U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

Scientific Name:

Capnia arapahoe

Common Name:

Arapahoe Snowfly

Lead region:

Region 6 (Mountain-Prairie Region)

Information current as of:

04/21/2015

Status/Action

___ Funding provided for a proposed rule. Assessment not updated.

___ Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

___ New Candidate

_X_ Continuing Candidate

___ Candidate Removal

> ___ Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status
>
> ___ Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species
>
> ___ Range is no longer a U.S. territory
>
> ___ Insufficient information exists on biological vulnerability and threats to support listing

___ Taxon mistakenly included in past notice of review

___ Taxon does not meet the definition of "species"

___ Taxon believed to be extinct

___ Conservation efforts have removed or reduced threats

___ More abundant than believed, diminished threats, or threats eliminated.

Petition Information

___ Non-Petitioned

_X_ Petitioned - Date petition received: 04/06/2010

90-Day Positive:04/26/2011

12 Month Positive:05/10/2012

Did the Petition request a reclassification? **No**

For Petitioned Candidate species:

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing? **Yes**

Explanation of why precluded:

Higher priority listing actions, including court approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for this species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The Progress on Revising the Lists section of the current CNOR (http://endangered.fws.gov/) provides information on listing actions taken during the last 12 months.

Historical States/Territories/Countries of Occurrence:

- **States/US Territories**: Colorado
- **US Counties**:County information not available
- **Countries**:Country information not available

Current States/Counties/Territories/Countries of Occurrence:

- **States/US Territories**: Colorado
- **US Counties**: Boulder, CO, Larimer, CO
- **Countries**:Country information not available

Land Ownership:

Until 2013, only one Arapahoe snowfly population was confirmed to be present. This population is present along approximately 1,640 feet (ft) (500 meters (m)) of Elkhorn Creek, a small mountain stream managed entirely by the USDA Forest Service (USFS), Arapaho Roosevelt National Forest, Canyon Lakes Ranger District, in Colorado. The Arapahoe snowfly was previously identified in Young Gulch in 1986 but has not been identified there since then (Heinhold *et al.* 2014, p. 134). More recently, new field surveys in 2013 and 2014 have identified additional Arapahoe snowfly populations in seven localities, including Elkhorn Creek, Sheep Creek (a tributary of the Big Thompson River), Central Gulch (a tributary of Saint Vrain Creek), and Bummer's Gulch, Martin Gulch, and Bear Canyon Creek (tributaries of Boulder Creek) (Belcher 2015; Heinhold *et al.* 2014, p. 134). However, numbers of specimens collected at each location were extremely low, with a maximum of 8 individuals collected at Elkhorn Creek and between 1 to 4 individuals collected elsewhere (Belcher 2015; Heinhold *et al*. 2014, p. 134). These new locations occur on Forest Service land, Boulder County Open Space, and private land. Continued sampling and laboratory work in 2015 and the future will allow the researchers to further evaluate these new Arapahoe snowfly populations.

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Biological Information

Species Description:

The Arapahoe snowfly is a type of stonefly. Stoneflies are small insects distinguished by their ability to fold their two pairs of wings back along the abdomen; however, none fly well (Williams and Feltmate 1992, pp. 33 and 35). Most stoneflies are inconspicuous insects that fly clumsily (Hynes 1976, p. 135). Species of the genus *Arsapnia*, which includes the Arapahoe snowfly, are typically distinguished from other genera by physical characteristics of the epiproct (a projection at the end of the abdomen) (Nelson and Baumann 1989, p. 312). The Arapahoe snowfly adult is dark colored with a body length of approximately 0.2 inches (in.) (5 millimeters (mm)) and a wing length of approximately 0.2 in. (5 mm) (Nelson and Kondratieff 1988, p. 77). The immature stage has not been described.

Taxonomy:

The Arapahoe snowfly is an insect in the order Plecoptera (stonefly), the family Capniidae (small winter stonefly), and the genus *Arsapnia* (snowfly) (NatureServe 2009, p. 1; Integrated Taxonomic Information System 2013, p. 1). In North America, there are 674 known species of stoneflies (Stark *et al*. 2009, pp. 3–4). The nearest relatives of the Arapahoe snowfly are the Utah snowfly (*C. utahensis*) and the Sequoia snowfly (*C. sequoia*), both of which are a minimum of 400 miles (mi) (640 kilometers (km)) from the known locality for Arapahoe snowfly (Nelson and Kondratieff 1988, p. 79). The Arapahoe snowfly was first discovered in 1986 and identified as a new species in 1988 (Nelson and Kondratieff 1988, p. 77). The scientific community accepts the current taxonomic status of the Arapahoe snowfly (Nelson and Kondratieff 1988, p. 77; Nelson and Baumann 1989, p. 314; Stark *et al*. 2009, p. 3; Integrated Taxonomic Information System 2013, p. 1). Consequently, we conclude that the current best available information indicates Arapahoe snowfly is a valid species and, therefore, a listable entity under section 3(16) of the Endangered Species Act. This species was previously known as *Capnia arapahoe*, however, more recent scientific publications use the scientific name *Arsapnia arapahoe*, based on a recent DNA analysis of a female specimen (Belcher 2015, p. 2). Therefore, for the purposes of this species assessment, we are using the scientific name *Arsapnia arapahoe* for the Arapahoe snowfly.

We note that a recent genetic analysis (Heinhold *et al*. 2014) of the mitochondrial DNA barcodes of the Arapahoe snowfly and two other closely related species (*A. coyote* and *A. decepta*) indicates a discrepancy between the morphology and the DNA barcodes of these species. Specifically, the morphological analysis shows that the Arapahoe snowfly and the sympatric species, *A. decepta*, are distinct species, but the genetic DNA barcode analysis was not able to differentiate between the two species (Heinhold *et al.* 2014, p. 131). The Arapaho Roosevelt National Forest is currently planning a genetic study of the Arapahoe snowfly to sequence the mitochondrial and nuclear DNA of this species and closely related species to determine the genetic relationships of these species. Additionally, the study will likely generate genetic markers that would increase our ability to detect specimens in the future (Fairchild, 2015b, p. 1). We will evaluate the results of this study when they become available.

Habitat/Life History:

Until 2013, the Arapahoe snowfly had only been documented in two small streams: Young Gulch and Elkhorn Creek (Nelson and Kondratieff 1988, p. 77). Both streams are small tributaries of the Cache la Poudre River and resemble other streams in the Front Range of the Rocky Mountains of Colorado (Nelson and Kondratieff 1988, p. 79). At these upstream reaches, the Cache la Poudre River flows freely through the Cache la Poudre Canyon for approximately 62 mi (100 km) before becoming a plains river near Fort Collins (Medley and Clements 1998, p. 632). Upper reaches of both Young Gulch and Elkhorn Creek feature steep slopes with ponderosa pine (*Pinus ponderosa*) (Nelson and Kondratieff 1988, p. 79). Lower reaches of both streams near their confluences with the river, where the species has been collected, are more open in topography, with cottonwood (*Populus angustifolia*), willow (*Salix* spp.), Rocky Mountain maple (*Acer glabrum*), chokecherry (*Padus virginiana*), and alder (*Alnus incana*) trees along the stream margins (Colorado State University 2010, p. 1). Elevations at collection sites are 5,800 feet (ft) (1,768 meters (m)) at Young Gulch and 6,600 ft (2,010 m) at Elkhorn Creek (Nelson and Kondratieff 1988, p. 77). Both streams have a pebble, cobble, and bedrock substrate (Nelson and Kondratieff 1988, p. 79). In the summer and fall, sections of both streams may become intermittent (Nelson and Kondratieff 1988, p. 79). Both Young Gulch and Elkhorn Creek are within the Canyon Lakes Ranger District of the Roosevelt National Forest managed by the USFS. There also are several private land holdings along the upstream reaches of both drainages. We believe habitat conditions in the other sites where Arapahoe snowfly was more recently confirmed are likely similar.

Stoneflies are primarily associated with clean, cool, running waters (Surdick and Gaufin 1978, p. 3; Brittain 1990, p. 1; Williams and Feltmate 1992, p. 35; Palma and Figueroa 2008, p. 81; Stewart and Stark 2008, p. 311). Water temperature is a major influence on stonefly growth and development (Brittain 1983, p. 445). Stonefly nymphs (juvenile phase) tend to have specific water temperature, substrate type, and stream size requirements that are reflected in their distribution and succession along stream courses (Stewart and Stark 2008, p. 311). Their requirement for high dissolved oxygen concentrations may restrict the nymphs to cool, clean habitats with considerable water movement (Williams and Feltmate 1992, p. 39; Heinold 2010, p. 17). Winter stonefly nymphs, including Arapahoe snowfly nymphs, undergo diapause (dormancy) in the hyporheic zone–an active interface between the surface stream and groundwater where exchanges with water, nutrients, and dissolved oxygen occur (Boulton *et al*. 1998, p. 59; Hancock 2002, p. 763). The hyporheic zone is vulnerable to impacts from both surface water and groundwater (Hancock 2002,

p. 763). Exchange between surface water and groundwater may be the most important regulator of biological activity in the hyporheic zone; without flow to renew nutrients and oxygen and flush wastes, the sediments become unsuitable habitat (Hancock 2002, p. 764). Human activities, such as water diversions, sedimentation from roads and trail, wastewater inputs, and livestock grazing, can impact the hyporheic zone (Hancock 2002, p. 765).

