

Status of  
Many-Stemmed Spider-Flower  
(*Cleome multicaulis*)  
in Wyoming



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## Abstract

*Cleome multicaulis* is an annual halophytic wetland plant found sporadically from central Wyoming to the vicinity of Mexico City. The species has apparently never been abundant, and has been documented from fewer than 20 major locations in the past two centuries. In the United States, extant populations occur only in the San Luis valley of south-central Colorado and the Steamboat Lake playa wetland complex in Natrona County, Wyoming. *C. multicaulis* was first confirmed in Wyoming from a collection on BLM lands north of Pathfinder Reservoir in 1980, but may have been originally discovered in the state by the Stewart party in 1843. The Steamboat Lake population was resurveyed in 1999-2000 and found to contain 500,000 to 1,000,000 individuals in a total area of about 200 acres. This species occurs primarily in moist, whitish, alkaline soils dominated by dense stands of *Distichlis stricta*, *Spartina gracilis*, *Juncus balticus*, and *Scirpus nevadensis* bordering shallow natural playa lakes. Populations may also occur in sparsely vegetated clayey dunes and depressions bordering playa wetlands, or on low knolls of *Sarcobatus vermiculatus*. Demographic studies in Colorado indicate that maintenance of a seedbank is critical for the long-term survival of this species and influences yearly abundance. Rangelwide, *C. multicaulis* is threatened by water development projects to encourage urban and farmland expansion, competition from exotic species, and pesticides. The Wyoming population is protected in Pathfinder National Wildlife Refuge and is largely unthreatened under current refuge management. Although listing under the Endangered Species Act may not be warranted at present, this species remains vulnerable to global extinction and should be considered for designation as a state BLM sensitive species.

## Acknowledgements

I would like to thank Mary Neighbours, former Database Manager with WYNDD, for her assistance with field surveys in 1999. Carol Riley kindly shared information on population biology and soil characteristics of *Cleome multicaulis* populations in the San Luis Valley in Colorado. Susan Spackman of the Colorado Natural Heritage Program shared recent reports and information from sites in southern Colorado. Laura and Max Welp assisted with field surveys near Laramie in August 1999. Jeff Carroll of the BLM Wyoming State Office provided funding for this project.

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## INTRODUCTION

Many-stemmed spider-flower (*Cleome multicaulis*) was discovered in central Mexico in the early 1800s by Sessé and Mociño, and a painting of their specimen (Figure 1) formed the basis for DeCandolle's scientific description of the species in 1824. *C. multicaulis* was first observed in the United States in 1851 in southern New Mexico and Arizona (Jennings 1998). Gray (1853) described the Arizona specimens as a new species, *Cleome sonora*, apparently unaware of the earlier collections from Mexico (this taxonomic confusion would persist until Iltis' monographic work in the 1950s). During the next 150 years, Many-stemmed spider-flower was collected infrequently in southern Colorado, southern Arizona, southwest Texas, central Wyoming, and northern and central Mexico. In all, the species has been documented from fewer than 20 locations worldwide, many of which are no longer presumed to be extant (Jennings 1998).

*Cleome multicaulis* was identified as one of 839 "endangered" plants in the United States by the Smithsonian Institution in 1975 (Ayensu and DeFilipps 1978) and was proposed for listing under the Endangered Species Act in 1976. Although not listed at that time, it remained a Category 2 candidate for listing from 1980-1996, when the candidate program was disbanded (US Fish and Wildlife Service 1996). As a result, this species currently has no legal, rangewide, protection status.

Many-stemmed spider-flower was first discovered in Wyoming by Lynn Fisher north of Pathfinder Reservoir in 1980. This population was not relocated until 1992, when Fertig (1993) documented several hundred thousand individuals along Steamboat Lake and adjacent natural playa lakes near the northwest arm of Pathfinder Reservoir. Although locally abundant at this site, the plant's specialized habitat and limited distribution still makes it a species of management concern. To address these concerns, the Bureau of Land Management (BLM) Wyoming State Office contracted with the University of Wyoming and the Wyoming Natural Diversity Database (WYNDD) in 1999 to conduct field surveys of *C. multicaulis* on public lands in central Wyoming. The results of this study, as well as information on the biology, distribution, habitat, population size, potential threats, conservation status, and potential management needs of *C. multicaulis* in Wyoming are discussed in the following report.

## METHODS

Information on the habitat and distribution of *Cleome multicaulis* was obtained from scientific literature, specimens from the Rocky Mountain Herbarium (RM), unpublished reports from state natural heritage programs, and knowledgeable individuals. USGS topographic maps, geologic maps (Love and Christiansen 1985), and BLM land status maps were used to identify areas of potential habitat for ground survey. Field surveys were conducted by Mary Neighbours and Walter Fertig of WYNDD in July-August 1999 and August 2000 (survey routes are shown in Appendix C). Data on habitat, reproduction, phenology, and associated species were collected using WYNDD plant survey forms. Locations of occurrences were mapped on 7.5 minute USGS topographic maps and digitized as an Arc-View theme. Voucher specimens were collected for deposit at the RM. Information gathered in the field was entered into the computerized Element Occurrence database of WYNDD.

Figure 1. Painting of *Cleome multicaulis* from Sessé and Mociño's *Icones Florae Mexicanae* (Hunt Institute for Botanical Documentation 1998) and the basis for DeCandolle's description of the species. Note the enlarged taproot and multiple basal stems, two features that are not typical of this species!



Permanent photo monitoring points were established at two sites near Steamboat Lake to visually record changes in habitat quality on Pathfinder National Wildlife Refuge. Photos were taken from permanent monuments (fenceposts and re-bar stakes) and information gathered on vegetation composition and structure following the methodology of Elzinga et al. (1998). Photos and results from this monitoring effort are included in Appendix B.

## SPECIES INFORMATION

### Classification

Scientific Name: *Cleome multicaulis* Sessé and Mociño ex DC. (DeCandolle 1824; Iltis 1958). Holotype: Mexico: Sessé and Mociño 3326 (Madrid). DeCandolle (1824) based the description of this species on a painting in Sessé and Mociño's unpublished *Icones Florae Mexicanae* (Figure 1). No location data are available for the type collection, although Jennings (1998) believes it probably came from the vicinity of Mexico City.

Common Name: Many-stemmed spider-flower, Playa spider-flower, Slender spiderflower.

Family: Capparaceae or Capparidaceae (Caper family).

Synonyms: *Cleome sonorae* A. Gray, *Peritoma sonorae* (A. Gray) Rydb. (Gray 1853; Rydberg 1906).

Phylogenetic Relationships: The genus *Cleome* consists of 150-170 species found mostly in the tropics and subtropics of Africa and the Americas (Vanderpool 1993). *C. multicaulis* is one of 6 species from western North America in Section *Peritoma* (Iltis 1958). Based on morphology and habitat, Iltis (1957) concluded that *C. multicaulis* was most closely related to *C. serrulata* and probably near the base of the *Peritoma* complex.

Legal Status: *Cleome multicaulis* was a Category 2 (C2) Candidate for potential listing under the Endangered Species Act from 1980-1996 (US Fish and Wildlife Service 1993). With the elimination of the C2 program in 1996, it no longer has any rangewide federal protection. *C. multicaulis* is currently listed as Sensitive by the BLM Colorado state office (Spackman et al. 1997) and has been proposed for similar status by the BLM Wyoming state office. This species is not protected under state law in Wyoming.

Natural Heritage Rank: The Association for Biodiversity Information (formerly the heritage division of The Nature Conservancy) and the network of natural heritage programs gives *Cleome multicaulis* a rank of G2G3, indicating that the species is intermediate between being globally "imperiled because of rarity" and "rare or local throughout its range" (Fertig and Beauvais 1999). At the state level, Many-stemmed spider-flower is ranked S2S3 in Colorado, S1 (critically imperiled) in Arizona and Wyoming, and SH (historical) in New Mexico and Texas.

Description: Many-stemmed spider-flower is a slender, glabrous annual forb with erect, unbranched or sparingly branched leafy stems 20-70 cm tall (Figures 1-3). The leaves are sessile (or nearly so) and palmately compound with 3 narrow leaflets 1-2 cm long and less than 1.5 mm wide that may be folded along the midrib. Flowers have 4 pink or pinkish-white petals 4-6 mm long and are borne on

thin stalks in the axils of reduced leaves. The 6 stamens are equal in length to the petals. Fruits are narrow, multi-seeded capsules up to 2 cm long with a stalk-like base (gynophore) above the 15-22 mm fruitstalk and droop at maturity. Seeds are light brown, smooth, nearly globose, and less than 2.5 mm (Iltis 1958; New Mexico Native Plant Protection Advisory Committee 1984; Fertig et al. 1994).

Similar Species: *Cleome serrulata* is a more robust plant, with broader leaflets, larger fruit, and entire (undivided) flower bracts, and has stamens that are much longer than the petals. *C. lutea* has yellow flowers (Dorn 1992).

Geographic Range: *Cleome multicaulis* ranges from central Mexico (near Mexico City) to southeast Arizona, southwest New Mexico, and southwest Texas, with disjunct populations in south-central Colorado and central Wyoming (Fertig et al. 1994; Jennings 1998). Wyoming populations are restricted to 1-2 sites in the North Platte River Valley near the northwestern arm of Pathfinder Reservoir in southwest Natrona County (Figure 4; Table 1; Appendix A), nearly 320 miles (515 km) north of the nearest occurrence in southern Saguache County, Colorado. Elsewhere, populations have been documented from the San Luis Valley in Alamosa, Costilla, Rio Grande, and Saguache counties (Colorado), Presidio County (Texas), Hidalgo and Grant or Luna counties (New Mexico), Cochise, Pinal, and Apache counties (Arizona), and the Mexican states of Chihuahua, Durango, Jalisco, Michoacan, and Mexico (Jennings 1998; Spackman et al. 1997).

Extent of Surveys in Wyoming: The earliest confirmed report of *Cleome multicaulis* in Wyoming is based on a specimen collected by Lynn Fisher on BLM lands just north of Pathfinder Reservoir in July 1980 (Occurrence # 001, Table 1; Appendix A). O’Kane (1988) suggested that this population was established by recent long-distance dispersal by waterfowl and indicated that Fisher’s collection site was from the banks of a stock pond. Hollis Marriott and Mary Neighbours of WYNDD were unable to relocate Fisher’s collection site (T30N R85W S25 NW4 of NE4) in two visits in 1989 and failed to locate suitable habitat. No stock ponds or playa lakes are indicated at Fisher’s collection site on USGS or BLM topographic maps.

Fertig (1993) discovered an extensive population of *Cleome multicaulis* along the shores of Steamboat Lake and adjacent playa lakes north of the northwest arm of Pathfinder Reservoir in June 1992 (Occurrence # 002, Table 1; Appendix A). Steamboat Lake is exactly 6 miles west of Fisher’s 1980 collection site, suggesting the possibility that the Range reported on Fisher’s specimen label may be incorrect (R86W rather than R85W). Fertig surveyed additional habitat near Pathfinder, Alcova, Gray Reef, Glendo, and Guernsey reservoirs in 1992, but no other populations were found. In 1999-2000, Neighbours and Fertig revisited the Steamboat Lake area and surveyed other potential sites on public lands along the North Platte River, Sweetwater River Valley, Ferris Sand Dunes, Chain Lakes, Great Divide Basin, and Laramie Plains, but found no new *C. multicaulis* sites (see Appendix C for 1999-2000 survey routes). Recent floristic surveys in central Wyoming by Welp (1997) and Taylor (2000) were also unsuccessful in documenting new occurrences of this species.

Figure 2. Line drawing of *Cleome multicaulis* by W. Fertig from Fertig et al. (1994).

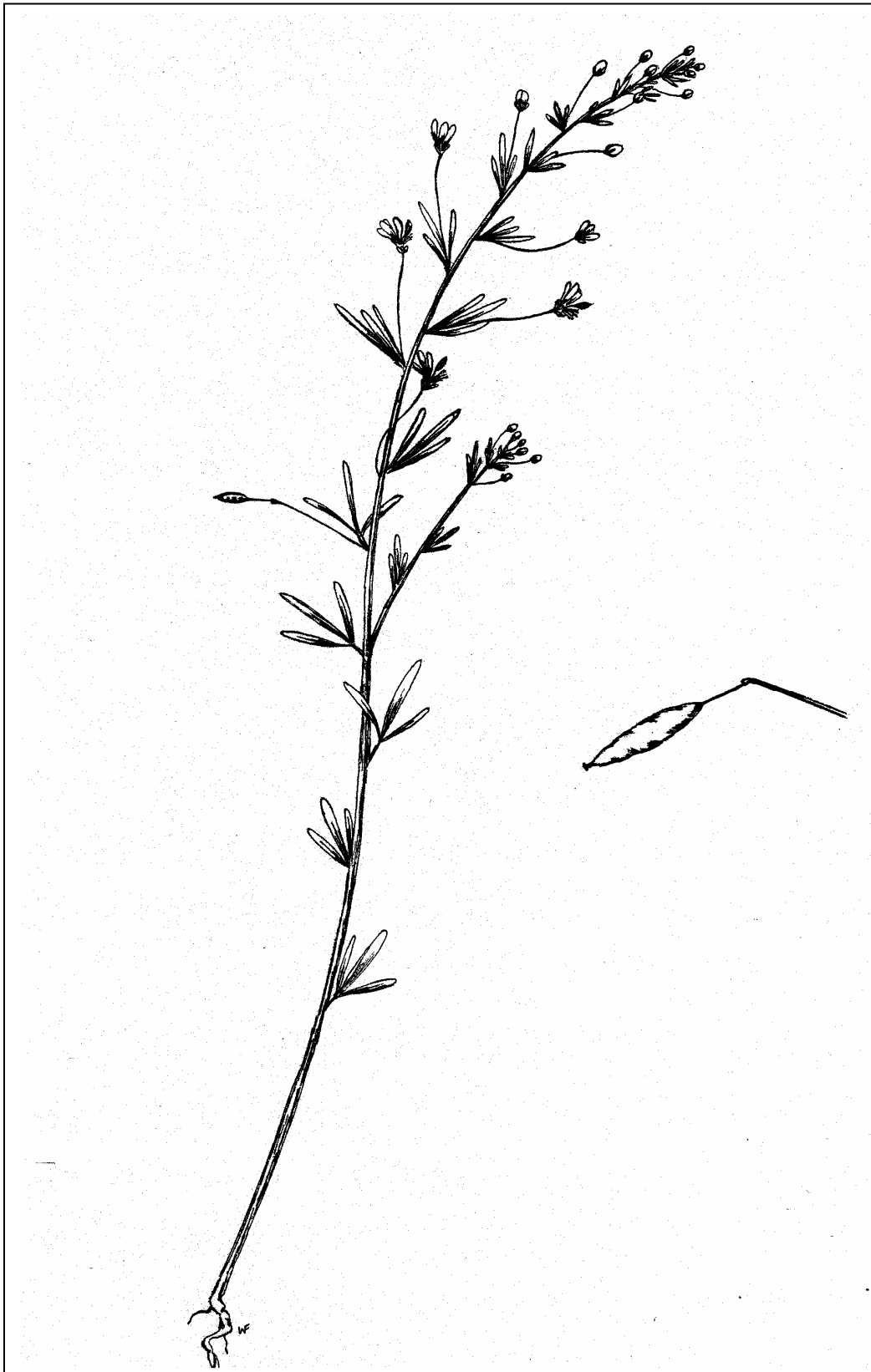




Figure 3. Photo of *Cleome multicaulis* from the north shore of Steamboat Lake. WYNDD photograph by Walter Fertig, 13 August 1992.



