

Schoenocrambe barnebyi (Barneby Reed-Mustard)

5-Year Review: Summary and Evaluation



Photo by Tom Clark, National Park Service; used with permission.

**U.S. Fish and Wildlife Service
Utah Field Office – Ecological Services
West Valley City, Utah 84119**

July 2011

5-YEAR REVIEW
***Schoenocrambe barnebyi* (Barneby reed-mustard)**

1 GENERAL INFORMATION

1.1 Purpose of 5-Year Reviews

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

1.2 Reviewers

Lead Regional Office: Mountain-Prairie Region (Region 6)
Mike Thabault, Assistant Regional Director-Ecological Services, 303-236-4210
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1.3 Methodology Used to Complete the Review

On October 6, 2008, we published a Notice of Review in the Federal Register (FR) (73 FR 58261) soliciting any new information on the *Schoenocrambe barnebyi* (Barneby reed-mustard) that may have a bearing on its classification as endangered or threatened. We did not receive any comments in response to the FR notice. This 5-year review was primarily written by the Utah Field Office with substantive contributions and review by the Mountain-Prairie Regional Office. It summarizes and evaluates information provided in the recovery plan, current scientific research, and surveys related to the species. All pertinent literature and documents on file at the Utah Field Office were used for this review (See References section below for a list of cited documents). We interviewed individuals familiar with *S. barnebyi* as needed to obtain specific information.

1.4 Background

1.4.1 FR Notice Citation Announcing Initiation of This Review

73 FR 58261, October 6, 2008

1.4.2 Listing History

Original Listing

FR notice: 57 FR 1398, January 14, 1992

Entity listed: Species

Classification: Endangered range-wide

1.4.3 Review History

Since the Federal listing of *Schoenocrambe barnebyi* in 1992, we have not conducted a status review or 5-year review. However, we considered the species' status in the 1994 Recovery Plan (USFWS 1994).

1.4.4 Species' Recovery Priority Number at Start of 5-year Review

At the start of this 5-year review, the Recovery Priority Number (RPN) for *Schoenocrambe barnebyi* was 11. This number indicated: 1) the plant was listed as a full species; 2) populations face a moderate degree of threat; and 3) recovery potential is low (see TABLE 1).

TABLE 1. The ranking system for determining RPNs was established in 1983 (48 FR 43098, September 21, 1983, as corrected in 48 FR 51985, November 15, 1983).

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

1.4.5 Recovery Plan

Name of Plan: Utah Reed-Mustards: Clay Reed-Mustard (*Schoenocrambe argillacea*), Barneby Reed-Mustard (*Schoenocrambe barnebyi*), Shrubby Reed-Mustard (*Schoenocrambe suffrutescens*) Recovery Plan (hereafter referred to as the “Recovery Plan”).

Date Approved: September 14, 1994

2 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment Policy

This section of the 5-year review is not applicable to this species because the ESA precludes listing Distinct Population Segments (DPSs) for plants. For more information, see our 1996 DPS policy (61 FR 4722, February 7, 1996).

2.2 Recovery Planning and Implementation¹

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

2.2.2 Adequacy of recovery plan?

The recovery criteria are no longer reflective of the best scientific information available. The Recovery Plan is 17 years old, and much of the information is now dated and inaccurate. Section 4(F)(1)(B)(ii) defines “objective, measurable criteria” as those that when met, would result in a determination that the species be removed from the ESA. In order to determine whether a species is endangered or threatened, or has improved to the point of reclassification or delisting, the ESA requires an explicit analysis of the 5 listing/delisting factors. The recovery objectives and criteria found in the 1994 Recovery Plan do not reference the five listing/delisting factors. In addition, we need to reevaluate the recovery criteria target for achieving populations of 2,000 plants as we do not know if that constitutes a minimum viable population size. Nevertheless, the species’ status relative to these criteria are discussed below so as to show progress, or lack thereof, toward recovery.

2.2.3 Progress Toward Recovery

Criterion 1: Discover or establish 5 populations of 2,000 or more individuals per population for downlisting and 10 populations of 2,000 or more individuals per population for delisting. These populations must be demonstrated to be at or above minimum viable population levels.

Status: Comprehensive surveys within suitable habitat throughout the range of the species are not complete. The limited survey information we have, predominantly from Capitol Reef National Park (Capitol Reef), indicates there are fewer than 3,000 individuals across the entire range of

the species. This estimate is far fewer than the 10,000-20,000 individuals recommended in the Recovery Plan. In addition, we have not determined a minimum viable population size for *Schoenocrambe barnebyi*. The first demographic-based recovery criterion is **not met**.

Criterion 2: Establish formal land management designations which would provide for long-term protection on undisturbed habitat.

Status: We have not established conservation areas or other land management designations that provide protection specifically for *Schoenocrambe barnebyi* for any of the known populations. Bureau of Land Management (BLM) has no formal land designation specifically protecting *S. barnebyi*; however, one Wilderness Study Area (WSA) and three designated Areas of Critical Environmental Concern (ACECs) are in the vicinity of the plant's recorded site locations and contain suitable habitat (see section 2.3.2.4 below). Because comprehensive range-wide surveys have not been done and historical site locations were not recorded accurately (see section 2.3.1.1 below), we do not know the extent to which these land management designations may provide protection to the species on BLM lands. Existing laws, regulations, and policies within Capitol Reef (see section 2.3.2.4 below) provide protection for the species on their lands from the threats that led to the original listing (see section 2.3.2 below). This recovery criterion is **partially met**.

Recovery Plan Actions

In addition to the above criteria, the Recovery Plan includes recovery actions. In this section, we briefly review our progress for each action.

(1) Control mineral development and other activities in *Schoenocrambe barnebyi* habitat through Sections 7 and 9 of the ESA and other relevant laws and regulations. We completed several Section 7 consultations since listing *Schoenocrambe barnebyi* (1992) and publishing the Recovery Plan (USFWS 1994). We completed three noteworthy programmatic Section 7 consultations with the BLM: the Richfield Field Office Resource Management Plan (RMP) (BLM 2008a), the Price Field Office RMP (BLM 2008b), and the Renewal of 17 Grazing Allotments in the San Rafael Swell (BLM 2009). These consultations included conservation measures designed to minimize impacts to this species and its habitat that may result from the implementation of BLM-authorized activities. Specific conservation measures included conducting intensive surveys and monitoring activities, avoiding surface disturbance in habitat, dispersing recreational activities away from habitat, and avoiding key habitats during livestock trailing and herding activities. However, not all conservation measures are initiated, for instance the monitoring and surveying have not begun.

We are not aware of any violations under Section 9 of the ESA. The species occur in a very remote area in the San Rafael Swell making documentation of unauthorized access and law enforcement particularly problematic for this species.

This recovery action is **ongoing** as projects are proposed that may affect *Schoenocrambe barnebyi*.

- (2) **Inventory suitable habitat and determine population and distribution.** In 1994, we estimated the total number of *Schoenocrambe barnebyi* plants to be approximately 2,000 and knew of only 2 populations containing 3 sites (Ecosphere Environmental Services (Ecosphere) 1992; USFWS 1994), the majority of which were thought to occur on BLM lands (Ecosphere 1992). We now estimate the total population to be approximately 2,251 individuals within 4 *S. barnebyi* populations containing a total of 15 sites, the majority of which are located on Capitol Reef lands (Clark 2005a; see section 2.3.1.2 below). The most recent estimates report less than 200 plants from BLM lands (Clark 2005a; see section 2.3.1.2 below). Despite this available information, comprehensive survey information is severely lacking or existing information is outdated, as further described below. Thus, we do not have sufficient information to provide an accurate picture of population numbers or distribution for *S. barnebyi*.

The species is known to occur on the Moenkopi Formation, Kaibab Limestone, and on the Carmel Formation. Comprehensive surveys within Capitol Reef on suitable habitat on north-facing, steep talus slopes of the Moenkopi Shale and Kaibab Limestone Formations determined there were approximately 2,100 acres of suitable habitat (Clark 1997). We do not know how much habitat exists within Capitol Reef on the Carmel Formation as this habitat type was not comprehensively surveyed (Clark 2005a). Comprehensive surveys for suitable habitat on BLM lands have not been done. Therefore, we do not know how much suitable habitat exists on BLM lands.

This recovery action is **partially met**. Comprehensive surveys are needed to provide us with accurate population estimates and species distribution across the entire range.

- (3) **Establish and conduct monitoring, biological, ecological, life history, and minimum viable population studies; evaluate the phylogenetic relationships between *Schoenocrambe* species.** One monitoring site at Capitol Reef documented a decline in the number of plants between 1994 and 2001 (Anderton 2002; Clark 1997; see TABLE 3). There are some studies regarding *Schoenocrambe* at the

genus level, but no genetics studies specific to *S. barnebyi* (see section 2.3.1.4 for further information). No other studies researching the biology, ecology, population viability, or any other type of demographic studies are available.

This recovery action is **not met**.

- (4) Establish formal land management designations which would provide for habitat protection for this species.** There are no conservation areas or other land management designations that provide protection specifically for *Schoenocrambe barnebyi*. The BLM has no formal land designation specifically protecting *S. barnebyi*. One WSA and three designated ACECs are in the vicinity of the plant's recorded site locations (see section 2.3.2.4 below). However, because comprehensive range-wide surveys are not available (see section 2.3.1.1 below), we do not know the extent to which these land management designations provide protection to the species on BLM lands. Existing laws, regulations, and policies within Capitol Reef (see section 2.3.2.4 below) provide protection for the species and its habitat on their lands from the threats that led to the original listing (see section 2.3.2 below).

