

Species Biological Report

Dudley Bluffs Bladderpod (*Physaria (Lesquerella) congesta*)



and

Dudley Bluffs Twinpod (*Physaria obcordata*)



Photos courtesy of: Steve L. O’Kane Jr.

Prepared by:
U.S. Fish and Wildlife Service
Western Colorado Ecological Services Field Office
Grand Junction, Colorado

January 2020

Notice regarding use of proprietary data

All plant locations given are approximate. Exact plant locations are proprietary data of the Colorado Natural Heritage Program. Contact the Colorado Natural Heritage Program to obtain location information.

Literature citation of this document should read as follows:

U.S. Fish and Wildlife Service. 2020. Species Biological Report Dudley Bluffs Bladderpod (*Physaria (Lesquerella) congesta*) and Dudley Bluffs Twinpod (*Physaria obcordata*). U.S. Fish and Wildlife Service, Grand Junction, Colorado. 43 pp.

ACRONYMS AND ABBREVIATIONS

ACEC	Area of Environmental Concern
AML	Appropriate Management Level
Bladderpod	Dudley Bluffs bladderpod (<i>Physaria congesta</i>)
BLM	Bureau of Land Management
CAN	Colorado Natural Area
CNHP	Colorado Natural Heritage Program
DBG	Denver Botanic Gardens
ESA	Endangered Species Act
HMA	Herd Management Area
NSO	No Surface Occupancy
OHV	Off-Highway Vehicle
PEIS	Approved Land Use Plan Amendments/Record of Decision for Allocation of Oil Shale and Tar Sands Resources on Lands Administered by Bureau of Land Management in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement
PRLA	Preference Right Lease Area
RD&D	Research, Development, and Demonstration
RMP	Resource Management Plan
RMPA	Resource Management Plan Amendment for Oil and Gas Development
ROW	Right-of-way
Service	U.S. Fish and Wildlife Service
SSA	Species Status Assessment
Twinpod	Dudley Bluffs twinpod (<i>Physaria obcordata</i>)
WRFO	Bureau of Land Management White River Field Office

This Species Biological Report informs the Draft Recovery Plan for the Dudley Bluffs bladderpod (*Physaria congesta*) and the Dudley Bluffs twinpod (*Physaria obcordata*) (U.S. Fish and Wildlife Service (Service) 2020). The Species Biological Report is a comprehensive biological status review by the Service for the Dudley Bluffs bladderpod and Dudley Bluffs twinpod and provides an account of the species' overall viability. A Recovery Implementation Strategy, which provides the expanded narrative for the Dudley Bluffs bladderpod and Dudley Bluffs twinpod recovery activities and implementation schedule, is available at <https://ecos.fws.gov/ecp/species/7751> and <https://ecos.fws.gov/ecp/species/6701>. The Recovery Implementation Strategy and Species Biological Report will be updated on a routine basis.

EXECUTIVE SUMMARY

Dudley Bluffs bladderpod (bladderpod) (*Physaria congesta*) and Dudley Bluffs twinpod (twinpod) (*Physaria obcordata*) are herbaceous perennial plants in the mustard family (Brassicaceae). The two plants were discovered in 1982 during a floristic inventory of the Piceance Basin in northwestern Colorado, and federally listed as threatened on February 6, 1990 (55 FR 4152). Both species are edaphic (soil) endemic species, inhabiting white shale barrens and outcrops, deltaic and fluvial calcareous sandstones and siltstones, and derived fragile soils along drainages and tributaries. All known populations occur within a rectangular range spanning 27 miles east to west and 19 miles north to south in Rio Blanco County, Colorado. The species are threatened by mineral extraction and energy development; livestock and wild horse grazing; wildfire; nonnative invasive species; off-highway vehicle use; small population sizes and geographic ranges; and climate change.

To evaluate the biological status of these species both currently and into the future, we consider the species' viability as characterized by resiliency, redundancy, and representation. Bladderpod and twinpod need multiple resilient populations across their range to maintain persistence into the future and avoid extinction. The estimated number of bladderpod and twinpod plants is relatively high for such small ranges. However, these species' pattern of rarity, being locally abundant on small areas of specialized habitat, makes them particularly vulnerable to surface disturbances despite their high densities. While bladderpod is more abundant than twinpod, the twinpod is found in more occurrences across a larger range. Given the close proximity of occurrences and narrow ranges of the species, it is possible that a single catastrophic event, such as a wildfire, could affect multiple occurrences. Ecological representation is low for both species. Being restricted to a specific soil type, there is little ecological diversity across the ranges of the species. Genetic diversity is moderate for both species.

Table of Contents

ACRONYMS AND ABBREVIATIONS.....	3
EXECUTIVE SUMMARY	4
INTRODUCTION	6
OVERVIEW OF THE SPECIES.....	7
Status of the Species	7
Taxonomy and Species Description.....	7
Bladderpod.....	8
Twinpod	9
Habitat Characteristics	11
Bladderpod.....	12
Twinpod	13
Distribution and Population Trends.....	13
Bladderpod.....	14
Twinpod	16
Genetics.....	17
Summary of Current Resiliency, Redundancy, and Representation.....	17
REASONS FOR LISTING/THREATS ASSESSMENT	18
Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range	18
Mineral Extraction and Energy Development	18
Livestock and Wild Horse Grazing.....	22
Wildfire	24
Invasive Species.....	25
Off-Highway Vehicle Use	26
Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes	27
Factor C: Disease or Predation	27
Factor D: Inadequacy of Existing Regulatory Mechanisms	27
Local Laws and Regulations	28
State Laws and Regulations	28
Federal Laws and Regulations	29
Factor E: Other Natural or Manmade Factors Affecting Continued Existence of the Species.	30
Small Populations and Geographic Range.....	30
Climate Change.....	30

ONGOING CONSERVATION EFFORTS.....	31
Inventory and Monitoring	31
Habitat Protection	32
Research.....	34
Additional Conservation Actions.....	35

INTRODUCTION

The Species Biological Report is intended to be an in-depth review of the species’ biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The Species Biological Report is intended to be an interim approach as we transition to using a species status assessment (SSA) as the standard format that the Service utilizes to analyze species as we make decisions under the Endangered Species Act (ESA). The intent is for the Species Biological Report to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from candidate assessment to listing to consultations to recovery. Many species will have a Species Biological Report or SSA developed during the listing process. However, for species that are currently listed, such as the Dudley Bluffs bladderpod and Dudley Bluffs twinpod, a Species Biological Report or SSA may be first developed during the recovery process. As such, the Species Biological Report or SSA will be a living document. In this document, we consider what the two species need to maintain viability by characterizing the statuses of the species in terms of their resiliency, redundancy, and representation (USFWS 2016; Wolf et al. 2015).

- **Resiliency** is having sufficiently large populations for the species to withstand stochastic events (arising from random factors).
- **Redundancy** is having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations).
- **Representation** is having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity of populations across the species’ range.

OVERVIEW OF THE SPECIES

Status of the Species

The Dudley Bluffs bladderpod (bladderpod) (*Physaria congesta*) and Dudley Bluffs twinpod (twinpod) (*Physaria obcordata*) were federally listed as threatened species under the ESA on February 6, 1990 (55 FR 4152). Critical habitat was not designated for either species due to concerns for the plants' vulnerability to vandalism or collection if detailed maps were to be published. Both species have a recovery priority number of 8C, which indicates a moderate degree of threat, high recovery potential, species-level taxonomy, and conflict with development projects or other forms of economic activity (Table 1). While there is a continual threat to the habitats of the species, the species do not face immediate extinction, and because threats to the species are understood, threats could potentially be alleviated by the implementation of regulatory mechanisms.

Bladderpod is ranked S1 in the state of Colorado by the Colorado Natural Heritage Program (CNHP), meaning the species is critically imperiled due to rarity or biological factors that make it vulnerable to extirpation from the state. Twinpod is ranked S1S2, meaning the species is critically imperiled to imperiled in the state (CNHP 2014). Since the entire range for both species is located within the state of Colorado, extirpation from the state would mean extinction of the species.

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

Table 1. The above 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).

Taxonomy and Species Description

Bladderpod and twinpod are herbaceous perennial plants in the mustard family (Brassicaceae). The two plants were discovered in 1982 during a floristic inventory of the Piceance Basin in northwestern Colorado, conducted by the Colorado Natural Heritage Inventory (O'Kane 1987). An earlier collection of bladderpod, unrecognized as such, was made in 1959. The two species were subsequently described by Dr. Reed Rollins, an expert on plants in the mustard family, who visited the Piceance Basin and observed the species in 1983 (Rollins 1983; Rollins 1984). With the exception of Parachute beardtongue (*Penstemon debilis*), another federally threatened species, these two herbaceous perennials are the rarest of several shale-associated plant species in the Piceance Basin (55 FR 4152).

Bladderpod

Physaria congesta (bladderpod) was formerly known as *Lesquerella congesta*. However, the two genera are morphologically indistinguishable aside from a single aspect of fruit morphology. Therefore, *Lesquerella* was united with the genus *Physaria*, and many species with *Lesquerella* names were transferred to *Physaria* (Al-Shehbaz and O'Kane Jr 2002; O'Kane et al. 1999). At that time, the name of *Lesquerella congesta* was changed to *Physaria congesta*, with no change in the plant's recognition as a distinct species. Although the name *Physaria congesta* is not disputed, since this change occurred after the species was listed, this revision has not yet been incorporated into 50 CFR 17.12 and the species is still referred to as *Lesquerella congesta* on the "List of Endangered and Threatened Plants."

Bladderpod is an extremely small cushion (low-growing, mat-forming) plant 0.4-1.2 inches (in) [1-3 centimeters (cm)] in diameter with fruiting stems up to 0.6 in (1.5 cm) tall. The cushion growth characteristic is an adaptation to erosive badland soils and has evolved independently in several unrelated taxa in this area. Bladderpod has small, linear-oblongate, smooth-edged, silvery leaves 0.3-0.5 in [8-13 millimeters (mm)] long and 0.08-0.12 in (2-3 mm) wide; a dense mass of bright yellow flowers; and rounded, pubescent fruits 0.10-0.14 in (2.5-3.5 mm) wide (Figure 1). Bladderpod is easily distinguishable from other plant species growing in the area (55 FR 4152).

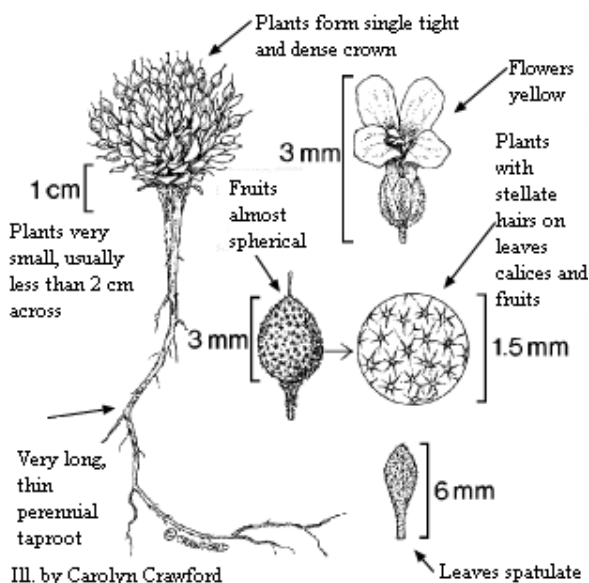


Figure 1. Dudley Bluffs bladderpod (*Physaria congesta*) identification (Spackman et al. 1997)

Bladderpod flowers from mid- to late April through early June. Fruit maturation continues through mid-June. Fruit dehiscence (opening at maturity) begins in mid-May and continues into mid-June. Vegetative growth initiation is highly variable, beginning as early as late February or early March when snow cover is absent and surface temperatures are warm enough to initiate

growth (Holsinger 2009a). Like most species of *Physaria*, bladderpod is an obligate outcrosser (self-incompatible), requiring pollen from other bladderpod plants and depending on pollinators for successful reproduction (Clark 2013). It is uncertain how long bladderpod individuals live, but over the course of seven years of monitoring by the BLM, a large proportion of the individuals persisted the entire seven years and it is likely that plants can live much longer (Krening 2019).

Twinpod

Twinpod grows 4.7-7.1 in (12-18 cm) tall with oblanceolate, smooth-edged leaves 1.6-3.1 in (4-8 cm) long and 0.4-0.6 in (1.0-1.5 cm) wide. Leaves have a silvery sheen due to a dense covering of overlapping, dish-shaped trichomes (small hairs or growths on the surface of the plant) (Figure 2). The plant has yellow flowers 0.3-0.4 in (7-9 mm) long, and slightly inflated heart-shaped fruits.

