STATUS OF *RORIPPA CALYCINA* (PERSISTANTSEPAL YELLOWCRESS) IN WYOMING

Prepared for the Bureau of Land Management
Wyoming State Office, Cody, Lander, Rawlins and Worland Field Offices

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ABSTRACT

Rorippa calycina (Persistantsepal yellowcress) was discovered in Wyoming in 1977 at Seminoe Reservoir. Two systematic surveys have been conducted for it focusing on reservoir settings. This project was proposed to evaluate its natural habitat, its persistence in reservoir habitat, and to present a current compilation of records that include all intervening years. The resulting report provides evidence that it is a natural part of the flora in ephemeral wetlands and dry washes of the Wyoming Basins Ecoregion. Records of the past decade show that it is also widespread at stock dams of the BLM Cody Field Office. It generally persists at large reservoirs and, perhaps most important, is now known from up to 41 occurrences, thus providing a broader picture of its natural adaptations and resilience.

ACKNOWLEDGEMENTS

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Cover photo: *Rorippa calysina* (Persistantsepal yellowcress) at Boysen Reservoir. Bonnie Heidel.

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I. INTRODUCTION

Rorippa calycina (Persistantsepal yellowcress) was first discovered by F. V. Hayden in 1854 at two locations about 150 miles apart (aerial) on the Yellowstone River, in both Montana and North Dakota. During the next 120 years, this species was observed only three more times, once in Montana and twice on the Arctic coast of the Northwest Territories (Mulligan and Porsild 1966). The apparent scarcity of *R. calycina* was basis for characterizing it as threatened in a report prepared by the Smithsonian Institution (1975) at the direction of Congress under the Endangered Species Act; later recommended for listing as Threatened under the Endangered Species Act (Ayensu and DeFillipps 1978). It was not listed at that time, and remained a species under review by the US Fish and Wildlife Service.

This species was first discovered in Wyoming on the Seminoe Reservoir in Wyoming 1977 by Ronald Schreibes, bringing it to the attention of Wyoming botanists conducting extensive fieldwork. From 1979-1981, nine additional occurrences were discovered in the state and a new population was located in Montana (Lichvar 1981). One collection was made on the Medicine Bow River by Ronald Hartman (*10386* RM); all others were made on reservoirs. The first Wyoming survey was conducted by Robert Lichvar in 1980 (Lichvar 1981) who targeted both reservoirs and free-flowing river in five days of fieldwork that took him from southern Wyoming to the Yellowstone River and Fort Peck Reservoir in Montana. Lichvar found it to be extensive on Seminoe Reservoir (North Platte River) but did not find it in downstream reservoir surveys (as far as Guernsey Reservoir), or on free-flowing rivers (the Medicine Bow and the Powder Rivers) or at any other survey sites. He compiled information on the known collection sites and evaluated habitat suitability where it was sought but not found. He considered it to be threatened by potential changes in water management and herbicide use. For 15 years following Lichvar's study, additional collections of *R. calycina* were made. A second study was conducted by Fertig and Welp (1998) leading to 23 discrete locations (occurrences), many with multiple locations (suboccurrences) as representing the most up to date and extensive information on the species.

In 2001, *Rorippa calycina* was designated Sensitive in Wyoming (USDI BLM 2001). For another 15 years afterward, additional collections were made. Finally, in 2017, a third Wyoming study of *R. calycina* was proposed to provide an updated compilation, to seek native habitat context, and to begin to address the interchangeability of disturbed habitat, particularly reservoirs, with native habitat. The work was carried out in 2020 and the resulting report summarizes existing data on the biology, distribution, habitat, population size and potential threats of *R. calycina* in Wyoming.

II. METHODS

Information on the distribution and habitat of *Rorippa calycina* was compiled at the Wyoming Natural Diversity Database (WYNDD) for field planning, focusing on records that had not been addressed in prior WYNDD reports. The Rocky Mountain Herbarium online database was also queried to check for any additional records. This included 13 new records collected by the BLM Cody Field Office that and three records provided by the BLM Rawlins Field Office.

Potential distribution of *Rorippa calycina* has been characterized in two potential distribution modeling projects (Fertig and Thurston 2003, Andersen et al. 2016). In both models, the species' restriction to wetland habitat resulted in a pixelated pattern of potential distribution concentrated in basins of the Wyoming Basins Ecoregion where it was already known to occur.

Fieldwork to survey *Rorippa calycina* was originally planned for five field offices in 2020 with field assistants, but travel limits constrained work to independent surveys in two field office. The 2020 surveys were conducted on 10 days on July 7, 10-11, 15-17, 22-23, and August 19-20. Boysen Reservoir visits were made incidental to *Cryptantha subcapitata* fieldwork on 8 June. The priority for surveys were to relocate collections that had only a single visit in order to get more robust survey data, particularly those in native habitat, to relocate 1997 surveys that had been mapped accurately on reservoir shores to evaluate persistence, and to survey for new locations using aerial imagery.

III. RESULTS - SPECIES INFORMATION

A. Classification

1. Species Scientific name: *Rorippa calycina* (Engelm.) Rydb. (Rydberg 1900. Stuckey 1972). The lectotype species was collected by F.V. Hayden in 1854 (Hayden s.n. MO) from: sandy bottoms on Yellowstone [River] near Fort Sarpy. Stuckey placed this near the town of Sheffield in Custer County, Montana upstream from Miles City, Montana. Sometime that same year, Hayden also collected it at the mouth of the Yellowstone near Fort Union in MacKenzie County, North Dakota.

2. Synonyms: none

3. Common name: Persistantsepal yellowcress

4. Family: Brassicaceae (Mustard Family)

5. Size of genus: The *Rorippa* genus has 85 species worldwide; 22 of them are in western North America and nine are in Wyoming; the others are in the Andean region of South America (Al-Shehbaz 2010).

6. Phylogenetic relationships: All information on relationships presented in Fertig and Welp (1998) remains current and succinct. They said: *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. The former was originally treated as a variety of *R. calycina*. According to Stuckey, all three represent old, relic species and the only survivors of a formerly more widespread and morphologically variable complex. They all have globes to subglobose fruits, pointed tapering hairs and generally less than 35 seeds per silicle. Among Wyoming species, *R. calycina* is most closely related to *R. sinuata* (Stuckey 1972).

