981), although current estimates are based on a larger number of samples. Individual populations may fluctuate in numbers from year to year, depending on summer high-water levels. Populations are largely restricted to mudflats and sandy beaches in small inlets in reservoirs or along the flat banks of small ponds and streams. These sites are typically inhabited by a variety of native or exotic bunchgrasses and early-successional forb species. *R. calycina* is notably absent from rocky or steep slopes and areas with dense cover of forbs or shrubs. Periodic flooding and recession of water appears to be necessary for the establishment and maintenance of *R. calycina* colonies. Changes in water management that reduces this periodicity of disturbance or permanently inundates low-lying seed banks may be the primary threat to survival of this species. Additional threats include competition from aggressive weedy species (especially *Tamarix chinensis*), habitat degradation by high recreation use, and herbicide spraying. Nearly one-half of the currently known populations are found within state or national parks managed primarily for recreation use. Although presently secure, the high degree of potential threats to this species makes it a good candidate for state BLM watch-list status.

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Appendix A.
Element Occurrence Records and Population Maps
for *Rorippa calycina*