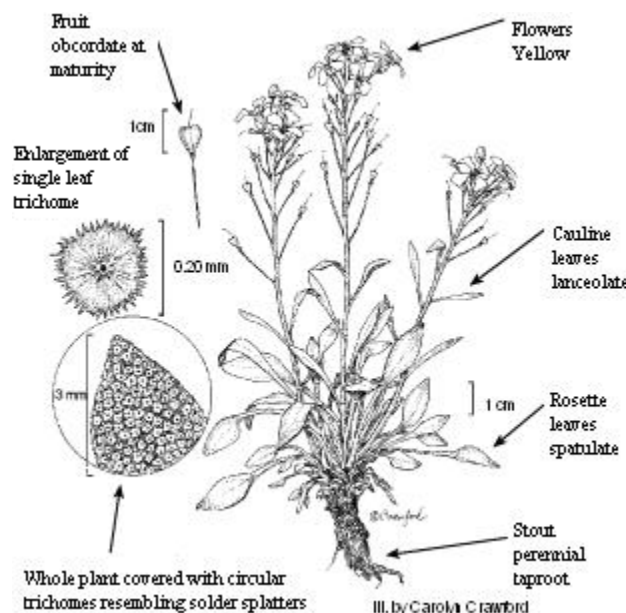


Figure 2. Dudley Bluffs twinpod (*Physaria obcordata*) identification (Spackman et al. 1997)

Twinpod is similar in appearance to a common species, double bladderpod (*Physaria acutifolia*), and a rare species, Piceance bladderpod (*Physaria parviflora*). Although the fruits and leaves of these two species have a slightly different shape than those of twinpod, the best way to distinguish twinpod from its look-alikes in the field is to view the trichomes through a magnifying lens. Double bladderpod and Piceance bladderpod have distinctly stellate (star-shaped) trichomes, whereas twinpod has dish-shaped trichomes covering its stems, leaves, and fruits (Spackman et al. 1997).

Twinpod flowers from late May through mid-June, with fruit maturation continuing through the end of July. Fruit dehiscence begins in mid-June and continues into August. Vegetative growth is estimated to begin in early May, perhaps sooner.

Twinpod plants occur in lower densities than bladderpod. Shifting substrates and soil loss from highly erosive soils, especially on steep slopes, are probably major sources of natural mortality (O'Kane 1987).

Like bladderpod, twinpod is an outcrossing species that requires pollinators aid in reproduction by transferring pollen from the flowers of one plant to another. Primary pollinators of twinpod are ground-nesting native bees in the families Andrenidae and Halictidae (Tepedino et al. 2012; Clark 2013).

The majority of twinpod pollinators are generalist foragers, meaning they will visit a variety of species and flower types. Two bee species observed visiting twinpod flowers are likely mustard family specialists: *Andrena hicksi* and *Andrena walleyi*. While other taxa such as flies, wasps, and ants have been present, most of these species likely provide limited pollination. Wasps and ants observed visiting twinpod did not carry pollen on their bodies. Some fly taxa were relatively common visitors, and a few individuals carried pollen, but the only non-bee pollinator considered to be of any importance was a fly of the genus *Gonia*.

Pollinator foraging distance increases with body size (Greenleaf et al. 2007), and the typical flight distances of bees observed visiting twinpod plants vary from 66 feet (ft) to 1969 ft [20 meters (m) to 600 m] (Tepedino et al. 2012). Pollinator nest site requirements can be very specific based on substrate material, texture, moisture, salinity, and aspect (Cane 2001). Nest sites are more often a limiting factor for pollinator welfare than pollen or nectar sources (Gathmann and Tscharntke 2002). There is currently no evidence of pollinator limitation in twinpod plants (Tepedino et al. 2012). However, additional development within 1969 ft (600 m) of twinpod habitat could reduce the availability of pollinator nest sites.

Seeds are small and are probably dispersed by overland flow of water, gravity, and perhaps by small insects such as ants. The presence of mustard oils in all parts of the plant most likely prevents dispersal by birds (O'Kane 1987) because of compounds in the oil that are irritating to most animals. Monitoring by the BLM has shown twinpod individuals to live at least eight years. Under favorable conditions, twinpod plants can reach maturity in three years; under less ideal conditions, it may take five or more years for plants to mature (Krening 2019).

Tepedino (2012) examined potential hybridization between twinpod and *Physaria acutifolia* (sharp-leaf twinpod), a look-alike species often found near twinpod. *P. acutifolia* plants treated with twinpod pollen did not reproduce. However, a twinpod plant treated with pollen from *P. acutifolia* produced fruits. Unfortunately, fruits were removed by cattle grazing before collection and counts could be made. Eight of the 12 bee species visitors collected from *P. acutifolia* plants were also captured at twinpod plants. Pollination movement between species is likely and hybridization between these two species is possible, but it is unknown to what extent it might be occurring or what impacts it might be having on the species.

Habitat Characteristics

Bladderpod and twinpod are found exclusively in the Piceance Basin in Rio Blanco County, Colorado on barren white shale outcrops exposed through erosion of drainages predominantly associated with the Thirteenmile Creek Tongue of the Green River Formation (Figure 3). Both species are soil endemic species (55 FR 4152), meaning they are restricted to a specific soil type. Soils are predominantly of the Irigul-Parachute complex, comprised of irigul soils (shallow, well-drained, upland ridge and sideslope soil derived from sandstone and hard shale) and Parachute soils (moderately deep, well-drained soils derived from sandstone or basalt) (BLM 2007). Average annual precipitation is approximately 13 in (0.3 m) evenly distributed throughout the year. Average annual temperature is 42.8 degrees Fahrenheit (6 degrees Celsius) (O'Kane 1987). The species occur in areas containing rich deposits of extractable oil shale and sodium minerals such as nahcolite and dawsonite (55 FR 4152).

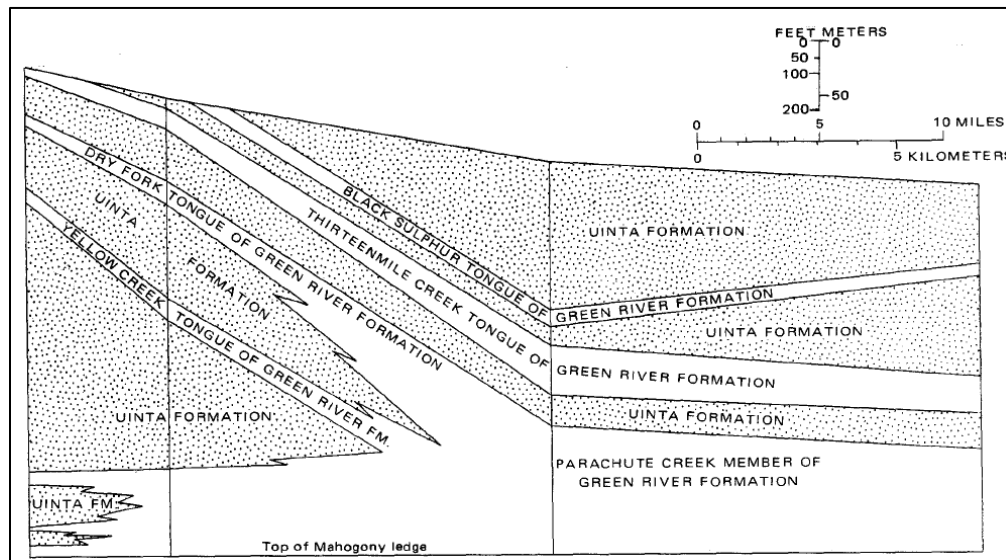


Figure 3. Formation stratigraphy in the Piceance Basin (Duncan 1974). Erosional forces may expose any of these layers.

Bladderpod and twinpod are associated with cold-deciduous shrublands and scarcely vegetated rock screes (O'Kane 1987). They are frequently associated with species such as: *Agropyron sp.* (wheatgrass); *Amelanchier utahensis* (Utah serviceberry); *Artemisia dracunculus* (tarragon); *Artemisia frigida* (fringed sage); *Artemisia ludoviciana* (white sagebrush); *Artemisia tridentata* (big sagebrush); *Astragalus detritalus* (debris milkvetch); *Astragalus lutosus* (dragon milkvetch); *Atriplex confertifolia* (shadscale); *Cirsium barnebyi* (Barneby's thistle); *Cryptantha sp.* (cryptantha); *Elymus elymoides* (bottlebrush squirreltail); *Ericameria nauseosus* (rubber rabbitbrush); *Erigeron composites* (fernleaf fleabane); *Eriogonum lonchophyllum* (spearleaf buckwheat); *Euphorbia fendleri* (prostrate spurge); *Galium coloradense* (Colorado bedstraw); *Linanthus pungens* (granite prickly phlox); *Machaeranthera grindelioides* (rayless tanseyaster); *Mentzelia sp.* (blazingstar); *Oenothera caespitosa* (tufted evening primrose); *Oryzopsis hymenoides* (Indian rice grass); *Penstemon pachyphyllus* (thickleaf penstemon); *Phacelia*

heterophylla (varileaf phacelia); and *Physaria acutifolia* (common twinpod) (O'Kane 1987; Roberts 2010a). The surrounding hills and mesas support pinyon-juniper (*Pinus edulis* and *Juniperus osteosperma*) woodlands (O'Kane 1987). Broad habitat characteristics are similar among both species; however, each inhabits a unique micro-habitat.

Bladderpod

Bladderpod grows on the Thirteenmile Creek and Yellow Creek tongues of the Green River Formation on level surfaces at the points of ridges where narrow outcrops of white shale are exposed (Figure 4) (Service 2008). Plants typically occur on slopes less than 15 percent (BLM 2007). These sites are often above steep sideslopes where twinpod plants are found (Roberts 2010b; Roberts 2010c). Additional occurrences of bladderpod have been discovered in the Dudley Gulch drainage on Uinta Formation soils. At this site, very thin layers of the Uinta formation overlay the Thirteenmile Creek Tongue, which occurs less than 1.6 feet (0.5 m) below the surface. These overlying Uinta strata are thin enough that bladderpod can either root into the underlying Thirteenmile Creek tongue or access the specific underlying minerals required by the species (Holsinger 2009b).

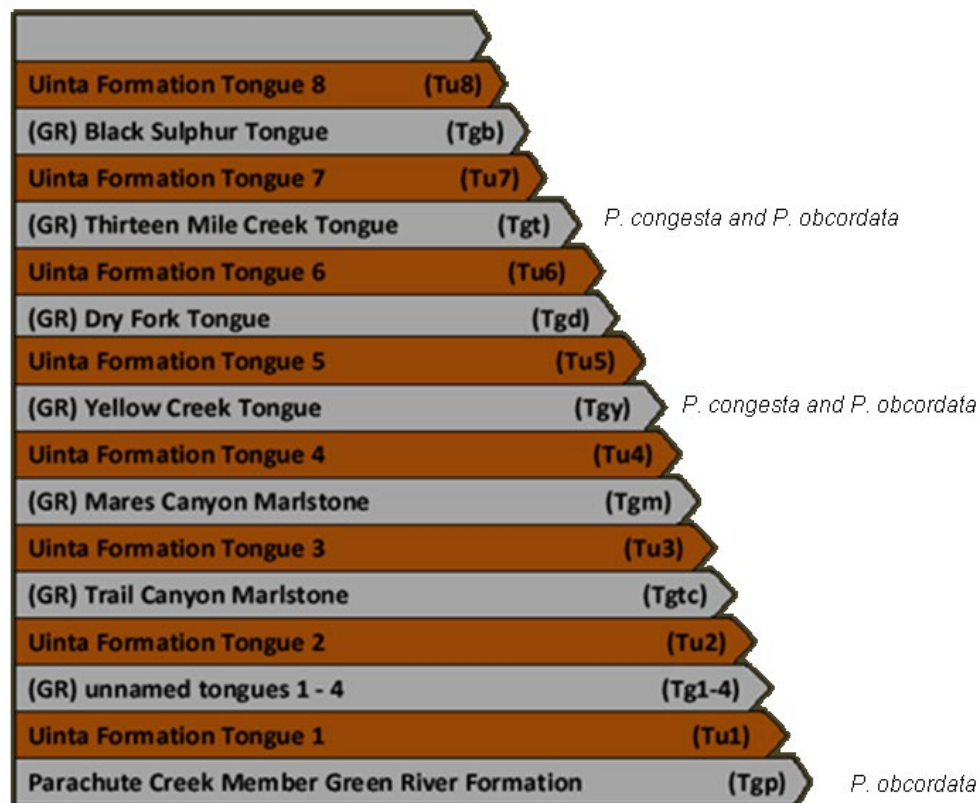


Figure 4. Intertonguing of the Uinta Formation with the Green River Formation (Roberts 2010c). Erosional forces may expose any of these layers.

It is not known whether the bladderpod is dependent on disturbance for survival. Limited evidence suggests that small-scale disturbances can result in significant losses of plants (55 FR 4152). Given its preference for flatter habitats, it is likely that the bladderpod is less adapted to natural disturbance than the twinpod that is generally found on steeper slopes.