B. Present legal or other formal status

1. National 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* has no legal status under the Act.

2. Global Heritage rank: *Rorippa calycina* has a Global Heritage rank of G3 – vulnerable globally – assigned by NatureServe. This indicates that the species is rare or local throughout its range. This has generally been assigned for species having 21-100 occurrences.

3. State Legal status: BLM sensitive (USDI BLM 2001). This report presents the most current species' distribution and habitat information for re-evaluating salient data against BLM sensitive designation criteria.

4. State Heritage rank: The State Heritage rank is S3 – vulnerable in Wyoming. There are at least 41 occurrences, at least one of which is not extant, and nine of which might be part of population complexes. This information that is presented with the rest of State Rank information in this report. The State rank and Global rank are the same because Wyoming is the only jurisdiction where it is known to be extant and acknowledged as a native member of the state flora.

In Montana and North Dakota, it has a state rank of SH (known only from historic collections). In addition, it has been collected in the Northwest Territories where its rank is SU (status undetermined) based on the question raised by Mulligan and Porsild (1966) whether it could be present in the flora as "introduced" or accidental as a non-native species or an accidental native species that does not persist. The authors inferred it could have been introduced by man, but Lichvar noted that it seems at least as plausible that it could have been an accidental introduction associated with migratory waterfowl. The first two collections were in 1962, 1965 and 1997, with no additional information to indicate whether it was common were collected or persisting since collection (Northwest Territories Species Search 2021).

C. Description

1. General non-technical description: Persistentsepal yellowcress is a perennial herb with stems 10-40 cm tall; it is reported as rhizomatous (Fertig and Welp 1998). The stems and foliage are pubescent throughout with stiff, unbranched tapering hairs expanded at the base. 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 (Al-Shehbaz 2010, Hitchcock et al. 1964, Dorn 2001, Fertig et al. 1994).

2. Technical description: Perennial; densely hirsute throughout (trichomes pointed, expanded basally). Stems simple or few from base, erect to prostrate, branched distal, 1-4 dm. Basal leaves sessile; blade oblong to oblanceolate (lateral lobes oblong to obovate), 2.5-5.5 (7) cm x 5-13 mm, base auriculate to amplexicaul, margins sinuate. Racemes elongated. Fruiting pedicles ascending to suberect (somewhat appressed to rachis), strait or curved, 2-5(-6) mm (glabrous or sparsely hirsute). Flower sepals persistent after anthesis, ascending, oblong-ovate, (2.2-) 2.5-3.7 x 0.7-1.4 mm; median filaments 1.8-2.2 mm; anthers oblong, 0.5-0.6 mm. Fruits silicles, straight, globes or broadly oblong, 2-4 x 1.5-2.5 mm, valves short-strigose; ovules 30-44 per ovary; style 1-2.5 mm. Seeds biseriate, yellowish, ovoid, 0.6-0.7 mm (0.4-0.6 mm diam.), colliculate (Al-Shehbaz 2010).

3. Local field characters: The perennial growth form, fruit shape as globose to subglobose, hairiness throughout with unbranched tapering hairs expanded at the base, and the persistent sepals are diagnostic. The leaves are sinuate-lobed their entire length with round-lobed leaflets.

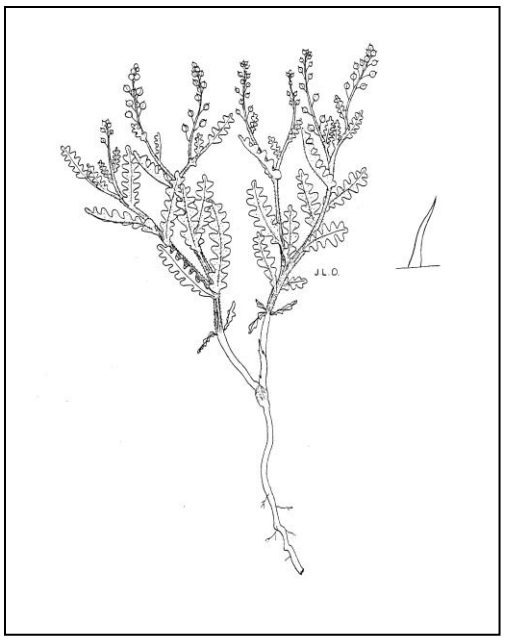

Figure 2 (above). *Rorippa calycina* whole plant, by Bonnie Heidel. Note burial in sand.

Figure 1 (above). *Rorippa calycina*, by Jane L. Dorn. In: Fertig et al. 1994.

Figure 3 (above). *Rorippa calycina* whole plant, by Walter Fertig

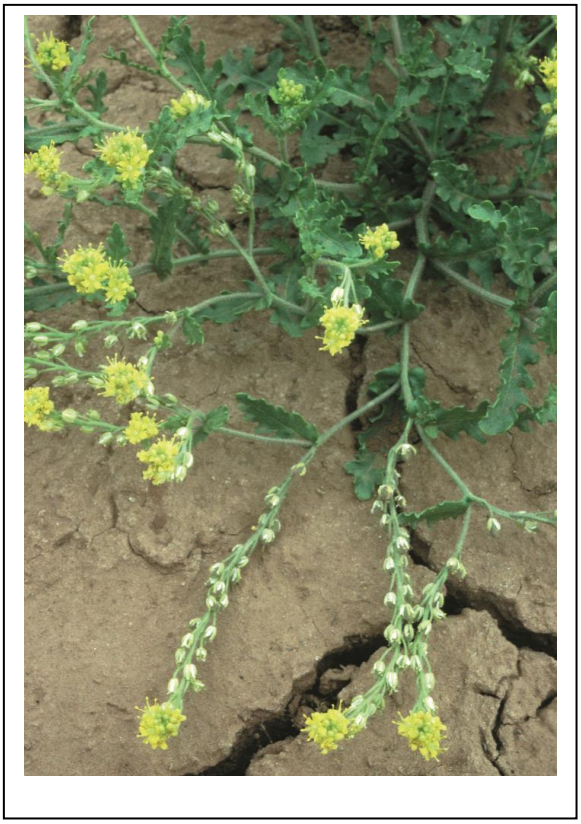

Figure 4 (right). *Rorippa calycina* close-up, by Jennifer Whipple. Note the persistent sepals on the fruits.