The species of aquatic macroinvertebrates present in a watershed are an important indicator of the watershed's long-term health (Fleming 1999, p. 93; DeWalt *et al.* 2005, p. 942). Whether or not sensitive families of insects remain in a stream is a useful indicator of upstream watershed health (Fleming 1999, p. 94). Of all orders of insects, stoneflies are the most sensitive to habitat alteration, pollution, and siltation, and therefore they are the best insect indicators of the quality of an aquatic environment (Baumann 1979, p. 241; Rosenberg and Resh 1993, p. 354; Fleming 1999, p. 94; Heinold 2010, p. 18). With increased stream perturbation, the number of stonefly taxa will decrease (Barbour *et al.* 1999, pp. 7.15-7.16). On a tolerance index for aquatic macroinvertebrates ranging from 1 to 10, with 10 representing the most tolerant, stoneflies were the least tolerant to stream perturbation with a tolerance index from 1.7 to 4.4 (Fleming 1999, p. 94). Winter stoneflies (family Capniidae) rate in the mid-range for stoneflies, with a tolerance index of 3.0 (Fleming 1999, p. 94).

A study tested the Cache la Poudre River for the presence of 271 compounds, including volatile organic compounds, pesticides, wastewater compounds, and *Escherichia coli* (Collins and Sprague 2005, p. 1). Most (257) of these compounds were not detected in the river, and all concentrations detected were less than established water quality standards (Collins and Sprague 2005, p. 1). The river is considered generally pristine (Medley and Clements 1998, p. 632; George Weber Environmental, Inc. 2007, p. 7). Based upon what is known regarding habitat requirements of the Arapahoe snowfly, the mainstem river itself is not a likely source of potential habitat due to the fact that known and historic occurrences were both found in small, intermittent streams. However, it also is not a likely barrier to any potential dispersal of the species into appropriate habitats along other tributaries of the Cache la Poudre.

Prior to 2011, we lacked specific water quality data for Young Gulch and Elkhorn Creek. Recognizing this data deficiency, the Service and USFS collaborated in 2011 and 2012 to collect water quality data at both creeks. Although Young Gulch was dry for the first sampling on December 8, 2011, we collected water samples on August 23, 2012, to assess conditions after the High Park Fire. This large wildfire burned portions of Young Gulch and approximately 42,634 acres of the Arapaho Roosevelt National Forest during the early summer 2012 (InciWeb 2013, p. 1). Water quality sampling occurred approximately 984 ft (300 m) above each creek's confluence with the Cache la Poudre River. At Young Gulch, samples were collected within the perimeter of the High Park Fire along a recently burned stretch of creek. Table 1 summarizes the water quality data (Sanchez 2011a, p. 2; 2011b, pp. 2, 14; 2012, p.1).

TABLE 1. Water quality data collected from Elkhorn Creek on December 8, 2011, and August 23, 2012, and from Young Gulch on August 23, 2012 (Sanchez 2012, p. 1).

WATER QUALITY PARAMETER	MEASUREMENT		
	Elkhorn Creek December 8, 2011	Elkhorn Creek August 23, 2012	Young Gulch August 23, 2012 *(Post Wildfire)*
Water temperature	32.5°F (0.3°C)	59.0°F (15.0°C)	63.1°F (17.3°C)
Conductivity	150.9 microsiemens per centimeter (μS/cm)	171.8 μS/cm	360.4 μS/cm
pH	6.46	7.5	7.7
Dissolved oxygen	11.18 milligrams per liter (mg/L) (>90% O_2 saturation)	9.1 mg/L	7.9 mg/L
Total inorganic nitrogen	<0.21 mg/L	<0.13 mg/L	<0.11 mg/L
Ammonium	<0.10 mg/L	<0.10 mg/L	<0.10 mg/L
Total suspended solids	<5 mg/L	<5 mg/L	8 mg/L
Total dissolved solids	88–96 mg/L	112–114 mg/L	228 mg/L
Total coliform	Present*	130–170 per 100 mL*	1,600 per 100 mL*

From our knowledge of other winter stoneflies, the water quality values collected at Elkhorn Creek on December 8, 2011, and August 23, 2012, appear adequate to support the species during the early winter and late summer. Conversely, higher measurements for conductivity, total suspended solids, total dissolved solids, and total coliforms recorded at Young Gulch on August 23, 2012, suggest that waters were too polluted to support the Arapahoe snowfly. However, unsuitable habitats likely extirpated the Arapahoe snowfly from Young Gulch prior to sampling and before the High Park Fire burned the creek in June 2012. The wildfire deposited debris and ash into Young Gulch, decreasing the water quality and further reducing habitat quality, but without pre-fire data we cannot quantitatively assess the impact of the High Park Fire on Arapahoe snowfly habitats. If funding allows, the Service and USFS will continue monitoring the water quality of both streams, as well as the additional streams where the species was more recently confirmed, in order to improve our understanding of habitat requirements and any seasonal fluctuations that might influence the Arapahoe snowfly. We hope to sample during additional snowfly life phases including the emergence of adults (early spring), egg hatch (late spring), and summer diapause.

Due to its rarity and relatively recent discovery, few studies have been conducted on the Arapahoe snowfly. Sampling for adult specimens is limited to late winter/early spring when adults are present above ground. Snowflies generally cannot be identified at the species level during most of their life stages, including the nymph stage. The difficulties in distinguishing among species of snowfly nymphs, compounded by the difficulty of sampling under ice in winter, have largely precluded the study of individual species (Stewart and Stark 2002, p. 122). Detailed life histories are well known for less than 5 percent of stonefly species (Stewart and Stark 2002, p. 23). Therefore, our knowledge of the Arapahoe snowfly's life history comes from knowledge about stoneflies (order Plecoptera) in general, other members of the winter stonefly family (family Capniidae), and other species of snowfly. We expect that the life history of the Arapahoe snowfly is similar to these related species.

Stoneflies have a complex lifecycle that requires terrestrial habitat during the adult phase and aquatic habitat during the nymph phase (Lillehammer *et al.* 1989, p. 183; Williams and Feltmate 1992, p. 33). Having both a terrestrial and aquatic phase creates dependence on two different environments (Brittain 1990, p. 1). The majority of the stonefly life cycle is spent as a developing nymph in the aquatic environment, while their brief terrestrial adult stage of 3–4 weeks is primarily focused on reproduction (Brittain 1990, p. 1; Williams and Feltmate 1992, p. 33). Winter stoneflies have a univoltine (1-year) life cycle (Hynes 1976, pp. 146–147).

As water levels decrease through the winter, adult winter stoneflies emerge in late winter from the space that forms under stream ice (Hynes 1976, p. 136). Winter streamflow is essential for winter stoneflies (Jacobi and Cary 1996, p. 696). Temperature is also important, with emergence occurring earlier in warmer years (Hynes 1976, p. 137). Arapahoe snowfly adults have only been collected in late March and early April (Mazzacano undated, p. 2). After emergence, winter stonefly males drum (beat their abdomen on the ground or on vegetation) to search for mates, with a frequency that is species and sex specific (Hynes 1976, p. 139). Unmated females reply, the males approach and drum again, and the process repeats until they meet and mate (Hynes 1976, p. 139). Mating occurs on the ground or on vegetation adjacent to the aquatic habitat (Brittain 1990, p. 1).

Females release eggs into the stream, which attach to the substrate (Stewart and Stark 2008, p. 311). Most stoneflies lay 100 to 2,000 eggs (Brittain 1990, p. 4). Winter stonefly eggs hatch within 3–4 weeks (Stewart and Stark 2008, p. 312). Hatching success is high within a water temperature range of 41 to 59ºF (5 to 15ºC) (Brittain 1990, p. 5). Most stoneflies show rapidly decreasing hatching success over 68ºF (20ºC) (Brittain 1990, p. 5). As water temperatures rise, nymphs burrow into the streambed and undergo summer diapause (Harper and Hynes 1970, pp. 925–926; Williams and Feltmate 1992, p. 39; Stewart and Stark 2002, p. 34; Mazzacano undated, p. 2). This adaptation enables winter stoneflies to inhabit streams that may reach unsuitably high temperatures or dry during the summer (Harper and Hynes 1970, pp. 925–926; Stewart and Stark 2002, p. 34). Diapause may also be a mechanism for synchronizing the timing of feeding with leaf drop in the fall (Stewart and Stark 2002, p. 35). As water temperatures drop in the fall, nymphs become more active. Most winter stoneflies nymphs feed by shredding detritus (debris), and active nymphs are usually found in leafy or woody stream debris (Short and Ward 1981, p. 341; Mazzacano undated, p. 2; Stewart and Stark 2008, p. 379).

Stoneflies have limited dispersal capabilities (Brittain 1990, pp. 2 and 10). This lack of mobility prevents them from crossing even small ecological barriers, resulting in a high degree of local speciation (Hynes 1976, p. 135). A study in the United Kingdom that collected more than 22,500 adult stoneflies from 15 different species found that half of all stoneflies were taken within 59 ft (18 m) of the stream channel, and 90 percent traveled less than 197 ft (60 m) (Petersen *et al.* 2004, pp. 934, 938, and 942). Most studies also suggest a low tendency of in-stream drift for stonefly nymphs (Stewart and Szczytko 1983, p. 117).

Historical Range/Distribution:

Many snowflies are endemic species, with a narrow range limited to a small geographical or ecological area (Nebeker and Gaufin 1967, p. 416; Nelson and Baumann 1989, p. 292; Nelson 2008, pp. 178-179; Kondratieff and Baumann 2002, p. 399). Similarly, the Arapahoe snowfly's distribution appears highly restricted. It is only historically known from two small tributaries of the Cache la Poudre River in northern Colorado–Young Gulch and Elkhorn Creek (Nelson and Kondratieff 1988, p. 77; Heinold and Kondratieff 2010, p. 282). Habitat where the species has been collected extends from the confluences with the river to approximately 1,640 ft (500 m) upstream for both streams (Heinold 2011a, unpaginated). Approximately 5 mi (8 km) separates these two streams. The species was first discovered in March 1986 in Young Gulch, but, despite repeated searches during most of the past 25 years, it has not been found again in that locale (Nelson and Kondratieff 1988, p. 77; Heinold 2011b and 2011c, unpaginated, and 2014, p. 134). In April 1987, the species was first located in Elkhorn Creek and has been found in subsequent searches in this stream (Nelson and Kondratieff 1988, p. 77). Repeated searches (at least 17 searches in the past 16 years) had also been conducted in 11 additional nearby waterways with similar ecological characteristics; however, until 2013, the species had not been located in any new streams (Heinold 2011b, unpaginated; Heinhold 2014 *et al.*, p. 134; Belcher 2015).