Twinpod

Twinpod occurs on steep colluvial slopes and barren white shale outcrops of primarily the Thirteenmile Creek Tongue, but also on the Yellow Creek Tongue and Parachute Creek Member of the Green River Formation, where the formation is exposed along down-cutting drainages (Service 2008). Other suitable Green River Formation Tongues include Dry Fork and Garden Gulch (Figure 4) (Service 2012). Twinpod occurs on an average slope of 45 percent (Hayden 2010). These shale slopes are naturally erosive and are vulnerable to the effects of gravity and overland water flow (O'Kane 1987).

Twinpod plants have been found to colonize artificially created sites and disturbed areas, such as road cuts and a pipeline right-of-way (ROW), downslope of existing populations (BLM 2007; Krening 2019). While the twinpod is not apparently dependent on disturbance for survival, the species possesses unique qualities that allow it to persist at these sites while other species do not (O'Kane 1987). It is unclear whether twinpod succeed in these areas because of reduced competition or because disturbance triggers or aids germination, growth, or reproduction.

A predictive distribution model was developed to assist land managers in understanding and mapping the potential distribution of both species. Modeling revealed that, as expected, bladderpod is closely tied to the Thirteenmile Tongue of the Green River Formation. This association accounted for 70 percent of the model variability. Bladderpod appears to be more reliant on tolerable temperatures than precipitation. Twinpod was also tied to the geologic substrate, but less so than bladderpod. Twinpod is apparently constrained by winter minimum temperatures and seasonal precipitation patterns (CNHP 2013).

Distribution and Population Trends

All known bladderpod and twinpod populations occur within a rectangular range spanning 27 miles east to west and 19 miles north to south (Figure 5).

Approximately 88.4 percent of total occupied bladderpod and twinpod habitat occurs on public lands managed by the BLM (Table 2). The BLM has designated four Areas of Critical Environmental Concern (ACEC), which contain approximately 55.8 percent of the total occupied bladderpod and twinpod habitat (Table 3) (CNHP 2018a-r; Dupire, in litt 2018a). By definition, ACECs highlight areas within public lands where special management attention is needed to protect important historical, cultural, scenic, and natural resources.

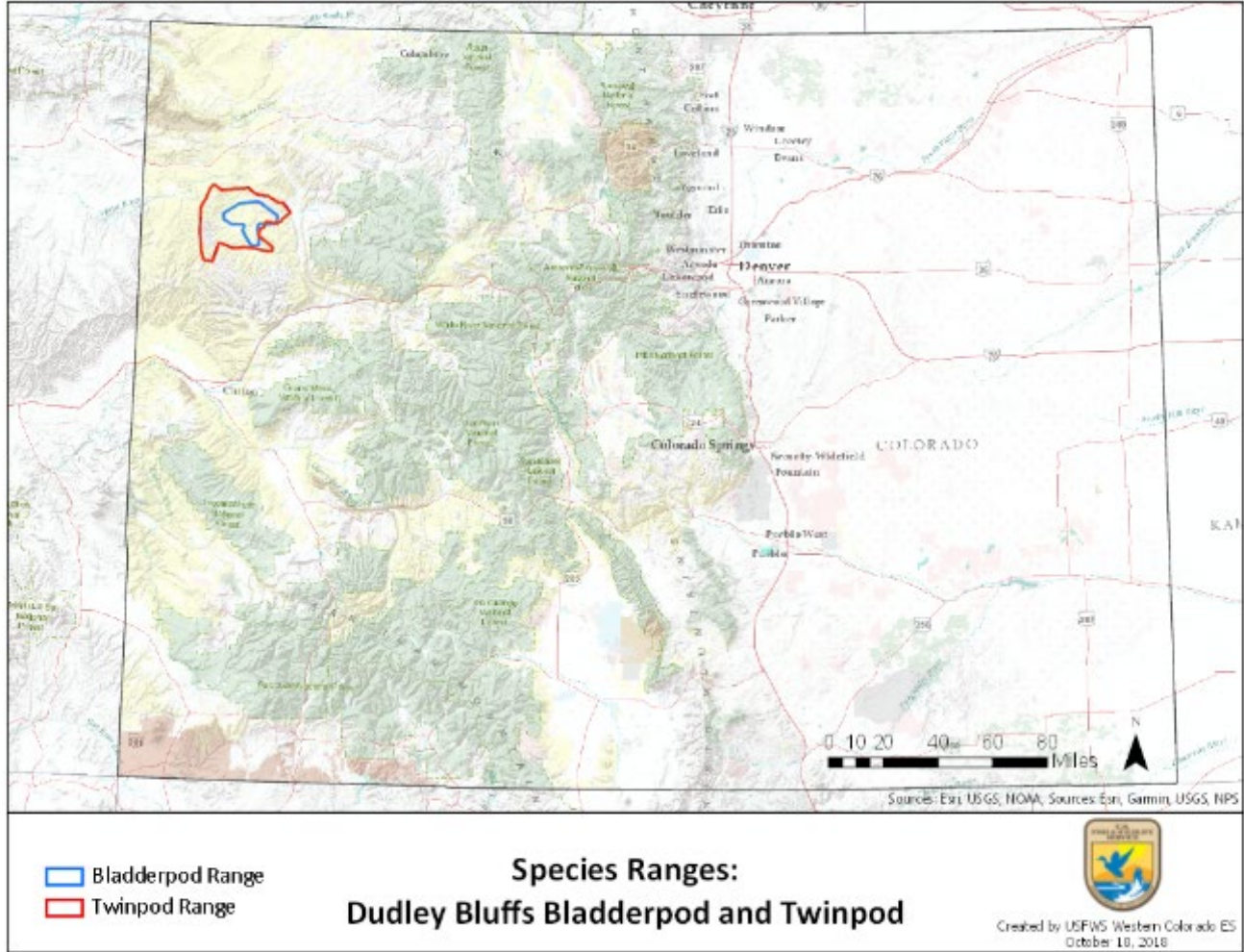


Figure 5. Dudley Bluffs bladderpod and twinpod known ranges.

Bladderpod

There are seven known occurrences of bladderpod on an estimated 950.8 acres (384.7 ha) of BLM, State, and private lands within a 10 mile by 10 mile area. In this Species Biological Report, an occurrence is defined as an area of land in which a species is, or was, present. Occurrences are separated by distinct features on the landscape (e.g. ridges, rivers, roads) or by a separation distance of at least 0.6 miles (mi) [1 kilometer (km)] of unsuitable habitat or 1.2 mi (2 km) between known plant observations in suitable habitat. The estimated total number of bladderpod plants ranges from 219,300 to 731,300 (Table 2).

					Area			BLM	BLM	State	State	Private	Private
Species	Occurrence	EO ID*	Rank**	Number of Plants	ac	ha	% of total	ac	%	ac	%	ac	%
Bladderpod	Yellow Creek/Confluence	5963	A	34,000 - 530,000	435.8	176.3	45.8	413.4	94.9	-	-	22.4	5.1
	Duck Creek	3286	A	14,000 - 15,000	321.8	130.2	33.8	257.8	80.1	-	-	64.1	19.9
	Dudley Gulch North	8318	A	129,700	75.0	30.4	7.9	71.3	95.1	-	-	3.7	4.9
	Yellow Creek/Pinto Mesa	1241	B	5,000 - 10,000	11.2	4.5	1.2	11.2	100	-	-	-	-
	Lower Ryan Gulch	9789	A	21,600	49.8	20.2	5.2	49.8	100	-	-	-	-
	Square S Ranch	11232	A	10,000 - 20,000*	6.0	2.4	0.6	6.0	100.0	-	-	-	-
	Yellow Creek-Base Line/Barcus Creek	4006	B	5,000+	51.2	20.7	5.4	44.2	86.3	7.0	13.7	-	-
	TOTAL			219,300 - 731,300	950.8	384.7	100	853.7	89.8	7.0	0.7	90.2	9.5
Twinpod	Calamity Ridge/Beard's Cabin	61	A	11,600	83.6	33.8	24.2	68.9	82.4	-	-	14.7	17.6
	North Pinto Gulch/ Lower Yellow Creek	1254	C	500+	13.8	5.6	4.0	13.8	100	-	-	-	-
	McKee Gulch/Rock School	4508	C	400+	17.3	7.0	5.0	9.8	56.6	-	-	7.5	43.4
	Alkali Flat Draw/Barcus Creek	5242	B	1,100+	15.2	6.2	4.4	15.2	100	-	-	-	-
	Dudley Bluffs	6830	AB	2,700+	46.4	18.8	13.4	37.1	80.0	-	-	9.3	20.0
	Calamity Ridge/Yanks Gulch	7014	B	3,000	19.1	7.7	5.5	19.1	100	-	-	-	-
	Ryan Gulch/Horse Draw	8694	A	14,800	85.5	34.6	24.7	85.5	100	-	-	-	-
	Piceance Creek	13184	X?	Possibly extirpated	-	-	-	-	-	-	-	-	-
	Hay Gulch	13871	B	2,000+	13.1	5.3	3.8	-	-	13.1	100	-	-
	Piceance Creek	15000	B	1,000 - 5,000	17.3	7.0	5.0	8.0	46.2	-	-	9.3	53.8
	Barcus Creek	15351	BC	500 - 1,000	3.9	1.6	1.1	3.9	100	-	-	-	-
	(New occurrence: no name)	No EOID	No Rank	5,000 - 10,000	30.7	12.4	8.9	30.7	100	-	-	-	-
	TOTAL			42,600 - 52,100	345.9	140.0	100	292.0	84.4	13.1	3.8	40.8	11.8
TOTAL (both species)					1296.7	524.7	100	1145.7	88.4	20.1	1.6	131.0	10.1

Table 2. Known occurrences of bladderpod and twinpod ((CNHP 2018a-r; Dupire, in litt 2018a). Percentages may not add to 100 due to rounding. *EO ID: Element Occurrence identification number. **Occurrence rank assigned by CNHP: A – Excellent estimated viability; B – Good estimated viability; C – Fair estimated viability; X? – Possibly extirpated

Occupied Habitat Within Areas of Critical Environmental Concern		Area	
		ac	ha
Bladderpod	Ryan Gulch ACEC	49.8	20.1
	Dudley Bluffs ACEC	49.7	20.1
	Duck Creek ACEC	478.1	193.5
	TOTAL	577.6	234
Twinpod	Ryan Gulch ACEC	84.2	34.1
	Dudley Bluffs ACEC	43.4	17.6
	Yanks Gulch/Upper Greasewood Creek ACEC	18.9	7.6
	TOTAL	146.5	59
TOTAL (both species)		724.1	293

Table 3. Bladderpod and twinpod occupied habitat within BLM Areas of Critical Environmental Concern.

The BLM has conducted annual monitoring for bladderpod at Duck Creek and 1145 Road since 2012 and at two Yellow Creek compressor sites since 2015. From the initiation of monitoring through the 2018 field season, three of the four BLM bladderpod monitoring sites have experienced significant declines (BLM 2018). At compressor station #1, a significant decrease in plant density in 2016 was followed by a rebound in 2017 and steep decline in 2018. Like compressor station #1, compressor station #2 showed a significant decrease in plant density in 2016, and again in 2018. However, plant density at compressor station #2 continued to decline between 2016 and 2017 as well. At the 1145 Road site, an increase in plant density was observed in 2017 following a monsoon rain event in 2016 that had caused plant loss due to heavy erosion and down-cutting. Despite the increase, mean plant density remains well below historic levels for the site. Plant density at Duck Creek has been stable with no significant change observed (BLM 2018).

Twinpod

There are 12 known twinpod occurrences on an estimated 345.9 acres (140.0 ha) of BLM, State, and private lands within a 27 mile by 19 mile area. The estimated total number of twinpod plants is 42,600 to 52,100 (Table 2). One occurrence at Piceance Creek is thought to be extirpated, in an area that was part of a wildfire prior to 2005. In 2013, approximately 18 person hours were spent searching for twinpod in the area that had burned; no twinpod plants were found.

The BLM has conducted annual monitoring for twinpod at their Yellow Fence site since 2011 and at Ryan Gulch ACEC since 2015. Both sites have experienced significant declines since monitoring was established (BLM 2018). The Yellow Fence site remained stable or increasing between 2011 and 2017, followed by a steep decline in 2018. At the Ryan Gulch ACEC site, the population has declined by 73 percent since 2015. Two additional study sites, Calamity Ridge and Pipeline, were established in 2017. Both showed slight declines in 2018 (BLM 2018).

Genetics

Genetic analysis showed moderate levels of genetic diversity in both species, with bladderpod having higher diversity than twinpod (Schwabe and Ramp Neale 2016). Some occurrences of twinpod exhibited significant inbreeding, and heterozygosity was low in both species (Schwabe and Ramp Neale 2016). Genetic analysis also showed a strong geographic structure in twinpod with three regional genetic groups: western, northern, and southern. Bladderpod genetics suggest a trend toward northern and southern clusters; however, these data were not significant (Schwabe and Ramp Neale 2016).

