Status of *Lepidium integrifolium* var. *integrifolium*

(Entire-leaved peppergrass) in Wyoming

Prepared for
Bureau of Land Management
Wyoming State Office and Kemmerer Field Office

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April 2004

Agreement No. KAA010012
Task Order No. KAF0020012

ABSTRACT

Lepidium integrifolium var. *integrifolium* (entire-leaved peppergrass) was surveyed in 21 polygons of potential habitat as determined in potential distribution modeling, and across all public lands in the Cokeville and Fossil areas that appeared to have alkaline meadow habitat as indicated on color aerial photographs. One Fossil Butte area polygon generated by the model supported a subpopulation of *Lepidium integrifolium* var. *integrifolium* but color aerial photographs proved to have greatest effectiveness in locating new sites. Concurrent surveys were conducted by botanical expert Clayton Kyte, National Park Service on Fossil Butte National Monument. As a result of 2003 surveys, there are a total of three populations in Wyoming covering an estimated 420 acres of occupied habitat with population numbers that are bracketed between 21,000-155,000 plants with the majority of subpopulations on Fossil Butte National Monument and Cokeville Meadows National Wildlife Refuge. The occurrences are all part of the Bear River watershed, in settings with well-developed alluvial deposits and salt-accumulation zones. Only one new occurrence was documented, representing the first record for *Lepidium integrifolium* var. *integrifolium* in Uinta County, Wyoming. *Lepidium integrifolium* var. *integrifolium* appears to be relatively secure on public lands barring indiscriminate herbicide use or non-native species encroachment.

ACKNOWLEDGEMENTS

Clayton Kyte (National Park Service) provided information and insight on *Lepidium integrifolium* var. *integrifolium* from his survey and observations at Fossil Butte National Monument, later contributing to review of this report. Walter Fertig (formerly Wyoming Natural Diversity Database; WYNDD) fostered interest in *L. i.* var. *integrifolium* and compiled information that greatly facilitated this project. Ben Franklin (Utah Natural Heritage Program) provided Utah status information to WYNDD. Lamont Glass and Douglas Damberg (Seedskadee National Wildlife Refuge) provided maps of those tracts held in fee title as part of the Cokeville Meadows National Wildlife Refuge. Rob Thurston (WYNDD) provided potential distribution maps of *L. i.* var. *integrifolium* in a format for fieldwork. Tessa Dutcher helped digitize populations after fieldwork. Joy Handley prepared the distribution maps of *L. i.* var. *integrifolium* and helped edit the report. The support of Jim Glennon and Jeff Carroll with the Bureau of Land Management was essential. The contributions of all are gratefully acknowledged.

This work was conducted under a challenge cost-share agreement between the Bureau of Land Management and Wyoming Natural Diversity Database, Agreement No. KAA010012.

This report is to be cited:
Heidel, B. 2004. Inventory of *Lepidium integrifolium* var. *integrifolium* (Entire-leaved peppergrass) in southwestern Wyoming. Report prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie.

Cover photo: *Lepidium integrifolium* var. *integrifolium* in flower, by B. Heidel

TABLE OF CONTENTS

APPENDIX

TABLES

FIGURES

INTRODUCTION

The primary purpose of this project was to survey for *Lepidium integrifolium* var. *integrifolium* (entire-leaved peppergrass) and determine its status. Prior to this study, *L. integrifolium* var. *integrifolium* was known from three collection records in Wyoming and four recent collection records in Utah, two historic records that may have been collected in either Wyoming or Utah, and additional historic collection records in Utah. In order to assess the conservation status of this taxon, the BLM contracted with the University of Wyoming - Wyoming Natural Diversity Database (WYNDD) to conduct field surveys, test the potential distribution model, and compile information on its biology and status. The results are presented in the following report. It is referred to by its full scientific name, *Lepidium integrifolium* var. *integrifolium*, throughout the report, even though it is the only variety of this species present in Wyoming.

METHODS

Prior to the field season, information on the habitat and distribution of *Lepidium integrifolium* var. *integrifolium* was reviewed in the state plant species abstract (Fertig 2000a) and in element occurrence records. Specimens were reviewed at the Rocky Mountain Herbarium (RM). A potential distribution model based on known distribution and negative distribution data (Fertig and Thurston 2003) was applied, and the polygons of potential habitat were overlain on surface management maps to plan fieldwork around primary potential habitat on BLM-administered lands. The polygons of potential habitat were concentrated on seven U.S. Geological Survey maps (7.5') in Lincoln and Uinta counties, and surveys were conducted in the largest polygons on each quad map that overlapped with public lands. Surveys for *L. integrifolium* var. *integrifolium* on BLM lands were coordinated with concurrent surveys on Fossil Butte National Monument conducted by Clayton Kyte, National Park Service biological technician in 2003. Other resources that were used for planning and conducting fieldwork included BLM 1:100,000 surface management maps (Fontenelle Reservoir, Kemmerer), a Wyoming surface geology map (Love and Christiansen 1985), and a map of U.S. Fish and Wildlife Service fee title lands in the Cokeville Meadows National Wildlife Refuge, in addition to color aerial photographs at the same scale as the U.S. Geological Survey maps, provided on loan by BLM. The color aerials were photographed in 1980 late in the growing season (29 Aug in Fossil Area, 2 Sept in Cokeville area).

WYNDD surveys of *Lepidium integrifolium* var. *integrifolium* were conducted June 17-22 and 29, 2003. During the survey, the taxon was in flower, its most conspicuous stage, and beginning to set fruit. National Park Service surveys of *L. integrifolium* var. *integrifolium* had started earlier in the Fossil Butte National Monument. Clayton Kyte, biological technician at the Monument, and the author visited the original Chicken Creek site, first discovered by Kyte in 1995; and a nearby site on Smallpox Creek, where a population was located and mapped by Kyte in 2003. The visits contributed to the search images, and Kyte provided background information about the history of land-use in and around the Monument.

A total of 21 polygons of potential habitat in seven U.S. Geological Survey quad (7.5') maps were surveyed for *Lepidium integrifolium* var. *integrifolium* along the following drainages in the Fossil Butte area: Bullpen Creek, Collett Creek, Little Muddy Creek, North Fork of Twin Creek, South Fork of Twin Creek, East Fork of Twin Creek, lower Hay Hollow. Only one polygon of potential habitat was found to support *L. integrifolium* var. *integrifolium* on the South Fork of Twin Creek at the edge of the Twin Creek valley bottom. Farther west, the following drainages were surveyed in the Cokeville area: Antelope Creek, Horse Creek, Sublette Creek, and Wyman Creek. The efforts to relocate the species in the Cokeville area were successful when the model was abandoned and riparian habitat on Bear River was made the focus of survey. Use of the color aerial photos to locate salt-affected alkaline meadows proved to be the most effective resource for identifying potentially suitable riparian habitat in this study.

SPECIES INFORMATION

Classification

Scientific Name: *Lepidium integrifolium* Nutt. ex Torrey & A. Gray var. *integrifolium*

Common Name: Entire-leaved peppergrass

Family: Brassicaceae (mustard family)

Synonyms:
Lesquerella integrifolium Nutt (Torrey and Gray 1838)
Lesquerella utahense Jones (Jones 1881)
Lesquerella zionis Nelson (Nelson 1906)
Lesquerella montanum var. *integrifolium* (Nutt.) comb. nov. C.L. Hitchcock (Hitchcock 1936)

The first three taxonomic treatments were recognized as synonyms and transferred under *Lepidium montanum* var. *integrifolium* by C. L. Hitchcock (1936), later placed in *L. integrifolium* var. *integrifolium* by Rollins (1993).

History of the Taxon: *Lepidium integrifolium* var. *integrifolium* was first collected by Thomas Nuttall (*s.n.*) before 1838 in the Rocky Mountains, in the "plains toward the Columbia," and described by him as a new species, *Lesquerella integrifolium* Nutt (Torrey and Gray 1838). It was next collected by George Vasey in 1868 on the Bear River which could have been in either Utah or Wyoming. Lester Frank Ward collected it from Richfield in Sevier County, Utah in 1875 and in Glenwood in Beaver County, Utah (year unknown). In 1875, a collection was made by Elmore Palmer with no more location information than stating it was from Utah. Marcus Jones collected it from Milford in Beaver County, Utah in 1888, from Vermillion, Utah in 1894, and from "Carter, Uintah County" in 1896 (*Jones 5631a*). The latter was inferred by Hitchcock to represent a Utah collection, but is not in the current Atlas of the Vascular Plants of Utah (Utah State University - Department of Geography and Earth Resources 2004). There is not a townsite of Carter in Uintah County, Utah but the collection may be from Carter, Uinta County in Wyoming. It was also collected by J.A. Harris for osmotic pressure studies from the Sanpete Valley of Sanpete County Utah in 1923, by R. Olsen near Ephraim in Sanpete County, Utah in

1934 and by Bassett Maguire near Moroni in Sanpete County, Utah in 1940. The first unequivocal Wyoming collection was made from Fossil Station by G.W. Letterman in Lincoln County, Wyoming. The year of this collection was not recorded, but other information about Letterman collections indicates that the year was probably 1885.

Lepidium integrifolium var. *integrifolium* was not collected in Wyoming again until 1969 by Rupert Barneby, 4.5 miles south of Cokerville (*sic*), in Lincoln County. In 1996, it was discovered on Fossil Butte National Monument by Park Service naturalist Clayton Kyte. The Monument is close to the historic Fossil Station and this discovery and the 1995 discovery is considered to represent rediscovery of the population first documented 110 years earlier in 1885 by Letterman.

In Utah, *Lepidium integrifolium* var. *integrifolium* has been documented from four northeast and south-central counties, but there are only four recent collection records and they are all from Rich County, along the Bear River in northeastern Utah (Ben Franklin 2004 personal communication). In Wyoming, the Cokeville occurrence is also along the Bear River, and the Fossil Butte occurrence is on Twin Creek and Twin Creek tributaries, part of the Bear River watershed.

Legal Status

Lepidium integrifolium var. *integrifolium* is listed as sensitive by the Bureau of Land Management in Wyoming (USDI BLM 2001). The goals of the BLM policy for sensitive species are to:

- ? Maintain vulnerable species and habitat components in functional BLM ecosystems
- ? Ensure sensitive species are considered in land management decisions
- ? Prevent a need for species listing under the Endangered Species Act
- ? Prioritize needed conservation work with an emphasis on habitat

The information provided in this report provides the basis for carrying out the goals of existing policies and coordinating with other land agencies that maintain shared populations with the Wyoming BLM.

Lepidium integrifolium var. *integrifolium* was not included in the initial lists of rare species in Wyoming because it was not recognized in the state flora until a review of the *Lepidium* treatment (Rollins 1993) by Walter Fertig. He added it to the Wyoming plant species of concern list (Fertig 1996) and reported it to the state botany community (Fertig 1995, 2001). It is recognized in the most current state flora (Dorn 2001). It was designated sensitive by the Bureau of Land Management - Wyoming State Office in 2001 (USDI BLM 2001). The taxon receives no legal protection under Wyoming state law, and has neither agency status nor legal protection in Utah.

Nature Heritage Rank: NatureServe (formerly the heritage division of The Nature Conservancy) and the network of state natural heritage programs has assigned *Lepidium integrifolium* a rank of G2, indicating that it is "imperiled because of rarity" throughtout its range. The type variety, *L. integrifolium* var. *integrifolium*, is ranked T1?, indicating that the variety may be critically

imperiled throughout its range. A question mark follows this rank because the historic collections were much more widely-distributed than recent collections and the historic collections outnumber recent ones, though there has not been systematic survey prior to this study. In Wyoming, the species is ranked S1 "critically imperilled because of extreme rarity" and it has a Wyoming contribution rank of "very high" signifying that Wyoming populations contribute greatly to the taxon's rangewide persistence (Keinath et al. 2003). The results of this survey document that the two main occurrences are far more extensive and the taxon more numerous than previously known, while only one new occurrence was added. The S1 rank is retained for *L. integrifolium* var. *integrifolium* in Wyoming. In Utah, it is also ranked S1 and tracked (Ben Franklin 2004 personal communication).