Because the Arapahoe snowfly was only collected in Young Gulch on one occasion prior to 2013, we do not know if Young Gulch actually supported a historical population, what the size of that population was, or why it was extirpated. However, Young Gulch has several hydrologic characteristics that may make it less desirable than Elkhorn Creek as Arapahoe snowfly habitat. Young Gulch is a shorter stream, which arises at a lower elevation (7,500 ft (2,290 m)) than Elkhorn Creek (10,000 ft (3,050 m)). Thus, any accumulated snowfall in the upper levels of the drainage will melt sooner and more quickly, drying the stream earlier in the year than Elkhorn Creek. There is no minimal flow water right on Young Gulch, as there is on Elkhorn Creek (Colorado Water Conservation Board (CWCB) and Colorado Division of Water Resources (CDWR) 2011, unpaginated). As noted above, when water samples were collected from Elkhorn Creek in Arapahoe snowfly habitat on December 8, 2011, Young Gulch was dry. Additionally, the High Park Fire of 2012 burned the lower and upper reaches of Young Gulch, further rendering potential habitats unsuitable. Although Young Gulch had flowing water on August 23, 2012, analysis of the water samples suggested that the High Park Fire decreased the quality of waters such that they are currently unsuitable to support the Arapahoe snowfly. Additionally, a flash flood disaster in September 2013 scoured vegetation and deposited sediment along Young Gulch (USFWS 2014, p. 1) and may have further damaged Arapahoe snowfly habitats.

Young Gulch and Elkhorn Creek also experience different levels of recreational use. Young Gulch features a well-developed trailhead at Highway 14 that experiences heavy, year-round use from hikers, bikers, backpackers, and horseback riders (USFS 2011c, pp. 1, 2). The trail follows Young Gulch and includes approximately 45 stream crossings (Casamassa 2011, p. 4). Aquatic macroinvertebrates present at a given stream site are related to the number of stream crossings above that site, with the total number of larval species (including stoneflies) negatively related to the number of stream crossings (Gucinski *et al.* 2001, p. 26). The amount of usage and the number of stream crossings likely contribute to a high sediment load, which may have factored into the extirpation of the species at this location. The USFS closed the Young Gulch trailhead to recreational use following the High Park Fire and reopened the trail briefly in 2013 before closing it again due to damage from the flash flood disaster of September 2013 (Oberlag 2013, p. 1; USFS 2014, p. 1). The Young Gulch trailhead remains closed and the USFS is evaluating trail reroutes that will reduce the number of stream crossings and the proximity of the trail to the stream for the purposes of providing improved protection of the Arapahoe snowfly (USFS 2014, p. 1; Fairchild 2015a).

Current Range Distribution:

The species was known from 1 male specimen collected in 1986 in Young Gulch; and 1 male in 1987, 10 males and 2 females in 2009, and 1 male in 2011, all in Elkhorn Creek (Heinold and Kondratieff 2010, p. 281; Heinold 2011d, unpaginated). During a search of Elkhorn Creek on March 17, 2009, approximately 500 specimens of 4 species of snowflies were collected, but only 5 of those specimens were Arapahoe snowfly (Heinold 2011a, unpaginated). This low degree of detection indicates rarity at this location for the species.

Field observations from new surveys completed in 2013 and 2014 found the Arapahoe snowfly in Elkhorn Gulch and 6 other streams, including Sheep Creek (a tributary of the Big Thompson River), Central Gulch (a tributary of Saint Vrain Creek), and Bummer's Gulch, Martin Gulch, and Bear Canyon Creek (tributaries of Bear Creek) (Belcher 2015; Heinhold *et al*. 2014, p. 1). Numbers of specimens collected at each location were extremely low, with a maximum of 8 individuals collected at Elkhorn Creek and between 1 to 4 individuals collected elsewhere (Heinhold *et al.* 2014, p. 134), with low detection rates similar to those previously detected at Elkhorn Creek in 2009.

At this time, we do not have specific information on the impacts and stressors occurring at these new sites. Therefore, in this species assessment we are relying on the Elkhorn Creek site, which has been well studied, to provide general information on the site conditions and the types of impacts and stressors to the Arapahoe snowfly. We expect that any stressors to the species at the new sites would be similar to those in Elkhorn Creek, because they are in the same general geographic area and the habitat conditions in the new sites are similar to Elkhorn Creek. However, we will investigate the specific site conditions at the new locations in future species assessments.

Population Estimates/Status:

Given the low numbers of individuals that have been collected over the years, we have no information available regarding population trends for the Arapahoe snowfly.

Distinct Population Segment(DPS):

Not applicable.

Threats

A. The present or threatened destruction, modification, or curtailment of its

habitat or range:

Under Factor A we evaluate climate change, recreation, development, forest management, and grazing to the Elkhorn Creek populations. At this time, we do not have specific information on the impacts and stressors occurring at the new sites where Arapahoe snowfly was only recently confirmed. Therefore, we are relying on the Elkhorn Creek site, which has been well studied, to provide information on the general types of impacts and stressors to the Arapahoe snowfly. Based on the similarity of habitat conditions with the new sites, we assume the impacts to the species at those sites would be similar to Elkhorn Creek. We will investigate the specific site conditions at the new locations in future species assessments.

Climate Change

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

Climate change is affecting the western United States more than any other part of the country outside of Alaska (Saunders *et al.* 2008, p. iv). The hydrological cycle of the western United States changed significantly over the second half of the 20th century (Barnett *et al.* 2008, p. 1080). Numerous studies show more winter precipitation falling as rain instead of snow, earlier snowmelt, and associated changes in river flow (Barnett *et al.* 2008, p. 1080). Between 1978 and 2004, the spring pulse (onset of streamflow from melting snow) in Colorado shifted earlier by 2 weeks (Ray *et al.* 2008, p. 2). Although there is no identified decrease in runoff to date, average annual runoff is projected to decrease significantly for the South Platte River basin (which includes Elkhorn Creek) over the next 50–60 years (U.S. Bureau of Reclamation (BOR) 2011, p. 94). A decline of 8 percent is projected by the 2020s, 14 percent by the 2050s, and 17 percent by the 2070s, due primarily to increased temperatures and little projected change in precipitation (BOR 2011, p. 94).

A precipitous decline in lower elevation snowpack below 8,200 ft (2,500 m) elevation is predicted to occur across the western United States by the middle of the 21st century, and modest declines of 10-20 percent will occur in snowpack above 8,200 ft (2,500 m) elevation (Regonda *et al.* 2005, p.376; Ray *et al.* 2008, p. 1). According to topographic maps, the headwaters of Elkhorn Creek approach 10,000 ft (3,050 m) elevation, indicating that Elkhorn Creek may begin to experience some effects from reduced snowpack within the next 50 years.

A local habitat that depends on snowmelt to maintain a sufficient quantity of in-stream flows is likely to be sensitive to projected reductions in average snowpack, as well as to changes in the timing and intensity of precipitation (Glick *et al.* 2011, p. 20). Species that breed in intermittent streams are likely to be highly susceptible to climate impacts such as rising temperature regimes; winter precipitation arriving more frequently as rain than snow; and shifts in the timing of snowmelt, runoff, and peak stream flows (Glick *et al.* 2011, p. 41). Species that are poor dispersers also may be more susceptible as they will be less able to move from areas that climate change renders unsuitable and into areas that become newly suitable (Glick *et al.* 2011, p. 49). The Arapahoe snowfly is found in a very localized habitat, breeds in intermittent streams, and is considered a poor disperser. Consequently, it may be particularly vulnerable to changes in climate.

Temperature has critical effects on aquatic macroinvertebrates through its combined influences on dissolved oxygen and metabolic activity (Durance and Ormerod 2007, p. 943). Stoneflies' adaptation to cold environments places them at a competitive disadvantage in warmer climates (Brittain 1990, p. 9; Haiderkker and Hering 2007, p. 473). A study in the United Kingdom found that spring macroinvertebrate abundance declined by an average rate of 21 percent across all species for every 1.8ºF (1ºC) rise in stream temperature in circumneutral (pH near neutral) streams (Durance and Ormerod 2007, p. 942). Sixteen species of stoneflies were among the 84 macroinvertebrate species noted in these streams (Durance and Ormerod 2007, p. 951). Air temperatures in the northern Front Range of Colorado increased 2.5ºF (1.4ºC) from 1977-2006 (Ray *et al*. 2008, p. 10). Stream temperatures also are expected to increase as the climate warms (Ray *et al.* 2008, p. 41).

There is limited pH data specific to Elkhorn Creek. However, in 1973 the USFS recorded a pH of 7.5 in Elkhorn Creek headwaters and also near the confluence of Elkhorn Creek with the Cache la Poudre River (USFS 1973, p. 1). More recently, pH readings of 6.46 during the early winter and 7.5 during the late summer were recorded in Elkhorn Creek near the confluence with the Cache la Poudre River (Sanchez 2011, p. 2; Sanchez 2012, p. 1). These pH values are considered circumneutral. The pH values of the Cache la Poudre River are circumneutral to somewhat alkaline, with pH values documented from 7.52 to 8.67 (Medley and Clements 1998, p. 634). It is reasonable to conclude that Elkhorn Creek also is circumneutral. In a study conducted over a 25-year period in the United Kingdom, scarcer taxa disappeared in circumneutral streams that showed progressive temperature increases (Durance and Ormerod 2007, p. 943). Thus, currently observed trends might result in the same fate for the Arapahoe snowfly.