Summary of Current Resiliency, Redundancy, and Representation

The resiliency of bladderpod and twinpod occurrences is bolstered by the high number of plants in each occurrence. Bladderpod occurrences range from 5,000 to possibly 530,000 plants; twinpod occurrences contain an estimated 400 to 14,800 plants. The estimated number of bladderpod and twinpod plants is relatively high for such small ranges. However, these species' pattern of rarity, being locally abundant on small areas of specialized habitat, makes them vulnerable to surface disturbances despite their high densities.

Bladderpod and twinpod have limited redundancy in comparison to more widespread plant species. While bladderpod is more abundant than twinpod, the twinpod is found in more occurrences across a larger range. There are seven occurrences of bladderpod and twelve occurrences of twinpod. However, one twinpod occurrence is thought to be extirpated due to wildfire. Given the close proximity of occurrences and narrow ranges of the species, it is possible that a single catastrophic event could affect multiple occurrences.

Ecological representation is low for both species. Although there are differences in micro-habitat between the two species, each species is restricted to a specific soil type, and there is little to no ecological diversity among occurrences of each species. Genetic representation is higher than ecological representation. Genetic analysis showed moderate levels of genetic diversity in both species, with bladderpod having higher diversity than twinpod (Schwabe and Ramp Neale 2016). Genetic analysis also showed a strong geographic structure in twinpod with three regional genetic groups: western, northern, and southern. Bladderpod genetics suggest a trend toward northern and southern clusters; however, these data were not significant (Schwabe and Ramp Neale 2016).

REASONS FOR LISTING/THREATS ASSESSMENT

Section 4 of the ESA and its implementing regulations (50 CFR part 424) set forth the procedures for adding species to the Federal list of endangered and threatened species. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the ESA. Below, we present a summary of threats affecting the bladderpod and twinpod according to these five listing 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; and (E) other natural or manmade factors affecting its continued existence.

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Mineral Extraction and Energy Development

Overview

Bladderpod and twinpod grow on tongues of white Green River shale within the overlying Uinta Formation, which is considered overburden to the thick underlying oil shale deposits. Beneath the overburden of the surface Uinta Formation, this area at the center of the Piceance Basin contains thick, rich sections of oil shale in the mahogany zone and sodium minerals in the underlying saline zone. In some areas of the Piceance Basin, geology is such that coal, sodium, and oil shale resources also overlay natural gas reserves. These mineral-rich areas where the extraction of one mineral does not destroy the quality of the others are often referred to as multiple mineral, or multiminerall, zones. Nearly all occurrences of bladderpod and twinpod are located within this multiminerall zone. As we discuss in more detail below, many of these occurrences are located in parcels currently leased for oil, gas, and other mineral development. Because of their strong association with oil shale geology, many bladderpod and twinpod populations are vulnerable to impacts resulting from current and future extraction of these minerals, though impacts to date have been localized, and conservation measures have proven successful in minimizing impacts to bladderpod and twinpod.

The 1990 listing rule and 1993 Recovery Plan projected the extraction of these leasable minerals to be the primary threat to the species (55 FR 4152; USFWS 1993). While not discussed in the listing rule or the 1993 recovery plan, our 2008 5-year Review Summary and Evaluation also identified the designation of Federal energy corridors and ongoing natural gas exploration, production, and related development as threats to the species (USFWS 2008).

Current and previous mineral extraction in the Piceance Basin includes natural gas, oil shale, and nahcolite mining. Associated development includes a variety of short- and long-term infrastructure such as roads, pipelines, well pads, compressor stations, power lines, mine portals, staging sites, injection wells, and processing facilities. Potential impacts of mineral extraction include direct loss of plants, habitat loss and fragmentation, introduction of invasive species, and associated impacts on species' genetic diversity and plant-pollinator relationships; however,

Clark (2013) found oil and gas development to have little to no effect on pollinator community abundance in bladderpod and twinpod habitats.

Roads have been linked to short- and long-term impacts on plant genetic diversity, population viability (Debinski and Holt 2000); pollination (Gathmann and Tschardt 2002); vegetation composition, percent cover, and biomass; soil temperature, chemistry and pH (Farmer 1993; Myers-Smith et al. 2006); water content; surface-water flow and runoff patterns; erosion and sedimentation rates; albedo; and water quality (Forman and Alexander 1998). In addition, road network construction, maintenance, and ongoing use have the ability to affect species through an increase in fugitive dust. Development of each new gas well can require between 375 and 1,375 round trips by large trucks to deliver materials, supplies, and equipment, depending on the depth and location of the well. An estimated 0.25 truck trips per day are required to maintain operating wells (Kuhn 2006). For every vehicle traveling one mile of unpaved roadway once a day, every day for a year, approximately 2 ½ tons [2,268 kilograms (kg)] of dust are deposited along a 1,000 ft (305 m) corridor centered on the road (Sanders 2008). Most pipelines, power lines, and other rights-of-way associated with energy development are accessed by some sort of road or access route, with varying levels of use. Future road construction and use is expected to continue to affect soil hydrology in the Piceance Basin by accelerating stormwater runoff, soil erosion, and sediment transport (BLM 2007).

Energy development in the Piceance Basin has managed to avoid many of these impacts by siting pads, pipelines, and roads outside of bladderpod and twinpod occupied habitat, and indirect impacts from development have likely had less impact on bladderpod and twinpod than originally thought. Graff and Alward (2012) found distance from development had little to no effect on the structure of bladderpod habitat, and there was no evidence to suggest that twinpod density or reproductive success differed between sites that were near and far from development.

Localized impacts have been reported. In 1991, an unauthorized disturbance assumed to be a seismic shot hole destroyed an estimated 100 to 150 bladderpod plants (BLM 2002a). An unknown number of twinpod plants will be directly impacted during upcoming planned ground-moving activities to address erosion in a pipeline ROW, and twinpod plants were likely destroyed during the construction of this pipeline, since the presence of the species was unknown at the time of construction (Dupire, pers comm 2018b). Given the rate and extent of energy development in the Piceance Basin, we believe that there have likely been other inadvertent and undocumented losses of these species, though localized disturbance has likely impacted only a small percentage of individuals. While the species' specialized soil requirements makes them more vulnerable to localized disturbance, it can also allow land management agencies to more easily avoid habitat when disturbance conservation measures are put in place.

Natural Gas Production

Five of the top 52 natural gas fields in the United States are located in the Piceance Basin (Energy Information Administration 2007). Approximately 81 percent of bladderpod occupied habitat and 76 percent of twinpod occupied habitat are currently leased for oil and gas development (BLM 2018). Many of these leases were issued prior to the adoption of the 1997 BLM White River Field Office (WRFO) Resource Management Plan (RMP). Therefore,

stipulations such as No Surface Occupancy (NSO) do not apply to development of those leases (BLM 1997). Most oil and gas leases have a 10-year life; if renewed or resold upon expiration, appropriate stipulations are ordinarily attached to the lease at that point in time.

Since 1997, the WRFO Planning Area has experienced a dramatic increase in oil and gas drilling activity. The number of drilling permits approved by the WRFO rose from 58 in 2001 to 200 in 2006 (BLM 2009b). The oil and gas industry indicated that the potential exists to develop over 13,000 oil and gas wells in the Piceance Basin by 2026 (71 FR 34389), and the WRFO's reasonable foreseeable development scenario projected the potential need for 2,146 well pads, averaging 8 wells per pad by the end of 2028 on Federal and private lands within the WRFO Planning Area. However, the actual number of drilling permits processed per year by the WRFO has been much lower than this projection.

In response to the rising level of oil and gas activity, the WRFO completed an Environmental Impact Statement and issued a Resource Management Plan Amendment for Oil and Gas Development (RMPA) that provides for the development of 1,100 well pads with 13,200 ac (5,342 ha) of associated disturbance (BLM 2015). The majority of development is expected to take place within the Mesaverde Play Area, a regionally extensive area of tight-gas accumulation that includes the Piceance Basin.

The 2015 RMPA states that areas within 660 ft (201 m) of occupied and suitable habitat for federally listed, proposed, and candidate species would be open to oil and gas leasing with a NSO stipulation. In rare cases, the NSO is not applied because the lease rights predate the designation of ACECs and the existing RMP. The RMPA also states that new ROW authorizations would exclude areas within 330 ft (101 m) of occupied habitat of federally listed and proposed plant species, and activities within 1,970 ft (600 m) of occupied habitat are subject to Conditions of Approval. In addition, fugitive dust control measures must take place within 330 ft from the edge of occupied or suitable habitat, and invasive plant control is prioritized in occupied and suitable habitat (BLM 2015).

Exceptions may be made by the BLM if no plants will be directly impacted or affected by the action. In the past, these exceptions, which were also included in the 1997 RMP, have resulted in the placement of pipelines, well pads, and roads in suitable habitat close to the plants both within and outside of ACECs. Some well pads and pumping stations were placed within 197 ft (60 m) of plants, and pipelines were placed within 164 ft (50 m) of plants. Unpaved roads run along the edge of occupied plant habitat within 43 ft (13 m) of plants (Holsinger 2009b).

Oil Shale Development

In 2003, rising oil prices and increasing concerns about the economic costs and security of oil imports gave rise to a BLM oil shale Research, Development, and Demonstration (RD&D) program on lands managed by the BLM in Colorado, Utah, and Wyoming, where largest and most concentrated known oil shale resources in the world are located in the Green River Formation. The scope of the program was to lease small tracts of Federal lands to privately owned energy companies for the purpose of conducting long term oil shale RD&D projects (Crawford et al. 2012).

Oil shale has been produced to meet energy demands in other countries, but as of yet, it has not proven economically recoverable in the United States. Under the RD&D program, seven RD&D leases have been issued in the Piceance Basin. Five of these leases existed prior to BLM's 2013 Approved Land Use Plan Amendments/Record of Decision for Allocation of Oil Shale and Tar Sands Resources on Lands Administered by Bureau of Land Management in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement (PEIS). Each included an initial lease area of 160 ac (65 ha) and an additional Preference Right Lease Area (PRLA) of 4,960 ac (2,007 ha). A second round of RD&D lease sales resulted in two additional leases being granted in 2012. These leases included an initial lease area of 160 ac (65 ha) each and an associated PRLA of approximately 480 ac (194 ha). Only two of the seven RD&D leases remain current, and neither is likely to be developed (Krening 2019). One of the two remaining leases will expire in 2021.

A variety of facilities and infrastructure are required for oil shale development including facilities such as coal-fired power plants, transmission lines, pipelines, access roads, and employer-provided housing. Total associated surface disturbance would vary based on those needs. Bladderpod and twinpod could be affected by oil shale extraction by a variety of factors including injury or mortality of individuals; soil and seed bank disturbance and removal; vegetation clearing; habitat fragmentation; impeded seed dispersal; changes in drainage patterns; erosion; sedimentation from runoff; oil and contaminant spills; fugitive dust; increased human access; spread of invasive plant species; air pollution; and loss of pollinator habitat.

On BLM leased land, the PEIS stipulates that no surface disturbance occur within 300 ft (91 m) of listed plants, and temporary fencing, dust abatement, and follow-up monitoring must occur if disturbance occurs within 600 ft (183 m) from a listed plant. Oil shale research tracts contain no known bladderpod or twinpod populations, and, to date, we are not aware of any instances of loss of plants as a result of oil shale development. Despite vast oil shale deposits, there has not been sustained commercial production anywhere in the country (Committee on Natural Resources 2018; National Oil Shale Association 2017), and oil shale development is not anticipated to increase in the area.

Energy and Utility Corridors

Although not addressed in the 1990 listing decision or 1993 recovery plan, our 5-year review (USFWS 2008) identified energy corridors as a threat to both the bladderpod and twinpod. Section 368 of the Energy Policy Act of 2005 (42 U.S.C. 15801 *et seq.*) directed the Secretaries of Agriculture, Commerce, Defense, Energy, and Interior to designate energy transport corridors for oil, gas, and hydrogen pipelines and electricity transmission and distribution facilities on Federal lands. Federal agencies since identified preferred corridors to concentrate development, although utilities are not necessarily restricted to these corridors (BLM 2009a). A portion of the designated Westwide Energy Corridor occurs on BLM land in the Piceance Creek area within the range of bladderpod and twinpod.

By facilitating utility development, designation of the Westwide Energy Corridor may make the Piceance Basin more attractive to energy companies and is likely to encourage increased levels

of disturbance. Construction of new energy infrastructure could result in direct and indirect impacts similar to those caused by natural gas and oil shale development, such as habitat loss and fragmentation, introduction of invasive species, and direct mortality. Although no known bladderpod or twinpod plants occur within the permitted ROW, one twinpod occurrence is located approximately 0.3 mi (0.5 km) from the energy corridor and mapped potential habitat occurs within the corridor. Plants occurring in or near existing ROWs may be particularly vulnerable to impacts, since new infrastructure development is often concentrated in existing ROWs rather than designating new ROWs.

Sodium Mineral Development

One of the world's largest and most significant nahcolite (sodium) reserves occurs in the Piceance Basin. The mineral was discovered near Piceance Creek in 1964, and mining in the area has occurred since the early 1970s (Hardy et al. 2003). Nahcolite deposits are currently mined in situ via solution mining, whereby hot water is injected via deep wells to thermo-mechanically fracture the surrounding oil shale and dissolve the mineral for recovery at the surface. As is the case in the Piceance Basin, nahcolite typically co-occurs with oil shale reserves.