Figure 4. Distribution of *Cleome multicaulis* in Wyoming.

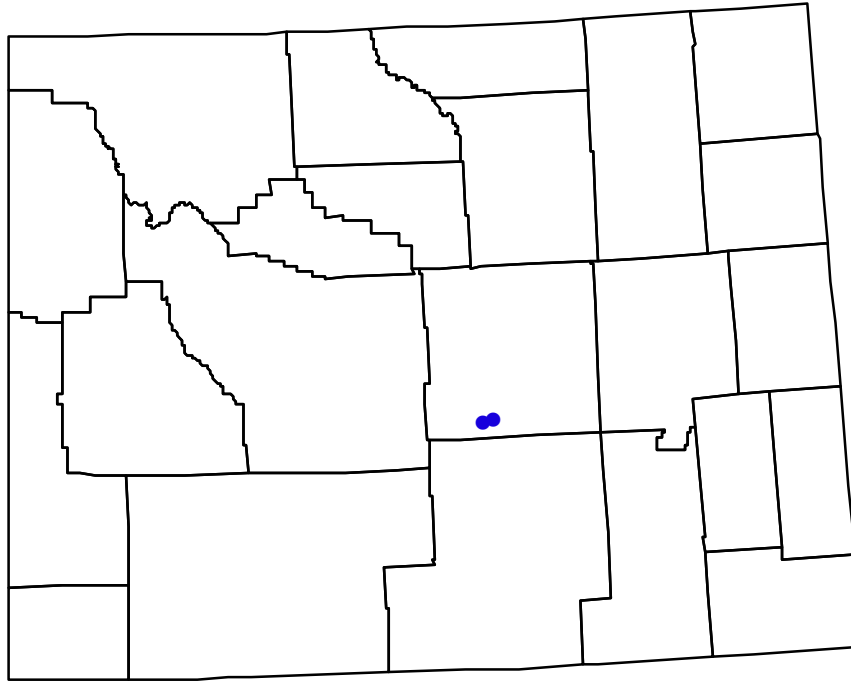


Table 1.  
Locations of *Cleome multicaulis* in Wyoming

Occurrence # 001  
County: Natrona  
USGS Quad: Benton Basin SW  
Latitude: 42° 32' 52" North (centrum)  
Longitude: 106° 57' 50" West (centrum)  
Township/Range/Section: T30N R85W S25 (NW4 of NE4).  
Location: North Platte River Valley, just north of Pathfinder Reservoir, ca 1.5 air miles south of WY State Highway 220.  
Comments: This location could not be relocated in 1989 (M. Neighbours, personal comm.).

South Latitude: 42° 31' 50" North  
North Latitude: 42° 32' 57" North  
Longitude: 107° 03' 32" West (centrum)  
East Longitude: 107° 02' 10" West  
West Longitude: 107° 04' 52" West  
Township/Range/Section: T30N R85W S29 (S4), S30 (W2 of NW4, NE4 of SW4, N2 of SE4, S2 of SW4 of NE4, & NW4 of SE4SE4), S32 (NE4NE4); T30N R86W S25 (NE4).  
Location: North Platte River Valley, Steamboat Lake and chain of small alkali lakes and playas extending ca 2 miles to the east-southeast (towards Sanford Peak), 0.5-2.5 miles northwest of NW arm of Pathfinder Reservoir and on south side of WY Highway 220, ca 0.5 miles west of junction with Dry Creek Road, ca 45 air miles southwest of Casper.

Occurrence # 002  
County: Natrona  
USGS Quad: Sanford Ranch  
Latitude: 42° 32' 27" North (centrum)



Iltis (1952) cites an historical collection by Gordon (s.n.) at Kew from “Platte River”. This specimen may have been collected by Alexander Gordon, one of four botanists (including Karl Geyer) who traveled across central Wyoming in 1843 on the “pleasure excursion” of Scottish adventurer Sir William Drummond Stewart. The Stewart party followed the North Platte River to its confluence with the Sweetwater (inundated today under Pathfinder Reservoir) and then on past Independence Rock (just 3.5 miles southwest of Steamboat Lake) to South Pass in late July 1843 (Cronquist et al. 1972; Dorn 1986). If this specimen is authentic and attributable to Alexander Gordon, it would represent the first record of *Cleome multicaulis* in the United States and dispel rumors that the Wyoming population may be adventive.

**Habitat:** In Wyoming, Many-stemmed spider-flower is found primarily on whitish, alkali-rich, strongly hydrogen-sulfide-scented soils bordering shallow, spring-fed playa lakes or dried lakebeds (Figures 5-6). Populations of *Cleome multicaulis* are most abundant on damp (but not flooded) flats with approximately 90% cover of *Spartina gracilis*, *Distichlis stricta*, *Juncus balticus*, *Puccinellia nuttalliana*, *Scirpus nevadensis*, and *Triglochin maritimum*. These flats may border playa lakes, or are found in a 3-4 meter wide concentric zone between unvegetated to sparsely vegetated (mostly with *Scirpus pungens*) alkali lakeshore mudflats and drier, slightly sandier upslope dunes (Table 2; Figure 7). In some areas, *C. multicaulis* is the dominant herbaceous

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Figure 5. Habitat of *Cleome multicaulis* along north shore of Steamboat Lake, Natrona County, Wyoming. Plants are most abundant in dense stands of *Distichlis stricta*, *Spartina gracilis*, and *Juncus balticus* along the lake. *C. multicaulis* is also present, but sparse, on patches of white, salt-encrusted soils in the lower foreground. WYNDD photograph by Walter Fertig, 27 July 1999.





plant and may contribute 25% of the total vegetative cover. Within the *Spartina*/*Distichlis* zone, *C. multicaulis* may also be found in localized patches of *Carex praegracilis*, *Hordeum jubatum*, *Elymus smithii*, and *Sarcobatus vermiculatus*. Populations of *C. multicaulis* are less abundant on clayey dunes surrounding alkaline lakes with less than 50% cover of *Spartina gracilis*, *Triglochin maritimum*, and *Sporobolus airoides*, or on low hummocks of *Sarcobatus vermiculatus*. Small patches may also occur in dry alkaline depressions with 20% cover of *Distichlis stricta*, *Spartina gracilis*, *Suaeda calceoliformis*, *Crepis runcinata*, and *Haplopappus* [*Pyrrocoma*] *lanceolatus*.

All Wyoming populations occur at an elevation of approximately 5860 feet (1786 m). Soils are derived from Miocene-age, white, soft tuffaceous sandstones (Love and Christiansen 1985). Average annual precipitation in the Pathfinder Reservoir area (based on weather station data from Pathfinder Dam) is 9.48 inches (240.8 mm), with peak precipitation coming from April-June. Mean annual temperature is 44.7° F (7.0° C). Mean maximum and minimum temperatures in January are 31.3° F and 11.0° F (- 0.4° and - 11.7° C) and mean maximum and minimum temperatures in July are 86.2° and 54.4° F (30.1° and 12.4° C) (Martner 1986).

Riley (2001, in ed.) recently completed a 3-year study of soil characteristics at *Cleome multicaulis* sites in the San Luis Valley of Colorado and found that these plants were typically found on saline-sodic soils with an upper crust of salts produced from intense evaporation of subsurface moisture. *C. multicaulis* was most dominant on sites with a pH of 9.33, but could persist at a pH of up to

Table 2. Species Commonly Associated with *Cleome multicaulis*

Scientific Name	Common Name	Growth form
<i>Carex praegracilis</i>	Clustered field sedge	Perennial Graminoid
<i>Crepis runcinata</i>	Meadow hawksbeard	Perennial Forb
<i>Distichlis stricta</i>	Alkali saltgrass	Perennial Graminoid
<i>Elymus smithii</i> [ <i>Agropyron smithii</i> ]	Western wheatgrass	Perennial Graminoid
<i>Haplopappus lanceolatus</i> [ <i>Pyrrocoma lanceolata</i> ]	Lance-leaf goldenweed	Perennial Forb
<i>Hordeum jubatum</i>	Foxtail barley	Perennial Graminoid
<i>Juncus balticus</i>	Baltic rush	Perennial Graminoid
<i>Puccinellia nuttalliana</i>	Nuttall's alkali-grass	Perennial Graminoid
<i>Sarcobatus vermiculatus</i>	Greasewood	Shrub
<i>Scirpus nevadensis</i>	Nevada bulrush	Perennial Graminoid
<i>Scirpus pungens</i> var. <i>polyphyllus</i>	Three-square bulrush	Perennial Graminoid
<i>Spartina gracilis</i>	Alkali cordgrass	Perennial Graminoid
<i>Sporobolus airoides</i>	Alkali sacaton	Perennial Graminoid
<i>Suaeda calceoliformis</i>	Seablite	Perennial Forb
<i>Triglochin maritimum</i>	Seaside arrowgrass	Perennial Graminoid

Figure 6. Habitat of *Cleome multicaulis* along playa lakes dominated by *Distichlis stricta* and *Spartina gracilis* ca 1.2-1.6 air miles west of Sanford Peak and 0.7 miles ESE of Steamboat Lake, Natrona County, Wyoming. WYNDD photograph by Walter Fertig, 22 August 2000.

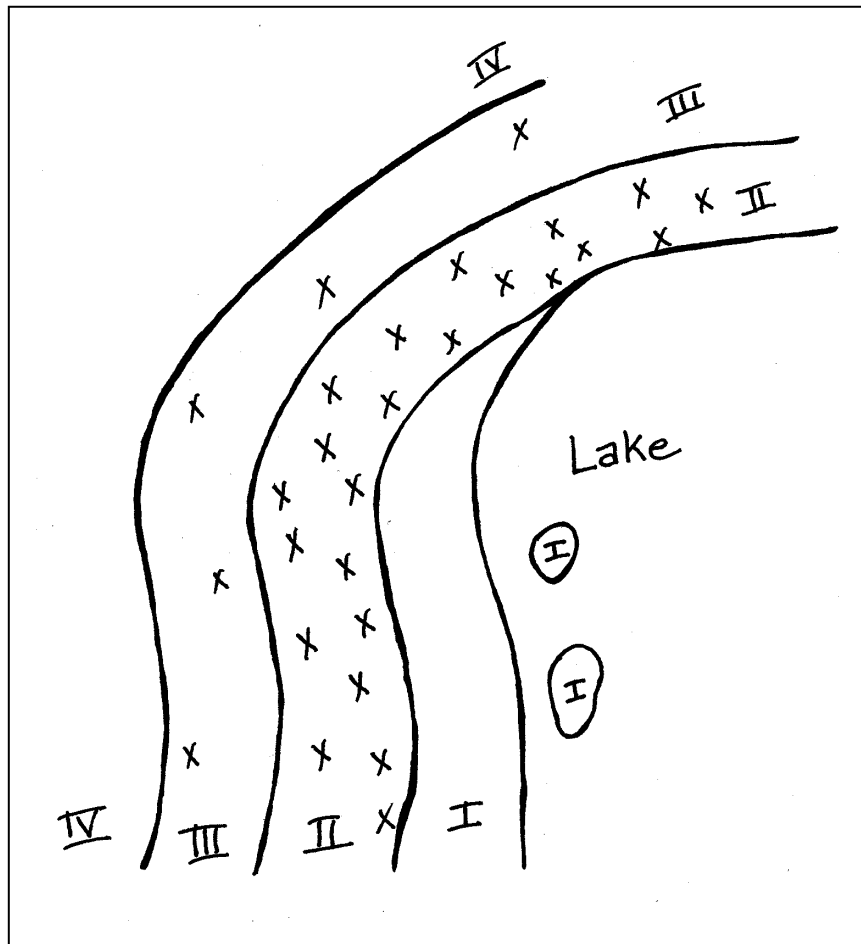


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9.95. Electrolytic conductivity (Ec) of San Luis Valley soils ranged from 0.79 to 67.68 dS/m (mean 8.507), but *C. multicaulis* plants were most abundant where mean Ec was 10.63 and absent where Ec was greater than 41.92 dS/m. Soils were primarily sandy clay loams, loamy sands, or sandy clays with moisture values ranging from 1.23% to 144.24 % (mean 31.7%). *C. multicaulis* was typically predominant in sites with lower soil moisture than *Distichlis* or *Juncus balticus*. Major soil cations were Na<sup>+</sup> and K<sup>+</sup>, while Cl<sup>-</sup> and SO<sub>4</sub><sup>-</sup> were the major soil anions present (Riley 2001, in ed.).

As in Wyoming, *Cleome multicaulis* populations in the San Luis Valley are typically found in communities of *Distichlis stricta*, *Sarcobatus vermiculatus*, or *Juncus balticus* (Riley 2001, in ed.). Elsewhere in the southwest and Mexico, *C. multicaulis* has been reported from saline or alkaline soils surrounding sinks, ponds, meadows, or old lake beds in salt desert scrub, *Scirpus*, *Sarcobatus*, or *Distichlis* communities at 3000-8000 feet (915-2450 m) (Iltis 1958; New Mexico Native Plant Protection Advisory Committee 1984; Graff 1992; Spackman et al. 1997).

Figure 7. Habitat Zonation of *Cleome multicaulis* along Steamboat Lake. "X" indicates the presence of *Cleome multicaulis* colonies. Zone I consists of barren alkali mudflats or sparsely vegetated stands of *Scirpus pungens* var. *polyphyllus* (vegetative cover ca 25-35%) on islands or banks of Steamboat Lake. Zone II is dominated by dense cover of *Distichlis stricta*, *Spartina gracilis*, *Juncus balticus*, *Puccinellia nuttalliana*, *Scirpus nevadensis*, and *Triglochin maritimum* (vegetative cover ca 90%) and contains the largest and densest populations of *C. multicaulis*. Zone III contains clayey dunes with ca 50% cover of *Spartina gracilis*, *Triglochin maritimum*, and *Sporobolus airoides* and bare patches of *Crepis runcinata* and *Haplopappus lanceolatus*. Zone IV contains dryland vegetation on rolling, sandy terrain. Zones I-III average 3-4 meters wide. Illustration by W. Fertig.



Population Size and Trends: In Wyoming, *Cleome multicaulis* is currently known from a single, large population along the shores of Steamboat Lake and other natural playa lakes in a 2-mile zone just north of Pathfinder Reservoir. This population was conservatively estimated at 200,000-300,000 individuals by Fertig (1993) during surveys in June and August 1992. This estimate was increased to 500,000-1,000,000 plants during a revisit to the site by Fertig and Neighbours in July 1999. Fertig discovered an additional 25,000 individuals at three previously unsurveyed playas at the south end of the wetland complex in August 2000. The entire population covers an area of approximately 200 acres. This species is thought to be stable to increasing at the Steamboat Lake site, at least over the last decade.

The population reported by Fisher from BLM lands 6 miles east of Steamboat Lake has not been relocated since its initial discovery in 1980. This population may be extirpated, or is perhaps based on incorrect label data (see discussion on page 8).

The largest populations of Many-stemmed spider-flower are found in the San Luis Valley of south-central Colorado. Surveys in 1986 by O’Kane, Anderson, and Dixon (Colorado Natural Heritage Program records) and Graff (1992) documented approximately 1.5-10.5 million plants at 20 main wetland sites in the valley. Current census figures are unavailable for other known populations across the range of this species, many of which are historical and perhaps extirpated (Jennings 1998).