4. Similar species: *Rorippa sinuata* has fruits that are generally over 3X longer than wide, over 5 mm long, with 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. 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. Seedlings of *Ambrosia tomentosa* have wider leaves with whitish undersides. Seedlings of annual *Potentilla* species typically have 3-5 round-lobed leaves.

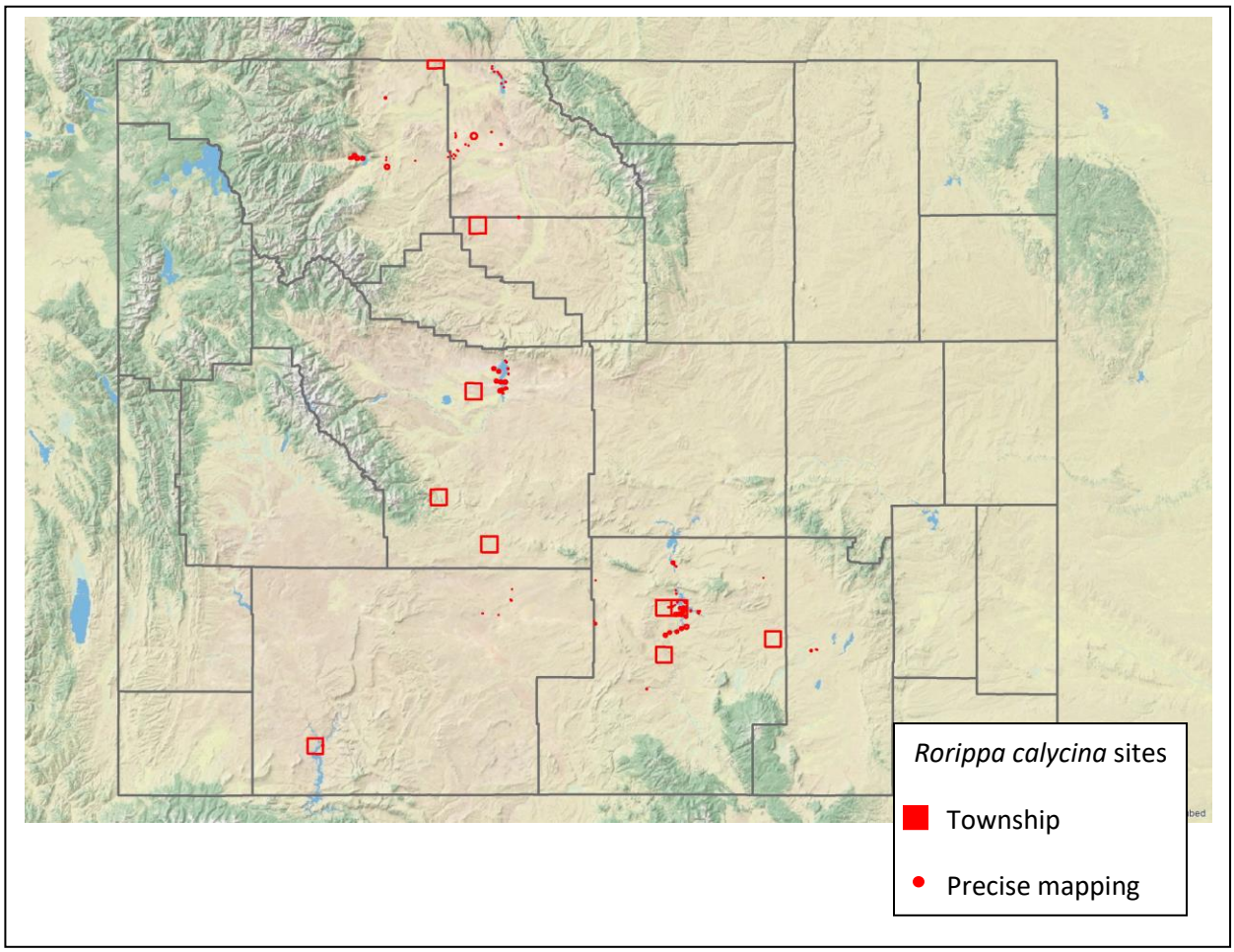

Figure 5 (above). Distribution of *Rorippa calycina* in Wyoming.

D. Geographical distribution

1. Range: Regional endemic of south-central Montana, northwestern 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; Fertig and Welp 1998, Heidel 2001, Al-Shehbaz 2010). The only known extant populations are in Wyoming, where it is found in the Wyoming Basins Ecoregion on the Big Horn, Green, Medicine Bow, North Platte and Green River drainages, and elsewhere in the Big Horn, Great Divide, Laramie and

Wind River Basins (Albany, Big Horn, Carbon, Fremont, Park, Sweetwater, and Washakie counties). Early reports of it from Nebraska are based on misidentification (Steinauer pers. commun. 2021). In the past, it was also been reported in some floras that had not recognized the distinction between it and *Rorippa columbiae* (e.g., Hitchcock and Cronquist 1973). Some sources such as the PLANTS database also include it in the Idaho flora based on Davis (1952) who inferred it to be present in Idaho based on its presence in both Montana and Wyoming.

2. Extant sites: Fertig and Welp (1998) reported 23 occurrence records in the database, following occurrence standards that include separation distance. Records are no longer stored as occurrences in the WYNDD database, but they represent working approximations of populations, and there are now about 41 comparably discrete locations (18 records added since 1997)(Table 1). In 1998 and 2021 tallies, 12 of the records are on three reservoirs so they might possibly be thought of as three population complexes. Though on the same body of water, each location or cluster of locations reflect nearest inflow and shoreline contours, and so they are still regarded as separate. Floristics inventories conducted through the Rocky Mountain Herbarium contributed greatly to species' distribution (Refsdal 1996, Roderick et al. 1999, Taylor 2000, Welp et al. 1995, 1996, Welp 1997).

There were 28 waypoints recorded for *R. calycina* in 2020 as part of this study, but only one represents a new discrete sites. One new location and 48 more negative waypoints were documented in 2021.