Although there are no formal land management designations that specifically protect the species' habitat, the intent of this recovery action is **partially met**. At least 2,100 acres of suitable habitat and 75% of the known populations occur within Capitol Reef and are afforded protection through existing laws, regulations, and policies (Clark 1997, 2005a; see section 2.3.2.4 below).

- (5) Propagate individuals of each species in horticultural facilities.** We are not aware of any seed germination trials or attempts to propagate *Schoenocrambe barnebyi* (Center for Plant Conservation (CPC) 2010; see section 2.3.2.2 below).

This recovery action is **not met**.

- (6) Establish new populations/stands.** There are no new populations established and no efforts are underway to create new populations of the species. We do not fully understand what caused the rarity of *Schoenocrambe barnebyi* nor do we fully understand the threats the species faces because we lack long-term demographic and monitoring data for this species. Thus, we no longer consider establishing new populations of species a viable alternative until we fully understand what caused the rarity of the species in the first place, and the ramifications that reintroductions may have at the population level (i.e., outcrossing).

This recovery action is **not met**.

(7) **Develop public awareness, appreciation, and support for the conservation of *Schoenocrambe barnebyi*.** Capitol Reef had a public display in their visitors' center promoting awareness and educating the public about rare plants within Capitol Reef and their unique relationship to the local geology. The display was removed in 2009 due to old age. Capitol Reef has no plans to restore the display at this time.

This recovery action is **not met**.

2.3 Updated Information and Current Species Status

2.3.1 Background on the Species

2.3.1.1 Biology and Life History

We have little information on the biology and life history of *Schoenocrambe barnebyi*. *S. barnebyi* is a perennial herb in the mustard family (Brassicaceae). Plants reproduce sexually and flower from late April to mid or late May (Welsh and Neese 1984). Gravity, wind and rain are thought to be the primary dispersal agent of seeds (Welsh and Neese 1984).

We now know that *Schoenocrambe barnebyi* occurs on the Moenkopi, Chinle, Cutler, Kaibab Limestone, and Carmel Formations (Clark 1997, 1999, 2005a). Prior to 2005, *S. barnebyi* was thought to be restricted to red clay soils derived from the Moenkopi and Chinle formations. The majority of populations were located on members of the Moenkopi Formation but some plants were found on adjacent geological formations including the Chinle and Cutler Formations and Kaibab Limestone (Clark 1997, 1999, 2005a). Then in 2005, a new population (Horse Saddle—for further information see section 2.3.1.2 below) was discovered on the eastern edge of Capitol Reef on the Carmel Formation (Clark 2005a). This population location represents a new substrate type previously not known to support *S. barnebyi*. No other surveys were conducted on the Carmel Formation, so we do not know to what extent this formation supports the species.

The majority of the known occupied sites are on cool, steep, north-facing slopes, along mid- or upper-slopes in pinyon pine/juniper communities. Therefore, most surveys have focused on this habitat type. Occasionally, plants are found down slope of occupied sites where seeds have rolled or been blown downhill. Plants also may occur on different exposures in the higher elevation sites, potentially due to cooler temperatures (Clark 2005a). As mentioned above, the species was found on the Carmel Formation 6 years ago and this formation has not been surveyed throughout the range of the species. Furthermore, many of the survey data we have for the species pre-date global positioning systems when site

locations were recorded to the nearest township, range and section, or dots were placed on 1:24,000 topo maps to depict the general location of the site. Therefore, we do not fully understand the species' habitat use and distribution across the landscape. More research and survey work must be completed to better assess the biology and life history of *Schoenocrambe barnebyi* in order to better assess the threats the species faces.

2.3.1.2 Distribution, Abundance, and Trends

Schoenocrambe barnebyi is a narrow endemic species, which is a species that has a limited distribution range due to geographic or physical barriers. We believe the soil substrate required for growth may be a limiting factor for this species (see section 2.3.1.1 above). Plants occur between 5,000 and 6,850 feet (ft) (1,524 and 2,088 meters (m)) in elevation (see TABLE 2).

Schoenocrambe barnebyi's range is restricted to BLM and Capitol Reef lands in northern Wayne and southern Emery counties in central Utah (see FIGURE 1). We do not have a clear understanding of the total distribution, or even the potential available habitat, for this species on these lands. For example, we know of approximately 2,100 acres of suitable habitat on north-facing, steep talus slopes of the Moenkopi Shale and Kaibab Limestone formations in the northern parts of Capitol Reef (Clark 1997). However, we do not know how much habitat exists within Capitol Reef on the Carmel Formation because these areas have not been assessed (Clark 2005a). In addition, habitat suitability across the species range on BLM land has not been assessed, and we do not have comprehensive surveys in these areas.

When we published the Recovery Plan, we estimated the total number of *Schoenocrambe barnebyi* plants to be approximately 2,000 and knew of only 2 populations² containing 3 sites (Ecosphere 1992; USFWS 1994):

- One population with two sites was on BLM land (Sy's Butte/Hidden Splendor Mine population).
- One population with one site was within Capitol Reef (Sulphur Creek population).

The majority of plants were thought to occur within the Sy's Butte/Hidden Splendor Mine population on BLM lands (USFWS 1994; Ecosphere 1992).

We now estimate the total population to be approximately 2,251 individuals within 4 *Schoenocrambe barnebyi* populations containing a total of 15 sites (Clark 2005a; see TABLE 2). The majority of individuals (approximately 75%) are now thought to occur within Capitol Reef:

- One population with 2 sites is on BLM lands (Sy's Butte/Hidden Splendor Mine population).
- Three populations with 13 sites are located in Capitol Reef (Freemont River (5 sites), Sulphur Creek (7 sites), and Horse Saddle populations (1 site)).

The Sy's Butte/Hidden Splendor Mine population is the only known population in Emery County and occurs on BLM lands. This population occurs in the southern portion of the San Rafael Swell, north and east of Muddy Creek, and along the San Rafael Reef (see FIGURE 1). As stated previously, this population contains two known sites: Sy's Butte (type locality discovered in 1980) and Hidden Splendor Mine (see TABLE 2). These two sites were visited several times since their original discovery in 1980. The Sy's Butte/Hidden Splendor population was estimated to have 2,000 plants in 1992 (Ecosphere 1992); however, we do not have specifics on how these estimates were derived. Repeat inventories of the Sy's Butte site counted only 25 plants in 1981, 40 in 1984, and 30 in 1985 (Anderson 1985)—no information is available for the Hidden Splendor Mine site during these years. Additional surveys in 1999 reported 31 plants from the Sy's Butte site and 49 plants from the Hidden Splendor site (Clark 1999)—not all habitats in the area were surveyed in 1999 due to its steepness (Clark 1999). In 2009, the Sy's Butte site was surveyed again and 89 plants were counted (Ivory 2009). In summary, we do not know the accuracy of the 1992 estimate of 2,000 plants for the Sy's Butte/Hidden Splendor Mine population. In addition, we do not believe the more recent surveys were comprehensive, and thus they likely do not provide accurate population numbers or trend information.

TABLE 2. Total estimated number of plants in four populations of *Schoenocrambe barnebyi* (Clark 1997, 2005b; Ivory 2009).

SITE NAME	LAST YEAR SURVEYED	AGENCY	ELEVATION	# OF PLANTS
Sy's Butte/Hidden Splendor Mine Population				
Sy's Butte	2009	BLM	5,807 ft (1,770 m)	89
Hidden Splendor Mine	1999	BLM	5,000 ft (1,524 m)	31
<i>Subtotal</i>				120
Fremont River Population				
Fremont River #1	1997	Capitol Reef	5,669–5,770 ft (1,728–1,759 m)	65
Fremont River #2	1997	Capitol Reef		144
Fremont River #3	1997	Capitol Reef		92
Fremont River	1997	Capitol Reef	5,974–6,178 ft (1,821–1,883 m)	4
Cuts Ridge/Fremont River	2004	BLM, Capitol Reef	6,646–6,850 ft (2,026–2,088 m)	108
<i>Subtotal</i>				413
Sulphur Creek Population				
Sulphur Creek #1	1997	Capitol Reef	5,533 ft (1,717 m)	326
Sulphur Creek #2	1997	Capitol Reef	5,682 ft (1,732 m)	125
Sulphur Creek #3	1997	Capitol Reef	5,873 ft (1,790 m)	13
Sulphur Creek #4	1997	Capitol Reef	5,935 ft (1,809 m)	350
Upper Sulphur Creek	1997	Capitol Reef	5,909–6,063 ft (1,801–1,848 m)	700
Sulphur Creek	1997	Capitol Reef	5,741 ft (1,750 m)	3
Johnson Mesa/Sulphur Creek	1997	Capitol Reef	6,575 ft (2,004 m)	109
<i>Subtotal</i>				1,626
Horse Saddle				
Horse Saddle	2005	Capitol Reef	6,362 ft (1,939 m)	92
<i>Subtotal</i>				92
TOTAL				2,251

