Gaura neomexicana subsp. *coloradensis*

(Colorado butterfly plant)

5-Year Review:

Summary and Evaluation

Photo by the U.S. Fish and Wildlife Service

U.S. Fish and Wildlife Service

Wyoming Ecological Services

Cheyenne, Wyoming

December 2012

5-YEAR REVIEW

Subspecies reviewed: ***Gaura neomexicana* subsp. *coloradensis***

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5-YEAR REVIEW
Colorado butterfly plant (*Gaura neomexicana* subsp. *coloradensis*)

1. GENERAL INFORMATION

1.1. Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since the time it was listed or since the most recent 5-year review. Based on the outcome of the 5-year review, we recommend whether the species should: (1) be removed from the list of endangered and threatened species; (2) be changed in status from endangered to threatened; (3) be changed in status from threatened to endangered; or (4) remain unchanged in its current status. Our original decision to list a species as endangered or threatened is based on the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and we review new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process that includes public review and comment.

1.2. Reviewers

Lead Regional Office: Mountain-Prairie Region (Region 6)
Mike Thabault, ARD Ecological Services, 303/236-4210
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Lakewood Ecological Services, Susan Linner, Field Supervisor, 303/236-4773
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Grand Junction Ecological Services, Gina Glenne, Botanist, 970/243-2778

Nebraska Ecological Services, Michael D. George, Field Supervisor, 308/382-6468
Nebraska Ecological Services, Matt Rabbe, Wildlife Biologist, 308/382-6468

1.3. Methodology used to complete the review

On June 20, 2011, we published a Notice of Review in the *Federal Register* (76 FR 35906) soliciting any new information on *Gaura neomexicana* subsp. *coloradensis* that may have a bearing on its classification as endangered or threatened. For the purposes of this 5-year review, we will refer to *Gaura neomexicana* subsp. *coloradensis* as the Colorado butterfly plant. We received many comments in response to our inquiries to known experts. This 5-year review was primarily written by staff from the Wyoming Ecological Services Office with substantive contributions from interested parties and review by cooperating field and regional offices. This document summarizes and evaluates information provided in the recovery plan outline, current scientific research, and surveys related to the subspecies. All pertinent literature and documents on file at the Wyoming Ecological Services Field Office were used for this review (See References section below for a list of cited documents). We interviewed individuals familiar with the Colorado butterfly plant as needed to clarify or obtain specific information.

1.4. Background

1.4.1. Federal Register Notice citation announcing initiation of this review

76 FR 35906; June 20, 2011

1.4.2. Listing history

Original Listing
Federal Register notice: 65 FR 62302; October 18, 2000
Entity listed: Subspecies
Classification: Threatened Rangewide

Critical Habitat Designation
FR notice: 70 FR 1940; January 11, 2005

1.4.3. Review History

The subspecies' status has not undergone formal review since its listing in 2000.

1.4.4. Subspecies' Recovery Priority Number at start of 5-year review

At the start of the 5-year review, the Recovery Priority Number for the Colorado butterfly plant was 9C. This ranking indicates that: (1) the subspecies faces a moderate degree of threats; (2) the subspecies has a high potential for recovery; and, (3) the taxon is a subspecies. The subspecies rank is elevated by the addition of "C" indicating there is or may be a conflict with construction or other development projects, or other forms of economic activity (see Table 1). A "High" degree of threat means extinction is almost certain in the immediate future because of rapid population decline or habitat destruction. "Moderate" means the

subspecies will not face extinction if recovery is temporarily held off, although there is continual population decline or threat to its habitat. A subspecies in the "Low" category is rare, or is facing a population decline which may be a short-term, self-correcting fluctuation, or the impacts of threats of the subspecies' habitat are not fully known (48 FR 43098).

Table 1. The below ranking system for determining Recovery Priority Numbers was established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	**High**	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	**9C**
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

1.4.5. Recovery Outline

Name of outline: Recovery Outline for the *Gaura neomexicana* ssp. *coloradensis* (Colorado Butterfly Plant)

Date approved: May 2010

2. REVIEW ANALYSIS

2.1. Application of the 1996 Distinct Population Segment (DPS) policy

This section of the 5-year review is not applicable to this subspecies because the Endangered Species Act (Act) precludes listing DPSs of plants. For more information, see our 1996 DPS policy (61 FR 4722, February 7, 1996).

2.2. Recovery Planning and Implementation[1]

2.2.1. Does the subspecies have a final, approved recovery plan?

☐ Yes

☒ No

2.2.2. Adequacy of recovery plan?

There is no recovery plan.

2.2.3. Progress toward recovery

Progress toward recovery has included the completion of (1) surveys in potential habitat, (2) voluntary management/stewardship agreements with private landowners, and (3) a habitat management plan (INRMP) and a Memorandum of understanding for the F. E. Warren Air Force Base populations. Also, vigor and trend of many known existing populations have been monitored on a regular basis. Prior to beginning recovery planning efforts, the Service intends to conduct a more thorough formal evaluation of the need for this subspecies to remain on the list of Threatened and Endangered Species. This evaluation will include an objective, science-based analysis that will thoroughly evaluate the current and potential threats to the Colorado butterfly plant. If this evaluation indicates that the threats presently acting on this subspecies do not warrant a "threatened" classification under the Act, then the Service will take steps to change the status of the subspecies at that time.

[1] Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed subspecies, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a subspecies, and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently, and the subspecies is robust enough, to downlist or delist the subspecies. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the subspecies. Overall, recovery is a dynamic process requiring adaptive management, and assessing a subspecies' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of subspecies status in this 5-year review on progress that has been made toward recovery since the subspecies was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

2.3. Updated Information and Current Subspecies Status

2.3.1. Background on the Subspecies

2.3.1.1. Taxonomic classification or changes in nomenclature

The Colorado butterfly plant was initially described as *G. coloradensis* by Rydberg (1904) based on material collected in 1895 near Fort Collins, Colorado. Munz (1938) changed the species to *G. neomexicana* and reduced it to the variety *coloradensis*. At present, the taxon is recognized as *G. n.* Woot. subsp. *coloradensis* (Rydb.) P.H. Raven and Gregory (Colorado butterfly plant or Colorado bee blossom) (U.S. Department of Agriculture, Natural Resource Conservation Service 2008).

Recent molecular data demonstrate that *Gaura*, together with the unispecific genus *Stenosiphon*, comprise a group sharing a common origin. This group is embedded within the diverse genus *Oenothera*, and may be best treated as part of that genus. The morphological characters used to delimit the genus are: nutlike, indehiscent capsules with one to four seeds; and flowers mostly zygomorphic with short stigma lobes. These characters still delimit the group, but now are viewed as specializations derived within *Oenothera* (Hoggard *et al.* 2003). Wagner has proposed a name change to *Oenothera coloradensis* subsp. *coloradensis* (Wagner *et al.* 2007); however, U.S. Department of Agriculture, Natural Resource Conservation Service's Plants Database (2008), the International Plant Name Index (2012), and the Integrated Taxonomic Information System (2008) have *G. n.* subsp. *coloradensis* as the accepted name. We are considering whether to formally accept the proposed taxonomic revision. Until the taxonomy is formally changed, we will continue to refer to this subspecies as *G. n.* subsp. *coloradensis.*

2.3.1.2. Biology and life history

The Colorado butterfly plant is a short-lived, perennial herb with a ground level arrangement of leaves around the plant's central stem that lives for several years before bearing fruit once and then dying. In the flowering stage, this plant has one to a few reddish, hairy stems that are 2 to 3 feet (50 to 80 centimeters (cm)) tall. Flowers are arranged in long, branched clusters on the stems. Only a few flowers are open at any one time. In the pre-flowering stage, the above-ground portion of the plant consists only of an arrangement of oblong, hairless leaves clustered at ground level. These leaves are 1 to 7 inches (3 to 18 cm) long (Marriott 1987; Fertig 1994; Fertig *et al.* 1994; Fertig 2000a, 2000b, 2001).

The Colorado butterfly plant occurs on moist, streamside soils on level or slightly sloping floodplains and drainage bottoms at elevations of 5,000 to

6,400 feet (1,524 to 1,951 meters). Colonies are often found in low depressions or along bends in wide, active, meandering stream channels a short-distance upslope of the actual channel. The plant requires early- to mid-succession riparian habitat. It commonly occurs in habitat types that are usually intermediate in moisture between wet, streamside communities dominated by sedges, rushes, and cattails, and dry, upland short-grass prairie. Typically, Colorado butterfly plant habitat is open, without dense or overgrown vegetation. *Salix exigua* (coyote willow) and *Cirsium arvense* (Canada thistle) may become dominant in areas of Colorado butterfly plant habitat that are not periodically flooded or otherwise disturbed.

The plant occurs on soils derived from conglomerates, sandstones, and mudstones and siltstones of volcanic origin of the Tertiary White River, Arikaree, and Oglalla Formations (Love and Christiansen 1985). These soils are common in eastern Colorado and Wyoming. The Colorado butterfly plant is an early successional plant (although probably not a pioneer) adapted to use stream channel sites that are periodically disturbed. Historically, flooding was probably the main cause of disturbance in the plant's habitat, although wildfire and grazing by native herbivores also may have been important. Although flowering and fruiting stems may exhibit increased mortality because of these events, vegetative rosettes appear to be little affected (Mountain West Environmental Services 1985). The establishment and survival of seedlings appears to be enhanced at sites where tall and dense vegetation has been removed by some form of disturbance. In the absence of occasional disturbance, the plant's habitat can become choked by dense growth of willows, grasses, and exotic plants (Floyd 1995a; Fertig 1994, 1996). This prevents new seedlings from becoming established and replacing plants that have died (Floyd 1995a; Fertig 1996).

Individual populations of Colorado butterfly plant typically consist of numerous subpopulations, each with dozens to hundreds of flowering stems and rosettes. These subpopulations are often widely scattered and may be isolated by gaps of seemingly suitable habitat. It is not uncommon for subpopulations to be scattered along stream channels, with gaps of up to 4 miles (6.4 km) between neighboring subpopulations.

Population growth rates in the Colorado butterfly plant appear to be influenced by rates of seedling establishment and survival of vegetative rosettes to reproductive maturity. These factors may be influenced by summer precipitation (Marriot *et. al.* 1988; Floyd 1995a; Fertig 1996, 1997, 1998a, 1998b; Floyd and Ranker 1998). During the drought of 1994, sample plots on Francis Emroy (F.E.) Warren Air Force Base (Warren AFB) experienced 47 percent less seedling recruitment than in

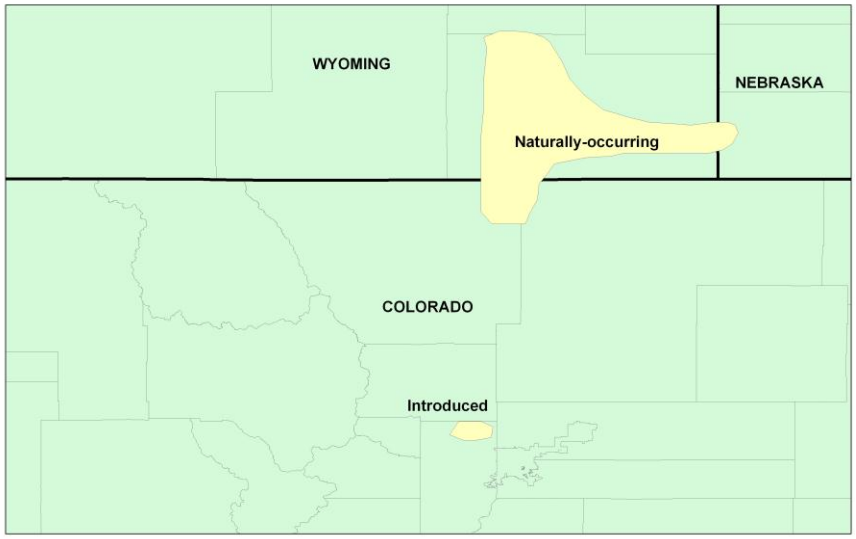
the preceding year (Floyd and Ranker 1998). Differences in soil moisture and vegetative cover may also influence recruitment success (Munk *et al.* 2002).

Vegetative rosette populations may be relatively stable and capable of surviving adverse climatic years when new seedling establishment is low. Large numbers of seedlings may be important for the long-term growth, replenishment, and survival of the populations (Floyd and Ranker 1998).

2.3.1.3. Distribution, Abundance, and Trends

Colorado butterfly plant populations depend on disturbance, such as floods, fire, etc., to maintain open to semi-open habitat. Prior to 1984, the Colorado butterfly plant was known from only five extant populations in Laramie County, Wyoming and northern Weld County, Colorado. Intensive rangewide surveys from 1984-1986 resulted in the discovery of 17 new populations, extending the known range (Figure 1) of the Colorado butterfly plant to a major segment of western and southern Laramie County in Wyoming, as well as a small portion of adjacent Kimball County, Nebraska (Fertig 1994, Marriott 1987). One additional population was discovered in Wyoming during field surveys in 1992-93. It was also noted during the 1992-93 field surveys that most known populations of the Colorado butterfly plant were thriving 7-9 years after their discovery. In 1998, the total population of Colorado butterfly plants rangewide was projected to be 282,000-301,800 (Fertig 1998b). However, four previously known populations in Colorado and five in Wyoming had not been located since 1986 and may have become extirpated (Fertig 1998b).

Figure 1. Rangewide distribution of the Colorado butterfly plant.



We also know of four other Colorado butterfly plant populations in Colorado (two of which were last observed in 1895, one in 1942, and one in 1944) that are known or assumed to have become extirpated (Fertig 1994).

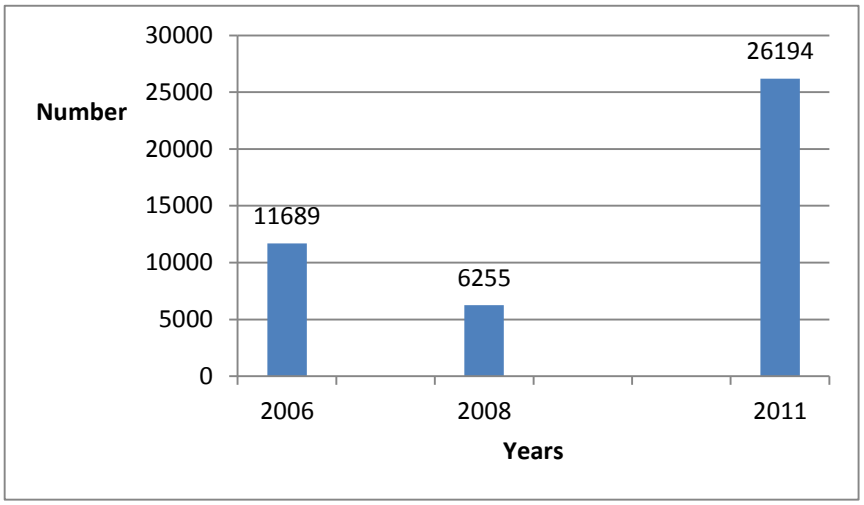
COLORADO

Naturally-occurring populations of Colorado butterfly plant occur in northern Weld and Larimer Counties in northern Colorado on two areas that are owned by the City of Fort Collins. The first is Meadow Springs Ranch—an area that has historically been managed for livestock grazing and municipal sewage treatment. The second area is the Soapstone Prairie Natural Area—an area that is owned and managed for preservation and conservation purposes by the City of Fort Collins, Colorado. On the Soapstone Prairie Natural Area, 26,194 individuals were counted during the most recent 2011 survey. In addition to the two naturally-occurring populations described above, a small, introduced population of Colorado butterfly plant occurs at Chambers Preserve in Jefferson County. This introduced population was established from seed and transplants from the University of Wyoming in the mid-1980s (CNHP 2012). Additionally, one lone individual was found in Upper Church Ditch in Jefferson County and 11 individuals were found near Clear Creek in Adams County in 2011 and these are presumed to have been derived from the introduced population at Chambers Preserve.

Soapstone Prairie

The Soapstone Prairie Natural Area populations are located in Larimer County, Colorado near the Wyoming border approximately 20 miles (32.2 kilometers (km)) north of Wellington, Colorado (City of Fort Collins Natural Areas Program 2007)(Figure 2). Colorado butterfly plants on the Soapstone Prairie Natural Area appear to be stable or increasing. The numbers reported below are for flowering individuals – the total population size (including vegetative rosettes) would be much higher. The area is currently owned and managed by the City of Fort Collins as part of an 18,728 acre (7579 ha) Natural Area. In May 2011, the managers of the Soapstone Prairie Natural Area conducted a prescribed burn on a portion of the area occupied by the Colorado butterfly plant. Increased numbers of bolted plants were observed in the burned area following the burn. However, increased numbers of bolted plants were also observed in the unburned areas that year (Strouse 2012 pers. comm.). Surveys in future years may better indicate what effect the burn may have had on population productivity.

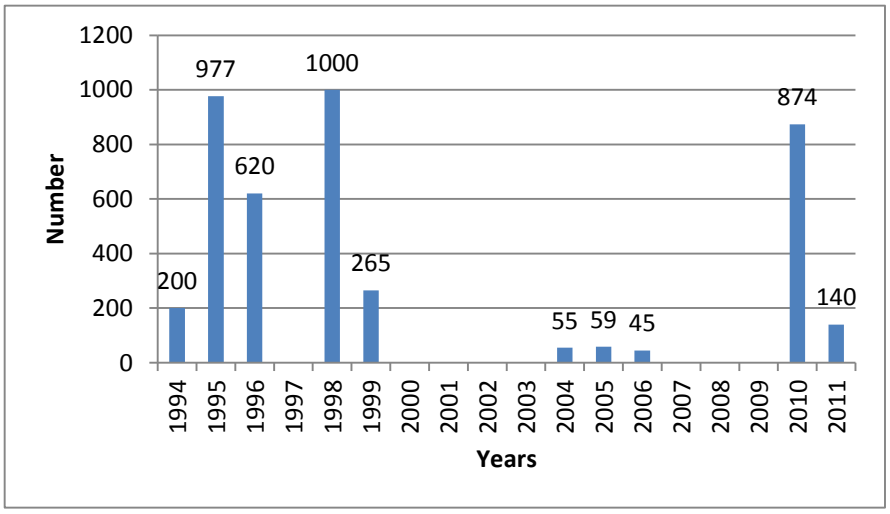
Figure 2. Soapstone Prairie Colorado butterfly plant survey results for surveys conducted in years 2006, 2008, and 2011.



Meadow Springs

This population occurs within an approximately 0.5 mile (0.8 km) section of a wet meadow along Spring Creek 14 miles (22.5 km) northwest of Wellington, Colorado (Floyd 1995b)(Figure 3). The area is grazed by cattle. *Cirsium arvense* (Canada thistle) and *Euphorbia esula* (leafy spurge) have been identified at the site. The area has been grazed April-November since the 1860s. The recorded threats at this site are human-caused alterations in stream levels (the area was part of a sludge treatment system) and intense grazing pressure (CNHP 1995, Hazlett 2004, Strouse 2012 pers. comm.).

Figure 3. Meadow Springs Colorado butterfly plant survey results from years 1994, 1995, 1996, 1998, 1999, 2004, 2005, 2006, 2010, and 2011.



Upper Church Ditch

The Upper Church Ditch population is located approximately 8.5 miles (13.7 km) southeast of Boulder, Colorado in Jefferson County. The habitat consists of a small wetland that lies in a roadside ditch built along a hill near a major roadway. Adjacent private land is grazed. A single individual was discovered at this location on July 19, 2011. The plant was growing on the edge of a small patch of cattails and forbs with grasses dominating the surrounding area. This area had apparently received road runoff and erosion as evidenced by channels very close to the plant. Based solely on the population size, this occurrence has an extremely high likelihood of becoming extirpated in the near future. Continued monitoring is recommended. The seeds may be coming from another source. There is a potential seed source on Walnut Creek. The single individual appeared healthy and had flowers and developing fruits; however on a subsequent visit the top half of the plant was gone (either grazed or fell off). The area was thoroughly searched and no rosettes were found (CNHP 2012).

Chambers Preserve – Walnut Creek

The Chambers Preserve—Walnut Creek population is located approximately 2 miles (3.2 km) south of Broomfield, Colorado in Jefferson County. The habitat consists of an inundated floodplain and streambank of an urban riparian area. There were 100 individuals (including bolted plants and rosettes) observed on July 7, 2011. The population is introduced and was established from seed and transplants provided by the University of Wyoming Botany Department in the mid 1980s. In 1992, 47 individuals (12 flowering individuals and 35 rosettes) were documented. Our records indicate that the population was only surveyed in the years 1992 and 2011. This population remains small and is located in a heavily developed urban area. Noxious weeds are dense and dominant in the area. Long-term survival of this population is precarious (CHNP 2012).

Clear Creek at Broadway Street Bridge

The Clear Creek at Broadway Street Bridge population is located approximately 2 miles (3.2 km) north of Denver, Colorado in Adams County. The habitat consists of an inundated floodplain and streambank of an urban riparian area. There were 11 individuals (including bolted plants and rosettes) observed on July 19, 2011. The plants at this site were flowering and looked healthy and were located in a flooded part of the creek and were partially submerged. Colorado butterfly plant populations depend on disturbance, such as floods, fire, etc., to maintain open to semi-open habitat. The population is surrounded by dense urban development and a variety of noxious weeds (CNHP 2012).

NEBRASKA

Two populations of Colorado butterfly plant have been documented in Nebraska: one population along Lodgepole Creek in Kimball County and one population at Oliver Reservoir State Recreation area (Fertig 2000b). Survey results from 2004 suggested the subspecies was extirpated from the State. However, a 2008 Colorado butterfly plant survey in Nebraska found no plants at Oliver Reservoir State Recreation Area, but 12 plants were found along Lodgepole Creek. No other populations of Colorado butterfly plant are presently known to occur in Nebraska (Steinhauer 2009 pers. comm., Wooten 2008).

Lodge Pole Creek

This site consists of an 8-mile (12.9 km) stretch along Lodgepole Creek in Nebraska between the Wyoming border and the town of Bushnell, Nebraska. The area is privately owned and is mainly composed of short-grass prairie used for grazing horses and cattle. A survey in 1992 found 547 plants. The site has been dry over the last decade. However, a 4000 feet (1200 meter) stretch contained water in 2008 as a result of a leak in a livestock water supply pipe. There, seven plants were observed, though no plants were documented in this area when the area was surveyed in 1992 (Wooten 2008).

Oliver Reservoir State Recreation Area

This site consists of a state-owned impoundment on Lodgepole Creek and is used as a recreational area. It is located east of the town of Bushnell, Nebraska and approximately 11 miles (17.7 km) downstream from the Wyoming border. Forty-three plants were observed at the site in 1992. However, no plants were observed during a 2008 survey (Steinhauer 2009 pers. comm., Wooten 2008).

WYOMING

In Wyoming, populations of Colorado butterfly plant appear restricted to Laramie and Platte Counties (USFWS 2004). Approximately 90 percent of known occurrences in Wyoming are on private lands, almost 10 percent are on state lands, and three occurrences are on Federal lands of the Warren AFB.

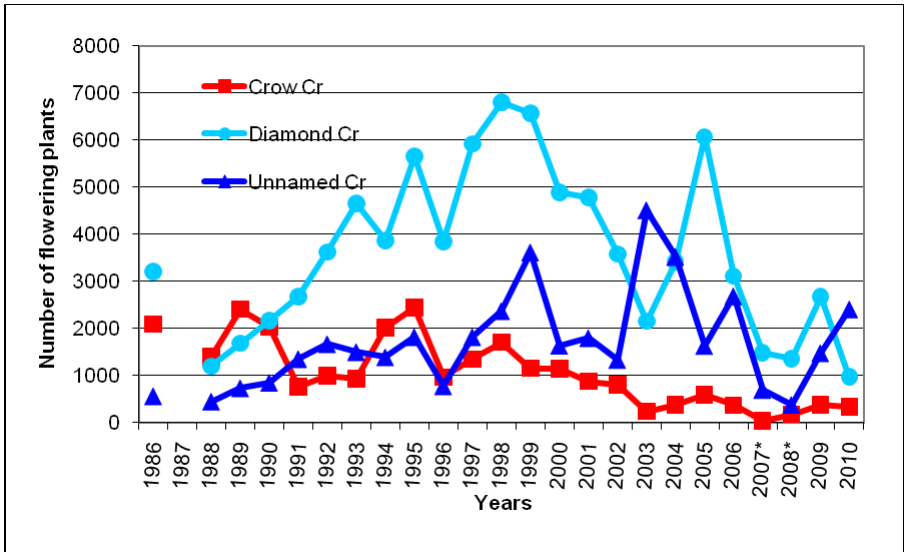
F.E. Warren Air Force Base

Annual monitoring of these populations by the Wyoming Natural Diversity Database has been conducted for the past 23 years and is ongoing (Heidel and Handley 2011)(Figure 4). Since 1986, sites on the Warren AFB have had large increases of *Cirsium arvense* (Canada thistle), *Euphorbia esula* (leafy spurge) and the native *Salix exigua* (coyote willow)(Heidel and Handley 2011). Heavy insect herbivory was

documented at each site on the base in 2007—an event in which every plant had the majority of its leaf area eaten and seed production was impaired (Heidel *et al*. 2011).

Three separate areas on Warren AFB contain Colorado butterfly plants: Crow Creek, Diamond Creek and Unnamed Creek. Crow Creek is the largest of the three creeks. It has perennial flow, intermittent flooding, abandoned channels, beaver dams, springs, and seeps. Crow Creek has a wetland thicket dominated by *Salix exigua* (coyote willow), interrupted by small woodland bands, and wet and dry meadow opening (Heidel and Handley 2011). Diamond Creek is a large tributary to Crow Creek and is a highly meandering, seasonally-flowing creek. Diamond Creek flows through wet and dry meadows and a narrow wooded segment at the mouth (Heidel and Handley 2011). Unnamed Creek is a very small tributary of Crow Creek. It has ephemeral flow, an outflow buried underground, and a watershed much smaller than the other two areas. The Unnamed Creek site has wet and dry meadows and small patches of shrubs (Heidel and Handley 2011).

Figure 4. F.E. Warren Air Force Base Colorado butterfly plant survey results



Taken from Heidel and Handley 2011.
* indicate documented beetle herbivory

Private and State Land Populations in Wyoming

The following locations occur on private or State land in Wyoming. The annual monitoring of these populations by USFWS personnel resulted from the formalization of agreements (Wildlife Extension Agreements or WEAs) with the landowners or leaseholders of these areas. Surveys have

been repeated annually for most of these areas by USFWS staff since 2004, or in some cases since 2005.

Given the number of areas to be surveyed, limited USFWS staff time, and the need to survey many of the areas before the fields were cut for hay by the landowners, the exact number of Colorado butterfly plants in large groups were, in certain years, estimated by surveyors. We made these estimates by observing the density of plants and estimating the diameter of the grouping. We used visual count estimation as an index of population trend each year. The numbers of plants recorded are incorporated into the following graphs. This method has provided the USFWS with consistent population trend estimates over time.

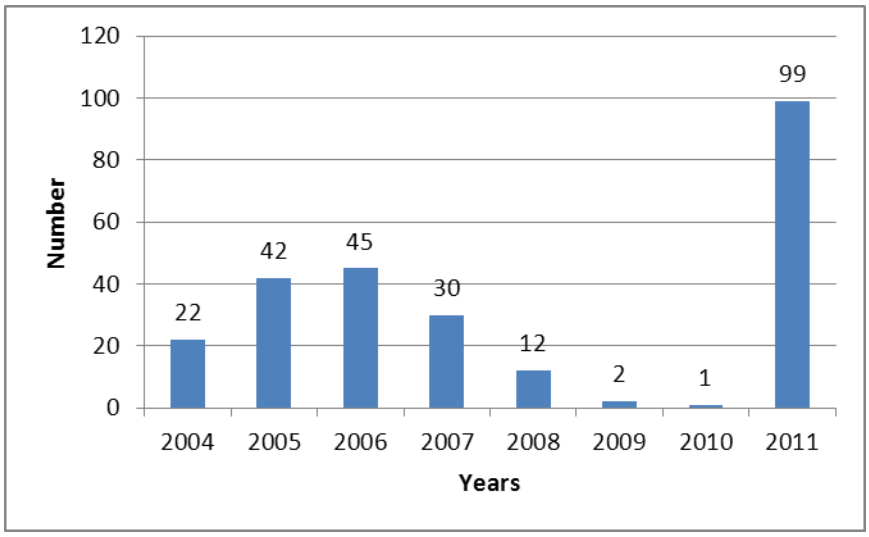
Regularly-surveyed areas were selected by USFWS personnel for each WEA based on the ease of accessibility to the occupied area and the size of the stream reach that a small survey crew could realistically cover in a limited timeframe. For instance, the WEA for Nimmo Ranch covers approximately 1300 acres (526 ha) of habitat along approximately 18 stream miles (29 km) of Horse Creek that contains Colorado butterfly plant. However, we consistently surveyed 2-5 miles (3.2-8.0 km) of the best and most accessible habitat for the Colorado butterfly plant. The graphs that follow show survey data for that section of each WEA that we survey on a regular basis.

Over the years, we've observed some populations fluctuating over several orders of magnitude. Subpopulations may appear very small some years and then rebound. The cause for this rebound is often undetermined, but may be related to annual, seasonal fluctuations in rainfall or temperature.

Bressler Property

This site consists of a 0.5 mile (0.8 km) section of Lodgepole Creek north of the town of Burns, Wyoming (Figure 5). Since surveys were begun, the area has been heavily grazed by a small herd of cattle. A 36 foot by 56 foot (11 m X 17 m) 3-strand barbed wire fence exclosure was built around the core population of plants in 2005 to protect them from grazing. Although the exclosure remained intact from 2005-2009, surveyors observed evidence (e.g., tracks, grazed plants) indicating that cattle (possibly calves) did occasionally penetrate the exclosure. Prior to the surveys of 2009, a major flood and a tornado came through the area demolishing the landowner's barn, other outbuildings, and the Colorado butterfly plant exclosure. That flood may have either washed in Colorado butterfly plant seeds from a population upstream or possibly the increased moisture from the flood allowed germination of seeds in the existing seedbank, as two years after the flood, numbers of flowering Colorado butterfly plant were at a level that far exceeded any numbers observed previously.

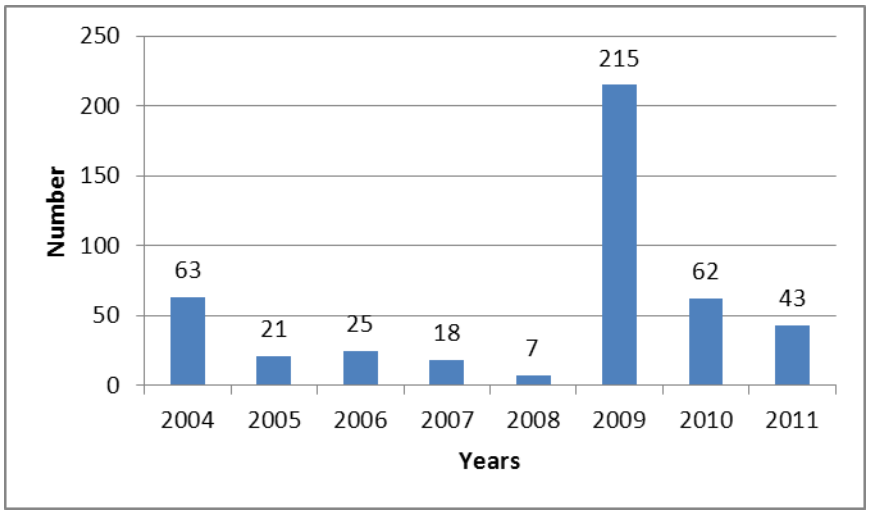
Figure 5. Bressler property Colorado butterfly plant survey results



City of Cheyenne-Belvoir Ranch

This site consists of a 1-mile (1.6 km) section of Lone Tree Creek approximately 6.5 miles (10.5 km) southwest of Cheyenne, Wyoming (Figure 6). The western portion of the area is cut for hay, whereas the eastern portion of the area is grazed by cattle and/or horses. The 2008 survey was conducted after the western portion of the area had already been hayed and this may be the reason that counts were low that year. The entire area under a WEA agreement for the City of Cheyenne-Belvoir Ranch is approximately 200 acres (81 ha) in size.

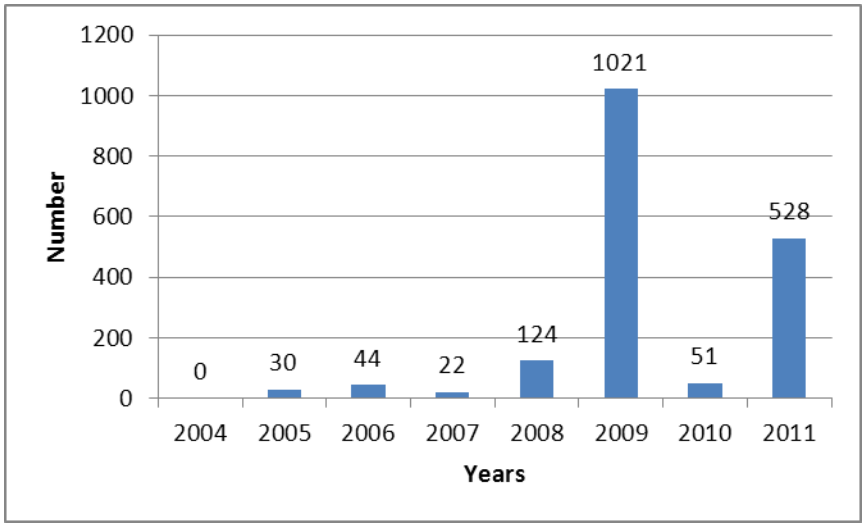
Figure 6. City of Cheyenne--Belvoir property Colorado butterfly plant survey results



Dolan Property

This site consists of a 0.25 mile (0.4 km) section of Lodgepole Creek approximately 2.75 miles (4.4 km) northwest of the Town of Hillsdale, Wyoming (Figure 7). Horses were present on the property in 2007, but the plants present that year did not appear to have been grazed. Livestock have not been observed at this site in other survey years. The area is not known to have been cut for hay since USFWS surveys began and therefore, haying has not had an influence on the numbers of plants observed. Succession by shrubs and willows is evident on the south side of this area. Colorado butterfly plant groups exist among the shrubs and willows and appear to be in competition with the overstory plants. The entire area under a WEA agreement for the Dolan property is approximately 91 acres (37 ha) in size.

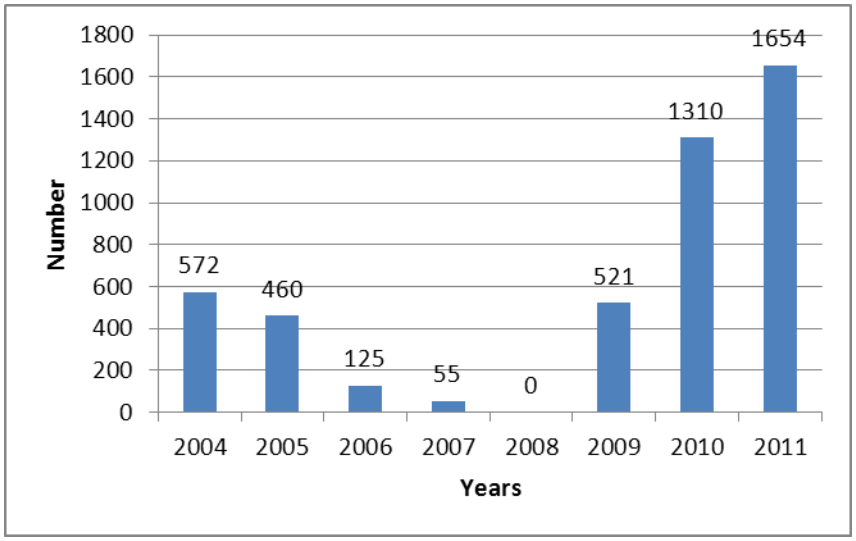
Figure 7. Dolan property Colorado butterfly plant survey results



Dyno Nobel Property

This site consists of both sides of a prairie meadow on a 0.25 mile (0.4 km) stretch of Lone Tree Creek 4 miles (6.4 km) southwest of Cheyenne, Wyoming (Figure 8). The area is cut for hay in mid-summer. The 2008 survey was conducted after the meadow had been hayed and the Colorado butterfly plants had been presumably removed as a result of the haying activities. The 2007 survey may have been conducted after haying as well.

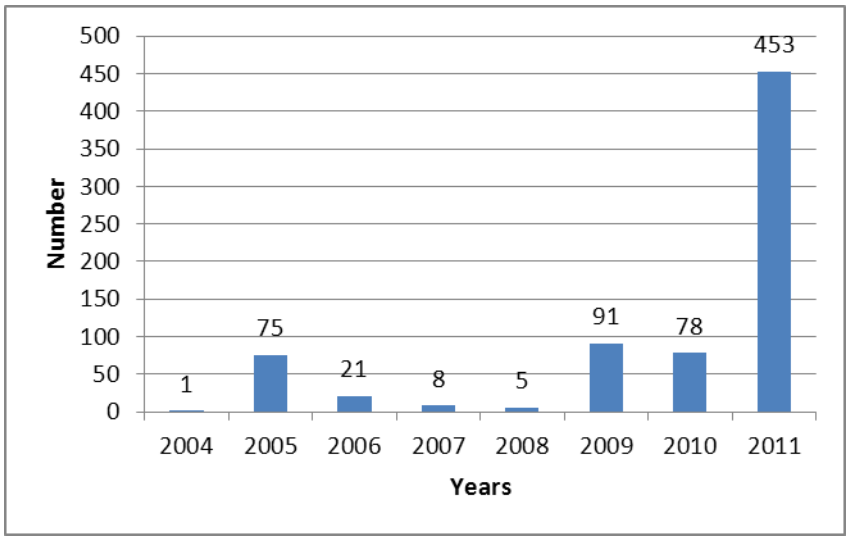
Figure 8. Dyno Nobel property Colorado butterfly plant survey results



Epler Property

This site consists of both sides of a riparian corridor on a 0.5 mile (0.8 km) stretch of Lodgepole Creek 2 miles (3.2 km) northeast of the Town of Hillsdale, Wyoming (Figure 9). The area is a mix of grass, forbs, and shrubs and is regularly grazed. During the 2010 survey, it was noted that the creek had apparently flooded prior to that survey. The increase in plant numbers in 2011 may have been due to the flood that occurred in 2009.

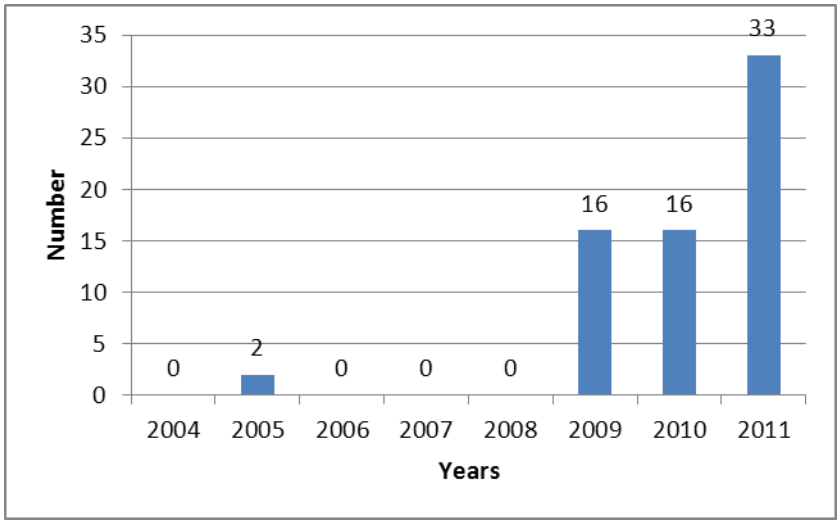
Figure 9. Epler property Colorado butterfly plant survey results



Goertz Property

This site consists of both sides of a grazed rangeland meadow on a 0.5 mile (0.8 km) stretch of Lodgepole Creek 8 miles (12.9 km) northwest of Cheyenne, Wyoming (Figure 10). It was noted that the site was extremely dry in 2006 compared to previous years. The entire area under a WEA agreement for the Goertz property is approximately 145 acres (58.6 ha) in size.

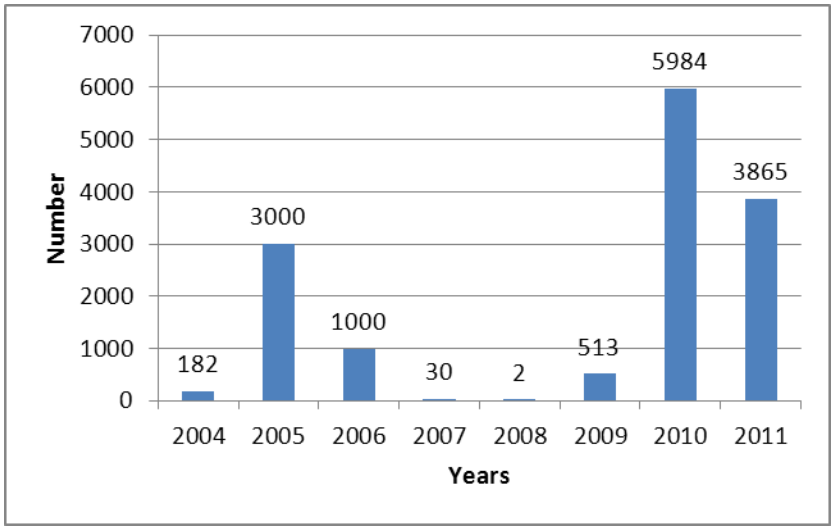
Figure 10. Goertz property Colorado butterfly plant survey results



King Ranch

This site consists of both sides of an irrigated hay meadow on a 0.5 mile (0.8 km) stretch of Diamond Creek south of Happy Jack Road in Laramie County (Figure 11). The area is cut for hay mid-summer and is grazed during other times of the year. Primary grasses observed within the hay meadow are *Bromus inermis* (smooth brome) and *Phleum pretense* (timothy). The entire area under a WEA agreement for the King Ranch is approximately 145 acres (58.6 ha) in size.

Figure 11. King Ranch *G. n.* subsp. *coloradensis* survey results

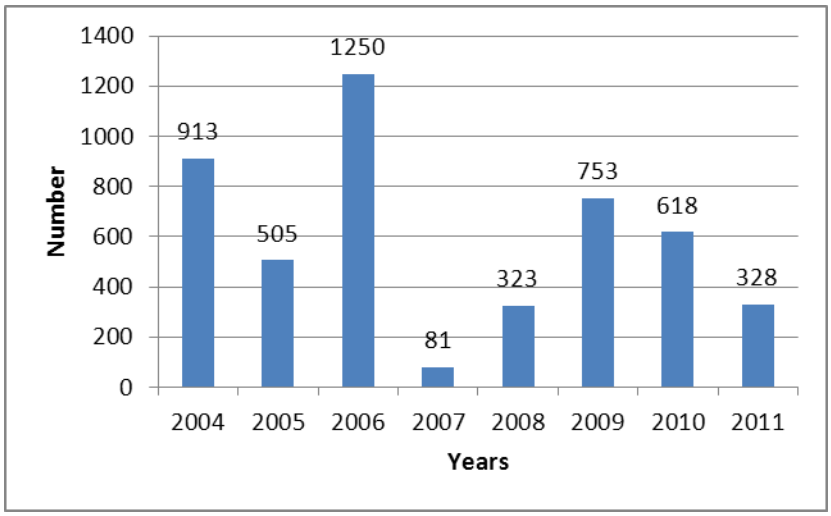


The 2008 survey was conducted after the habitat was cut for hay. Presumably most plants were removed. The 2004 and 2007 surveys may have been conducted "post-haying" as well. In 2011, the land managers of this site appeared to have plowed and/or disced portions of the north side of this site. As a consequence, very few flowering plants were observed that summer in the north section. However, on the south side, the Colorado butterfly plants were so numerous that the entire southwest portion of the field was white with Colorado butterfly plant flowers.

Nimmo Ranch – Small Tributary to Horse Creek

This site consists of a 0.75 mile (1.2 km) section along both sides of a small intermittent stream that traverses a rolling native prairie on Wyoming State Trust Land (Figure 12). The stream is a northeast flowing tributary to Horse Creek and is located approximately 19 miles (30.6 km) north-northwest of Cheyenne, Wyoming. The parcel is leased by a private ranch for cattle grazing. The Colorado butterfly plant is not restricted to this one drainage in the area. Adjacent small drainages also have sizeable populations, although those areas are not a part of a WEA at this time.

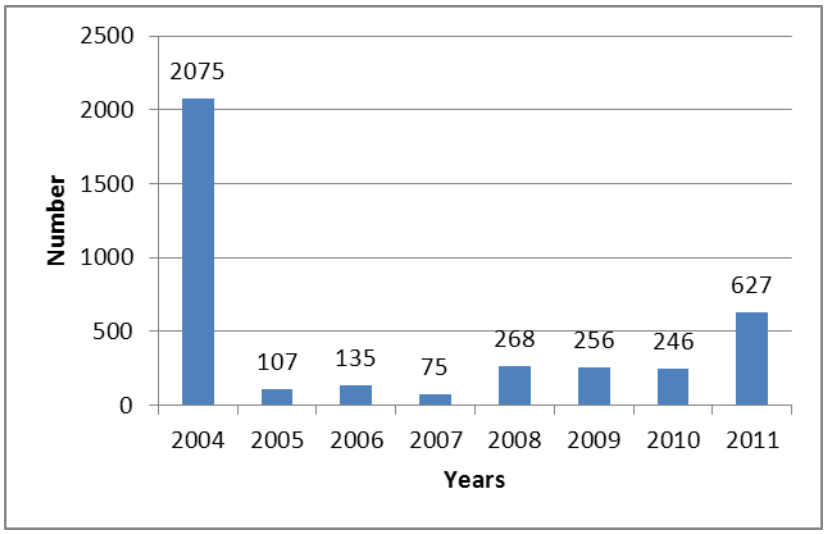
Figure 12. Nimmo Ranch--Small Tributary to Horse Creek Colorado butterfly plant survey results



Nimmo Ranch-Horse Creek - Central

This site consists of both sides of a 1-mile (1.6 km) section of Horse Creek approximately 20 miles (32.2 km) north of Cheyenne, Wyoming (Figure 13). The south side of Horse Creek is native prairie separated by large stands of willows. The north side of Horse Creek is a meadow of predominantly *Bromus inermis* that is annually cut for hay. Flooding occurs in this section of Horse Creek.

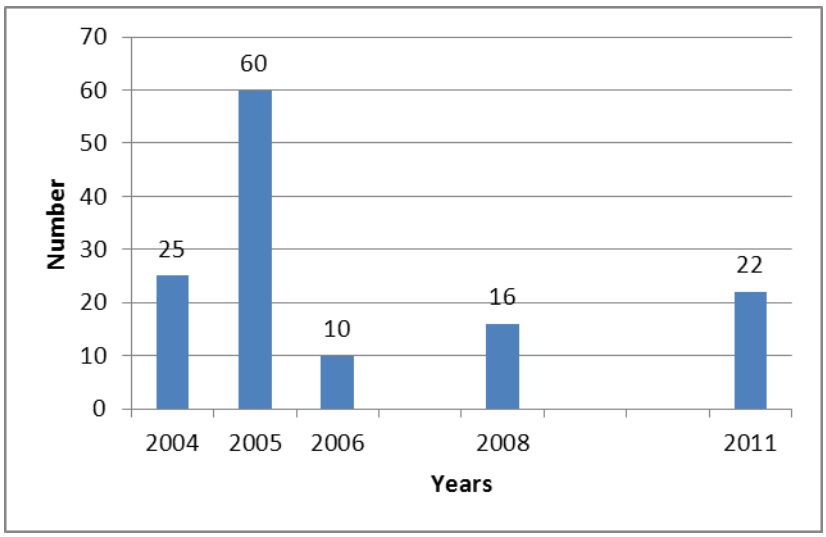
Figure 13. Nimmo Ranch-Horse Creek – Central Colorado butterfly plant survey results



Nimmo Ranch-Horse Creek - East

The site consists of a 0.25 mile (0.4 km) section of a large meandering bend of Horse Creek (Figure 14). This area is characterized by native prairie and wetland vegetation. During wet years, the area has been exceedingly muddy and in other years, the area has been fairly dry. This site is the only site known, to date, where a Colorado butterfly plant population co-occurs with a population of federally threatened *Spiranthes diluvialis* (Ute ladies'-tresses orchid). Surveys at this site were not conducted in 2007, 2009, or 2010.

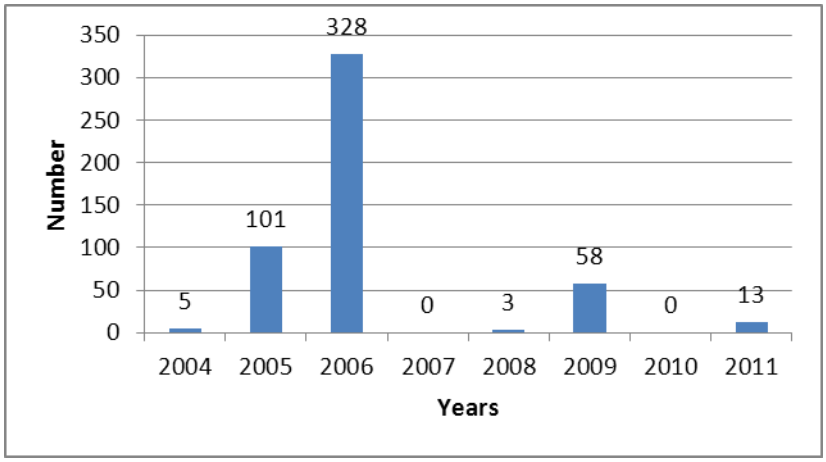
Figure 14. Nimmo Ranch-Horse Creek – East Colorado butterfly plant survey results



LW Bar Ranch—Repshire Property

The site consists of a 0.75 mile (1.2 km) section of Lodgepole Creek approximately 2 miles (3.2 km) north of the Town of Hillsdale, Wyoming (Figure 15). This rangeland area is normally grazed by cattle. During the 2006 survey, it was noted that there did not appear to be grazing at this site at that time.

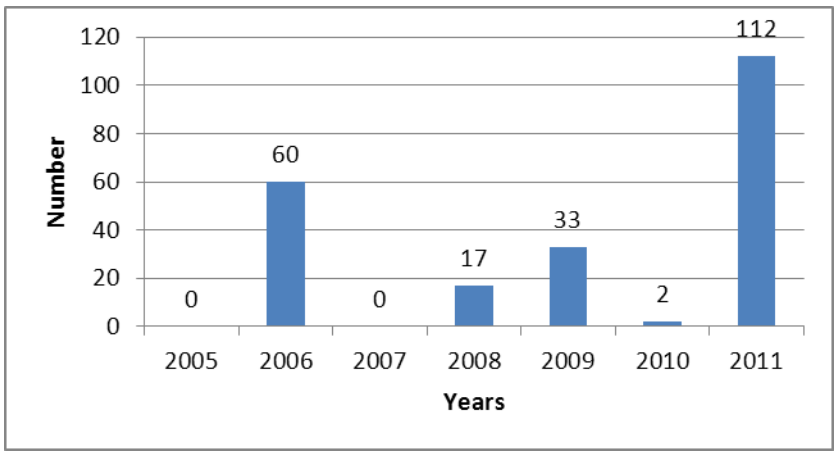
Figure 15. LW Bar – Repshire Colorado butterfly plant survey results



Risha Property East

This site consists of a 0.6-mile (1 km) section of Lodgepole Creek approximately 2.5 miles (4 km) north of the Town of Burns, Wyoming (Figure 16). This rangeland area is normally grazed by cattle. The increase in 2011 may have been partially due to a flood that occurred in 2009.

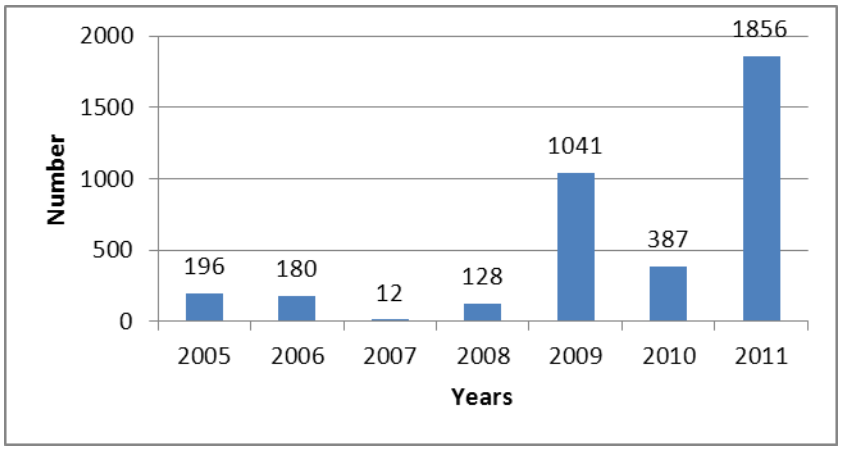
Figure 16. Risha East Colorado butterfly plant survey results



Risha Property West.

This site consists of a 0.5 mile (0.8 km) section of Lodgepole Creek approximately 2.75 miles (4.4 km) northwest of the Town of Burns, Wyoming (Figure 17). This rangeland area has been very lightly grazed by a few horses during survey years. This area is adjacent to and upstream from the Bressler property where a tornado and major flood impacted the area in 2009.

Figure 17. Risha West Colorado butterfly plant survey results



2.3.1.4. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)

Rangewide, little is known of the genetic variability within or between populations of Colorado butterfly plant. Currently there is no indication that genetic variability is an important or potential limiting factor to the conservation of this subspecies. Given the large number of populations and individuals, genetic factors may play a minimal role in its conservation.

Tuthill and Brown (2003) investigated genetic variation within and between Colorado butterfly plants at three sites on the F.E. Warren Air Force Base in Wyoming. Their study indicated that the genetic composition of the Crow Creek plants was different than the plants at the other two survey sites on the base. The investigators theorized that the genetic differences observed could have been the result of historic differences, changes in vegetation at the Crow Creek site, or an artifact of limited sampling.

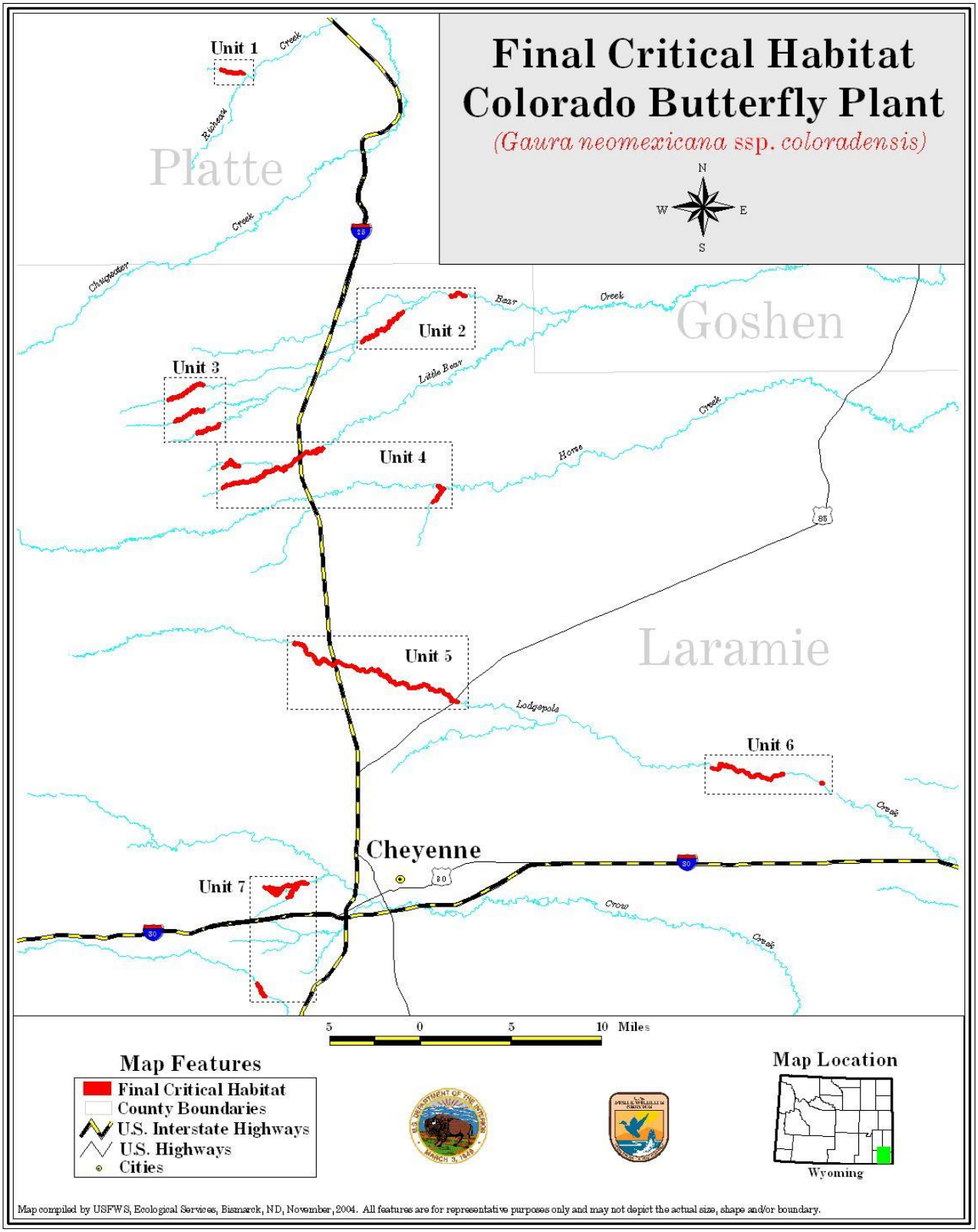
During the summer of 2011, Colorado butterfly plant tissue samples were collected from populations in Wyoming and Colorado as part of a study to describe the genetics of this plant. The results of this study are still pending.

2.3.1.5. Critical Habitat

On January 11, 2005, seven units in Wyoming were designated as critical habitat for the Colorado butterfly plant (70 FR 1940). The units are: (1) Tepee Ring Creek; (2) Bear Creek East; (3) Bear Creek West; (4) Little Bear Creek/Horse Creek; (5) Lodgepole Creek West; (6) Lodgepole Creek East; and (7) Borie (see Figure 18). At the time of the designation, the

only known naturally occurring population in Colorado was the Meadow Springs Ranch population. This site was excluded from the final critical habitat designation under section 4(b)(2) of the Act because the benefits of exclusion outweighed the benefits of inclusion. Specifically, this area was covered by Wildlife Extension Agreements that provided for the conservation of the Colorado butterfly plant. Other historical locations in Boulder, Douglas, and Larimer Counties in Colorado were not included in the designation because the areas did not contain the primary constituent elements. The primary constituent elements are detailed below. The critical habitat designation did not include any portions of Nebraska because no areas in the State were known to contain populations or suitable habitat at the time of the designation (70 FR 1940, January 11, 2005).

Figure 18. Final Critical Habitat the Colorado Butterfly Plant



The final designation of critical habitat for the Colorado butterfly plant included the following critical habitat primary constituent elements: (1) subirrigated, alluvial soils on level or low-gradient floodplains and drainage bottoms at elevations of 5,000 to 6,400 feet (1,524 to 1,951 meters); (2) a mesic moisture regime, intermediate in moisture between wet and dry, streamside communities dominated by sedges, rushes, cattails, and dry upland shortgrass prairie; (3) early- to mid-succession riparian (streambank or riverbank) plant communities that are open and without dense or overgrown vegetation (including hayed fields that are disced every 5 to 10 years to a depth of 8 to 12 inches (20 to 30 centimeters), grazed pasture, other agricultural lands that are not plowed or disced regularly, areas that have been restored after past aggregate extraction, areas supporting recreation trails, and urban/wildland interfaces); and (4) hydrologic and geologic conditions that maintain stream channels, floodplains, floodplain benches, and wet meadows that support patterns of plant communities associated with the Colorado butterfly plant (65 FR 62302, January 11, 2005).

2.3.2. Five-Factor Analysis - threats, conservation measures, and regulatory mechanisms

2.3.2.1. A. Present or threatened destruction, modification or curtailment of its habitat or range

The Colorado butterfly plant is faced with many threats to its habitat or range. These include: herbicide spraying, potential overgrazing by cattle or horses, haying and mowing, water development, land conversion for cultivation, competition from exotic plants, habitat degradation resulting from plant succession, recreational use of its habitat, and loss of habitat to urban growth have been described as threats to the Colorado butterfly plant (Marriott, Fertig 1994). Based on the outcomes of predictive models, climate change may become a significant threat in the future (Dawson *et al.* 2011, Smith *et al.* 2009, U.S. CCSP 2008).

Herbicide Spraying

The indiscriminate spraying of herbicides is a threat to this subspecies. The Colorado butterfly plant is highly susceptible to commonly used herbicides when they are applied non-selectively. For instance, in 1983, nearly one-half of the mapped *G. n.* subsp. *coloradensis* populations on F.E. Warren Air Force Base were inadvertently destroyed when sprayed with Tordon, a persistent herbicide, during efforts to control *Cirsium arvense* (Canada thistle), *Euphorbia esula* (leafy spurge), and other exotic plants. Herbicide use along road crossings, in and adjacent to Colorado butterfly plant populations, has been noted (65 FR 62302).

Some herbicides may continue to function months after their application, thus potentially contaminating the plant's habitat, causing direct mortality, or reducing the viability of individuals and populations. However, evidence of this threat has not been recently observed in the field. Many populations are currently under WEAs or other management plans and landowners have agreed not to spray herbicides within 100 feet (31 meters) of the plant.

The Service is fully aware of, and supports, the need to control noxious weeds on private and public property. The Service recommends to all landowners with WEAs a manner in which herbicide may be applied in order to control species such as Canada thistle (*Cirsium arvense*) and leafy spurge (*Euphorbia esula*), at the same time as protecting populations of the Colorado butterfly plant. *S*uch voluntary agreements involve the individual landowner working with the Service to address the landowner's needs while providing protection to the plant. The Service has recognized for years that uncontrolled invasive weed species will lead to the elimination of habitat for the Colorado butterfly plant. We rank this threat as currently low.

Grazing and Livestock Management

Potential for Overgrazing. Livestock grazing can be a threat at some sites if grazing pressures are high or concentrated during the summer flowering period. Additionally, plants are occasionally uprooted or trampled by livestock and wildlife grazing in the vicinity. In addition to the intensity of grazing, the timing of grazing may be key to Colorado butterfly plant population vigor. Observations have shown that the plant can persist and thrive in habitats that are grazed during the non-growing season or grazed on a short-cycle rotation (65 FR 62302). Other effects of overgrazing may include soil compaction, change in soil chemistry from manure inputs, a change in soil moisture, or a change in plant composition of the habitat (i.e., an increase in weedy species in the habitat). We are unaware of cases where overgrazing has led to the extirpation of any populations or subpopulations.

Many of these ancillary effects have not yet been documented at the sites occupied by the Colorado butterfly plant. The populations that experience high grazing pressure have the capacity to rebound (as in the case of the Bressler data (Figure 5)). This threat is currently low.

Beneficial effects of grazing. Because the Colorado butterfly plant depends upon early to mid-successional riparian habitat, moderate to low levels of grazing may generally have beneficial effects to populations. Lack of grazing can lead to late successional habitat development in areas occupied by the Colorado butterfly plant. Dense willow cover can

dominate areas where grazing is lacking (Fertig 1994). The Colorado butterfly plant is not able to effectively compete for sunlight (and potentially moisture as well) with taller overstory plant species (Fertig 1994). In these areas, often no Colorado butterfly plants are observed. Grazing can provide benefits by reducing the competing vegetative cover and allowing Colorado butterfly plant seedlings to become established. Livestock (through ingestion of the seeds) could potentially serve as a seed dispersal mechanism for this plant. Therefore, the lack of adequate grazing pressure could result in reduced dispersal pathways for seeds. Livestock grazing is a primary and beneficial use of the habitat of most of the known Colorado butterfly plant populations, making this a low threat.

Haying or Mowing Activities

Because the Colorado butterfly plant depends upon open to semi-open habitat, haying or mowing activities may have beneficial effects on populations. Competition for sunlight (and possibly moisture) with overstory plants may lead to the reduction or extirpation of populations if haying or mowing activities are halted in areas where these activities are currently employed. Many areas of Colorado butterfly plant habitat with haying or mowing activities occurring in mid to late summer support large, stable populations. We have observed that some areas without haying or mowing activities support dense stands of willows and no Colorado butterfly plants. Therefore, we feel that there is a management tradeoff between adverse effects to individual plants from haying activities and benefits to the population as a whole. We feel that this threat is currently low because those areas that we monitor that are hayed and mowed support large populations in the appropriate habitat type.

Water Development

Construction of stock ponds and reservoirs has inundated some Colorado butterfly plant habitat in the past and made it unsuitable. The development of irrigation canals to move water to croplands may remove moisture from occupied or potentially suitable habitat leaving it in a drier, unsuitable condition within stream drainages. The management of water resources for domestic and commercial uses, coupled with encroaching agricultural land use, has had a tendency to channelize and isolate water resources and fragment, realign, and reduce riparian and moist lowland habitat that could otherwise serve as potential Colorado butterfly plant habitat in some areas (65 FR 62302). The Colorado butterfly plant may benefit from flood events and any development that reduces the effects of flooding could reduce the viability of the populations. Furthermore, if floods disperse seeds of this plant, then dams that form water impoundments may act as barriers to seed dispersal thus preventing downstream plant colonization.

Natural flooding within Colorado butterfly plant habitat may have been altered by the construction of flood control structures, water impoundments, and by irrigation and channelization practices. Planned future water development projects have not been documented as currently threatening populations currently monitored. Because the threat of water development is localized with a small overall exposure, we currently give this threat a low overall threat ranking.

Land conversion to cropland

Land conversion to cropland is listed as one of the main threats to this subspecies (65 FR 62302). Land conversion may have eliminated habitat, rendered habitat unsuitable, or reduced habitat suitability for this subspecies in some of southeastern Wyoming or northeastern Colorado. However, we have no documentation of specific instances where this has occurred. Currently, the known populations of this plant do not appear to be threatened by this type of development. For this reason, we give this threat a low overall ranking.

Natural Disturbance and Ecological succession of habitat

In some areas, a threat to Colorado butterfly plant populations is the progression of habitat unsuitability resulting from ecological succession of the plant community. Without periodic disturbance events, the open to semi-open habitats preferred by the Colorado butterfly plant can become choked by tall and dense growth of willows, grasses, and exotic weeds (Fertig 1994). Natural disturbances, such as flooding, fire, and native ungulate grazing, were apparently sufficient in the past to create favorable habitat conditions for the plant. In the absence of natural disturbances today, managed disturbance may be necessary to maintain and create areas of suitable habitat (Fertig 1994, 1996).

Ecological succession at monitored agricultural sites indicates a low level of threat. Some non-agricultural sites that lack regular disturbances, such as grazing or haying, may have moderate levels of impact from this threat. This threat has the potential to reduce the capacity and vigor of the majority of the sites that we monitor. However, the majority of the sites that we monitor are regularly disturbed by either grazing or haying. Therefore, this threat does not appear to be adversely affecting the populations in most cases and we currently rank this threat as low.

Loss of habitat from urban growth

Residential and urban development around the cities of Cheyenne and Fort Collins has modified areas of formerly suitable Colorado butterfly plant habitat so that the subspecies no longer occurs in those localities. We are

unaware of this type of development currently threatening known populations. Therefore, we assign an overall threat level ranking of low to this threat.

Recreational use of habitat

High recreational use by campers, motorists, and fishermen was identified as a threat to a population of Colorado butterfly plant on State park lands in Nebraska (65 FR 62302). Recent survey efforts at this location did not document any Colorado butterfly plant individuals (Wooten 2008). The population may currently be extirpated. This is an historic threat with no known current exposure level across the subspecies' range. Therefore, we give this threat an overall ranking of low.

Climate change

Scientific evidence currently indicates that the increase in greenhouse gases in the Earth's atmosphere caused by the burning of fossil fuels such as coal, oil, and natural gas are having a worldwide effect on the Earth's climate. Worldwide temperatures have risen over the past century and that trend is expected to continue. With worldwide warming, the polar ice caps and montane glaciers are melting at accelerated rates and below normal precipitation is occurring in many areas (Barry and Seimon 2000, Hall and Fagre 2003, Thomas *et al*. 2009).

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Future climate change will be the product of natural variability acting over multiple spatial and temporal scales superimposed on human-caused

trends (Gray *et al.* 2003, 2004; Jackson *et al.* 2009). Predicting ecological and biogeographic responses to climate change constitutes an immense challenge for ecologists (Jackson *et al.* 2009, Romme and Turner 1991). The effect that climate change could have on the Colorado butterfly plant is unknown at this time. The Colorado butterfly plant currently inhabits a small geographic area with specific annual temperature and soil-moisture requirements. A drastic increase in the temperature of the habitat could lead to thermal or hydrologic changes to stream systems that support Colorado butterfly plants. The new habitat characteristics due to climate change could become outside of the tolerance limits of the Colorado butterfly plant. Lower precipitation levels potentially caused by climate change could lead to reduced flows of Horse Creek, Lone Tree Creek, Bear Creek, and Lodgepole Creek and a reduction of available habitat for the Colorado butterfly plant.

Climate change is a potentially imminent and future threat. There is a large degree of uncertainty regarding what the localized effects of climate change will be and how localized effects may potentially impact the Colorado butterfly plant and its habitat. Given that there are no known current impacts from this potential threat, and the extent of future threats is unknown, we rank the overall threat level for this threat as low.

Oil and gas development

Oil and gas development was not specifically identified as a threat at the time of listing (65 FR 62302) (70 FR 1940). However, recent exploration activities in southeastern Wyoming and northeastern Colorado (Nickerson 2012, Ningen 2010, Oil-shale-gas 2012) could lead to drilling activities that may affect some populations of the Colorado butterfly plant. Adverse effects to individuals or populations could include contamination of habitat, change in hydrology within the habitat, introduction of exotic species, and direct loss of habitat. Effects from oil and gas development to Colorado butterfly plant populations have not been observed in the past, but are possible in the future. Given that there are no known current impacts from this potential threat and that the extent of future threats from oil and gas development are unknown at this time, we give this threat a current overall rating of low.

2.3.2.2. B. Overutilization for commercial, recreational, scientific, or educational purposes

Deleterious effects of research efforts

Identified potential deleterious effects that may arise from research efforts include: (1) the potential loss of individual Colorado butterfly plants from experimental spraying of noxious weeds with herbicide; (2) the minimal loss of small quantities of plant material or seeds for genetic analysis; and

(3) the loss of individuals from experimental transplantation of individuals to new or historic habitat. The occurrence of these threats is rare or localized in nature with insignificant exposure occurring to the populations making this a low-level threat.

Collection for horticultural purposes

Another potential threat is the collection of this taxon from the wild for horticultural purposes. Another species of *Gaura* (*Gaura lindheimeri*) is used for ornamental purposes and the potential may exist for the Colorado butterfly plant to become popular in this respect. Many cultivars (e.g., Crimson Butterflies, Passionate Rainbow, Pink Fountain, Sunny Butterflies, and White Fountain) have been developed from *G. linheimeri* (Blessington *et al.* 2012) and enough variation appears to exist in the Colorado butterfly plant that similar efforts could be undertaken by horticulturalists for this taxon as well. The effect that this threat would have on individuals would be the direct removal of plants or seeds from the population or the manipulation of the taxon's genetics over time. We are unaware of this occurring and we consider this a low-level threat.

2.3.2.3. C. Disease or predation

Disease

There are no known diseases affecting Colorado butterfly plant populations. Therefore, we rank this threat as low.

Predation

The Colorado butterfly plant is highly palatable to a variety of mammalian and insect herbivores (*e.g.,* cattle, horses, pronghorn (*Antilocapra americana*), flea beetles). In some cases, it appears to compensate for herbivory by increasing branch and fruit production (65 FR 62302). In 2007, heavy insect herbivory by flea beetles (*Altica* spp.) was documented on the F.E. Warren Air Force Base—an event in which every plant had the majority of its leaf area eaten and seed production was impaired (Heidel *et al.* 2011). The most frequent flea beetle species collected was *A. foliaceae*, a native species. The Colorado butterfly plant population returned to pre-infestation numbers in 2009-2010, evidence that it can survive via vegetative plants and the seed bank. Impacts to individual plants from herbivory may include reduced viability and quantity of plants and seeds. Colorado butterfly plant populations appear to have the capacity to withstand current insect and mammalian herbivory impacts. Therefore, we rank this threat as currently low.

2.3.2.4. D. Inadequacy of existing regulatory mechanisms

Federal Endangered Species Act

The Act includes a number of regulatory provisions that could provide some protections to the Colorado butterfly plant as long as it is listed. The Act is the primary law that has protected the Colorado butterfly plant since its listing in 2000.

Section 4
Section 4 of the Act allows for the protection of threatened species through regulation. This protection may apply to the Colorado butterfly plant in the future if such regulations were to be issued. Seeds from cultivated specimens of threatened plants are exempt from these prohibitions provided that their containers are marked ''Of Cultivated Origin.'' Certain exceptions to the prohibitions apply to agents of the Service and state conservation agencies.

Section 6
Funding may be available through section 6 of the Act for the States to conduct recovery activities. We are unaware of any section 6 monies that have been sought by the states for the protection of the Colorado butterfly plant.

Section 7
Section 7 of the Act states that Federal agencies, in consultation with the Service, shall carry out programs for the conservation of endangered species. Section 7 requires that Federal agencies consult with the Service if they determine that any of their authorized actions may affect a listed species (BLM 2005, USFWS 2001a, 2001b). Federal agency actions that may require section 7 consultation could include such activities as altering vegetation, particularly through the use of herbicides; implementing livestock grazing management that alters vegetation during the flowering season of the Colorado butterfly plant; construction of roads, hiking, or biking trails along or through riparian areas; channelization and other alteration of perennial streams and their hydrological regimes for flood control and other water management purposes; permanent and temporary damming of streams to create water storage reservoirs or to alter the stream's course; construction of residential, commercial, and industrial developments, including roads, bridges, public utilities and telephone lines, pipelines, and other structures in Colorado butterfly plant habitat; and sand and gravel and other types of mining activities within or upstream of Colorado butterfly plant habitat.

Section 7 consultation may be required by the Air Force if they determine that any of their actions may affect the plant (USFWS 2001b). Similarly, if pipeline or transmission line rights-of-way authorization were pursued

through a site occupied by any population (on or off Federal lands), this could trigger section 7 consultation between the approving Federal agency and the Service (USFWS 2001a). Some populations occupying private or other lands could be underlain by Federally-owned minerals. If so, the U.S. Bureau of Land Management (BLM) could have discretionary authority over the leasing of federal mineral rights under those parcels. The Bureau could also be responsible for the approval of grazing allotment management plans made up of a mix of private, state, or Federal lands that may cover areas occupied by the Colorado butterfly plant. If so, the discretionary action by the Bureau of approving a grazing allotment management plan could trigger a section 7 consultation with the Service.

Section 9

The Act and the Service's implementing regulations set forth a series of general prohibitions and exceptions that apply to all threatened plants. All prohibitions of section 9(a)(2) of the Act, implemented by 50 CFR 17.71, apply. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to import or export, transport in interstate or foreign commerce in the course of a commercial activity, sell or offer for sale in interstate or foreign commerce, or remove the species to possession from areas under Federal jurisdiction.

Collection of listed plants or activities that would damage or destroy listed plants on Federal lands is prohibited without a Federal permit. Such activities on non-Federal lands would constitute a violation of section 9 of the ESA if they were conducted in knowing violation of State law or regulation, or in the course of violation of State criminal trespass law. Otherwise, such activities would not constitute a violation of the Act on non-Federal lands.

Section 10

The ESA provides for the issuance of permits to carry out otherwise prohibited activities involving threatened plants under certain circumstances. Permits are available for scientific purposes and to enhance the propagation or survival of the Colorado butterfly plant. For threatened plants, permits are available for botanical or horticultural exhibition, educational purposes, or special purposes consistent with the purposes of the ESA.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) (42 U.S.C. 4371 et seq.) provides some protections for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires an agency to analyze projects for potential impacts to the human

environment, including natural resources. In cases where the analysis reveals significant environmental effects, the Federal agency must discuss mitigation that could offset those effects (40 CFR 1502.16). These mitigations usually provide some protections for listed species. However, NEPA does not require that adverse impacts be mitigated, only that impacts be assessed and the analysis disclosed to the public. In the absence of the ESA's protections, it is unclear what level of consideration and protection Federal agencies would provide through the NEPA process.

Bureau of Land Management (BLM) Sensitive Species

Since it is currently listed as federally threatened, the BLM currently has in place conservation measures to protect the Colorado butterfly plant (BLM 2005). All discretionary activities authorized by the BLM that may affect this plant must undergo section 7 consultation with the Service. Furthermore, the BLM's 6840 Manual states that all federally designated candidate species, proposed species, and delisted species in the 5 years following their delisting shall be conserved as BLM sensitive species (BLM 2008). However, no populations of Colorado butterfly plant are currently found on BLM managed lands. Therefore, BLM's analysis of effects of its proposed actions to the Colorado butterfly plant are limited to those projects that cross properties owned by other entities, but still maintain a Federal nexus with BLM. The BLM developed a programmatic statewide biological assessment for this subspecies (BLM 2005). In the absence of the Act's protections, the BLM would protect the Colorado butterfly plant for a period of at least 5 years following delisting.

Other Regulatory Mechanisms

In addition to the protections of the Act, other management protections that currently apply to certain populations of this plant include the management plan of the F.E. Warren Air Force Base. Additionally, other entities have agreed to maintain populations of, and allow for surveys for this plant on the lands that they manage. These additional entities include the: (1) City of Fort Collins-Soapstone Prairie Natural Area, (2) City of Fort Collins-Meadow Springs Ranch, (3) Chambers Preserve-Walnut Creek (4) City of Cheyenne-Belvoir Ranch, and (5) numerous private landowners in Wyoming that have formalized voluntary agreements (Wildlife Extension Agreements or WEAs) with the Service coordinating management efforts. The plant is listed as Sensitive by the U.S. Forest Service, although no populations are currently known from Forest Service lands (65 FR 62302).

Habitat along Crow and Diamond Creeks on F.E. Warren Air Force Base has been designated as the Colorado Butterfly Plant Research Natural Area dedicated to the protection of the Colorado butterfly plant, and the

Air Force has developed a management plan for this area (Marriott and Jones 1988). Under various memoranda of understanding and cooperative agreements with the Service and The Nature Conservancy, the Air Force has been conducting conservation activities for the Colorado butterfly plant since 1982 (65 FR 62302)(USFWS 1982, 1999, 2004, 2010b). However, the current Memorandum of Agreement between the Service and the Air Force could be terminated at any time (with 60 days notice). As part of its Integrated Natural Resource Management Plan (INRMP) the Base is currently implementing a weed-control program with special restrictions on the spraying of pesticides in Colorado butterfly plant habitat (Warren Air Force Base 2004). Continued implementation of conservation actions on the Base will enhance the overall conservation of this plant.

State Implemented Regulatory Mechanisms

Colorado and Wyoming have no state-level endangered plant laws that protect the Colorado butterfly plant. In Nebraska, protections for plants are a part of the overall state endangered species act. However, given the very low plant numbers in Nebraska, the protection that the Nebraska endangered species program has for the protection of the subspecies as a whole, is negligible, at this time.

Local Conservation Planning

No county or local laws or regulations protect the Colorado butterfly plant. In 1983, a population of Colorado butterfly plant was introduced to an area in Westminster that is owned by the Westminster Open Space. Although, there is currently no active management of the area, the introduction did result in an established population of plants.

Conclusion for Factor D. – Inadequacy of existing regulatory mechanisms

Over 90 percent of the occurrences of this plant are found on private land and in those cases, the requirement to perform section 7 consultations per the ESA does not apply. Additionally, the ESA does not prohibit incidental take of plants. All of the threats identified in this 5-year review are at a low overall threat level. The current threats to this subspecies do not appear to be extensive or significant to current population persistence in the majority of the Colorado butterfly plant populations. For these reasons, we feel regulatory mechanisms in place, other than the ESA are adequate.

2.3.2.5. E. Other natural or manmade factors affecting its continued existence

Herbicide Spraying

The most serious threat on agricultural lands is non-selective use of broadleaf herbicides for the control of *Cirsium arvense* (Canada thistle), *Euphorbia esula* (leafy spurge), and other exotic plants (Marriott 1987). The noxious weed problem in Laramie County, Wyoming, is particularly evident on F.E. Warren Air Force Base. Although competition from these invasive species may have serious negative implications for populations of Colorado butterfly plant, the plant appears to be highly susceptible to commonly used herbicides when they are applied non-selectively. In 1983, nearly half of the mapped populations on F.E. Warren Air Force Base were inadvertently destroyed when sprayed with Tordon, a persistent herbicide. Additionally, herbicide use along road crossings in and adjacent to Colorado butterfly plant populations has been noted (65 FR 62302). Spraying with herbicides can lead to direct mortality or reduced viability of the Colorado butterfly plant. Currently, there are management agreements in place that prevent this type of activity occurring on many monitored populations. We feel that this is a rarely occurring threat with insignificant exposure level to the taxon rangewide, making it a low-level threat at this time.

Recreational use of habitat

Recreational use by campers, motorists, and fishermen has been documented as a threat to populations in Nebraska (65 FR 62302). Recreational use could potentially lead to a reduction or elimination of suitable habitat, or a reduction or elimination of the Colorado butterfly plant's themselves. Recreational use in monitored populations of Colorado butterfly plant is a rarely occurring threat with small exposure level to the taxon rangewide. Therefore, we give this threat an overall threat ranking of low.

Vulnerability due to small population size

Over the years, we've observed populations fluctuating over several orders of magnitude. Subpopulations may appear very small some years and then rebound. The cause for this rebound is often undetermined, but may be related to annual, seasonal fluctuations in rainfall or temperature. It was believed that small population sizes may have been a threat in the past. However, our data suggest that small populations are capable of rebounding (See Figures 3 through 17). Therefore, we give this threat an overall threat ranking of low.

Insecticide spraying

The spraying of insecticide for agricultural, municipal, or residential purposes has the potential to affect the pollinators of the Colorado butterfly plant. However, we do not have records indicating that spraying of insecticides is currently affecting any populations of Colorado butterfly plant. Therefore, we currently give this threat an overall threat level of low.

2.4. Synthesis

At the time of listing, we concluded the Colorado butterfly plant was threatened due to a number of threats to its survival, including small population size, herbicide use, ecological succession in the absence of disturbance, grazing, mowing, agricultural conversion of its habitat, water diversions, channelization, competition from exotic plants, urban expansion, and lack of protection (65 FR 62302). Many of these threats continue to affect the Colorado butterfly plant although to different degrees at different sites. Populations appear to naturally fluctuate in response to precipitation levels and height of surrounding vegetation (effects either from competition with exotic species; grazing, haying, or mowing; or ecological succession at the various sites).

The Colorado butterfly plant occurs on one federally owned property—the Warren Air Force Base. Because of the plant's status under the Act, the U.S. Air Force has developed a plan to ensure that this subspecies continues to exist on the base. The Act's protections have led to the protection of the plant from herbicide use on the base as well as other potential disturbances. Warren AFB has committed to funding annual surveys for more than 20 years—the longest running survey effort for the plant, to date. Section 7 consultations under the ESA have occurred for Federal actions that may affect the Colorado butterfly plant. Since the extent of the plant's occurrences on Federal land is limited to only three locations on the Warren AFB, the section 7 consultation aspect of the subspecies' protection has been limited. Section 7 consultations have occurred for pipelines that have crossed potential habitat on private lands, if those pipelines had a Federal nexus, as well for highway and transit projects with Federal funding.

Critical habitat was designated in 2005 (70 FR 1940). The critical habitat designation provides an additional layer of protection for projects that have a Federal nexus. Wildlife Extension Agreements (WEAs) were put in place in 2004. Eleven WEAs were ultimately secured between landowners and the Service, providing protection to 2,564 ac (1,038 ha) along 37 mi (59 km) of riparian habitat. The WEAs provide an opportunity for the landowners and the Service to coordinate efforts of agricultural operations and population data collection to facilitate the conservation needs of the plant.

The Colorado butterfly plant is influenced by many different factors and it is difficult to differentiate the influences from human-caused threats versus those influences resulting from natural effects such as local annual precipitation levels. Since the subspecies was listed, we feel it has received greater protection and monitoring than it did pre-listing.

Many populations of the plant were documented to have become extirpated prior to listing, but only one location (the population on the subspecies' easternmost distribution boundary) is known to have become extirpated since the plant was listed. The plant's listing has led to our increased understanding of its biology, the status of its populations, the factors that influence its populations, and our development and support of recommended land management practices that strive to best conserve and manage populations.

We now have annual survey data for the plant. We also have WEA agreements with many land managers that manage populations in Wyoming and Colorado. Our understanding of distribution, abundance, and trends is now more thorough. Natural population fluctuations are evident that are apparently caused by natural events such as flooding or annual precipitation levels. In the future, urban and private land development within the subspecies' habitat may continue to increase with the demands placed on such resources that an increased human population will have. For instance, a reduction of stream flow in the habitats occupied by this subspecies, either due to irrigation for agricultural purposes or for municipal use, could put the subspecies at greater risk. Climate change was not considered a threat when the Colorado butterfly plant was listed. Climate trends generally indicate higher temperature and less precipitation in the western United States. Because Colorado butterfly plant populations are restricted to a narrow range of streamside vegetated habitat areas in the western United States, we consider climate change and associated potential changes to its habitat a potential impending threat.

Our understanding of threats has become clearer over time. With increasing quantities of data, it is becoming apparent that mowing and haying of the plant's habitat during the prime flowering period for the plant is compatible with the management and preservation of moderate to large populations of the plant. Some very large populations are found on areas that are hayed and grazed annually. So the threat of mowing and grazing may not be as limiting to plant populations as was previously thought.

All of the threats identified in this analysis are at a low overall threat level to Colorado butterfly plant populations. The threats identified do not appear to be extensive or significant to current population persistence in the majority of populations that we monitor. Although the ESA does not prohibit incidental take of plants on private lands, we believe that the regulatory mechanisms in place, are adequate.

We do, however, feel the subspecies faces localized threats due to herbicide use, ecological succession in the absence of disturbance, agricultural conversion of its habitat, water diversions, channelization, competition from exotic plants, urban expansion, and climate change. In our previous recovery outline (USFWS 2010b), we characterized these threats at a *moderate* threat level. After a thorough analysis of population trends and potential threats during this 5-year review, we believe the current threats facing the subspecies, at least for the populations that we monitor, are better characterized as *low*. The biggest factors likely driving the status of the subspecies at most sites are natural fluctuations in precipitation levels as well as ecological succession in the absence of

disturbance. Other factors, such as grazing and mowing appear to be less detrimental, and in many cases, beneficial to the population as a whole.

The populations that we monitor in Wyoming appear to occasionally undergo substantial fluctuations in size, but appear to be robust. Given the current management of the habitat at each of these sites, we anticipate long term persistence of those populations. The naturally occurring populations in northern Colorado that we monitor also appear to be stable or increasing. The populations occurring in central Colorado that were derived from introduced plants may not be at sites that are suitable for long-term persistence given the localized threats. Furthermore, the long-term persistence of populations found in western Nebraska may be precarious given that this area has local threats that are significant. However, the extent of the threats acting on the populations on private lands in Wyoming without WEA agreements is unknown at this time.

Many of the threats characterized as acting on the subspecies at the time of its listing such as herbicide use, ecological succession in the absence of disturbance, agricultural conversion of its habitat, water diversions, channelization, competition from exotic plants, urban expansion, and lack of protection may continue to have significant influences on the plant's survival on private lands in Wyoming for which we have no monitoring program or formalized cooperative management agreements. There are many privately-owned areas throughout this plant's distribution in Wyoming that we have no population data or current information. Populations for which we currently have no data could have higher levels of threat than we can account for in this 5-year review. Currently monitored populations should continue to be monitored in the immediate future. Climate change predictive models show changes for North America's climate in future years further adding to the uncertainty of the conditions of the plant's habitat in the coming years.

We intend to conduct a more thorough formal evaluation of the need to keep this subspecies listed as "threatened" under the Act. This evaluation will include an objective, science-based analysis that will thoroughly evaluate the current and potential threats to the Colorado butterfly plant throughout its range. If this evaluation indicates that the threats presently acting on this subspecies do not warrant a "threatened" classification under the Act, then the Service will take steps to delist the subspecies at that time.

3. RESULTS

3.1. Recommended Classification:

☐ Downlist to Threatened
☐ Uplist to Endangered
☐ Delist

☒ No change is needed

3.2. New Recovery Priority Number

Given that all of the threats identified for the subspecies in this 5-year review are at a low overall threat level, we recommend that the subspecies be recategorized from the 9C category (indicating that there are moderate threats affecting the subspecies) to the 15C category, indicating that this subspecies has a low degree of threat and high recovery potential.

4. RECOMMENDATIONS FOR FUTURE ACTIONS

This section is intended to create a road map to what needs to happen in the next 5 years to move recovery forward. It is hoped that this list will help those involved with recovery of this subspecies recognize and prioritize actions necessary for recovery and delisting of the Colorado butterfly plant. The future actions necessary were separated into the following five categories: administrative actions, surveys and monitoring, threats abatement, research, and planning.

Administrative Actions

- Continue with, and renew, the Memorandum of Understanding and the Agreement with the U.S. Air Force for formal cooperative management efforts.

- Seek opportunities to establish voluntary agreements with additional landowners having populations on their lands.

- Seek section 6 funding & other funding opportunities to address needs of the Colorado butterfly Plant.

- Conduct a more thorough formal evaluation of the need to keep this subspecies listed as "threatened" under the Act

Surveys and Monitoring

- Continue monitoring populations.

- Discuss the potential need for genetic monitoring and develop a genetic monitoring protocol if deemed necessary.

Threats Abatement

- Seek opportunities to engage private landowners in long-term land easement agreements.

- Discuss potential to reestablish populations in Colorado, Wyoming, and Nebraska in areas where the taxon has been extirpated.

- Cooperate with other agencies and parties to ensure that adequate cooperative strategies are in place to address monitoring for and control & eradication of potential exotic species introductions in nearby habitats that could increase the threat risk to the Colorado butterfly plant.

Research

- Acquire more information regarding the Colorado butterfly plant habitat requirements.

Planning

- To make further progress toward recovery and delisting, formation of a recovery team may be appropriate. A recovery plan with objective and measurable delisting criteria could be developed in order to move forward with achieving full recovery of the Colorado butterfly plant. Prior to beginning recovery planning efforts, the Service intends to conduct a more thorough formal evaluation of the need to keep this subspecies listed as "threatened" under the Act. This evaluation will include an objective, science-based analysis that will thoroughly evaluate the current and potential threats to the Colorado butterfly plant throughout its range. If this evaluation indicates that the threats presently acting on this subspecies do not warrant a "threatened" classification under the Act, then the Service will take steps to delist the subspecies at that time.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF THE COLORADO BUTTERFLY PLANT
(*Gaura neomexicana* subsp. *coloradensis*)

Current Classification: Threatened rangewide

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable: 15C

Review Conducted By:

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve_____ Date 12-17-12
Field Supervisor, Wyoming Ecological Services Field Office

Appendix A Key

Factors -	A = The present or threatened destruction, modification, or curtailment of its habitat or range
	B = Overutilization for commercial, recreational, scientific, or educational purposes
	C = Disease or predation
	D = The inadequacy of existing regulatory mechanisms
	E = Other
Scope -	Geographic extent of threat factor occurrence
Immediacy -	Time frame of stressor
Intensity -	Strength of stressor
Exposure -	Level of total known population exposed to threat source
Response -	Type of physiological/behavioral response

Overall Threat Level – Integration of the scope, immediacy, intensity, exposure, and response at the subspecies level

APPENDIX A

Colorado butterfly plant (CBP) (*Gaura neomexicana* subsp. *coloradensis*)
Threats, Stressors, and Their Associated Scope, Immediacy, Intensity, Exposure, Response, and Overall Threat Level Ratings

Threat		Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
1	Herbicide spraying	Contamination of habitat	A	Rare	Historic/Future	Moderate	Insignificant	Reduced vigor/ Mortality	Low
		Direct mortality of CBPs	E	Rare	Historic/Future	High	Insignificant	Mortality	Low
		Reduced viability of CBPs	E	Rare	Historic/Future	High	Insignificant	Reduced vigor	Low
2	Overgrazing by livestock	Soil compaction	A	Localized	Historic/Current/Future	Moderate	Small	Reduced vigor	Low
		Reduction in size of CBPs by partial or complete ingestion by livestock	C	Localized	Historic/Current/Future	Moderate	Small/Moderate/High	Reduction in reproductive capacity or vigor/ Mortality	Low
3	Lack of adequate grazing by livestock	Competition for sunlight, with overstory plant species (Succession)	A	Rare	Historic/Current/Future	Low	Small	Reduced vigor or reproductive capacity	Low
		Loss of potential seed dispersal mechanism (through ingestion of seeds by traveling livestock)	A	Not observed	Conjectural	Low	None	Unknown	Low

Threat		Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
4	Lack of Haying	Competition for sunlight with overstory plant species (Succession)	A	Rare	Historic/Current/Future	Low	Small	Reduced vigor or reproductive capacity	Low
5	Haying	Removal of seed-producing plants and seeds for hay production	A	Localized	Historic/Current/Future	Moderate	Small	Mortality/ Reduction in reproductive capacity	Low
6	Mowing at suboptimal times of year	Removal of leaves and stems of plants	E	Not observed	Conjectural	Low	None	Unknown	Low
7	Water development	Inundation of plants and seeds	A	Rare	Conjectural	High	Small	Mortality	Low
		Rendering habitat unsuitable for subspecies	A	Rare	Localized	High	Small	Mortality	Low
		Altering hydrology of habitat (e.g., reduction in flood events, desiccation or hydrologic saturation of stream reaches downstream of dams)	A	Rare	Localized	High	Small	Mortality/ Reduced Vigor	Low
		Impoundments acting as barriers to dispersal of seeds	A	Not observed	Conjectural	Moderate	None	Reduction in reproductive capacity	Low
		Introduction of non-native plant species during seeding of dam and spillway	A	Not observed	Conjectural	Low	None	Increased competition	Low
8	Land conversion to cropland	Habitat unsuitable or suitability reduced	A	Not observed	Conjectural	High	None	Mortality	Low
9	Disturbance and Ecological Succession	Reduction in CBP population viability	A	Localized	Historic/Current/Future	Moderate	Low	Reduction in reproductive capacity and vigor	Low
10	Loss of habitat from urban growth	Elimination of plants and suitable habitat	A	Localized	Historic/Future	High	Small	Mortality	Low
11	Recreational use of habitat	Reduction or elimination of suitable habitat	A	Rare	Historic/Future	Moderate	Small	Mortality	Low

Threat		Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
		Reduction or elimination of CBPs	E	Rare	Historic/Future	Moderate	Small	Mortality	Low
12	Climate change	Change in habitat suitability characteristics	A	Possibly rangewide	Current/Future	Low	Large	Unknown	Low
13	Vulnerability due to small population sizes	Extirpation of populations	E	Localized	Historic/Current/Future	Low	Moderate	No response observed	Low
14	Deleterious effects of research efforts	Potential loss of individual CBPs from experimental spraying of noxious weeds with herbicide	B	Rare	Historic	High	Insignificant	Mortality/ Reduced vigor	Low
		Minimal loss of small quantities of plant material or seeds for genetic analysis	B	Localized	Historic/Current/Future	Low	Insignificant	Reduced vigor and reproductive capacity	Low
		Loss of individuals from experimental transplantation of individuals to new or historic habitat	B	Not observed	Conjectural	Low	None	Mortality	Low
15	Oil and gas development	Contamination of habitat	A	Not observed	Conjectural	Moderate	None	Mortality/ Reduced vigor	Low
		Change in hydrology of habitat	A	Not observed	Conjectural	Low	None	Unknown	Low
		Elimination of habitat	A	Not observed	Conjectural	Low	None	Mortality/ Reduced vigor	Low
		Introduction of exotic invasive plant species (weeds)	E	Localized	Historic/Current/Future	Moderate	None	Mortality/ Reduced vigor	Low
		Increased greenhouse gases in the atmosphere from burning fossil fuels that may lead to more variable/extreme weather patterns	A	Possibly rangewide	Current/Future	Moderate	Insignificant	Unknown	Low

Threat		Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
		Increased CO_2 in the atmosphere from burning fossil fuels may lead to increase in vigor of competing weedy plant species (Note: may also increase the vigor CBPs)	A	Not observed	Conjectural	Low	None	Unknown	Low
16	Lack of (or inefficiency of) existing regulatory mechanisms independent of ESA	Suboptimal management of populations	D	Localized	Historic/Current/Future	Moderate	Moderate	Mortality/ Reduced vigor and reproductive capacity	Low
		Inadvertent mortality or reduction of viability of individuals	D	Rare	Historic/Current/Future	Moderate	Small	Mortality/ Reduced vigor and reproductive capacity	Low
		Suboptimal management of habitat	D	Localized	Historic/Current/Future	Moderate	Moderate	Mortality/ Reduced vigor and reproductive capacity	Low
17	Insecticide spraying	Reduction in pollination rates due to lower numbers of pollinators	E	Not observed	Conjectural	Low	None	Reduced reproductive capacity	Low
18	Collection for horticultural purposes	Direct removal of plants or seeds from population	B	Not observed	Conjectural	Low	None	Mortality/ Reduced vigor and reproductive capacity	Low
19	Disease	Modification of plant parts in response to pathogens	C	Rare	Conjectural	Low	Insignificant	Unknown	Low
		Reduced viability/quantity of seeds in response to pathogens	C	Not observed	Conjectural	Low	None	Reduced vigor and reproductive capacity	Low

Threat		Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
20	Predation	Reduced viability/quantity of plants and/or seeds from insect herbivory	C	Localized	Historic/Current/Future	Low	Insignificant	Reduced vigor and reproductive capacity	Low
		Reduced viability/quantity of plants and/or seeds from mammalian herbivory	C	Localized	Historic/Current/Future	Moderate	Small	Mortality/ Reduced vigor and reproductive capacity	Low

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APPENDIX B.
Implemented Conservation Measures

1	Surveys conducted in potential habitat
2	Voluntary management/stewardship agreements with private landowners
3	Habitat management plan (INRMP) implemented on Air Force Base populations
4	Vigor and trend of many known existing populations monitored
5	Memorandum of Understanding/Agreement established for Air Force Base populations
6	Soapstone Prairie and Meadow Springs populations in Colorado under protective management by municipal government (City of Fort Collins)
7	Belvoir Ranch population in Wyoming under protective management by municipal government (City of Cheyenne)