A laboratory study found that larval growth of one species of stonefly (*Leuctra nigra*) increased with increasing water temperature from 43 to 68ºF (5.9 to 19.8ºC); however, mortality also increased, resulting in only 7–10 percent of individuals completing their life cycle at the three higher temperatures, compared with 23–27 percent at the three lower temperatures (Elliot 1987, p. 181). The number of eggs laid also decreased at higher temperatures (Elliot 1987, p. 181). As previously noted, air temperatures in the northern Front Range of Colorado increased 2.5ºF (1.4ºC) from

1977–2006 and stream temperatures also are expected to increase (Ray *et al.* 2008, pp. 10 and 41). This suggests that water temperatures in Elkhorn Creek could increase to levels harmful to sensitive taxa such as the Arapahoe snowfly.

Disturbances such as insect outbreaks and wildfire are likely to intensify in a warmer future with drier soils and longer growing seasons (Field *et al.* 2007, p. 619; Karl *et al.* p. 82). Ongoing outbreaks of mountain pine beetle (*Dendroctonus ponderosae*) in Colorado are probably caused primarily by climate, specifically drought and high temperature (Romme *et al.* 2006, p. 4; Black *et al.* 2010, p. 1). Mountain pine beetles typically exist as small populations that feed on the innermost bark layer of trees that have been weakened by disease or injury (Black *et al.* 2010, p. 7). However, they can erupt to epidemic levels if stand structure and climatic conditions are appropriate and overcome the defenses of even healthy trees, leading to widespread mortality of host species (Field *et al.* 2007, p. 623; Black *et al.* 2010, p. 7).

Ponderosa pine is the dominant vegetation in the upper watershed of Elkhorn Creek (Nelson and Kondratieff 1988, p. 79). Mountain pine beetle infestations are building in ponderosa pine forests along the Front Range of Colorado, with an outbreak detected in northern Larimer County (Ciesla 2010, pp. 2, 10, and 34). This outbreak encompasses the range of the Arapahoe snowfly. Infestations in ponderosa pine along the Northern Front Range increased by more than 10-fold from 2009-2010, from 22,000 acres (ac) (8,903 hectares (ha)) to 229,000 ac (92,673 ha) (Ciesla 2011, pp. 6-7). Mountain pine beetle activity is expected to increase in the Front Range over the next several years (Ciesla 2011, p. 8). The mountain pine beetle outbreak in northern Colorado could affect water quantity and quality. As trees die and fall, forest cover becomes less dense, allowing greater exposure of snowpack to solar radiation, causing faster runoff and increased soil erosion (Ciesla 2010, p. 17).

Epidemics that kill trees over large areas also provide dead, desiccated fuels for large wildfires (Field *et al.* 2007, p. 623). A warming climate encourages wildfires through a longer summer period that dries fuels, promoting easier ignition and faster spread (Field *et al.* 2007, p. 623). In the last 3 decades, the wildfire season in the western United States increased by 78 days (Field *et al.* 2007, p. 622; Saunders *et al.* 2008, p. 20). Fire suppression during the 20th century likely created a high hazard of catastrophic fire in ponderosa pine forests of the northern Front Range in Colorado (Veblen *et al.* 2000, p. 1178). Catastrophic fire can impact aquatic macroinvertebrates. For example, following fires in Yellowstone National Park in 1988, there was a change in aquatic macroinvertebrates from shredder and collector species (such as snowflies) to scraper and filter-feeding species (Neary *et al.* 2009, p. 142). Similarly, following the 1996 Dome wildfire in New Mexico, aquatic macroinvertebrate shredders (including winter stoneflies) common in pre-fire years were reduced or eliminated, and had not recovered by 5 years post-fire (Vieira *et al.* 2004, pp. 1243 and 1251). Taxa with weak dispersal abilities and specialized feeding requirements (including winter stoneflies) became rare after the Dome wildfire (Vieira *et al.* 2004, p. 1256). A wildfire in the Elkhorn Creek watershed could eliminate rare macroinvertebrates such as the Arapahoe snowfly. Although unsuitable habitats likely extirpated the Arapahoe snowfly from Young Gulch before the High Park Fire burned the creek in June 2012, the wildfire further reduced the quality of potential habitats.

In conclusion, climate change is resulting in both potentially present and threatened modification of Arapahoe snowfly habitat. Climate change is modifying Arapahoe snowfly habitat in several ways including: (1) the predicted significant reduction in snowpack, (2) the present increase in temperature as well as continued threatened increases in future years, (3) the present and increasing outbreak of mountain pine beetle in ponderosa pine, and (4) the threatened increased likelihood of wildfire. Although available information indicates that climate change could potentially be modifying the species' habitat at the present time, we do not have any information that indicates this is currently threatening the species. However, the impacts from each of these stressors are reasonably expected to increase into the future, and the species' limited distribution and life history characteristics make it extremely vulnerable to the predicted impacts. Therefore, we consider modification of habitat as a result of climate change a threat to the species.

Recreation

Recreational use has been lower along Elkhorn Creek than in Young Gulch (USFS 2009a, p. 4), where we believe that heavy recreational use may have contributed to the species' extirpation. However, a new trailhead was completed along Elkhorn Creek in 2010 that expanded the parking area and improved trail access (USFS 2009b, p. 4). Consequently, trail usage is likely to increase along the lower section of Elkhorn Creek in and near Arapahoe snowfly habitat. There are several areas along upper sections of Elkhorn Creek where trails are causing increased run-off and erosion (USFS 2009a, p. 48). Consequently, the USFS has identified 14 stream crossings for improvement (Casamassa 2011, p. 3). These trails originate 6–7 mi (10–11 km) upstream from where the Arapahoe snowfly has been found and progress further upstream, away from known Arapahoe snowfly habitat on Elkhorn Creek. We have no information at this time to indicate that sedimentation from these trails is impacting downstream Arapahoe snowfly habitat. The USFS is currently evaluating trail reroutes in Young Gulch in order to reduce the number of stream crossings and to move the trail further from the stream (Fairchild 2015a).

Recreation has been increasing in the northern Front Range as a result of increasing population growth in Colorado (USFS 2009b, p. 1). The nearest city is Fort Collins, Colorado, approximately 31 miles from Elkhorn Creek. Fort Collins' population has grown rapidly in recent years. The 2006 population estimate was 129,467, an 8.7 percent increase from 2000 (City of Fort Collins 2008b, unpaginated). The 2014 population estimate was 155,400 (City of Fort Collins 2015, unpaginated). Usage of trail systems throughout the Cache la Poudre River canyon will likely increase as the population continues to grow.

Specific information on the types of recreational usage for Elkhorn Creek, or other sites where the species is present, is not available. However, we expect the Elkhorn Creek recreational usage to be similar to usage patterns in nearby Young Gulch, where the USFS estimates that approximately 83 percent of recreational users were day-hikers, 10 percent bicyclists, 4 percent back-packers, and 1 percent horseback riders (Casamassa 2011, p. 5). Dogs are often allowed off-leash on USFS trails, including Elkhorn Creek trails (Casamassa 2011, p. 5). Common environmental impacts associated with trail usage include vegetation loss, soil compaction, erosion, muddiness, degraded water quality, and disruption of wildlife (International Mountain Biking Association (IMBA) 2007, p.

1; Marion and Wimpey 2007, unpaginated). The environmental degradation caused by hikers and mountain bikers is similar; both are substantially less than degradation caused by horses (Marion and Wimpey 2007, unpaginated). Eroded soils that enter streams increase sedimentation that can impact habitat directly or contribute to algae blooms that deplete dissolved oxygen (IMBA 2007, p. 8). Even localized disturbance can harm rare species (Marion and Wimpey 2007, unpaginated). Because Arapahoe snowfly nymphs require high dissolved oxygen levels (see Habitat section), algal blooms could indicate dissolved oxygen levels unsuitable for Arapahoe snowfly habitation.

In summary, recreational use within the Elkhorn Creek watershed is expected to increase as the human population increases, but the majority of trails originate 6–7 mi (10–11 km) upstream from where the Arapahoe snowfly has been found, and progress further upstream, away from known Arapahoe snowfly habitat. We have received no new information on stressors related to recreational use in the past year. At present, we do not consider recreational use within the Elkhorn Creek watershed a threat to the species.

Development

The number of species of stoneflies as well as the percentage of stoneflies compared with all insect species decreases with increasing stream perturbations (Barbour *et al*. 1999, pp. 7.15–7.16). Roads, water diversions, and wastewater inputs are the primary development activities occurring in the Elkhorn Creek watershed.

Roads

Road construction and use can result in large increases in suspended sediments, with potentially detrimental effects on water quality and aquatic macroinvertebrates (Anderson and Potts 1987, p. 681; Gucinski *et al.* 2001, p. vii; Grace 2002, p. 13; Angermeir *et al.* 2004, p. 19). A number of studies have demonstrated declines in invertebrate densities and biomass following sedimentation events by directly affecting aspects of their physiology or by altering their habitat (Anderson 1996, p. 8). Arapahoe snowfly nymphs inhabit the hyporheic zone in spaces between and beneath large substrate particles such as pebbles and cobbles. Sediment can clog these spaces, cementing the stream bottom, inhibiting the flow of dissolved oxygen, and making the habitat unsuitable for macroinvertebrate species such as stoneflies (Furniss *et al.* 1991, p. 302; Waters 1995, p. 65; Anderson 1996, pp. 6 and 8; Grace 2002, pp. 24-25). The aquatic macroinvertebrate species present at a given stream site are related to the number of stream crossings above that site, with the total number of larval species (including stoneflies) negatively related to the number of stream crossings (Gucinski *et al.* 2001, p. 26).