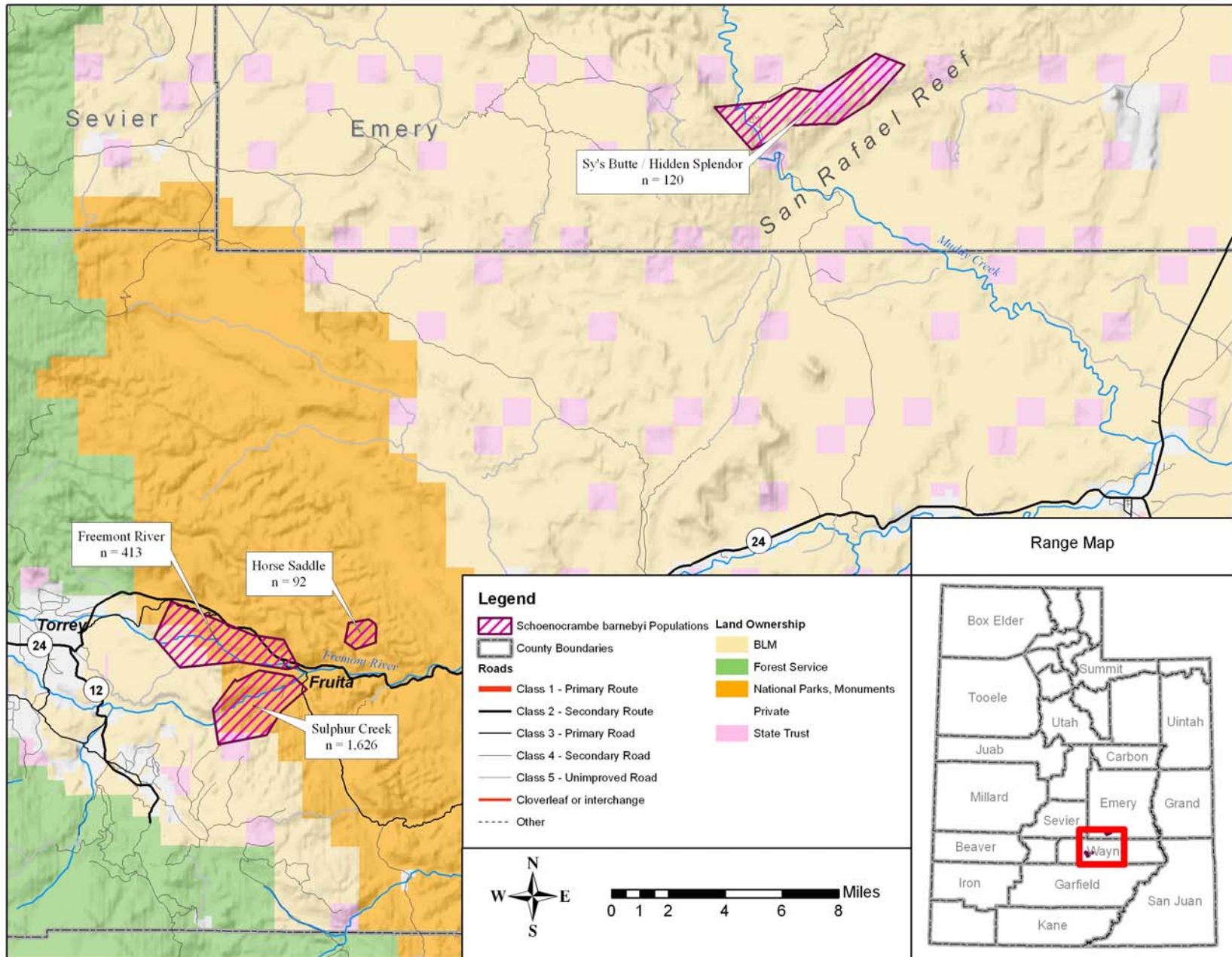


FIGURE 1. Distribution Map of *Schoenocrambe barnebyi* in Emery and Wayne Counties in Central Utah.

The Fremont River population is in Wayne County, within Capitol Reef, and is near Fruita, Utah (see FIGURE 1). Suitable habitats on Moenkopi Shale and adjacent Kaibab Limestone were surveyed within Capitol Reef in 1997—four *Schoenocrambe barnebyi* sites were documented within the Fremont River population (Clark 2005b). A fifth site was discovered in 2004 (Clark 2005a). A total of 413 plants were counted within this population from the 1997 and 2004 surveys (Clark 2005b). This represents the second largest population. Surveys were comprehensive and included all known habitats, except for the Carmel Formation. All sites within the Fremont River population were only visited once and, therefore, we do not have any trend data. Four of the five sites were last visited in 1997 and the fifth site was visited in 2004; therefore, we do not have current information for this population.

The Sulphur Creek population is in Wayne County, occurs within Capitol Reef, is south of Fruita, Utah, and is south of the Fremont River population (see FIGURE 1). Suitable habitats on Moenkopi Shale and adjacent Kaibab Limestone were surveyed within Capitol Reef in 1997—seven *Schoenocrambe barnebyi* sites were documented within the Sulphur Creek population, including one previously reported site (Clark 1997, 2005b). A total of 1,626 plants were counted within this population in 1997 and, therefore, represents the largest population (Clark 2005a). Surveys were comprehensive and included all known habitats, except for the Carmel Formation. All but one site within the Sulphur Creek population were visited only once and, therefore, we do not have any trend data for the population. With the exception of the monitoring plot at one site, the most recent surveys were conducted in 1997; therefore, we do not have current information for this population. One monitoring plot was established in this population in 1994. Results are discussed below.

The Horse Saddle population is in Wayne County, occurs within Capitol Reef, is north-east of Fruita, Utah, and is located at the Horse Mesa saddle (see FIGURE 1). The Horse Saddle population is located approximately 4 air miles (6.4 kilometers (km)) northeast of the Fremont and Sulphur Creek populations and approximately 25 air miles (40 km) southwest of the Sy's Butte/Hidden Splendor Mine population. The Horse Saddle population was discovered in 2005 (Clark 2005a). This new population was found on the Carmel Formation, a substrate previously unknown to support the species. A total of 92 plants were counted in this population in 2005 (Clark 2005a). No comprehensive surveys were done on the Carmel Formation (Clark 2005a). Therefore, we do not know whether this number represents an accurate estimate of the Horse Saddle population and the data is 6 years old, so we do not have current information for this population either.

As previously described, limited information is available on the demographic trends of *Schoenocrambe barnebyi*. Only one of the four populations has an established monitoring site, located in Capitol Reef (Sulphur Creek population). Irregular monitoring between 1994 and 2001 documented a significant decline in the number of plants within the monitoring plot (Clark 1997; Anderton 2002; see TABLE 3). We have no information on the cause of this decline. Monitoring has not occurred since 2001 but an informal visit during the flowering season in 2002 found almost no flowering plants and most appeared dead with very little new growth (Anderton 2002). The decline was attributed to the very dry winter and spring of 2002. Casual observation of the monitoring plot in 2009 indicated a possible recovery; plants appeared vigorous and healthy compared to the 2002 visit (Clark pers. comm. 2009b). However, we have no quantitative information to determine whether there was a change in the number of plants since 2001.

TABLE 3. Number of Plants at Spence Monitoring Plot at Capitol Reef from 1994-2001 (Clark 1997; Anderton 2002).

MONITORING YEAR	1994	1997	1998	1999	2000	2001
Total live plants	130	70	25	32	36	37
# of dead plants	N/A	N/A	0	0	7	7
% of total					19%	19%
# of eaten plants	N/A	N/A	2	1	0	5
% of total			8%	3%		14%

2.3.1.3 Genetics, Genetic Variation, or Trends in Genetic Variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)

There is no available information on the genetics for *Schoenocrambe barnebyi*. Genetic studies to better define the *Schoenocrambe* at the genus level were conducted and are described below in section 2.3.1.4.

2.3.1.4 Taxonomic Classification or Changes in Nomenclature

Schoenocrambe barnebyi was first collected from the San Rafael Swell area by Harris in 1980 (Welsh 1981). Welsh described it originally as *Thelypodopsis barnebyi* (Welsh 1981). It was later placed with the genus *Schoenocrambe* by Rollins (Rollins 1982).

In 2005, Al-Shehbaz renamed *Schoenocrambe* to *Hesperidanthus* (Al-Shehbaz 2005, 2010) on the basis of molecular, cellular, and morphological data. However, *Schoenocrambe barnebyi* is still listed as the scientifically accepted name within Integrated Taxonomic Information System (ITIS) and the USDA Plants Database (ITIS 2011; USDA 2011). Because *Hesperidanthus* is the most recently published name by the

taxonomic authority for these genera, we propose changing the name in the FR to reflect this best available scientific data (Al-Shehbaz 2005, 2010). We also will formally request the name be changed in ITIS and the USDA Plants Database. Until the name can be changed in the FR, we will continue to refer to this species as *S. barnebyi*.

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

Schoenocrambe barnebyi was listed as endangered based on low population numbers, limited distribution, threats associated with mining activities, and visitor trampling (57 FR 1398–1403, January 14, 1992). To help identify new threats in addition to the threats we identified when we listed the species, we systematically examined what we know about *Schoenocrambe barnebyi*'s life history in the context of the same five factors we considered when we listed the species. In order to better understand how any given threat actually affects the species, each identified threat was partitioned into *stressors*, which are processes or events that negatively impact the species. Through this threats assessment process, we evaluated each stressor for its *scope*, *immediacy*, and *intensity*, as a way to identify the true magnitude of the potential threat to *Schoenocrambe barnebyi*. We then characterized both the *exposure* of *Schoenocrambe barnebyi* to the stressors and the *response* we would expect from the species if exposed to the stressor. Using this approach, we are able to integrate the scope, immediacy, intensity, exposure, and response at the species level into an *overall threat level* (see TABLE 4 and APPENDIX A). The threats presented here are ranked according to our “Draft Guidance for Conducting Threats Assessment under the ESA” (USFWS 2006).