Population Biology and Ecology: *Cleome multicaulis* colonies at Steamboat Lake and surrounding playa lakes in central Wyoming occur at high densities, even in somewhat marginal habitat. In 1999, typical *C. multicaulis* density ranged from 135-1300 individuals per square meter, depending on habitat quality (with denser populations found on moister soils and sites dominated by *Distichlis stricta*/*Spartina gracilis* vegetation). Riley (2001, in ed.) has observed even higher spider-flower densities in sample plots in the San Luis Valley (3-356 individuals in .4 x .4 m plots, or 19-2225 plants per square meter). In Wyoming, dense patches of *C. multicaulis* may represent up to 10% of the total plant cover in a localized area. Individual plants in dense patches typically are shorter and less branched than those found in more open sites and may produce fewer seeds (Riley 2001, in ed.). Density may vary from year to year, depending on seedling recruitment, available soil moisture, and soil pH (Riley 2001, in ed.).

Flowering has been observed at the Steamboat Lake site from June 24-August 22, and probably extends into early to mid-September, depending on seasonal weather conditions. Fruits begin to mature in early July and continue to be produced into September (Graff 1992). Pollination biology is still poorly understood for this species (Riley 2001, in ed.), but Iltis (1958) has suggested that bees are the probable pollinator of members of the *Cleome* genus. Riley (personal communication) believes that *C. multicaulis* may have a mixed breeding system and has the potential to self-fertilize.

Despite being an annual, *Cleome multicaulis* has a “structured” population, consisting of a mix of seeds, seedlings, and reproductive plants representing multiple generations resulting from a long-lived seedbank (Riley 2001, in ed.). In the San Luis Valley, seeds may persist in the seedbank for at least 3 years (and probably more). Once seeds have germinated, individual plants may pass through

1-4 different above-ground growth stages: seedling (<15 cm tall with no buds), juvenile (>15 cm tall with no buds), small reproductive (<15 cm tall with < 4 flower buds), and large reproductive (>15 cm tall with > 4 flower buds) (Riley 2001, in ed.). By censusing plants in sample plots every two weeks, Riley was able to estimate population growth rates using a Periodic Matrix model. She found that population growth rates varied widely between plots, ranging from 0.08 (a decline) to 10.11 (a sharp increase). The highest rates of population increase were found in sites that began with a low population density, suggesting that fecundity is highest in disturbed or newly colonized areas (Riley 2001, in ed.). Overall, seedling survivorship to reproductive age was high, following a Deevey Type I pattern, and was not constrained by population density (Riley 2001, in ed.).

Riley (2001, in ed.) found that large reproductive individuals produce an average of 7.3 seeds per fruit, while small plants produce 2.6 seeds per fruit. Seed dispersal mechanisms are still poorly known in *C. multicaulis*. Seeds are not known to float (Graff 1992), but may move laterally through the soil by winter flooding (Riley 2001, in ed.). High winds may also move seeds short distances, and waterfowl have been suspected of long-distance transport (O’Kane 1988). Riley (2001, in ed.) has observed seeds germinating in areas that have been recently flooded. To date, attempts to germinate this species under greenhouse conditions have been difficult (Riley, personal communication).

Riley (2001, in ed.) considers the San Luis Valley colonies of *Cleome multicaulis* to represent a “remnant population” maintained by a long-lived seedbank, rather than a series of subpopulations within a metapopulation maintained by periodic immigration of seeds from an outside source. Thus, *C. multicaulis* is capable of withstanding periods of poor habitat conditions through in situ recruitment from its seedbank rather than shifting its local range in response to environmental changes. This population structure necessitates a conservation strategy that preserves the integrity of the seedbank (Riley 2001, in ed.).

*Cleome multicaulis* may co-occur with *C. serrulata* at Steamboat Lake and in the San Luis Valley, but no evidence of hybridization has been documented. The two taxa typically occur in slightly different habitats, with *C. serrulata* often favoring better-drained sandy soils in Wyoming. Neither species is readily grazed, perhaps due to the presence of anti-herbivory secondary chemical compounds in their foliage. No evidence of grazing on *C. multicaulis* was observed at the Steamboat Lakes site in 1999-2000.

## ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Current Management: The Steamboat Lake population (WY Occurrence # 002) is found entirely within Pathfinder National Wildlife Refuge, managed by the US Fish and Wildlife Service. Wyoming Occurrence # 001 (if legitimate) is found on lands managed by the BLM Casper Field Office. Populations in the San Luis Valley are managed by The Nature Conservancy (Mishak Lakes Preserve), the state of Colorado (Russell Lakes and San Luis Lakes State Wildlife Areas), US Fish and Wildlife Service (Alamosa and Monte Vista National Wildlife Refuges), the BLM Canon City District, and private owners. Other populations in New Mexico, Arizona, Texas, and in Mexico are on private or public lands with no formal protection.

Existing and Potential Threats: Throughout its range, the primary threat to *Cleome multicaulis* is probably loss of habitat due to water development (O’Kane 1988; Riley 2001, in ed.). Draining of wetlands for expansion of farmland or new subdivisions has been identified as a major threat in the San Luis Valley, as significant loss of soil moisture can make sites unsuitable for this wetland species. Water impoundments can also be a threat by permanently inundating formerly occupied habitat. Management activities that entail periodic flooding followed by water draw-down may be adequate to maintain *C. multicaulis* populations, but also need to take into account protection of the seedbank (Riley 2001, in ed.). On agricultural lands, pesticide runoff may be a threat, as well as competition from aggressive, introduced weed species such as whitetop (*Cardaria* spp.) and Canada thistle (*Cirsium arvense*).

At Steamboat Lake, threats to *Cleome multicaulis* are currently low due to the protected status of the area. Some evidence of livestock activity (mostly trails and dung) have been observed at this site in 1992 and 1999, but no signs of grazing have been observed on this species (Fertig 1993). Recreational use of the refuge is low, due to the high density of mosquitoes and horse-flies, and lack of developed campgrounds, trails, boat-ramps, or stocked fish. The Murie Audubon Society of Casper, Wyoming, is currently developing interpretive signs at the Refuge to encourage greater use by birders, but this is not likely to be a threat to the large population. A small patch of Canada thistle is present on the north shore of the lake, but has not yet spread to other areas. Demand for the water at Steamboat Lake is currently low, and will probably remain so given the availability of water in nearby Pathfinder Reservoir.

Management Recommendations: The population of *Cleome multicaulis* at Steamboat Lake is currently large and apparently stable and healthy. It is currently protected within Pathfinder National Wildlife Refuge and is relatively unthreatened. Active management is not required at the present time to ensure high population numbers. Periodic monitoring should continue, however, to ensure that current conditions are maintained and to detect possible downward population trends. Such monitoring should involve permanent photo points and qualitative censuses of population size, habitat condition, changes in associated species (especially exotics), and changes in moisture availability. Additional research should focus on unanswered questions regarding the plant’s pollination biology, seed longevity, seed dispersal, and germination requirements. Additional areas of potential habitat should be investigated as possible areas of undetected populations or for establishing new colonies. Given the abundance of this species in the San Luis Valley and at Steamboat Lake, listing under the Endangered Species Act is probably premature at this time, but continued management attention as a BLM Sensitive species is warranted.

## SUMMARY

*Cleome multicaulis* is an annual halophytic wetland plant found sporadically from central Wyoming to the vicinity of Mexico City. The species has apparently never been abundant, and has been documented from fewer than 20 major locations in the past two centuries. In the United States, extant populations occur only in the San Luis valley of south-central Colorado and the Steamboat Lake playa wetland complex in Natrona County, Wyoming. *C. multicaulis* was first confirmed in Wyoming from a collection on BLM lands north of Pathfinder Reservoir in 1980, but may have been originally discovered in the state by the Stewart party in 1843. The Steamboat Lake

population was resurveyed in 1999-2000 and found to contain 500,000 to 1,000,000 individuals in a total area of about 200 acres. This species occurs primarily in moist, whitish, alkaline soils dominated by dense stands of *Distichlis stricta*, *Spartina gracilis*, *Juncus balticus*, and *Scirpus nevadensis* bordering shallow natural playa lakes. Populations may also occur in sparsely vegetated clayey dunes and depressions bordering playa wetlands, or on low knolls of *Sarcobatus vermiculatus*. Demographic studies in Colorado indicate that maintenance of a seedbank is critical for the long-term survival of this species and influences yearly abundance. Rangewide, *C. multicaulis* is threatened by water development projects to encourage urban and farmland expansion, competition from exotic species, and pesticides. The Wyoming population is protected in Pathfinder National Wildlife Refuge and is largely unthreatened under current refuge management. Although listing under the Endangered Species Act may not be warranted at present, this species remains vulnerable to global extinction and should be considered for designation as a state BLM sensitive species.

#### LITERATURE CITED

- Ayensu, E. S. and R. A. DeFilipps. 1978. Endangered and Threatened Plants of the United States. Smithsonian Institution and World Wildlife Fund, Washington, DC.
- Cronquist, A., A.H. Holmgren, N.H. Holmgren, and J.L. Reveal. 1972. Vol. 1: Geological and botanical history of the region, its plant geography and a glossary. The vascular cryptogams and the gymnosperms. Intermountain Flora, Vascular Plants of the Intermountain West, USA. New York Botanical Garden, Bronx, NY.
- DeCandolle, A.P. 1824. Prodrumus 1:240.
- Dorn, R. D. 1986. The Wyoming Landscape, 1805-1878. Mountain West Publishing, Cheyenne, WY.
- Dorn, R. D. 1992. Vascular Plants of Wyoming, second edition. Mountain West Publ., Cheyenne, WY.
- Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. BLM Technical Reference 1730-1.
- Fertig, W. 1993. Field survey for *Cleome multicaulis*, *Cymopterus williamsii*, and *Sullivantia hapemanii* in north-central Wyoming. Report prepared for the Bureau of Land Management Casper District by the Wyoming Natural Diversity Database, Laramie, WY.
- Fertig, W. and G. Beauvais. 1999. Wyoming Plant and Animal Species of Special Concern. Wyoming Natural Diversity Database, Laramie, WY.
- Fertig, W., C. Refsdal, and J. Whipple. 1994. Wyoming Rare Plant Field Guide. Wyoming Rare Plant Technical Committee, Cheyenne, WY.

Graff, D. 1992. Status report for *Cleome multicaulis* on Blanca wetlands. Bureau of Land Management, San Luis Resource Area, Alamosa, CO.

Gray, A. 1853. *Plantae Wrightianae* 2:16.

Hunt Institute for Botanical Documentation. 1998. The Torner Collection of Sessé and Mociño Biological Illustrations. Carnegie Mellon CD Press, version 1.0.

Iltis, H.H. 1952. A revision of the New World species of *Cleome*. PhD dissertation, Washington University, St. Louis, MO.

Iltis, H. H. 1957. Studies in the Capparidaceae. III. Evolution and phylogeny of the western North American Cleomoideae. *Annals Missouri Botanical Garden* 44:77-119.

Iltis, H. H. 1958. Studies in the Capparidaceae – V. Capparidaceae of New Mexico. *Southwestern Naturalist* 3:133-144.

Jennings, W. F. 1998. Herbarium survey of specimens of *Cleome multicaulis*. Report prepared for the Colorado Natural Areas Program.

Love, J. D. and A. C. Christiansen. 1985. Geologic Map of Wyoming. US Geological Survey.

Martner, B. 1986. Wyoming Climate Atlas. Univ. of Nebraska Press, Lincoln, NE.

New Mexico Native Plant Protection Advisory Committee. 1984. A Handbook of Rare and Endemic Plants of New Mexico. University of New Mexico Press, Albuquerque, NM.

O’Kane, S. 1988. Colorado’s rare flora. *Great Basin Naturalist* 48(4): 434-484.

Riley, C.D. 2001 (in ed.). Population dynamics and habitat characteristics of *Cleome multicaulis* an annual wetland halophyte of the San Luis Valley. Doctoral dissertation, Colorado State University, Ft. Collins, CO.

Rydberg, P.A. 1906. *Bulletin Torrey Botanical Club* 33:142.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, US Forest Service, and US Fish and Wildlife Service by the Colorado Natural Heritage Program, Ft. Collins, CO.

Taylor, A.R. 2000. The vascular flora of the Upper North Platte River drainage, Wyoming. Master’s thesis, University of Wyoming, Laramie, WY.



US Fish and Wildlife Service. 1993. Plant taxa for listing as Endangered or Threatened species; Notice of Review. Federal Register 58(188): 51144-51190.

US Fish and Wildlife Service. 1996. Endangered and Threatened Species, Plant and Animal Taxa; Proposed Rule. Federal Register 61 (40):7596-7613.

Vanderpool, S.S. 1993. Capparaceae. In: J.C. Hickman, ed. The Jepson Manual, Higher Plants of California. University of California Press, Berkeley, CA.

Welp, L. 1997. A floristic survey of the Great Divide Basin, Green Mountains, and Upper Sweetwater Plateau in southwest Wyoming. Master's thesis, University of Wyoming, Laramie, WY.

Appendix A.  
Element Occurrence Records and Location Maps

WYOMING NATURAL DIVERSITY  
DATABASE  
-Element Occurrence Record-

*CLEOME MULTICAULIS*  
MANY-STEMMED SPIDER-FLOWER  
Occurrence # 001

Status

Data Sensitive?: N  
Identification verified: Y  
TNC Global Rank: G2G3  
WYNDD State Rank: S1  
Federal Status: Former C2  
WY Distribution Note: Disjunct

Location

County: Natrona  
USGS Quad Name: Benton Basin SW  
Latitude: 423252N  
Longitude: 1065750W  
Map Accuracy: Medium; location is within  
an approximately 1.5 mile radius from point  
on USGS topo map.  
Town/Range/Section: T30N R85W S25  
(NW4 of NE4)  
Location: North Platte River Valley, just  
north of Pathfinder Reservoir ca 1.5 air  
miles south of WY State Highway 220, east  
of Horse Creek.

Population Data

Last Observed: 1980-07-25  
First Observed: 1980-07-25  
Data: 1980-07-25: In flower and fruit.

Habitat: Not reported.  
Elevation: 5900 feet Size: acres

Comments: This site was resurveyed in 1989  
by Mary Neighbours and Hollis Marriott,  
but no plants were observed. There is a  
chance that the range reported by Fisher  
is in error, and should be R86W. This would  
place the population on the northwest shore  
of Steamboat Lake, right in the midst of EO  
# 002. Fisher's specimen represents the first  
confirmed report for this plant in Wyoming,  
although Iltis (1952 unpublished doctoral  
dissertation) mentions a vague report from  
the "Platte River" which may be attributable  
to Alexander Gordon of the 1843 Stewart  
Party. This report needs further  
investigation.

Managed Area: BLM Casper Field Office

Specimens: Fisher, L. (s.n.). 1980. RM.