Description

Lepidium integrifolium var. *integrifolium* is a perennial forb with erect to prostrate, minutely-pubescent stems 15-25 cm tall from a thick, branched caudex covered with remnant leaf bases. Basal leaves are 3-8.5 cm long x 6-25 mm wide and have elliptic to oblanceolate blades with entire margins and sparse pubescence (especially on the veins and margins). Stem leaves are 1-4 cm long, elliptic to elliptic-obovate, overlapping with one another, gradually reduced in size, and glabrate. Flowers have 4 pubescent sepals and 4 white petals less than 3 mm long. Fruits are glabrous, flat, ovate to lance-ovate silicles 3-4.2 mm long with styles 0.4-0.7 mm long (Rollins 1993; Welsh et al. 1987, Fertig 2000a, Dorn 2001).

Lepidium integrifolium var. *integrifolium* is the only variety in the state. The other variety, *L. integrifolium* var. *heterophylla*, is restricted to canyons of south-central Utah (Rollins 1993), and differs from *L. integrifolium* var. *integrifolium* in having teeth on the basal leaves and few stem leaves. Hitchcock (1936) stated that "the variety *integrifolium* is outstanding because of the large fruits (although no larger than occasionally found in plants of var. *jonesii*), and because of the thick, fleshy, entire leaves… "

Lepidium integrifolium var. *integrifolium* has a set of characteristics including entire leaves, thick taproot, and fruits over 3 mm long that are unique among species of *Lepidium* in Wyoming (Fertig 2000a). The characteristic features of *L. integrifolium* var. *integrifolium* compared to related or similar *Lepidium* species are presented in Table 1. In Wyoming, *Lepidium integrifolium* var. *integrifolium* is most similar to *L. montanum* var. *alyssoides* but the latter has narrowly linear, mostly entire leaves (some have a few lobes at the base) and is typically over 60 cm tall (Fertig 1995). *Lepidium latifolium* has entire to serrate leaves, fruits 1.5-2 mm long, and typically is over 80 cm tall (Rollins 1993, Welsh et al. 1993, Fertig 2000a). Among other similar species, *L. barnebyanum* has linear leaves and petals over 3 mm long and is a narrow endemic of white shales in Duchesne County, Utah. In addition, *L. integrifolium* var. *integrifolium* may be casually mistaken for other genera of mustards, most notably members of the genus *Cardaria* (hoary cress), Wyoming noxious weeds. The *Cardaria* species have fruits that are rounded rather than strongly flattened in cross-section.

Table 1. Characteristic features of *Lepidium integrifolium* var. *integrifolium* and other *Lepidium* species

Species	**Leaves**	**Growth form**	**Fruit length (mm)**	**Petal length (mm)**
Lepidium integrifolium var. *integrifolium*	Well-developed basal leaves, stem leaves entire, elliptic to elliptic-obovate, numerous and overlapping; sparsely pubescent with minutely papillose trichomes on veins and margins	Stems mostly erect, also decumbent or prostrate, perennial 15-25 (30) cm tall, arising from a thick caudex	3-4.2	2.7-3 (3.1)
Lepidium integrifolium var. *heterophyllum*	Well-developed basal leaves that are coarsely-toothed toward apex; stem leaves few, remote, sparsely pubescent with minutely papillose trichomes on veins and margins to nearly glabrous	Stems often decumbent, perennial 15-25 (30) cm tall, arising from a thick caudex	3-4	ca. 3
Lepidium montanum var. *montanum*	Poorly-developed basal leaves, stem leaves mostly pinnatifid or lobed, at least below, usually hairy	Bushy upright perennial	2.8-4.1	2.5-3.5
Lepidium montanum var. *alyssoides*	Poorly-developed basal leaves, stem leaves narrowly linear, usually entire, usually hairy	Upright perennial, taller than wide, usually over 60 cm tall	2.8-4.1	2.5-3.5
Lepidium barnebyanum	Well-developed basal leaves, stem leaves linear, glabrous	Upright perennial, 7-12 cm tall, arising from a caudex	1.5-2	3-6.2
Lepidium latifolium	Well-developed basal leaves, entire or crenate-serrate, glabrous	Upright perennial, over 80 cm tall	1.5-2	1.5

All of the *Lepidium* species presented in Table 1 are usually restricted to upland habitats except for *L. integrifolium* var. *integrifolium* and *L. latifolium*, all are native except *L. latifolium*, and all are in Wyoming except *L. barnebyanum* and L. *integrifolium* var. *heterophylla.*

A close-up photo of *Lepidium integrifolium* var. *integrifolium* showing the large, flattened fruits that are slightly notched at the top, is presented in Figure 1. A close-up photo of the flowers is on the cover. Figure 2 is an illustration of the taxon. Three photos showing the whole plant are presented in Figures 1, 3 and 4 to demonstrate the range in growth forms; from the typical spreading form (Figure 3), to the infrequent prostrate form (Figure 4), and the strictly upright form (Figure 1) in shade among shrubs of *Sarcobatus vermiculatus* (greasewood).

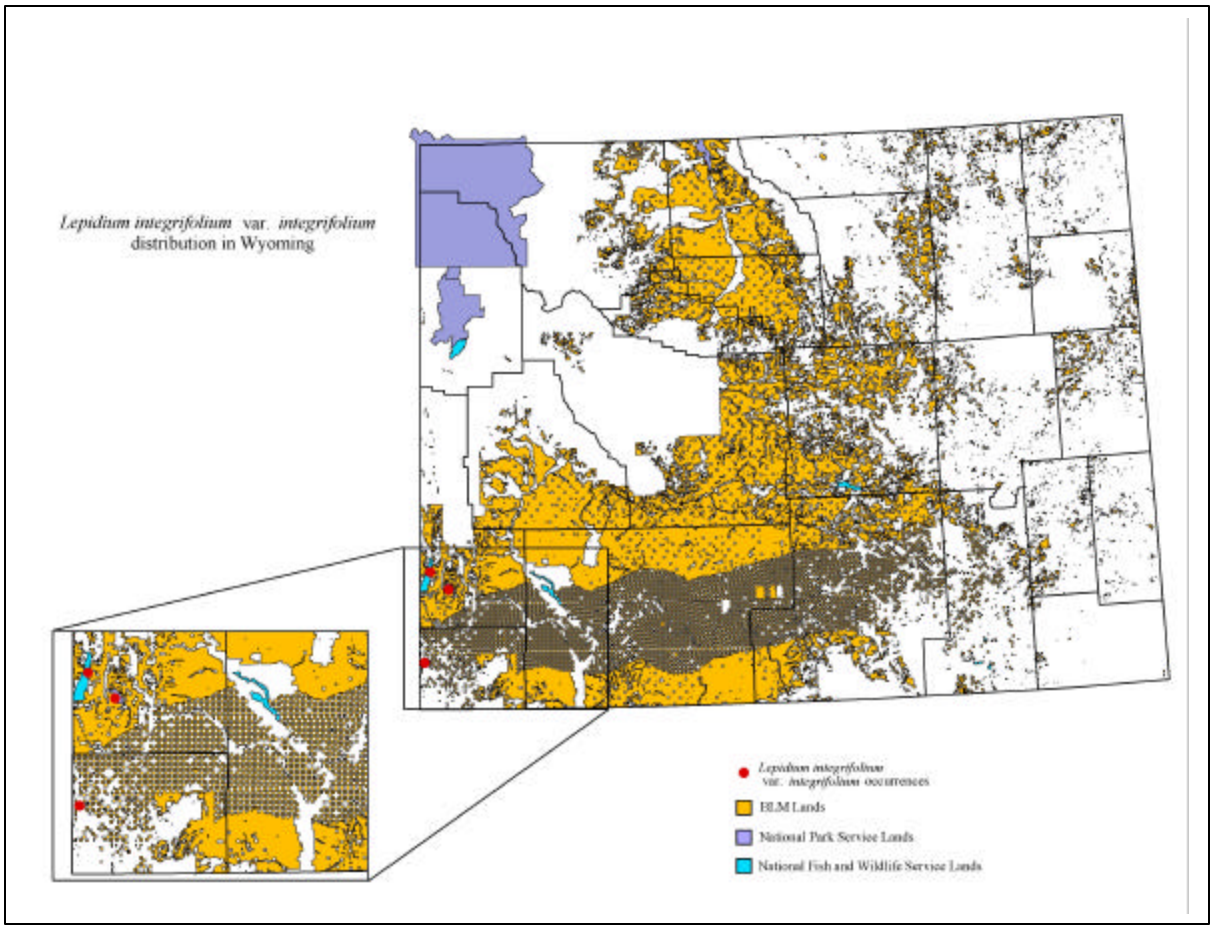
Figure 1. *Lepidium integrifolium* var. *integrifolium* in flower and fruit, by B. Heidel

Figure 2. Illustration of *Lepidium integrifolium* var. *integrifolium*, by Walter Fertig

Figure 3. Typical growth form of *Lepidium integrifolium* var. *integrifolium*, by B. Heidel

Figure 4. Prostrate growth form of *Lepidium integrifolium* var. *integrifolium*, by B. Heidel

Figure 5. Distribution of *Lepidium integrifolium* var. *integrifolium* in Wyoming



Geographic Range

Lepidium integrifolium var. *integrifolium* is a regional endemic of northeastern Utah and southwestern Wyoming. In Wyoming, it is known only from the southern Overthrust Belt in Lincoln and Uinta counties (Figure 5). The Bear River watershed contains all extant occurrences. The Bear River leaves Wyoming in Uinta County and re-enters it in Lincoln County. The Utah occurrences in Rich County lie between upper and lower Bear River occurrences in Wyoming. In addition, it is historically known from south-central Utah. It is reported from south-central Wyoming by Rollins (1993) but there are no supporting collection records unless there has been an unpublished interpretation that the original Nuttall collection and field log information correspond with south-central Wyoming, or Rollins recognized the 1896 collection from Carter, Uintah County as being in Wyoming rather than Utah and atypically characterized it as south-central rather than southwestern Wyoming.

The geographic extent and complexity of Wyoming occurrences has been greatly expanded by the 2003 surveys conducted by the National Park Service and WYNDD. The locations and extent of the three documented populations are summarized in Table 2. The largest population, at Cokeville, is present in four discrete areas of the Bear River and totals app. 413 acres. The extensive Fossil Butte population is present in seven discrete streams or stream

reaches. The smallest population was not exhaustively surveyed because the only apparent public land in the area was the road right-of-way. All populations are mapped in Appendix A. There is a distance of about 18 miles of valley that separates the nearest segment of the Bear Creek population from the nearest upstream segment of the Twin Creek population.

Table 2. Locations of *Lepidium integrifolium* var. *integrifolium*

Nearest Town/ EO#	**River**	**Ownership**	**USGS Quad Name**	**Township/Range/Section**[1]
Fossil Butte #001	Twin Creek and tributaries	National Park Service, BLM	Fossil, Nugget	T21N R117W Sec. 10, 15 T21N R118W Sec. 1, 11 T22N R118W Sec. 35, 36
Cokeville #002	Lower Bear River	U.S. Fish & Wildlife Service, State of Wyoming	Beckwith, Cokeville	T23N R119W Sec. 6-9, 17-18; T23N R120W Sec. 36 T24N R119 W Sec 33
Almy #003	Upper Bear River	Uinta County highway department	Murphy Ridge	T16N R121W Sec. 36

Extent of Surveys in Wyoming

Systematic surveys of *Lepidium integrifolium* var. *integrifolium* were made in 2003 to relocate recent and historic records and expand known distribution using a model of potential distribution (Fertig and Thurston 2003). A total of 21 polygons of potential habitat were surveyed for *Lepidium integrifolium* var. *integrifolium* by WYNDD, representing almost all of the large polygons (>80 acres) on public land. Each polygon was surveyed at 1-5 sites within the polygons, focusing on salt-affected habitats. Only one polygon of potential habitat was found to support *L. integrifolium* var. *integrifolium* and it was on South Fork of Twin Creek in the valley below Fossil Butte National Monument. The effort to relocate the species in the Cokeville area was successful when the model was discarded and riparian habitat was made the focus of survey. Halfway through the fieldwork, the survey's focus was changed to riparian habitats that resembled those of confirmed Cokeville and Fossil Butte area occurrences. Color aerial photographs were used successfully to locate salt-affected areas associated with drainage courses in these landscapes.