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

When we listed *Schoenocrambe barnebyi* and wrote the Recovery Plan, we believed mining development was a significant threat to *S. barnebyi* populations and habitat (57 FR 1398, January 14, 1992; USFWS 1994). In addition, visitor trampling, particularly with Capitol Reef, was considered a primary threat at the Sulphur Creek population. TABLE 5 lists the threats we identified in our current threats assessment that could or have resulted in the destruction, modification, or curtailment of the habitat or range of *S. barnebyi*.

TABLE 4. Key to overall threat level ranking components.

<p><i>Scope</i> (geographic extent of the stressor)</p>	Localized – less than 1 population
	Moderate – 1 or more populations
	Rangewide – stressor is present throughout the range
<p><i>Immediacy</i> (timeframe of the stressor)</p>	Imminent – is the stressor present and acting on the target now
	Future – anticipated in the future
	Historic – or has the impact already occurred
<p><i>Intensity</i> (the strength of the stressor itself)</p>	Low
	Moderate
	High
<p><i>Exposure</i> (the extent to which a target resource & stressor actually overlap in space and/or time given the scope)</p>	Small (<10% of population is exposed)
	Moderate (11-30% of population is exposed)
	High (>31% of population is exposed)
<p><i>Response</i> (level of physiological/behavioral response due to a specific stress considering growth, fecundity, and mortality rates)</p>	Basic need inhibited–basic plant needs for growth & development
	Mortality – identifiable reduction in growth rate or survival
<p><i>Overall Threat Level</i> (integration of the scope, immediacy, intensity, exposure, and response at the species level)</p>	Potential (at this point in time, we lack scientific information regarding this factor to determine the overall threat level)
	Low (at this point in time, no action is needed)
	Moderate (action is needed)
	High (immediate action necessary)

TABLE 5. Factors Affecting the Habitat and Overall Threat Level Ranking.

FACTORS AFFECTING THE HABITAT	OVERALL THREAT LEVEL	
	Potential	Low
Mining		X
Grazing	X	
OHV Use	X	
Trampling	<i>No longer considered a threat</i>	
Invasive Species and Fire	X	
Erosion	X	

Note: APPENDIX A provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.

Mining

The primary threat to *Schoenocrambe barnebyi* identified at the time of listing and in the Recovery Plan was habitat loss and degradation associated with future uranium mining on BLM lands (57 FR 1398, January 14, 1992; USFWS 1994). Mining related activities may result in increased surface disturbances, increased foot and vehicle traffic, reduced air quality, vegetation disturbance, and removal of top soil and overburden. Surface disturbances may impact the species by crushing or trampling plants, causing soil erosion and compaction, degrading suitable habitat, losing pollinator populations and habitat, reducing plant vigor and reproductive potential, reducing seed bank quantity and quality, and increasing invasive plant occurrences thereby increasing fire risk (Brock and Green 2003; BLM 2008a).

All of the known individuals on BLM land occur in areas that are open to mineral exploration or development (BLM 2008a). Six mining claims occur near the Sy’s Butte/Hidden Splendor Mine and mining activities may have extirpated a portion of this population during the 1950s and 1960s (Anderson 1985; USFWS 1994). Mining shafts from this time period are currently being closed (Conrad pers. comm. 2009; Ivory pers. comm. 2009). With the exception of the Lucky Strike Mine, there has been no mining since the 1960s (Conrad pers. comm. 2009; Ivory pers. comm. 2009). Because BLM lands remain open to mineral exploration and development and there are existing mining claims near the Sy’s Butte/Hidden Splendor Mine population that may recommence at any time (Conrad pers. comm. 2009), future uranium mining continues to be a threat on BLM lands. We consider this threat to be currently low because it has been over 40 years since active mining occurred, and we are not aware of any current mining proposals in this area.

Mining is not permitted on Capitol Reef lands (see 2.3.2.4 below). Therefore, mining is not considered to threaten populations (Freemont River, Sulphur Creek, and Horse Saddle) on Capitol Reef lands.

In summary, this threat is not imminent and the exposure is small; therefore, the overall threat to the species is **low** at this time (see APPENDIX A). However, mining is still considered a threat to the species on BLM lands because all of the known individuals of *Schoenocrambe barnebyi* are located within areas of historic mining activities that remain open to mineral development. If mining commences in the future and survey efforts identify additional *S. barnebyi* populations, we would reevaluate the degree of threat that mining poses to the species.

Grazing

Livestock grazing may result in the direct loss or damage to plants and their habitat through trampling, soil compaction, increased soil erosion, invasion of noxious weeds, and disturbance to pollinators (Kauffman et al. 1983; Fleischner 1994; Kearns et al. 1998; DiTomaso 2000). Sheep and cattle grazing were identified as possible historic threats to populations of *Schoenocrambe barnebyi* (57 FR 1398, January 14, 1992; USFWS 1994). At the time of listing, the intensity of grazing at known *S. barnebyi* populations was not expected to significantly impact the species. Grazing intensity has not increased since we finalized the Recovery Plan (BLM 2009). However, we do not have any monitoring data that evaluates the effects of grazing on *S. barnebyi* populations.

Active grazing allotments overlap the entire range of *Schoenocrambe barnebyi* on BLM lands. We conducted Section 7 consultations with BLM for grazing permit renewals on 17 allotments, comprising the entire range of *S. barnebyi*. In those Section 7 consultations, BLM committed to conducting intensive surveys and monitoring activities for applicable listed species (including *S. barnebyi*) over the term of the renewed grazing permits (BLM 2008a, 2008b, 2009; USFWS 2009a, 2009b). The intent of the surveying and monitoring activities is to collect information on the potential impacts of livestock, recreational, or other land management uses on the long-term viability of all listed plant species, including *S. barnebyi*. However, the surveys and monitoring have not yet been initiated. To gain more insight into how the species responds to human induced impacts, we recommend BLM implement these surveying and monitoring conservation measures. A more holistic evaluation of the stressors associated with human-induced impacts coupled with those attributed to grazing may lead to better management of the Sy's Butte/Hidden Splendor Mine population in the future.

There are no active grazing allotments within the habitat of *Schoenocrambe barnebyi* in Capitol Reef (see 2.3.2.4 below). Therefore, we do not consider grazing to be a threat to the populations in Capitol Reef (Borthwick pers. comm. 2009b).

In summary, this factor has the **potential** to affect the habitat due mainly to the intensity of grazing being low and the exposure is small (i.e., populations on BLM lands) (see APPENDIX A). However, grazing is still considered a potential threat to the species because the populations of *Schoenocrambe barnebyi* on BLM lands are actively grazed and we do not have any monitoring data to determine the level of effects that grazing may cause at these locations. If future survey efforts identify additional *S. barnebyi* populations and monitoring data showed populations are affected by grazing, we will reevaluate the degree of threat grazing poses to the species.

Off-Highway Vehicle Use

We did not identify off-highway vehicle (OHV) activities as threats to *Schoenocrambe barnebyi* when we listed the species in 1992, nor in the Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). The OHV use may result in the direct loss or damage to plants and their habitat through soil compaction, increased soil erosion, reduced air quality, invasion of noxious weeds, and disturbance to pollinators and their habitat (Eckert et al. 1979; Lovich and Bainbridge 1999; Ouren et al. 2007; Wilson et al. 2009).

The use of OHVs in Utah has exploded in popularity over the past several decades (Burr *et al.* 2008). From 1998-2006, the number of registered OHVs in Utah has increased by 233% (Burr et al. 2008). The known *Schoenocrambe barnebyi* population on BLM lands (Sy's Butte/Hidden Splendor Mine) occurs in an area that is open to OHV traffic along designated routes only (BLM 2008a). Although illegal OHV use occurs within the vicinity (BLM 2011), to date, no direct or indirect impacts to the population or individual plants have been documented (Ivory 2009). Due to the remoteness of the population and the steepness of the terrain, we expect the overall scope of the threat to be low.

Within Capitol Reef, OHVs are not permitted in the known *Schoenocrambe barnebyi* habitat (see section 2.3.1.4 below) and, therefore, we do not consider it a threat to the populations in Capitol Reef (Borthwick pers. comm. 2009a).

In summary, this factor has the **potential** to affect the habitat because the scope is localized to moderate, the intensity is expected to be low, and the exposure of the species to the stressors associated with OHV use is small (i.e., populations on BLM lands) (see APPENDIX A). However, OHV use is still considered a potential threat to the species because the populations of *Schoenocrambe barnebyi* on BLM lands are in open OHV use areas and we do not have any monitoring data to determine the level of effects that OHV use may cause at these locations. If future survey efforts identify additional *S. barnebyi* populations and monitoring data showed populations are affected by OHV use, we will reevaluate the degree of threat OHV use poses to the species.

Erosion

Erosion was not considered a threat at the time of listing or in the recovery plan (57 FR 1398, January 14, 1992; USFWS 1994). However, natural erosion of *Schoenocrambe barnebyi* habitat was listed as a potential threat in a 1992 survey report for the BLM (Ecosphere 1992). *Schoenocrambe barnebyi* grows in very steep habitats with sparse vegetation. Plants may be uprooted, damaged or destroyed by gullying, slumping or rockslides.

Under natural circumstances, we presume the species has adapted to living on a highly erodible substrate. However, erosion may increase as climate changes. Climate change will likely increase heavy precipitation events which can increase soil erosion (Nearing et al. 2004; IPCC 2007; see section 2.3.2.5 below).