There are several areas along Elkhorn Creek where roads are causing increased run-off and erosion into the stream; consequently, the USFS rates the watershed as Class II or “at risk” (exhibiting moderate integrity relative to its potential condition and at risk of being able to support its beneficial uses) (USFS 2009a, p. 48). Unpaved roads create compacted, bare areas that increase runoff and erosion (USFS 2009a, p. 48). In addition, some road segments near Elkhorn Creek are steep and severely eroded (USFS 2009a, p. 48). Road density in the area averages 3.5 mi of roads per square mi (2.2 km per square km); a road density of 3.7 mi per square mi (2.3 km per square km) is considered high (USFS 2009a, p. A-1). Unpaved roads and jeep trails cross the Elkhorn Creek watershed approximately 20 times, according to topographic maps. One additional crossing is by a paved road. Unpaved roads, constructed of native materials, are more erosion prone than paved roads. The closest stream crossing by an unpaved road is approximately 5–6 mi (8–10 km) upstream of known occupied habitat for the Arapahoe snowfly. Given the distance from the species' habitat and the results of the minimal water quality information available, we cannot identify any impacts to the species in the Elkhorn Creek watershed.

Road salts are a common pollutant in regions with snowy winters and can enter air, soil, groundwater, and surface water from runoff, surface soils, or wind-borne spray (Center for Environmental Excellence 2009, p. 3; Silver et al. 2009, p. 942). Stoneflies are very sensitive to water salinity, with adverse effects apparent at low salinities (Hart *et al.* 1991, p. 136). However, the Colorado Department of Transportation concluded that magnesium chloride (the road salt used in Colorado Mountains) is highly unlikely to cause environmental damage at distances greater than 59 ft (18 m) from a roadway (Lewis 1999, p. vii; Center for Environmental Excellence 2009, p. 4). Highway 14 crosses Elkhorn Creek at its confluence with the Cache la Poudre River. Habitat for the Arapahoe snowfly extends from the confluence with the river to approximately 1,640 ft (500 m) upstream (Heinold 2011a, unpaginated). Therefore, approximately 3.6 percent of potential habitat may be impacted by the use of road salt. Sampling on December 8, 2011, and August 23, 2012, within this 1,640 ft (500 m) reach in Elkhorn Creek detected very low salinity levels (Sanchez 2011b, p. 2; Sanchez 2012, p. 1). Therefore, we do not consider the use of road salt to be a threat to the Arapahoe snowfly in the Elkhorn Creek watershed.

In conclusion, roads are contributing to an unacceptable sediment load resulting in the Elkhorn watershed being rated as Class II or "at risk." However, these roads are a minimum of 5 mi (8 km) upstream of the species' occupied habitat, and we have limited downstream water quality information in the vicinity of Arapahoe snowfly habitat to confirm or refute impacts. We believe that use of road salts causes minimal impact to the species' habitat. We have received no new information on these stressors related to roads in the past year. At present, we do not consider roads a threat to the species in the Elkhorn Creek watershed.

Water Diversions

Elkhorn Creek and 2 of its tributaries contain 35 water diversion structures, 23 of which have active water rights (CWCB and CDWR 2011, unpaginated). Diversion rights totaling rates of approximately 50 cubic feet per second (cfps) (1.4 cubic meters per second (cmps)) plus an additional volume of approximately 205 acre-feet (252,800 cubic meters) are permitted (CWCB and CDWR 2011, unpaginated). A minimum flow of 2 cfps (0.06 cmps) for Elkhorn Creek is included among the active water rights (CWCB and CDWR 2011, unpaginated). This minimum flow indirectly provides some protection to habitat of the Arapahoe snowfly. However, Elkhorn Creek is described as an intermittent stream (Nelson and Kondratieff 1988, p. 79), and during periods of low precipitation it may be dry, despite in-stream flow water rights. The species' life history includes a diapause stage which allows it to inhabit streams which may dry up due to high temperatures or low flows (Harper and Hynes 1970, pp. 925–926; Stewart and Stark 2002, p. 34).

In the upstream reach of the Cache la Poudre River that includes the confluence of Elkhorn Creek, water inputs and outputs tend to balance out (City of Fort Collins 2008a, p. 5). Further downstream, below the mouth of the Cache la Poudre Canyon, there are numerous water depletions (City of Fort Collins 2008a, pp. 5–6). However, the downstream river reach does not have the necessary habitat for the species and is many miles downstream from Elkhorn Creek.

Several water diversions on Elkhorn Creek or its tributaries have modified or curtailed habitat. However, a minimum flow of 2 cfps for Elkhorn Creek is included among the active water rights, and information on other species of winter stoneflies indicates that diapause enables them to withstand dry summer conditions. We received no new information on water diversions on the past year. At present, we do not consider water diversions a threat to the species in the Elkhorn Creek watershed.

Wastewater

The two largest known wastewater inputs within the Elkhorn Creek watershed are a Boy Scout camp (camp) located approximately 5–6 mi (8–10 km) upstream of known occupied habitat for the Arapahoe snowfly and a meditation and yoga retreat (retreat) located approximately 6–7 mi (10–11 km) upstream. Both facilities have septic tanks and constructed wetlands or evaporation ponds for treating wastewater prior to discharge into groundwater within the Elkhorn Creek watershed (North Front Range Water Quality Planning Association 2011, unpaginated). Both the camp and the retreat are building treatment facilities that will reduce the possibility of wastewater entering Elkhorn Creek (North Front Range Water Quality Planning Association 2011, unpaginated). With these precautions, we conclude that contamination of the Arapahoe snowfly habitat by wastewater from the camp or retreat is unlikely.

None of the streams in the project area are listed on the State Clean Water Act (CWA) section 303(d) list as impaired. However, groundwater monitoring wells installed both up-gradient and down-gradient from the retreat's wastewater treatment site show that all parameters, with the exception of chloride, had their lowest values (i.e., highest water quality) in groundwater up-gradient of the wastewater treatment site and their highest values (i.e., worst water quality) down-gradient of the wastewater treatment site (Zigler 2010, p. 5; Campbell 2011, unpaginated). Data submitted for June 2010, through July 2011, measured the following water quality parameters as summarized in Table 2 (units are in milligrams per liter).

Table 2 - Water quality from groundwater monitoring wells.

PARAMETER	LOWEST RECORDED VALUE	HIGHEST RECORDED VALUE
Total Inorganic Nitrogen	0.09 (up-gradient well)	10.77 (down-gradient well)
Total Coliform	Less than 1(both wells)	46 (down-gradient well)
Chloride	6 (up-gradient well)	43.9 (up-gradient well)
Sulfate	16.8 (up-gradient well)	132.2 (down-gradient well)
Total Dissolved Solids	142 (up-gradient well)	400 (down-gradient well)

Contaminant inputs can move from groundwater into surface water through the hyporheic zone

(Boulton *et al.* 1998, p. 73). Although down-gradient concentrations are elevated, none of the pollutants measured are priority pollutants under the CWA. Furthermore, we cannot make firm conclusions regarding the extent of contamination in the species' habitat caused by wastewater discharge into groundwater 5–7 mi (8–11 km) upstream. However, measurements recorded during the summer on August 23, 2012, when human use upstream is much greater than occurs during the winter, identified sewage and waste inputs, but at low levels (Sanchez 2012, p. 1). None of the groundwater or surface water quality information available indicates that nutrient enrichment (high levels of nitrogen or phosphorus), which could lead to algal blooms and decreased dissolved oxygen, is occurring. Wastewater inputs may have modified habitat through nutrient inputs into groundwater within the Elkhorn Creek watershed that could impact the hyporheic zone where Arapahoe snowfly nymphs undergo diapause. However, these inputs occur 5–7 mi (8–11 km) upstream, and limited water quality information in the vicinity of the species' known habitat suggests that inputs are low. Due to the limited sampling data available, we consider the available water quality data inadequate to confirm or refute nutrient enrichment. We received no new information on stressors related to wastewater in the past year. At present, we do not consider wastewater a threat to the species in the Elkhorn Creek watershed.

Forest Management

In this section we discuss management by the USFS to address the mountain pine beetle; specifically, spraying trees with carbaryl to protect against mountain pine beetle attack and removal of hazardous trees.

Carbaryl is one of the most effective and environmentally safe insecticides used to prevent mountain pine beetle attack (Hastings *et al.* 2001, p. 803). Nevertheless, carbaryl poses ecological risks, particularly to honey bees and aquatic invertebrates (U.S. Environmental Protection Agency (EPA) 2004, p. 1). It is rated as "very highly toxic" to aquatic invertebrates, with one of the test organisms a species of stonefly (*Chloroperla grammatica*) (EPA 2004, p. 46). Despite no-spray buffer zones around aquatic habitats, pesticides such as carbaryl may be deposited by drift or mobilized by runoff from upland areas (Beyers *et al.* 1995, p. 27). A study described by Beyers *et al.* (1995, p. 32) found that virtually all stoneflies collected from a stream following carbaryl spraying were dead; however, mortality was likely ameliorated by colonization from unaffected organisms of the same species in the substrate or living upstream. In recent years, the USFS has been spraying carbaryl on thousands of individual trees in the Canyon Lakes Ranger District in an effort to control the ongoing mountain pine beetle outbreak (USFS 2009c, 2010b, 2011a, unpaginated). However, none of the sites sprayed to date are within the Elkhorn Creek watershed (Casamassa 2011, pp. 5–6). Therefore, at present, we do not consider spraying with carbaryl a threat to the species in the Elkhorn Creek watershed.

The USFS also has been removing hazardous trees within the Canyon Lakes Ranger District that have been killed as a result of the mountain pine beetle outbreak (USFS 2009c, 2010b, 2011a, unpaginated). Hazardous trees in this area represent an imminent threat to public health and safety, and largely consist of lodgepole and ponderosa pine. The high percentage of dead trees also increases the amount of forest fuels available during a potential wildfire (USFS 2010a, p. 1).