3. Historical sites: None.

4. Unverified/Undocumented reports: None.

5. Sites where present status not known: Two occurrences had at least one unsuccessful relocation attempt. One of these is at the south end and east side of Boysen Reservoir, first found in 1985, but could not be located in a highwater condition of 1997 (#027). The population on Red Canyon Ranch (#021) could not be relocated, and its ponded creek habitat may have disappeared.

The potential distribution model of Fertig and Thurston (2003) accurately predicted the extent of potential habitat in the Big Horn Basin, and indicates that there is more potential habitat in Fremont County. Potential habitat in Campbell and Natrona counties (Figure 6) is less likely because they are mostly outside of the Wyoming Basins Ecoregion. The 2016 potential distribution model of Andersen et al. showed similar patterns (Figure 7).

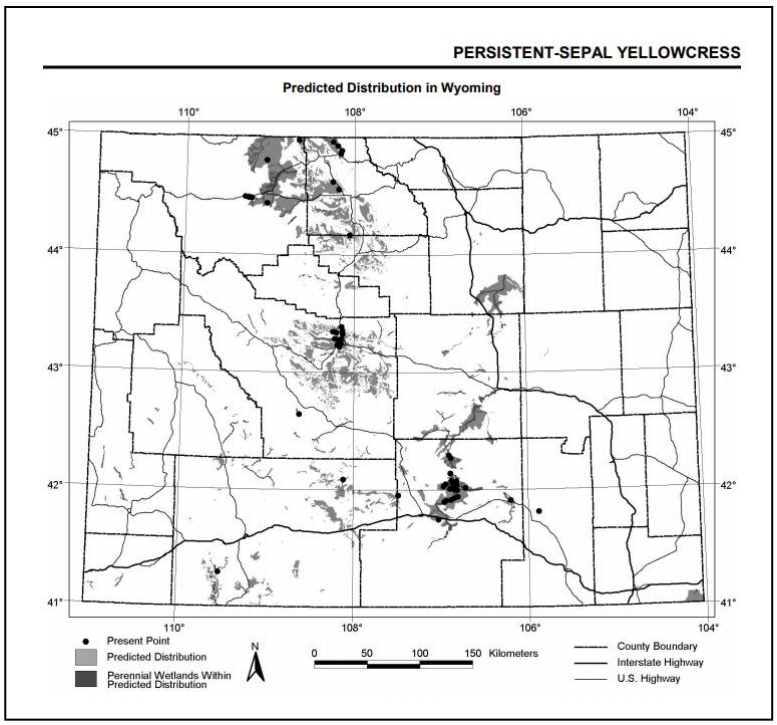

Figure 6. *Rorippa calycina* potential distribution in Fertig and Thurston (2003)

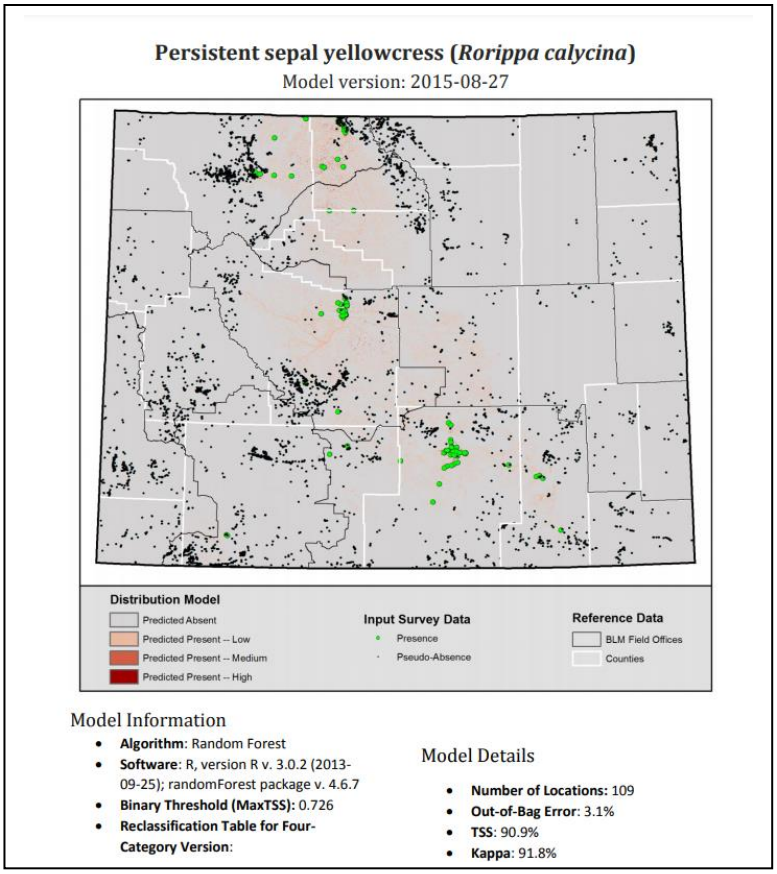

Figure 7. *Rorippa calycina* potential distribution in Andersen et al. (2016)

Table 1. Location information for known occurrences of *Rorippa calycina* on public land

EO#[1]	Site location	County	Legal Description[2] - no. of unique locations	USGS 7.5' Quad (s)	Last obs date	Agency	2020-21 survey
001	Seminoe Reservoir South end	Carbon	T24N R84W; T23N R84W; 8 locations	Seminoe Dam SE, Pats Bottom	1981	BOR BLM pvt	-
002	Dry Creek, small reservoir	Big Horn	T53N R94W Sec 20 – 1 location	Sheep Canyon	1999	BLM	-
003	Buffalo Bill Reservoir	Park	T52N R103W Sec 7, 15, 17, 18; T52N R104W Sec 12, 13; 14; locations	Irma Flats, Castle Rock Creek, Logan Mountain	1994	Buf Bill SP	-
004	Seminoe Reservoir East side	Carbon	T24N R84W Sec 1 – 1 location	Seminoe Dam SE	1979	BOR BLM	-
005	Medicine Bow River	Carbon	T22N R78W	Medicine Bow	1979	pvt	-
006	Yellowtail Reservoir, North end	Big Horn	T57N R94W Sec 7, 8, 16, 21,26; T57N R95W Sec 12; T58N R955W Sec 36; 14 locations	Kane, Natural Trap Care, Sykes Spring	1998	BigHNRA	-
007	Seminoe Dam West side	Carbon	T24N R84W; T24N R85W; 17 locations	Seminoe Dam SW	2020	BOR BLM pvt	Confirmed
008	Seminoe Reservoir, NW corner	Carbon	T25N R84W Sec 16, 21; 2 locations	Seminoe Dam SW, Seminoe Dam	1997	BOR BLM State	-
009	Pathfinder Reservoir, SE corner	Carbon	T27N R84W Sec 20, 33; 2 locations	Pathfinder Reservoir SW	2020	FWS BLM	Confirmed
011	Seminoe Reservoir, upstream backwater	Carbon	T22N R84W; T22N R85W; T23N R84W; 5 locations	Pats Bottom, Ferris Lake	1981	BOR BLM pvt	-
012	Boysen	Fremont	003N006ESec	Hidden	2005	Boysen	-