In addition, erosion may be accelerated through surface disturbing activities. As previously described, OHV use and grazing occur in the habitat of *Schoenocrambe barnebyi* on BLM lands. Although we believe the overall threat level of these activities to be currently low, we do not have monitoring data to adequately evaluate the effects, including erosion, of these uses to the plants.

Schoenocrambe barnebyi populations in Capitol Reef are provided protection from most surface disturbing activities discussed above (and see section 2.3.2.4 below) and, therefore, we do not consider human induced erosion to threaten these populations. However, increases in erosion due to climate change may still occur.

In summary, this factor has the **potential** to affect the habitat because erosion is not imminent, the intensity of the impact is low, and the exposure is small. However, we still consider erosion to be a potential threat to *Schoenocrambe barnebyi* due to the effects of climate change and the potential indirect effects from surface disturbances (e.g., mining, OHV use, and grazing) in the plant's occupied habitat on BLM lands. Specifically, we do not have any monitoring data to determine if surface disturbances from OHV use or grazing are causing erosion in a manner that affects the plants on BLM lands. If future survey efforts identify additional *S. barnebyi* populations and monitoring data showed populations are affected by erosion, we will reevaluate the degree of threat erosion poses to the species.

Trampling

At the time of listing and in our Recovery Plan, we identified trampling by Capitol Reef visitors as the primary impact on the *Schoenocrambe barnebyi* population at Sulphur Creek (57 FR 1398, January 14, 1992; USFWS 1994). However, trampling from hiking activities was later evaluated and determined to be unlikely (Clark 1997). Visitors tend to

remain along the trail in the creek bottom, away from the plants and the habitat due to the steepness of the terrain. An historic livestock trail through the population is no longer in use but is occasionally used by deer (Clark pers. comm. 2009a). All other sites within Capitol Reef were evaluated for potential impacts caused by hiking trails but none were documented (Clark 2005b). For these reasons, we no longer consider trampling a threat.

Invasive Species and Fire

Invasive species and fire were not considered threats at the time of listing or in the species' Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). However, the spread of nonnative invasive species is considered the second largest threat to imperiled plants in the United States (Wilcove et al. 1998). Invasive plants—specifically exotic annuals—negatively affect native vegetation, including rare plants. One of the most substantial effects is the change in vegetation fuel properties that, in turn, alter fire frequency, intensity, extent, type, and seasonality (Menakis et al. 2003; Brooks et al. 2004; McKenzie et al. 2004). Shortened fire return intervals make it difficult for native plants to reestablish or compete with invasive plants (D'Antonio and Vitousek 1992).

Mining, grazing, and unauthorized OHV use are activities that disturb soil surfaces within *Schoenocrambe barnebyi* habitat on BLM lands. In general, *B. tectorum* is known to invade areas in response to these types of surface disturbing activities (Hobbs 1989; Rejmanek 1989; Hobbs and Huenneke 1992; Evans et al. 2001). These types of surface disturbing activities do not occur on the populations in Capitol Reef. Currently wildland fires are considered unlikely to occur in *S. barnebyi*'s habitat due to the sparseness of vegetation associated with the species (Borthwick pers. comm. 2009c; Ivory pers. comm. 2009).

However, as previously described we do not have any monitoring data to determine the effects, or lack thereof, of surface disturbing activities in *Schoenocrambe barnebyi* habitat—our lack of monitoring data extends to a lack of knowledge regarding the occurrence and densities of annual invasive species in the habitat of *S. barnebyi*, in all populations. In addition, based on the available literature, we anticipate invasive species' distribution will increase over time due to ongoing surface disturbances coupled with the influences of climate change (Mayeux et al. 1994; Smith et al. 2000; Ziska et al. 2005).

In summary, this factor has the **potential** to affect habitat because the factor is not imminent, the intensity of the impact is low, and the exposure is small (see APPENDIX A). However, we consider invasive species to be a potential threat to *Schoenocrambe barnebyi* due to the effects of climate change and the potential effects of surface disturbances (e.g.,

mining, OHV use, and grazing) in the plant’s occupied habitat, particularly on BLM lands. Specifically, we do not have any monitoring data to determine to what degree invasive species occur in *S. barnebyi* habitat, or if it is increasing due to surface disturbances from OHV use or grazing. If future survey efforts identify additional *S. barnebyi* populations and monitoring data showed populations are affected by invasive species and fire, we will reevaluate the degree of threat invasive species and fire pose to the species.

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

Overutilization for commercial, recreational, scientific or educational purposes was not considered a threat at the time of listing, or in the recovery plan (57 FR 1398, January 14, 1992; USFWS 1994). *Schoenocrambe barnebyi* is not a plant of horticultural interest and is not collected for commercial purposes. It has no known medicinal value nor is it collected as a food source. Scientific collections for identification and documentation purposes have mostly occurred prior to listing. Few specimens are located in regional herbaria (SEINet 2010). No seed germination trials have occurred and the species is not propagated offsite (CPC 2010). Seed collections have taken place strictly for conservation purposes and are stored in CPC approved botanical gardens and storage facilities (Dodge 2009). Collections for scientific or educational purposes are limited to conservation and recovery purposes. Therefore, we do not consider overutilization for commercial, recreational, scientific, or educational purposes to be a threat to the species.

2.3.2.3 Disease or predation.

TABLE 6 lists the threats caused by disease or predation to *Schoenocrambe barnebyi*.

TABLE 6. Factors Related to Disease or Predation of the Species and Overall Threat Level Ranking.

FACTORS AFFECTING THE SPECIES	OVERALL THREAT LEVEL	
	Potential	Low
Disease	<i>Not considered a threat</i>	
Insect predation	<i>Not considered a threat</i>	
Browsing by ungulates	X	

Note: APPENDIX A provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.

Disease and predation were not considered factors affecting the species in the 1992 listing decision or in the 1994 Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). We have no information to suggest disease and insect predation are threats today. Potential impacts from sheep and cattle grazing are addressed above (see section 2.3.2.1).

Schoenocrambe barnebyi appears to be highly palatable to deer (Clark 2005b). We expect browsing to be localized and only affect a small portion of the populations. However, we do not have any information that browsing is occurring at a level that negatively impacts the species as a whole (Clark 2005b; Ivory 2009). For these reasons, this factor has the **potential** to affect the species. If future survey efforts identify additional *S. barnebyi* populations and monitoring data showed populations are affected by browsing or disease, we will reevaluate the degree of threat disease and predation pose to the species.

2.3.2.4 Inadequacy of existing regulatory mechanisms.

Below we analyze the current situation (i.e., the situation with ESA protections in place) and, in order to gauge the adequacy of regulatory mechanism, what would happen in the absence of the ESA's protections.

Federal Laws and Regulations

Land ownership within the mapped *Schoenocrambe barnebyi* populations is predominantly BLM and Capitol Reef (see TABLE 2 and FIGURE 1).

The National Environmental Policy Act (NEPA) (42 U.S.C. 4371 et seq.) provides some protections for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires an agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where the analysis reveals significant environmental effects, the Federal agency must discuss mitigation that could offset those effects (40 CFR 1502.16). These mitigations usually provide some protections for listed species. However, NEPA does not require that adverse impacts be mitigated, only that impacts be assessed and the analysis disclosed to the public. In the absence of the ESA's protections, it is unclear what level of consideration and protection Federal agencies would provide through the NEPA process.

The ESA is the primary Federal law that provides protection for *Schoenocrambe barnebyi* since listing (57 FR 1398, January 14, 1992). Section 7(a)(1) states that Federal agencies, in consultation with the USFWS, shall carry out programs for the conservation of endangered species. Section 7(a)(2) requires Federal agencies to consult with the USFWS to ensure any project they fund, authorize, or carry out does not jeopardize the continued existence of a listed species or modify their critical habitat. Jeopardy includes engaging in any action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). Section 9(a)(2) of the ESA prohibits the following activities: 1) the removal and reduction to possession (i.e., collection) of

endangered plants from lands under Federal jurisdiction, and 2) the malicious damage or destruction on lands under Federal jurisdiction, and 3) the removal, cutting, digging, damaging, or destruction of endangered plants on any other area in knowing violation of a State law or regulation, or in the course of any violation of a state criminal trespass law. Section 9 also makes illegal the international and interstate transport, import, export and sale or offer for sale of endangered plants and animals.

Measures specifically addressing the protection of *Schoenocrambe barnebyi* were included in Section 7 consultations for the BLM Price Field Office RMP (BLM 2008a), and the Renewal of 17 Grazing Allotments in the San Rafael Swell (BLM 2009). Without the ESA, we would not have completed these Section 7 consultations, nor developed species-specific conservation measures. As stated under section 2.3.2.1 (grazing) above, the BLM committed to conducting intensive surveys and monitoring activities for applicable listed species over the term of the renewed grazing permits (BLM 2008a, 2008b, 2009; USFWS 2009). However, no surveys or monitoring efforts are occurring at this time. Therefore, regulatory mechanisms are inadequate to protect the species.

The Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.) is the primary Federal law governing most land uses on BLM lands and would be the primary law affording *Schoenocrambe barnebyi* protection on BLM lands absent the ESA. Section 102(a)(8) of the Federal Land Policy and Management Act states public lands will be managed, in part, to provide protection to ecological and environmental resources. The Special Status Species Management Policy Manual #6840 directs BLM to manage habitat for sensitive species in a manner that will ensure that all actions authorized, funded, or carried out by the BLM do not contribute to the need for the species to become listed (BLM 2008c). Typically, this means the impacts to these species are considered during project planning stages and conservation measures may be included at the discretion of agency biologists.