The USFS estimates that approximately 85 percent (48,000 ac (19,000 ha)) of the Arapaho and Roosevelt National Forests have been infested by mountain pine beetles (USFS 2010a, p. 1). Some restrictions regarding tree removal exist within critical habitat for the threatened Preble's meadow jumping mouse (*Zapus hudsonius preblei*). Designated critical habitat for the mouse includes the downstream reaches of both Elkhorn Creek and Young Gulch that contain potential habitat for the Arapahoe snowfly. Mechanical vegetation and slash treatments within critical habitat will occur only during the mouse's hibernation period (November 1-April 30) (USFS 2010a, p. 15). Hand (chainsaw) treatment of vegetation and slash can occur at any time (USFS 2010a, p. 15). No new stream crossings would be allowed in critical habitat (USFS 2010a, p. 16). Adult Arapahoe snowflies have been collected in late March and early April (Mazzacano undated, p. 2), and could potentially be active during removal of hazardous trees.

Ponderosa pines are more common in the upper reaches of Elkhorn Creek than in downstream reaches (Nelson and Kondratieff 1988, p. 79). This reduces the likelihood of tree removal occurring in lower stream reaches near Arapahoe snowfly habitat. Nevertheless, upstream removal of hazardous trees could increase erosion and sediment loading due to soil disturbance near riparian areas (USFS 2010a, p. 40). However, leaving dead trees in place would increase the likelihood of large-scale or high intensity wildfires due to increased fuel loads (USFS 2010a, p. 44). A wildfire in the vicinity of Arapahoe snowfly habitat could result in extirpation of the species through loss of streamside vegetation important for adult Arapahoe snowfly habitat and as a food source for nymphs, and increased sedimentation. Therefore, at present, we do not consider removal of hazardous trees a threat to the species as it may be beneficial to the conservation of the species.

In conclusion, spraying of carbaryl is currently not implemented within the Elkhorn Creek watershed and, therefore, it is not a threat in known Arapahoe snowfly habitat. Removal of hazardous trees may occur in upstream reaches of Elkhorn Creek and could potentially contribute to sediment loading in these streams. However, we consider the increased risk to the species from wildfire, if these trees are left in place, to present a greater threat to the species. We have received no new information on these stressors related to forest management in the past year. At present, we do not consider forest management that addresses control of the mountain pine beetle a threat to the species in the Elkhorn Creek watershed.

Grazing

The USFS manages one active cattle grazing allotment in the Elkhorn Creek watershed (Elkhorn-Lady Moon allotment) (Casamassa 2011, p. 5). The Elkhorn-Lady Moon allotment permits stocking of 75 cow-calf pairs from June 1-September 30 (USFS 2006a, p. 4). Grazing has been discontinued on a second allotment (Seven Mile allotment) that also includes part of the Elkhorn Creek watershed (USFS 2006a, p. 9).

The effects of cattle grazing on streams have been well documented in the western United States (Clary and Webster 1989, p. 1; Chaney *et al.* 1993, p. 6; Fleischner 1994, p. 629; Belsky *et al.* 1999, p. 419; Agouridis *et al.* 2005, p. 592; Coles-Ritchie *et al*. 2007, p. 733). Cattle are attracted to and tend to loaf in riparian areas (Roath and Krueger 1982, p. 100; Chaney *et al.* 1993, p. 6;

Fleischner 1994, p. 629; Leonard *et al.* 1997, p. 11; Coles-Ritchie *et al.* 2007, p. 738). Grazing cattle can change watershed hydrology, alter stream channel morphology, erode soils, destroy riparian vegetation, impair water quality, and negatively affect aquatic species (Fleischner 1994, p. 635; Agouridis *et al.* 2005, p. 592). Water quality impacts can include increased nutrient levels, bacteria counts, protozoa, sediment loads, and water temperatures; and decreased levels of dissolved oxygen (Belsky *et al.* 1999, p. 421). Cattle-impacted streams usually have unstable, trampled streambanks that become significant sources of sediments when they erode, resulting in embedded streambeds that are less accessible to macroinvertebrates, like the Arapahoe snowfly, that use streambed habitat (Braccia and Voshell 2007, p. 198). Stream channel morphology impacts can include decreased channel and streambank stability during floods, and decreased bed gravel. Hydrology impacts can include decreased late season flows and water table levels (Belsky *et al.* 1999, pp. 421–422). Impacts to riparian vegetation can include decreased abundance of submerged and emergent higher plants and increased algae (Belsky *et al.* 1999, p. 422). All of these changes can alter the diversity, abundance, and species composition of invertebrate populations, particularly those that require cleaner and colder waters and coarser substrates (Belsky *et al.* 1999, p. 424).

The percentage of stoneflies and other shredders in a stream has a negative relationship with cattle density (Strand and Merrit 1999, p. 18; Braccia and Voshell 2007, p. 196; McIver and McInnis 2007, pp. 298 and 301). Higher stocking rates result in greater impacts to streams. Livestock excrement elevates stream water concentrations of inorganic phosphorus and nitrogen, which increases growth of filamentous algae and production by microbes that can reduce dissolved oxygen concentrations (Strand and Merrit 1999, p. 17). Reduced concentrations of dissolved oxygen can adversely affect stonefly nymphs, which have high oxygen requirements (Williams and Feltmate 1992, p. 39).

A Colorado study in the South Platte River watershed (which includes the Cache la Poudre River) found significantly higher counts of fecal bacteria in stream water at stocking rates of 0.38 cows per ac (0.94 cows per ha) or more (Gary *et al.* 1983, p. 128). As stated above, the grazing allotment on Elkhorn Creek has a much lower stocking rate that permits stocking 75 cow-calf pairs from June 11-September 30 on 11,605 ac (4,700 ha), or 0.006 cow-calf pairs per ac (0.02 cow-calf pairs per ha) (USFS 2006b, p. 34; 2007, p. 12; 2011b, p. 1). If only primary range within the allotment (1,975 ac (800 ha)) is considered, the stocking rate is higher (0.04 cow-calf pairs per ac (0.09 cow-calf pairs per ha)), but still much less than the stocking rate of 0.38 cows per ac (0.94 cows per ha) from the study. Therefore, fecal bacteria counts in Elkhorn Creek may not be as elevated as at the study site. Low concentrations (less than established water quality standards) of *E. coli* bacteria have been detected in the Cache la Poudre River during the summer, perhaps due to increased recreation and cattle grazing in the watershed, combined with warmer stream water temperatures that can enhance bacterial survival (Collins and Sprague 2005, p. 1). However, the source of *E. coli* detected in the river is not known.

The Elkhorn-Lady Moon allotment management plan states: (1) livestock will only graze a pasture once in any given year, (2) livestock will be removed when utilization reaches 45 percent on satisfactory upland range or 30 percent on unsatisfactory range, (3) livestock will be removed when stream reaches rated as functional-at-risk reach an average of 6 in. (150 mm) stubble height on tall sedges, and (4) livestock will be removed when streambank disturbance (trampling, exposed soils) reaches 20–25 percent of the key area stream reach (USFS 2007, p. 3; 2011b, pp. 1-3). The current grazing plan allows for a five pasture rotational system (USFS 2007, p. 4). The allotment plan notes that lower reaches of Elkhorn Creek within the allotment have varying degrees of grazing impacts including heavily grazed sedges and hoof shearing along portions of the streambank, resulting in a marginal proper functioning rating (USFS 2007, p. 10). At its closest point, the Elkhorn-Lady Moon allotment is approximately 6–7 mi (10–11 km) upstream from where the Arapahoe snowfly has been found. Summer sampling at Elkhorn Creek detected low levels of coliform contamination, suggesting that inputs are minimal (Sanchez 2012, p.1). We require additional sampling in order to make firm conclusions regarding the extent of contamination in the species' habitat caused by grazing 6–7 mi (10–11 km) or further upstream.

In conclusion, grazing may have modified habitat through sediment loading and nutrient inputs into upstream reaches of the Elkhorn Creek watershed. However, stocking rates are light and these inputs occur at least 6–7 mi (10–11 km) upstream from where the Arapahoe snowfly has been found. Water quality sampling in late summer, detected low, but insignificant levels of coliform contamination. We have received no new information on grazing in the past year. At present, we do not consider grazing a threat to the species in the Elkhorn Creek watershed.

Summary of Factor A

Potential present and threatened future habitat modification caused by climate change is a threat to the Arapahoe snowfly. Climate change is modifying Arapahoe snowfly habitat in several ways including: (1) the threatened reduction in snowpack, (2) the present increase in temperature as well as continued threatened increases in future years, (3) the present outbreak of mountain pine beetle in ponderosa pine, and (4) the threatened increased likelihood of wildfire. Although available information indicates that climate change could potentially be modifying the species' habitat at the present time, we do not have any information that indicates this is currently impacting the species. However, the impacts from each of these stressors are expected to increase into the future. Therefore, we consider habitat modification due to climate change a threat to the species.

Development in the Elkhorn Creek watershed includes the construction and use of numerous roads and trails, causing sedimentation that has resulted in a watershed rated as Class II or "at risk." Water diversions from Elkhorn Creek and wastewater inputs into groundwater in the Elkhorn Creek watershed also may be impacting Arapahoe snowfly habitat. However, the extent of impact in the downstream reach where the species occurs has not been determined. Therefore, at present, we do not consider development a threat to the species in the Elkhorn Creek watershed.

Forest management by the USFS regarding the ongoing mountain pine beetle epidemic includes carbaryl spraying of lodgepole and ponderosa pines to prevent infestations and removal of dead trees that are a potential hazard. However, carbaryl spraying is not occurring in the Elkhorn Creek watershed, and we consider tree removal to pose less of a threat to the Arapahoe snowfly than the increased risk from wildfire if dead trees are not removed. Therefore, at present, we do not consider forest management practices a threat to the species in the Elkhorn Creek watershed.

Some grazing occurs in upstream reaches of the Elkhorn Creek watershed. However, stocking rates are light, these inputs occur at least 6–7 mi (10–11 km) upstream from where the Arapahoe snowfly has been found, and while present, coliform levels are low. Therefore, at present, we do not consider grazing a threat to the species in the Elkhorn Creek watershed.