[1] The numbering is not sequential because it reflects past splitting and lumping of occupied habitat into occurrences. Gaps in numbering were reassigned in 2000 data entry.

[2] Electronic shapefiles accompany this report, taking the place of detailed legal descriptions.

	Reservoir South central		9,10,15, 16, 17,21; T38N R94W Sec 20; 5 locations	Valley, Bonneville SW		SP	
014	Seminoe Reservoir, Medicine Bow R backwater	Carbon	T84N R83W; 4 locations	Schneider Ridge, Seminoe Dame SE	1997	BOR pvt	-
020	Sixmile Creek, small reservoir	Big Horn Washakie	T48N R93W Sec 6; T49N R93W Sec 32; 2 locations	Schuster Flats NE	1981	BLM	-
021	Red Canyon	Fremont	T31N R99W; 1 location	Wolf Point	1986; couldn't be relocated in 1997	pvt	-
023	Boysen Reservoir W side	Fremont	004N 005E Sec 36 N ½; 004N 006E Sec 32; 2 locations	Bonneville SW	2012	Boysen SP	-
025	Boysen Reservoir NW corner	Fremont	004N 005E Sec 2, 7; 2 locations	Bonneville SW, Mexican Pass SE	1985	Boysen SP	-
027	Boysen Reservoir part of E side	Fremont	003N 006E Sec 3 or 4; 1 location	Bonneville SW	1985 (failed to find in 1997)	Boysen SP	-
031	Small reservoir N of Hogback Ridge	Carbon	T21N R85W; 1 location	Smith Draw East, Sinclair	1992	pvt	Adjoining public land was surveyed-not found
032	Lost Creek below Eagles Nest Spring	Sweetwater	T24N R95W Sec 2 SW ¼, 3 NE ¼; 7 locations	Eagles Nest Draw, Lost Creek Lake	2020	BLM	Confirmed in part
033	Flaming Gorge	Sweetwater	T15N R108W Sec 13; 2 locations, both sides of reservoir	Halfway Hollow East	1995	Ashley NF	-
034	Boysen Reservoir part of east	Fremont	005N 006E Sec 21; T39N R94W Sec 17, 29, 31; 7 locations	Bonneville SW, Boysen	2020	Boysen SP	Confirmed in part
035	Big Sand Coulee	Park	T56N R101 W Sec 34; 1 location	Badlands Hills	1990	BLM	-
036	Laramie	Albany	T21N R76W Sec 12;	Cannonball	2020	BLM	Confirmed

	Basin on Fetterman Rd		1 location	Cut, Wilcox			
037	Upland area near S end of Seminoe Reservoir	Carbon	T24N R84W Sec 32; 1 location	Ferris Lake, Seminoe Dam	1997	BLM	-
038	15-mile Cr	Big Horn	T54N R95W Sec 27; 1 location	Dutch Nick Flat NW, Sucker Dam	2002	BLM	-
040	Little Dry Cr	Big Horn	T54N R95W Sec 27; 1 location	Emblem SE	1987	BLM	-
041	W of Frannie	Park	58N R98W; 1 location	Deaver Reservoir	1987	pvt	-
042	Spring Cr	Park	T51N R101W Sec 31; 2 locations	Indian Pass	2013	BLM	-
043	Hay Reservoir	Sweetwater	T24N R96W Sec 36; 1 location	Bush Lake	2020	State	Confirmed
045	Emblem Draw	Big Horn	R53N R96W Sec 9; 1 location	Emblem	2004	BLM	-
046	Deadman Lake	Carbon	T23N R89W Sec 19; 1 location	Shamrock Hills	2020	BLM	Failed to find; but found at adjoining Lakes
047	Little Sage Cr	Carbon	T19N R86W Sec 29; 1 location	Kindt Reservoir	2007	BLM	No access
048	Antelope Flats	Fremont	T003N R004E; 1 location	Mexican Pass SW	2005	pvt	-
Add	S of Cody City Reservoir	Park	T52N R101W Sec 7, 18; 2 locations	Indian Pass	2010	BLM	-
Add	North Fork	Park	T52N R100W Sec 23	Eagle Pass	2010	BLM	-
Add	Horse Creek tribs	Big Horn	T53N R96W Sec 19, 20; 2 locations	Emblem	2010	BLM	-
Add	West Fork Creek	Big Horn	T53N R97W Sec 4; T54N R97W Sec 33; 4 locations	Gilmore Hill SE	2013	BLM	-

Add	Bridger Butte and Dry Creek tribs	Big Horn; Park	T52N R97W Sec 5, 7, 8, 17; T52N R98W Sec 1, 12; 6 locations	Y U Bench NE, Gilmore Hill SE	2013	BLM	-
Add	South Fork	Big Horn	T53N R97W Sec 34; 2 locations	Gilmore Hill SE	2013	BLM	-
Add	Lost Cr Lake	Sweetwater	T24N R96W Sec 36; 1 location	Lost Creek Lake	2020	State	New
Add	Lost Soldier Lake	Carbon			2021	BLM	New

6. Areas surveyed but species not located: A total of 76 negative survey locations were recorded as part of 2020-21 surveys in the Laramie, Hanna, Great Divide and Washakie Basins.