The only polygon with suitable habitat for *Lepidium integrifolium* var. *integrifolium* was found on the South Fork of Twin Creek. It lies in closer to the Twin Creek valley bottom than all known subpopulations distributed in Fossil Butte National Monument. The discovery of this subpopulation led to a shift in survey focus to valley bottom habitat. Fossil Station, where the species was first collected in about 1885, was a train station and town site, originally located about 1 mile east of the existing town and abandoned depot (Clayton Kyte 2003 personal communication). The presence of *L. integrifolium* var. *integrifolium* at the South Fork of Twin

[1] Refer to maps in Appendix A for precise locations and quarter-quarter sections.

Creek is close to the historic townsite and supports the interpretation that that the historic town site may have been the actual collection location rather than the nearest landmark. The historic town site is on private land. The second stage of survey in the Fossil Butte area focused on public lands along Twin Creek and the lower reaches of its tributaries.

The state land tract where Rupert Barneby's 1969 collection of *Lepidium integrifolium* var. *integrifolium* was provisionally mapped was surveyed without success. A re-evaluation of the location, clocked 4.5 miles south of Cokeville, corresponded with a tract of the Cokeville Meadows National Wildlife Refuge (NWR) along the Bear River, where it was immediately found. All BLM tracts in the vicinity were surveyed or considered and ruled out in providing suitable valley bottom habitat. Thereafter, the survey was expanded to two other newly-acquired Cokeville Meadows National Wildlife Refuge units and a nearby state tract on the lower Bear River valley. The wetland valley bottom is over 2.5 miles wide and they were distributed in outer valley bottom margins on opposite sides of the valley, spanning a distance of over 6 miles. The taxon may have once occupied the entire Bear River Valley in more or less continuous patterns, similar to more mobile meadow species, such as *Numenius americanus* (long-billed curlew), which still have extensive breeding habitat in the valley bottom.

Lepidium integrifolium var. *integrifolium* occurs upstream (south) from Cokeville Meadows NWR on the Bear River in Utah, and the Bear River originates farther upstream (south) in Wyoming. Therefore, the survey was expanded to the upper Bear River valley of Uinta County. However, the access to valley bottom public lands downstream from Woodruff Narrows was limited, and the valley bottom public lands above Woodruff Narrows that were mapped as public on surface management maps were posted as private. The gallery forest and thickets along the upper reaches indicates that habitat suitability diminishes as one moves upstream, but alkaline meadows are situated above the wooded habitat in places, and *L. integrifolium* var. *integrifolium* was discovered in a roadside right-of-way, representing the first unequivocal report of the taxon in Uinta County. Bear River State Park at Evanston was surveyed without finding the species or suitable habitat. There is a local airport that may have habitat, but it is not known whether it is a public or private facility. There were no surveys conducted further upstream.

The highest priority area that did not get surveyed was the Carter area in Uinta County. This area had not been identified in the potential distribution model, but it is possible that the 1896 collection by Jones came from here. Carter lies less than 30 miles northeast from the nearest populations at Almy and less than 40 miles southeast from Fossil Butte, but is along Muddy Creek in the Blacks Fork watershed, a tributary of the Green River. The town site itself lies along Muddy Creek and there are occasional alkali flats (personal observation) but, according to Love and Christiansen (1986), there are no Quaternary alluvial deposits along Muddy Creek within 5 miles that characterize other *L. interfolium* var. *interfolium* habitat elsewhere in Wyoming. There are, however, tributaries of Little Muddy Creek, to the north, that have Quaternary alluvium and may have potential habitat (Clayton Kyte 2003 personal communication). These represent the highest priorities for expanded survey in Wyoming.

Habitat

Lepidium integrifolium var. *integrifolium* is restricted to alkaline wet meadows associated with low-elevation riparian habitat of foothills and valley bottoms. Wyoming populations occur in sparsely vegetated, seasonally saturated flats of silts and silt loams derived from Quaternary alluvium (Love and Christiansen 1986), sometimes with a claypan. The soils have limited profile development and usually have a vesicular structure. The vegetation is dominated by *Distichlis stricta* (inland saltgrass) and *Carex praegracilis* (clustered field sedge) sometimes with *Sarcobatus vermiculatus*. The elevation range of the taxon in Wyoming is 6170-6790 feet. *Lepidium integrifolium* var. *integrifolium* has a much broader elevation range in Utah, including historic occurrences, at 4954-6266 feet (Utah State University - Department of Geography and Earth Resources 2004).

Lepidium integrifolium var. *integrifolium* habitat in the Fossil Butte area is dominated by *Sarcobatus vermiculatus* in many of the subpopulations (Figures 6 - 8). A vegetation classification was developed for Fossil Butte and mapped by Robert Dorn (1984). The habitat of *L. i* . var. *integrifolium* was mapped as the Saline Type on the West Fork of Chicken Creek. The rest of the Chicken Creek habitat for the taxon was mapped as wet meadow , cominated by "various Carex (sedges), Juncus balticus (Baltic rush), and Deschampsia cespitosa (tufted hairgrass). This does not fit the halophytic microhabitat where *L. i* . var. *integrifolium* occurs, and may be an artifact of mapping scale. As Dorn described the Saline Type, it includes both upland and riparian habitat. His description is presented below.

> Saline Type. This type was dominated by *Atriplex garderi* (Gardner saltbush), *Atriplex confertifolia* (shadscael saltbush), *Sarcobatus vermiculatus* (greasewood) and/or *Ceratoides lanata* (common winterfat). Other common species were *Artemisia spinescens* (bud sagewort) and *Sitanion hystrix* (bottlebrush squirreltail). The type occurred on alkaline soils on steep slopes, on benches, and in drainageways mostly in the south two-thirds of the Monument. The type was often barren in appearance and was never very; extensive. Common winterfat and bottlebrush squirreltail were often the only dominants on the more densely vegetated sites… (Dorn et al. 1984).

By contrast, habitat on the Bear River Valley is dominated by graminoids (Figures 9-11), though *Sarcobatus vermiculatus* is sporadically present at the fringes of the area.

In each locale where *Lepidium integrifolium* var. *integrifolium* occurs, it is restricted to a discrete hydrological zone that is seasonally saturated (occasionally inundated) early in the growing season and dominated by facultative wetland species. This zone can be found as the 30 m wide streambed at the head of an intermittent stream (e.g. West Fork of Chicken Creek), as a 10 m wide barren border beside seasonally inundated stream bottom (e.g., Smallpox Creek), or as a broad 500 m wide zone on the east side of the Bear River. The influences of hydrology are reflected in the contrasting pattern of distribution on the east versus the west side of the Bear River valley bottom. On the east side, the gradient is extremely subtle and the zone occupied by *L. integrifolium* var. *integrifolium* is broad, while the west side has a slightly steeper gradient, oxbow meanders closer to the outer valley margin, and significantly narrower zone of occupied habitat (Figures 9 and 10).

Figure 6. *Lepidium integrifolium* var. *integrifolium* habitat on Smallpox Creek, by B. Heidel

Figure 7. *Lepidium integrifolium* var. *integrifolium* habitat on mainstem of Chicken Creek, by B. Heidel

The majority of *Lepidium* species in Wyoming are upland species, with exception of *L. latifolium*, which is non-native. Outside of Wyoming, there are other rare wetland species in the genus *Lepidium*, such as *L. davisii* (Davis' peppergrass), a Great Basin endemic restricted to playas (Moseley 1996).

In each locale, *Lepidium integrifolium* var. *integrifolium* is restricted to salt-accumulation settings. Its succulent leaves are presumed to represent an adaptation for salt tolerance, which along with its habitat affinities, indicate that it is a halophyte. Salt accumulation is sometimes visible on the soil crust of the habitat. Halophytes dominate *Sarcobatus vermiculatus* stands, the most common habitat in the Fossil Butte area, and discrete bands and patches of *Distichilis stricta* within meadows dominated by *Carex praegracilis* as found along the Bear River Valley. These saltgrass bands are conspicuous when *L. integrifolium* var. *integrifolium* is in flower, compared to the surrounding meadow habitat, because of the relatively high concentrations of the white flowers of *L. integrifolium* var. *integrifolium* compared with other meadow forbs flowering at the time.

The dominants are halophytes in all settings, including *Distichilis stricta* and *Carex praegracilis*, sometimes with *Sarcobatus vermiculatus*, but there are cases where the habitat is not well-developed or grades into adjoining habitat. In one BLM tract on the South Fork of Twin Creek, *Lepidium integrifolium* var. *integrifolium* occurs in a shallow meander channel that is atypically dominated by *Artemisia cana* (silver sage). In one state tract on the lower Bear River, *L. integrifolium* var. *integrifolium* extends into the lower reaches of habitat dominated by *Ericameria nauseosa* var. *oreophila* (rubber rabbitbrush). Although it is not known whether *L. integrifolium* var. *integrifolium* contributes to the salt accumulation of its habitat, the non-native *L. latifolium* is reported to act as a "salt pump" - bringing salts up to the surface from its deep roots, and concentrating them at the surface (Renz 2004).

There are exotic species present in the habitat of *Lepidium integrifolium* var. *integrifolium*, although their cover is low. The superficial look-alikes in the *Cardaria* genus are Wyoming noxious weeds, and *Cardaria pubescens* (hoary cress whitetop) was noted in the landscapes, though not observed in the same alkaline meadow settings. The non-native wetland species that may have highest invasion potentials in the Bear River valley include members of the genus *Sonchus* (sow thistles) and *Cirsium arvense* (Canada thistle). The West Fork of Chicken Creek on National Park Service land has high numbers of *Ranunculus testiculatus* (bur buttercup) and *L. perfoliatum* (clasping pepperweed). The one BLM tract on the South Fork of Twin Creek dominated by *Artemisia cana* also has a local abundance of *Poa pratensis* (Kentucky bluegrass). In the Bear River Valley, another non-native member of the genus *Lepidium* occurs, *L. campestre* (field pepperweed). Infrequently, there are non-native ruderals, e.g. *Amaranthus retroflexus* (redroot amaranth), and where this species increases and dominates *L. integrifolium* var. *integrifolium* appears to decline and disappear. Herbicide applications along the county highway leading to Fossil Butte National Monument have caused *Bromus tectorum (cheatgrass)* to increase (Clayton Kyte 2003 personal communication) which could increase risk that cheatgrass will invade the Smallpox Creek subpopulations of *L. integrifolium var. integrifolium*.

Lepidium integrifolium var. *integrifolium* appeared to have high habitat fidelity in the Fossil Butte and Cokeville areas, such that tracts and patches within these areas that had suitable

habitat were very likely to support the species. A summary of the habitat settings for the species in each of the three locales where it has been documented is provided in Table 3.