Although we lack specific information on these potential stressors for the other sites where Arapahoe snowfly was more recently confirmed to be present, we assume their impacts would be similar to Elkhorn Creek.

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

At this time, we are not aware of any threats involving overutilization of the Arapahoe snowfly for any commercial, recreational, scientific, or educational purposes. We are aware that specimens have been collected for scientific purposes to describe the species and determine its distribution and abundance (Heinold and Kondratieff 2010, p. 281; Heinold 2011d, unpaginated). We are also aware of a proposed study that may include scientific collection. However, we have no information to suggest these collections have or will occur at levels that impact the overall status of the species. We have received no new information on overutilization in the past year. At present, we do not consider overutilization a threat to the species.

C. Disease or predation:

We are not aware of any diseases that affect the Arapahoe snowfly. Therefore, at present, we do not consider disease a threat to the species. We presume that Arapahoe snowfly nymphs and adults may occasionally be subject to predation by certain fish species, such as brook trout (*Salvelinus fontinalis*) or by certain bird species, such as the American dipper (*Cinclus mexicanus*). Both of these species are known to be present in Elkhorn Creek and to consume invertebrates (USFS 2006b, p. 69; eBird 2011, unpaginated). However, nymphs may be protected from most predation due to burrowing into the streambed to undergo diapause. We have no information that any predation is a threat to the species. We have received no new information on predation in the past year. At present, we do not consider predation a threat to the species.

D. The inadequacy of existing regulatory mechanisms:

The Act requires the Service to examine the adequacy of existing regulatory mechanisms with respect to ongoing and foreseeable threats that place the Arapahoe snowfly at risk of becoming either endangered or threatened. The species currently receives no direct protection under Federal, State, or local laws.

The Arapahoe snowfly is designated as "critically imperiled" at both the State and global level by Colorado's Natural Heritage Program (CNHP) and NatureServe respectively (NatureServe 2009, p. 1). However, this designation does not provide any legal protection for the species or its habitat. The CNHP has proposed a Potential Conservation Area (PCA) for the species that would encompass approximately 5,000 ac (2,000 ha) and include downstream portions of both Elkhorn Creek and Young Gulch (Colorado State University 2005, p. 2). This PCA has a Biodiversity Significance Rank of B1 for outstanding biodiversity significance. This is the highest level of biological diversity that can be assigned to a site. A PCA can provide planning and management guidance, but infers no legal status, and this PCA has only been proposed. The Arapahoe snowfly is designated as a "species of greatest conservation need" by Colorado Parks and Wildlife (CPW, formerly the Colorado Division of Wildlife, CDOW), based upon its global and State ranking by NatureServe and the CNHP (CDOW 2006, pp. 17 and 20). However, this designation also confers no protection to the species from the threats identified in Factors A and E.

The State of Colorado has had minimum in-stream flow water rights of 2 cfps (0.06 cmps) in Elkhorn Creek since 1978 (CWCB 2010, p. 10). This minimum flow indirectly provides some protection to habitat of the Arapahoe snowfly. However, Elkhorn Creek is described as an intermittent stream (Nelson and Kondratieff 1988, p. 79), and during periods of low precipitation it may be dry, despite in-stream flow water rights.

Many of the Arapahoe snowfly populations occur on USFS lands and are indirectly protected by the National Forest Management Act of 1976 (16 U.S.C. 1600 *et seq.*), which mandates how USFS lands are managed. The Land and Resource Management Plan (LRMP) for the Arapaho and Roosevelt National Forests and Pawnee National Grassland provides the framework to guide day-to-day resource management operation of the USFS within Arapahoe snowfly habitat. One of the goals of the LRMP is to restore, protect, and enhance habitats for endangered, threatened, and proposed species listed in accordance with the Act, as well as sensitive species appearing on the regional sensitive species list to contribute to their stabilization and full recovery (USFS 1997, p. 17). Habitat on USFS lands is managed to help assure that species whose viability is a concern survive throughout their range, that populations increase or stabilize, or that threats are eliminated (USFS 1997, p. 7).

As a candidate species for listing under the Act, the USFS automatically added the Arapahoe snowfly to its list of sensitive species (USFS 2011, p. 4; Oberlag 2013, p. 1). Activities that may affect sensitive species or their habitats require a more thorough analysis by the USFS (Fairchild 2013, p.1). Sensitive species policy dictates that the USFS review and document the effects of their actions on sensitive species to ensure that the activities do not cause a loss of viability or a trend toward listing under the Act (USFS 2011, p. 5). Therefore, the sensitive species designation affords the Arapahoe snowfly with some level of protection from USFS activities. However, even as a sensitive species, the management authorities that USFS has available are not adequate to protect the species from the primary threats of climate change and small population size (see Factor E).

All Federal agencies are required to adhere to the National Environmental Policy Act (NEPA) of 1970 (42 U.S.C. 4321 *et seq.*) for projects they fund, authorize, or carry out. The Council on

Environmental Quality's regulations for implementing NEPA (40 CFR 1500-1518) state that when preparing environmental impact statements, agencies must include a discussion on the environmental impacts of the various project alternatives, any adverse environmental effects that cannot be avoided, and any irreversible or irretrievable commitments of resource involved. Additionally, activities on non-Federal lands are subject to NEPA if there is a Federal action. The NEPA is a disclosure law, and does not require subsequent minimization or mitigation measures by the Federal agency involved. Although Federal agencies may include conservation measures for sensitive species as a result of the NEPA process, any such measures are typically voluntary in nature and not required by the statute.

Both stream reaches in Elkhorn Creek and Young Gulch where the Arapahoe snowfly has been located are included in critical habitat for the Preble's meadow jumping mouse, or Preble's (*Zapus hudsonius preblei*) designated on December 15, 2010 (75 FR 78430). Critical habitat extends 394 ft (120 m) from the edges of both streams, and is part of the Cache la Poudre River unit of critical habitat encompassing approximately 4,929 ac (1,995 ha) and 51 mi (82 km) of the river and its tributaries. Section 7(a)(2) of the Act requires Federal agencies to confer with us on any action funded, authorized, or carried out by a Federal agency that is likely to adversely affect the continued existence of the mouse or its designated critical habitat. Examples of specific activities that may adversely affect critical habitat and, therefore, require consultation include: land clearing; road construction; bank stabilization; intensive grazing; water diversions; changes to inputs of water, sediment, and nutrients; or any activity that significantly and detrimentally alters water quantity.

This designation currently provides some indirect protection to the Arapahoe snowfly. The bodies of the streams are not included as critical habitat, although activities in the streams such as water diversions, and changes to inputs of water, sediment, and nutrients will require consultation if those activities may adversely affect critical habitat. Actions that do not affect the Preble's meadow jumping mouse or its habitat, or do not have a Federal nexus, would not require consultation. Federal actions that occurred prior to 2003 did not require consultation because critical habitat for the mouse had not yet been designated. Designation of critical habitat for the Preble's meadow jumping mouse does not protect Arapahoe snowfly occupied habitat from the potential future effects of climate change, nor does it protect the body of Elkhorn Creek from some impacts to water quality that could likely occur without impacting designated critical habitat.

On December 15, 2009, the EPA published in the Federal Register (74 FR 66496) a rule titled, "Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act." In this rule, the EPA Administrator found that the current and projected concentrations of the six long-lived and directly emitted greenhouse gases—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride—in the atmosphere threaten the public health and welfare of current and future generations; and that the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas pollution that threatens public health and welfare (74 FR 66496). In effect, the EPA has concluded that the greenhouse gases linked to climate change are pollutants, whose emissions can now be subject to the Clean Air Act (42 U.S.C. 7401 *et seq*.; see

74 FR 66496). However, specific regulations to limit greenhouse gas emissions were only proposed in 2010. At present, we have no basis to conclude that implementation of the Clean Air Act in the foreseeable future (40 years, based on global climate projections) will substantially reduce the current rate of global climate change through regulation of greenhouse gas emissions. Thus, we conclude that the Clean Air Act does not adequately address the anticipated loss of suitable habitat as a result of environmental changes that result from climate change.

Summary of Factor D

There are no regulatory mechanisms that specifically protect the Arapahoe snowfly at the Federal, State, or local level. The species in Elkhorn Creek is indirectly protected, to some degree, by State requirements related to minimum flows in Elkhorn Creek, by the USFS, and by the critical habitat designation for the Preble's meadow jumping mouse, which encompasses the known habitat of the Arapahoe snowfly. These regulatory mechanisms cannot protect against climate change or a small population size (discussed under Factor E). We consider habitat loss and modification resulting from the environmental changes due to climate change to constitute a primary threat to the species. The United States is only now beginning to address global climate change through the regulatory process (e.g., Clean Air Act). We have no information on what regulations may eventually be adopted, and when implemented, if they would address the changes in Arapahoe snowfly habitat that are likely to occur in the foreseeable future. Consequently, we conclude that existing regulatory mechanisms are not adequate to address the threat of habitat loss and modification resulting from the environmental changes due to climate change or small population size to the Arapahoe snowfly in the foreseeable future. We will continue to evaluate the habitat conditions and the impacts and stressors to the newly identified populations of Arapahoe snowfly.

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

Under this factor we consider the small population size of the Arapahoe snowfly. A species may be considered rare because of a limited geographical range, specialized habitat, or small population size (Primack 1998, p. 176). The Arapahoe snowfly appears to have a limited occupied range and a very small population size. It has several characteristics typical of species vulnerable to extinction including: (1) a narrow geographical range, (2) only seven known populations, (3) a small population size (very few individuals have been found at each site), (4) ineffective dispersal capabilities, (5) a seasonal migrant depending on two or more distinct habitat types to complete its life cycle, and (6) characteristically found in stable, pristine environments (Primack 1998, pp. 178-187).