E. Habitat

Rollins (1993) succinctly described the habitat of *Rorippa calycina* as ”littoral edges of lakes and reservoirs, sandy stream margins, stock ponds” as incorporated in its description by Al-Shehbaz (2010). In the first Wyoming survey, it was described as most abundant on sandy, non-alkaline littoral edge settings where the area has not been disturbed recently, i.e., along littoral edges of reservoirs constructed in the past 20 years. The soils may range from alkaline to non-alkaline and loose to tight sand and clay (Lichvar 1981). In the second Wyoming survey, it was characterized as occurring on sandy or clay soils derived from 13 major Permian to Quaternary age formations (Fertig and Welp 1998) with a schematic drawing to show its relative position in the landscape on both sandy terraces and mudflats. The authors inferred that it survives inundation (Figure 8) and the question whether it persists in the seed bank at different elevations above/below water levels remains to be determined, including prolonged drought. It has more recently been documented on playa lakes and dry washes.

1. Associated vegetation (after Fertig and Welp 1998): *Rorippa calycina* is found in riparian corridors and wetland zones on moist sandy to muddy banks of streams, stock ponds, and man-made reservoirs near the high water line. These signify semi-disturbed or recently flooded openings, often 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 evaporated playa lakes.

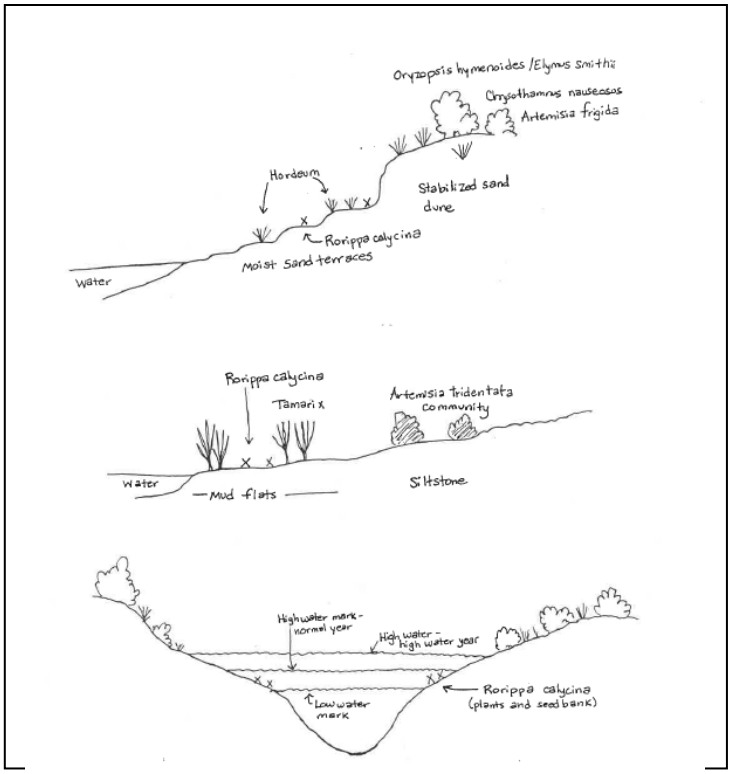

Figure 8. Topographic position of *Rorippa calycina* on the landscape. Top: Sandy terraced banks of reservoir inlet, with stabilized and unflooded bunchgrass-shrub community above the seasonally flooded shore zone occupied by R. calycina. Middle: Sandy-clay mud flats of gently sloping (0-3%) banks along 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 (Figure 6 in Fertig and Welp 1998)

2. Frequently associated species: Perhaps the most ubiquitous species, shared in common between settings and watersheds, is *Hordeum jubatum*, a wetland indicator species with "FACW" in the Arid West (USDI Army Corps of Engineers 2015). A list of associated species is presented in Table 2.

3. Soil relationships: *Rorippa calycina* was characterized as occurring on sandy or clay soils derived from 13 major Permian to Quaternary age formations (Fertig and Welp 1998). The new 2020-21 locations include playas with have silt substrate.

4. Topography: The species is restricted to low spots in the topographic gradient (Figure 8). In the past, this generally referred to valleys of perennial rivers. In 2020 it was also found associated with ephemeral creeks and isolated swales across the basin landscapes. These settings had a full spectrum of soil textures. Seminoe Reservoir has sandy soil texture throughout whereas Boysen Reservoir has areas of both sandy and clayey shores. In 2020-2021 it was surveyed on two playa lakes that may not have held water in either year.

Figures 9-10. *Rorippa calycina* persisted in both sheltered bays of Boysen Reservoir (left), and to a lesser extent, on wave-worked arm of Seminoe Reservoir (right)

Table 2. Species frequently associated with *Rorippa calycina*[3]

Scientific name	Common name
*Acroptilon repense**	Russian knapweed
Ambrosia psilostachya	Cuman ragweed
Ambrosia tomentosa	Bursage
Artemisia biennis var. biennis	Biennial wormwood
*Atriplex heterosperma**	Two-seed orache
Atriplex prostrata	Triangle orache
Bidens cernua	Nodding beggarsticks
Chenopodium berlandieri	Pitseed goosefoot
Chenopodium glaucum var. salinum	Oak-leaved goosefoot
Chenopodium rubra	Red goosefoot
*Cirsium arvense**	Canada thistle
Conyza canadensis	Canadian horseweed
Elymus smithii	Western wheatgrass
Grindelia squarrosa	Curlycup gumweed
Halogeton glomeratus	Halogeton
Hordeum jubatum	Foxtail barley
Iva axillaris	Povertyweed
Juncus arcticus ssp. balticus	Baltic rush
Juncus compressus	Roundfruit rush
Machaeranthera canescens	Hoary tansyaster
Poa secunda	Sandberg bluegrass
Polygonum aviculare	Prostrate knotweed
Potentilla anserina	Silverweed cinquefoil

[3] Species that are asterisked are non-native. Sources include Lichvar (1981), Fertig and Welp (1998), this study and Rocky Mountain Herbarium collection labels. Nomenclature follows original sources.