The Price BLM RMP provides some general habitat protection mechanisms for endangered plants such as oil and gas lease notices, WSAs, ACECs, and wilderness designations (BLM 2008a, 2008b). One WSA and three designated ACECs are in the vicinity of the plant's recorded site locations; however, as previously described (section 2.2.3) we have no accurate location information for sites on BLM lands and, therefore, are uncertain whether plants occur in these areas. Because comprehensive range-wide surveys are not available (see section 2.3.1.1), we do not know the extent to which these land management designations provide protection to the species on BLM lands.

Although the factors discussed above in section 2.3.2.1 have not led to large-scale surface disturbances within the known habitat on BLM lands, past mining activities likely extirpated portions of the Sy's Butte/Hidden Splendor Mine population. In addition, no systematic surveys or monitoring efforts have been conducted to determine if surface disturbances (i.e., grazing, OHV use) are affecting *Schoenocrambe barnebyi* populations. We recommend that BLM survey and monitor (see section 4) to determine the extent of the populations and the impact human activities have on these populations.

National Park Service (NPS) lands are administered under the provisions of the Organic Act of 1916 (16 U.S.C. 1, 2, 3, and 4), as amended and supplemented. The Organic Act specifies that the NPS will “promote and regulate the use of the Federal areas known as national parks, monuments, and reservations Y which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

The 1976 Mining in the Parks Act (16 U.S.C. 1901 et seq.), the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.), and the Clean Air Act of 1977, as amended, (42 U.S.C. 7401 et seq.) provided tools for parks to remove and prevent mining and drilling ventures (NPS 2002). All mining claims within Capitol Reef were either declared invalid or were nullified by 1986 (NPS 2002). By the end of the 1980s, oil and gas leases also were either eliminated or suspended (NPS 2002). All national parks are now closed to new Federal mineral leasing (NPS 2006). Capitol Reef's 1998 Final General Management Plan Development Concept Plan designates Primitive and Threshold Management Zones within the Park (NPS 1998). All Capitol Reef *Schoenocrambe barnebyi* sites are located within these Management Zones (NPS 1998). No off-road or off-trail recreational use is allowed within Capitol Reef within these zones. In addition, grazing is not allowed within either of these zones (NPS 1998). In order for Capitol Reef lands to be made available for activities that were removed (i.e., mining and grazing), Congress would have to change the laws which currently govern Capitol Reef. Because of these reasons, we believe there are adequate regulatory mechanisms in place within Capitol Reef to provide sufficient protective measures for the species in the absence of the ESA's protections.

State Laws and Regulations

Utah has no State laws or regulations that protect *Schoenocrambe barnebyi*.

Local or Other Laws and Regulations

There are no county or local laws or regulations protecting *Schoenocrambe barnebyi*.

Summary

There may be some limited policy-level protection afforded to the species through BLM’s Special Status Species Management Policy. Over the next 20 years, the BLM’s RMP would provide some protection from direct and indirect impacts through implementation of the conservation measures. However, BLM has not initiated the monitoring and surveying applicant committed measures included in the programmatic grazing consultation (BLM 2009); therefore, we lack data to support that these conservation measures provide adequate protection for the species.

Existing regulatory mechanisms that afford *Schoenocrambe barnebyi* protection on Capitol Reef lands are adequate to abate most of the threats the species faces within the Park. These mechanisms include the prohibition of mining, OHV use, and livestock grazing in areas that contain *S. barnebyi* and its habitat (see section 2.3.2.1 above).

We assign an overall threat level to this factor as **low** because we concluded that the threats that would require regulatory mechanisms (sections 2.3.2.1, 2.3.2.2, and 2.3.2.3) are potential or low—e.g., mining, OHV use, grazing. However, as previously described, we do not have any monitoring data to determine if these surface disturbing activities are impacting *Schoenocrambe barnebyi*. Even with the ESA’s protection, applicant committed conservation measures are not being adhered to (i.e., surveying and monitoring). If future survey efforts were to identify additional *S. barnebyi* populations or monitoring indicated populations were affected by land management actions, we would reevaluate the degree of threat that inadequacy of regulatory mechanisms pose to *S. barnebyi*.

2.3.2.5 Other natural or manmade factors affecting its continued existence.

The following are other threats to *Schoenocrambe barnebyi* which are not fully analyzed in the proceeding sections (TABLE 7).

TABLE 7. Other factors affecting the species and overall threat level ranking.

FACTORS AFFECTING THE SPECIES	OVERALL THREAT LEVEL		
	Potential	Low	Moderate
Small populations ³			X
Climate change	X		
Lack of scientific knowledge/monitoring ⁴			X

Note: APPENDIX A provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.

Small Populations

The original listing decision cited the limited distribution and low population numbers as a factor affecting the species (57 FR 1398, January 14, 1992). The species' rarity and limited distribution make it highly vulnerable to localized stochastic extinction events. While more sites have been found since the species was listed, it remains narrowly distributed in few populations and may be in decline (Clark 1997; Anderton 2002).

Half of the sites have fewer than 100 plants (Clark 2005b; see Table 2). Although small population size is an intrinsic vulnerability of the species, some sites may hold so few plants that they are not demographically stable in the medium to long term and some may be lost as a result of natural variation in population numbers in the short term. Population genetics studies have not been undertaken for *Schoenocrambe barnebyi*, but despite the overall lack of information on the population ecology of the species, we do know that small populations are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Only the larger sites of *S. barnebyi* may have sufficient genetic variability to provide for long-term adaptation to natural or manmade changes in their environment.

Small population size in and of itself is not considered a threat; however, it may increase the species' vulnerability if other threats discussed in this analysis are impacting the species. Even a small localized disturbance such as mining, OHV-related activities, or fire could result in the extirpation of a site. We determined the threat of climate change (see discussion below) has an overall threat level of moderate. Therefore, we consider the overall threat level for small population size to be **moderate**.

Climate Change

Species with limited ranges and restricted habitat requirements also are more vulnerable to the effects of global climate change (IPCC 2002; Jump and Penuelas 2005; Machinski et al. 2006; Krause 2010). Climate change was not discussed in the original rule to list the species or in the Recovery Plan. Over the past 50 years, the frequency of cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). Changes in the global climate system during the 21st century are hypothesized to be larger than those observed during the 20th century (IPCC 2007). For the next two decades, a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007). Afterward, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase of 0.6 to 4.0°C (1.1 to 7.2°F) with

the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007).

Although we expect bouts of heavy precipitation, climate change will result in an overall decrease in water resources in semi-arid areas like the western United States (IPCC 2007). An increase in heavy rainfall events may increase erosion in *Schoenocrambe barnebyi* habitat (see section 2.3.2.1 above). According to 18 of 19 regional climate models, the levels of aridity of recent drought conditions and perhaps those of the 1950s drought years will become the new climatology for the southwestern United States and annual mean precipitation levels will continue to decrease over the next century (Seager et al. 2007). Drought conditions led to a noticeable decline in survival, vigor and reproductive output of rare plants in the Southwest during the drought years of 2001 through 2004 (Anderton 2002; Van Buren and Harper 2002 and 2003; Hughes 2005; Clark and Clark 2007; Roth 2008a, 2008b). The only monitoring site for *S. barnebyi* at Capitol Reef showed a significant decline in plant numbers between 1994 and 1998 (see TABLE 3). No data was collected during the drought years after 2001, but casual observation indicates that *S. barnebyi* also may have been negatively affected by the drought of 2001-2004.

Climate change also is expected to increase levels of carbon dioxide (Walther et al. 2002; IPCC 2007; Karl et al. 2009). Studies have shown that annual invasive grasses show significantly higher plant densities, biomass and seed production at elevated CO² than native annuals (Smith et al. 2001; Ziska et al. 2005). In addition, populations of many pest species are limited by low temperatures during parts of their life cycle and warmer temperatures are expected to lead to more pest outbreaks in some areas (IPCC 2002).

Effects related to climate change, such as persistent or prolonged drought conditions, increased invasions of exotic species and pests, and increased heavy rainfall events, may affect the long-term persistence of *S. barnebyi*. Climate change could potentially reduce the overall abundance of *Schoenocrambe barnebyi*. However, a large degree of uncertainty exists regarding the extent of such effects. For these reasons, this factor has the **potential** to affect the species. Further studies should be conducted to monitor and minimize the effects of this potential threat (see section 4).

Lack of Scientific Knowledge/Monitoring

The lack of scientific knowledge of *Schoenocrambe barnebyi* may cause the species to be managed below optimal levels. While not a threat in and of itself, this factor affects our ability to manage and recover the species. We lack scientific knowledge and monitoring data throughout the range of

the species. We know little about *S. barnebyi*--its pollinators, range, habitat, and population trends. For example, we do not know why the original population estimate for BLM population was 2,000 individuals but surveys since have counted less than 200 plants. We do not know whether this represents a reduction in plant numbers or is an artifact of survey effort, making it difficult to analyze overall threat levels for the species. Because of this lack of scientific knowledge, opportunities for better management of the species could potentially be missed. Based on our current limited understanding of the species, we consider the overall threat levels for threats discussed in sections 2.3.2.1, 2.3.2.4, and 2.3.2.5 are all low. We could potentially move the species toward downlisting, recovery, and eventual delisting if we could better quantify the degree of threat the species faces and work toward alleviating those threats. However, the only site that has longer, albeit irregular, monitoring data shows the plant may be in decline, potentially negatively impacted by drought (Clark 1997; Anderton 2002), and potentially able to recover (Clark pers. comm. 2009b). The lack of trend data following the drought makes it difficult to determine to what degree drought may be a threat to the species.