Two occurrences of bladderpod and one occurrence of twinpod occur in sodium mineral leases. Of these, one bladderpod occurrence and one twinpod occurrence are located within the boundaries of active sodium mine tracts. However, we currently know of no instances where sodium mineral extraction has negatively impacted bladderpod or twinpod.

Livestock and Wild Horse Grazing

The 1990 bladderpod and twinpod listing rule noted concern for grazing impacts on the species, and trampling and browsing by livestock and wild horses were identified as threats to the species in our 2008 5-year review (55 FR 4152; USFWS 1993). In this section, we focus on the effects of grazing on bladderpod and twinpod habitats, as well as the impacts of trampling on the plants. The effects of herbivory on the species are discussed in Factor C: Disease or Predation.

Potential impacts of grazing include direct affects, such as trampling, crushing, injuring, or killing plants (Guthery and Bingham 1996). Potential indirect effects to plants include reduced plant vigor, reproductive capacity, and survival; habitat degradation due to alterations in vegetation community structure, composition, plant biomass, and structural attributes such as height, cover, and density (Mackie 1978); and proliferation of invasive species or less desirable species and pests (Giesen 1995; Masters and Sheley 2001; Young and Longland 1996); altered fire regimes, disruption of plant-pollinator relationships and processes (Gess 1993); accelerated erosion rates (Belsky et al. 1999); compaction of soil; reduced water infiltration; increased runoff; and increased soil temperatures and evaporation rates. Arid ecosystems, such as the Piceance Basin, are particularly susceptible to overgrazing impacts (Jones 2000).

Many bladderpod and twinpod populations occur within the range of wild horses. Wild horse herds in the Piceance Basin are distributed between the Piceance-East Douglas and North Piceance Herd Management Areas (HMA). Combined, these herd units encompass

approximately half the range of the species. Wild horses are not physically confined to HMAs, and animals stray outside these units. Therefore, bladderpod and twinpod occurrences outside of HMAs may also be exposed to wild horse herds, though likely to a lesser degree than plant populations in designated HMAs. Efforts are generally made to remove horses that move outside of the HMAs (BLM 2007; Miller, in litt 2012).

It had previously been assumed that livestock grazing had only incidental impacts on bladderpod and twinpod plants due to their low palatability, inaccessibility on steep slopes, dormancy during portions of the grazing period, and a general lack of abundant surrounding forage that would attract livestock. However, monitoring reports note livestock trampling on the species, including on steep hillsides in the Yanks Gulch ACEC (CHNP 2018a-r; 55 FR 4152).

In the Duck Creek ACEC, bladderpod were monitored at two locations with varying degrees of livestock and wild horse use. The first location, north and south Yellow Creek, was used by cattle for drinking water. The second location, Duck Creek, was used by both wild horses and cattle. Since wild horses are not physically confined to HMAs, it is possible that the first study site was also exposed to horses (Rickey and Kurzel 2007). From 1996 to 2002, both bladderpod populations saw declines in the number of plants. The Yellow Creek study site appeared to be stable for much of the study; the 10 percent decline at this site in the final year of the study may have been the result of a dry spring that year. Trampling damage was observed at the Duck Creek study site. This population, which is located within the HMA, saw a 35 percent decrease in number of plants from 1996 to 2002. During this same time period, horse numbers within the HMA exceeded the specified management level by up to 55 percent. The number of horses in the HMA was reduced to the appropriate management level (AML) in 2002. Damage to plants was caused by horses trailing through the site, rolling on plants, and fighting or scuffling on top of plants. In most cases, trampled plants were uprooted or severed at the crown, resulting in death of the plant.

In the Ryan Gulch ACEC, evidence of trampling by livestock was observed in 1993 (Tepedino et al. 2012). In response, a study plot was installed in 1994 to monitor twinpod in the area. Between 1994 and 2000, the total number of plants, total basal area, and total number of flower stems rebounded. However, the BLM noted that impacts from livestock were continuing at the site (BLM 2002b). Therefore, we are unable to make any conclusions about the impact of livestock on the species based on this study. In 2000, the BLM constructed an exclusion fence in the study area to keep livestock from accessing 297 ac (120 ha) of habitat. This area includes 18 ac (7 ha) of occupied bladderpod habitat and 19 ac (8 ha) of occupied twinpod habitat (BLM 2002b; USFWS 2009). In 2010, the BLM discovered a cattle trespass in the exclosure, along with extensive twinpod habitat damage, and approximately 35 twinpod plants had been uprooted (BLM 2010b). Still, these impacts are localized and likely affect only a small number of individuals rather than having species- or occurrence-level effects.

Wildfire

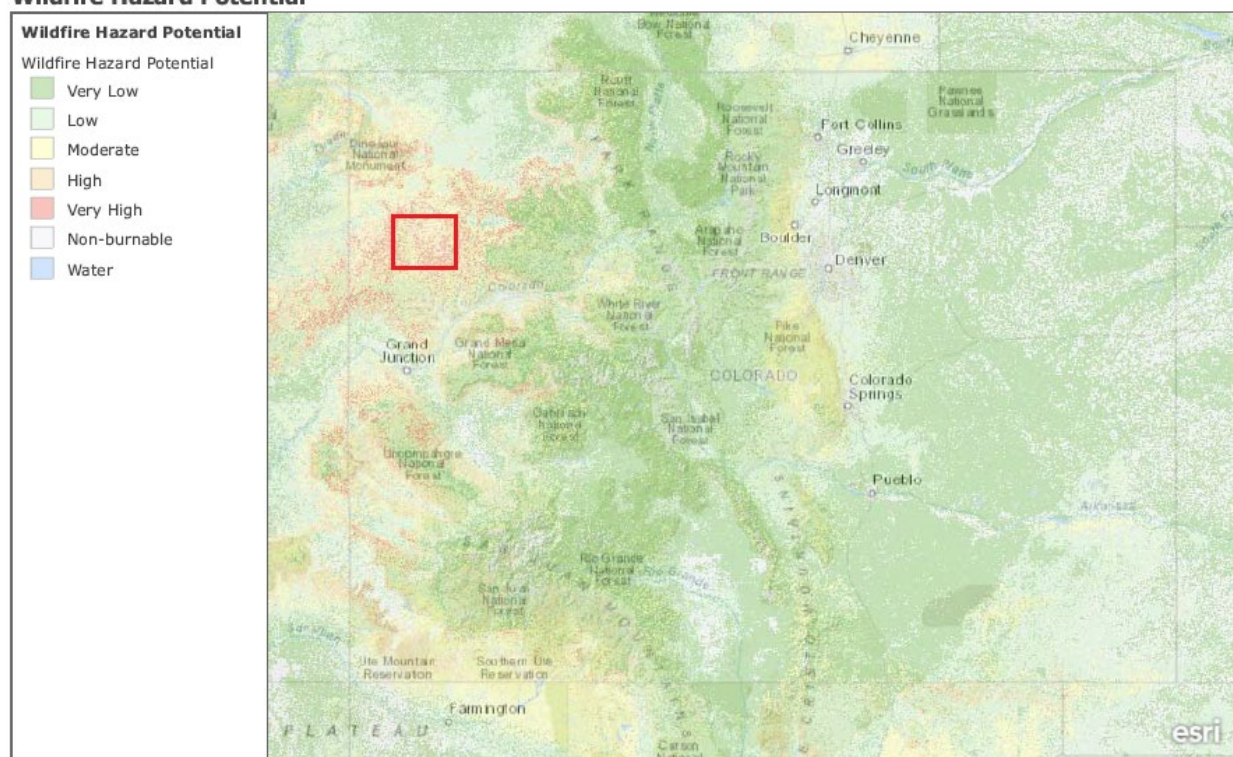
As with many areas across western North America, fuel composition and structure in the Piceance Basin has changed significantly in the last century, primarily due to an increase and prevalence of non-native annuals including cheatgrass. As a result, fire frequency and size have increased in lower elevation shrub communities including sagebrush and salt desert shrub types where bladderpod and twinpod occur. In woodland communities, it is thought that a combination of past fire suppression and grazing practices have promoted the expansion of pinyon-juniper and, in certain areas, reduced or removed understory vegetation that would normally fuel beneficial fires. Therefore, in those areas, fire return intervals may have decreased over time. While lightning strikes are the most common source of fire starts in the Piceance Basin, transmission lines associated with mining, oil and gas facilities, and other industrial uses pose a significant risk of wildfire in Rio Blanco County (BLM 2007).

Potential impacts include injury or loss of plants, habitat loss and fragmentation, and nonnative species invasion. One occurrence of twinpod was possibly extirpated due to wildfire; more than eight years after the fire, plants had still not reappeared in the area (CNHP 2018i). While little is known about these species' sensitivity to fire, we presume they are adapted to low fire-return intervals given their occurrence in barrens, desert shrub communities and grasslands, and woodlands. These areas are naturally resistant to fires due to sparse vegetation and limited fine fuels. However, changes in vegetation or activities that increase fire frequency and size are likely to negatively impact these species. Fire often promotes the establishment of cheatgrass and other invasive species, which may further increase fire risk. While grass species often establish faster or more successfully in disturbed areas, these species do not provide floral resources for pollinators (Tepedino 2009). Furthermore, the increase in fugitive dust in areas recovering from fire could interfere with plant respiration and plant-pollinator interactions.

Inadvertent impacts may also result from fire response activities, including fire suppression, reclamation, and stabilization of burned areas. Ground crews, motorized vehicles, and fire equipment may injure or destroy plants and habitat while moving through the area, and since bladderpod and twinpod habitats act as natural fire barriers, they may be incorporated into fire lines (BLM 1996). The BLM prioritizes sensitive habitats for protection from fire events and response (BLM 2007); however, the protection of sensitive habitats must not impede emergency actions.

Mechanical and chemical fuel treatments to minimize hazardous fire conditions in the WRFO typically preclude sensitive sites such as threatened and endangered species habitat, and the BLM prohibits prescribed fire activities in threatened and endangered species occupied habitat. Although the specific habitats of bladderpod and twinpod have low wildfire potential, the larger surrounding area ranges from moderate to very high wildfire hazard potential (Figure 6) (USFS 2018).

Wildfire Hazard Potential



This map layer portrays the Wildfire Hazard Potential, developed by the U.S. Forest Service's Fire Modeling Institute to help inform assessments of wildfire risk or prioritization of fuels management needs across large landscapes

Figure 6. Wildfire Hazard Potential in Colorado. The red box represents the range of bladderpod and twinpod.

Invasive Species

Invasive species were not identified as a threat in the 1990 listing rule, 1993 recovery plan, or the 2008 5-year review. However, the distribution and number of invasive species in the WRFO has continued to increase over time due to a variety of land uses. Invasive species populations within bladderpod and twinpod habitat now occur in areas previously considered to be free of invasives. The BLM anticipates that areas of degraded habitat in the WRFO Planning Area, such as those dominated by cheatgrass and other invasive species, are likely to continue in their present habitat conditions for the foreseeable future (BLM 2007).

Rare plants with small and fragmented populations are particularly vulnerable to negative effects from invasive species. Species responses include increased mortality and decreased survivorship; reduced plant size; reduced reproductive output; reduced growth and seedling recruitment; and reduced individual recruitment and population growth (Huenneke and Thomson 1995; Lesica and Shelly 1996; Pavlik 1994). Invasive species detrimentally affect native plant communities through competitive exclusion, altered pollinator behavior, niche displacement, hybridization, and changes in insect predation (D'Antonio and Vitousek 1992; Mooney and Cleland 2001; Olsen 1999). Invasive species have been shown to alter ecosystem characteristics

including geomorphology, fire regime, hydrology, microclimate, nutrient cycling, and productivity (Dukes and Mooney 2004). Such effects are not always obvious over the short-term, and may only manifest themselves as serious threats later in time. For instance, species diversity may temporarily increase with invading species following a disturbance event, but decreases over time (Debinski and Holt 2000).

Invasive species have been slow to establish in bladderpod and twinpod habitats, possibly due to the unique soils and harsh growing conditions inhabited by these species. *Halogeton glomerata* (halogeton), *Bromus tectorum* (cheatgrass), and *Centaurea maculosa* (spotted knapweed) occur primarily on the edges of occupied habitats where deeper and richer alluvial slopes occur (Holsinger 2009b). However, halogeton and cheatgrass have been found within areas of occupied habitat as well (USFWS 2010). Cheatgrass in particular poses a threat to bladderpod and twinpod due to its capacity to increase fire frequency, alter vegetation community composition, and self-perpetuate. Cheatgrass densities within bladderpod and twinpod occupied habitats were estimated to be less than one percent of total plant cover. In 2015, *Euphorbia esula* (leafy spurge) was observed in twinpod habitat during a site visit to Hay Gulch (CNAP 2015).