*Potentilla norvegica**	Norwegian cinquefoil
Potentilla paradoxa	Paradox cinquefoil
Potentilla rivalis	Brook cinquefoil
*Rumex crispus**	Curly dock
Rumex maritimus	Golden dock
Rumex triangulivalvis	Mexican dock
Salix exigua	Narrowleaf willow
*Salsola iberica?**	Prickly Russian thistle
*Spergularia rubra**	Red sandspurry
Suckleya suckleyana	Poison suckleya
*Tamarix chilensis**	Tamarisk
Verbena bracteata	Bigbract verbena
Xanthium strumarium	Rough cocklebur

1. Regional climate: Summaries of climate conditions at the Seminoe, Boysen and Yellowtail dams are reported in the Western Region Climate Center summaries (Table 3), sequenced from south to north.

Table 3. Climate conditions at three dams with *Rorippa calycina* on the reservoirs (NOAA 2021)

Station (NOAA no., duration, elevation)	Seminoe (488070) 1948-1001; 2002-2011 6361 ft (1939 m)	Boysen (481000) 1949-2020 4800 ft (1463 m)	Yellowtail (249240) 1963-2020 3660 ft (1116)
Mo. Precipitation in. (cm)	8.97 (22.78)	9.13 (23.19)	18.03 (45.80)
Mo. Av. Temperature °F (°C)	43.86 (6.59)	46.80 (8.22)	50.24 (10.13)

2, Local microclimate: The soils are damp at least early in the growing season, ameliorating the late season stress.

F. Population biology and demography

Mulligan and Porsild (1966) are quoted by Lichvar (1981) in describing *Rorippa calycina* is a colonizing species with two characteristics important to its survival: self-compatibility and strong vegetative reproduction.

1. Phenology: Flowering of *Rorippa calycina* is reported as May to August (Al Shehbaz 2010). Many of the specimens at Rocky Mountain Herbarium are noted as having both flowering and fruiting material on the same plant, reflecting the indeterminate inflorescence. There are specimens with both stages on record as early as 28 May and as late as 15 Sept, but the timing at any given locale is much narrower. The timing of phenological events for a

related species, *R. columbiae*, appears closely related to the timing of seasonal water recession (Salstrom and Gehring 1994; Harris 1992; Scherer 1991) and seedlings of it have been reported to initiate annual, above-ground growth roughly two weeks following the disappearance of seasonal waters. The phenology of *R. calycina* seedlings have not been reported but Mulligan and Porsild (1966) noted that seeds collected from one of the Northwest Territories sites germinate in 2 days. This is consistent with the species being an opportunistic wetland species.

G. Population size and condition

Total species numbers, as estimated by Fertig and Welp (1998) based on their visits to a segment of known locations was conservatively estimated at 15,000-25,000 plants. There were no estimates provided for the many new Big Horn Basin records. There were less than 1000 plants added in 2020-2021 surveys.

1. Trends: In the first discussion of *Rorippa calycina* trends, Lichvar (1981) postulated that the surge of collections since discovery may attributed to "new" reservoir habitat. The three reservoirs in Wyoming with highest *R. calycina* numbers had construction completed in 1939 (Seminoe Reservoir), 1952 (Boysen Reservoir) and 1966 (Yellowtail Dam).

Fertig and Welp suggested that an alternative monitoring strategy for the species needed to be developed involving some measure of annual census in combination with recording habitat change. Reservoir settings are dynamic habitats, and so its numbers are unlikely to remain stable if the habitat is unstable and if the zonation of suitable habitat shifts from year to year. They noted one specific instance of observing local numbers at the Boysen Reservoir bridge rest area as "several hundreds" in 1992, underwater in 1993, and with about 50 plants in 1994. Likewise, 2020 surveys on the O'Brien arm of Seminoe Reservoir in 2020 showed that the mouth had filled in where there had once been occupied habitat in 1997. The rest of the arm was subjected to strong wave action with winds that blow parallel to the shoreline. Nevertheless, most other locations along the arm had plants present in 2020 at or near the prior locations. Elsewhere on Boysen Reservoir I saw evidence in 2020 that the species survives short periods of inundation during the growing season (see Figures 21-22).

Reproductive biology

a. Type of reproduction: *Rorippa calycina* reproduces by seed, as well as asexually from elongating perennial rhizomes (Fertig and Welp 1998). Mulligan and Porsild (1966) reported that it is self-compatible, i.e. capable of selfing. Flowering stems arise in a cluster, so these clusters have been the basis of tallying individuals. There is no information on the extent that its rhizomes grow, so if remotely-spaced clusters do not represent unique individuals (genets), then estimates overestimate unique individuals.

b. Fecundity: *Rorippa calycina* has 30-44 ovules per ovary (Al-Shehbaz 2010), but for members of the genus, not all ovules mature. The indeterminate inflorescence and highly-branched plants can produce many silicles per plant. Healthy plants on Boysen Reservoir were observed with on the order of 1000 fruits per plant which, if each fruit only produced 10 mature seeds, would amount to 10,000 seeds per plant.

c. Longevity: Unknown.

d. Pollination biology: This taxon has been reported as self compatible (Mulligan and Porsild 1966) probably indicating a mixed mating system. In field and greenhouse studies of a close relative, *Rorippa columbiae* has demonstrated some self-compatibility: fertilization, fruit set and seed set have been achieved in the absence of pollinators (Kentnesse 2017). Yet this species relies heavily on outcrossing for sexual reproduction. Its pollinators are abundant, represent a diversity of insect families and genera, and have been observed carrying pollen between stems. A close examination of *R. columbiae* flower morphology indicates clear separation of anthers and stigmas, an adaptation common for ensuring outcrossing by pollinators (Silvertown and Charlesworth 2001) as discussed in Kentnesse (2017).

e. Seed dispersal and biology: Seeds are ovoid and 0.6-0.7 mm, a size that might float and disperse on water. They take on an angular shape when they dry, the size of coarse sand but much lighter.

f. Recruitment: Seedlings were sought during surveys but not observed.

G. Population ecology

1. Competition: *Rorippa calycina* is a colonizing species and likely to be a poor competitor that grows in sparse vegetation. This may also reflect its adaptation to disturbance conditions. Several of its associates in reservoir settings are annual species. In both reservoir and natural swale settings, foxtail barley (*Hordeum jubatum*) is dominant, and *R. calycina* grows between the widely-spaced grass bunches.

2. Herbivory: None observed. The species is not palatable and has glandular hairs.

3. Hybridization: None known.

4. General summary: Species' adaptations to natural disturbance dictate over population ecology.

H. Land ownership: There are five collection locations where it was collected on private land. In addition, Seminoe Reservoir records represent records below highwater mark which may entirely be administered by Bureau of Reclamation, despite adjoining uplands mapped as part of BLM land or private land ownership.