The lack of scientific knowledge and monitoring data occurs throughout the range of the species and is hampering our ability to effectively manage for it now. Therefore, we consider this factor has a **moderate** level of impact to the species.

Summary

The effects of small population size could be a detriment to the survival of *Schoenocrambe barnebyi*, particularly if the species is subjected to other threats (see Factor A and Climate Change). The effects of climate change are uncertain, but monitoring data (Anderton 2002) suggest the species is in decline and may be susceptible to drought conditions. Therefore, we assigned climate change an overall threat level of moderate. Because small population size increases the inherent vulnerability of species that are threatened by other factors, like climate change, the overall threat level for small population size was moderate. The lack of scientific knowledge and monitoring data for the species has hampered our ability to manage and recover the species to a moderate degree.

2.4 Synthesis

At the time of listing, we concluded that *Schoenocrambe barnebyi* was endangered (i.e., in danger of becoming extinct throughout all or a significant portion of its range) due to low population numbers, limited distribution, and threats associated with mining activities and visitor trampling (57 FR 1398-1403, January 14, 1992). New potential threats were identified in this 5-year review process that were not considered at the time of listing or in the Recovery Plan.

We examined the same five factors we considered when we listed the species and identified any potential new threats we have not previously considered. Once these potential threats were identified, we systematically analyzed the impacts using the ranking metrics presented in TABLE 4. This allowed us to assess the factors in relation to the species' exposure and evaluate the relative importance of each potential threat to the species' persistence and recovery, allowing us to rank the threats in order of importance (USFWS 2006; see APPENDIX A).

We assessed the factors related to trampling, overutilization of the species (including found personal/commercial uses, uses related to medicinal purposes or as a food source, and deleterious effects of research efforts), disease, and insect predation and determined these factors are not considered threats to the species.

We assessed the factors relating to future mining, the current levels of grazing, OHV use, invasive species and fire, erosion, browsing by deer, and inadequacy of existing regulatory mechanisms and we have determined the overall threat levels of these factors are low at this time. However, our current understanding of the overall level of threat these factors pose is limited by the overall lack of scientific knowledge regarding the species' distribution, biology and population trends. If future surveys locate additional populations and monitoring identifies how the species respond to these factors, we will reevaluate the degree of threat these factors pose to the species.

We assessed other threats to the species and assigned overall threat levels of moderate for small population size, climate change, and lack of scientific knowledge/monitoring. Because we lack a complete understanding of the *Schoenocrambe barnebyi* (its pollinators, range, and habitat) and do not have long-term monitoring data, we are unable to effectively manage the species to alleviate the threats of climate change coupled with those of small population sizes.

When analyzing the human-induced threats the species faces cumulatively with small population size and climate change, the species is inherently more vulnerable to stochastic extinction events and environmental changes. The species is vulnerable to the effects of inbreeding depression, low reproductive rates and reduced genetic diversity. In addition, other factors, such as prolonged or more frequent droughts and increased frequency in heavy rainfall events brought on by climate change may threaten the species and its habitat in the future.

Populations on Capitol Reef lands are afforded adequate protection to abate some of the threats for which the species was originally listed (OHV and mining activities). However, data collected at the only monitoring site suggests the species may be in decline (see section 2.3.1.2). The cause of this decline remains unclear but may be due to drought or effects associated with small population size such as inbreeding depression or pollination failure (see section 2.3.2.5). BLM lands have yet to be surveyed, monitoring commitments have yet to be realized, and adequate regulatory mechanisms that afford the species protection have yet to be developed. Therefore, the species remains vulnerable to the threats for which it was originally listed on BLM lands due to threats discussed in sections 2.3.2.1, 2.3.2.3, 2.3.2.4, and 2.3.2.5.

Over the past 19 years since the species was listed, little work has been accomplished toward meeting the recovery criteria and actions as identified in the Recovery Plan (see section 2.2.3). None of the recovery actions are considered complete.

Actions Not Initiated

- We have not reached the Recovery Plan's population goals of 10,000-20,000 individuals.
- We have not established and conducted monitoring, biological, ecological, life-history, and minimum viable population studies.
- We are not aware of any seed germination trials or attempts to propagate *Schoenocrambe barnebyi*.
- We have not established any new populations; however, we no longer believe this is a viable recovery action because we do not fully understand the threats the species faces because we lack long-term demographic and monitoring data for this species.
- Although Capitol Reef had a public display in their visitors' center promoting awareness and education about rare plants, this display was removed and has not been replaced.

Actions Partially Completed

- Comprehensive surveys within suitable habitat throughout the range of the species are not complete. Capitol Reef completed surveys more than 10 years ago on suitable habitat on the Moenkopi Shale and Kaibab Limestone Formations. Surveys have not been completed on the Carmel Formation throughout the range of the species. Comprehensive surveys have not been completed in any of the known formations on BLM lands.
- We have not established conservation areas or other land management designations that provide protection specifically for *Schoenocrambe barnebyi* for any of the known populations; however, there are existing laws, regulations, and policies that afford the species some protection (see section 2.3.2.4 above).

Ongoing

- We work with BLM to incorporate conservation measures to provided protection for the species through Section 7 consultation; however, not all of these conservation measures are being implemented.
- Other than some limited surveys to detect more populations, the goals and objectives discussed in the Recovery Plan have not been met, and in some instances, not initiated.

3 RESULTS

3.1 Recommended Classification

Based on our analysis of the current status of the species and the threats assessment, we do not recommend a status change at this time. We do not have enough information on the current status, distribution, ecology, population trends, and habitat requirements of the species to determine that the threats to the species that occurred at the time of listing no longer exist. Although current threat levels are largely considered low or moderate, we do not have any monitoring data to accurately evaluate how current and future threats are impacting the species. Furthermore, we have not met any of the recovery goals or completed any of the recovery actions as set forth in the Recovery Plan. Therefore, we have not met the downlisting or delisting criteria.

3.2 New Recovery Priority Number and Brief Rationale

We recommend we change the RPN to 17. This number indicates: 1) *Schoenocrambe barnebyi* is a full species; 2) populations face a low degree of threat; and 3) recovery potential is low (see TABLE 1). The recovery potential of the species is considered low based on our limited knowledge of the species, in particular the lack of baseline information on the status and distribution of the species and, therefore, unlikelihood of being able to meet the recovery criteria in the Recovery Plan.

4 RECOMMENDATIONS FOR FUTURE ACTIONS

4.1 Surveys, Monitoring, and Research

- The BLM and Capitol Reef should establish long-term trend monitoring to provide base line demographic data for the species. In addition to collecting baseline demographic data, BLM and Capitol Reef should collect data on the species' response to habitat conditions including how the factors considered in this 5-year review (see sections 2.3.2.1, 2.3.2.3, 2.3.2.4 and 2.3.2.5) are affecting the species.
- We recommend BLM and Capitol Reef initiate research projects to better understand threats to the species, its habitat, and biological requirements, including:
 - * Determining pollinators or pollination mechanisms including the identification of pollinators, pollinator availability, and their habitat requirements;
 - * Assessing seedbank viability, including seed viability and dispersal mechanisms and determining germination requirements;
 - * Analyzing population genetics to assess potential impacts from inbreeding depression;

- * Determining the species' vulnerability to prolonged drought and the potential impacts of climate change;
- * Determining the species response to invading nonnative species and its response to increased fire frequencies;
- * Determining habitat requirements, including soils, aspects, and climatic variables;
- * Determining the effects livestock grazing has on the species and its habitat;
- * Determining the effects OHV use has on the species and its habitat; and,
- * Determining the effects mining has on the species and its habitat.

4.2 Ex-situ Conservation

- Red Butte Gardens, or another qualified and permitted botanical garden, should collect seeds and store them with the CPC.
- Red Butte Gardens, or another qualified and permitted entity (i.e., Utah State University or U.S. Geological Survey's shrub lab), should research techniques needed to successfully propagate the species should we determine reestablishing populations in the wild is a viable recovery action.

4.3 Education

- We recommend Capitol Reef develop a new public display or revamp the existing one (see section 2.2.3 above). We recommend Capitol Reef showcase this public display in their visitors' center promoting awareness and education about rare plants within Capitol Reef and their unique relationship to the local geology. The display was removed in 2009 due to old age. Capitol Reef has no plans to restore the display at this time.
- The USFWS, BLM, and Capitol Reef should increase educational programs in schools, agency offices, and visitor centers to facilitate appreciation of and respect for sensitive areas which may contain habitat for threatened or endangered plants.

4.4 Administrative Actions

- The USFWS should establish a recovery team to update the Recovery Plan and to annually prioritize, assess, and fulfill recovery actions.
- Once we have new survey and research data, the USFWS should revise the Recovery Plan to explicitly address the relevant listing factors. The number of plants and populations referenced in the current recovery plan that are

required for long-term viability of the species are unsupported by our current understanding of the species' population status and needs revision. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. The Recovery Plan also should estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting. The Recovery Plan should include updated range and population numbers and should provide recognition for new and/or increased threats since the time of listing, such as the effects of increased drought conditions caused by global climate change.

- The USFWS, BLM, and Capitol Reef should support *Schoenocrambe barnebyi* recovery by providing personnel and fiscal resources yearly to implement recovery actions.
- The USFWS should publish in the FR a formal name change from *Schoenocrambe barnebyi* to *Hesperidanthus barnebyi* to reflect the best available science.
- The USFWS should formally request the name be changed in the ITIS and USDA plants databases.