Table 3. Habitat of *Lepidium integrifolium* var. *integrifolium*

Nearest Town	**Setting(s)**	**Elev.**	**Associated species**[2]
Fossil Butte	Streambeds, alluvial flats and margins in foothill and valley bottom settings	6590-6790	[*Achillea millefolium* (yarrow)],[*Artemisia cana*], *Atriplex gardneri* (Gardner's saltbush), *Carex praegracilis*, *Chenopodium glaucum* (common goosefoot), *Distichlis stricta*, *Elymus elymoides* (bottlebrush squirreltail), [*Lepidium perfoliatum*], [*Machaeranthera canescens* (hoary tansyaster)], *Poa nevadensis* (Nevada bluegrass), [*Poa secunda* (Sandberg bluegrass)], *Puccinellia nuttalliana* (Nuttall's alkaligrass), *Pyrrocoma lanceolata* (lanceleaf goldenweed), [*Ranunculus testiculatus*], *Sarcobatus vermiculatus*.
Cokeville	Broad valley bottom	6170-6190	[*Alyssum desertorum* (desert madwort)], [*Amarathus retroflexus*], *Atriplex gardneri*, [*Brassica rapa* (field mustard)], [*Capsella bursa-pastoris* (shepherd's purse)], *Carex praegracilis*, [*Ericameria nauseosa* var. *oreophila*], [*Descurainia sophia* (herb sophia)], *Distichlis stricta*, [*Elymus smithii* (western wheatgrass)], *Glaux maritima* (sea milkwort), *Iva axillaris* (povertyweed), *Juncus balticus* (Baltic rush),[*Lepidium campestre*], [*Lepidium perfoliatum*], *Plantago tweedyi* (Tweedy's plantain), *Poa nevadensis*, *Potentilla anserina* (silverweed cinquefoil), *Pyrrocoma lanceolata*, *Sisyrinchium idahoense* var. *occidentale* (Idaho blue-eyed grass), *Sonchus asper* (spiny sowthistle), *Sporobolus airoides* (alkali sacaton), *Thelypodium paniculatum* (northwestern thelypody).
Almy	Broad valley bottom	6600	*Carex praegracilis*, *Carex vallicola* (valley sedge), *Elymus trachycaulus* (slender wheatgrass), *Juncus balticus*, *Plantago tweedyi*, *Pyrrocoma lanceolata*, [*Suckleya suckleyan*a (poison suckeya).]

Of the eight plant species of concern at Fossil Butte National Monument, including three regional endemics, *Lepidium integrifolium* var. *integrifolium* was considered to be the "rarest" (Fertig 2000b) at that time. The other rare species are in uplands, Only *Astragalus lentiginosus* var. *salinus* (Sodaville milkvetch) may occur near habitat of *L. integrifolium* var. *integrifolium* (Fertig 2000b, Fertig et al. 1998). A rare sedge was collected in Cokeville, *Carex parryana* var. *unica* (Hall's sedge) - this represents a major state range extension and verification is pending.

[2] Atypical or uncommon associated species are set off in brackets.

Figure 8. *Lepidium integrifolium* var. *integrifolium* habitat on Twin Creek (BLM tract), by B. Heidel

The climate conditions where *Lepidium integrifolium* var. *integrifolium* is found are cold and semi-arid (Table 4). The average conditions during the June flowering period are relatively mild, but marked by high variability in both temperature and precipitation (USDI NOAA 2004).

Table 4. Climate data from stations nearest *Lepidium integrifolium* var. *integrifolium* populations

Climate variable	Fossil Butte, WY Elev.: 6780 ft, Duration of record: 8/1/1990-7/31/2003	Border 3N, WY (Station nearest Cokeville) Elev.: 6069 ft, Duration of record: 1/1/1902-9/30/1993	Evanston 1E, WY (Station nearest Almy) Elev.:6825 ft, Duration of record: 12/3/1890-7/31/2003
Mean annual ppt. (inches)	10.56	13.53	11.95
Month and mean value of peak ppt. (inches)	May - 1.28	May - 1.40	May - 1.37
Mean annual temperature (F)	39.1	38.1	40.1
June mean ppt. (min/max. ppt.; inches)	1.26 (0.15/4.60)	1.22 (0.00/4.97)	1.03 (0.00/4.02)
June mean T (min/max T)	54.9 (36.2/73.6)	55.8 (38.1/73.5)	55.4 (38.6/72.2)

Figure 9. *Lepidium integrifolium* var. *integrifolium* habitat on east side of Bear River, by B. Heidel

Figure 10. *Lepidium integrifoliu m* var. *integrifolium* habitat on west side of Bear River, by B. Heidel

Figure 11. *Lepidium integrifolium* var. *integrifolium* habitat on west side of Bear River, by B. Heidel

The potential distribution model of *Lepidium integrifolium* var. *integrifolium* was built upon the primary environmental determinants including bedrock geology (Early Eocene, and Permian/Triassic/Jurassic), land cover (Human Disturbed sites and Wyoming big sagebrush), soil (Aridic haplustolls and Ustic Haplocambids, as well as Ustic Halpargids and Torrifluvents), and surficial geology (alluvial fan, landslide, and slopewash -- includes alluvial deposits; Fertig and Thurston 2003). However, the surficial geology characteristics as they encompass alluvial deposits is the only set of attributes that closely corresponds with current understanding of *L. integrifolium* var. *integrifolium* habitat requirements.

Population Size and Trends

The three occurrences of *Lepidium integrifolium* var. *integrifolium* represent populations of contrasting magnitude and extent. Their documented extent totals about 420 acres and total numbers are estimated between 21,000-155,000. The Fossil Butte population consists of six discrete subpopulation clusters totaling approximately 3,500-10,000 plants. The total number of plants on three BLM tracts was estimated between 550-1100 and all others are on Fossil Butte National Monument. The population complex occupies an area of about 7.5 acres but spans a distance of over 5 miles in stream corridor habitat that may have been recurrent if not continuous.

The Cokeville population of *Lepidium integrifolium* var. *integrifolium* consists of at least four subpopulations in the range of 17,000 - 145,000 plants, corresponding with the four public tracts that were surveyed. The population complex occupies an area of about 413 acres on both sides of a very broad, flat valley, spanning a distance of over 6 miles of valley bottom habitat thay may have been continuous on either side. It is in a discrete band in three of the four tracts, and widely scattered across almost half of the northeasternmost tract (in Sec. 33). The local population estimates are rough estimates because the decumbent growth form with numerous, interlacing stems made it difficult to discern individuals at a glance, particularly under high density. Settings with particularly high density are shown in Figures 10 and 11; note the flowering individuals. High and low estimates were recorded by intensively subsampling the numbers of plants across the range of settings in each tract, and then extrapolating.

By contrast, only about 50 plants were found in the Almy roadside population.

Welsh et al. (1987) reported that *Lepidium integrifolium* var. *integrifolium* has been "collected only rarely, possibly because the habitat type has been exploited as marginal pastureland in Utah and Wyoming, and probably because its habitat is now occupied by the similar *Cardaria draba*, which is bypassed by most collectors." Stone (1998) suggested that populations from south-central Utah may be extirpated.

Population trends are discussed separately for each of the Wyoming occurrences because they are in different settings. Loss of *Lepidium integrifolium* var. *integrifolium* habitat is inferred at the Fossil Butte area. The Fossil Butte Station was situated on Twin Creek on a tract that is privately-owned. Segments of Twin Creek were channelized by the Union Pacific railroad after railroad bed construction (Clayton Kyte 2003 personal communication) and the result has been

continued down-cutting and entrenchment of the stream course, lowering of the water table, and loss or change of well-developed halophytic vegetation (Figure 12). In general, the railroad construction and road constructions through Twin Creek valley and across the West Fork of Chicken Creek may also have an affect on habitat. Only one subpopulation on BLM lands is directly along the main stem of Twin Creek but along an abandoned meander. The South Fork of Twin Creek is also deeply entrenched near occupied side-channel habitat. The channelization may be associated with upstream housing developments or a more distant reservoir upstream.

Figure 12. Incised stream course on Twin Creek, by B. Heidel

Stock dams were constructed prior to Fossil Butte National Monument designation on drainages supporting *Lepidium integrifolium* var. *integrifolium*. Subsequently they were removed under the National Park Service policy of landscape restoration. The pattern of *L. integrifolium* var. *integrifolium* distribution relative to these former structures offers a perspective on their affects. A small headwaters dam on the West Fork of Chicken Creek may have inundated *L. integrifolium* var. *integrifolium* habitat at and above the western edge of the western Monument border. This dam failed prior to Monument designation (Clayton Kyte 2003 personal communication). The former reservoir bottom has revegetated and there is a relatively high cover of graminoids that reproduce vegetatively by rhizomes. They include *Carex nebrascensis* (Nebraska sedge), *Juncus balticus* (Baltic rush), and a non-native sod-forming grass, *Poa pratensis* (Kentucky bluegrass), none of which are halophytic species. *Artemisia cana* (silver sagebrush) is also present. If the local vegetation did have halophytic vegetation prior to dam construction, then it has been changed whether due to changes in salt migration and groundwater movement patterns or the obscuring of the associated vegetation patterns by siltation. The drainage course above the former impoundment was on private land and was not surveyed, but there appeared to be little or no facultative wetland vegetation indicative of *L. integrifolium* var. *integrifolium* habitat. The taxon is present below the former dam where there are braided

channels in a broad stream bottom. It is not known whether *L. integrifolium* var. *integrifolium* is present in spite of the dam or because of it. Robert Dorn (Dorn et al. 1984) hypothesized that the relatively extensive alkaline habitat in this area was a result of salts being brought to the surface by the impoundment upstream. At least the breadth of the downstream floodplain and the degree of stream braiding below the dam were likely to have been enhanced by this dam's presence as new channels formed when water spilled over the top of the dam on one or more occassions (Clayton Kyte 2004 personal communication).

A second larger downstream dam was built across the mainstem of Chicken Creek. *Lepidium integrifolium* var. *integrifolium* is absent below the reservoir. Immediately downstream of this reservoir was a homestead (Dorn et al. 1984). The downstream corridor is relatively steep and deeply incised. Robert Dorn suggested that the severe erosion on lower Chicken Creek was a product of livestock trampling (1984), though it seems likely that the impoundment and water developments at the homestead were also contributing factors. There is extensive upstream habitat for *L. integrifolium var. integrifolium* in the mainstem of Chicken Creek and in the two branches (East and West Forks of Chicken Creek). In addition, there is one small patch of *L. integrifolium* var. *integrifolium* located in the former reservoir zone near the former high-water mark of the impoundment (Clayton Kyte 2004 personal communication). Fluctuating water levels could have created some habitat for it along the shoreline, but a thorough search by Kyte only turned up the single spot.

Loss of *Lepidium integrifolium* var. *integrifolium* habitat is inferred in the Bear River valley south of Cokeville. The Cokeville Meadows NWR is bordered mainly by lands that were converted to cultivated hay meadows. More recently, central pivot irrigation systems were installed, whether for hay or crop production. Ditch and canal construction, highway construction, and herbicide use were all likely to have reduced species' habitat and numbers. However, the presence of ditches and canals does not preclude species' persistence, and in fact one of the large population segments in Cokeville Meadows NWR lies immediately below a canal where the water and salt movement in the native habitat may even be augmented by the canal.

The direct and indirect responses of *Lepidium integrifolium* var. *integrifolium* to livestock grazing are not known. The affects of livestock grazing on the vegetation of Fossil Butte National Monument were addressed by Dorn et al. (1984), and areas along Chicken Creek and tributaries were found to be in generally poor condition. The Fossil Butte National Monument was managed for livestock production prior to its acquisition and designation in 1972. It was part of a 100,000 acre grazing allotment (Dorn et al. 1984). Before 1973, most livestock use was by sheep (Dorn et al. 1984). Sheep were overwintered on the monument, including a lambing band held on the Chick Creek Drainage from early March until late May (Beetle and Marlow 1974). Feral horses also grazed the area from shortly after settlement until their removal after Monument designation (Dorn et al. 1984). Outside of the Monument, the three BLM tracts where *L. integrifolium* var. *integrifolium* occurs are part of range allotments. One of the Cokeville Meadows NWR tracts is an old homestead and the taxon is present in suitable habitat there, except where there were corrals or other developments that fostered ruderal species and excluded native species. The collection label information for the specimen collected by Barneby near Cokeville characterized the associated species as "rushes and *Triglochin*." The former most

likely refers to *Juncus balticus*, still associated with the taxon, and the latter likely refers to *Triglochin maritima* (seaside arrowgrass), which is present in the area. Neither are particularly common or conspicuous in Cokeville Meadows National Wildlife Refuge. Both *Juncus balticus* and *Triglochin maritima* are native species that increase under grazing. Their association with *L. integrifolium* var. *integrifolium* indicates there was heavier grazing at the time of the 1969 Barneby collection, and that the taxon persists under some grazing. The evidence is incomplete.