5. Hybridization: None known.
6. General summary: Species' adaptations to natural disturbance dictate over population ecology.

H. Land ownership

There are five occurrences where it was collected on private land, and another five occurrences where the ownership or at least the access is not federal (Figure 5). Seminoe Reservoir records represent records below highwater mark which may entirely be administered by Bureau of Reclamation, despite adjoining uplands mapped as part of BLM land or private land ownership.

7. General summary: Species' adaptations to natural disturbance dictate over population ecology.

IV. CONSERVATION CONSIDERATIONS

A. Potential threats to currently known populations

Fertig and Welp (1998) said that the limited geographic range of *Rorippa calycina*, its high habitat specificity, and dependence on periodic disturbance makes this species potentially vulnerable to extirpation. This report presents information that broadens its geographic range and broadens its span of occupied habitat, so as to re-revaluate its conservation and management. The authors discussed five potential threats that are revisited in the following text (next page).

Figure 11. ORV tracks on Seminoe Reservoir traversed occupied habitat of *Rorippa calycina*

Figure 12. ORV wheels damaged *Rorippa calycina* plant on reservoir shore (left)

Figures 13-14. Two views of the same Boysen Reservoir shoreline subpopulation ~a year apart. Left: In flower in June 2019. Right: After flower in June 2020 after apparent inundation when *R. calycina* plants were just as dense, and appeared to have matured all seeds, but were 100% brown and brittle from fluctuating water levels.

1. WATER MANAGEMENT: Increasing water storage capacity was identified as a primary threat to *Rorippa calycina* along manmade reservoirs (Lichvar 1981, Fertig and Welp 1998). The latter authors go on to note that stable conditions and not just highwater conditions or fluctuating conditions are also potential threats to the species.

All of the recently reported records from the Big Horn Basin are at stock dams constructed in isolated settings with no natural wetland features, as indicated by reviewing imagery for each one

2. MINERAL DEVELOPMENT: Oil and gas well pads were present at the two playa populations, and associated developments such as access roads might contribute to development pressure.

3. RECREATION: The two reservoirs with highest numbers have hundreds of miles of shoreline whereas heaviest recreation use is concentrated at developed facilities. Docks, marinas, and campground developments were installed in the wake of reservoir construction, and so signify localized reduction of man-made habitat. Horseshoe Bay on Yellowtail Dam has an associated mudflat with common *R. calycina*, so that any work to redesign it might impact the species.

Other surface disturbances such as off-road vehicle use may impact local population segments, but barring repeated use, it appeared that they damaged rather than killed the plants in their path (Figures 19-20).

This study provides evidence of species' persistence at three reservoirs (Boysen, Pathfinder and Seminoe) relative to 1997 surveys with minor disappearance and colonization associated with habitat flux. The Boysen location was visited two years in a row. In the first year, it was visited at full flowering (Figure 21). In the second year, the species was visited when it had finished flowering and after emerging from inundation. Though completely brown, the fruits matured on the dead-looking plants and the plants appeared to have survived underground (Figure 22).

4. EXOTIC PLANTS/WEED CONTROL: Invasive species are present on all reservoirs to some extent. *Halogeton glomeratus* (Halogeton) and *Tamarix chinensis* (Tamarisk) are the most widespread, and other noxious weeds such as *Acroptilon repens* (Russian knapweed) are just arriving.

5. GRAZING: The species is not palatable due to essential oils and glandular hairs. Its ubiquity at stock dams, including areas where it repeats in about eight contiguous sections, probably reflects its ability to colonize man-made settings, and to persist under grazing. Its rhizomatous growth confers resiliency to the shallow soil disturbance of trampling.

B. Present considerations

1. Notification of BLM personnel of locations on BLM lands: This report is submitted to the BLM Cody, Lander, Rawlins, Rock Springs and Worland Field Offices and to the BLM State Office.

2. Status notes: BLM lands support the greatest number of the *Rorippa calycina* populations found on native habitat. BLM lands also support widespread habitat for the species associated with local disturbance, such as stock dams in the BLM Cody Field Office. If the stock dam locations are not in natural water features, then it seems likely that the species was not present before construction, and supports the idea that new habitat was created by their construction. In addition, major populations are on three reservoirs within state and federal parks (Boysen State Park and Bighorn Canyon National Recreation Area), and on a combination of Bureau of Reclamation land, Seminoe State Park and BLM land at Seminoe Reservoir.

Results of this survey and past surveys point to general persistence and resilience across the spectrum of settings, at a wide range of sizes and conditions. This study documented species' persistence at four locations on three reservoirs (Boysen, Pathfinder and Seminoe) with minor disappearance and colonization associated with habitat flux. The Boysen location was visited two years in a row, and in the second year, the species was inundated when it had finished flowering. Though the plants emerged from inundation completely brown, it still appeared as though the fruits matured on the dead-looking plants and the plants appeared to have survived underground.

3. Summary: This report represents an updated record of *Rorippa calycina* distribution and associated conditions. The new data help characterize its adaptations and *pre*-adaptations to man-made disturbance in an array of palustrine and riverine habitat across arid basin landscapes.

Its two closest relatives, *Rorippa columbiae* and *R. subumbellata*, are also adapted to successional settings but they are under much higher degrees of threat and habitat loss. The body of work on these related species offers a starting point for understanding *R. calycina*.

Rorippa calycina is only known to be extant in Wyoming, so it has a very high Wyoming contribution rank and WYNDD will continue to record information on it as a Species of Potential Concern. State Ranks are strongly influenced by the degree of certainty or uncertainty associated with threats, in addition to occurrence number tallies. There are still basic questions on the thresholds of survival/mortality, and net population trend.

Rorippa calycina was the first species to be studied by WYNDD for BLM (Lichvar 1981). It was a pilot study, followed by a WYNDD status report (Fertig and Welp 1998) as a robust treatment based on extended fieldwork. It is not customary to prepare sequels to status reports unless there is reason to suspect that population or habitat conditions have changed, or that there may be important gaps in species information. In this case, revisits and new records provided an opportunity to update information on the species.

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