Sources:

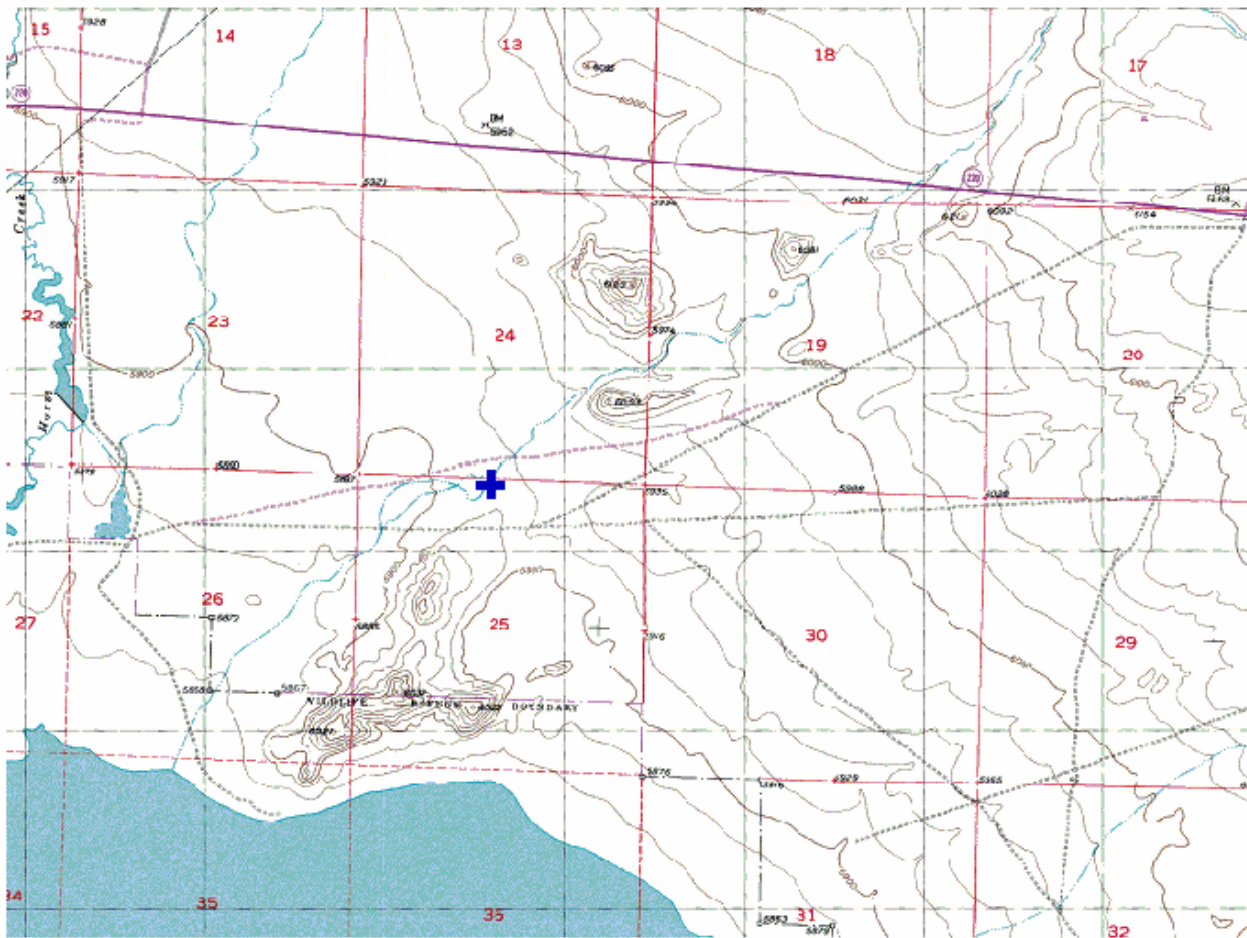
Fertig, W. 1993. Field Survey for *Cleome  
multicaulis*, *Cymopterus williamsii*, and  
*Sullivantia hapemanii* in north-central  
Wyoming. Report prepared for the Casper  
District, BLM, by the Wyoming Natural  
Diversity Database, Laramie, WY.

Author: Walter Fertig  
Edition Date: 00-10-17

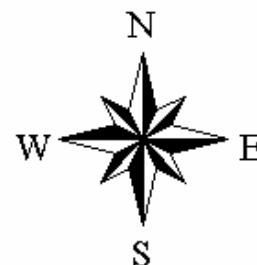
# Cleome multicaulis Occurrence # 001

## Benton Basin SW Quad

### T30N R85W S25 NW4 of NE4



**+** Cleome multicaulis



WYOMING NATURAL DIVERSITY  
DATABASE

-Element Occurrence Record-

*CLEOME MULTICAULIS*  
MANY-STEMMED SPIDER-FLOWER  
Occurrence # 002

Status

Data Sensitive?: No

Identification verified: Yes

TNC Global Rank: G2G3

WYNDD State Rank: S1

Federal Status: Former C2

WY Distribution Note: Disjunct

Location

County: Natrona

USGS Quad Name: Sanford Ranch

Latitude: 423227N (centrum)

South Latitude: 423150N

North Latitude: 423257N

Longitude: 1070332W (centrum)

East Longitude: 1070210W

West Longitude: 1070452W

Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range/Section: T30N R85W S29 (S4), S30 (W2 of NW4, NE4 of SW4, N2 of SE4, S2 of SW4 of NE4, & NW4 of SE4SE4), S32 (NE4NE4); T30N R86W S25 (NE4).

Location: North Platte River Valley, Steamboat Lake and chain of small alkali lakes and playas extending ca 2 miles to the east-southeast (towards Sanford Peak), 0.5-2.5 miles northwest of NW arm of Pathfinder Reservoir and on south side of WY Highway 220, ca 0.5 miles west of junction with Dry Creek Road, ca 45 air miles southwest of Casper.

Population Data

Last Observed: 2000-08-22

First Observed: 1992-06-24

Data: 2000-08-22: Sec 29 - extensive populations located along 3 new alkaline lakes, dry depressions, and mudflats by W. Fertig. Locally abundant (at least 25,000 individuals observed), with plants mostly in late flower or fruit. Plants often densely clustered in groups of 7-12 in sparsely vegetated sites to 25-30 per square foot in denser patches. Occurs with *Suaeda calceoliformis*, *Crepis runcinata*, *Haplopappus lanceolatus* in drier areas and *Scirpus nevadensis*, *S. pungens*, *Puccinellia*, *Distichlis*, and *Spartina* in wetter habitats.

1999-07-27: Population estimated at 500,000-1,000,000 individuals in survey by M. Neighbours and W. Fertig in Secs 25 & 30. Plants in bud, flower, and fruit. Density as high as 1300 plants per square meter in highly productive sites to 240 plants per square meter in sparser habitats. Plant height often matches that of its surrounding vegetation. Individual plants may be branched above, especially in areas of low density. Also occurs with *Scirpus nevadensis*.

1998-08-18: Observed in flower and fruit by Amy Roderick.

1992-08-13: Vigorous population of 200,000-300,000 plants observed near Steamboat Lake (Secs 25/30) by W. Fertig. Plants still producing flowers and fruits. Occurs most abundantly with *Juncus balticus*, but also found with *Spartina gracilis*, *Distichlis spicata*, and *Scirpus pungens*.

1992-06-24: Population discovered along Steamboat Lake by W. Fertig. Locally abundant along this and other lakes to southeast in Secs 25, 29, 30 and 32

(conservatively estimated at 300,000 individuals). Plants in flower and early fruit. Occurs with *Juncus balticus*, *Scirpus pungens*, *Spartina*, and *Distichlis*.

Habitat: Occurs in 3 main vegetation types:

(1) Most abundant in dense *Spartina gracilis*/*Distichlis stricta*/*Juncus balticus*/*Puccinellia nuttalliana*/*Scirpus nevadensis*/*Triglochin maritimum* vegetation on damp but not flooded whitish alkali clay soils in a 10-12 foot wide band along alkali lake shores between the mud flat zone (immediately bordering the lakeshore) and sparse, white clay dunes farther upslope. Vegetative cover typically 90%. Soils with strong hydrogen sulfide odor. Small patches within this vegetation may also be dominated *Carex praegracilis*, *Hordeum jubatum*, *Elymus smithii*, *Sarcobatus vermiculatus*, and *Cirsium arvense*.

(2) Clayey dunes of moist whitish alkali dominated by sparse (less than 50%) cover of *Spartina gracilis*, *Triglochin maritimum*, *Sporobolus airoides*, and occasional *Sarcobatus vermiculatus* hummocks. Often located in concentric bands just upslope of denser *Spartina*/*Distichlis*/*Juncus* vegetation.

(3) Sparse in dry, alkaline depressions with 20% cover of *Spartina gracilis*, *Distichlis stricta*, *Suaeda calceoliformis*, *Crepis runcinata*, and *Haplopappus lanceolatus* within matrix of *Sarcobatus vermiculatus* hummock vegetation.

Elevation: 5860 feet

Size: 200 acres

Managed Area: Pathfinder National Wildlife Refuge

Management Comments: Fences are in disrepair on the refuge. Plans to improve waterfowl habitat should take the needs of this species into consideration.

Specimens:

Fertig, W. (12784). 1992; (19247). 2000. RM.  
Roderick, A. (8452). 1998. RM.

Fertig, W. and M. Neighbours. (18849). 1999. RM.

Sources:

Fertig, W. 1993. Field Survey for *Cleome multicaulis*, *Cymopterus williamsii*, and *Sullivantia hapemanii* in north-central Wyoming. Report prepared for the Casper District, BLM, by the Wyoming Natural Diversity Database, Laramie, WY.

Author: Walter Fertig

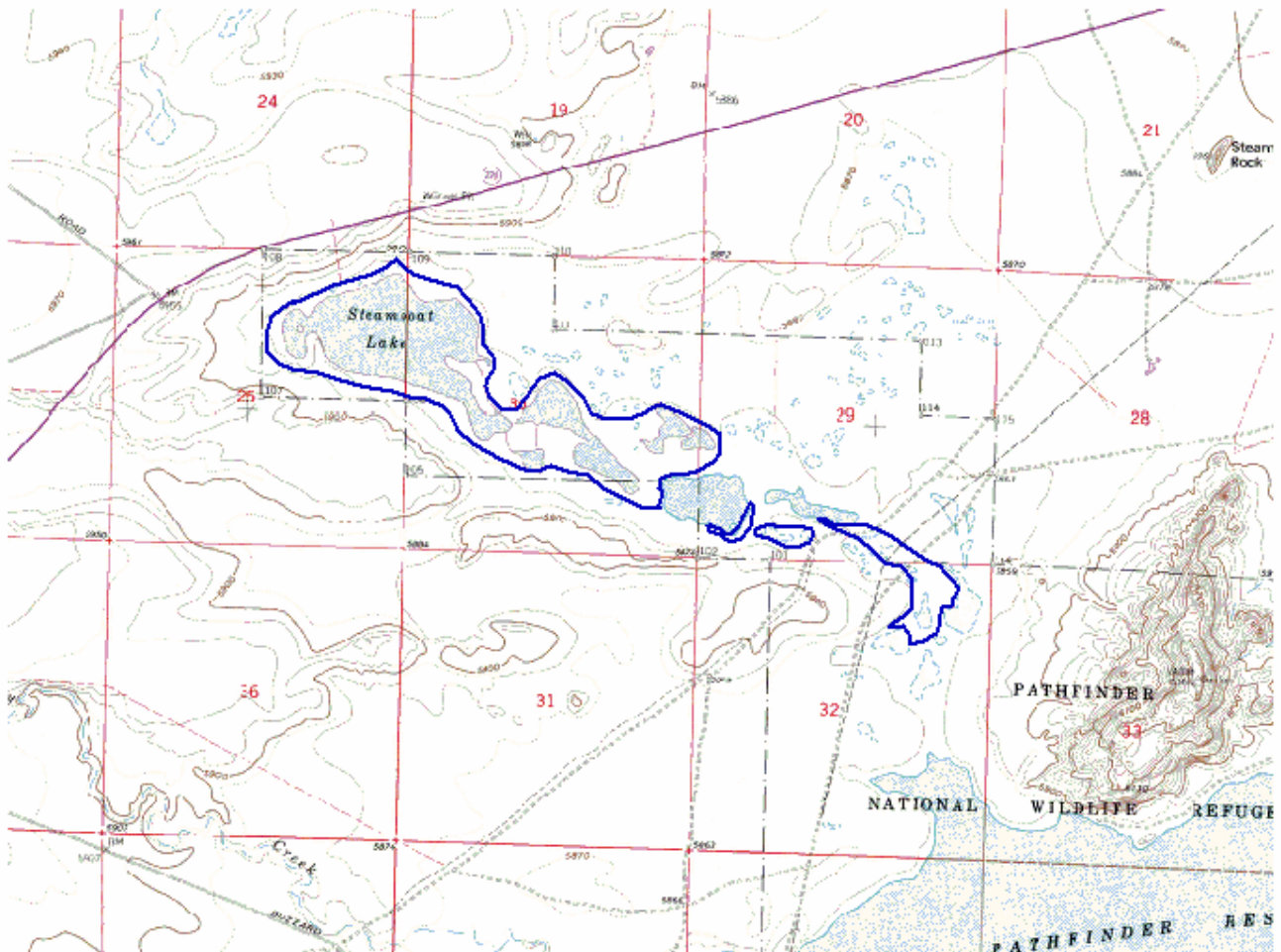
Edition Date: 00-10-18

# Cleome multicaulis Occurrence # 002

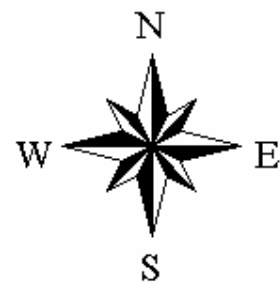
## Sanford Ranch Quad

### T30N R85W S29-30, 32

### T30N R86W S25



 **Cleome multicaulis**



## Appendix B.

### Photo Monitoring Points

Two permanent photo monitoring points were established along the west shore of Steamboat Lake on 27 July 1999 to serve as visual reference points to assess qualitative changes in habitat condition over time. At each photopoint, a series of color slides were taken to provide a panoramic view of the lake and surrounding uplands.

Photo point A is located at the last fence post along the boundary between Pathfinder National Wildlife Refuge and BLM lands to the west (along the NE4/NW4 line in Sec 25, T30N R86W, see map below). Photo # 8 (page 28) depicts the view from this photopoint to the southeast, and shows the western inlet of Steamboat Lake and the north end of Sanford Peak in the background. The photo depicts a lakeshore dominated by *Scirpus pungens* surrounded by dense *Spartina/Juncus balticus/Distichlis* vegetation. Photo # 9 (page 28) continues this view towards the south, depicting the south end of Sanford Peak and a broader band of *Spartina/Juncus/Distichlis* vegetation in the foreground. Photo # 10 (page 29) completes the panorama with a view to the south, showing the dry sandy-clay knolls at the south end of Steamboat Lake. Each of these photos was taken with a 115 mm lens using a handheld automatic camera.

Below: Location of photopoints for monitoring *Cleome multicaulis* habitat trends at Steamboat Lake. Photopoint A = red triangle, photopoint B = blue circle.