Other invasive species of concern include *Salsola iberica* (Russian thistle) and *Acroptilon repens* (Russian knapweed), which were observed in similar habitats on State lands in Hay Gulch (Holsinger 2009b). *Chorispora tenella* (purple mustard) and *Ceratocephala testiculata* (burr buttercup) occur in bladderpod populations at Duck Creek. These two non-native species are not thought to be competitive; however, their potential influence on bladderpod and twinpod is unknown (Kurz, in litt 2009). Vegetation diversity and native species cover is likely to continue declining in the face of resource development, wildland fires, and other disturbance (BLM 2007).

On February 18, 2010, the Service concurred with the BLM's determination that the WRFO Integrated Weed Management Plan, including chemical, mechanical, and biological treatments may affect, but is not likely to adversely affect bladderpod and twinpod (USFWS 2010) due to precautions identified in the Plan. As part of the weed management plan, BLM identified conservation measures to minimize the impacts of invasive species treatments on listed, proposed, and candidate plant species, including clearance surveys prior to treatment and treatment buffers. In 2017, the Service provided concurrence that the addition of three herbicides in the Integrated Weed Management Plan may affect, but is not likely to adversely affect bladderpod and twinpod (USFWS 2017).

Off-Highway Vehicle Use

Though not identified as a threat in the 1990 listing rule or 1993 Recovery Plan, Off-Highway Vehicles (OHVs) were identified as potentially causing habitat degradation and direct mortality of plants in BLM's 2008 Resource Management Plan amendments (BLM 2008). OHV use in the WRFO Planning Area has increased in recent years, and this trend is expected to continue into the future with growing demand for recreation opportunities.

On most BLM land in the WRFO, OHV travel is limited to existing routes from October 1 through April 30. Within known and mapped potential habitat for listed plants, OHV travel is

limited to existing routes year-round, with exceptions. Similarly, within ACECs, motorized vehicle travel is limited to designated roads and trails, with exceptions. For the purposes of hunting and game retrieval, firewood collection, camping, parking, and use by disabled recreationists, OHV travel is permitted within 300 ft (91 m) of existing routes in all areas, including known and potential habitat for listed plants and in ACECs. No areas in the WRFO are designated as open areas for OHV use (BLM 1997; BLM 2007). The BLM has constructed fences in some areas to prevent damage to bladderpod by recreationists (Marston, pers comm 2009b). While the BLM and CNHP have documented evidence of OHV disturbance in plant occurrences, the likelihood of plants being exposed to these impacts is relatively low (Marston, pers comm 2009b).

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial, recreational, scientific, or educational purposes was not identified as a threat in the listing document, past recovery plan, or 5-year review and is not currently known to be a threat to bladderpod or twinpod. We have no records indicating that bladderpod or twinpod were ever collected or sought after for commercial or recreational use. The Service has issued permits for scientific or educational collection to four organizations. These represent legitimate scientific or educational endeavors with limited impact to the species.

Factor C: Disease or Predation

During a pollination study from 1991 to 1993, frugivory (fruit removal) was observed on twinpod plants in the Ryan Gulch ACEC (Tepedino et al. 2012). Across all treatments studied, nearly 60 percent of fruits from twinpod plants being monitored had been removed. Substantial leaf and inflorescence herbivory had occurred as well. These impacts were thought to have been caused by livestock since fresh cattle tracks and feces were observed near grazed plants. Hubbard and Hansen (1976) documented cattle and wild horse herbivory of *Lesquerella* in the Piceance Basin, though it is not stated whether this was the Dudley Bluffs bladderpod. Despite observed herbivory, trampling and habitat degradation caused by cattle and wild horses are likely more severe than herbivory of bladderpod and twinpod plants themselves, though neither are believed to have species- or occurrence-level effects.

Factor D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing, no existing Federal or State laws were identified as specifically protective of the bladderpod or twinpod. The species were identified as management priorities in the Dudley Bluffs and Calamity Ridge ACECs, but these areas only protected about 20 percent of the species' known habitat (55 FR 4152). Our 2008 5-year review discussed the inadequacy of existing regulatory mechanisms in depth (USFWS 2008). In this Biological Report, we provide an updated assessment of existing regulatory mechanisms.

Local Laws and Regulations

Approximately 10 percent of bladderpod and twinpod occupied habitat occurs on private lands owned by ranches and energy companies. Removal, damage, or destruction of plants on private lands is not prohibited under the ESA. If a project does not have Federal involvement, private landowners are not required to survey for or avoid plants or their habitat; therefore, plants on private lands are likely to be more vulnerable to threats than those on Federal lands. Local laws or regulations protecting plants from these impacts could potentially benefit the species. We are not aware of any city or county ordinances or zoning that protects the species or their habitats. However, if State and Federal regulations are deemed adequate, this may not be necessary.

State Laws and Regulations

Removal of Federally listed plants from State land is not prohibited under the ESA. Except for criminal trespass protections, no State laws or regulations protect rare plant species in Colorado on State, Tribal, or private lands.

Approximately 1.6 percent of bladderpod and twinpod occupied habitat occurs on State lands managed by Colorado Parks and Wildlife (CPW). Common land uses in the area include recreation, grazing, and natural gas production; residential and commercial development are not allowed. While there is no legal mandate to protect these species on State lands, CPW often coordinates with the Service and the BLM on major activities to avoid and minimize impacts on sensitive species and habitats. Many of the CPW parcels in the area were purchased, in part, with Federal funds and require Federal involvement for major projects on these parcels (Colorado Division of Wildlife and USFWS 2007).

In 1988, CNAP designated the Yanks Gulch/ Upper Greasewood and Dudley Bluffs ACECs on BLM lands as State of Colorado Natural Areas (CNA). In a 2007 property exchange, Shell conveyed 1,780 ac (720 ha) of private property to Colorado Division of Wildlife (now Colorado Parks and Wildlife) (CPW) near the Oak Ridge State Wildlife Area in exchange for 3,023 acres (1,223 ha) of CPW-owned property in the vicinity of the Duck Creek ACEC. In the exchange, approximately 504 ac (204 ha), including 82 acres [33 ha] of occupied bladderpod habitat, were recommended for protection (Colorado Division of Wildlife and USFWS 2007). As a result, the land was conveyed to Shell under a conservation easement which included a commitment by Shell to provide long term protection for known bladderpod populations and suitable habitat in perpetuity. Shell agreed not to develop the area, allow surface occupancy, create ground disturbance, or engage in activities where bladderpod or suitable habitat occurs. Other provisions included installing signs and developing a conservation management and monitoring plan for protection of the plant. Pursuant to those terms, Shell installed fencing and “no trespassing” signs in 2007 on the property to prevent use of an abandoned two-track road occupied by bladderpod plants. In 2009, the Shell-Duck Creek CNA was designated on the 504 ac (204 ha) that had been recommended for protection.

Combined, the Yanks Gulch/Upper Greasewood, Dudley Bluffs, and Shell-Duck Creek CNAs include approximately 9,581 acres of land (3,877 ha) (CNAP 2009). CNAs are designated through a voluntary land management agreement between CNAP and a willing landowner. The

designation of a CNA officially recognizes the features of statewide significance that occur on a property and creates a formal relationship between the landowner and the State to monitor and protect those features. CNA designation allows CNAP to participate in management discussions and to provide resources such as funding, labor, and expertise to support stewardship, research, inventory, and monitoring of significant features. CNA agreements are voluntary and can be terminated at any time by either party with a 90-day written notice. However, the BLM directs the management of these CNAs through BLM Land Use Plans, and in the 30-year history of CNAP, only one out of 85 designations has been terminated (Kurzel, in litt 2009b).

Federal Laws and Regulations

The BLM's 1997 RMP designated ACECs and implemented NSO stipulations to protect bladderpod and twinpod on BLM land. However, these stipulations allow for exceptions, and leases predating the RMP are exempt from these requirements.

The ESA and its implementing regulations set forth a series of general trade prohibitions and exceptions that apply to threatened plants. 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 and reduce the species to possession from areas under Federal jurisdiction. The ESA also prohibits the malicious damage or destruction of areas under Federal jurisdiction and prohibits the removal, cutting, digging up, damaging, or destroying of threatened plants in knowing violation of any State law or regulation, including State criminal trespass law (50 CFR 17.71(a)).

Section 7(a) of the ESA, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if critical habitat is being designated. Regulations implementing this interagency cooperation provision of the ESA are codified at 50 CFR part 402. Section 7(a)(2) requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service. The ESA requires applicants to obtain a permit prior to removing plants from Federal lands.

If the species were delisted, the existing protections under the ESA would be removed. Per BLM policy, the species would be managed as a BLM sensitive species for at least 5 years, although this designation does not afford the same level of protection as for listed species. Furthermore, the NSO stipulation for plants occurring outside of ACECs would no longer apply to these species since the stipulation applies only to listed and candidate species.

Factor E: Other Natural or Manmade Factors Affecting Continued Existence of the Species

Small Populations and Geographic Range

The listing decision discussed the vulnerability of these species' small range and rarity. Although not a threat itself, having a small geographic range is a vulnerability that can exacerbate the effects of many of the threats evaluated in this assessment, such as mineral extraction and development, livestock and wild horse grazing, invasive species introductions, and OHV use. Compared to the effects of these threats on abundant and widespread species, impacts are proportionally larger to rare species with small geographic ranges. As population sizes decrease, a subsequent decrease in species representation caused by inbreeding depression and genetic drift becomes a greater concern. Populations with few individuals and low effective population size are likely to suffer from low genetic diversity (Ellstrand 1992; Ellstrand and Elam 1993; Karron et al. 1988; Loveless and Hamrick 1984). As population size diminishes, the chance of lost genetic diversity increases and the likelihood that gene flow from distant populations will replenish genetic variability decreases (Loveless and Hamrick 1984). The fragmented distribution of small populations further contributes to the feedback loop referred to as the extinction vortex (Soule 1986). Such depleted populations, and the species that they constitute, are more susceptible to both predictable and unexpected genetic, environmental, and demographic variables (Ellstrand 1992; Ellstrand and Elam 1993; Simberloff 1988; Soule 1987). Genetic analysis of bladderpod and twinpod shows moderate levels of genetic diversity in both species, though some occurrences of twinpod exhibited significant inbreeding (Schwabe and Ramp Neale 2016).

In addition, species with small geographic ranges are particularly susceptible to extirpation from stochastic or catastrophic events such as drought or wildland fire (McMullen 1998), due to their low levels of redundancy. This increased susceptibility is due to the likelihood that, although stochastic or catastrophic events are often localized in severity, such a localized event is more likely to impact a substantial portion of the species' range. The bladderpod and twinpod have relatively small geographic ranges, occurring within a 27 mile by 19 mile area.

Climate Change

Climate change was not addressed in the listing or recovery plan documents, but was identified as a potential threat in the 2008 5-year review. Monitoring by the BLM has shown climate events such as drought and heavy monsoonal rain to have the greatest impact on population trends of both species (Krening 2019). According to the Intergovernmental Panel on Climate Change, "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen" (IPCC 2014). During the second half of the 20th century, average Northern Hemisphere temperatures were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1,300 years (IPCC 2007). Since 1950, it is very likely that cold days, cold nights, and frosts have become less frequent on a global scale, and hot days and hot nights have become more frequent (IPCC 2007; IPCC 2014). Heat waves have likely become more frequent

over most land areas, and the frequency of heavy precipitation events has increased (IPCC 2007; IPCC 2014).

In the southwestern region of the United States, including western Colorado, warming is occurring more rapidly than elsewhere in the country, causing declines in winter snowpack and river flow (Karl et al. 2009). Under high-emission scenarios, the number of days over 90 degrees Fahrenheit could double by the end of the century (Karl et al. 2009). Future projections for the Southwest include increased temperatures, reductions in winter and spring precipitation, more intense and longer-lasting heat waves, and an increased probability of higher temperatures, heavier downpours, flooding, and erosion (Karl et al. 2009).

Monitoring has shown that the number of bladderpod and twinpod plants decreased during drought years but recovered in subsequent years with more moisture (BLM 1990; BLM 2002a; Rickey and Kurzel 2007; BLM 2018). The BLM recorded less than average precipitation in 2000, 2002, 2003, 2004, and 2006, along with loss of native vegetation, an increase in non-native species, and a decline in bladderpod and twinpod densities and abundance (BLM 2007). A 2016 monsoonal flood event and associated erosion are attributed to a significant decrease in bladderpod at the 1145 Road monitoring site. Heavier downpours, increased flooding, and increased erosion as a result of climate change could negatively affect the species over time..

The limited geographic range of the shale substrate that makes up bladderpod and twinpod habitat would likely limit the ability of the species to adapt to changes in climactic conditions by population migration. Climate change could exacerbate other threats to the species; however, the current data are not reliable enough at the local level for us to draw conclusions regarding the significance of climate change threats to bladderpod or twinpod.