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U.S. FISH AND WILDLIFE SERVICE
5-Year Review of *Schoenocrambe barnebyi* (Barneby reed-mustard)

Current Classification: Endangered rangewide

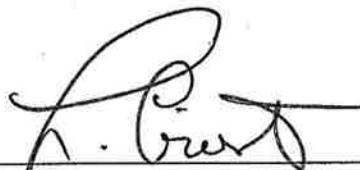
Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Review Conducted By: Daniela Roth, Botanist, Utah Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve 
Field Supervisor, Utah Ecological Services Field Office

Date 8/4/11

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve 
Assistant Regional Director – Ecological Services

Date 8/6/11

APPENDIX A

***Schoenocrambe barnebyi* (Barneby reed-mustard)**

Threats, Stressors, and Their Associated Scope, Immediacy, Intensity, Exposure, Response, and Overall Threat Level Ratings.

POPULATION									
THREAT ⁵ / POTENTIAL THREAT ⁶	STRESSOR ⁷	FACTOR ⁸	SCOPE ⁹	IMMEDIACY ¹⁰	INTENSITY ¹¹	EXPOSURE ¹²	RESPONSE ¹³	OVERALL THREAT LEVEL ¹⁴	
Sy's Butte/Hidden Splendor Mine									
1	MINING	Direct physical injury Mortality to individuals	A	Localized; portions of 1 of 4 populations	Historic Future	High	Small	Mortality	Low
		Vegetation disturbance	A	Moderate; 1 of 4 populations	Historic Future	High	Small	Basic need inhibited	Low
		Soil removal Disturbance	A	Localized; portions of 1 of 4 populations	Historic Future	High	Small	Mortality	Low
		Increased erosion	A	Moderate; 1 of 4 populations	Historic Future	Moderate	Small	Basic need inhibited & Mortality	Low
		Reduction in air quality	A	Moderate; 1 of 4 populations	Historic Future	Low	Small	Basic need inhibited	Low
		Introduced invasive plant species Alteration of wildfire frequency	A	Moderate; 1 of 4 populations	Future	High	Small	Basic need inhibited & Mortality	Potential
		Disturbance to pollinators	A	Moderate; 1 of 4 populations	Historic Future	Low	Small	Basic need inhibited	Low
2	GRAZING	Direct physical injury Mortality to individuals	A	Low; portions of 1 of 4 populations	Historic Imminent Future	Low	Small	Mortality	Low
		Soil removal Disturbance	A	Moderate; 1 of 4 populations	Historic Imminent Future	Low	Small	Basic need inhibited & Mortality	Low
		Vegetation disturbance	A	Low; portions of 1 of 4 populations	Historic Imminent Future	Low	Moderate	Basic need inhibited	Potential
		Introduced invasive plant species Alteration of wildfire frequency	A	Moderate; 1 of 4 populations	Future	Moderate	Small	Basic need inhibited & Mortality	Potential
		Disturbance to pollinators	A	Moderate; 1 of 4 populations	Historic Imminent Future	Low	Small	Basic need inhibited	Potential

POPULATION									
THREAT ⁵ / POTENTIAL THREAT ⁶	STRESSOR ⁷	FACTOR ⁸	SCOPE ⁹	IMMEDIACY ¹⁰	INTENSITY ¹¹	EXPOSURE ¹²	RESPONSE ¹³	OVERALL THREAT LEVEL ¹⁴	
3	OHV USE	Direct physical injury Mortality to individuals	A	Localized; portions of 1 of 4 populations	Historic Imminent Future	Low	Small	Mortality	Low
		Vegetation disturbance	A	Localized; portions of 1 of 4 populations impacted	Historic Imminent Future	Low	Small	Basic need inhibited	Potential
		Soil removal Disturbance-soil compaction	A	Localized; portions of 1 of 4 populations impacted	Historic Imminent Future	Low	Small	Basic need inhibited & Mortality	Potential
		Increased erosion	A	Moderate; 1 of 4 populations	Historic Imminent Future	Low	Small	Basic need inhibited & Mortality	Low
		Reduction in air quality	A	Moderate; 1 of 4 populations	Historic Imminent Future	Low	Small	Basic need inhibited	Potential
		Ignition of wildfire	A	Moderate; 1 of 4 populations	Future	Low	Small	Mortality	Potential
		Introduced invasive plant species Alteration of wildfire frequency	A	Moderate; 1 of 4 populations	Future	Low	Small	Basic need inhibited & Mortality	Potential
		Disturbance to pollinators	A	Moderate; 1 of 4 populations	Historic Imminent Future	Low	Small	Basic need inhibited	Low
4	EROSION	Soil removal Disturbance	A	Rangewide	Historic Future	Low	Small	Basic need inhibited & Mortality	Potential
5	LACK OF (OR INEFFICIENCY OF) EXISTING REGULATORY MECHANISMS INDEPENDENT OF ESA	Insufficient protective measures	D	Moderate; 1 of 4 populations	Historic Imminent Future	Low	Small	Mortality	Low
Sulphur Creek									
6	TRAMPLING	Direct physical injury Mortality to individuals	A	Insignificant; a few individuals (3 plants within reach of trail)	Not known to occur	Low	None	None known	No longer considered a threat

POPULATION									
THREAT ⁵ / POTENTIAL THREAT ⁶	STRESSOR ⁷	FACTOR ⁸	SCOPE ⁹	IMMEDIACY ¹⁰	INTENSITY ¹¹	EXPOSURE ¹²	RESPONSE ¹³	OVERALL THREAT LEVEL ¹⁴	
Sy's Butte/Hidden Splendor Mine; Freemont River; Sulphur Creek; and Horse Saddle									
7	INVASIVE SPECIES & FIRE	Vegetation disturbance	A	Rangewide	Future	Moderate	Small	Basic need inhibited	Potential
		Increased erosion	A	Rangewide	Future	Moderate	Small	Basic need inhibited & Mortality	Potential
		Introduced invasive plant species Alteration of wildfire frequency	A	Rangewide	Future	Moderate	Small	Basic need inhibited & Mortality	Potential
8	OVERUTILIZATION	Direct physical injury Mortality to individuals	B	Not known to occur	Not known to occur	None	None	None known	Not considered a threat
9	PERSONAL/COMMERCIAL USES	Reduction in population numbers	B	Not known to occur	Not known to occur	None	None	None known	Not considered a threat
10	DELETERIOUS EFFECTS OF RESEARCH EFFORTS	Reduction in population numbers	B	Not known to occur	Not known to occur	None	None	None known	Not considered a threat
		Reduction in seedbank	B	Not known to occur	Not known to occur	None	None	None known	Not considered a threat
11	DISEASE	Direct physical injury Mortality to individuals	C	Not known to occur	Not known to occur	None	None	None known	Not considered a threat
12	INSECT PREDATION	Direct physical injury Mortality to individuals	C	Not known to occur	Not known to occur	None	None	None known	Not considered a threat
14	BROWSING BY DEER	Direct physical injury Mortality to individuals	C	Localized	Future	Low	Small	Mortality	Potential
15	SMALL POPULATIONS ¹⁵	Loss of genetic diversity & resiliency	E	Rangewide	Historic Imminent Future	Moderate	Moderate	Basic need inhibited & Mortality	Moderate
16	CLIMATE CHANGE	Changes in hydrological conditions, habitat conditions	E	Rangewide	Imminent Future	Moderate	Moderate	Basic need inhibited & Mortality	Moderate
17	LACK OF SCIENTIFIC KNOWLEDGE/MONITORING ¹⁶	Potentially inadequate management of species	E	Rangewide	Historic Imminent Future	Low	Small	Basic need inhibited & Mortality	Moderate
		Potential failure to detect meaningful changes in population trends	E	Rangewide	Historic Imminent Future	Low	Small	Basic need inhibited & Mortality	Moderate

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

² We define a population to be a group of occurrence records (sites) located in the same geographic vicinity.

³ Small population size in and of itself is not considered a threat; however, it may increase the species' vulnerability if other threats are impacting the species.

⁴ While not a threat in and of itself, this factor affects our ability to manage and recover the species.

⁵ Any circumstance or event that is causing or will cause harm to the resource.

⁶ Any circumstance or event with the potential to cause harm to the resource.

⁷ A process or event with negative impact on target species.

⁸ Same factors used when making a listing decision: 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; or E – Other.

⁹ Geographic extent of the stressor: Localized – less than one population; Moderate – one population; or Rangewide – stressor is acting on species rangewide.

¹⁰ Timeframe of the stressor: Imminent – is the stressor present and acting on the target now; Future – anticipated in the future; or Historic – or has the impact already occurred.

¹¹ The strength of the stressor itself: Low, Moderate, or High.

¹² The extent to which a target resource and stressor actually overlap in space and/or time given the scope: Small, Moderate, or High.

¹³ Level of physiological / behavioral response due to a specific stress considering growth, fecundity, and mortality rates: Basic need inhibited – basic plant needs for growth & development; or Mortality – identifiable reduction in growth rate or survival.

¹⁴ Integration of the scope, immediacy, intensity, exposure, and response at the species level: Potential, Low, Moderate, or High.

¹⁵ Small population size in and of itself is not considered a threat; however, it may increase the species' vulnerability if other threats are impacting the species.

¹⁶ While not a threat in and of itself, this factor affects our ability to manage and recover the species.