There is no information on vegetation competition, but the halophytic conditions may curb high vegetation cover. Litter accumulation may possibly affect *Lepidium integrifolium* var. *integrifolium*. Much of its habitat in the Bear River Valley was native grass hayland at one time. One of the Cokeville Meadows NWR tracts with a large population had clearly been used as a hay meadow, and there were persistent vegetation patterns that indicate places where hay was stacked.

Of the three occurrences, it appears that the Almy area has the greatest extent of habitat conversion from ditching, draining, road construction, and other valley bottom developments which would be expected to correspond with greatest decline in population size and extent.

Population Biology and Ecology

Lepidium integrifolium var. *integrifolium* flowers from the second week of June to early July, and flowering is indeterminate. Fruits are present from late June to August. During the surveys it appeared that all mature plants were in flower, and the only plants that were seen in vegetative condition were immature (Figure 13); they were not part of census estimates. Thus, there were no distinctions recorded between flowering and nonflowering plants in population estimates.

The longevity and mean lifespan of *Lepidium integrifolium* var. *integrifolium* are not known. The stability or instability of its numbers is also not known. It might be possible to get pilot trend information from monitoring a small segment of the Fossil Butte National Monument population.

There is no information available on seed germination and biology of *Lepidium integrifolium* var. *integrifolium*. It was reported that pre-chilling deterred germination of another Intermountain *Lepidium* in playa habitat, *L. davisii* (Moseley 1996), an indication that germination took place in the same growing season as flowering. This report is consistent with the observation that there were immature plants of *L. integrifolium* var. *integrifolium* that had no more than four basal leaves and no vestiges of a cotyledon in June, possibly indicating fall germination (Figure 13). By their basal leaf development, it is thought that both of the plants in Figure 13 are first-year plants of the same age, so it is interesting to note that one of the two plants was producing a late-to-emerge pair of inflorescences in its first growing season. Dispersal vectors and seed biology for *L. integrifolium* var. *integrifolium* are not known.

Figure 13. Immature *Lepidium integrifolium* var. *integrifolium* plants, by B. Heidel

Pollination biology of *Lepidium integrifolium* var. *integrifolium* has not been researched. The most frequent insect visitor appeared to be *Pieris rapae* (cabbage white butterfly). This butterfly seemed to regularly visit *L. integrifolium* var. *integrifolium* even when there were other species of flowering mustards nearby. *Pieris rapae* is a widespread butterfly that feeds on flower nectar from a very wide array of plants including mustards, dandelion, red clover, asters, and mints (Struttman 2004).

There were no signs of browsing or grazing observed. Insect herbivory was noted on *Lepidium integrifolium* var. *integrifolium* in the Fossil Butte area, causing small perforations through the thickness of the leaf in places (see Figure 1). Other insect herbivory was concentrated at the leaf margin (Figure 13). Despite this herbivory, all plants appeared vigorous at the time of visit.

Current Management

Most of the Fossil Butte occurrence of *Lepidium integrifolium* var. *integrifolium* is protected in Fossil Butte National Monument managed by the National Park Service (NPS), although it extends onto BLM lands managed for multiple-use. Most of the Cokeville occurrence

is protected in the newly-established Cokeville Meadows National Wildlife Refuge (NWR), but continues onto state land that is managed for multiple-use.

All three colonies of *Lepidium integrifolium* var. *integrifolium* on BLM tracts in the Fossil Butte area have *L. integrifolium* var. *integrifolium* are situated near tract boundaries, as are the westernmost Fossil Butte National Monument subpopulations. Any maintenance work along the boundary or change in the way lands near, but outside, the BLM and NPS borders are managed may affect the taxon. The largest of the three BLM subpopulations directly adjoins the Union Pacific Railroad (Figure 8), where herbicide treatment in the corridor may have indirect affects on the adjoining subpopulation. All of the subpopulations are part of range allotments, but there were no direct signs of cattle grazing or trampling and limited sign of livestock trailing through the areas.

It appears that the Utah occurrences are on private lands, so it is all the more significant that the two large occurrences in Wyoming are concentrated on lands managed by the National Park Service and U.S. Fish and Wildlife Service. This underscores their contribution to range-wide viability, as summarized by Fertig et al. (1998) and Fertig (2000c).

Existing and Potential Threats

The habitat of *Lepidium integrifolium* var. *integrifolium* has been affected by channelization, ditching, impoundments, plowing to establish cultivated hay, dam construction, road construction, and railroad construction. Perhaps even more pervasive, or expressed as a cumulative effect, these above-mentioned changes to hydrology in the surrounding watershed may lead to development of incised channels, particularly where water flow is seasonal (Figure 13). This has the effect of lowering the water table, changing the patterns of salt migration, and reducing or eliminating suitable alkaline meadow habitat. *Lepidium integrifolium* var. *integrifolium* is potentially impacted by central pivot irrigation, which is occasional in the Bear River valley as seen on aerial photos and in casual observation on both Utah and Wyoming sides of the state line. This taxon is also potentially impacted by herbicides. There seem to be areas leased for haying on the Cokeville Meadows NWR, planted into non-native grasses. These cultivated hay lands do not support the taxon and may be the focus of herbicide treatment on the NWR. Direct herbicide application or drift could potentially impact the taxon. In one tract on the NWR, it seemed as though *L. integrifolium* var. *integrifolium* was absent or sparse in settings where it would otherwise have been common, and this locale is near a cultivated hay meadow.

Weed invasions are potential threats in their own right apart from the disturbances that they may accompany. Weeds may compete with seedlings for nutrients and light, and modify habitat conditions. Invasive non-native species in or near *Lepidium integrifolium* var. *integrifolium* habitat include *Cirsium arvense, Ranunculus testiculatus, Poa pratensis, Bromus tectorum*, and members of the genus *Sonchus*. There is limited historic information available to indicate their trends, but *Ranunculus testiculatus* was characterized as common on the Upper West Fork of Chicken Creek nearly 20 years ago, and *Bromus tectorum* was known from the area of the breached dam site on the Upper West Fork of Chicken Creek (Dorn et al. 1984).

It is not known whether *Lepidium integrifolium* var. *integrifolium* is a poor competitor or suppressed by litter accumulation under idle conditions. The history of mowing in the Bear River valley may have played a role in its persistence.

The populations in south-central Utah are thought to be extirpated (Stone 1998).

Figure 14. Relict roadside population of *Lepidium integrifolium* var. *integrifolium* at Almy, by B. Heidel

Highway maintenance directly affects *Lepidium integrifolium* var. *integrifolium*, and the Almy occurrence could be destroyed by road widening, grading or herbicide spraying (Figure 14). Weed-spraying has increased *Bromus tectorum* along the county highway that provides access to Fossil Butte National Monument which poses risk of this non-native annual invading nearby *L. integrifolium* var. *integrifolium* habitat. At least two of the extant Utah occurrences were reported as roadside collections, and could potentially be affected by road maintenance.

SUMMARY

The results of this *Lepidium integrifolium* var. *integrifolium* survey document an estimated 420 acres of occupied habitat in Wyoming and bracket population numbers between 21,000-155,000 plants. They are all part of the Bear River watershed, in settings with well-developed alluvial deposits and salt-accumulation zones. Only one new occurrence was documented. It is relatively secure on public lands barring indiscriminate herbicide use.

The three extant occurrences in Wyoming and the four recent Utah records together may indicate a need to review the global rank for this taxon. However, a global rank change is not

recommended at this time because at least three of the seven recent records are based on collections that may represent relict roadside populations. At least two of the four recent Utah collections may be from a single extensive population. Moreover, habitat loss has taken place between subpopulations, resulting in increased fragmentation. This status review is still preliminary without comparable surveys for *Lepidium integrifolium* var. *integrifolium* in Utah, and possibly in the Woodruff Narrows on the Bear River and the Carter area of the Blacks Fork watershed in Wyoming.

The potential distribution model of *Lepidium integrifolium* var. *integrifolium* deserves special discussion. It was developed by Fertig and Thurston (2003) and based on the only two collection points with location information. However, Barneby's 1969 collection record south of Cokeville had been mapped incorrectly. Kyte's 1996 collection site in Fossil Butte National Monument happened to represent the farthest upstream subpopulation of *L. integrifolium* var. *integrifolium* along the stream corridor. Thus, the model predicted polygons in upland foothills settings that proved generally unsuitable. Fertig and Thurston (2003) note that modeling wetland and riparian plants presents a special challenge because there is no statewide dataset of wetland features. To compensate for this lack of data, they developed a riparian area data layer, which was not used in the original *L. integrifolium* var. *integrifolium* model. It is possible that a meaningful potential distribution model could be created using the many additional distribution points from the extensive occurrences that have been documented and the riparian data layer.

Lepidium integrifolium var. *integrifolium* may be resilient to the widespread practices of grazing and mowing, but it is still threatened by loss of riparian habitat, and to some degree by changes in hydrology and salt migration associated with local and watershed-wide landuse practices that may make its habitat unsuitable.

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Torrey and Gray. 1838. Flora of North America. Vol. 1. Comprising the Polypetalous Division of the Dicotyledonous or Exogenous Plants.Wiley & Putnam, New York, NY.

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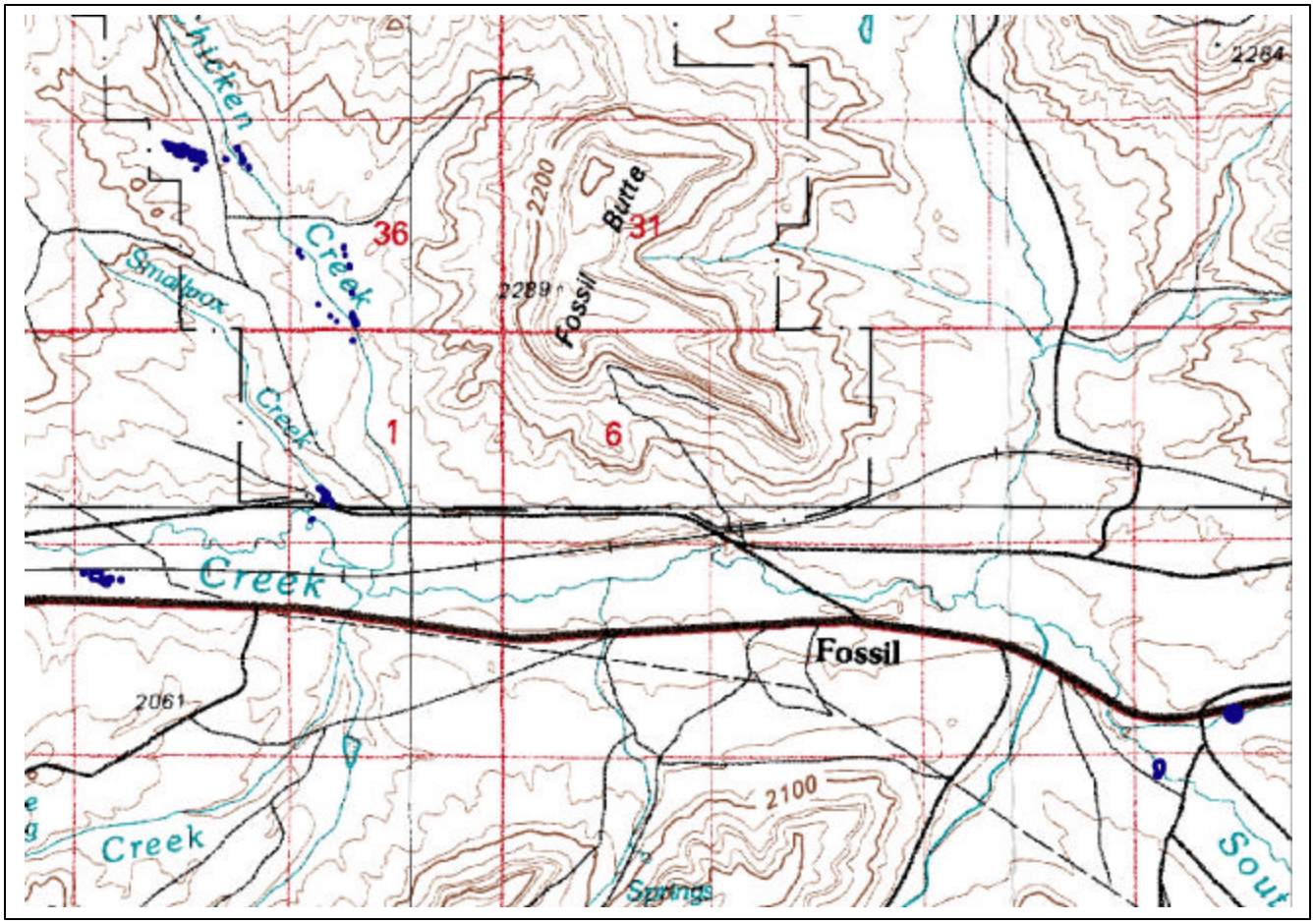
Appendix A. Element occurrences of *Lepidium integrifolium* var. *integrifolium*

Lepidium integrifolium var. *integrifolium*
Element Occurrence #001. Fossil
Nugget and Fossil (7.5' minute quad maps)



Legend

Lepidium integrifolium var. *integrifolium* colony

WYOMING NATURAL DIVERSITY DATABASE
-Element Occurrence Record-

LEPIDIUM INTEGRIFOLIUM VAR INTEGRIFOLIUM Number: 001

Common Name: ENTIRE-LEAVED PEPPERGRASS PDBRA1M192
Data Sensitive?: N Identification verified: Y
TNC Global Rank: G1G2T1? WYNDD State Rank: S1
Federal Status: WY Distribution Note: REGIONAL ENDEMIC
Management Status: WY BLM SSL

County: Lincoln
USGS Quad Name: FOSSIL
NUGGET
Latitude: 415052N Longitude: 1104637W
South Lat: East Long:
North Lat: West Long:
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range:	Section:	T/R/S Comments:
022N118W	35,36	Sec. 35: W2 OF NW4 OF NE4, E2 of NE4 of NW4; Sec. 36.
021N118W	1,11	Sec. 1: SW4 of SW4; Sec. 11: NW4 of NW4.

Location: Overthrust Belt, on lower reaches of six Twin Creek tributaries. On West Fork of Chicken Creek, west of main road in Fossil Butte National Monument, ca 4 air miles northwest of Fossil. Also east of main road in Fossil Butte Monument and east of Visitors Center on West Fork and immediately adjoining East Fork of Chicken Creek ca. 3 air miles northwest of Fossil. On Smallpox Creek, 0.3 miles west of the entrance to Fossil Butte National Monument on north and south sides of road, ca. 2 air miles west-northwest of Fossil. On an abandoned meander of Twin Creek, ca. 3 miles West of Fossil, immediately south of railroad tracks. On South Fork of Twin Creek, 0.1 miles west of Lincoln Rd. 328, ca. 1.5 air miles southeast of Fossil. Also 0.2 miles east of Lincoln Rd. 328, on East Fork of Twin Creek between I-80 and the old railroad grade.

Last Observed: 2003-06-24 First Observed: 1885
Occurrence Rank: AB
Rank Comments: Extensive population complex, in good condition except for some weediness, highly fragmented.

Data: 2003-06: Three Fossil Butte National Monument subpopulations were surveyed and digitized by Clayton Kyte, and three nearby BLM subpopulations were surveyed and mapped by B. Heidel, all in peak flowering. There are ca. 3.9 acres of occupied habitat on Fossil Butte NM and 3.5 acres on BLM tracts in the area. The two largest are in the upper West Fork of Chicken Creek, and in Smallpox Creek, primarily in Fossil Butte NM. Upper West Fork of

Chicken Creek in Sec. 35: continuous for 0.25 miles and estimated in 1000's by C. Kyte.
1999-06-18: Upper West Fork Chicken Creek colony previously tallied at ca 100 flowering and vegetative plants observed in walk-through survey by W. Fertig and L. Welp and estimated at 250-500. Plants prostrate to erect, with large basal rosettes. Most numerous at base of Sarcobatus plants (largest individuals found here, too). Occurs with Atriplex gardneri, Puccinellia, Ranunculus testiculatus, Poa secunda, and Pyrrocoma.
1998-08-13: Observed in fruit by C. Delmatier and C. Kyte.
1996-07-26: Upper West Fork Chicken Creek colony: Observed in fruit by Clay Kyte.
2003-06: Mainstem of Chicken Creek and mouths of West and East Forks in Sec 36 and eastern Sec 35, in at least 17 small, scattered locales spanning over 1 mile above former Impoundment, mapped by C. Kyte.
2003-06: Colony on Smallpox Creek in Sec. 1 estimated at 1000's and mapped by C. Kyte. 2003-06-22: Colony on abandoned meander of Twin Creek in Sec. 11 estimated at 500-1000 and less than 1 acres, mapped by B. Heidel.
2003-06-17: Colony on South Twin Creek in Sec. 15 estimated at 50-100 and at less than 1 acre, and mapped by B. Heidel.
2003-06-24: On plant found on East Twin creek in Sec. 10 in otherwise suitable but unoccupied habitat by B. Heidel. Variously occurs with Sarcobatus vermiculatus, Atriplex gardneri, Poa nevadensis, Puccinnellia nuttalliana, Pyrrocoma lanceolata, Carex praegracilis, Distichilis stricta. Upper West Fork of Chicken Creek has notable abundance of Ranunculus testiculatus. South Twin Creek has atypical proximity of Poa pratensis, Achillea millefolium, Artemisia cana. The species' microhabitat preferences vary by site, e.g., Sarcobatus mounds, or margins of salt flats.
1885: Collected from "Fossil" by G.W. Letterman.

Habitat: Alkaline meadow microhabitats along ephemeral to seasonal stream segments, including channel margins and meanders dominated locally by Sarcobatus vermiculatis, meadow margins with Poa nevadensis or Puccinnellia nuttalliana, and salt-accumulating bottoms or terraces with Distichilis stricta and Carex praegracilis. Soils are moist, silt alluvium, occasionally with a claypan, with numerous cracks and wedges.
Absent from adjacent Artemisia tridentata/Poa secunda meadows or dense sedge marshes.

Elevation: 6590-6790 feet Size: acres

Comments: Letterman's general precision collection from "Fossil

Station" is included in this record. According to Ernie Nelson of the Rocky Mountain Herbarium, Letterman passed through Wyoming in 1885. The Fossil Station was located 1 mile east of its present location until 1902 when the station and townsite were moved to the present location, according to C. Kyte. Fossil Butte NM colonies were digitized by Clayton Kyte [NAD27]. Land uses and historic habitat alterations include impoundments, localized stream channelization and diversion, possible lowering of groundwater levels and habitat loss from upstream erosion and water uses, and livestock grazing.

Managed Area:
FOSSIL BUTTE NATIONAL MONUMENT
BLM KEMMERER FIELD OFFICE

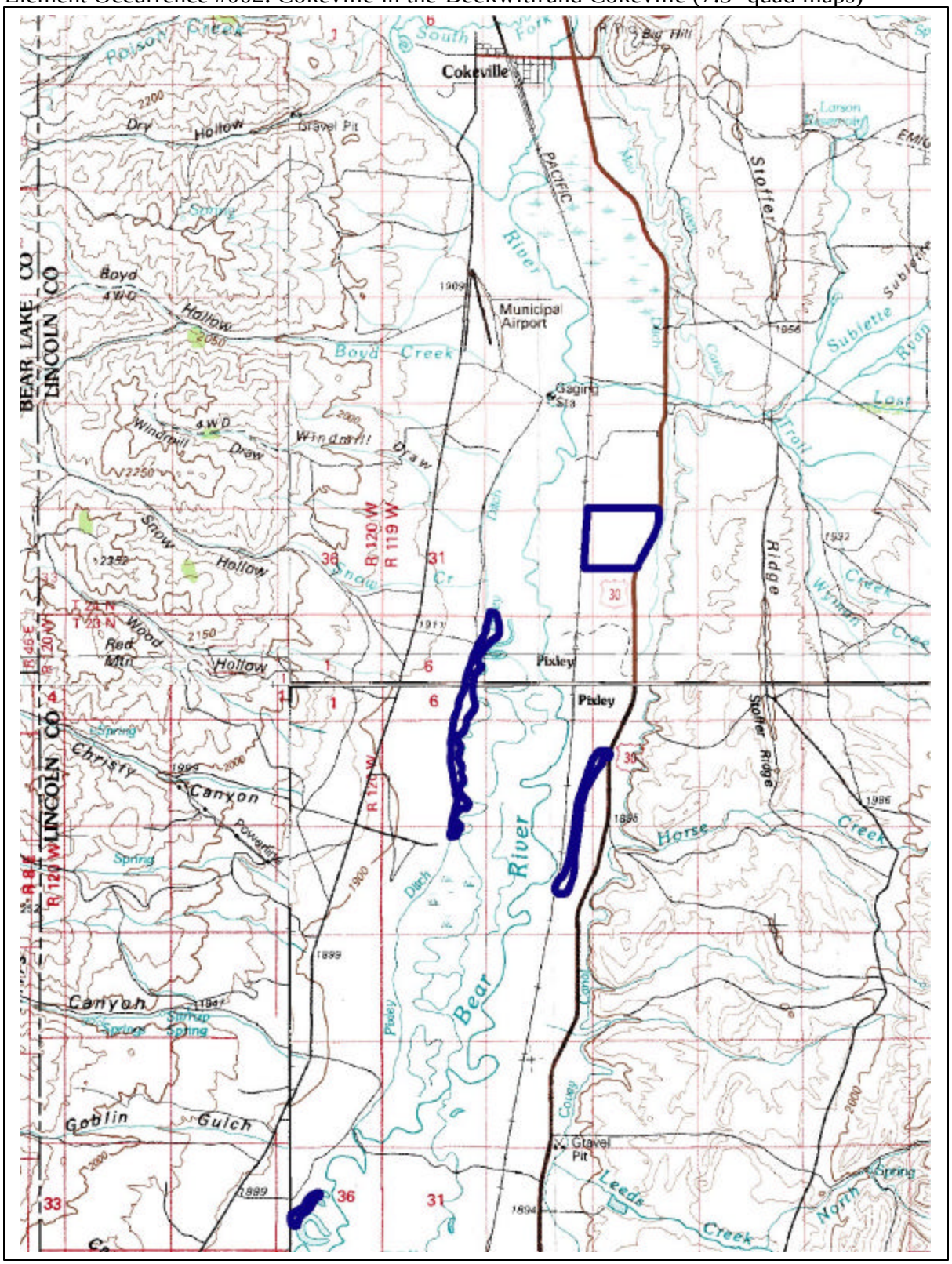
Specimens: Letterman, G.W. (120). 1885? GH, US.
Kyte, C. (96-167). 1996. RM, FOBU.
Delmatier, C. and C. Kyte. (7983). 1998. RM, FOBU.
Heidel, B. (2316) RM.

Sources: Hitchcock, C. L. 1936. The genus Lepidium in the United States. Madrono 3: 265-320.
Fertig, Walter. Former Botanist of Wyoming Natural Diversity Database. 1117 West Grand Canyon Dr., Kanab, UT 84741. 453-644-8129.
Heidel, Bonnie. Botanist of Wyoming Natural Diversity Database. P.O. Box 3381, University of Wyoming, Laramie, WY. 82071.

Author: Bonnie Heidel Edition Date: 07-03-24

Lepidium integrifolium var. *integrifolium*

Element Occurrence #002. Cokeville in the Beckwith and Cokeville (7.5' quad maps)



Legend ■ *Lepidium integrifolium* var. *integrifolium* colony

WYOMING NATURAL DIVERSITY DATABASE
-Element Occurrence Record-

LEPIDIUM INTEGRIFOLIUM VAR INTEGRIFOLIUM Number: 002

Common Name: ENTIRE-LEAVED PEPPERGRASS PDBRA1M192
Data Sensitive?: N Identification verified: Y
TNC Global Rank: G1G2T1? WYNDD State Rank: S1
Federal Status: WY Distribution Note: REGIONAL ENDEMIC
Management Status: WY BLM SSL

County: Lincoln
USGS Quad Name: BECKWITH
COKEVILLE

Latitude: 420124N Longitude: 1105601W
South Lat: 415533N East Long: 1105601W
North Lat: 420124N West Long: 1105959W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range:	Section:	T/R/S Comments:
024N119W	33	Sec. 33 NW 1/4
023N119W	6-9, 17-18	Sec 6 SE4; Sec 7 E2, Sec 8 E2 of SE4; Sec 9 SW4 of NW4
023N119W	36	Sec 36 W2

Location: Bear River Valley, 4.5-10.5 miles south of Cokeville, on both sides of Bear River valley.

Last Observed: 2003-06-20 First Observed: 1969-06-19
Occurrence Rank: AB
Rank Comments: Large population, locally abundant, and once contiguous in native habitat.

Data: 2003-06-20: Estimated totals of 17,000-145,000 in at least four areas which were historically continuous, totaling ca. 400 acres, mapped by B. Heidel.
2003-06-19: Sec. 33 tract: Estimated 5,000-10,000 plants where locally common in Distichilis stricta patches mainly within Carex praegracilis zones. Occurs with Pyrrocoma lanceolata, Thelypodium paniculatum, Juncus balticus, Atriplex gardneri, Sonchus spp. in places.
1969-06-19: Occurs with rushes and Triglochin on specimen label by Barneby.
2003-06-20: Sections 6, 7, and 18: Estimated 10,000-100,000 plants where nearly continuous for 1.5 miles in narrow zone between Pixley Ditch and elongate meandered wetland below; also present sporadically in low numbers immediately above Pixley Ditch at alkaline margins. Occurs with Distichilis stricta, Poa nevadensis, Atriplex gardneri, Pyrrocoma lanceolata, Plantago tweedyi.

2003-06-20. Sections 8, 9 and 17: Estimated 1,000-2,000 plants along gentle slope marking wet meadow transition. Occurs with Sarcobatus vermiculatus in southern end, and with Distichilis stricta and sometimes Carex praegracilis and Amaranthus retroflexus in northern end. 2003-06-20: Sec. 36: Estimated 1,000-1,500 plants in broad flats above oxbow wetlands. Occurs with Distichilis stricta and Pyrrocoma lanceolatus, extending into vegetation with Chrysothamnus naseosus var oreophilus, Elymus smithii and Alyssum desortum.

Habitat: Moist alkaline meadows spanning broad, level valley bottom. Most extensive at outer valley zones, on moist silt loam, 0-5% slope. Salt-affected zones and patches within Carex praegracilis wet meadow.

Elevation: 6170-6190 feet Size: 105 acres

Comments: The Sec. 33 subpopulation location corresponds closely with directions to the 1969 collection.

Managed Area:
BLM KEMMERER FIELD OFFICE
STATE OF WYOMING

Ownership:

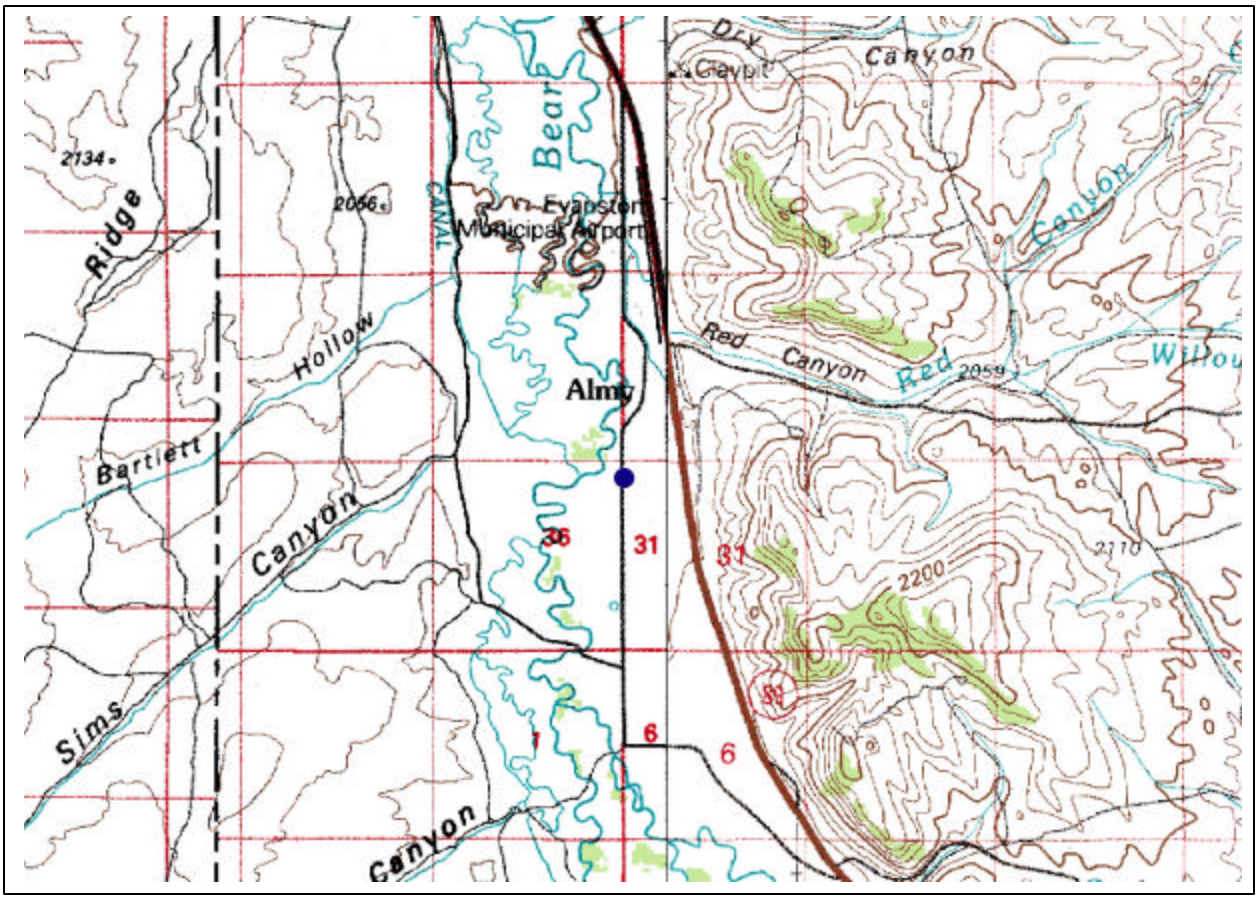
Mgmt Comments:

Specimens: Barneby, R.C. (15088). 1969. BRY.
Heidel, B. (2306, 2307, 2309, 2314). RM, BRY.

Sources: Heidel, Bonnie. Botanist of Wyoming Natural Diversity Database. P.O. Box 3381, University of Wyoming, Laramie, WY. 82071.

Author: Bonnie Heidel Edition Date: 03-07-24

Lepidium integrifolium var. *integrifolium*
Element Occurrence #003: Almy
Murphy Ridge Quad (7.5')



Legend

Lepidium integrifolium var. *integrifolium* colony

WYOMING NATURAL DIVERSITY DATABASE
-Element Occurrence Record-

LEPIDIUM INTEGRIFOLIUM VAR INTEGRIFOLIUM Number: 003

Common Name: ENTIRE-LEAVED PEPPERGRASS PDBRA1M192
Data Sensitive?: N Identification verified: Y
TNC Global Rank: G1G2T1? WYNDD State Rank: S1
Federal Status: WY Distribution Note: REGIONAL ENDEMIC
Management Status: WY BLM SSL

County: Uinta
USGS Quad Name: MURPHY RIDGE

Latitude: Longitude:
South Lat: East Long:
North Lat: West Long:
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range:	Section:	T/R/S Comments:
016N121W	36	NE4 OF NE4

Location: Overthrust Belt, app. 0.4 miles south of Almy, on west side of Uinta Rd. 107 (Almy Road).

Last Observed: 2003-06-28 First Observed: 2003-06-28
Occurrence Rank: D
Rank Comments: Small relict population, disturbed setting

Data: 2003-06-28: In flower and early fruit. Est. 50 plants in an area less than 10 m long and ca. 1 m wide. Occurs with Carex praegracilis, Elymus trachycaulus, Juncus balticus, Plantago tweedyi, and Pyrrocoma lanceolata.

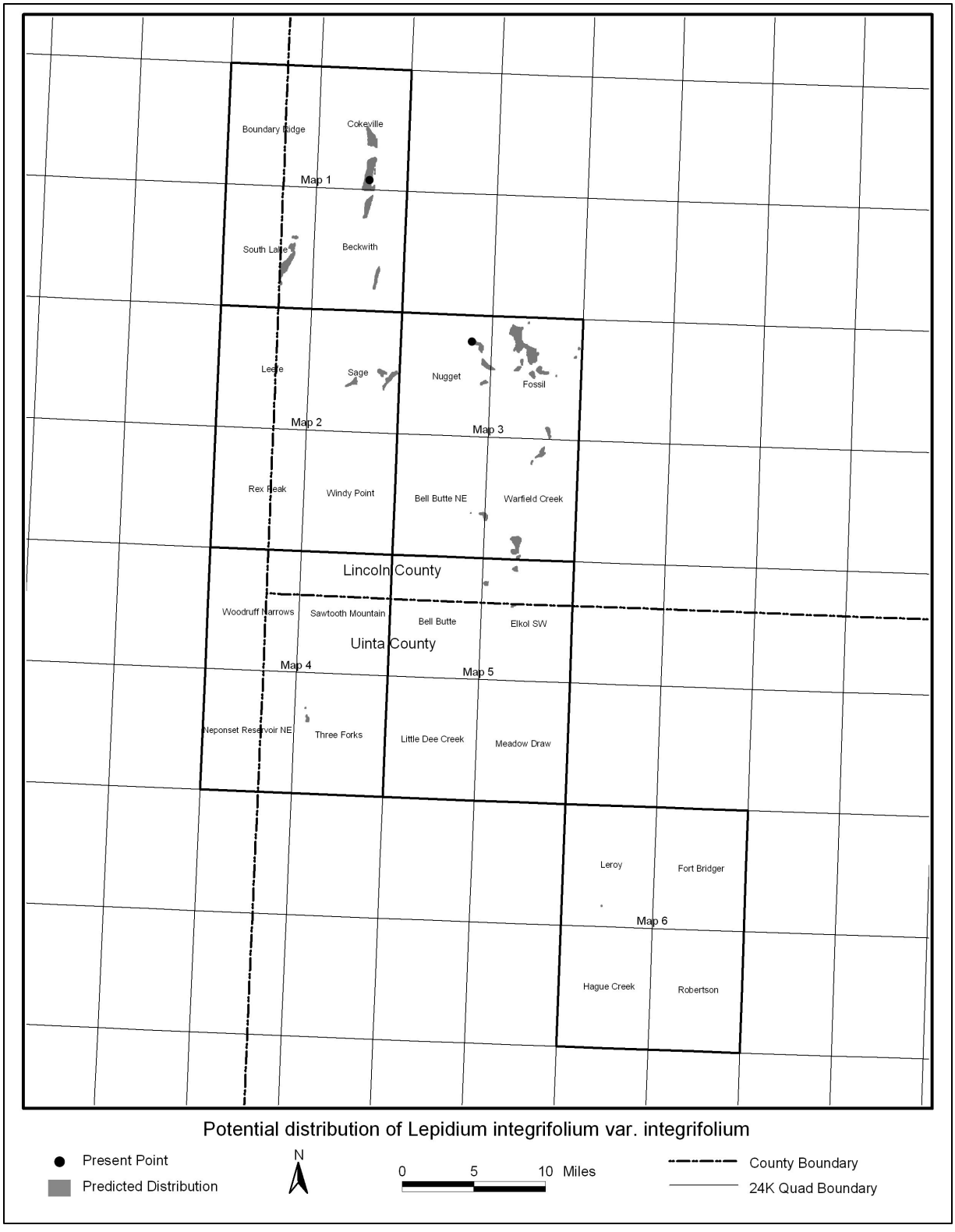
Habitat: Narrow band of wet meadow habitat on moist, deep loam, between outer road corridor and small ditch in outer margins of Bear River valley, surrounded by open rangeland, wooded river corridor, and scattered settlement.