ONGOING CONSERVATION EFFORTS

Inventory and Monitoring

Surveys and Mapping

The CNHP began tracking bladderpod and twinpod 1982 and has continued to update occurrence location records since that time. In 2009, the BLM instituted a mapping protocol for applicants proposing ground disturbing activities. The protocol required a survey distance of 656 ft (200 m) beyond the edge of proposed disturbances and mandatory reporting to CNHP. The protocol also included mandatory invasive species mapping in listed plant habitat (Marston, pers comm 2009b). In 2010, the BLM increased the required survey distance to 1,969 ft (600 m) to account for impacts to pollinator habitat (BLM 2010a).

In 2007, Rio Blanco County contracted CNHP to survey for critical biological resources in the County with funding provided by the County, Great Outdoors Colorado, CDOW, and the BLM. The purpose of the project was to provide a data resource for managers, planners, and citizens of Rio Blanco County for conducting proactive planning. The project produced updated records for three bladderpod occurrences and four twinpod occurrences and identified one new twinpod

occurrence. CNHP continues to maintain a state-wide database of rare plant occurrences, which includes bladderpod and twinpod.

Demographic Monitoring

Long- and short-term monitoring projects have been implemented, primarily in ACECs and CNAs. The CNAP has led monitoring of bladderpod and twinpod occurrences at Dudley Bluffs, Ryan Gulch, Duck Creek, and Yanks Gulch ACECs. Many of these monitoring locations were originally set up by the BLM and CNAP in the 1980s and 1990s. In 2009, the BLM and CNAP added three new Natural Areas with Articles of Designation to formalize a plan for cooperation and monitoring (Marston, pers comm 2009b). The CNAP also uses Volunteer Stewards who qualitatively monitor Duck Creek, Dudley Bluffs, and Ryan Gulch on an annual basis to observe rare plant occurrences and identify threats (Kurznel, in litt 2009a).

The BLM has conducted annual monitoring of twinpod since 2011 and of bladderpod since 2012. Since then, they have added additional monitoring sites for a total of four bladderpod sites and four twinpod sites (BLM 2018).

Mapping and Modeling

In 2006, CNHP used the Element Distribution Modeling process to map suitable habitat for bladderpod and twinpod. This map was further refined in 2013 using new occurrence data obtained after 2006.

Habitat Protection

Federal

Approximately 88 percent of total occupied habitat for bladderpod and twinpod occurs on public lands managed by the BLM. Under section 7(a)(1) of the ESA, Federal agencies are required to utilize their authorities in furtherance of the ESA by carrying out programs for the conservation of listed species. Agencies are also required to consult with the Service under section 7(a)(2) of the ESA if their actions may affect federally listed species.

The BLM has designated four ACECs, which contain approximately 56 percent of total occupied bladderpod and twinpod habitat. An ACEC designation carries no protective measures itself; however, specific conditions are often added to protect rare plants within ACECs. The Dudley Bluffs, Ryan Gulch, Duck Creek, and Yanks Gulch/Upper Greasewood ACECs are classified as avoidance areas for the permitting of land use authorizations. A NSO stipulation applies to the Ryan Gulch, Dudley Bluffs, and Duck Creek ACECs and for areas outside of ACECs that are mapped as occupied or suitable habitat (Marston, in litt 2009a). A NSO designation prohibits long-term use or occupancy of the land surface to protect identified resource values. Permitting and NSO exceptions may be granted on a case-by-case basis.

The BLM has made efforts to restrict motorized vehicle travel in all ACECs to designated roads and trails, with exceptions. Several four-wheel drive roads which intersected two bladderpod occurrences were closed in an effort to allow recolonization of the roads by these plants. Outside of ACECs, motorized vehicle travel is limited to existing routes within known and potential habitat for bladderpod and twinpod; however, routes have not been designated. Exceptions include camping, firewood collection, and game retrieval.

In 2009, the BLM, CNAP, and Shell installed fencing in the Duck Creek ACEC and Shell-Duck Creek Natural Area to protect bladderpod from motorized vehicles (Etzel, in litt 2009). Fencing was also installed in the Dudley Bluffs ACEC to minimize the impacts of livestock on bladderpod and twinpod plants, and a grazing exclosure was constructed in the Ryan Gulch ACEC to prevent livestock from entering occupied habitat.

The 2015 RPMA states that a plant inventory and environmental analysis is required prior to approving a surface-disturbing activity or other activity that could impact bladderpod or twinpod within occupied, suitable, or potential habitat. Under the RMPA, areas within 330 ft (101 m) of occupied habitat are excluded from new ROW authorizations; areas 330 to 660 ft (101 to 201 m) of occupied habitat or within 660 ft (201 m) of suitable habitat are considered avoidance areas for new ROW authorizations; and activities within 1,970 ft (600 m) of occupied habitat are subject to Conditions of Approval, which include conservation measures to minimize impacts to pollinators. Oil and gas leasing may occur within 660 ft (201 m) of occupied habitat with a NSO stipulation (BLM 2015).

State

Approximately 1.6 percent of the total occupied habitat for the bladderpod and twinpod occurs on State lands managed by CPW. The 1990 Recovery Plan recommended that the Service develop a cooperative agreement with CPW for management of the Yellow Creek bladderpod populations, since a portion of these populations occur on State lands. While the CPW often coordinates activities with the Service, a cooperative agreement as described has not been developed.

The CNAP has designated four CNAs containing bladderpod and twinpod plants, covering a total of 9,681 ac (3,918 ha). Of these total acres, 9,177 ac (3,714 ha) are located on BLM lands, and 504 ac (204 ha) are on property owned by Shell Frontier Oil and Gas, Inc. (CNAP 2009; Kurzel, in litt 2009b). A CNA is a voluntary land management agreement that explicitly details the resources for which an area is designated and outlines the roles of each partner in the stewardship of those values. This designation allows CNAP to sit at the table to partake in management discussions and to provide resources such as funding, labor, and expertise to support stewardship, research, inventory, and monitoring of significant features. While the agreement is voluntary and may be terminated at any time, in the 30 year history of the program, only one out of 85 designations has ever been terminated.

Private

Approximately 10 percent of the total occupied habitat for the bladderpod and twinpod occurs on private lands. A conservation easement applies to 504 ac (204 ha) owned by Shell in the Shell-Duck Creek Natural Area, including approximately 82 ac (33 ha) of bladderpod occupied habitat. The agreement includes a commitment by Shell to provide long-term protection for known bladderpod populations and suitable habitat in perpetuity; install fencing and “no trespassing” signs; and develop a conservation management and monitoring plan. In May of 2009, the BLM installed barrier fencing to protect bladderpod. The fencing is primarily on public lands, but four of the posts were installed in the Shell-Duck Creek Natural Area (Etzel, in litt 2009).

Research

The following projects and studies have been completed:

- 1987 Seed Collection

In 1987, bladderpod and twinpod seeds were collected by the Denver Botanic Gardens (DBG). During grow-out and germination experiments, both species were successfully grown from seed. Collected seed was deposited at the National Seed Storage Laboratory in Fort Collins, CO, and in a seed storage facility at DBG.

- Alkaloid Analysis

The CNAP provided funds to the DBG to perform alkaloid testing on the rarest plant species in the State, including the bladderpod and twinpod. Both species tested negative for alkaloid compounds.

- 2010 Seed Collection

The CNAP provided funds to the DBG to perform seed collection of the rarest species in the State, including the bladderpod and twinpod.

- Transplant and Seed Propagation

A study was conducted by researchers from Colorado State University to determine the best approach for establishing new populations of bladderpod and twinpod in suitable unoccupied habitat. The research included laboratory, greenhouse, and field studies, including transplanting and seeding 12 areas of suitable habitat and measuring plant establishment rates (Paschke and Jonas 2016).

- Soil Characteristics

ExxonMobil Production Company provided funds to Hayden-Wing Associates, LLC to analyze soil samples collected from occupied and unoccupied bladderpod and twinpod habitat. Preliminary analysis suggested that occupied habitat can be distinguished from unoccupied habitat that otherwise appears to be suitable based on phosphorus and sodium levels in the soil (Hayden-Wing Associates LLC 2010).

- Effects of Oil and Gas Development
A field study was conducted by BIO-Logic, Inc. to determine the indirect effects of oil and gas development on bladderpod and twinpod. The study focused primarily on the effects of unpaved roads. Results identified a correlation between proximity to development and bladderpod abundance and fecundity. This trend was not observed for twinpod (Graff and Alward 2012).
- Reproductive Biology and Impacts of Energy Development
A study was conducted by a student of Utah State University to determine the effects of oil and gas development on pollinators and the importance of pollination for bladderpod and twinpod reproduction. Results suggested little to no impact on the abundance of pollinators, nesting, or community composition due to oil and gas development within rare plant habitat. The small sample size may have inhibited the ability to detect differences in these attributes. The study also identified pollinator species that were most efficient in carrying bladderpod and twinpod pollen (Clark 2013).

Additional Conservation Actions

Sponsored by the Colorado Rare Plant Conservation Initiative, a preliminary Conservation Action Plan for bladderpod and twinpod was developed in 2008. A follow-up workshop was held in 2010 with participants from the BLM, CNHP, CNAP, Service, The Nature Conservancy, Utah State University, and private consultants. An updated Conservation Action Plan was produced in 2011, which includes strategies for alleviating threats to the bladderpod and twinpod (Panjabi and Neely 2011).

LITERATURE CITED

Al-Shehbaz, I.A., and S.L. O'Kane Jr. 2002. *Lesquerella* is united with *Physaria* (Brassicaceae). *Novon* :319-329.

Belsky, A.J., A. Matzke, and S. Uselman. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. *Journal of Soil and Water Conservation* 54(1):419-431.

Bureau of Land Management (BLM). 1989. Yanks Gulch ACEC Monitoring Evaluation.

Bureau of Land Management (BLM). 1990. White River RMP/EIS Management Situation Analysis Resource Area Profile.

Bureau of Land Management (BLM). 1996. White River Resource Area Proposed Resource Management Plan and Final Environmental Impact Statement.

Bureau of Land Management (BLM). 1997. White River Record of Decision and Approved Resource Management Plan. Craig District, Meeker, Colorado.

Bureau of Land Management (BLM). 2002a. Dudley Bluffs ACEC Monitoring Evaluation (November 14, 2002). White River Field Office, Meeker, Colorado.

Bureau of Land Management (BLM). 2002b. Ryan Gulch ACEC Monitoring Evaluation (November 14, 2002). White River Field Office, Meeker, Colorado.

Bureau of Land Management (BLM). 2007. Oil and Gas Resource Management Plan Amendment / Environmental Impact Statement: Analysis of the Management Situation.

Bureau of Land Management (BLM). 2008. Proposed Oil Shale and Tar Sands Resource Management Plan Amendments to Address Land Use Allocations in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement. 2.

Bureau of Land Management (BLM). 2009a. Approved Resource Management Plan Amendments/Record of Decision (ROD) for Designation of Energy Corridors on Bureau of Land Management-Administered Lands in the 11 Western States.

Bureau of Land Management (BLM). 2009b. Reasonable Foreseeable Development Scenario for Oil and Gas Activities in the BLM White River Field Office: Rio Blanco, Moffat and Garfield Counties, Colorado. White River Field Office, Meeker, Colorado.

Bureau of Land Management (BLM). 2010a. Letter to inform of changes to the White River Field Office (WRFO) Special Status Plant Species and Noxious Weed survey protocol.

Bureau of Land Management (BLM). 2010b. Re-initiation of informal Section 7 consultation for ExxonMobil installation of a 16-inch steel, 4-inch flexible gas pipeline. White River Field Office, Meeker, Colorado.

Bureau of Land Management (BLM). 2013. Approved Land Use Plan Amendments/Record of Decision (ROD) for Allocation of Oil Shale and Tar Sands Resources on Lands Administered by the Bureau of Land Management in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement.

Bureau of Land Management (BLM). 2015. White River Field Office Record of Decision and Approved Resource Management Plan Amendment for Oil and Gas Development. White River Field Office, Meeker, Colorado.

Bureau of Land Management (BLM). 2017. BLM - Colorado Threatened and Endangered Plant Species 2017 Monitoring Summary and Status Report.

Bureau of Land Management (BLM). 2018. BLM Colorado Oil and Gas Leases. ArcGIS Map Service.

Bureau of Land Management (BLM). 2018. BLM - Colorado Threatened and Endangered Plant Species Monitoring Program 2018 Status Report.

Cane, J. 2001. Habitat fragmentation and native bees: a premature verdict? *Conservation Ecology* 5(1).

Clark, S.L. 2013. Reproductive biology and impacts of energy development on *Physaria congesta* and *Physaria obcordata* (Brassicaceae), two rare and threatened plants in the Piceance Basin, Colorado.

Colorado Division of Wildlife, and US Fish and Wildlife Service (USFWS). 2007. Final Environmental Assessment: Piceance Property Exchange Involving Lands and Water Rights Owned by Colorado Division of Wildlife and Shell Frontier Oil & Gas Inc.

Colorado Natural Areas Program (CNAP). 2009. Shell-Duck Creek Natural Area Articles of Designation.