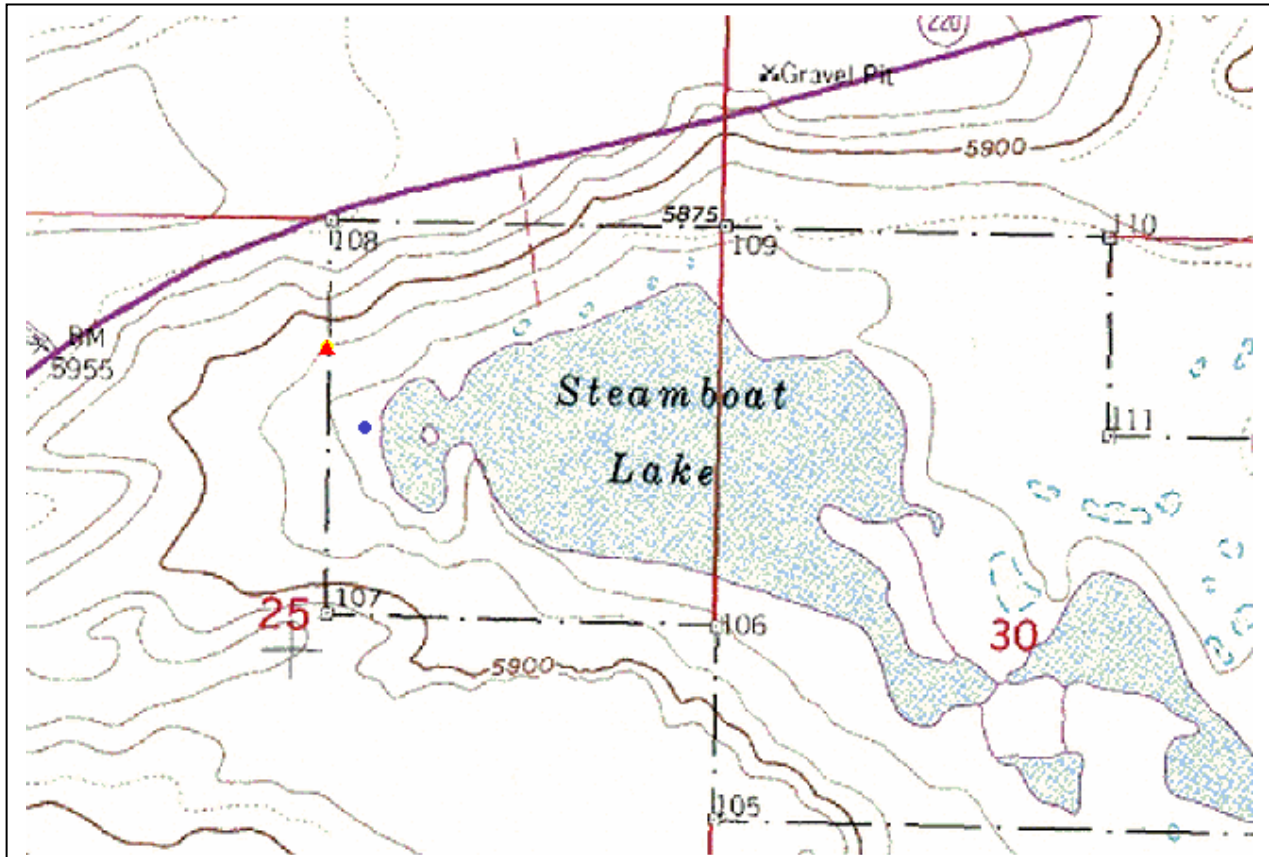




Photo Point A. # 8. Photo taken 27 July 1999 by W. Fertig with 115 mm lens.



Photo Point A # 9. Photo taken on 27 July 1999 by W. Fertig with 115 mm lens.





Photo Point A # 10. Photo taken on 27 July 1999 by W. Fertig with 115 mm lens.



Photo point B is located approximately 40 feet from the west shore of Steamboat Lake at the head of a large east-west running slough. The point may be reached by following the boundary fenceline due south to the refuge sign, and then turning to the head of the east-west slough. The photopoint is marked by orange-tipped re-bar and is located on the south bank of the slough, heading towards the lake. Photo B # 17 (page 30) was taken facing due East with a 35 mm lens and depicts white alkaline flats on the west shore of the lake dominated by sparse vegetation of *Scirpus pungens*. Photo # 20 (page 30) shows the wetlands at the south end of the western inlet of Steamboat Lake, including dense stands of *Spartina/Juncus/Distichlis* vegetation with abundant *C. multicaulis* and was taken with a 115 mm lens. Photo # 21 (page 31, also taken with a 115 mm lens) is a view to the east-southeast and shows the full length of Sanford Peak. Photo #22 (page 31, 115 mm lens) is a view due west of the photopoint and shows the east-west running slough that leads into Steamboat Lake. *C. multicaulis* plants are locally abundant in the densely vegetated bottom of the slough (except where replaced by *Typha* and *Scirpus pungens*) and along the drier whitish clay slopes with *Elymus cinereus/Sporobolus airoides*. Photo # 23 (page 32, 35 mm lens) is a view due north of the photopoint and depicts Photopoint A. The foreground of photo #23 shows the gradation from semi-barren whitish alkaline lakeshores (Zone I of Figure 7) to densely vegetated *Spartina/Juncus/Distichlis* vegetation (Zone II), to dry upland sandy-clay sagebrush grassland (Zone IV).

Photo Point B # 17. Photo taken by W. Fertig on 27 July 1999 with 35 mm lens.



Photo Point B # 20. Photo taken by W. Fertig on 27 July 1999 with a 115 mm lens.





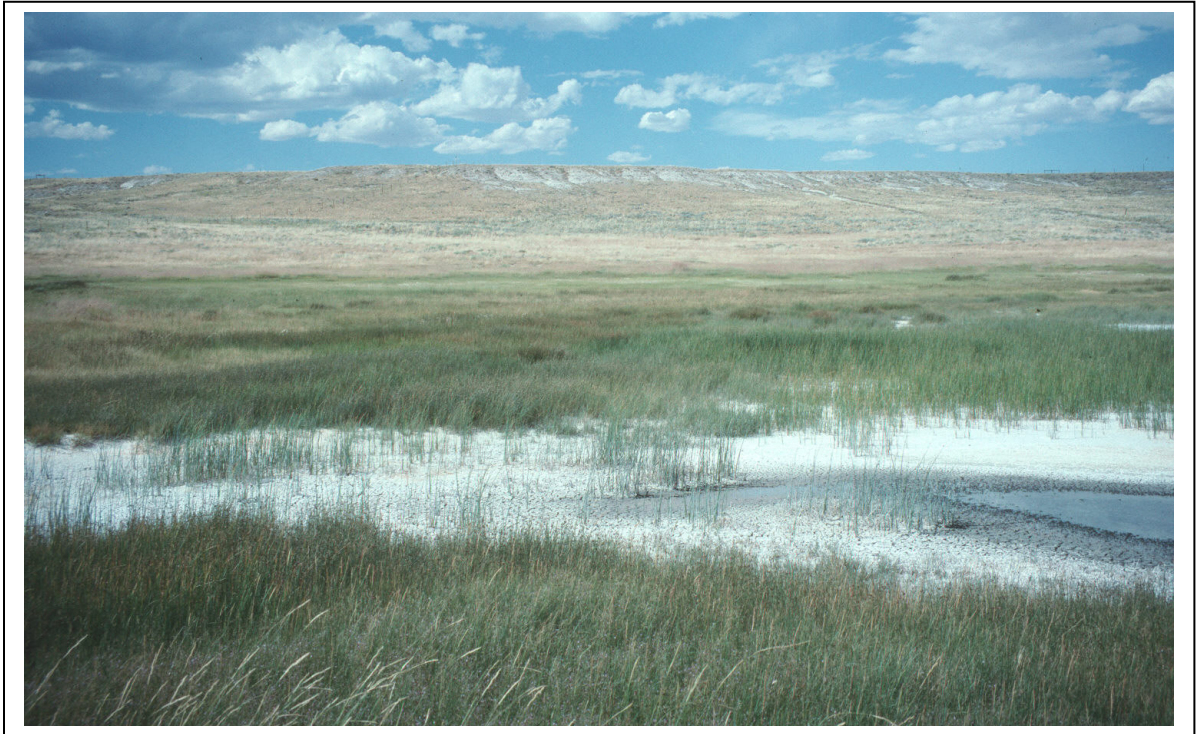
Photo Point B # 21. Photo taken on 27 July 1999 by W. Fertig with a 115 mm lens.



Photo Point B # 22. Photo taken by W. Fertig on 27 July 1999 with a 115 mm lens.



Photo Point B # 23. Photo taken by W. Fertig on 27 July 1999 with a 35 mm lens.



## Appendix C.

### 1999-2000 Survey Routes

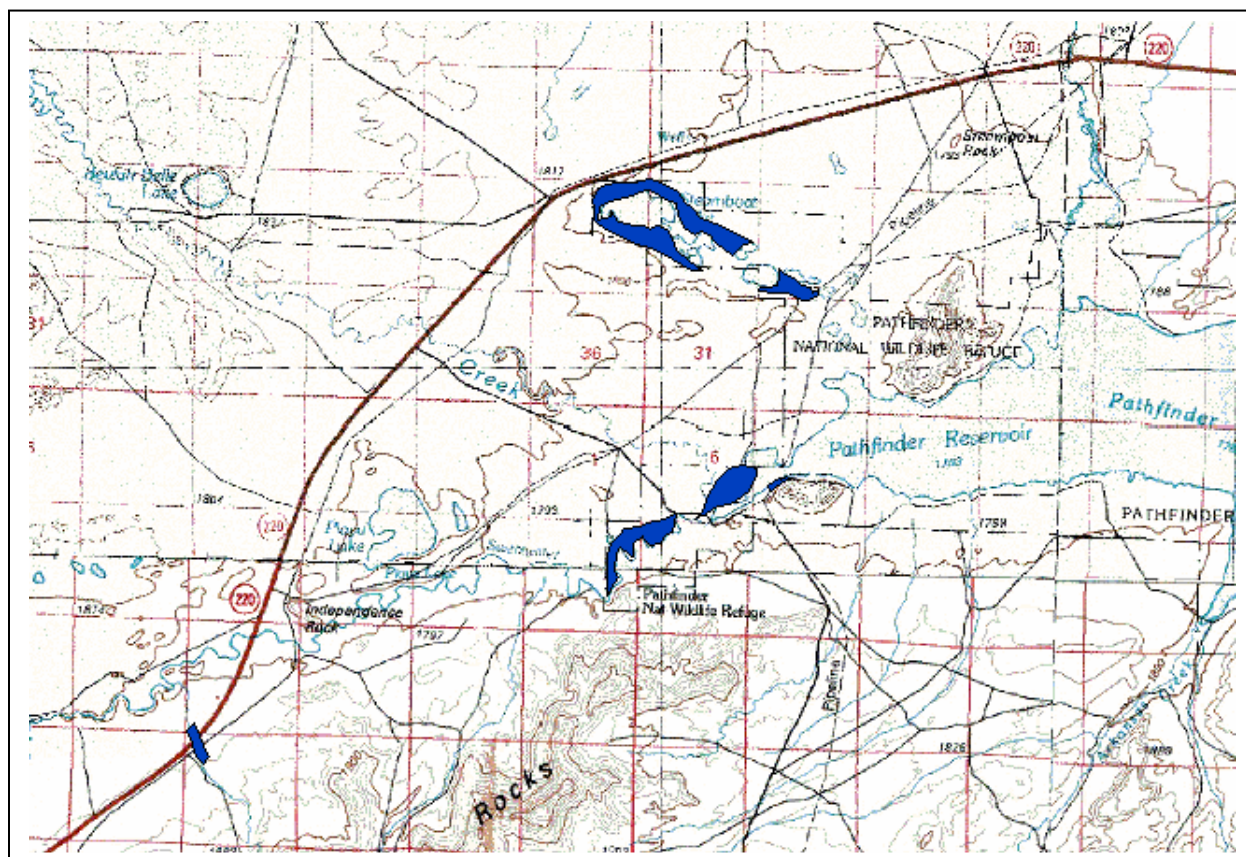
Surveys for *Cleome multicaulis* were conducted by Mary Neighbours (July 1999) and Walter Fertig (July-August 1999 and July-August 2000). Potential areas for survey were determined from BLM land management maps and USGS topographic maps based on the presence of alkaline ponds, streams, and wetlands on accessible public lands. Surveyed locations are depicted on the accompanying maps and are summarized below:

DATE	SURVEYOR	COORDINATES	<i>C. multicaulis</i> FOUND?
July 1999	Neighbours	T30N R90W S16	No
July 1999	Neighbours	T31N R90W S22-23	No
July 1999	Neighbours	T31N R90W S13	No
July 1999	Neighbours	T31N R90W S12	No
July 1999	Neighbours	T29N R88W S20	No
July 1999	Neighbours	T29N R88W S28	No
July 1999	Neighbours	T28N R88W S3	No
July 1999	Neighbours	T28N R88W S12	No
July 1999	Neighbours	T29N R87W S32; T28N S6	No
July 1999	Neighbours	T29N R87W S36	No
July 1999	Neighbours	T29N R86W S16,21	No
July 1999	Neighbours	T25N R88W S31	No
July 1999	Neighbours	T25N R89W S25, R88W S30	No
July 1999	Neighbours	T25N R89W S24	No
July 1999	Neighbours	T24N R88W S34	No
July 1999	Neighbours	T24N R92W S16	No
July 1999	Neighbours	T25N R92W S35	No
July 1999	Neighbours	T24N R93W S19	No
July 1999	Neighbours	T27N R92W S7	No
July 1999	Neighbours	T27N R92W S17	No
July 1999	Neighbours	T23N R87W S6	No
July 1999	Neighbours	T23N R90W S24	No
July 1999	Neighbours	T23N R90W S20	No
July 1999	Neighbours	T23N R91W S12	No
July 1999	Neighbours	T23N R91W S10	No
July 1999	Neighbours	T23N R91W S32	No
July 1999	Neighbours	T22N R91W S8	No
July 1999	Neighbours	T22N R91W S26	No
July 1999	Neighbours	T21N R90W S16	No
July 1999	Neighbours	T23N R92W S8	No
July 1999	Neighbours	T23N R92W S18	No
July 1999	Neighbours	T23N R93W S6	No
July 1999	Neighbours	T23N R94W S35	No
July 1999	Neighbours	T22N R94W S2	No
July 1999	Neighbours	T18N R93W S18	No
July 1999	Neighbours	T18N R93W S6	No
July 1999	Neighbours	T19N R94W S26	No
27 July 1999	Neighbours	T29N R85W S5	No
27 July 1999	Fertig & Neighbours	T30N R86W S25	Yes

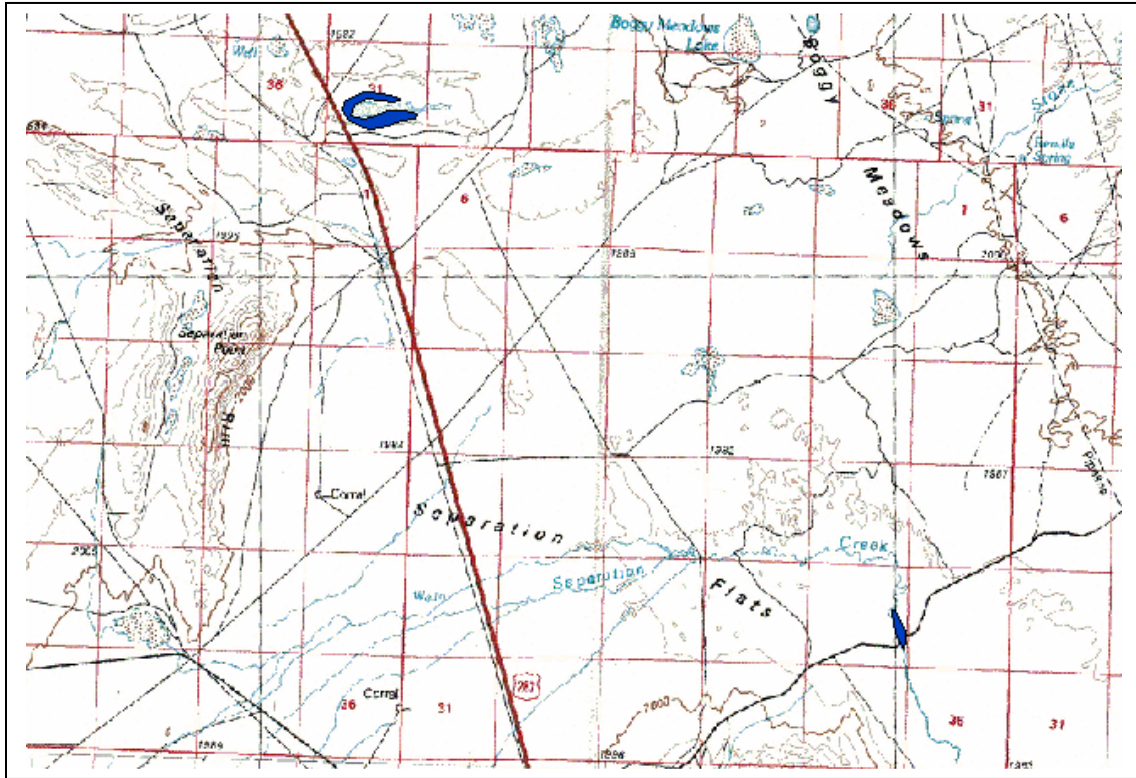


15 August 1999	Fertig & Welp	T14N R75W S4	No
21 August 1999	Fertig & Welp	T15N R73W S3	No
22 August 1999	Fertig	T15N R73W S4	No
26 August 1999	Fertig	T16N R75W S2	No
26 August 1999	Fertig	T16N R74W S6-7	No
28 August 1999	Fertig	T26N R89W S27,34	No
28 August 1999	Fertig	T28N R88W S18-19	No
28 August 1999	Fertig	T29N R88W S35, T28N S3	No
August 1999	Fertig	T14N R74W S16-17	No
August 1999	Fertig	T14N R74W S17,20	No
13 July 2000	Fertig	T25N R87W S1	No
22 August 2000	Fertig	T29N R85W S7, R86W S13	No
22 August 2000	Fertig	T29N R85W S6	No
22 August 2000	Fertig	T30N R85W S29	Yes

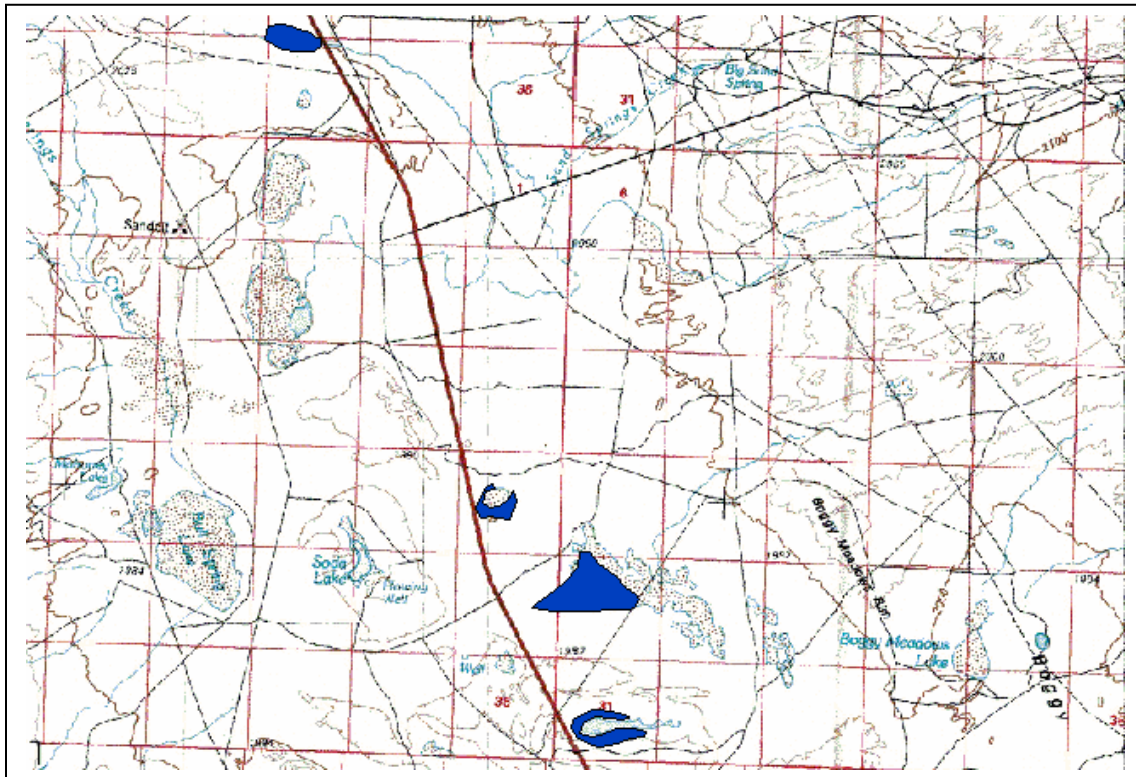
1999-2000 survey routes, BLM 1:100,000 Bairoil, Rattlesnake Hills, Casper, and Shirley Basin quads, T29-30N, R85-86W.



1999-2000 survey routes, BLM 1:100,000 Bairoil quad, T24-25N, R88-89W.

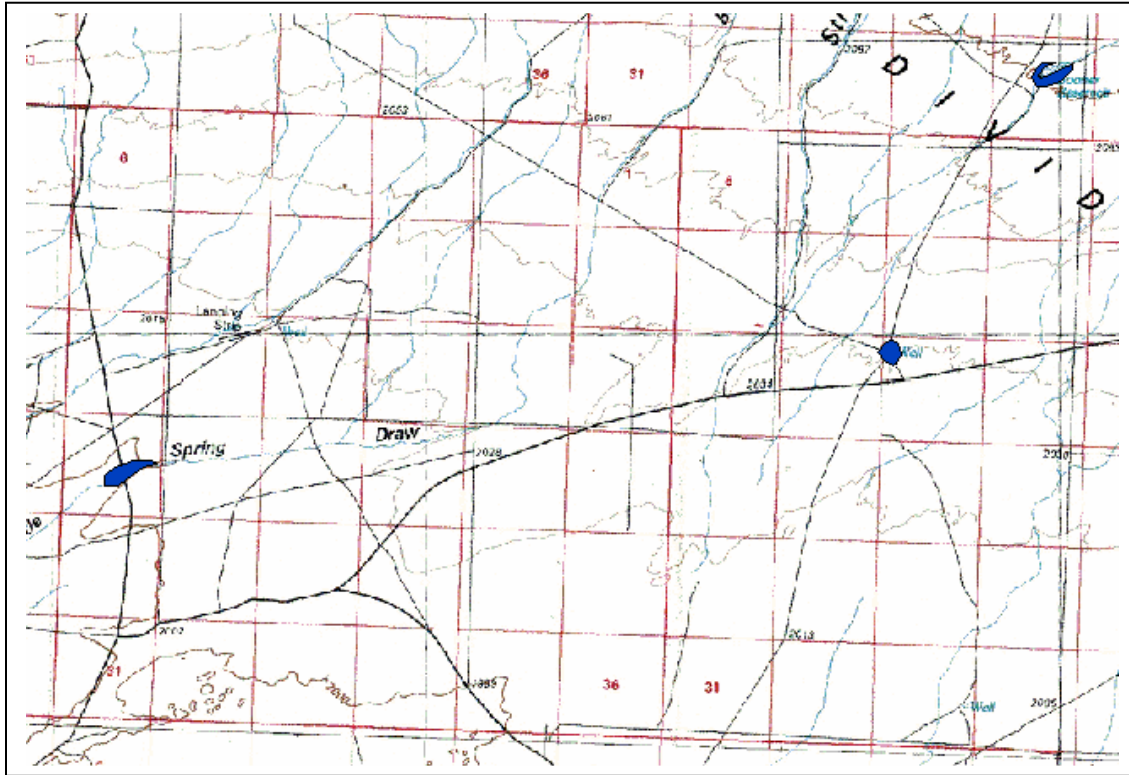


1999-2000 survey routes, BLM 1:100,000 Bairoil quad, T25-26N, R88-89W.

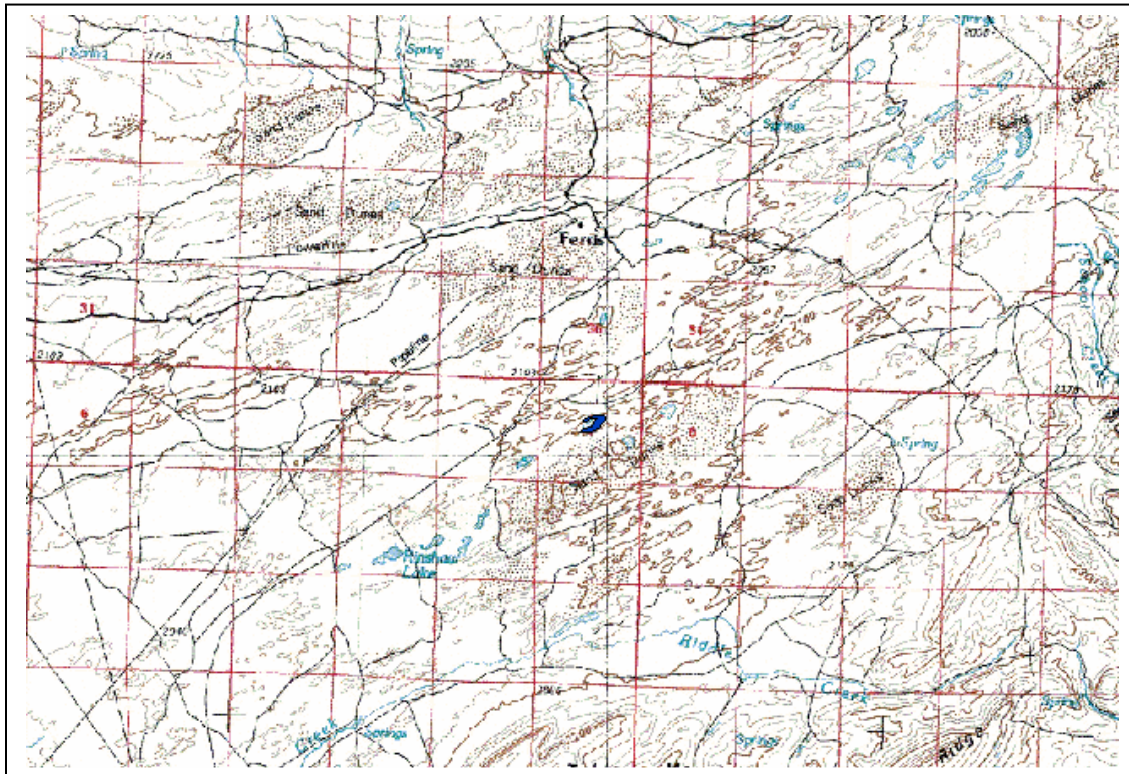




1999-2000 survey routes, BLM 1:100,000 Bairoil quad, T24-25N, R92-93W.

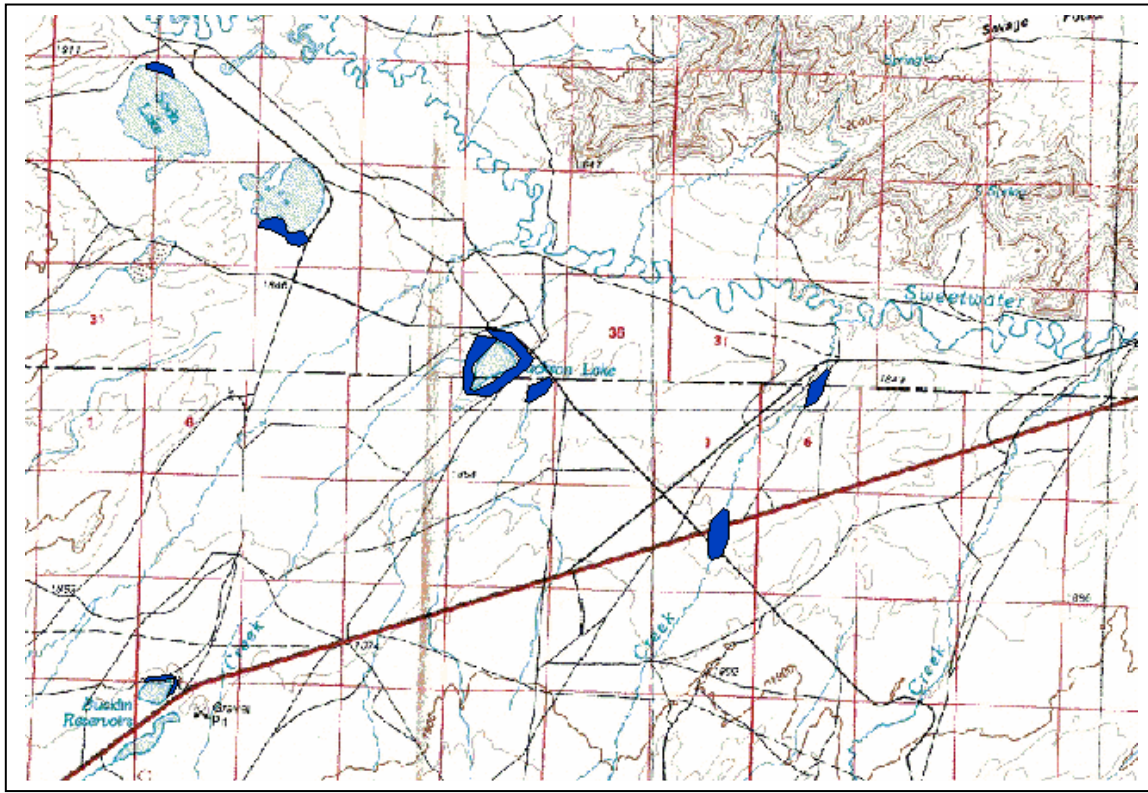


1999-2000 survey routes, BLM 1:100,000 Bairoil quad, T25-26N, R86-87W.

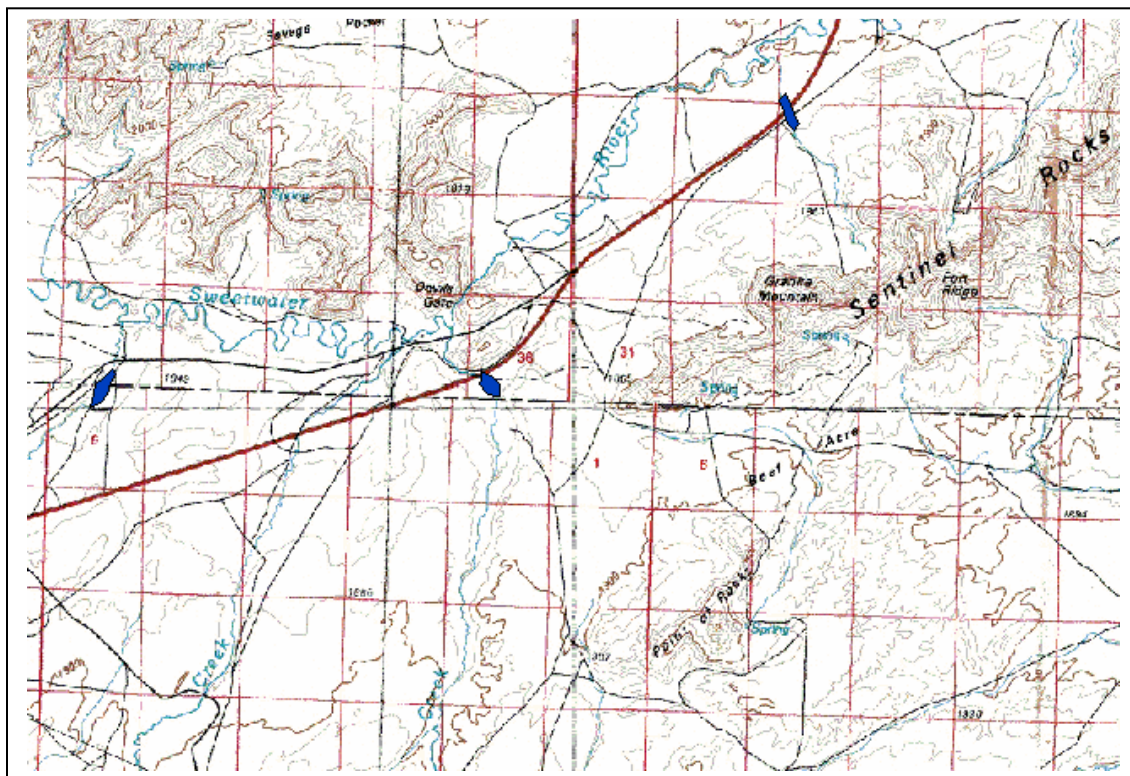




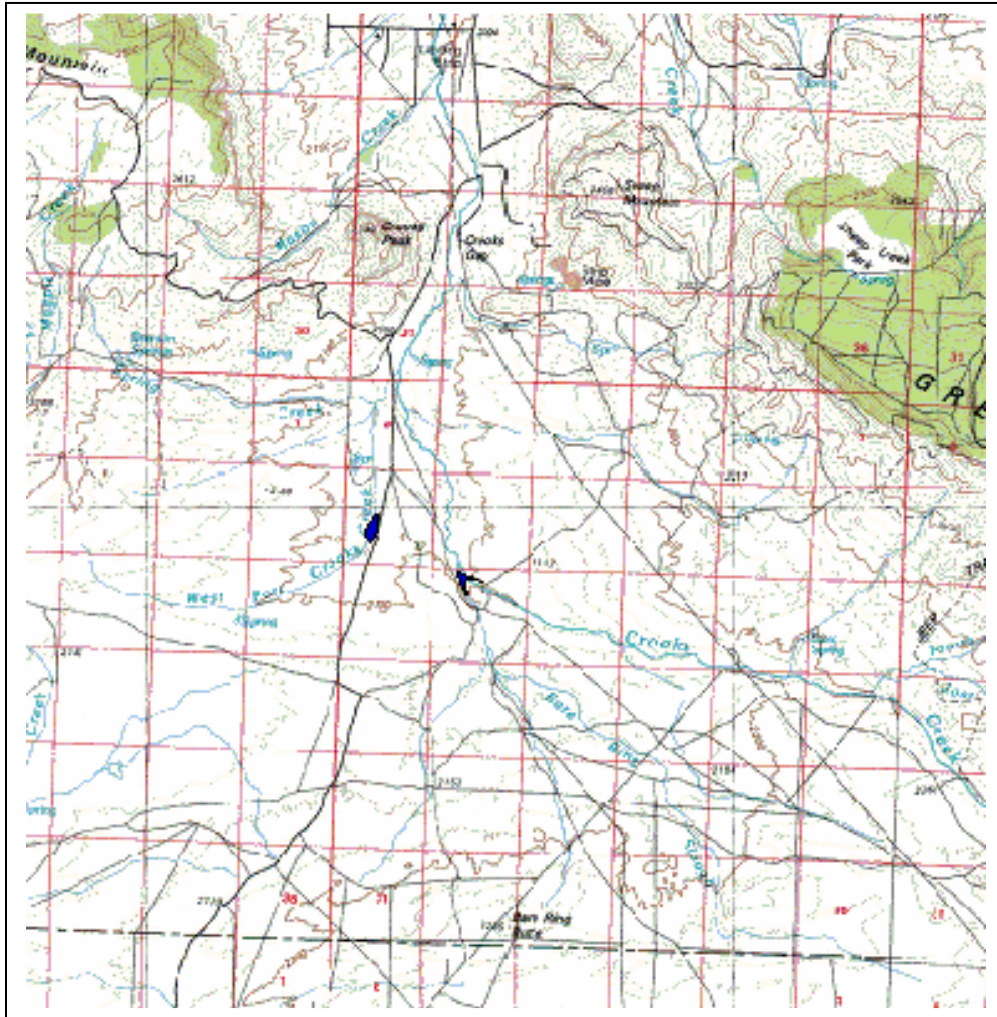
1999-2000 survey routes, BLM 1:100,000 Bairoil quad, T28-29N, R87-88W.



1999-2000 survey routes, BLM 1:100,000 Bairoil quad, T28-29N, R86-87W.

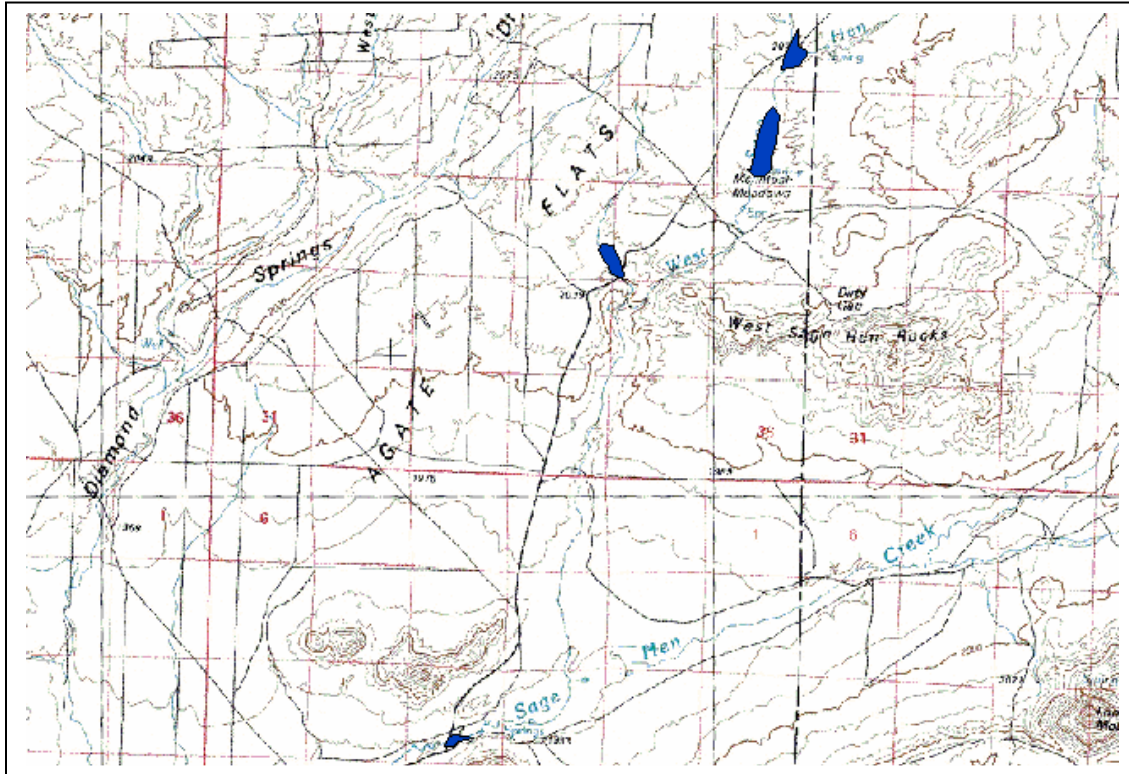


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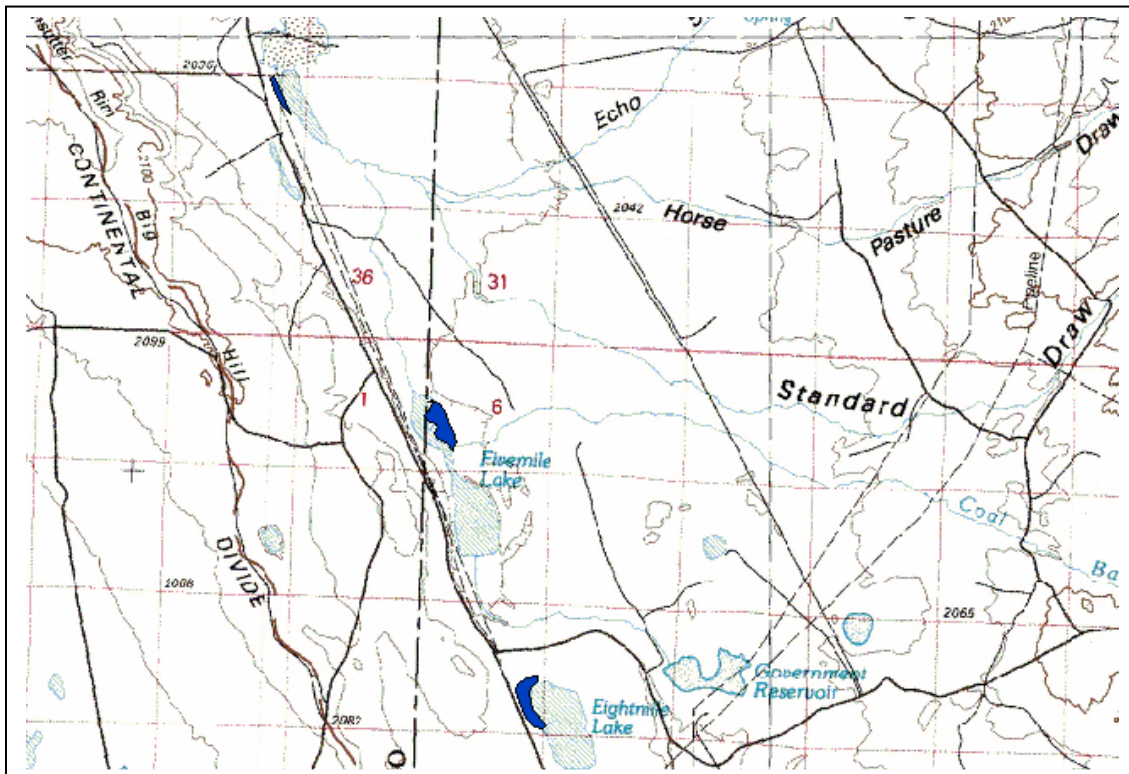




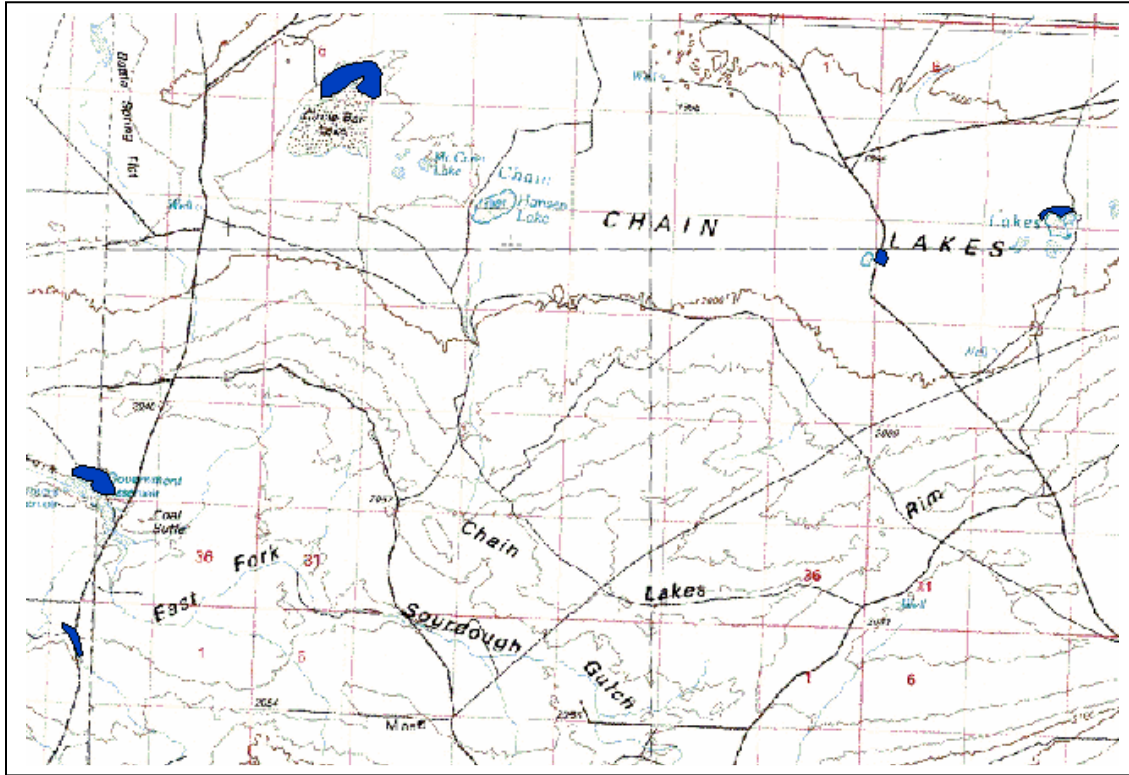
1999-2000 survey routes, BLM 1:100,000 Rattlesnake Hills quad, T30-31N, R89-90W.



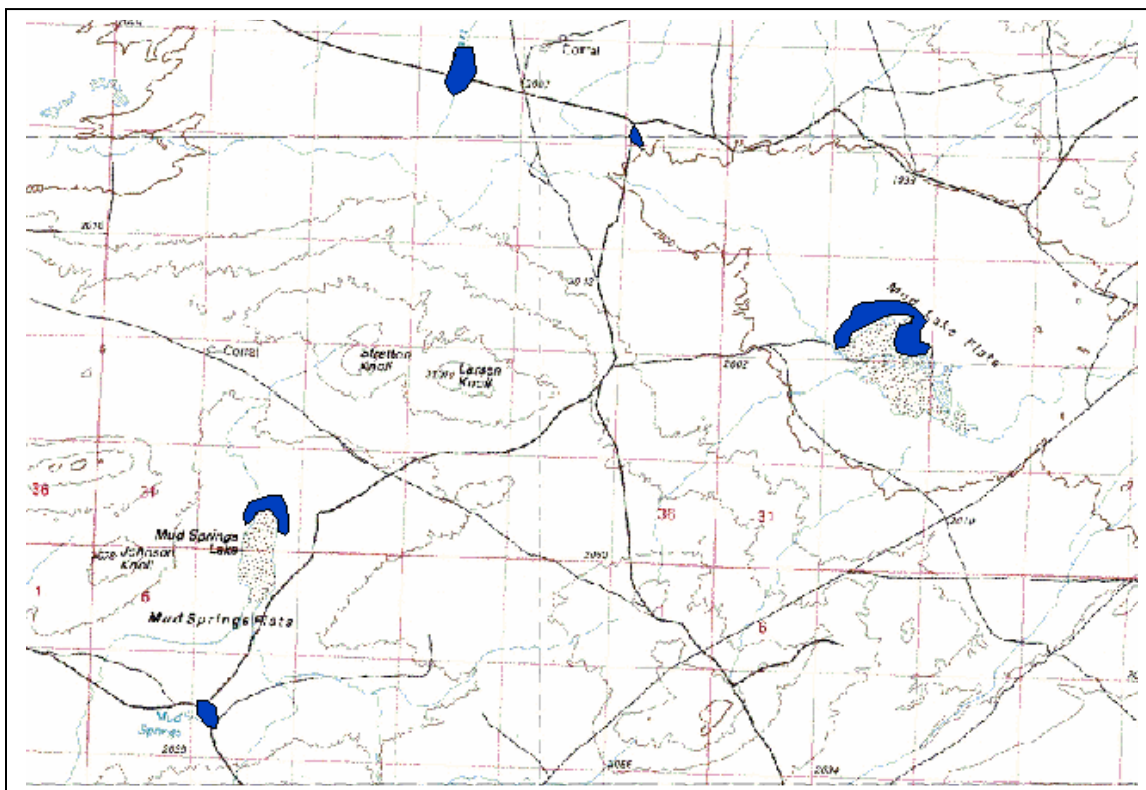
1999-2000 survey routes, BLM 1:100,000 Rawlins quad, T18-19N, R93-94W.



1999-2000 survey routes, BLM 1:100,000 Rawlins quad, T22-23N, R92-94W.

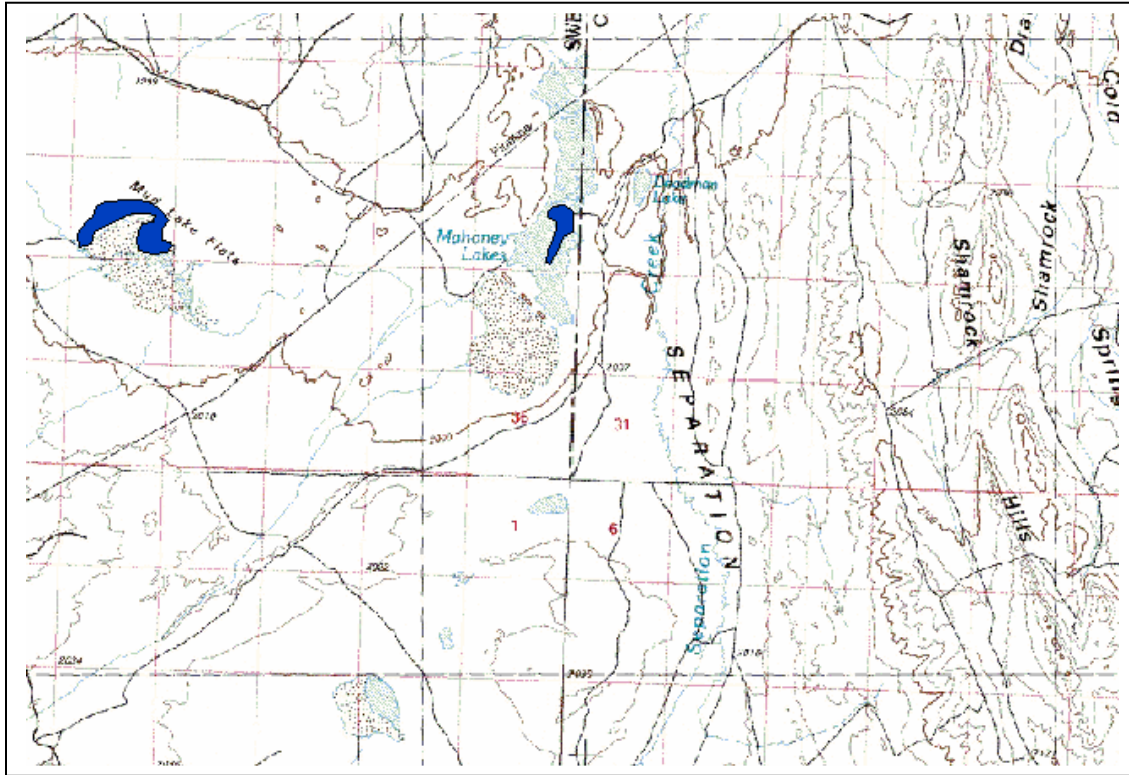


1999-2000 survey routes, BLM 1:100,000 Rawlins quad, T22-23N, R90-91W.

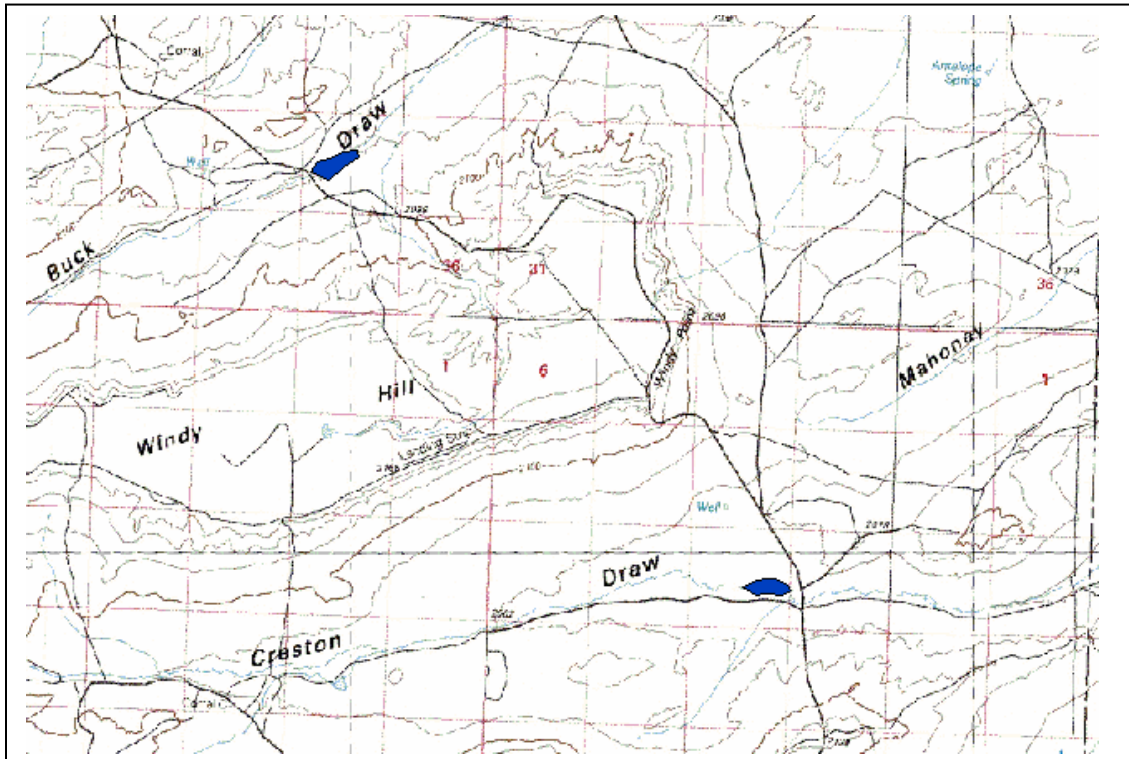




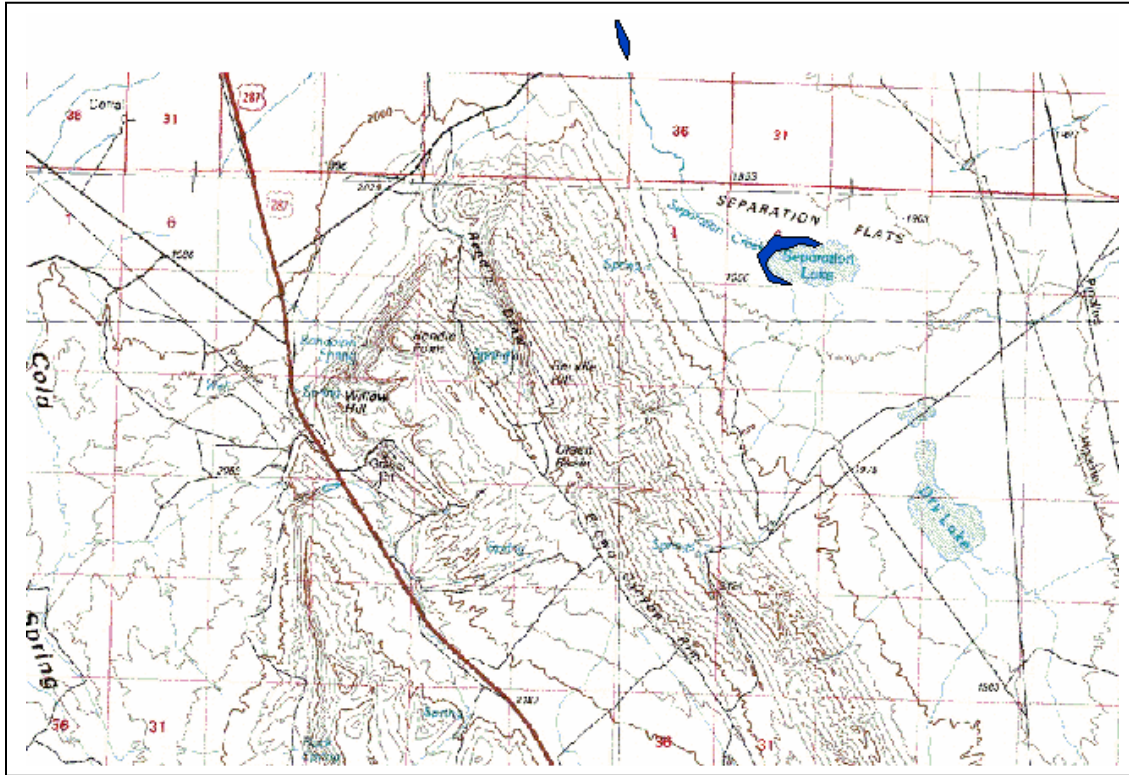
1999-2000 survey routes, BLM 1:100,000 Rawlins quad, T22-23N, R89-90W.



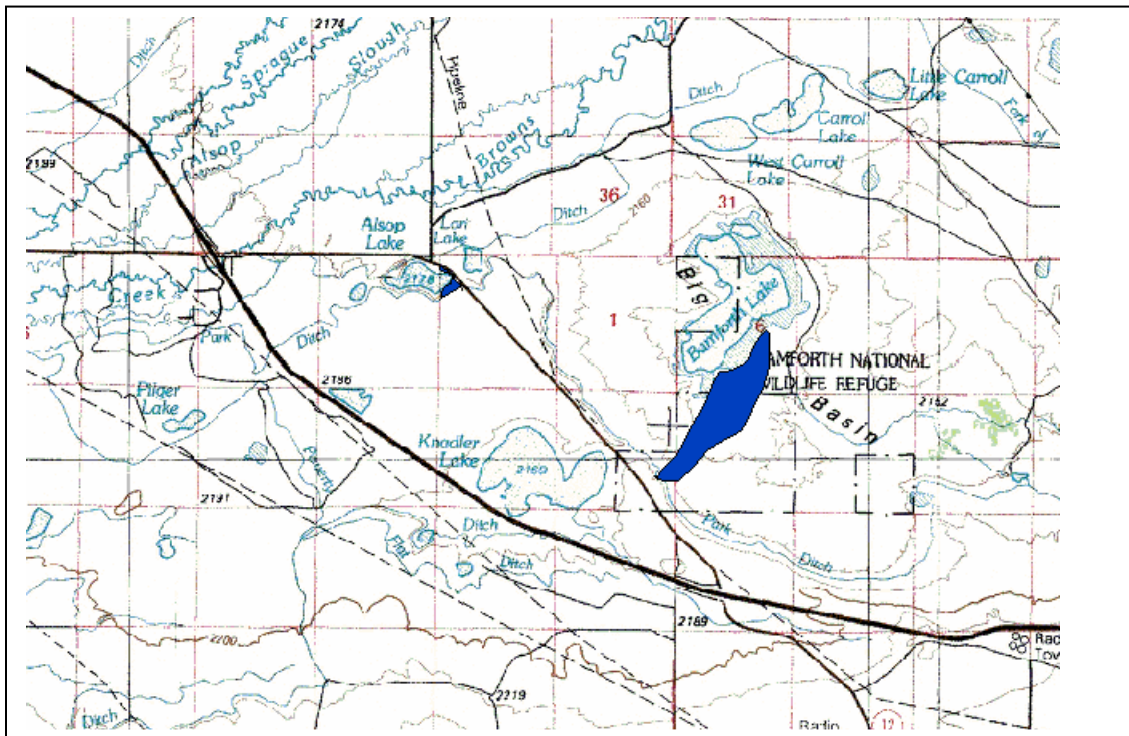
1999-2000 survey routes, BLM 1:100,000 Rawlins quad, T21-22N, R90-91W.



1999-2000 survey routes, BLM 1:100,000 Rawlins quad, T23-24N, R87-88W.

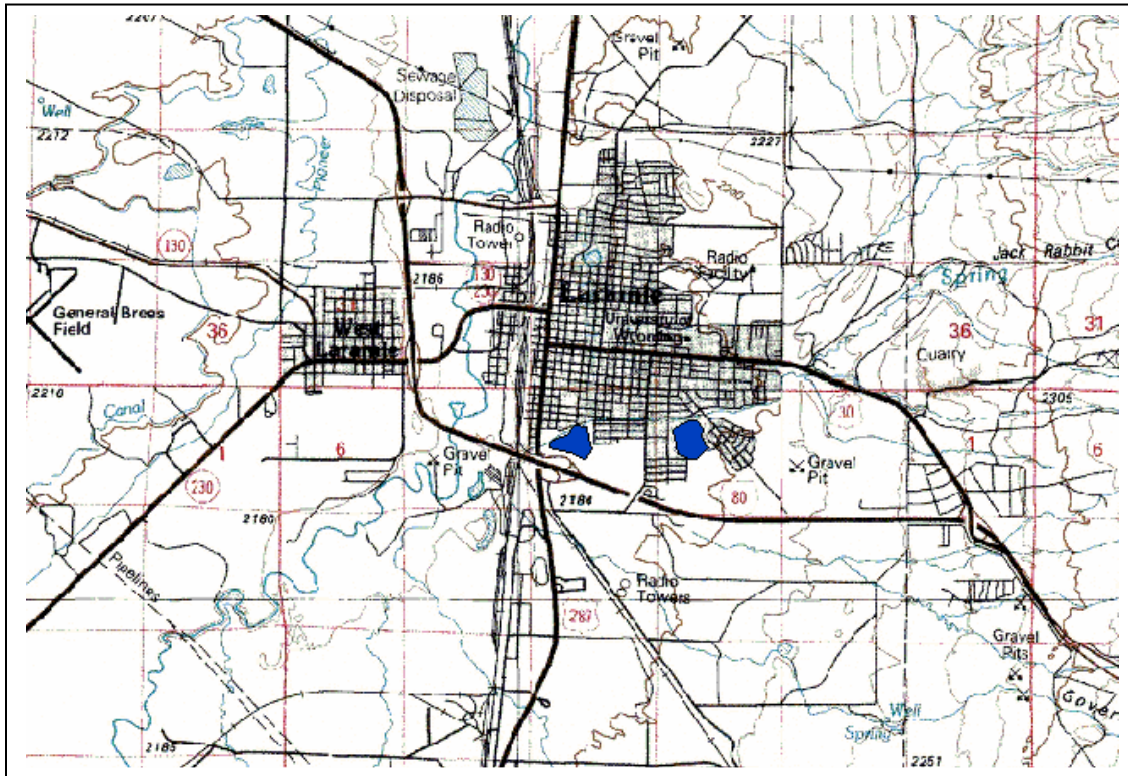


1999-2000 survey routes, BLM 1:100,000 Laramie quad, T16-17N, R74-75W.





1999-2000 survey routes, BLM 1:100,000 Laramie quad, T15-16N, R73-74W.



1999-2000 survey routes, BLM 1:100,000 Laramie quad, T14-15N, R74-75W.