Elevation: 6600- feet Size: 1 acres

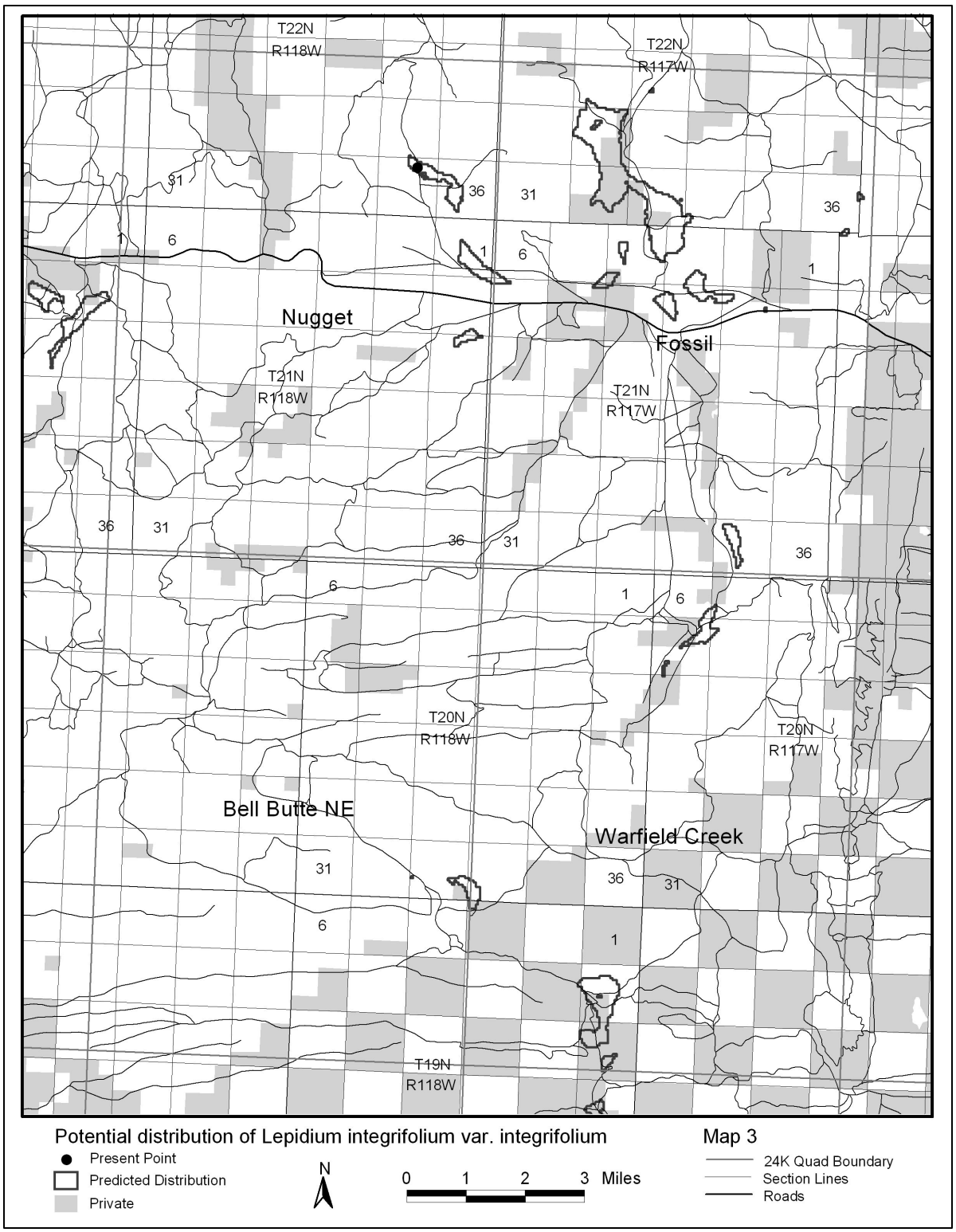
Comments: The roadside is county highway. The adjoining section is mapped as state land on the BLM land status map of 1994, but is posted as private, and includes tracts that have been plowed, and housing development.
Managed Area:
Ownership: Mgmt Comments:
Specimens: Heidel, B. (2320). 2003. RM.

Sources: Heidel, Bonnie. Botanist of Wyoming Natural Diversity Database. P.O. Box 3381, University of Wyoming, Laramie, WY. 82071.
Author: B. Heidel Edition Date: 03-07-24

Appendix B. *Lepidium integrifolium* var. *integrifolium* potential distribution in southwestern Wyoming



Appendix C. *Lepidium integrifolium* var. *integrifolium* potential distribution in the Fossil Butte quad map



All polygons on public land outside of Fossil Butte National Monument that are shown on this map were surveyed for *Lepidium integrifolium* var. *integrifolium*.

Appendix D. Updated state species abstract for *Lepidium integrifolium* var. *integrifolium*

-State Species Abstract-
-Wyoming Natural Diversity Database-

LEPIDIUM INTEGRIFOLIUM VAR. *INTEGRIFOLIUM*
ENTIRE-LEAVED PEPPERGRASS
Family: Brassicaceae

Status:
US Fish & Wildlife Service: None.
Agency Status: WY BLM: Sensitive.

Heritage Rank:
Global: G1G2T1? State: S1
WYNDD Plant List: Regional Endemic
(Very High Wyoming Contribution Rank)

Description: Entire-leaved peppergrass is a perennial forb with erect to prostrate, minutely-pubescent stems 15-25 cm tall from a thick, branched caudex covered with remnant leaf bases. Basal leaves are 3-8.5 cm long x 6-25 mm wide and have elliptic to oblanceolate blades with entire margins and sparse pubescence (especially on the veins and margins). Stem leaves are 1-4 cm long, gradually reduced in size, and glabrate. Flowers have 4 pubescent sepals and 4 white petals less than 3 mm long. Fruits are glabrous, flat, ovate to lance-ovate silicles 3-4.2 mm long with styles 0.4-0.7 mm long (Rollins 1993; Welsh et al. 1993).

Synonyms: *Lepidium montanum* var. *integrifolium*.

Identification Comments: Combinations of entire leaves, thick taproot, and fruits over 3 mm long are unique among Wyoming species of *Lepidium.*

Similar Species: *Lepidium barnebyanum* has linear leaves and petals over 3 mm long and is a narrow endemic of white shales in Duchesne County, Utah. *L. latifolium* has entire to serrate leaves, fruits 1.5-2 mm long,

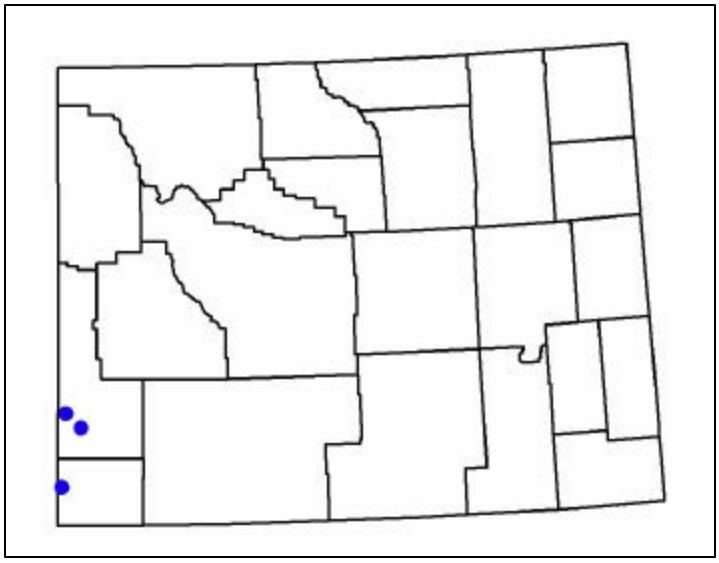
Above, below: *Lepidium integrifolium* var. *integrifolium,* by Bonnie Heidel

Above: *Lepidium integrifolium* var. *integrifolium* by Walter Fertig.

and typically is over 80 cm tall. *L. montanum* var. *alyssoides* has narrowly linear, mostly entire leaves (some have a few lobes at the base) and is typically over 60 cm tall.

Flowering/Fruiting Period: Flowers from mid-June-early July, and fruits are present from late June-August.

Distribution: Regional endemic of northeastern Utah and southwestern Wyoming. In Wyoming, known only from the southern Overthrust Belt in Lincoln and Uinta counties, all in the Bear River watershed.



Wyoming distribution of *Lepidium integrifolium* var. *integrifolium.*

Habitat: Wet meadows associated with low-elevation riparian habitat of foothills and valleybottoms, at margins where salts accumulate. Wyoming populations occur in sparsely vegetated and seasonally wet silt flats, sometimes with a claypan, dominated by *Distichilis stricta* and *Carex praegracilis*, sometimes with *Sarcobatus vermiculatus*, at 6170-6790 feet.

Above, below: *Lepidium integrifolium* var. *integrifolium* habitat, by Bonnie Heidel

Occurrences in Wyoming: Known from three extant occurrences in the state, the most recent observed in 2003.

Abundance: Estimated between 21,000-155,000 plants statewide. Rare to locally common in suitable habitat.

Trends: Loss is inferred at the Fossil Butte Station and was likely elsewhere in Wyoming with valleybottom agricultural developments. Stone (1998) suggested that populations from south-central Utah may be extirpated.

Protection status: Part of one occurrence is protected in Fossil Butte National Monument, extending onto BLM lands managed for multiple-use. A second occurrence is protected in Cokeville National Wildlife

Refuge extending onto state lands managed for multiple-use.

Threats: The habitat has been impacted by channelization, ditching, impoundments, plowing to establish tamegrass hayland, road construction, and railroad construction. It is potentially impacted by herbicides. Many populations in Utah are thought to be extirpated.

Managed Areas: Occurs in Fossil Butte National Monument, the BLM Kemmerer Field Office, Cokeville National Wildlife Refuge, and state lands.

References:

Fertig, W. 1995. More new plant species for Wyoming. Castilleja 14(1): 4-5.

Fertig, W. 1999. Wyoming Basins Ecoregion target plant species and potential plant conservation sites. Report prepared for the Nature Conservancy Wyoming Field Office by the Wyoming Natural Diversity Database, Laramie, Wyoming.

Fertig, W. 2000. Rare vascular plant species in the Wyoming portion of the Utah-Wyoming Rocky Mountains Ecoregion. Prepared for the Wyoming Nature Conservancy by the Wyoming Natural Diversity Database, Laramie, WY.

Fertig, W. 2000. Vascular plant species checklist and rare plants of Fossil Butte National Monument. Report prepared for the National Park Service Northern Colorado Plateau Network by the Wyoming Natural Diversity Database, Laramie, WY.

Fertig, W., L. Welp, and S. Markow. 1998. The status of rare plants in southwest Wyoming. Report prepared for the Bureau of Land Management by the Wyoming Natural Diversity Database, aramie, Wyoming.

Heidel, B. 2004. Status of *Lepidium integrifolium* var. *integrifolium* (Entire-leaved peppergrass) in Wyoming. Report prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie.

Hitchcock, C. L. 1936. The genus *Lepidium* in the United States. Madrono 3: 265-320.

Rollins, R.C. 1993. The Cruciferae of Continental North America, Systematics of the Mustard Family from the Arctic to Panama. Stanford Univ. Press, Stanford, CA.

Stone, D. 1998. Endemic and rare plants of Utah: an overview of their distribution and status. Prepared for the Utah Reclamation Mitigation and Conservation Commission and US Department of the Interior by the Utah Division of Wildlife Resources, Salt Lake City, UT.

Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins, (eds). 1993. A Utah Flora, second edition, revised. Brigham Young University Print Services, Provo, UT.

Author: Walter Fertig

Date: 00-09-29

Update Author: Bonnie Heidel

Update: 04-03-14