Colorado Natural Heritage Program (CNHP). 2013. Iterative Distribution Modeling for Two Endemic Plants of the Northern Piceance Basin.

Colorado Natural Heritage Program (CNHP). 2014. Colorado Rare Plant Guide: *Penstemon debilis*, www.cnhp.colostate.edu.

Colorado Natural Heritage Program (CNHP). 2018a. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 11232. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018b. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 1241. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018c. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 3286. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018d. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 4006. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018e. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 5963. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018f. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 8318. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018g. Level 1 Element Occurrence Report: *Physaria congesta* EO ID 9789. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018h. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 1254. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018i. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 13184. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018j. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 13871. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018k. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 15000. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018l. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 15351. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018m. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 4508. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018n. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 5242. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018o. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 61. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018p. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 6830. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018q. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 7014. Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program (CNHP). 2018r. Level 1 Element Occurrence Report: *Physaria obcordata* EO ID 8694. Colorado State University, Fort Collins, Colorado.

Committee on Natural Resources. 2018. Hearing Memorandum: Examining the Natural Gas and Oil Shale Opportunities in Western Colorado. In May 25, 2018, .

Crawford, P.M., C. Dean, J. Stone, and J. Killen. 2012. Assessment of Plans and Progress on US Bureau of Land Management Oil Shale RD&D Leases in the United States.

D'Antonio, C.M., and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. *Annual Review of Ecology and Systematics* 23(1):63-87.

Debinski, D.M., and R.D. Holt. 2000. A survey and overview of habitat fragmentation experiments. *Conservation Biology* 14(2):342-355.

Dukes, J.S., and H.A. Mooney. 2004. Disruption of ecosystem processes in western North America by invasive species. *Revista chilena de historia natural* 77(3):411-437.

- Duncan, D.C. 1974. Four newly named tongues of Eocene Green River Formation, Northern Piceance Creek Basin, Colorado.
- Dupire, M. 2018a. Email communication from Matthew Dupire (BLM) to Aimee Crittendon (Service): New Occurrence of Dudley Bluffs Twinpod. April 16, 2018.
- Dupire, M. 2018b. Crittendon, A. Planned Pipeline Erosion Control in Occupied Twinpod Habitat.
- Ellstrand, N.C. 1992. Gene flow by pollen: implications for plant conservation genetics. *Oikos* :77-86.
- Ellstrand, N.C., and D.R. Elam. 1993. Population genetic consequences of small population size: implications for plant conservation. *Annual Review of Ecology and Systematics* 24(1):217-242.
- Energy Information Administration. 2007. US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2007 Annual Report. :B-1.
- Etzel, K. 2009. Ewing, C. BLM and Shell Bladderpod Barrier Fencing.
- Farmer, A.M. 1993. The effects of dust on vegetation—a review. *Environmental pollution* 79(1):63-75.
- Federal Register notice. 1990. Endangered and Threatened Wildlife and Plants; Final Rule to Determine *Lesquerella congesta* (Dudley Bluffs Bladderpod) and *Physaria obcordata* (Dudley Bluffs Twinpod) to be Threatened Species. 55 Federal Register 4152.
- Forman, R.T., and L.E. Alexander. 1998. Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 29(1):207-231.
- Gathmann, A., and T. Tschardt. 2002. Foraging ranges of solitary bees. *Journal of Animal Ecology* 71(5):757-764.
- Gess, F. 1993. Effects of increasing land utilization on species representation and diversity of aculeate wasps and bees in the semi-arid areas of southern Africa. *Hymenoptera and biodiversity*.
- Giesen, K.M. 1995. Evaluation of livestock grazing and residual herbaceous cover on Sage Grouse nest success. Final Report.
- Graff, A., and R. Alward. 2012. Quantifiable Effects of Oil and Gas Development on Dudley Bluffs Bladderpod (*Physaria congesta*) and Dudley Bluffs Twinpod (*Physaria obcordata*) and their Habitats in Western Colorado. BIO-Logic, Inc., Montrose, Colorado.
- Greenleaf, S.S., N.M. Williams, R. Winfree, and C. Kremen. 2007. Bee foraging ranges and their relationship to body size. *Oecologia* 153(3):589-596.

Guthery, F.S., and R.L. Bingham. 1996. A theoretical basis for study and management of trampling by cattle. *Journal of Range Management* :264-269.

Hardy, M., M. Ramey, C. Yates, and K. Nielsen. 2003. Solution Mining of Nahcolite at the American Soda Project, Piceance Creek, Colorado.

Hayden-Wing Associates LLC. 2010. Soil Characteristics of Occupied and Unoccupied Habitat of Dudley Bluffs Twinpod and Dudley Bluffs Bladderpod in the Northern Piceance Creek Basin of Northwestern Colorado. A report prepared for ExxonMobil Production Company. Hayden-Wing Associates, LLC, Laramie, Wyoming.

Holsinger, K. 2009a. Personal correspondence.

Holsinger, K. 2009b. Track Changes: comments on Rough Draft Recovery Plan.

Hubbard, R.E., and R.M. Hansen. 1976. Diets of wild horses, cattle, and mule deer in the Piceance Basin, Colorado. *Journal of Range Management* :389-392.

Huenneke, L.F., and J.K. Thomson. 1995. Potential interference between a threatened endemic thistle and an invasive nonnative plant. *Conservation Biology* 9(2):416-425.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: Synthesis report. Contribution of working groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change :104.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)] .

Jones, A. 2000. Effects of cattle grazing on North American arid ecosystems: a quantitative review. *Western North American Naturalist* :155-164.

Karl, T.R., J.M. Melillo, T.C. Peterson, and S.J. Hassol. 2009. Global climate change impacts in the United States. Cambridge University Press.

Karron, J.D., Y.B. Linhart, C.A. Chaulk, and C.A. Robertson. 1988. Genetic structure of populations of geographically restricted and widespread species of *Astragalus* (Fabaceae). *American Journal of Botany* 75(8):1114-1119.

Krening, P. 2019. Peer Review Comments on the Species Biological Report: Dudley Bluffs Bladderpod (*Physaria* (*Lesquerella*) *congesta*) and Dudley Bluffs Twinpod (*Physaria* *obcordata*).

Kuhn, D.B. 2006. Highway Freight Traffic Associated with the Development of Oil and Gas Wells. Utah Department of Transportation.

- Kurz, B. 2009. Draft Dudley Bluffs Recovery Plan: CNAP Comments.
- Kurzel, B. 2009a. Ewing, C. Dudley Bluffs Conservation Efforts: Colorado Natural Areas Program. June 9, 2009.
- Kurzel, B. 2009b. Ewing, C. Natural Areas containing Dudley Bluffs plants. July 20, 2009.
- Lesica, P., and J.S. Shelly. 1996. Competitive effects of *Centaurea maculosa* on the population dynamics of *Arabis fecunda*. *Bulletin of the Torrey Botanical Club* :111-121.
- Loveless, M.D., and J.L. Hamrick. 1984. Ecological determinants of genetic structure in plant populations. *Annual Review of Ecology and Systematics* 15(1):65-95.
- Mackie, R.J. 1978. Impacts of livestock grazing on wild ungulates. In *Transactions of the North American Wildlife and Natural Resources Conferences*, .
- Marston, M. 2009a. Ewing, C. ACEC NSO Stipulations. July 10, 2009.
- Marston, M. 2009b. Ewing, C. BLM *Physaria congesta* and *Physaria obcordata* conservation measures.
- Masters, R.A., and R.L. Sheley. 2001. Principles and practices for managing rangeland invasive plants. *Journal of Range Management* :502-517.
- McMullen, A.L. 1998. Factors concerning the conservation of a rare shale endemic plant: the reproductive ecology and edaphic characteristics of *Penstemon debilis* (Scrophulariaceae). Master of Science. Utah State University, Logan, Utah.
- Miller, Z. 2012. Sharp, C. Wild horse confinement in White River Field Office Herd Management Areas. March 19, 2012.
- Mooney, H.A., and E.E. Cleland. 2001. The evolutionary impact of invasive species. *Proceedings of the National Academy of Sciences of the United States of America* 98(10):5446-5451.
- Myers-Smith, I.H., B.K. Arnesen, R.M. Thompson, and F.S. Chapin III. 2006. Cumulative impacts on Alaskan arctic tundra of a quarter century of road dust. *Ecoscience* 13(4):503-510.
- National Oil Shale Association. 2017. U.S. Oil Shale Opportunity: An Untapped Domestic Oil & Gas Resource Waiting to Create Jobs, Generate Tax & Royalty Revenues and Further Domestic Energy Security.
- O'Kane, S.L. 1987. Status Report for *Physaria obcordata*.

- O'Kane, S.L., I.A. Al Shehbaz, and N.J. Turland. 1999. Proposal to conserve the name *Lesquerella* against *Physaria* (Cruciferae). *Taxon* 48(1):163-164.
- Olsen, B.E. 1999. Impacts of noxious weeds on ecologic and economic systems. *Biology and management of noxious rangeland weeds* :19-35.
- Panjabi, S., and B. Neely. 2011. Piceance Basin Conservation Action Plan 2011 Update. The Nature Conservancy and the Colorado Natural Heritage Program.
- Paschke, M., and J. Jonas. 2016. Restoring Populations of Threatened *Physaria* species in the Piceance Basin: 2016 Annual Report.
- Pavlik, B.M. 1994. Demographic monitoring and the recovery of endangered plants. *Restoration of endangered species: conceptual issues, planning and implementation* :322-350.
- Rickey, M., and B.P. Kurzel. 2007. Ten-year population trends in *Lesquerella congesta* at Duck Creek Area of Critical Concern. Colorado Natural Areas Program, Denver, Colorado.
- Roberts, R. 2010a. Associated plant Species Observed on Dudley Bluffs Bladderpod and Twinpod Occupied Habitats.
- Roberts, R. 2010b. Conversation Record.
- Roberts, R. 2010c. Piceance Basin Geology in Relationship to Rare Plant Habitats. Personal Observation.
- Rollins, R.C. 1983. Studies in the Cruciferae of Western North America. *Journal of the Arnold Arboretum* 64(4):491-510.
- Rollins, R.C. 1984. Studies in the Cruciferae of Western North America II. Contributions from the Gray Herbarium of Harvard University (214):1-18.
- Sanders, T.G. 2008. Road Dust Suppressants Research Results.
- Schonewald-Cox, C.M., S.M. Chambers, B. MacBryde, and W.L. Thomas editors. 1983. *Genetics and conservation; a reference for managing wild animals and plant populations*. London (UK) Benjamin/Cummings, .
- Simberloff, D. 1988. The contribution of population and community biology to conservation science. *Annual Review of Ecology and Systematics* 19(1):473-511.
- Soule, M.E. 1986. *Conservation biology: the science of scarcity and diversity*. Sinauer, Sunderland, MA .
- Soule, M.E. 1987. *Viable populations for conservation*. Cambridge university press.

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

Tepedino, V.J. 2009. The Pollination Biology of a Piceance Basin Endemic, *Physaria obcordata* (Cruciferae). Utah State University, Logan, Utah.

Tepedino, V.J., W.R. Bowlin, and T.L. Griswold. 2012. Pollinators complicate conservation of an endemic plant: *Physaria obcordata* (Cruciferae) in the Piceance Basin, Colorado. *Natural Areas Journal* 32(2):140-148.

U.S. Fish and Wildlife Service (USFWS). 1993. Dudley Bluffs Bladderpod and Dudley Bluffs Twinpod Recovery Plan.

U.S. Fish and Wildlife Service (USFWS). 2008. Dudley Bluffs Bladderpod (*Lesquerella congesta* or *Physaria congesta*) and Dudley Bluffs Twinpod (*Physaria obcordata*) 5-Year Review Summary and Evaluation.

U.S. Fish and Wildlife Service (USFWS). 2009. Dudley Bluffs Plants GIS Derived Spreadsheets and Maps.

U.S. Fish and Wildlife Service (USFWS). 2010. Integrated Weed Management Plan for the BLM White River Field Office: Biological Opinion.

U.S. Fish and Wildlife Service (USFWS). 2012. Draft Guidance for Section 7 Consultations that Include Plants Within the State of Colorado. Personal Observation.

U.S. Fish and Wildlife Service (USFWS). 2016. USFWS Species Status Assessment Framework: an integrated analytical framework for conservation, Version 3.4 dated August 2016.

U.S. Fish and Wildlife Service (USFWS). 2017. Concurrence with the Biological Assessment for the Addition of Aminopyralid, Rimsulfuron, and Fluroxypyr to the WRFO IWMP.

U.S. Forest Service (USFS). 2018. Wildfire Hazard Potential. ArcGIS Map Service .

Wolf, S., B. Hartl, C. Carroll, M.C. Neel, and D.N. Greenwald. 2015. Beyond PVA: why recovery under the Endangered Species Act is more than population viability. *Bioscience* 65(2):200-207.

Young, J.A., and W.S. Longland. 1996. Impact of alien plants on Grant Basin rangelands. *Weed Technology* 10(2):384-391.