Extinction may be caused by demographic stochasticity due to chance realizations of individual probabilities of death and reproduction, particularly in small populations (Shaffer 1981, p. 131; Lande 1993, pp. 911–912). Environmental stochasticity can result in extinction through a series of small or moderate perturbations that affect birth and death rates within a population (Shaffer 1981, p. 131; Lande 1993, p. 912). Lastly, extinction can be caused by random catastrophes (Shaffer 1981, p. 131; Lande 1993, p. 912). The Arapahoe snowfly is vulnerable to extinction due to: (1) demographic stochasticity due to its small population size, (2) environmental stochasticity due to continued small perturbations caused by ongoing modification and curtailment of its habitat and range, and (3) the chance of random catastrophe such as wildfire.

Small populations also can be vulnerable due to a lack of genetic diversity (Shaffer 1981, p. 132). We have minimal information regarding genetic diversity of the Arapahoe snowfly. A minimum viable population (MVP) of 1,000 may be adequate for species of normal genetic variability, and a MVP of 10,000 should permit long-term persistence and continued genetic diversity (Thomas 1990, p. 325). These estimates should be increased by at least 1 order of magnitude (to 10,000 and 100,000) for insects because they usually have greater population variability (Thomas 1990, p. 326). Based upon available information, the Arapahoe snowfly likely does not meet these minimum population criteria for maintaining genetic diversity.

Summary of Factor E

The Arapahoe snowfly is rare due to its limited range, few known populations, and its small population size. It also is an ineffective disperser, a seasonal migrant depending on two or more distinct habitat types to complete its life cycle, and it requires a pristine environment. The restricted range of the species does not necessarily constitute a threat in itself. However, all of these characteristics combine to make the species more vulnerable to extinction due to demographic stochasticity, environmental stochasticity, and random catastrophe. The presence of specific threats including climate change increases the vulnerability of this small population. Current regulatory mechanisms are inadequate to protect against these threats. Therefore, at present, we consider its small population size to increase the species' vulnerability to the other threats described.

Conservation Measures Planned or Implemented :

If funding allows, the Service and USFS will continue, and expand, the water quality monitoring at Elkhorn Creek and Young Gulch as well as at the new population sites. More monitoring is needed during the Arapahoe snowfly’s critical breeding and early development periods, and to analyze trends over time. Sampling dates may be added in early summer to evaluate potential impacts during busy, recreational periods. Water quality testing may also be expanded to analyze concentrations of other contaminants, such as pharmaceuticals and personal-care products that may accumulate within streambeds and degrade aquatic habitats. Additionally, water quality sampling and habitat monitoring will likely continue at Young Gulch to assess the recovery of potential habitats following the High Park Fire. Additional habitat monitoring would help assess the impact of habitats from the September 2013 flash flood disaster.

The USFS is amending the grazing management plan for the Elkhorn-Ladymoon allotment to recognize the installation of additional fencing (Obele 2013, p. 1). Additionally, the USFS’s National Fire Retardant environmental impact statement directs operators to avoid dropping retardant within 300 feet of water, which may limit impacts to aquatic habitats at Elkhorn Creek (Oberlag 2013, p. 1). As a candidate species, the USFS automatically added the Arapahoe snowfly to its list of sensitive species, which requires the USFS to more thoroughly analyze the effects of their actions on the species (USFS 2011, p. 4; Oberlag 2013, p.1). As a result, the Arapaho Roosevelt National Forest expanded the fire retardant buffers to 600 feet at Elkhorn Creek and Young Gulch to protect the Arapahoe snowfly (Fairchild 2013, p.1).

A Colorado State University and USGS study designed to assess population sizes and distribution of the Arapahoe snowfly began in March 2013 and continues at this time (Fairchild 2013, p. 1; Belcher 2014a, p. 1). This study aims to quantify populations and the distribution of the species within the Cache la Poudre Canyon, and other locations, while also assessing the potential effects of the High Park Fire (Belcher 2012, p. 1). Continued sampling will allow the researchers to further evaluate new populations and to develop population estimates.

Summary of Threats :

This status review identified threats to the Arapahoe snowfly attributable to Factors A, D, and E at Elkhorn Creek. Potential present and threatened habitat modification caused by climate change is impacting the Elkhorn Creek watershed. We also find that the species is at risk due to its small population size. We currently lack specific information about potential stressors at the newly confirmed population sites. Therefore, until we have the opportunity to fully evaluate the conditions at the new population sites, we assume that the types of impacts and stressors at the new locations are generally similar to those described for Elkhorn Creek. Regulatory mechanisms are inadequate to protect the species from impacts due to climate change or its small population size. Table 3 summarizes the conclusions for Elkhorn Creek from our five factor analysis.

TABLE 3. Summary of five factor analysis for the Arapahoe snowfly, Elkhorn Creek.

FACTOR/STRESSOR	THREAT CONCLUSION
Factor A:	
Climate Change:	
Reduced Snowpack	Future threat
Increased Temperature	Ongoing and future threat
Mountain Pine Beetle	Ongoing and future threat
Wildfire	Future threat
Development:	
Roads	Present, but not a threat
Water Diversions	Present, but not a threat
Wastewater Inputs	Present, but not a threat
Forest Management:	
Carbaryl Spraying	Not present, not a threat
Tree Thinning	Present, but not a threat
Grazing	Present, but not a threat
Recreational Use	Present, but not a threat
Factor B:	
Overutilization	Present, but not a threat
Factor C:	
Disease	Not present, not a threat
Predation	Present, but not a threat
Factor D:	
Inadequate Regulatory Mechanisms	Ongoing and future threat
Factor E:	
Small Population Size	Ongoing and future threat

For species that are being removed from candidate status:

_____ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

Recommended Conservation Measures :

- Continue monitoring the water quality at Elkhorn Creek and Young Gulch. Expand sampling dates into the breeding and early development periods and test for other potential sources of contamination, such as pharmaceuticals and personal care products.
- Carefully analyze recreational use at the parking area and trail along Elkhorn Creek, especially near known habitat areas at the confluence with the Cache la Poudre River.
- Continue to monitor the recovery of Young Gulch from the effects of the High Park Fire.
- Assess impacts to habitats from the September 2013 flood disaster.
- Continue to survey for new populations of the Arapahoe snowfly.
- Additional conservation measures will be developed as appropriate for the new populations.

Priority Table

Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	Non-imminent	Monotypic genus	4
		Species	**5**
		Subspecies/Population	6
Moderate to Low	Imminent	Monotype genus	7
		Species	8
		Subspecies/Population	9
	Non-Imminent	Monotype genus	10
		Species	11
		Subspecies/Population	12

Rationale for Change in Listing Priority Number:

Magnitude:

Threats to the Arapahoe snowfly are of high magnitude because climate change, inadequate regulatory mechanisms, and a small population size occur throughout the range of the species. Although seven new populations have been identified, the number of individuals in each new population remains low (Heinhold *et al.* 2014, p. 134).

Imminence :

We consider the threats to the Arapahoe snowfly overall to be non-imminent because: (1) although increases in temperature in excess of those known to adversely impact stoneflies have been documented in the northern Front Range of Colorado, we have no information to indicate that the species has actually been adversely affected by these temperatures; and (2) a small population size with a very limited range results in increased vulnerability to extirpation caused by threats from climate change and sedimentation; however, the species has been located in Elkhorn Creek consistently since 1987.

While regulatory mechanisms are currently inadequate to protect the species from the previously described threats, these impacts do not appear to be affecting the existing population in Elkhorn Creek.

These actual, identifiable threats are covered in detail under the discussion of Factors A, D, and E of this species assessment. We previously acknowledged that few studies have been conducted on the Arapahoe snowfly due to its rarity, the difficulties in distinguishing among species of snowfly nymphs, and difficulties of sampling under ice in winter. Consequently, most of the best available information regarding specific impacts caused by the various threats comes from our knowledge about stoneflies (order Plecoptera) in general, other members of winter stonefly (family Capniidae), and other species of snowfly.

The Arapahoe snowfly is a valid taxon at the species level and, therefore, receives a higher priority than a subspecies, but a lower priority than a species in a monotypic genus. The Arapahoe snowfly faces high magnitude, non-imminent threats, and is a valid taxon at the species level. Thus, in accordance with our LPN guidance, we have assigned the Arapahoe snowfly an LPN of 5.

__Yes__ Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

Emergency Listing Review

__No__ Is Emergency Listing Warranted?

We reviewed the available information to determine if the existing and foreseeable threats render the species at risk of extinction now such that issuing an emergency regulation temporarily listing the Arapahoe snowfly under section 4(b)(7) of the Act is warranted. We determined that issuing an emergency regulation temporarily listing the species is not warranted for this species at this time, because the species is not under immediate threat of extinction. Impacts from climate change, a small population size, and lack of adequate regulatory mechanisms are cumulative, but are increasing gradually. However, if at any time we determine that issuing an emergency regulation temporarily listing the Arapahoe snowfly is warranted, we will initiate this action at that time.

Description of Monitoring:

We actively monitored water quality at Elkhorn Creek, once per year in 2011 and 2012; however, a lack of funds has prevented us from continuing annual monitoring since then. If funding allows, the Service and USFS hope to continue monitoring water quality and habitat conditions, with added sampling dates throughout the year.

A Colorado State University and USGS study designed to assess population sizes and distribution of the Arapahoe snowfly began in March 2013 and is continuing at this time (Fairchild 2013, p. 1; Belcher 2014a, p. 1). The USFS is also funding this study. Continued sampling and laboratory work will allow the researchers to further evaluate new populations and to develop population estimates.

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

none

Indicate which State(s) did not provide any information or comment:

Colorado

State Coordination:

We received no new information from the State of Colorado for this species assessment. Due to the Arapahoe snowfly's distribution on Federal lands, we had not previously coordinated with the State of Colorado, nor has the State provided information, although we will coordinate with the State in the future.

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Approval/Concurrence:

Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: ______________________ 05/27/2015
Date

Concur: ______________________ 12/15/2015
Date

Did not concur: ______________________ ________
Date

Director's Remarks: