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50 CFR Part 17

Endangered and Threatened Wildlife and Plants; Listing *Lepidium papilliferum* (Slickspot Peppergrass) as a Threatened Species Throughout Its Range; Final Rule

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[RIN 1018-AW34]

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[MO 922105-0008-B2]

Endangered and Threatened Wildlife and Plants; Listing *Lepidium papilliferum* (Slickspot Peppergrass) as a Threatened Species Throughout Its Range

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine that *Lepidium papilliferum* (slickspot peppergrass), a plant species from southwest Idaho, is a threatened species under the Endangered Species Act of 1973, as amended (Act). This final rule implements the Federal protections provided by the Act for this species. We have determined that critical habitat for *L. papilliferum* is prudent but not determinable at this time.

DATES: This rule becomes effective December 7, 2009. The effective date has been extended to 60 days after publication in the **Federal Register** to allow the U.S. Bureau of Land Management (BLM) to finish conferring with the Service under section 7(a)(4) of the Act on the BLM's issuance of grazing permits within the range of *Lepidium papilliferum*.

ADDRESSES: This final rule is available on the Internet at *http://www.regulations.gov* and also at *http://www.fws.gov/idaho*. Comments and materials received, as well as supporting documentation used in the preparation of this rule, will be available for public inspection, by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Idaho Fish and Wildlife Office, 1387 S. Vinnell Way, Room 368, Boise, ID 83709; by telephone at 208-378-5243; by facsimile at 208-378-5262.

FOR FURTHER INFORMATION CONTACT: Jeff Foss, Field Supervisor, at above address, telephone, and facsimile, or by electronic mail at: *fw1srbocomment@fws.gov*. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800-877-8339.

SUPPLEMENTARY INFORMATION:

Background

Lepidium papilliferum is a small, flowering plant in the mustard family (Brassicaceae). The plant grows in unique microsite habitats known as slickspots, which are found within the semiarid sagebrush-steppe ecosystem of southwestern Idaho. The species is endemic to this region, known only from the Snake River Plain and its adjacent northern foothills (an area approximately 90 by 25 miles (mi) (145 by 40 kilometers (km)), or 2,250 square miles (mi^2) (5,800 square kilometers (km^2)), with a smaller disjunct population on the Owyhee Plateau (an area of approximately 11 by 12 mi (18 by 19 km), or 132 mi^2 (342 km^2). The restricted distribution of *L. papilliferum* is likely due to its adaptation to the specific conditions within these slickspot habitats. The absence of all perennial plant species from these sites likewise demonstrates the specialization of *L. papilliferum* persisting in the unique conditions provided by slickspots (Fisher *et al.* 1996, p. 16). The primary threat to *L. papilliferum* (as described under *The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,* below) is the present or threatened destruction, modification, or curtailment of its habitat and range due to the increased frequency and extent of wildfires under a wildfire regime modified and exacerbated by the spread of invasive nonnative plants, particularly nonnative annual grasses such as *Bromus tectorum* (cheatgrass). In addition, even under conservative projections of the consequences of future climate change, the threats posed by wildfire and the invasion of *B. tectorum* are expected to further increase within the foreseeable future. Other threats to the species include competition and displacement by nonnative plant species, development, potential seed predation by harvester ants, and habitat fragmentation and isolation of small populations.

Previous Federal Actions

On July 15, 2002, we proposed to list *Lepidium papilliferum* as endangered (67 FR 46441). On January 12, 2007, we published a document in the **Federal Register** withdrawing that proposed rule (72 FR 1622). For a description of Federal actions concerning *L. papilliferum* prior to the 2007 withdrawal, please refer to that 2007 withdrawal document. The withdrawal of the proposal to list *L. papilliferum* was based on our conclusion that, while its sagebrush-steppe matrix habitat is becoming increasingly degraded, the best available data at the time provided no evidence indicating that this degradation was impacting *L. papilliferum* within its slickspot microsites. Furthermore, we concluded that, although we found that abundance on the Idaho Army National Guard's Orchard Training Area (OTA) had decreased in recent years, the observed rangewide fluctuations in population numbers appeared to be consistent with varying levels of spring rainfall, as expected. On April 6, 2007, Western Watersheds Project filed a lawsuit challenging our decision to withdraw the proposed rule to list *L. papilliferum.* On June 4, 2008, the U.S. District Court for the District of Idaho (Court) reversed the decision to withdraw the proposed rule, with directions that the case be remanded to the Service for further consideration consistent with the Court's opinion (*Western Watersheds Project* v. *Kempthorne,* Case No. CV 07-161-E-MHW (D. Idaho)).

After issuance of the Court's remand order, we published a public notification of the reinstatement of our July 15, 2002, proposed rule to list *Lepidium papilliferum* as endangered and announced the reopening of a public comment period on September 19, 2008 (73 FR 54345). The initial comment period closed on October 20, 2008. After the close of the comment period, new information became available that was relevant to our evaluation. Much of this information was contained in reports based on several independent analyses of the available information regarding *L. papilliferum* population trends on the OTA in southwest Idaho, the rangewide Habitat Integrity and Population (HIP) monitoring, and a recent analysis of *L. papilliferum* data collected on the Inside Desert (Owyhee Plateau) from 2000 to 2002. To ensure that our review of the species' status was complete, we announced another reopening of the comment period on March 17, 2009, for a period of 30 days (74 FR 11342). We posted several documents on *http://www.regulations.gov* for public review and comment, including the additional information and statistical analyses we received after the January 2007 withdrawal notice (72 FR 1622; January 12, 2007). A summary of the comments we received and our responses is provided in this document, following our finding.

Species Information

Description

Lepidium papilliferum is an intricately branched, tap-rooted plant, averaging 2 to 8 inches (in) (5 to 20

centimeters (cm)) high, but occasionally reaching up to 16 in (40 cm) in height. Leaves and stems are covered with fine, soft hairs, and the leaves are divided into linear segments. Flowers are numerous, 0.1 in (3 to 4 millimeters (mm)) in diameter, white, and four petalled. Fruits (siliques) are 0.1 in (3 to 4 mm) across, round in outline, flattened, and two-seeded (Moseley 1994, pp. 3, 4; Holmgren *et al.* 2005, p. 260). The species is monocarpic (it flowers once and then dies) and displays two different life history strategies—an annual form and a biennial form. The annual form reproduces by flowering and setting seed in its first year, and dies within one growing season. The biennial life form initiates growth in the first year as a vegetative rosette, but does not flower and produce seed until the second growing season. Biennial rosettes must survive generally dry summer conditions, and consequently many of the biennial rosettes die before flowering and producing seed. The number of prior-year rosettes is positively correlated with the number of reproductive plants present the following year (ICDC 2008, p. 9; Unnasch 2008, p. 14; Sullivan and Nations 2009, p. 44). The proportion of annuals versus biennials in a population can vary greatly (Meyer *et al.* 2005, p. 15), but in general annuals appear to outnumber biennials (Moseley 1994, p. 12).

Seed Production

Depending on an individual plant's vigor, the effectiveness of its pollination, and whether it is functioning as an annual or a biennial, each *Lepidium papilliferum* plant produces varying numbers of seeds (Quinney 1998, pp. 15, 17). Biennial plants normally produce many more seeds than annual plants (Meyer *et al.* 2005, p. 15). Average seed output for annual plants at the OTA (an Idaho Army National Guard (IDARNG) training area on BLM land) was 125 seeds per plant in 1993 and 46 seeds per plant in 1994. In contrast, seed production of biennials at this site in 1993 and 1994 averaged 787 and 105 seeds per plant, respectively (Meyer *et al.* 2005, p. 16). Based on data collected from a 4–year demography study on the OTA, survivorship of the annual form of *L. papilliferum* was demonstrated to be higher than survivorship of biennials (Meyer *et al.* 2005, p. 16). For example, of the 4,065 plants counted in spring of 1993, a total of 2,503 survived to fruit as annuals, while only 85 survived to fruit as biennials in spring of 1994. Meyer *et al.* (2005, p. 21) hypothesize that the reproductive strategy of *L. papilliferum* is a plastic response, meaning that larger plants will flower and produce seed in their first season, whereas smaller plants that stand less chance of successfully setting seed in their first season will delay reproduction until the following year. The biennial life form is thus maintained, despite the higher risk of mortality.

Like many short-lived plants growing in arid environments, above-ground numbers of *Lepidium papilliferum* individuals can fluctuate widely from one year to the next, depending on seasonal precipitation patterns (Mancuso and Moseley 1998, p. 1; Meyer *et al.* 2005, pp. 4, 12, 15; Palazzo *et al.* 2005, p. 9; Menke and Kaye 2006a, p. 8; Menke and Kaye 2006b, pp. 10, 11; Sullivan and Nations 2009, p. 44). Mancuso and Moseley (1998, p. 1) note that sites with thousands of above-ground plants one year may have none the next, and vice versa. Above-ground plants represent only a portion of the population; the seed bank (a reserve of dormant seeds, generally found in the soil) contributes the other portion, and in many years constitutes the majority of the population (Mancuso and Moseley 1998, p. 1). Seed banks are adaptations for survival in a ''risky environment,'' because they buffer a species from stochastic (random) impacts, such as lack of soil moisture (Baskin and Baskin 2001, p. 160).

Seed Viability and Germination

The seeds of *Lepidium papilliferum* are found primarily within the slickspot microsites where the plants are found (Meyer and Allen 2005, pp. 5, 6). Slickspots, also known as mini-playas or natric (high sodium content) sites, are visually distinct openings in the sagebrush-steppe created by unusual soil conditions characterized by significantly greater sodium and clay content relative to the surrounding area (Moseley 1994, p. 7). The vast majority of *L. papilliferum* seeds in slickspots have been located near the soil surface, with lower numbers of seeds located in deeper soils (Meyer *et al.* 2005, p. 19; Palazzo *et al.* 2005, p. 3). *Lepidium papilliferum* seeds have been found in slickspots even if no above-ground plants are present (Meyer *et al.* 2005, p. 22; Palazzo *et al.* 2005, p. 10). When above-ground plants are present, flowering usually takes place in late April and May, fruit set occurs in June, and the seeds are released in late June or early July. Seeds produced in a given year are dormant for at least a year before any germination takes place. Following this year of dormancy, approximately 6 percent of the initially viable seeds produced in a given year germinate annually (Meyer *et al.* 2005, pp. 17, 18). When combined with an average annual 3 percent loss of seed viability, approximately 9 percent of the original seed cohort per year is lost after the first year. Thus, after 12 years, all seeds in a given cohort will likely have either died or germinated, resulting in a maximum estimated longevity of 12 years for seeds in the seed bank (Meyer *et al.* 2005, p. 18).

Billinge and Robertson (2008, pp. 1005-1006) report that both small and large *Lepidium papilliferum* populations share similar spatial structure, and that spatial structuring within its unique microsite slickspot habitats suggests that both pollen dispersal and seed dispersal are low for this species and occur over short distances (Robertson *et al.* 2006a, p. 3; Billinge and Robertson 2008, pp. 1005-1006). Modeling of dispersal and seed dormancy characteristics of desert annual plants predicts that plants with long-range dispersal will have few dormancy mechanisms and thus quick germination (Venable and Lawlor 1980, p. 272). Contrary to this prediction, however, *L. papilliferum* has delayed germination (Meyer *et al.* 2005, pp. 17-18), and, therefore, according to the model, may not disperse long distances. The primary seed dispersal mechanism for *L. papilliferum* is not known (Robertson and Ulappa 2004, p. 1708), although viable seeds have been found outside of slickspots, indicating that some seed dispersal is occurring beyond slickspot habitat (Palazzo *et al.* 2005, p. 10). Additionally, beginning in mid-July, entire dried-up biennial plants and some larger annual plants have been observed to break off at the base and are blown by the wind (Stillman, pers. obs., as reported in Robertson *et al.* 2006b, p. 44). This tumbleweed-like action may have historically resulted in occasional long-distance seed dispersal (Robertson *et al.* 2006b, p. 44). Ants are not considered to be a likely disperser despite harvesting an average of 32 percent of fruits across six sites (Robertson and White 2007, p. 11).

Lepidium papilliferum seeds located near the soil surface show higher rates of germination and viability (Meyer and Allen 2005, pp. 6-8; Palazzo *et al.* 2005, p. 10) and the greatest seedling emergence success rate (Meyer and Allen 2005, pp. 6-8). Viable seeds were more abundant and had greater germination rates from the upper 2 in (5 cm) of soil (Palazzo *et al.* 2005, pp. 8, 10), while Meyer and Allen (2005, pp. 6-8) observed the upper 0.08 in (2 mm) optimal for germination. Deep burial of

L. papilliferum seeds (average depths greater than 5.5 in (14 cm)) can entomb viable seeds and may preserve them beyond the 12–year period previously assumed as the maximum period of viability for *L. papilliferum* seeds (Meyer and Allen 2005, pp. 6, 9). However, seeds buried at such depth, even if they remain viable, are unlikely to regain the surface for successful germination. The effects of environmental factors such as wildfire on *L. papilliferum* seed dormancy and viability are currently unknown, although *L. papilliferum* abundance is reduced in burned areas (see discussion of Wildfire under **Summary of Factors Affecting the Species**).

Pollination

Lepidium papilliferum is primarily an outcrossing species requiring pollen from separate plants for more successful fruit production and has a low seed set in the absence of insect pollinators (Robertson 2003a, p. 5; Robertson and Klemash 2003, p. 339; Robertson and Ulappa 2004, p. 1707; Billinge and Robertson 2008, pp. 1005-1006). *Lepidium papilliferum* is able to self-pollinate; however, with a selfing rate (rate of self-pollination) of 12 to 18 percent (Billinge 2006, p. 40; Robertson *et al.* 2006a, p. 40). In pollination experiments where researchers moved pollen from one plant to another, fruit production was observed to be higher with pollen from distant sources (4 to 12.4 mi (6.5 to 20 km) distance between patches of plants) compared to fruit production for plants pollinated with pollen from plants within the same patch (246 to 330 feet (ft) (75 to 100 meters (m)) distance within a plant patch) (Robertson and Ulappa 2004, p. 1705; Robertson *et al.* 2006a, p. 3).

Fruits produced from fertilized flowers reach full size approximately 2 weeks after pollination (Robertson and Ulappa 2004, p. 1706). Each fruit typically bears two seeds that drop to the ground when the fruit dehisces (splits open) in midsummer (Billinge and Robertson 2008, p. 1003).

Known *Lepidium papilliferum* insect pollinators include several families of bees (Hymenoptera), including Apidae, Halictidae, Sphecidae, and Vespidae; beetles (Coleoptera), including Dermestidae, Meloidae, and Melyridae; flies (Diptera), including Bombyliidae, Syrphidae, and Tachinidae; and others (Robertson and Klemash 2003, p. 336; Robertson *et al.* 2006b, p. 6). Seed set was not limited by the number of pollinators at any study site (Robertson *et al.* 2004, p. 14). Studies have shown a strong positive correlation between insect diversity and the number of *L. papilliferum* flowering at a site (Robertson and Hannon 2003, p. 8). Measurement of fruit set per visit revealed considerable variability in the effectiveness of pollination by different types of insects, ranging from 0 percent in dermestid beetles to 85 percent in honeybees (Robertson *et al.* 2006b, p. 15).

Genetics

The majority of species in the genus *Lepidium* have a base chromosome count of eight (Mummenhoff *et al.* 2001, p. 2051). Chromosome numbers for pollen mother cells in *L. papilliferum* ranged from 15 to 17 ($n = 15.96 \pm 0.16$; Table 3; Figure 3), confirming that the plant is a tetraploid (has four sets of homologous chromosomes, as opposed to the more usual set of two) (Robertson *et al.* 2006b, p. 38).

The genetics of *Lepidium papilliferum* have been studied using samples collected from areas across the entire range of the species (Stillman *et al.* 2005, pp. 6, 8, 9; Larson *et al.* 2006, p. 14 and Fig. 4; Smith *et al.* in press, pp. 15-16). Genetic exchange can occur either through pollen or seed dispersal. Some researchers consider *L. papilliferum* to be closely related to *L. montanum*, and *L. papilliferum* was originally described as *L. montanum* var. *papilliferum* in 1900 by Louis Henderson. Results of genetic studies comparing *L. papilliferum* with *L. montanum* indicate that *L. papilliferum* forms a monophyletic group or subgroup that is genetically distinct from *L. montanum* (Larson *et al.* 2006, p. 13 and Figs. 4, 8; Smith 2006, pp. 5-7, Fig. 1). A more recent study examining the relationship between *L. montanum, L. papilliferum*, and *L fremontii* found that *L. papilliferum* is considered a sister taxa or closely related to *L. fremontii*, a native mustard of western North America (Smith *et al.* in press, pp. 15-16). Both *L. fremontii* and *L. papilliferum* are morphologically and ecologically distinct from *L. montanum,* and recent analyses reflect that both are monophyletic (organisms that share a common ancestor) with apparently little gene flow between them and *L. montanum* (Smith *et al.* in press, p. 18).

Some genetic differences have been observed between *Lepidium papilliferum* occurring on the Snake River Plain (now separated into the Boise Foothills and Snake River Plain regions) and the Owyhee Plateau. Plants in the Snake River Plain and the Owyhee Plateau populations are separated by a minimum of 44 mi (70 km), which is considered beyond the distance that insect pollinators can travel or that seed dispersal can occur. Sites in the Snake River Plain with fewer numbers of plants (16 to 746 flowering individuals) had less genetic diversity than sites with larger numbers of plants (more than 3,000 flowering individuals) (Robertson *et al.* 2006b, p. 42; Billinge and Robertson 2008, p. 1006), although this correlation between population size and genetic diversity was not evident in the Owyhee Plateau region (Stillman *et al.* 2005, p. 9; Robertson *et al.* 2006b, p. 41). The lowest values for average number of alleles per locus were detected in two of the smallest populations (Seaman's Gulch in the Boise Foothills region and Orchard in the Snake River Plain region); in contrast, the largest number of alleles per locus was detected in the second largest population (Kuna Butte SW in the Snake River Plain) (Robertson *et al.* 2006b, Table 4). Larson *et al.* (2006, p. 14 and Fig. 4) also found geographically well-defined populations of *L. papilliferum* between the Snake River Plain and Owyhee Plateau based on genetics. In contrast to the Stillman *et al.* (2005) study, Larson's findings indicate the possibility of depressed genetic diversity in *L. papilliferum* based on significantly greater average similarity coefficients within collection sites of *L. papilliferum* compared to those of *L. montanum* (Larson *et al.* 2006, p. 13).

In summary, recent genetic studies thus confirm that *Lepidium papilliferum* is a full species distinct from *L. montanum*. The currently accepted taxonomy recognizes *Lepidium papilliferum* (Henderson) A. Nels. and J.F. Macbr. as a full species (Taxonomic Serial No. 53383, Integrated Taxonomic Information System (ITIS), 2009). In addition, populations of *L. papilliferum* in the Owyhee Plateau demonstrate distinctive genetic differences from individuals in the Snake River Plain, likely a reflection of the isolation of these two populations due to limited seed dispersal and the limited range of pollinators, resulting in little current gene flow between them. Finally, there is some evidence that *L. papilliferum* has reduced genetic variability relative to other native species of *Lepidium*, such as *L. montanum*, and that smaller populations of *L. papilliferum* have less genetic diversity than larger populations.

Monitoring of *Lepidium papilliferum* Populations

There are several biological programs designed to monitor populations of *Lepidium papilliferum* over time, and, in some cases, its habitat as well. The primary monitoring programs are

described here to assist in understanding subsequent references to them in this document.

The Idaho Natural Heritage Program (INHP) uses element occurrences (EOs) to broadly describe the distribution of *Lepidium papilliferum* and assigns rankings to each EO based on measures of habitat quality and species abundance. EOs of *L. papilliferum* are defined by grouping occupied slickspots that occur within 1 km (0.6 mi) of each other; all occupied slickspots within a 1 km (0.6 mi) distance of another occupied slickspot are aggregated into a single EO. The definition of a single EO is based on the distance over which individuals of *L. papilliferum* are believed to be capable of genetic exchange through insect-mediated pollination (Colket and Robertson 2006). Due to the nature of their definition, individual EOs may differ greatly in size, based on whether there are many occupied slickspots distributed widely across the landscape relatively close to one another (which would comprise a single, large EO), or whether there are only a few (or even a single) slickspot(s) that occur close together but are relatively isolated from other occupied slickspots (which would comprise a single, small EO).

Each EO is assigned a qualitative rank defined by population size and habitat quality; EO ranks are periodically updated when new ranking information becomes available. Currently, no *Lepidium papilliferum* EOs are ranked A, which is defined as an EO with greater than 1,000 detectable above-ground plants occurring in the best habitat and landscape quality. The habitat quality rank diminishes from the highest of A to the lowest quality of D. An E ranking signifies that at least one plant was observed, but no abundance, habitat, or landscape data are available (Colket *et al.* 2006, p. 4). A rank of F indicates the most recent survey failed to find any *L. papilliferum* plants. A rank of H indicates *L. papilliferum* plants have not been documented at that location since 1970 based on old herbarium records with geographically vague location descriptions, such as a town name. A rank of X indicates *L. papilliferum* plants had been extirpated from that EO, based on agricultural conversion, commercial or residential development, or other documented habitat destruction where *L. papilliferum* plants had been previously recorded. An EO can also be ranked as X if it receives an F rank five times within a 12–year period (Colket *et al.* 2006, p. 4). The current rankings for *L. papilliferum* are reviewed below in the section **Element Occurrences Rangewide**.

The Habitat Integrity Index (HII) program conducted by the Idaho Conservation Data Center (ICDC, now the INHP) was the first rangewide effort aimed at monitoring *Lepidium papilliferum* and its habitat. The HII was initiated in 1998 and ran for 5 years through 2002 (Mancuso and Moseley 1998; Mancuso *et al.* 1998; Mancuso 2000, 2001, 2002, 2003). Although 52 transects were established over the years, a total of 17 transects were sampled during all years of HII monitoring (Mancuso 2003, p. 3); no rangewide monitoring of *L. papilliferum* was conducted in 2003. Monitoring was initially based on a system of transects of varying lengths across the range of *L. papilliferum*, each subjectively located to include 10 slickspots on sites known to contain *L. papilliferum* (summarized in Sullivan and Nations 2009, p. 33; see Mancuso *et al.* 1998 for details). The primary goal of the HII methodology was to assess the overall habitat condition, including attributes associated with the slickspots and the sagebrush-steppe habitat; *L. papilliferum* abundance was assessed categorically (assigned to a range of values) in this program.

In 2004, the HII was replaced by the Habitat Integrity and Population (HIP) monitoring protocol, also implemented by the ICDC. HIP monitoring has been conducted annually since its implementation, thus 5 years of HIP data are now available (through 2008) (ICDC 2008, p. 2; State of Idaho 2008). The HIP protocol was designed to provide data more replicable and specific to the monitoring required for the Candidate Conservation Agreement (CCA) developed by the State of Idaho, BLM, and others in 2003 (State of Idaho *et al.* 2003). HIP presents measures of habitat, disturbance, and plant community attributes at each transect as well as counts of *L. papilliferum* rosettes and reproductive plants observed (with the exception of 2004, which still utilized categorical assessments of plant abundance). Similar to the HII protocol, HIP is based on transects of varying lengths subjectively located to include 10 slickspots along their lengths (see Colket 2005 for details on the HIP methodology); however, the HIP protocol includes a significantly greater number of rangewide transects, having increased from the original 70 established in 2004 to 80 today (ICDC 2008, p. 3).

HIP monitoring has been annually conducted since 2004 and consists of the following procedures: (1) Establish and permanently mark HIP transects; (2) record location information; (3) take photographs; (4) measure population, habitat, and disturbance attributes at selected slickspots; (5) measure plant community attributes; and (6) analyze and describe the results (Colket 2008, p. 3).

The INHP's EO records and the HII–HIP monitoring programs cover the entire range of *Lepidium papilliferum*. In addition, monitoring that has occurred within a subset of the species' range, on the Idaho Army National Guard's Orchard Training Area (OTA), provides particularly important information on the status of *L. papilliferum* due to the long-term nature of the monitoring programs. The sagebrush-steppe on the OTA is considered to be some of the highest-quality habitat remaining within the range of *L. papilliferum*, and the OTA is home to one of the largest and most expansive EOs of the species (Sullivan and Nations 2009, p. 22). Two of the OTA programs have been monitoring the same locations annually (with a few exceptions) since the early 1990s, and hence provide up to 18 years of population data for *L. papilliferum*. These two monitoring programs are known as rough census areas and special-use plots; both are conducted by staff or contractors of the OTA.

The methods of the rough census monitoring areas are presented in Sullivan and Nations 2009 (pp. 28-29). Briefly, the program began in 1990 by monitoring 5 areas but expanded to the current total of 15 rough census areas by 1994; the combined extent of the rough census areas on the OTA is 866.1 ac (350.5 ha). Counts are conducted by technicians who walk across parallel transects 66 ft (20 m) apart and record the total number of *Lepidium papilliferum* individuals observed in any occupied slickspots that are found; reproductive status is not noted. The sizes of the 15 rough census areas differ, ranging from 4.1 ac (1.7 ha) to 138.3 ac (56.0 ha), and not all areas have been monitored in all years; thus, analyses of the data must be standardized by transforming the raw count data to plant density (number of plants per unit area) to account for these differences (Sullivan and Nations 2009, p. 36). Using density as the index of population abundance instead of total counts also allowed for the use of 18 years of rough census data, from 1990 through 2008 (there were no counts in 1999), although only a few of the rough census areas were monitored in the earlier years.

The special-use plots are also located on the OTA. Although called ''plots,'' these are actually a series of 16 belt transects, each containing a single

slickspot (see Sullivan and Nations 2009, pp. 29-33, for details). A stake is centered in the single slickspot, and each year the number of *Lepidium papilliferum* individuals with a 16.4-ft (5-m) radius of that stake (comprising a 32.8-ft (10-m) diameter circle) are counted (additional habitat information is collected from the remainder of the belt transect). *Lepidium papilliferum* abundance estimates for each of the 16 central circular plots has been collected annually each year from 1991 through 2008; thus, 18 years of special-use plot data are available. As all special-use plots were the same size and were surveyed in all years, estimates of abundance are based on reported total counts of individual plants (Sullivan and Nations 2009, p. 37). Beginning in 2000, the special-use plot data distinguished between blooming and nonblooming individuals.

All of these programs provide information regarding the status of *Lepidium papilliferum* and its habitat, and will be referenced throughout this rule. In addition, we reference *L. papilliferum* Management Areas, which are units containing multiple EOs in a particular geographic area with similar land management issues or administrative boundaries as defined in the 2003 CCA (State of Idaho, p. 9). At a larger scale is the *L. papilliferum* (or ''LEPA'') Consideration Zone, an area also designated by the 2003 CCA and defined as all areas that may or do contain *L. papilliferum* (State of Idaho 2003, p. 21). The LEPA Consideration Zone includes the entire range of the species, including all Management Areas and all EOs.

Ecology and Habitat

The native, semiarid sagebrush-steppe habitat of southwestern Idaho where *Lepidium papilliferum* is found can be divided into two plant associations, each dominated by the shrub *Artemisia tridentata* ssp. *wyomingensis* (Wyoming big sagebrush): *A. tridentata* ssp. *wyomingensis–Achnatherum thurberianum* (formerly *Stipa thurberiana*) (Thurber's needlegrass) and *A. tridentata* ssp. *wyomingensis–Agropyron spicatum* (bluebunch wheatgrass) habitat types (Moseley 1994, p. 9). The perennial bunchgrasses *Poa secunda* (Sandberg's bluegrass) and *Sitanion hysrix* (bottlebrush squirreltail) are commonly found in the understory of these habitats, and the species *Artemisia tridentata* ssp. *tridentata* (basin big sagebrush), *Chrysothamnus nauseosus* (grey rabbitbrush), *Chrysothamnus viridiflorus* (green rabbitbrush), *Eriogonum strictum* (strict buckwheat), *Purshia tridentata* (bitterbrush), and *Tetradymium glabrata* (little-leafed horsebrush) form a lesser component of the shrub community (Moseley 1994, p. 9; Mancuso and Moseley 1998, p. 17). Under relatively undisturbed conditions, the understory is populated by a diversity of perennial bunchgrasses and forbs, including species such as *Achnatherum* (formerly *Oryzopsis) hymenoides* (Indian ricegrass), *Achillea millefolium* (common yarrow), *Phacelia heterophylla* (varileaf phacelia), *Astragalus purshii* (Pursh's milkvetch), *Phlox longifolia* (longleaf phlox), and *Aristida purpurea* var. *longiseta* (purple threeawn) (Moseley 1994, p. 9; Mancuso and Moseley 1998, p. 17; Colket 2005, pp. 2-3). Menke and Kaye (2006a, p. 1) describe high quality matrix habitat conditions for *L. papilliferum* as sagebrush-steppe habitat in late seral condition, and Fisher *et al.* (1996, p. 1) note that ''habitat with vigorous *Lepidium* populations has not been recently burned, is not heavily grazed, has an understory of native bunchgrasses, and a well developed microbiotic soil crust.'' Moseley (1994, p. 4) suggests that *L. papilliferum* serves as an indicator species for the health of the sagebrush-steppe ecosystem in the western Snake River Plain.

The biological soil crust, also known as a microbiotic crust or cryptogamic crust, is one component of quality habitat for *Lepidium papilliferum*. Such crusts are commonly found in semiarid and arid ecosystems, and are formed by living organisms, primarily bryophytes, lichens, algae, and cyanobacteria, that bind together surface soil particles (Moseley 1994, p. 9; Johnston 1997, p. 4). Microbiotic crusts play an important role in stabilizing the soil and preventing erosion, increasing the availability of nitrogen and other nutrients in the soil, and regulating water infiltration and evaporation levels (Johnston 1997, pp. 8-10). In addition, an intact crust appears to aid in preventing the establishment of invasive plants (Brooks and Pyke 2001, p. 4, and references therein; see also Serpe *et al.* 2006, pp. 174, 176). These crusts are sensitive to disturbances that disrupt crust integrity, such as compression due to livestock trampling or off-road-vehicle (ORV) use, and are also subject to damage by fire; recovery from disturbance is possible but occurs very slowly (Johnston 1997, pp. 10-11).

As described earlier, *Lepidium papilliferum* occurs in slickspot habitat microsites scattered within the greater semiarid sagebrush-steppe ecosystem of southwestern Idaho. *Lepidium papilliferum* has infrequently been documented outside of slickspots, on occasion being found on disturbed soils, such as along graded roadsides and badger mounds. These are rare observations and the vast majority of plants documented over the past 19 years of surveys and monitoring for the species are documented within slickspot microsite habitats (USFWS 2006, p. 20). For example, in 2002, a complete census of an 11,070-ac (4,480-ha) area recorded approximately 56,500 slickspots (U.S. Air Force, 2003, p. 15), of which approximately 2,450 (about 4 percent) were occupied by *L. papilliferum* plants (Bashore, pers. comm. 2003, p. 1). Of the approximately 11,300 *L. papilliferum* plants documented during the survey effort, only 11 plants were documented outside of slickspots (U.S. Air Force 2002, in summary attachment of document).

Slickspots are visually distinct openings characterized by soils with high sodium content and distinct clay layers; they tend to be highly reflective and relatively light in color, which makes them easy to detect on the landscape (Fisher *et al.* 1996, p. 3). Slickspots are distinguished from the surrounding sagebrush matrix as having the following characteristics: microsites where water pools when rain falls (Fisher *et al.* 1996, pp. 2, 4), sparse native vegetation, distinct soil layers with a columnar or prismatic structure, higher alkalinity and clay content and natric properties (Fisher *et al.* 1996, pp. 15-16; Meyer and Allen 2005, pp. 3-5, 8; Palazzo *et al.* 2008, p. 378), and reduced levels of organic matter and nutrients due to lower biomass production (Meyer and Quinney 1993, pp. 3, 6; Fisher *et al.* 1996, p. 4). Fisher *et al.* (1996, p. 11) describe slickspots as having a ''smooth, panlike surface'' that is structureless and slowly permeable when wet, moderately hard and cracked when dry. Although the low permeability of slickspots appears to help hold moisture (Moseley 1994, p. 8), once the thin crust dries, out the survival of *L. papilliferum* seedlings depends on the ability to extend the taproot into the argillic horizon (soil layer with high clay content), to extract moisture from the deeper natric zone (Fisher *et al.* 1996, p. 13).

Slickspots have three primary layers: The surface silt layer, the restrictive layer, and an underlying moist clay layer. Although slickspots can appear homogeneous on the surface, the actual depth of the silt and restrictive layer can vary throughout the slickspot (Meyer and Allen 2005; Tables 9, 10, and 11). The top two layers (surface silt and restrictive) of slickspots are normally very thin; the surface silt layer varies in

thickness from 0.1 to 1.2 in (a few mm to 3 cm) in slickspots known to support *Lepidium papilliferum*, and the restrictive layer varies in thickness from 0.4 to 1.2 in (1 to 3 cm) (Meyer and Allen 2005, p. 3). The rangewide mean surface silt layer depth was 0.31 in (0.78 cm) based on a 2005 study of 769 slickspots of unknown occupancy sampled at 79 transects (Colket 2006, p. 38). Additionally, measurements of the depth of the clay layer next to *L. papilliferum* plants at the Juniper Butte Training Range were taken in 2007 and 2008 to assess if depth of the clay layer could be a significant factor for plant germination. The average depth of the clay layer next to plants measured in 2007 was 2.5 in (6.3 cm), with a range from 1.2 to 4.7 in (3.0 to 12.0 cm) (n=18), and in 2008 was 2.1 in (5.4 cm) with a range from 1.6 to 3.1 in (4.0 to 8.0 cm) (n=16) (CH2MHill 2008a, p. 13). It appears that depth to the clay layer is not as critical to germination at the Juniper Butte Training Range as other factors may be (such as depth to surface of the soil, the timing and amount of moisture, seed bank, and ability of the slickspot to capture and maintain adequate moisture).

It is not known how long slickspots take to form, but it is hypothesized to take several thousands of years (Nettleton and Peterson 1983, p. 193; Seronko 2006). Climate conditions that allowed for the formation of slickspots in southwestern Idaho are thought to have occurred during a wetter Pleistocene period. Holocene additions of wind-carried salts (often loess deposits) produced the natric soils (high in sodium) characteristic of slickspots (Nettleton and Peterson 1983, p. 191; Seronko 2006). It may take several hundred years to alter or lose slickspots through natural climate change or severe natural erosion (Seronko 2006). Some researchers hypothesize that, given current climatic conditions, new slickspots are no longer being created (Nettleton and Peterson 1983, pp. 166, 191, 206). As slickspots appear to have formed during the Pleistocene and new slickspots are not being formed, the loss of a slickspot is apparently a permanent loss.

Some slickspots subjected to light disturbance in the past may apparently be capable of re-forming (Seronko 2006). Disturbances that alter the physical properties of the soil layers, however, such as deep disturbance and the addition of organic matter, may lead to destruction and permanent loss of slickspots. For example, such techniques as deep soil tilling, the addition of organic matter, and addition of gypsum have been recommended for the elimination of slickspots from agricultural lands in Idaho (Peterson 1919, p. 11; Rasmussen *et al.* 1972, p. 142). Slickspot soils are especially susceptible to mechanical disturbances when wet (Rengasmy *et al.* 1984, p. 63; Seronko 2004). Such disturbances disrupt the soil layers important to *Lepidium papilliferum* seed germination and seedling growth, and alter hydrological function. Meyer and Allen (2005, p. 9) suggest that if sufficient time passes following the disturbance of slickspot soil layers, it is possible that the slickspot soil layers may regain their pre-disturbance configuration, yet not support the species. Thus, while the slickspot appears to have regained its former character, some essential component required to sustain the life history requirements of *L. papilliferum* has apparently been lost, or the active seed bank is no longer present.

Most slickspots are between 10 square feet (ft^2) and 20 ft^2 (1 square meter (m^2) and 2 m^2) in size, although some are as large as 110 ft^2 (10 m^2) (Mancuso *et al.* 1998, p. 1). Slickspots cover a relatively small cumulative area within the larger sagebrush-steppe matrix, and only a small percentage of slickspots are known to be occupied by *Lepidium papilliferum*. For example, a 2002 inventory of the 11,070 acre (ac) (4,480 hectare (ha)) Juniper Butte Range on the Owyhee Plateau found approximately 1 percent (109 ac (44 ha)) of the sagebrush-steppe area consisted of slickspot habitat, and of that slickspot habitat, only 4 percent (4 ac (1.6 ha)) was occupied by above-ground *L. papilliferum* plants (U.S. Air Force 2002, p. 9). It is not known why *L. papilliferum* is not found in a greater proportion of slickspot microsites (Fisher *et al.* 1996, p. 15).

The highest monthly temperatures within the range of *Lepidium papilliferum* normally occur in July (approximately in the low 90 degrees Fahrenheit (approximately 33 degrees Celsius)), and lowest monthly temperatures occur in January (approximately in the low 20 degrees Fahrenheit (minus 7 degrees Celsius)). Precipitation tends to fall as rain, primarily in winter and spring (November to May); the lowest rainfall occurs in July and August, with the months of June, September, and October receiving slightly more rainfall than July and August. Average annual precipitation patterns vary within the species' range, and are generally higher in the northern regions (e.g., 11.7 in (29.7 cm) near Boise, 7.4 in (18.8 cm) at the city of Bruneau, and 9.9 in (25.1 cm) at Mountain Home).

Several analyses have shown a positive association between above-ground abundance of *Lepidium papilliferum* and spring precipitation in the same year. Evaluating rangewide HII monitoring data collected over 4 years from 1998 to 2001, Palazzo *et al.* (2005, p. 9) found a positive relationship (p-value less than 0.01) between abundance of above-ground plants and February to June precipitation. Meyer *et al.* (2005, p. 15) found that an increase in February through May precipitation increased the number of *L. papilliferum* seedlings at the OTA based on *L. papilliferum* census and survival data collected from 1993 to 1995. CH2MHill (2007a, p. 14) analyzed data from 2005 to 2007 collected at the Juniper Butte Range in the Owyhee Plateau region and found a positive correlation between spring precipitation and plant numbers. Utilizing HII monitoring data collected from 1998 to 2002, as well as 2004 HIP monitoring data, Menke and Kay (2006a, b) found that March to May precipitation accounted for 99.4 percent of the variation in *L. papilliferum* abundance for the years 1998 to 2001 (2006a, p. 8), and 89 percent for the years 1998 to 2002, and 2004 (2006b, pp. 10-11). These results appear to have been strongly influenced by the data point for 1998, which was an unusually wet spring (Unnasch 2008, p. 16). Because the 1998 HII data represents an outlier with respect to both *L. papilliferum* abundance and precipitation, it largely determines the regression relationship by itself; thus, Menke and Kaye's 2006 conclusion that abundance increases with spring precipitation is not well supported (Sullivan and Nations 2009, p. 140). More recently, however, Sullivan and Nations (2009, pp. 30, 41) analyzed data collected at the OTA over a period of 18 years between 1990 and 2008, and found evidence that both plant density at the rough census areas and plant abundance at special-use plots were positively related to mean monthly precipitation in late winter and spring (January through May). Thus, analysis of this long-term dataset again points to a strong relationship between *L. papilliferum* abundance and spring precipitation. This correlation of abundance with spring rainfall is important, as it at least partially explains annual fluctuations in *L. papilliferum* population numbers.

In contrast, precipitation in the fall or early winter may have a negative effect on *Lepidium papilliferum* abundance the following spring (Meyer *et al.* 2005, p. 15; Sullivan and Nations 2009, p. 39). It has been suggested that this negative

relationship may be the result of prolonged flooding of the slickspot microsites, causing subsequent mortality of overwintering biennial rosettes (Meyer *et al.* 2005, pp. 15-16). This suggestion is supported by the analysis of 9 years of OTA data from the period 2000-2008 that shows a negative association between October to January precipitation and abundance of non-blooming *L. papilliferum* the following spring, although only the relationship with October to December precipitation is statistically significant (Sullivan and Nations 2009, p. 43). For blooming plants, the negative association between October to January precipitation and spring abundance was highly significant (Sullivan and Nations 2009, pp. 43-44).

However, Unnasch (2008, p. 2) found no relationship between precipitation and the abundance of *Lepidium papilliferum* in an analysis of HIP data collected over a 3–year period from 2005 to 2007. Unnasch hypothesized that *L. papilliferum* may manifest threshold effects in germination and that there is a pulse of germination following a requisite amount of rainfall that could lead to a major flush of *L. papilliferum* germination during very wet years. If total rainfall is below that threshold, annual germination is more random (Unnasch 2008, p. 16). Comparing his results to those of Menke and Kaye, Unnasch (2008, p. 15) suggests that the relationship with spring precipitation reported by Menke and Kaye was strongly affected by abundance data from the year 1998, although in turn the relatively short 3–year study period may have influenced Unnasch's study results. Sullivan and Nations (2009, pp. 140, 142) likewise suggested that the exceptionally high precipitation in 1998 likely influenced the results of Menke and Kaye's analysis. However, as described above, Sullivan and Nation's more robust analysis of 18 years of data from the OTA confirmed a positive correlation between spring precipitation and the abundance of *L. papilliferum* (Sullivan and Nations 2009, pp. 40-44). As both annual precipitation and plant abundance are highly variable, the numbers of years included in the data set for evaluation is of great importance in determining the degree of confidence in the outcome of any statistical analysis. For this reason, the Service believes the Sullivan and Nations (2009, pp. 40-44) evaluation of the 18–year dataset from the OTA is the best available data regarding the relationship between precipitation and abundance of *L. papilliferum*.

Recent analyses suggest that temperature also influences the annual abundance of *Lepidium papilliferum*. Although Menke and Kaye (2006b, p. 8) found that minimum and maximum temperatures were not statistically correlated with *L. papilliferum* abundance based on a limited number of years of data, Sullivan and Nations (2009, p. 46-57) used more precise temperature data in concert with the 18–year *L. papilliferum* abundance dataset from the OTA to evaluate the potential interaction between precipitation, temperature, and plant abundance. Their analysis of the data collected between 1990 and 2008 suggests a complex relationship between temperature and precipitation that influences the abundance of *L. papilliferum* on an annual basis. In short, they found that temperature and precipitation interact during the months of October through January such that the lowest density or abundance of *L. papilliferum* in the spring follows a fall or early winter when both precipitation and temperature are low, or both are high. Spring plant density or abundance is greatest following a fall or early winter when either precipitation is high and temperature is low, or precipitation is low and temperature is high (Sullivan and Nations 2009, p. 56). During late winter and spring, analysis of one OTA dataset (the ''rough census'' areas) suggested that temperature had a negative impact on *L. papilliferum* density, such that density is greater when precipitation is high but temperatures during March through May are lower (Sullivan and Nations 2009, p. 47), whereas the model of the OTA special-use plots suggests only a positive interaction of *L. papilliferum* abundance with precipitation during this time period, with no temperature effect (Sullivan and Nations 2009, p. 47). Sullivan and Nations caution that the limited geographic area within which the interactions of precipitation and temperature were studied limits the ability to extrapolate the observed relationship beyond the bounds of the OTA (Sullivan and Nations 2009, p. 57).

The sparse native vegetation naturally present at slickspots suggests that *Lepidium papilliferum* is more tolerant than surrounding vegetation at surviving in alkaline soils and spring inundation (e.g., Moseley 1994, p. 8, 14; Fisher *et al.* 1996, pp. 11, 16). Plant ecology literature suggests that plants tolerant of stress (e.g., plants that are capable of growing in harsh alkaline soils) are poor competitors (Grime 1977, p. 1185), making *L. papilliferum* a potentially poor competitor with other plants. In recent years, there are increasing observations of nonnative plants encroaching into slickspots, and consistent with theory, the evidence suggests that *L. papilliferum* is not able to successfully compete with these invasive exotics. Sullivan and Nations (2009, p. 111) report an ''apparent mutual exclusivity'' between nonnative plant species examined and *L. papilliferum* in slickspots. In other words, if plants such as *Bassia prostrata* (prostrate kochia or forage kochia, formerly *Kochia prostrata*) or *Bromus tectorum* are present in a slickspot, *L. papilliferum* is most often reduced in numbers or entirely absent.

Range and Distribution

The range of *Lepidium papilliferum* is restricted to the volcanic plains of southwest Idaho, occurring primarily in the Snake River Plain and its adjacent northern foothills, with a single disjunct a population on the Owyhee Plateau (Figure 1). The plant occurs at elevations ranging from approximately 2,200 ft (670 m) to 5,400 ft (1,645 m) in Ada, Canyon, Gem, Elmore, Payette, and Owyhee Counties (Moseley 1994, pp. 3-9). Based on differences in topography, soil, and relative abundance, we have further divided the extant *Lepidium papilliferum* populations into three physiographic regions: the Boise Foothills, the Snake River Plain, and the Owyhee Plateau. The nature and severity of factors affecting the species also vary between the three physiographic regions for the purposes of analysis. For example, urban and rural development, agriculture, and infrastructure development has been substantial in the sagebrush-steppe habitat of the Boise Foothills and the Snake River Plain regions, while very little of these types of development has occurred within the Owyhee Plateau region. Genetic analyses reveal some separation between the greater Snake River Plain and Owyhee Plateau populations of *L. papilliferum* (Larson *et al.* 2006, p. 14), as might be expected due to their relative isolation. We are not aware of any studies that may have examined the relative genetic differentiation, if any, of the Boise Foothills population from the remainder of the Snake River Plain.

Figure 1. Range of *Lepidium papilliferum* in southwest Idaho, showing its distribution in the three physiographic provinces of the Snake River Plain, Boise Foothills, and Owyhee Plateau.

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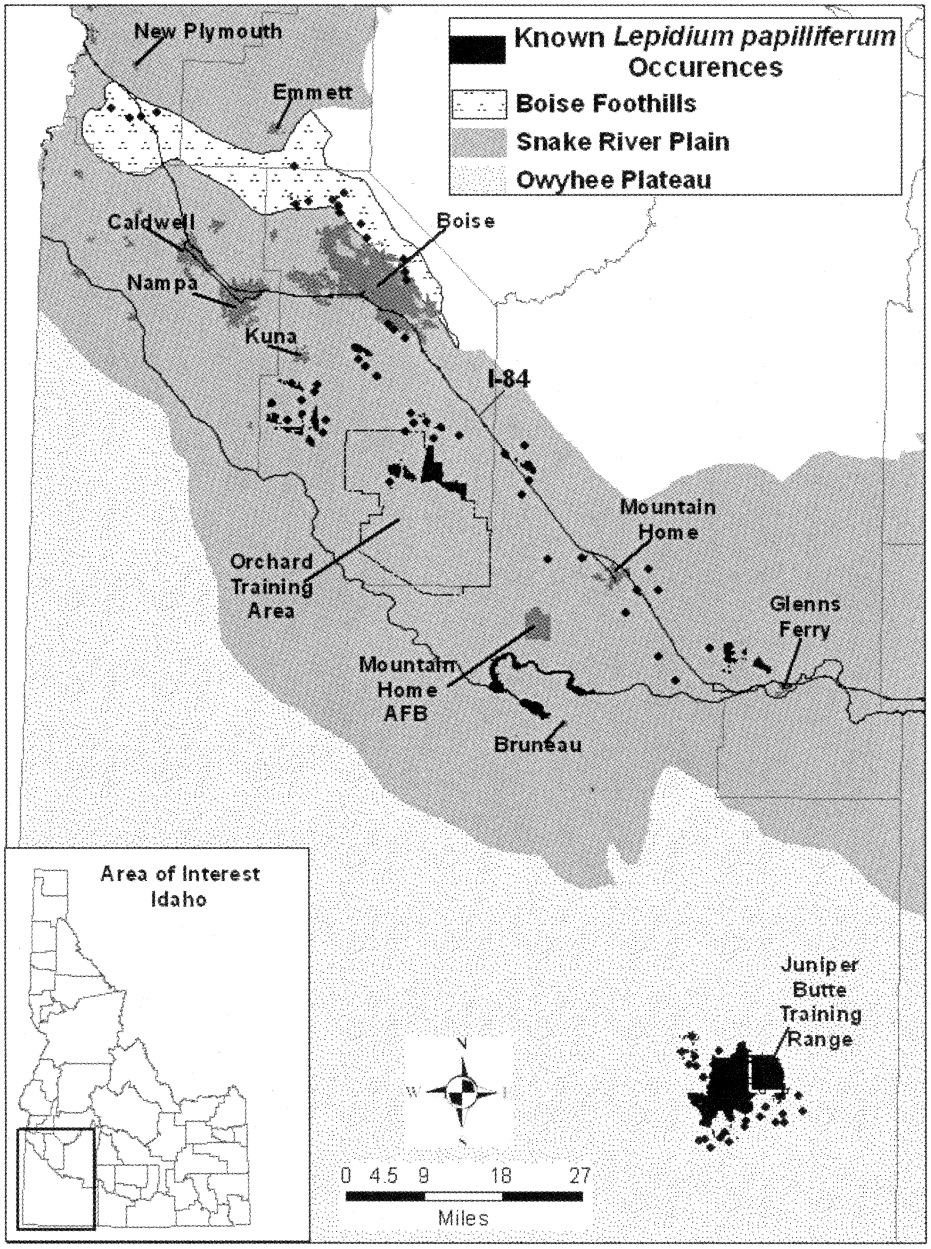

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As of February 2009, there were 80 extant EOs in the three physiographic regions that collectively comprise approximately 15,801 ac (6,394 ha) of total area that is broadly occupied by *Lepidium papilliferum* (Cole 2009b, Threats Table). The area actually occupied by *L. papilliferum* is a small fraction of the total acreage, since slickspots occupy only a small percentage of the landscape, and *L. papilliferum* then occupies only a fraction of those slickspots (see U.S. Air Force 2002, p. 9, for an example). Table 1 presents the distribution and landownership and management information for all *L. papilliferum* EOs, in total and by region.

TABLE 1. DISTRIBUTION AND LAND OWNERSHIP OF *Lepidium papilliferum* ELEMENT OCCURRENCES BY PHYSIOGRAPHIC REGION (COLE 2009B, THREATS TABLE; SULLIVAN AND NATIONS 2009, P. 77).

All areas are estimates, and may not total exactly due to rounding.

Lepidium papilliferum EOs	Number of EOs [percent of total]	Federal ownership in acres (hectares) [percent of total]	State ownership in acres (hectares) [percent of total]	Private ownership in acres (hectares) [percent of total]	Total EO Area (hectares) [percent of total rangewide EO area]
Snake River Plain	43 [54]	12,754 ac (5,160 ha) [98]	55 ac (22 ha) [0.5]	164 ac (66 ha) [1.5]	12,980 ac (5,250 ha) [82]
Boise Foothills	16 [20]	89 ac (36 ha) [48]	0 ac (0 ha) 0	96 ac (39 ha) [52]	185 ac (75 ha) [1.2]
Owyhee Plateau	21 [26]	2,636 ac (1,067 ha) [99.7]	7 ac (3 ha) [0.3]	0 ac (o ha) [0]	2,643 ac (1,070 ha) [16. 8%]
All extant EOs	80 [100]	15,479 ac (6,264 ha) [98.0]	62 ac (25 ha) [0.4]	260 ac (105 ha) [1.6]	15,801 ac (6,394 ha) [100]

The range of *Lepidium papilliferum* was first estimated in 1994 (Moseley 1994, p. 6). Expanded survey efforts in recent years have resulted in an increase in the amount of known occupied habitat, particularly on the Owyhee Plateau and in the Boise Foothill regions. Between 2003 and 2006, 16 new EOs were documented, all within 3 mi (4.8 km) of previously existing EOs: 2 on the Snake River Plain with a total area of 2.7 ac (1 ha), and 14 on the Owyhee Plateau with a total area of 46.6 ac (18 ha) (Colket *et al.* 2006, Tables and Appendix A). Since 2006, additional surveys of previously unsurveyed lands have resulted in the discovery of several new occupied sites. Because most of these newly discovered sites were within 1 km (0.6 mi) of a documented EO, they typically resulted in the expansion or merging of existing EOs rather than the creation of a new EO. For example, in 2007, 2,560 ac (1,036 ha) of BLM land on the Owyhee Plateau were inventoried for *L. papilliferum* just south of the U.S. Air Force's Juniper Butte Training Range. Of the 2,171 slickspots surveyed, 200 (9 percent) were occupied by *L. papilliferum* with a total of 1,059 flowering plants and 214 rosettes (ERO 2007, pp. 1, 7-8), resulting in the expansion of EO 16 (Cole 2009a, p. 38). Surveys conducted in 2008 in the vicinity of the Ada County landfill in the Boise Foothills region revealed nearly 5,000 plants in 75 slickspots (Cole 2008, p. 8), which expanded the size of existing EOs 38 and 65 (Cole 2009a, p. 39). Pre-development surveys conducted during 2007 by URS Corporation (URS) on BLM and private lands in the Boise Foothills region northwest of the City of Eagle detected 43 occupied slickspots out of 187 surveyed, with approximately 17,880 *L. papilliferum* plants (URS 2008, p. 10). These observations expanded the total area of EO 76 (Cole 2009a, p. 39). Finally, additional survey efforts on previously surveyed areas at the OTA resulted in the documentation of 365 new occupied slickspots in 2005, resulting in further expansion of existing EO 27 (URS 2005, pp. 6-7).

Not all potential *Lepidium papilliferum* habitats in southwest Idaho have been surveyed, and it is possible that additional *L. papilliferum* sites may be found outside of areas that are currently known to be occupied. Recent modeling was completed to develop a high-quality, predictive-distribution model of *L. papilliferum* to identify potential habitat (Colket 2008, p. 1). Although surveys were conducted in 2008 in some areas identified as potential, previously unsurveyed habitat, these did not result in any new locations of the species (Colket 2008, pp. 4-6). There have also been searches for *L. papilliferum* in eastern Oregon, but the species has never been found there (Findley 2003, p. 1). We have no historical records indicating that *L. papilliferum* has ever been found anywhere outside of its present range in southwestern Idaho, as described in this rule.

Abundance and Population Trend

Forming a reliable estimate of any trend in the abundance of *Lepidium papilliferum* over time is complicated by multiple factors. For one, since individuals of the species may act as either an annual or a biennial, in any given year there will be varying numbers of plants acting as spring-flowering annuals versus overwintering rosettes. The relative proportions of these two life history forms can fluctuate annually depending on a variety of factors, including precipitation, temperature, and the abundance of rosettes produced the previous year (Unnasch 2008, pp. 14-15; Sullivan and Nations 2009, pp. 43-44, 134-135). Secondly, *L. papilliferum* has a long-lived seed bank, likely as an adaptation to unpredictable conditions, in which years of good rainfall favorable for germination and survival may be followed by periods of drought; a persistent seed bank provides a population buffer against years of poor reproductive potential in such a highly variable environment (Meyer *et al.* 2005, p. 21). Only a small percentage of *L. papilliferum* seeds germinate annually, resulting in an estimated maximum longevity of 12 years for seeds in the seed bank (Meyer *et al* 2005, p. 18). The presence of this persistent seed bank confounds the ability to determine any trend in abundance over time, as the number of above-ground plants that can be counted in any one year represents only a subset of the latent population that is present in the seed bank. In effect, it takes at least 12 years to trace the fate of a single year's cohort of seeds, resulting in a significant lag effect in detecting any real underlying change in total population abundance over the long term.

An additional complicating factor in trying to detect any population trend for *Lepidium papilliferum* is the extreme

variability of annual abundance or density of the plant. As is common for desert annuals, the numbers of *L. papilliferum* can vary dramatically from year to year, depending on environmental conditions. As an example, the total number of plants on the 16 special-use plots at the OTA went from 624 individuals in 1997 to 3,330 plants in 1998, subsequently dropping back down again to 756 plants in 1999; total abundance over the years 1991 through 2008 ranged from a low of 249 plants to 15,236 individuals (Weaver 2008). Some of the great variation in yearly plant numbers is likely due to the relationship between *L. papilliferum* and precipitation, as described above. The annual abundance or density of *L. papilliferum* shows a significant positive association with levels of spring rainfall, roughly from March through May (Meyer *et al.* 2005, p. 15; Palazzo *et al.* 2005, p. 9; Sullivan and Nations 2009, pp. 39-41), and survival of potential biennials is associated with increased summer rainfall (Meyer *et al.* 2005, p. 15). There is also some suggestion that increased winter precipitation may show a negative association with plant abundance, although not all analyses are consistently significant on this point (Meyer *et al.* 2005, pp. 15-16; Sullivan and Nations 2009, pp. 39-41). Temperature also appears to play a role in annual abundance of *L. papilliferum* in concert with precipitation, although the exact nature of the relationship is complex and not well understood (Sullivan and Nations 2009, p. 57). Furthermore, the interaction between temperature, precipitation, and *L. papilliferum* abundance appears to vary regionally between the Boise Foothills, Owyhee Plateau, and Snake River Plain (Sullivan and Nations 2009, pp. 103-104).

Because the population dynamics of *Lepidium papilliferum* are complicated, surrogate methods of monitoring the status of the species, such as monitoring the status of the ecosystem upon which it depends, may be preferable to counts of individual plants. For example, due to the extreme annual fluctuations in annual plant abundance and the complicating nature of the long-lived seed bank for this species, Mancuso and Moseley (1998, p. 1) note that ''estimating the number of above-ground plants is by itself not a reliable measure to evaluate population and species viability.'' As an alternative or supplement to population monitoring, they suggest monitoring the ecological integrity of *L. papilliferum* habitat, essentially using measures of habitat quality and quantity as a surrogate for assessing the status or viability of *L papilliferum*. Habitat monitoring is a recommended method of monitoring annual plants with a long-lived seed bank, where in some years the majority of the plant population is expressed in the seed bank rather than as above-ground plants (Elzinga *et al.* 1998, p. 55). For these reasons, we consider that data regarding the trends in habitat quality and quantity for *L. papilliferum* provide us with information that is equally important, if not more so, than direct counts of individual plants in evaluating the overall status of the species. Trends in habitat quality are discussed in the **Habitat Quality** section of this document, as well as under *The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range* in the **Summary of Threats Affecting the Species** section, below.

From a statistical standpoint, the extreme variability in annual abundance or density estimates greatly reduces the ability to reliably detect a long-term trend in the population without many years of standardized data. The presence of the persistent seed bank adds further uncertainty to the determination of population trend, as 12 years may effectively be considered to represent a single generation of the plant. Relatively short-term analyses of abundance estimates for the purposes of estimating a population trend are thus of limited utility due to the high variance observed in the data (Sullivan and Nations 2009, p. 93). In our evaluation, we weighed the relative quality of the available datasets for discerning population trend in *Lepidium papilliferum* according to the degree of confidence we had in the results of any analyses, given the great degree of variability observed and the multiple factors potentially influencing annual counts of the plant.

Four data sets are available that provide some index or measure of *Lepidium papilliferum* abundance: Rangewide EO records, rangewide HII–HIP transects, rough census data collected on the OTA, and special-use plot data from the OTA. Each of these programs is described in the **Monitoring of *Lepidium papilliferum* Populations** section, above, and the degree to which we relied on the information provided by them is described below.

The INHP records of *Lepidium papilliferum* EOs provide only estimated ranges or categorical estimates of abundance, and are so variable in both size and space over time that we considered these records to be informative in terms of evaluating the current overall condition of the species, but we did not rely on EO records for temporal population trend estimates.

Five years of HII monitoring data (1998 to 2002) and 5 years of HIP monitoring data (2004 to 2008) are available on *Lepidium papilliferum* abundance and habitat condition rangewide. Although the HII–HIP program provides valuable information regarding the relationship between *L. papilliferum* abundance and measures of habitat quality or disturbance, the time series of this data set is considered too short to reliably detect any trend in rangewide population abundance, due to the extreme annual variability in the data (Sullivan and Nations 2009, p. 93).

We consider the best available data regarding *Lepidium papilliferum* abundance to be the long-term datasets from the OTA, including the rough census areas and special-use plots, which provide 18 years of population monitoring information. The relative value of the OTA dataset is supported by the analysis of Sullivan and Nations (2009), a report resulting from our contract with an independent consulting firm to evaluate the available population trend data for *L. papilliferum,* as well as to analyze any information available regarding potential relationships between the abundance of *L. papilliferum* and measures of habitat quality or disturbance. Considering the available data from the HII–HIP monitoring, and the rough census area and special-use plot monitoring from the OTA, Sullivan and Nations considered that the long-term nature of the datasets from the OTA make these data the best available data when attempting to model trends through time (Sullivan and Nations 2009, p. 56). Furthermore, they placed slightly greater confidence in the analyses based on the rough census areas as opposed to the special-use plots, since the special-use plots are in effect a subset of the rough census areas and are based on counts from only a single slickspot, and are therefore subject to greater variability in response to localized impacts (Sullivan and Nations 2009, pp. 55, 96). They also noted that the HII and HIP programs do not yet have sufficient data to determine population trends rangewide (Sullivan and Nations (2009, p. 93). However, they determined that all three programs—rangewide HIP, OTA rough census areas, and OTA special-use plots— track annual changes in *L. papilliferum* abundance similarly, and each can act as an index of abundance. Based on their analysis, they concluded that the trend observed on the OTA may be considered likely representative of

the trend across the entire range of the species (Sullivan and Nations 2009, p. 96).

Analysis of Population Trend

Sullivan and Nations analyzed the data on *Lepidium papilliferum* numbers (density or total abundance) from both the rough census areas and the special-use plots at the OTA, assuming a simple linear trend and using a repeated measures implementation of the general negative binomial regression model to account for the large variances in the data (a statistical technique for determining whether a statistically significant trend exists when using a data set with counts from the same areas every year and large changes in the values between years). The model was not intended to describe the complex pattern in the relative density or abundance of *L. papilliferum* over time, but only to determine whether there is evidence of any overall population trend (Sullivan and Nations 2009, p. 38).

Based on this model, of the two OTA datasets, Sullivan and Nations (2009, pp. 3, 55, 96) considered the rough census data to be slightly more reliable. Their analysis of this rough census data showed a negative trend in density with a slope of -0.086 over the years 1990 to 2008; this trend was statistically significant ($p = 0.0087$, two-sided p-value) (Sullivan and Nations 2009, pp. 38-39). Because plant density was unusually high on a single rough census area, the Study 4 Site, the data were reanalyzed, removing that site as a potentially highly influential data point. The result was a more shallow negative slope (-0.059), but the trend remained statistically significant ($p = 0.0046$) (Sullivan and Nations 2009, p. 39).

Rough census area densities were further regressed against 3–month running averages of precipitation. *Lepidium papilliferum* density was positively associated with mean monthly precipitation in each of the January to March, February to April, and March to May periods, and negatively associated with mean monthly precipitation for the periods October to December, November to January, and December to February; these relationships were all significant at $p < 0.0001$ (Sullivan and Nations 2009, pp. 39-40). These findings are consistent with those of Meyer *et al.* 2005 (pp. 15-16), which reported a positive association between *Lepidium* seedlings recruited and spring precipitation, and a likely negative association with winter precipitation, which is postulated to drown overwintering rosettes.

The analysis of abundance data from the special-use plots on the OTA reveals a similarly negative slope over the years 1991 through 2008, but the results were not statistically significant ($p = 0.2857$) (Sullivan and Nations 2009, p. 4). In other words, based on the count data from the special-use plots, there was not sufficient evidence to conclude that the slope of abundance over time was significantly different from zero. The relationship between abundance and spring precipitation on the special-use plots was similar to that observed on the rough census areas; mean monthly precipitation in January to March, February to April, and March to May were all positively associated with abundance and all were statistically significant ($p < 0.0001$). There was no significant relationship, however, between fall or winter precipitation and *Lepidium papilliferum* abundance on the special-use plots (Sullivan and Nations 2009, p. 41). Using a shorter time-series of data from 2000 to 2008, Sullivan and Nations (2009, pp. 43-44) found that the abundance of blooming plants was positively associated with both the current year's precipitation and the number of rosettes present in the previous year, and that the number of rosettes was negatively associated with precipitation in the prior October to December period.

The researchers concluded that there is ''limited evidence for declining populations,'' because trends on the OTA are negative but only statistically significant for the rough census areas (Sullivan and Nations 2009, pp. 2, 44). In earlier analyses of *Lepidium papilliferum* population HII–HIP data, Menke and Kaye had initially reported a negative rangewide population trend for the periods 1998 through 2002 (Menke and Kaye 2006a) and for 1998 through 2004 (Menke and Kaye 2006b). However, Sullivan and Nations (2009, p. 141) point out that the fact that the HII transects were first monitored during a higher-than-average abundance year in 1998 greatly influenced the interpretation of the short time-series dataset, and suggest that the negative trend in abundance is not supported when abundance in subsequent years is included. Additionally, as described above, the HII–HIP data collection has not yet occurred over a long enough period to allow for reliable trend analyses (Sullivan and Nations 2009, p. 93). In comparing the mean number of *L. papilliferum* per transect resulting from his own analyses of HIP data from 2005 through 2007 with the results reported by Menke and Kaye (2006b), Unnasch (2008, p. 14) suggests that, since 1999, there has been no consistent rangewide population trend for the species.

Although Sullivan and Nations did not attempt to discern a trend in population numbers based on the HIP data, they did compare mean total abundance of *Lepidium papilliferum* per transect between physiographic regions, based on the HIP data from 2004 through 2008. They found that relative abundance was significantly different between regions, being greatest in the Boise Foothills region and lowest on the Owyhee Plateau region; abundance on the Snake River Plain region was intermediate between the other two (Sullivan and Nations 2009, p. 103).

In summary, we have reviewed all of the best available scientific and commercial data available to us to determine whether we can discern a long-term trend in the abundance of *Lepidium papilliferum*. The extreme variability in annual counts of the species makes it difficult to discern a trend in numbers with statistical confidence. For this reason, we place greater confidence in the longest time series of monitoring data available to us, that from the OTA (up to 18 years of data for some rough census areas and all special-use plots). In addition, as described above, Sullivan and Nations suggest that the data from the rough census areas may be considered slightly more reliable than that from the special-use plots (Sullivan and Nations 2009, pp. 3, 55). The long-term data from the OTA, which we considered to be the best available data for attempting to model trends through time in agreement with Sullivan and Nations (2009, pp. 3, 56), suggest that population numbers may be trending downward on the OTA. Although numbers on both the rough census areas and the special-use plots showed a slightly negative slope over time, only the analysis of the rough census areas was statistically significant (Sullivan and Nations 2009, pp. 38-40). We considered this to be relatively limited evidence of a downward trend in the population, given the lack of consistently significant results between the two monitoring programs. Furthermore, the slope is not steep, annual variation in plant numbers continues to be extremely high, and the plant has demonstrated an ability to rebound from low numbers due to the persistent seed bank.

We do recognize, however, that the OTA provides some of the highest quality habitat remaining for *Lepidium papilliferum*. Therefore, we believe it is reasonable to infer that if the population is trending downward there, then conditions are likely worse in the

remainder of the plant's range where habitat conditions are more degraded. This conclusion is supported by the analysis of Sullivan and Nations (2009, p. 96), which suggests that the trends on the OTA, as a general index of abundance, might reasonably be considered representative of trends rangewide (Sullivan and Nations 2009, p. 96). Direct evidence in support of this argument, however, is lacking. In addition, since the abundance of *L. papilliferum* is associated with annual precipitation, we considered whether any trend in precipitation over the same time period for which the rough census areas and special-use plot data were collected might be correlated with the observed negative trend in plant numbers. Assuming a simple linear trend, analogous to the model used by Sullivan and Nations in their analysis of *L. papilliferum* density and abundance at the OTA over time, we found no significant trend in precipitation at the OTA over the years 1991 through 2007 (data were not available for 2008). Although we evaluated total annual precipitation, total and mean winter precipitation, total and mean spring precipitation, and 3–month moving averages across the year, least squares regression did not yield any slopes of precipitation over time that were statistically significant from zero (Zwartjes 2009, p. 1). Any observed negative trend in *L. papilliferum* density or abundance at the OTA thus appears to be independent of any trend in precipitation over the time period of interest.

In weighing all of this information, we conclude that the best available evidence suggests that *Lepidium papilliferum* numbers may be trending downward. The dataset from the rough census areas on the OTA shows a significant downward trend in density over the last 18 years. Furthermore, we believe it is reasonable to infer that this negative trend may be similar or possibly even greater rangewide in areas outside the high quality habitat of the OTA, and this trend appears to be independent of any trend in precipitation. The best available scientific and commercial data therefore suggest that over the past two decades, *L. papilliferum* has likely significantly declined in abundance.

In terms of projecting this trend into the future, however, there are many uncertainties associated with both the data and the model that preclude our ability to do so; these include, but are not limited to: Great annual variability in plant numbers, the confounding influence of the long-lived seed bank, the complications associated with annual variability in both precipitation and temperature, and the inconsistent results between the special-use plots and the rough census areas on the OTA. The evaluation of Sullivan and Nations was based on a simple model of *Lepidium papilliferum* abundance or density as a linear function of time, and intended only to discern whether there was any general trend in the population. The authors acknowledge that the dynamics are complicated, and note their model is not intended to describe (nor explain) the details of the temporal pattern of abundance or density of *L. papilliferum* (Sullivan and Nations 2009, p. 38). In addition, we do not have any models for *L. papilliferum* based on multivariate analyses, which would simultaneously take into account additional variables such as precipitation, to potentially allow for the prediction of abundance or density of *L. papilliferum* over time based on projected conditions. Although the currently available model is helpful in terms of interpreting the population information available to date and indicates that *L. papilliferum* has likely been trending downward, for all of the reasons outlined above, it would be inappropriate to rely on this model to predict any future population trajectory for *L. papilliferum*.

Habitat Quality

As described above under ''**Ecology and Habitat**,'' the natural sagebrush-steppe community that surrounds the slickspot microsites in which *Lepidium papilliferum* occurs is dominated by sagebrush (primarily *Artemisia tridentata* ssp. *wyomingensis*) with a diverse understory of native perennial bunchgrasses and forbs. Historically, fires were relatively infrequent in this ecosystem, likely occurring on the order of every 100 years (Whisenant 1990, p. 4). Data on the plant community and fire history pattern are some of the habitat quality attributes collected as part of *Lepidium papilliferum* HIP monitoring, which has been conducted rangewide since 2004. Results from the 2008 HIP monitoring conducted at 80 HIP transects indicated that over the past 5 years, 14 of the transects (18 percent) that were initially characterized by predominantly native vegetation have undergone overall declines in habitat quality, primarily due to increased nonnative species cover (Colket 2009, pp. 10). Furthermore, this increase in nonnatives was observed not only in the surrounding plant community, but in the slickspots occupied by *L. papilliferum* as well. *Bromus tectorum* was the most common nonnative species in slickspots, followed by *Agropyron cristatum* (crested wheatgrass), *Ceratocephala testiculata,* formerly *Ranunculus testiculatus* (bur buttercup), and *Lepidium perfoliatum* (clasping-leaf pepperweed) (ICDC 2008, p. 9). Noxious or aggressive nonnatives detected in HIP transect slickspots include *Linum perenne* ('Appar' blue flax), *Centaurea cyanus* (garden cornflower), *Bassia prostrata* (prostrate kochia or forage kochia), *Chondrilla juncea* (rush skeletonweed), and *Cardaria draba* (whitetop) (Colket 2009, pp. 8-9).

A review of the rangewide HIP transect data for evidence of fire history reveals that 38 of 80 HIP transects (48 percent) currently show no effects from wildfire and 6 others (7.5 percent) were predominantly unburned. Five transects (6.25 percent) had partially burned (with approximately half of the area unburned), 13 (16.25 percent) were predominantly burned, and 18 (22.5 percent) have completely burned (Colket 2009, Table 5). HIP classifies areas as burned if they are devoid of shrub cover or have patchy shrub cover in areas that exhibit the site capacity to support a healthy sagebrush-steppe community; this may include areas that have recently or historically burned. Four HIP transects were burned in 2007 in the Murphy Complex Fire in the Owyhee Plateau geographic region (Colket 2009, p. 23). Sixty-six of the 80 HIP transects (83 percent) have nearby wildfire effects within 1,640 ft (500 m) (Colket 2009, p. 26). A recent geospatial data analysis evaluating the total *Lepidium papilliferum* EO area affected by wildfire from 1957 to 2007 found that the perimeter of 107 wildfires that had occurred encompassed approximately 11,442 ac (4,509 ha), or 73 percent of the total EO area rangewide (Stoner 2009, p. 48). However, caution should be used in interpreting this geospatial information, as this represents relatively coarse vegetation information that may not reflect that some EOs may be located within remnant unburned islands of sagebrush habitat within fire perimeters.

Several features of slickspots and their surrounding habitat were consistently more degraded in areas that had burned. Slickspots in burned areas had lower soil crust cover and greater exotic (nonnative) species cover, and the total native species cover and shrub cover were consistently lower in burned transects, while total exotic species cover,, including *Bromus tectorum*, was consistently higher in burned transects (Menke and Kaye 2006b, p. 19). Sullivan and Nations (2009, p. 3) found a significantly negative relationship

between the abundance or density of *Lepidium papilliferum* and both the presence of *B. tectorum* and past fire. The positive association between the abundance of *B. tectorum* and fire frequency is well established (Whisenant 1990, p. 6). The complex and positive feedback loop between the encroachment of invasive annual grasses such as *B. tectorum*, increased fire frequency, and decreased integrity of biological soil crusts contributes to the degradation of sagebrush-steppe habitat quality for *L. papilliferum* (for additional details, see the *Modified Wildfire Regime* and *Invasive Nonnative Plant Species* discussions under Factor A of **Summary of Factors Affecting the Species**).

Element Occurrences Rangewide

The EO ranking system utilized by the INHP is described above in the **Monitoring of *Lepidium papilliferum* Populations** section. In brief, occurrences of *Lepidium papilliferum* are ranked based on measures of habitat quality and species abundance. The first EO ranks for *L. papilliferum* were assigned in 1993 (Colket *et al.* 2006, Tables 1-13). In 2006, *L. papilliferum* EO specifications and ranking were updated and revised by the ICDC to apply more consistent EO specifications rangewide (Colket *et al.* 2006, pp. 15-44). Due to the change in methods in 2006, EO rankings assigned before 2006 are not comparable to those assigned after 2006. Currently, EO ranks are more consistently assigned, are useful as an assessment of estimated viability or probability of persistence, and help prioritize conservation planning or actions (NatureServe 2002).

As of February 2009, the INHP has ranked 80 extant EO records for *Lepidium papilliferum* based on habitat quality and abundance (Cole 2009b, Threats Table). In addition, nine EOs are ranked as extirpated or probably extirpated, and seven EOs are considered historical (information is too vague for relocation of the sites). All nine extirpations were formerly verified locations from old herbarium collections (the most recent from 1955) where the habitat is now completely developed or converted to agricultural lands (Colket *et al.* 2006, Table 13). The 80 extant (as of February 2009) EOs represent a reduction in the number of extant EOs (85) known in 2006. However, this reduction in the number of EOs is due to the merging of EOs associated with new locations of plants rather than from the loss of individual EOs. As of February 2009, there are no A-ranked EOs for *L. papilliferum*; the most common EO ranks for *L. papilliferum* rangewide are C and D (Table 2). EO ranks also vary by physiographic region. A little more than one-half of the extant EO area in the Boise Foothills region is ranked as C, which means there are 50 to 399 above-ground plants, low to moderate introduced nonnative plant species cover, and EOs are partially burned. Approximately three-quarters of the total EO area in the Snake River Plain is ranked B, meaning there are 400 to 999 above-ground plants, the native plant community is intact with low introduced nonnative plant species cover, and EOs are largely unburned. The majority of the B-ranked EO acreage rangewide occurs on the Idaho Army National Guard's Orchard Training Area (OTA). The majority of the total EO area in the Owyhee Plateau physiographic region is also ranked B.

EO size can also influence the ranking of an EO as a percentage of total rangewide EO area. For example, one EO (number 27) located on the OTA in the Snake River Plain region has a total area of 7,163 acres (2,899 ha) and accounts for roughly 59 percent of all the area within *Lepidium papilliferum* EOs assigned a B rank throughout the entire range of the species. There are less than 2.2 ac (1 ha) of B-ranked area in the Boise Foothills region, and nearly 2,540 B-ranked ac (1,028 ha) on the Owyhee Plateau. Therefore, according to the EO rankings, the majority of the highest quality remaining habitat for *L. papilliferum* occurs on the Snake River Plain (see Table 2), with most of that occurring within the OTA.

TABLE 2. EXTANT ELEMENT OCCURRENCE (EO) RANKS ACROSS THE ENTIRE RANGE OF *Lepidium papilliferum* (INHP data from February 2009).

Element Occurrence Rank	No. EO's	Hectares	Acres	Percent of Area
Boise Foothills				
B	1	0.84	2.07	1.65
BC	1	1.79	4.41	3.53
C	5	28.34	70.03	56.05
D	6	15.37	37.99	30.40
F	3	4.23	10.46	8.37
TOTAL	**16**	**50.57**	**124.96**	**100.00**
Snake River Plain				
B	5	3,875.14	9,575.47	73.77
BC	1	1.42	3.51	0.03
C	19	935.06	2,310.53	17.80
D	12	350.44	865.94	6.67
D?	1	0.78	1.93	0.01

TABLE 2. EXTANT ELEMENT OCCURRENCE (EO) RANKS ACROSS THE ENTIRE RANGE OF *Lepidium papilliferum*—Continued

(INHP data from February 2009).

Element Occurrence Rank	No. EO's	Hectares	Acres	Percent of Area
F	4	89.82	221.94	1.71
NR	1	0.20	0.48	0.00
TOTAL	**43**	**5,252.86**	**12,979.81**	**100.00**
Owyhee Plateau [1]				
B	5	1,027.50	2,537.00	96.02
C	4	21.85	53.99	2.04
D	5	18.42	45.52	1.72
E	0	0.00	0.00	0.00
F	7	2.36	5.83	0.22
TOTAL	**21**	**1070.13**	**2,644.35**	**100.00**

[1] Note that Sullivan and Nations (2009, pp. 79-81) differed in their overview of extant EOs in the Owyhee Plateau as they presented EO 16 as each of its 27 individual sub-EOs (sub-EOs 700-726). Table 2 combines all Owyhee Plateau sub-EOs into the single EO 16 and also incorporates changes as described in the February 2009 INHP *Lepidium papilliferum* data.

Summary of Factors Affecting the Species

Section 4 of the Act and its implementing regulations (50 CFR 424) set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors relevant to *Lepidium papilliferum* is discussed below.

A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Several threat factors are contributing to the destruction, modification, or curtailment of *Lepidium papilliferum*'s habitat or range. The sagebrush-steppe habitat of the Great Basin where *L. papilliferum* occurs is becoming increasingly degraded due to the impacts of multiple threats, including the invasion of nonnative annual grasses, such as *Bromus tectorum*, and increased frequency of fire. As described below, *B. tectorum* can impact *L. papilliferum* directly through competition, but also indirectly by providing continuous fine fuels that contribute to the increased frequency and extent of wildfires. Frequent wildfires have numerous negative consequences in the sagebrush-steppe system, which is adapted to much longer fire-return intervals, ultimately resulting in the conversion of the sagebrush community to nonnative annual grasslands, with associated losses of native species diversity and natural ecological function. Because the modified wildfire regime and invasion of *B. tectorum* create a positive feedback loop, it is difficult to separate out the effects of each of these threat factors independently. We have attempted to do so here, but much of the discussion may overlap due to the inherent synergism between these two threat factors.

In addition to wildfire and nonnative plants, development poses a threat to *Lepidium papilliferum*, both directly through the destruction of populations and loss of slickspot microsites, and indirectly through habitat fragmentation and isolation (discussed separately under Factor E, below). The loss of slickspots is a permanent loss of habitat for *L. papilliferum*, since the species is specialized to occupy these unique microsite habitats that were formed in the Pleistocene, and once lost, slickspots cannot be recreated on the landscape.

Livestock pose a threat to *Lepidium papilliferum*, primarily through mechanical damage to individual plants and slickspot habitats. However, the current livestock management conditions and associated conservation measures address this potential threat such that it does not pose a significant risk to the viability of the species as a whole.

All of these threats have long been recognized as contributing to the ongoing degradation of the sagebrush-steppe ecosystem of southwestern Idaho. However, we have only recently received independent evaluations of the direct relationship between the more significant threats and indicators of population viability specifically for *Lepidium papilliferum*. New evidence suggests that there is a significant negative association between cover of nonnative plant species and wildfire and the abundance of *L. papilliferum*, such that the species appears to be in decline across its range, with adverse impacts continuing and likely increasing into the foreseeable future. Each of the threat factors contributing to the present or threatened destruction, modification, or curtailment of *L. papilliferum*'s habitat or range is assessed in detail below.

Modified Wildfire Regime

Fire was historically infrequent in the desert shrublands of the Great Basin, as

the native plant communities of the native annuals and bunchgrasses did not provide sufficient fine fuels to carry large scale wildfires. The bare spaces between widely spaced shrubs and relatively low fuel loads in such ecosystems as the sagebrush-steppe generally prevented fires from spreading very far, and any fires that did burn were usually restricted to relatively small, isolated patches (Brookes and Pyke 2001, p. 5; Whisenant 1990, pp. 4, 6). Natural fire return intervals in sagebrush-steppe prior to the arrival of European settlers are estimated to have ranged from 60 to 110 years; the estimate for the more xeric *Artemisia tridentata* ssp. *wyomingensis* sagebrush community inhabited by *Lepidium papilliferum* is estimated to have been as long as 100 years (Wright and Bailey 1982, p. 158) and possibly up to 240 years (Baker 2006, p. 181). Beginning in the early 1900s, however, the widespread invasion of nonnative plant species, particularly annual grasses such as *Bromus tectorum* and *Taeniatherum caput-medusae*, has created a bed of continuous fine fuels across the southwest Idaho landscape. The continuous fine fuels provided by these nonnative annual grasses result in more frequent fires due to greater horizontal fuel continuity, increased fuel surface-to-volume ratio, and various properties that facilitate wildfire ignition, such as lower moisture content and thus increased flammability (Whisenant 1990, p. 6; Pellant 1996, p. 3 and references therein; Brooks *et al.* 2004a, p. 679). Nonnative annual grasses also provide for more continuous and uniform fires, burning across extensive areas of the landscape. Native bunchgrasses provide a patchy, discontinuous fuelbed such that fires are not easily carried and tend to burn only in small patches. The continuous fires carried by nonnative annual grasses such as *B. tectorum*, on the other hand, leave few or no patches of unburned vegetation, which can inhibit the post-fire recovery of native sagebrush-steppe vegetation by eliminating seed sources for regrowth of the native species (Whisenant 1990, p. 4; Pyke 2007). *Bromus tectorum*, in particular, apparently alters the soil environment such that it creates a positive feedback loop, enhancing the environment for its own growth and generating conditions conducive to further invasion (Pyke 2007). As *B. tectorum* has become more dominant in the sagebrush-steppe habitat of the Snake River Plain over the past several decades, wildfire frequency intervals have become shortened from the historical average of 60 to 110 years to the current frequency intervals of 5 years or less (Wright and Bailey 1982, p. 158; Billings 1990, pp. 307-308; Whisenant 1990, p. 4; USGS 1999; West and Young 2000, p. 262; Launchbaugh *et al.* 2008, p. 3; Zouhar *et al.* 2008, pp. 40-41).

The dramatic increase in the frequency of wildfires has a particularly negative effect on the native plant community in this region that has historically experienced fire relatively infrequently, and thus is dominated by plants that are not adapted to short fire-return intervals. Many of the native species of the sagebrush-steppe ecosystem are killed outright by wildfires and do not have adaptations such as underground rhizomes for post-fire vegetative regrowth, but must reproduce by seed. As a result, under a regime of increasingly frequent fire, perennial plants tend to be lost from the landscape (Whisenant 1990, p. 9). Sagebrush (*Artemisia* spp.), for example, are easily killed by fire (Baker 2006, p. 178 and references therein; Cooper *et al.* 2007, p. 8; USDA Forest Service Fire Effects Information System 2009). Because they are not adapted to frequent fires, sagebrush does not resprout after burning, as many fire tolerant species do (Young and Evans 1978, pp. 283, 287; Brooks and Pyke 2001, pp. 6-7; USDA Forest Service Fire Effects Information System 2009), but must rely upon seed sources for reestablishment. Natural revegetation requires a nearby remnant seed source, as from an unburned patch of sagebrush, which now rarely occurs because of the more continuous and extensive fires that occur if a *B. tectorum* understory is present (USDA Forest Service Fire Effects Information System 2009). In addition, when fires occur as frequently as every 3 to 5 years, even if seedlings should begin to grow there is not sufficient time for sagebrush to regenerate prior to the next fire cycle. Thus, sagebrush is eliminated from the plant community, which in turn allows for conversion to annual grassland (Whisenant 1990, p. 9; Pyke 2007; USDA Forest Service Fire Effects Information System 2009). The short fire-return intervals now experienced in this region prevent the sagebrush-steppe community from recovering and attaining late seral stage condition, thus eliminating high quality habitat for *L. papilliferum*.

The dramatic increase in frequency and extent of wildfires has contributed to the conversion of vast areas of sagebrush-steppe into invasive annual grasslands (USGS 1999). Since post-fire conditions are favorable for further invasion and establishment of nonnative annual grasses, invasive grasses soon dominate the community, leading to the establishment of an invasive grass-increased fire frequency cycle (Whisenant 1990, p. 4; Brooks and Pyke 2001, p. 5; D'Antonio and Vitousek 1992, pp. 73, 75; Brooks *et al.* 2004a, p. 678). Invasive grasses promote recurrent fires, which in turn convert high diversity native shrublands to low diversity alien grasslands; these grasslands then burn more frequently and expansively across the landscape, creating disturbance conditions that promote the further expansion of the invasive grasses, and so on. This invasive grass-fire cycle has been recognized in Great Basin shrub ecosystems since the 1930s (Brooks and Pyke 2001, p. 5, and references therein). As an example, at the Snake River Birds of Prey National Conservation Area in the Snake River Plain area of southern Idaho, nearly half of the native sagebrush-steppe habitat (a total of 494,211 ac (200,000 ha)) converted to nonnative annual grasslands in less than 10 years by a series of 200 fires (Smith and Collopy 1998, as cited in Brooks and Pyke 2001, p. 7).

The rate of conversion from sagebrush-steppe to annual grasslands continues to accelerate in the Snake River Plain of southwest Idaho (Whisenant 1990, p. 4). As the coverage of *Bromus tectorum* continues to increase in the region, it is reasonable to expect that the extent and frequency of wildfires will likewise continue to increase, given the demonstrated positive feedback cycle between these factors (Whisenant 1990, p. 4; Brooks and Pyke 2001, p. 5; D'Antonio and Vitousek 1992, pp. 73, 75; Brooks *et al.* 2004a, p. 678). Climate change models also project a likely increase in fire frequency within the semiarid Great Basin region inhabited by *Lepidium papilliferum* (see *Climate Change* under Factor E, below).

Wildfire therefore contributes to the continuing invasion and establishment of nonnative annual grasslands within the range of *Lepidium papilliferum*, which in turn further increases the likelihood of more frequent and intense wildfires across the range of the species (Brooks *et al.* 2004a, pp. 677-687). But wildfire's role in promoting the invasion of annual grasses goes beyond its circular positive impact on the fire cycle, as nonnative annual grasses and other nonnative plant species that are likely to invade following fire have numerous other negative effects on *L. papilliferum*, slickspots, and the surrounding sagebrush-steppe ecosystem as well, as described below under *Invasive Nonnative Plant Species.*

Wildfire also damages biological soil crusts, which are important to the sagebrush-steppe ecosystem and slickspots where *Lepidium papilliferum* occur, because the soil crusts stabilize and protect soil surfaces from wind and water erosion, retain soil moisture, discourage annual weed growth, and fix atmospheric nitrogen (Eldridge and Greene 1994 as cited in Belnap *et al.* 2001, p. 4; Johnston 1997, pp. 8-10; Brooks and Pyke 2001, p. 4). Fires can cause severe damage to soil crusts, altering their ecological function and creating an opportunity for invasion by weedy annual plant species (Johnston 1997, p. 10; Brooks and Pyke 2001, p. 4, and references therein). In a statistical analysis of HII and HIP data between 1998 and 2004, burned areas had less soil crust cover and higher nonnative plant cover (Menke and Kaye 2006b, p. 3). In general, *L. papilliferum* abundance is greatest in areas that also have the greatest cover of soil crust (Boise Foothills and Snake River Plain), although the populations in the Owyhee Plateau contrasted in showing a slightly negative (but not statistically significant) relationship with soil crust cover (Sullivan and Nations 2009, p. 135). Fire in the presence of shrubs, particularly sagebrush, tends to be greater in intensity, which decreases the potential for soil crust recovery (Johnston 1997, p. 11); therefore, recovery of these crusts after a fire is less likely in the sagebrush-steppe habitat where *L. papilliferum* occurs. Given the generally positive association between soil crust cover and *L. papilliferum*, the compromised integrity of the microbiotic crust in response to fire likely has a negative impact on *L. papilliferum* as well.

More frequent wildfires also promote soil erosion and consequent sedimentation, as perennial grasses that normally limit erosion are eliminated in arid environments such as the sagebrush-steppe ecosystem (Bunting *et al.* 2003, p. 82). Increased sedimentation can result in a silt layer that is too thick for optimal *Lepidium papilliferum* germination (Meyer and Allen 2005, pp. 6-7). Wind erosion following wildfire can also remove the top silt layer of slickspots, exposing the clay vesicular layer below, as observed at HIP transect 721 following the 2007 Murphy Complex Fire (U.S. BLM 2007, p. 23). However, effects of the loss of the upper slickspot silt layer on *L. papilliferum* are not known.

The threats of wildfire and nonnative invasive species working in concert are considered the predominant factor affecting *Lepidium papilliferum*, particularly its habitat quality. In a statistical analysis of HII data over 5 years between 1998 and 2001, areas that had burned earlier in the study and were left with depleted shrub and soil crust did not recover (Menke and Kaye 2006a, p. iii). Burned areas had less native plant cover, greater nonnative plant cover, increased slickspot perimeter compromise (the slickspot boundaries lose definition), and increased organic debris accumulation (Menke and Kaye 2006a, p. iii). As mentioned above, analysis of additional HII and HIP data from 1998 through 2004 showed that burned areas had less soil crust cover and greater nonnative plant cover (Menke and Kaye 2006b, p. 3). Past wildfires thus appear to have had a lasting negative impact on the plant community surrounding slickspots, including increased nonnative species cover and decreased soil crust cover (Menke and Kaye 2006b, p. 19). Although we recognized wildfire as one of the primary threats affecting the matrix habitat of *L. papilliferum* in our 2007 finding, at that time we did not have any data that directly tied wildfire with a negative impact on the species itself, as would be demonstrated, for example, by a corresponding decline in *L. papilliferum* abundance (72 FR 1622, 1635; January 12, 2007).

As discussed above, several researchers have noted signs of increased habitat degradation for *Lepidium papilliferum*, most notably in terms of exotic species cover and wildfire frequency (e.g., Moseley 1994, p. 23; Menke and Kaye 2006b, p. 19; Colket 2008, pp. 33-34), but only recently have analyses demonstrated a statistically significant negative relationship between the degradation of habitat quality, both within slickspot microsites and in the surrounding sagebrush-steppe matrix, and the abundance of *L. papilliferum*. Sullivan and Nations (2009, pp. 114-118, 137) found a consistent, statistically significant negative correlation between wildfire and the abundance of *L. papilliferum* across its range. Their analysis of 5 years of HIP monitoring data indicated that *L. papilliferum* ''abundance was lower within those slickspot (sic) that had previously burned'' (Sullivan and Nations 2009, p. 137), and the relationship between *L. papilliferum* abundance and fire is reported as ''relatively large and statistically significant,'' regardless of the age of the fire or the number of past fires (Sullivan and Nations 2009, p. 118). The nature of this relationship was not affected by the number of fires that may have occurred in the past; whether only one fire had occurred or several, the association with decreased abundance of *L. papilliferum* was similar (Sullivan and Nations 2009, p. 118).

The evidence also points to an increase in the geographic extent of wildfire within the range of *Lepidium papilliferum*. Since the 1980s, 59 percent of the total *L. papilliferum* management area acreage rangewide has burned, more than double the acreage burned in the preceding three decades (from the 1950s through 1970s). Based on available information, approximately 11 percent of the total management area burned in the 1950s; 1 percent in the 1960s; 15 percent in the 1970s; 26 percent in the 1980s; 34 percent in the 1990s; and as of 2007, 11 percent in the 2000s (data based on GIS fire data provided by BLM Boise and Twin Falls District; I. Ross 2008, pers. comm. and A. Webb 2008, pers. comm., as cited in Colket 2008, p. 33). Based on the negative relationship observed between fire, *L. papilliferum*, and habitat quality as described above, we conclude that this increase in area burned translates into an increase in the number of *L. papilliferum* populations subjected to the negative impacts of wildfire.

An evaluation of *Lepidium papilliferum* EOs for which habitat information has been documented (79 of 80 EOs) demonstrates that most have experienced the effects of fire. Fifty-five of 79 EOs have been at least partially burned (14 of 16 EOs on the Boise Foothills, 30 of 42 EOs on the Snake River Plain and 11 of 21 EOs on the Owyhee Plateau), and 75 EOs have adjacent landscapes that have at least partially burned (16 of 16 EOs on the Boise Foothills, 39 of 42 EOs on the Snake River Plain, and 20 of 21 EOs on the Owyhee Plateau) (Cole 2009b, Threats Table).

In 2008, 38 of the 80 HIP transects were unburned, 6 were predominantly unburned, 5 approximately half burned and half unburned, 13 were predominantly burned, and 18 were completely burned. Sixty-six HIP transects had been at least partially burned to within 1,500 ft (500 m) (Colket 2009, p. 26). In 2007, the Inside Desert Fire on the Owyhee Plateau burned 2,695 ac (1,041 ha) within Management Area 11, and the Elk Mountain Fire burned 11,868 ac (4,083 ha) within Management Area 11; both fires were part of the 652,016 ac (263,862 ha) Murphy Complex Fire in the Owyhee Plateau region (Colket 2009, p. 65). In 2008, the first year of HIP monitoring following the fire was completed in the four transects (Transects 701, 711, 719, and 721) that burned in the Murphy Complex Fire

(Colket 2009, p. 24). All 10 slickspots at HIP transect 701 had been previously burned before being burned again in 2007. At HIP transect 711, only 1 slickspot had been previously burned, but 9 of its 10 slickspots were burned in the Murphy Complex Fire. HIP transects 719 and 721 were completely unburned high quality big sagebrush habitat before the Murphy Complex Fire burned all 10 slickspots at both HIP transects (Colket 2009, p. 24).

A 2009 geospatial data analysis evaluating the total *Lepidium papilliferum* EO area affected by wildfire from 1957 to 2007 found that 107 wildfires have occurred, the fire perimeters of which included approximately 11,442 ac (4,509 ha), or 73 percent of the total EO area (Stoner 2009, p. 48).

Table 3 shows the evidence of wildfires documented through HIP rangewide transect monitoring in 2008 and includes both recent and historical fires. Wildfire evidence can remain on the landscape for up to 20 years.

TABLE 3. EVIDENCE OF WILDFIRE DOCUMENTED AT HIP TRANSECTS IN 2008 (COLKET 2009, TABLE 5, PP. 50-62).

Physiogeographic Region	Number of HIP transects at least partially burned	Number of HIP transects not burned	Total HIP transects	Adjacent landscapes within 0.31 miles (500 meters) of HIP transects either burned or partially burned
Boise Foothills	7	3	10	10
Snake River Plain	21	26	47	38
Owyhee Plateau	14	9	23	19
TOTAL	**42 (52.5 percent)**	**38 (47.5 percent)**	**80 (100 percent)**	**67 (84 percent)**

The effects of fire disturbance and habitat degradation are evident in some of the earliest photographs of HII and HIP transects, which show habitats lacking shrubs and dominated by *Bromus tectorum*. However, photographs from the early 1990s of transects that had not burned prior to being established were comprised primarily of native *Artemisia tridentata* with a nonnative *B. tectorum* or *Ceratocephala testiculata* understory. As of 2008, 14 of 80 total HIP transects had changed from a higher to a lower habitat quality classification since 2004, or had been partially or completely burned (Colket 2009, pp. 8-9). The photographs demonstrate that many of the transects that burned are now devoid of *A. tridentata* and are instead dominated by *B. tectorum* (Colket 2009, pp. 63-64).

At present, ongoing control efforts may slow the incidence of wildfire in some areas, but are not capable of preventing wildfires across the range of *Lepidium papilliferum*. For example, four established HIP transects on the Owyhee Plateau burned in 2007 in the Inside Desert and Murphy Complex fires, even though wildfire control measures were in place and implemented (Colket 2009, p. 24). In the Snake River Plain region, portions of two EOs (EO 32, EO 26) were burned in 2006 by the Ten York Fire and Cold Fire respectively. No EOs or portions of known EOs are documented to have burned in the Snake River Plain and Boise Foothills regions in 2007 (U.S. BLM 2008a, p. 21). On the OTA, the IDARNG has demonstrated intensive management efforts implemented to suppress wildfire and using wildfire-rehabilitation activities with minimal ground disturbance have been effective in reducing the threat of wildfire and the rate of spread of nonnative invasive species (for additional information, see *Wildfire Management and Post-Wildfire Rehabilitation* section below). However, such intensive management is currently concentrated within *L. papilliferum* EOs and is possible only within a limited range of *L. papilliferum*. This may explain why the highest quality habitat remaining is on the OTA, where the greatest infrastructure is in place to manage and control wildfires.

Summary of Modified Wildfire Regime

The observed increases in frequency and geographic extent of wildfires, the negative consequences for *L. papilliferum* and its habitat associated with the invasion of nonnative grasses and wildfire, the strong positive feedback loop between wildfire and conversion of sagebrush-steppe to annual grasslands, and the lack of effective rangewide control mechanisms all contribute to the current modified wildfire regime being the greatest ongoing threat to *L. papilliferum*'s existence. In addition, the best available data indicates that fire frequency is likely to increase in the foreseeable future due to increases in cover of *B. tectorum* and the projected effects of climate change (see *Invasive Nonnative Plant Species*, below, and also *Climate Change* under Factor E, below). Ongoing habitat loss and degradation is a result of the current wildfire regime, which is interrelated with several other negative factors, including: Increased nonnative species cover, especially annual grasses; increased sedimentation and organic debris accumulation in slickspots, which could alter slickspot function and hinder germination of *L. papilliferum*; the loss of native matrix vegetation, particularly shrubs; decreased native plant species diversity; decreased cover of microbiotic crusts; and habitat fragmentation due to isolation of habitat patches following fire.

Given the observed negative association between the abundance of *Lepidium papilliferum* and the increased frequency of fire, as well as the demonstrated negative impacts of frequent fire on the components that normally provide high quality habitat for *L. papilliferum*, such as late seral stage sagebrush and high microbiotic crust cover, we consider the current wildfire regime to pose a significant threat to *L. papilliferum*. Recurrent fire promotes the continued invasion of nonnative annual grasses and other invasive nonnative plants, along with all of their associated negative effects (see *Invasive Nonnative Plant Species* below). Based on the observed increases in the cover of *Bromus tectorum* throughout the range of the species, the lack of effective control mechanisms, and projections under most climate change models, we expect the degree of this threat will continue and likely increase within the foreseeable future. The significant threat posed by the current modified wildfire regime is pervasive throughout the range of the species.

Invasive Nonnative Plant Species

Invasive nonnative plants have become established in *Lepidium papilliferum* habitats by spreading through natural dispersal (unseeded) or have been intentionally planted as part of revegetation projects (seeded). Invasive nonnative plants can alter multiple attributes of ecosystems, including geomorphology, wildfire regime, hydrology, microclimate, nutrient cycling, and productivity (Dukes and Mooney 2003, pp. 1-35). They can also negatively affect native plants through competitive exclusion, niche displacement, hybridization, and competition for pollinators; examples are widespread among native taxa and ecosystems (D'Antonio and Vitousek 1992, pp. 63-87; Olson 1999, p. 5; Mooney and Cleland 2001, p. 1). Geospatial analyses indicate that approximately 20 percent of the total area of all *L. papilliferum* EOs rangewide is dominated by introduced invasive annual and perennial plant species (Stoner 2009, p. 81), and monitoring of HIP transects rangewide indicates that nonnative plant cover is continuing to increase at a relatively rapid pace (Colket 2008, pp. 1, 3). Although, historically, disturbance of native communities tended to pave the way for invasion by nonnative plants, today nonnative annual plants such as *Bromus tectorum* are so widespread that they have been documented spreading into areas not impacted by disturbance (Piemeisel 1951, p. 71; Tisdale *et al.* 1965, pp. 349-351; Stohlgren *et al.* 1999, p. 45). The known impacts of nonnative plants on *L. papilliferum* are discussed in this section.

One of the characteristics of slickspots is that they are largely devoid of native shrubs, grasses, and forbs, with the exception of *Lepidium papilliferum*; this is one of the features that make slickspots relatively easy to detect on the landscape (Moseley 1994, pp. 8, 14; Fisher *et al.* 1996, pp. 3-4, 11; Colket 2008, p. 1). *Lepidium papilliferum* has adapted to the unique edaphic and hydrological (soil and water) properties of the slickspot microsites that it inhabits, and has thus evolved with little competition from other native plants (Moseley 1994, p. 14). Weedy, nonnative plants have begun to invade these slickspots, however, including *Agropyron cristatum, Bromus tectorum*, *Lepidium perfoliatum, Ceratocephala testiculata*, and, in some areas, *Bassia prostrata* (Colket 2009, p. 3; Fisher *et al.* 1996, p. 4; Sullivan and Nations 2009, p. 99).

In our January 12, 2007, finding (72 FR 1622), we recognized invasive nonnative plants as one of the primary factors degrading the quality of *L. papilliferum*'s habitat, but at the time we had no evidence demonstrating any negative association between the presence of nonnative plant species and either the abundance of *L. papilliferum* itself or the proportion of *L. papilliferum* in flower. For example, Menke and Kaye (2006b, p. 15) originally reported no correlation between the abundance of *L. papilliferum* and weedy species cover, either within slickspots or in the surrounding matrix vegetation. However, more recent analyses of the additional years of data now available have revealed a significant negative association between the presence of weedy species and the abundance or density of *L. papilliferum*, to the point that *L. papilliferum* may be excluded from slickspots (Sullivan and Nations 2009, pp. 109-112). Although the specific mechanisms are not well understood, some of these plants, such as *A. cristatum* and *B. tectorum*, are strong competitors in this arid environment for such limited resources as moisture, which tends to be concentrated in slickspots (Pyke and Archer 1991, p. 4; Moseley 1994, p. 8; Lesica and DeLuca 1998, p. 4), at least in the subsurface soils (Fisher *et al.* 1996, pp. 13-16). The available information, detailed below, indicates that nonnative plants in both slickspots and the surrounding matrix vegetation are negatively affecting *L. papilliferum*. Furthermore, we now have additional evidence that areas occupied by *L. papilliferum* formerly dominated by native vegetation are experiencing relatively rapid increases in cover of nonnative plant species; for example, Colket (2008, pp. 1, 3) reports that 22 of the 80 HIP transects (28 percent) have shown increases in nonnative plant species cover of 5 percent or more over the last 4 to 5 years. Here we discuss the effects of nonnative plant species on *L. papilliferum* and its habitat, detailing the evidence related to unseeded and seeded nonnative plants separately.

Unseeded Nonnative Invasive Plants

The most common unseeded nonnative annual grasses known to occur in *Lepidium papilliferum*'s habitat include *Bromus tectorum* and *Taeniatherum caput-medusae*. Annual nonnative forbs now commonly associated with slickspots include *Lepidium perfoliatum, Salsola kali* (tumbleweed, also known as Russian thistle), *Sisymbrium altissimum* (tumble mustard, also known as tall tumble mustard), and *Ceratocephala testiculata* (Colket 2009, pp. 8-9).

As discussed under *Modified Wildfire Regime* above, *Bromus tectorum* in particular has become dominant in many sagebrush-steppe habitat areas during the last century due to livestock grazing, agriculture, and wildfire impacts (Pickford 1932, p. 165; Piemeisel 1951, p. 71; Peters and Bunting 1994, p. 34; Vail 1994, pp. 3-4; Brooks and Pyke 2001, pp. 4-6). Vast areas of sagebrush shrublands have been converted to *B. tectorum* in the past century (about 31,000 mi^2 (80,000 km^2) in the Great Basin alone) (Menakis *et al.* 2003, p. 284). Low-elevation sites, which are relatively dry and experience wide variation in soil moisture, appear to be more vulnerable to *B. tectorum* invasion than higher elevation sites with more stable soil moisture. *Bromus tectorum* plants tend to be larger and more fecund in a post-wildfire environment than on unburned sites, potentially leading to subsequent increases in density on burned sites under favorable climatic conditions (Zouhar 2003a, as summarized in Zouhar *et al.* 2008, p. 154). The invasion of nonnative plant species, particularly annual grasses, has had a greater effect on the lower elevation sagebrush shrublands in the Snake River Plain of Idaho that historically experienced less frequent fire than higher elevation sites in the region; the higher elevation sites have higher precipitation and historically had more fine grasses and more frequent wildfires (Gruell 1985, pp. 103-104; Peters and Bunting 1994, p. 33). These lower elevation sagebrush shrublands include the range of *Lepidium papilliferum*. As detailed under *Modified Wildfire Regime*, above, the *B. tectorum*–fire cycle modifies and degrades the native sagebrush-steppe ecosystems on which *L. papilliferum* depends, and recurrent fire prevents the system from achieving the late seral stage condition that characterizes high-quality habitat for the species.

In addition to perpetuating the cycle of increased wildfire within the range of *Lepidium papilliferum*, nonnative plants such as *Bromus tectorum* and *Taeniatherum caput-medusae* can have additional negative impacts on *L. papilliferum* through competition, displacement, and altering the ecological function of slickspots. Invasive grasses can replace native plants such as *L. papilliferum* by outcompeting them for resources, such as soil nutrients or moisture (Brooks and Pyke 2001, p. 6, and references therein). *Bromus tectorum* in particular appears to displace native plants by prolific seed production, early germination, and superior competitive abilities for the

extraction of water and nutrients (Pellant 1996, pp. 3-4; Pyke 2007). In addition, *B. tectorum* is capable of modifying the ecosystems by altering the soil temperatures and soil water distribution (Pellant 1996, p. 4). Evidence that *B. tectorum* is likely displacing *L. papilliferum* is provided by Sullivan and Nations' (2009, p. 135) statistical analyses of *L. papilliferum* abundance and nonnative invasive plant species cover within slickspots. Working with 5 years of HIP data collected from 2004 through 2008, Sullivan and Nations found that the presence of other plants in slickspots, particularly invasive exotics such as *Bassia prostrata* and *Bromus tectorum*, was associated with the almost complete exclusion of *L. papilliferum* from those microsites (Sullivan and Nations 2009, pp. 111-112). Of all the factors considered in their analysis, only the amount of *B. tectorum* in the plant community around slickspots showed a consistent relationship with the abundance of *L. papilliferum* across all three physiographic regions comprising the range of the species, and in all cases this relationship was significantly negative (Sullivan and Nations 2009, pp. 131, 136-137).

In addition to the roughly 3.3 million ac (1.3 million ha) of public lands in the Great Basin already dominated by *Bromus tectorum* (translating to about 5,156 mi^2 or 13,354 km^2), Pellant (1996, p. 1, and references therein) identifies another 76.1 million ac (30.8 million ha, or 119,000 mi^2 (308,210 km^2)) either infested with this nonnative grass or susceptible to invasion by the species, and suggests that the spread of *B. tectorum* could increase in the future due to its adaptability, including the presence of multiple genotypes.

The dominance of *Bromus tectorum* in an area may also be positively related to the density of Owyhee harvester ants (*Pogonomyrmex salinus*), which represent an emerging threat to *Lepidium papilliferum*. The replacement of sagebrush by annual grasses, such as *B. tectorum*, apparently creates conditions favorable to nesting of the native harvester ant, leading to expanded range and density of this potentially important seed predator of *L. papilliferum*. The invasion of *B. tectorum* and other nonnative annual grasses may thus exacerbate the threat posed by seed predation (see Factor C, Disease or Predation, below, for details).

Bradley and Mustard (2006, p. 1146) found that the best indicator for predicting future invasions of *Bromus tectorum* was the proximity to current populations of the grass. Colket (2009, pp. 37-49) reports that 52 of 80 HIP transects (65 percent) had *B. tectorum* cover of 0.5 percent or greater within slickspots in at least 1 year between 2004 and 2008; nearly 95 percent of slickspots had some *B. tectorum* present. If current proximity to *B. tectorum* is an indicator of the likelihood of future invasion by that nonnative species, then *Lepidium papilliferum* is highly vulnerable to future invasion by *B. tectorum* throughout its range. If the invasion of *B. tectorum* continues at the rate witnessed over the last century, an area far in excess of the total range occupied by *L. papilliferum* could be converted to nonnative annual grasslands within the foreseeable future. First introduced around 1889 (Mack 1981, p. 152), *B. tectorum* cover in the Great Basin is now estimated at approximately 30,888 mi^2 (80,000 km^2) (Menakis *et al.* 2003, p. 284), translating into an historical invasion rate of approximately 257 mi^2 (666 km^2) a year over 120 years. If the spread of *B. tectorum* continues at even half of that rate, an area equal in size to the 2,250 mi^2 (5,800 km^2) range of *L. papilliferum* would be invaded by *B. tectorum* in less than 20 years. In addition, climate change models for the Great Basin region also predict climatic conditions that will favor the growth and further spread of *B. tectorum* (see Factor E, *Climate Change*, below).

There is increasing evidence that nonnative plants are invading formerly sparsely vegetated slickspots (Moseley 1994, p. 14), and the presence of these nonnative plants within slickspots is negatively associated with the abundance of *Lepidium papilliferum* (Sullivan and Nations 2009, pp. 109-113). Although Menke and Kaye (2006b, p. 15) found no significant correlation between weedy species cover and either abundance of *L. papilliferum* or proportion of *L. papilliferum* in flower based on a single year of observations (2004), Sullivan and Nations' (2009, p. 135) statistical analyses of plant abundance and nonnative invasive plant species cover within slickspots (based on 5 years of HIP data from 2004 through 2008) indicated that *L. papilliferum* abundance decreased with increased *Bromus tectorum* cover in the Boise Foothills and the Snake River Plain at statistically significant levels. There was no relationship evident on the Owyhee Plateau; however, the authors note that there is little *B. tectorum* in the slickspots in that region. Therefore, the nature of any relationship in that region would be difficult to detect (Sullivan and Nations 2009, p. 135). Although *B. tectorum* is not yet invading slickspots to a great extent in the Owyhee Plateau region, its increasing presence across the landscape is indicative of degraded *L. papilliferum* habitat (Sullivan and Nations 2009, pp. 136-137). Similarly, survey sites on the Owyhee Plateau from 2000 through 2002 with ''abundant'' weeds (referred to as unseeded nonnative plants) had 26 percent fewer total *L. papilliferum* plants when compared to the least-weedy sites, and more rosettes than flowering plants, indicating proportionally fewer flowering *L. papilliferum* plants (Popovich 2009, p. 26).

Another nonnative annual grass, *Taeniatherum caput-medusae*, overlaps in both distribution and habitat requirements with *Bromus tectorum*. Introduced in the late 1880s, the subsequent rapid spread of *T. caput-medusae*, has caused serious management concerns in the Great Basin because of its vigorous competitive nature and ability to transform native shrub and perennial grass ecosystems to annual grass monocultures, much like *B. tectorum* (USDA Forest Service Fire Effects Information System 2009).. *Taeniatherum caput-medusae* cover increases and rapidly spreads under frequent fires at the expense of native species, and may even replace *B. tectorum* (Hironaka 1994, pp. 89-90; Brooks and Pyke 2001, p. 5; USDA Forest Service Fire Effects Information System 2009). *Taeniatherum caput-medusae* is unpalatable to livestock and has low forage value. When dry, the dead *T. caput-medusae* vegetation decomposes slowly and forms a persistent dense litter on the soil surface. Similar to *B. tectorum*, accumulated *T. caput-medusae* litter enables stand-replacement fires to occur in ecosystems that are not adapted to frequent fire (Brooks and Pyke 2001, p. 5; Norton *et al.* 2007, pp. 2-3; Hironaka 1994, pp. 89-90). Wildfires in *T. caput-medusae*-infested areas usually minimally damage soil surfaces and soil erosion is limited, but enough *T. caput-medusae* seeds typically survive to produce thin, vigorous stands of *T. caput-medusae* plants the following year. Within a few years, stand densities approach pre-fire levels, perpetuating the modified wildfire regime (Hironaka 1994, pp. 89-90; Brooks and Pyke 2001, p. 5; Norton *et al.* 2007, pp. 2-3; Chambers 2008, p. 53). As with *B. tectorum, T. caput-medusae* continues to expand its range in association with increased fire frequency (USDA Forest Service Fire Effects Information System 2009).

Other nonnative invasive species in sagebrush-steppe habitats have the ability to displace native plant species, such as *Lepidium papilliferum*. For example, *Chondrilla juncea* (rush skeletonweed) is an unseeded, nonnative, invasive, perennial plant found in some HIP transect slickspots (Colket 2009, p. 8). In 2008, *C. juncea* was observed during native plant surveys in the Boise Foothills to be widespread and occurring in small, low-density stands (Cole 2008, p. 13). Ongoing recreation-related soil disturbance from pedestrians and cyclists will likely encourage *C. juncea* invasion into *L. papilliferum* sites (Cole 2008, p. 13). *Chondrilla juncea* moves into new areas primarily through wind-transported seed dispersal and root fragment transport, but persists and expands primarily through bud formation on root systems of established plants (Kinter *et al.* 2007, p. 393; USFS 2009). Disturbance to aboveground *C. juncea* plants stimulates formation of root buds, making this invasive plant difficult to control, and potentially allowing this nonnative invasive plant to displace *L. papilliferum*.

Examining the presence of *Bassia prostrata, Bromus tectorum, Agropyron cristatum*, total seeded nonnative plants, total unseeded nonnative plants, and biological crust cover, Sullivan and Nations (2009, p. 109) concluded that ''near mutual exclusivity of these plants (excepting biological crust) and slickspot peppergrass is a dominant pattern.'' Although, historically, few species other than *L. papilliferum* were found in slickspots, nonnative plant species now appear to be displacing *L. papilliferum* from its specialized slickspot microsite habitats. The results from 2008 HIP monitoring revealed that all 80 HIP transects (10 transects on the Boise Foothills, 48 transects on the Snake River Plain and 22 transects on the Owyhee Plateau) monitored within 54 EOs had some nonnative, unseeded plant cover (Colket 2009, Table 4, pp. 37-49). Within some transects, the amount of nonnative plant cover within slickspots was high. For example, within the Boise Foothills, 1 of 10 HIP transects had 85 percent nonnative plant cover and 1 of 10 transects had nonnative plant cover between 25 and 50 percent of the transect. On the Snake River Plain, 2 of 48 transects had nonnative plant cover between 25 and 50 percent of the transect. Unseeded nonnative invasive plant cover was lowest in the Owyhee Plateau, where none of the 22 HIP transects had unseeded nonnative invasive plant cover greater than 10 percent (Colket 2009, Table 4, pp. 37-49). At this point, a minority of transects has a high degree of nonnative plant cover. The evidence indicates, however, that the degree of nonnative plant cover is increasing, and can do so at a relatively rapid rate (because Colket (2008, pp. 1-3) reported increases in nonnative plant species cover of 5 percent or more over the span of 4 to 5 years in 28 percent of the HIP transects formerly dominated by native plant species).

Existing conservation measures designed to reduce the potential adverse effects of nonnative, unseeded species are addressed in three conservation documents (CCA, U.S. Air Force Integrated Natural Resource Management Plan (INRMP), and IDARNG INRMP) that apply to approximately 98 percent of *Lepidium papilliferum*'s occupied range. The CCA includes conservation measures designed to protect remnant blocks of native vegetation, prioritize weed control measures at *L. papilliferum* EOs, develop and implement protective weed control techniques, describe revegetation requirements for disturbed areas, educate the public on nonnative species and their spread, use vehicle wash points and stations, and support research and funding for nonnative species control (State of Idaho *et al.* 2006, pp. 131-132). The military also has a number of ongoing efforts to suppress nonnative species on U.S. Air Force and IDARNG managed lands. All military vehicles entering the IDARNG's OTA from areas more than 50 mi (80.4 km) away are washed at a high-pressure wash-rack facility to prevent weed seed introduction. Small patches of noxious weeds are hand-pulled when they are found by IDARNG staff, and other larger noxious weed sites on the OTA are reported annually to BLM for treatment (IDARNG 2004, p. 67). The U.S. Air Force tries to reduce the impacts of exotic annual species by reseeding disturbed areas with native vegetation to the maximum extent practicable, eradicating noxious weeds prior to their spreading, and requiring the cleaning of U.S. Air Force vehicles and equipment on a wash rack upon return to the base. The U.S. Air Force avoids the use of pesticides within 25 ft (8 m) of slickspots and uses pesticides only if wind conditions are favorable (directed away from the slickspot) to prevent the loss of *L. papilliferum* (U.S. Air Force 2004, pp. R-4, R-5). While these efforts are beneficial, their effectiveness is limited by the challenge of controlling or eliminating invasive nonnative plants from all the sagebrush-steppe ecosystems where *L. papilliferum* occurs, due to the sheer magnitude of the problem, logistical and budgetary limitations, and the still-evolving methodology for restoring these ecosystems to their natural condition (Bunting *et al.* 2003, p. 82; Pyke 2007).

Seeded Nonnative Invasive Plants

Rangeland revegetation projects on public lands in southwest Idaho have included providing forage for livestock, controlling erosion, preventing wildfires, reducing nonnative annual grass density, and rehabilitating watersheds. To meet these revegetation objectives, land managers often plant nonnative species, which can outcompete native species and result in decreased biodiversity (summarized by Harrison *et al.* 1996; Beyers 2004, p. 953). For example, *Agropyron cristatum,* a forage species that was once commonly planted in revegetation projects within the range of *Lepidium papilliferum*, is a strong competitor, and its seedlings are better than some native species at acquiring moisture at low temperatures (Pyke and Archer 1991, p. 4; Lesica and DeLuca 1998, p. 1; Bunting *et al.* 2003, p. 82). We now know that when *A. cristatum* is present in a slickspot, *L. papilliferum* tends to be few in numbers or absent altogether (Sullivan and Nations 2009, p. 109), indicating that *A. cristatum* is likely displacing *L. papilliferum*. *Thinopyrum intermedium* (intermediate wheatgrass, formerly *Agropyron intermedium*) has also been seeded in some southern Idaho rangeland areas, including the Owyhee Plateau region, where it is found in *L. papilliferum* sites on U.S. Air Force (CH2MHill 2008a, p. 5) and BLM lands (ERO Resources Corporation 2008, p. 10; Colket 2009, pp. 37-49). One long-term research study (73 years) conducted in Utah, Idaho, and Nevada found that once established, *T. intermedium* and *Bromus inermis* (smooth brome) dominate a site and suppress not only other herbaceous species, but also *Artemisia* spp. and *Purshia tridentata* (bitterbrush) recruitment (Monson 2002, p. 2). Natural recruitment of native species on the U.S. Air Force's Juniper Butte Range in the Owyhee Plateau region is impeded by establishment of *T. intermedium* (CH2MHill 2008a, p. 17). The introduction of these nonnative plants and consequent displacement of the native species that comprise late seral stage sagebrush habitat contributes to the ongoing degradation and loss of quality habitat for *Lepidium papilliferum*.

In addition to contributing to the degraded condition of *Lepidium papilliferum* habitat in general, the best

available data suggest that there may be a negative relationship between seeded nonnative plant species and the abundance of *L. papilliferum*. Statistical analyses of habitat type and *L. papilliferum* abundance from surveys conducted from 2000 through 2002 in the Owyhee Plateau region indicated that the number of *L. papilliferum* plants per site was three times higher in native sagebrush-steppe habitat areas or burned areas that had not been seeded compared to areas seeded with *Agropyron cristatum* (Popovich 2009, p. 25). Similarly, the density of *L. papilliferum* plants was nearly twice as high in a site dominated by native grasses than in a site that had been seeded with *A. cristatum* on the Owyhee Plateau (Young 2007, p. 28). Rangewide, there was no statistical relationship between *A. cristatum* cover and *L. papilliferum* abundance based on 2004 through 2008 HIP data (Sullivan and Nations 2009, p. 136). Although the data regarding *A. cristatum* in the surrounding plant community thus appear to be somewhat equivocal, the evidence suggests that *A. cristatum* successfully competes with and ultimately displaces *L. papilliferum* once it invades occupied slickspots (Sullivan and Nations 2009, p. 109).

Bassia prostrata is another nonnative species that has been used for rangeland habitat restoration. Abundant numbers of *B. prostrata* plants have been observed (greater than 1,000 plants) in relatively small slickspots, and *B. prostrata* is documented as a direct competitor with *Lepidium papilliferum* in slickspots (DeBolt 2002; Quinney 2005). An evaluation study of the Poen Fire rehabilitation project located in the Snake River Plain region documented the loss of *L. papilliferum* along five monitoring transects, coupled with a dramatic increase in *B. prostrata* over a 6–year period following aerial seeding after the fire (DeBolt 2002). Observations of four slickspots supporting both *L. papilliferum* plants and *B. prostrata* plants in 2000 were void of *L. papilliferum* and dominated by *B. prostrata* in 2005 (Quinney 2005). Sullivan and Nations (2009, pp. 110-112) also found that *L. papilliferum* was absent from slickspots when *B. prostrata* was present; this relationship was particularly strong on the Snake River Plain, which comprises more than 80 percent of the EO area for *L. papilliferum*. These observations all indicate that *B. prostrata* is a strong competitor with *L. papilliferum* in slickspots and is capable of excluding *L. papilliferum* from slickspots within a short period of time.

Although *Bassia prostrata* has not been observed at the HIP transects on the OTA (ICDC 2007b, p. 1), it has been documented on five HIP monitoring transects in the Snake River Plain region at least once between 2004 and 2008. While the majority of these transects have less than 1 percent cover of *B. prostrata,* one transect (19B) is documented as having up to 38.5 percent cover of *B. prostrata* within slickspots (Colket 2009, Table 4, p. 39). In 2006, five new observations of *B. prostrata* occurring within slickspots were documented at four HIP transects in the Snake River Plain region and one HIP transect in the Boise Foothills region, in addition to the three HIP transects located on the Snake River Plain region, where it was previously observed. Four of these five *B. prostrata* observations were in permanently marked slickspots on HIP transects. As *B. prostrata* had not been detected in the general occurrence area or along the vegetation transect before it appeared in the slickspots, this indicates that *B. prostrata* can invade formerly unoccupied slickspots quickly.

Expansion of seeded *B. prostrata* into unseeded areas could be detrimental to *Lepidium papilliferum* and its habitat, due to its rapid growth within slickspots and ability to replace *L. papilliferum* within slickspots (ICDC 2007a, p. 29; see also discussion above). In addition, between 2004 and 2008, *B. prostrata* was documented in the general area around six HIP transects (but not within the slickspots themselves, as above); five of these six observations were first detected in 2008 (Colket 2009, Table 4, pp. 38-46), indicating that this invasive species is quickly moving into areas where it has not been observed before and that currently support *L. papilliferum*. *Bassia prostrata* is also documented to occur in slickspots in areas that had not been seeded with this invasive forb species after the Poen Fire (DeBolt 2002), indicating the species is spreading on its own.

The 2008 HIP monitoring results revealed that, of the 80 HIP transects monitored within 54 EOs, 18 transects had some level of nonnative, seeded plant cover (Colket 2009, Table 4, pp. 37-49). For example, seeded nonnative invasive plant cover was highest on the Owyhee Plateau region, where 4 of 22 transects had nonnative, seeded species cover between 5 and 10 percent and 11 of 22 transects had nonnative, seeded plant cover below 1 percent (Colket 2009, Table 4, pp. 46-49). Nonnative, seeded plant cover is minimal in the remainder of the range of *Lepidium papilliferum*, with the Boise Foothills region only having 3 of 10 HIP transects with nonnative, seeded plant cover in 2008, and the Snake River Plain region having only 4 of 48 transects with nonnative, seeded plant cover in 2008. In general, the documented percentage of nonnative plant cover in the 2008 HIP transect monitoring is attributable to *Agropyron cristatum*, except for one site in the Snake River Plain region that contains 14.1 percent cover in *Bassia prostrata*, down from 38.5 percent cover in 2007 (Colket 2009, p. 39). Approximately 80 percent (9,163 ac (3,708 ha)) of the Juniper Butte Range is dominated by nonnative perennial plant communities as a result of past wildfire rehabilitation efforts (U.S. Air Force 1998, pp. 3-120 to 3-121).

Increases in cover of invasive, nonnative, seeded grass species may also be problematic for *Lepidium papilliferum.* After HIP transect 715 was fenced in 2005, *Agropyron cristatum* cover increased so much that the slickspots were barely visible in 2008 (Colket 2009, p. 23). The number of *L. papilliferum* individuals at HIP transect 715 ranged from 224 to 273 in 2004 and was 286 in 2005, but these numbers dropped to 16, 17, and 10 plants in 2006, 2007, and 2008, respectively. It is unclear whether this decrease in the number of *L. papilliferum* plants is related to the increase in *A. cristatum* cover and associated litter cover in the slickspots (Colket 2009, p. 23).

Although nonnative seed was formerly used extensively for revegetation projects, currently the trend is toward increased use of native seed. Management practices involving the use of nonnative seed vary among the land management agencies. As specified in a Conservation Agreement between the BLM and the Service (U.S. BLM and FWS 2006, p. 17), *Bassia prostrata* is not recommended for rehabilitation projects within the range of *Lepidium papilliferum*, although it may be used as a last resort species for stabilization projects adjacent to *L. papilliferum* habitat. BLM emphasizes the use of native plants, including forbs, in seed mixes and avoids the use of invasive nonnative species when possible (State of Idaho *et al.* 2006, p. 26). In January 2004, the BLM issued an Instruction Memorandum directing employees to comply with CCA requirements for emergency stabilization and wildfire rehabilitation activities (State of Idaho *et al.* 2006, p. 71). Use of native species in extensive wildfire rehabilitation projects varies based on native seed availability and site conditions that may affect seeding success rates. For example, the 2007 Murphy Complex Fire burned a portion of areas occupied by *L. papilliferum* in

the Owyhee Plateau region. Seed mixtures for emergency stabilization and restoration efforts used both native and non-invasive nonnative species; however, BLM did not use any *Agropyron cristatum, B. prostrata*, or *Thinopyrum intermedium* seed in the Murphy Complex Fire restoration effort (U.S. BLM 2008a, p. 1). In contrast, 120 ac (48.6 ha) that burned in the 2005 North Ham Fire, located within Management Area 10 in the Snake River Plain region, was drill-seeded with a nonnative, perennial grass-seed mixture comprised of 50 percent *A. cristatum* and 50 percent *Psathyrostachys juncea* (Russian wildrye) (U.S. BLM 2008a, p. 16). Drill and aerial seedings implemented in 2006 and 2007 in response to the Cold Fire (also in Management Area 10) included both native and nonnative seed mixtures. In some cases, BLM determined post-wildfire seedings using nonnative species were preferable due to their ability to compete successfully with the high density of *Bromus tectorum* present in some *L. papilliferum* MAs (U.S. BLM 2008a, p. 24).

Although the use of native plant species for post-wildfire rehabilitation projects is preferable, there have been ongoing problems with the availability and high cost of native seed (Jirik 1999, p. 110; Brooks and Pyke 2001, p. 9; Zouhar *et al*. 2008, p. 265). In recent years, BLM has been investing more resources in securing native seed and stock reserves through the Great Basin Native Plant Selection and Increase Project and the Great Basin Restoration Initiative. Consequently, more native seed and plant sources are available for ongoing and future restoration efforts for sagebrush-steppe habitat, but more progress is needed to ensure the availability and affordability of native seed for restoration efforts.

The U.S. Air Force and the IDARNG have ongoing efforts to address invasive, nonnative, seeded plants on their managed lands. The U.S. Air Force uses both native and nonnative, non-invasive plant materials and does not use *Bassia prostrata, Thinopyrum intermedium*, or salt-tolerant species such as *Atriplex canescens* (four-wing saltbush) in their restoration and revegetation efforts, with native plants used to the maximum extent practicable and in concert with the military mission for rehabilitation efforts on its lands on the Owyhee Plateau (U.S. Air Force 2004, p. R-4). The IDARNG INRMP for the OTA on the Snake River Plain includes objectives for maintaining and improving *Lepidium papilliferum* habitat and restoring areas damaged by wildfire. The plan specifies that the IDARNG will use native species and broadcast seeding, collecting, and planting small amounts of native seed not commercially available and will monitor the success of seeding efforts (IDARNG 2004, p. 72-73). Since 1991, the IDARNG, using historical records, has restored several areas using native seed and vegetation that was present prior to past wildfires. The IDARNG continues to use restoration methods that avoid or minimize impacts to *L. papilliferum* or its habitat, with an emphasis on maintaining species present in presettlement times (IDARNG 2004, p. 73).

Summary of Invasive Nonnative Plant Species

Invasive nonnative plant species pose a serious and significant threat to *Lepidium papilliferum*, especially when the synergistic effects of nonnative, annual grasses and wildfire are considered. Invasive, nonnative, unseeded species that pose threats to *L. papilliferum* include the annual grasses *Bromus tectorum* and *Taeniatherum caput-medusae* that are rapidly forming monocultures across the southwestern Idaho landscape. Nonnative plant species contribute to increased fire frequency, alter ecological function, outcompete and displace native plant species, and degrade the quality and composition of sagebrush-steppe habitat for *L. papilliferum*. The presence of *B. tectorum* in the surrounding plant community shows a consistently significant negative relationship with the abundance of *L. papilliferum* across all physiographic regions (Sullivan and Nations 2009, pp. 131, 137), and a significant negative relationship with *L. papilliferum* abundance within slickspots in the Snake River Plain and Boise Foothills regions (Sullivan and Nations 2009, p. 112). These results contrast with the information that was available to us at the time of our 2007 finding, which did not indicate any statistically significant relationship between invasive nonnative plants and the abundance of *L. papilliferum*, either in slickspots or in the surrounding plant community (72 FR 1622, p. 1635; January 12, 2007). Additionally, we have increasing evidence that nonnative plants are invading the slickspot microsite habitats of *L. papilliferum* (Colket 2009, Table 4, pp. 37-49) and successfully outcompeting and displacing the species (Grime 1977, p. 1185; DeBolt 2002, in litt; Quinney 2005, in litt; Sullivan and Nations 2009, p. 109). Monitoring of HIP transects shows that *L. papilliferum*-occupied sites that were formerly dominated by native vegetation are showing relatively rapid increases in the cover of nonnative plant species (Colket 2008, p. 1, 33). Regarding *B. tectorum* in particular, vast areas of the Great Basin are already dominated by this nonnative annual grass, and projections are that far greater areas are susceptible to future invasion by this species (Pellant 1996, p. 1). In addition, most climate change models project conditions conducive to the further spread of nonnative grasses such as *B. tectorum* in the Great Basin desert area occupied by *L. papilliferum* in the decades to come (see *Climate Change* under Factor E, below).

Given the observed negative association between the abundance of *Lepidium papilliferum* and invasive nonnative plants both within slickspot microsites and in the surrounding plant community, the demonstrated ability of some nonnative plants to displace *L. papilliferum* from slickspots, and the recognized contribution of nonnative plants such as *Bromus tectorum* to the increased fire frequency that additionally poses a primary threat to the species, we consider invasive nonnative plants to pose a significant threat to *L. papilliferum*. Nonnative grasses such as *B. tectorum* may additionally play a role in increased seed predation that poses a threat to *L. papilliferum* by providing habitat for the expansion of native harvester ant colonies (see Factor C, Disease or Predation, below). Currently, there are no feasible means of controlling the spread of *B. tectorum* or the subsequent increases in wildfire frequency and extent once *B. tectorum* is established on a large scale (Pellant 1996, pp. 13-14; Menakis *et al*. 2003, p. 287; Pyke 2007). The eradication of other invasive nonnative plants poses similar management challenges, and future land management decisions will determine the degree to which seeded nonnative plants may affect *L. papilliferum*. Based on the lack of effective control mechanisms, the demonstrated increases in nonnative plant cover in the range of the species, and the likely increases in cover of *B. tectorum* and other nonnative plant species predicted based on their successful invasive characteristics and models of climate change, we expect the degree of the threat from invasive nonnative plant species to continue and likely increase within the foreseeable future. We consider invasive nonnative plants, in conjunction with the modified wildfire regime, to pose the greatest threat to the viability of *L. papilliferum*. The significant threat posed by invasive nonnative plants is pervasive throughout the range of *L. papilliferum*.

Development

Development, as defined for HIP monitoring purposes, includes buildings, roads, water tanks, utility lines, railroad tracks, and fences (Colket 2009, Appendix A, HIP Protocol, p. 12). Agricultural development is recorded under a separate category. Residential, commercial, and agricultural development prior to 1955 has been reported as the cause for five documented and four probable extirpations of *Lepidium papilliferum* (Colket *et al.* 2006, p. 4). All forms of development can affect *L. papilliferum* and slickspot habitat, whether directly or indirectly, through habitat conversion (resulting in direct loss of individuals and permanent loss of habitat), or through habitat degradation and fragmentation as a result of consequent increased nonnative plant invasions, increased ORV use, increased wildfire, and changes to insect populations (ILPG 1999, pp. 1-3; Robertson and White 2007, pp. 7, 13).

The most direct impact of development is the outright loss of *Lepidium papilliferum* populations due to habitat conversion, such as when habitat occupied by *L. papilliferum* is converted to a residential development or an agricultural field, resulting in the permanent loss of the plant population and the habitat. As mentioned above, development has been documented as the cause of several population extirpations of *L. papilliferum* in the past, and at present, there are 10 approved or proposed development projects located in the Boise Foothills and Snake River Plain regions, all within the LEPA Consideration Zone (an area that contains *Lepidium papilliferum* identified within the CCA) (State of Idaho 2008). These activities include four approved, planned residential communities in Ada County totaling 4,062 ac (1,644 ha), and six other development projects submitted for approval to Ada County totaling 9,831 ac (3,978 ha). This area is in the Boise Foothills, which, although it represents a relatively small geographic extent of *L. papilliferum*'s range, supports the most dense and regionally abundant populations of the species (Sullivan and Nations 2009, p. 103). Several other planned communities on an additional 44,500 ac (18,008 ha) are proposed, but have not yet been submitted for County or other planning agency approval. In addition, large-scale planned communities have been proposed for the southern portion of the Snake River Plain region in Elmore County. These numbers reflect only planned communities which, by definition, are 640 ac (259 ha) or larger and do not include smaller developments, such as subdivisions (State of Idaho 2008). Developments of this nature likely lead to the extirpation of populations through permanent habitat conversion; they may also indirectly impact *L. papilliferum*, as described below. While it is unlikely that all of these planned communities will move forward in the near future due to the current economic climate, the scale of potential future residential and commercial development may impact several of the remaining *L. papilliferum* populations across the range of the species (State of Idaho 2008).

Indirect effects to *Lepidium papilliferum* are a likely consequence of the linear infrastructure associated with urban and residential development. In 2006, utility lines and accompanying roads were documented running through at least four EOs, natural gas pipelines were documented running through two EOs, and existing roads bisect at least six EOs (Colket *et al.* 2006, Appendix C). Additional infrastructure associated with the planned development projects described above is expected.

In addition to direct habitat destruction and associated loss of individual *L. papilliferum* plants, utility corridors and roads may allow increased ORV access, resulting in potential destruction or degradation of slickspots and possible direct mortality of individuals of *L. papilliferum*. They may also increase the chance of nonnative plant invasions (most notably *Bromus tectorum*, as described above), human-ignited wildfires, and contribute to habitat fragmentation and its associated consequences. The effects of these threats are summarized here, and additional details are provided under *Invasive Nonnative Plant Species* and *Current Wildfire Regime*, above, and Factor E, Habitat Fragmentation, below.

Transportation and utility corridors associated with urban and residential development can increase the spread of nonnative invasive plants. Roads appear to create avenues for invasion by *Bromus tectorum*, for example, because there is generally a positive significant association between nonnative, disturbance-tolerant species such as *B. tectorum* and proximity to roads (Forman and Alexander 1998, p. 210; Gelbard and Belnap 2003, pp. 424-425, 430-431; Bradley and Mustard 2006, p. 1142). Bradley and Mustard (2006, p. 1146) found an even stronger association between the presence of *B. tectorum* and power-line corridors, and they suggest that the stronger relationship between *B. tectorum* and recent disturbance (that is, power lines; roads were considered an historical disturbance) suggests that future placement of either roads or power lines would very likely result in invasion by *B. tectorum*.

Increased urban and residential development also increases the probability of human-ignited wildfires, presumably by increasing the area of the urban-wildland interface (e.g., Keeley *et al.* 1999, p. 1829; Romero-Calcerrada *et al.* 2008, pp. 341, 351; Syphard *et al.* 2008, pp. 610-611). Increases in human habitation and activity in the rangelands of southern Idaho have contributed to the increase in wildfire starts in recent years. For example, in the Jarbidge Field Office area of the BLM (Owyhee Plateau region), where 21 of 80 total EOs are found, 43 percent of the wildfires occurring since 1987 were human-caused (Launchbaugh *et al.* 2008, p. 3). Proximity to urban areas and roads can be an important causal factor associated with wildfire ignitions (Kalabokidis *et al.* 2002, p. 6; Brooks *et al.* 2004b, p. 3; Romero-Calcerrada *et al.* 2008, p. 351; Syphard *et al.* 2008, pp. 610-611).

Many of the ongoing and planned developments will require the construction of power, gas, and other transmission lines, as well as new road construction, which will impact and fragment *Lepidium papilliferum* habitats. In addition, several interstate-utility activities within the range of *L. papilliferum* have been proposed, including a new electric transmission line between Boardman, Oregon, and Murphy, Idaho (Boardman Hemingway project); a new transmission line between Casper, Wyoming, and Murphy, Idaho (Gateway West project); and a natural gas pipeline proposed, but currently on hold, that would run from Opal, Wyoming, through southern Idaho and end in Stanfield, Oregon (Sunstone Pipeline project) (State of Idaho 2008). The proposed route of the Gateway West Transmission Line project currently bisects habitat occupied by *L. papilliferum*.

Insect populations may also be affected by development, potentially impacting the primary vector of pollination and genetic exchange for *Lepidium papilliferum*. Insect densities have been documented as being lower in developed areas than in native habitats (Gibbs and Stanton 2001, p. 82; McIntyre and Hostetler 2001, p. 215; Zanette *et al.* 2005, p. 117; Clark *et al.* 2007, p. 333). Changes in native habitat caused by ongoing development or conversion of lands to agriculture may impact insect pollinator populations by removing specific food sources or habitats required for breeding or nesting

(Kearns and Inouye 1997, p. 298; McIntyre and Hostetler 2001, p. 215; Zanette *et al.* 2005, pp. 117-118). Habitat isolation and fragmentation resulting from development may also impact *L. papilliferum* by decreasing pollination from distant sources, possibly resulting in decreased reproductive potential (e.g., lower seed set) and reduced genetic diversity (see *Habitat Fragmentation and Isolation of Small Populations*, under Factor E, below). Reductions in pollinators due to development could thus potentially impact *L. papilliferum* reproductive success as well as contribute to reduced genetic variability, as the plant is dependent on insect pollination for successful reproduction and the transfer of genetic material between populations.

Ongoing and planned residential and urban development currently threaten the long-term viability of *Lepidium papilliferum* occurrences on private land, primarily in the Snake River Plain and Boise Foothills regions (Moseley 1994, p. 20; State of Idaho 2008; Stoner 2009, pp. 13-14, 19-20). All or portions of 12 *L. papilliferum* EOs covering 224 ac (90.7 ha) (1.0 percent of the total area of all EOs - not including EOs managed by cities or counties) occur on private land subject to development. Two of these 12 EOs are smaller than 1 ac (0.4 ha) and are classified as having fair to poor habitat quality (INHP data as of January 14, 2009); therefore, these EOs are particularly vulnerable to extirpation through development. Surveys conducted in 2008 documented that 21 of 80 HIP transects rangewide are located within 213 ft (65 m) of development, and 66 of 80 HIP transects were within 1,640 ft (500 m) of development. Proximity to development carries increased risk of mechanical disturbances (such as from ORV use), increased risk of wildfire ignition and invasion by nonnative plant species, as discussed above, and possibly decreases in the diversity or abundance of pollinators as well as vulnerabilities associated with fragmentation and isolation of small populations, as discussed under Factor E, below.

Summary of Development

Although the threat of development is relatively limited in scope, the impact of development on *Lepidium papilliferum* can be severe, potentially resulting in the direct loss of individuals, and perhaps more importantly, the permanent loss of its slickspot microsite habitats. The destruction of slickspots is of concern due to the finite nature of this limited resource. As described in the Background section, *L. papilliferum* occurs primarily in these specialized slickspot microsites. Slickspots and their unique edaphic and hydrological characteristics are products of the Pleistocene, and they likely cannot be recreated on the landscape once lost. The potential loss of slickspots, particularly those slickspots that are occupied by the species and thus clearly have the ability to provide the requisite conditions to support *L. papilliferum*, is therefore of great concern in terms of providing for the long-term viability of the species. In addition, since not all slickspots have above-ground plants in all years (see **Background** section, above), even the loss of currently unoccupied slickspots may represent the permanent loss of a finite specialized microhabitat that has the potential to support the species. Development additionally has the potential for more indirect impacts to the species, by contributing to increased habitat fragmentation, nonnative plant invasion, human-caused ignition of wildfires, and potential reductions in the population of insect pollinators.

Based on the best available information, past development has eliminated some historical *Lepidium papilliferum* EOs, and planned and proposed future developments threaten several occupied sites in the Snake River Plain and Boise Foothills regions. Most of the recent development has primarily occurred on the Snake River Plain and Boise Foothills regions, which collectively comprise approximately 83 percent of the extent of EOs; development has not been identified as an issue on the Owyhee Plateau (Stoner 2009, pp. 13-14, 19-20). We are aware of 10 approved or proposed development projects planned for these regions (State of Idaho 2008, pp. 3-5), which would affect 13 out of 80 EOs (16 percent of EOs). Though these developments are not certain to occur, they represent the likely location and magnitude of development over the foreseeable future. Development of sagebrush-steppe habitat is of particular concern in the Boise Foothills region, which, although relatively limited in its geographic extent, supports the highest abundance of *L. papilliferum* plants per HIP transect (Sullivan and Nations 2009, pp. 3, 103, 134).

We consider development to be a significant threat within the Boise Foothills and Snake River Plain portions of the range of *Lepidium papilliferum*, as the outcome of this threat is severe where it occurs and likely results in the permanent loss of populations and irreplaceable slickspot microsite habitats. However, this threat is not so imminent or sweeping in scope as to pose an immediate risk of extirpation to the populations of *L. papilliferum* in these regions, nor do we consider the threat of development to be equal to the magnitude and intensity of the primary threats of the modified wildfire regime and invasive nonnative plants. We consider development to pose a significant but lesser threat to the species.

Livestock Use

Livestock use in areas that contain *Lepidium papilliferum* has the potential to result in both positive and negative effects on the species, depending on factors such as stocking rate and season of use. Herbivory by livestock does not appear to be a problem, as *L. papilliferum* seems to be largely unpalatable to anything but insects (see Factor C, Disease or Predation, below). Livestock herbivory of invasive nonnative plants, especially annual grasses such as *Bromus tectorum*, is suggested as one of the potential benefits of livestock use that may contribute to the restoration of the sagebrush-steppe ecosystem (e.g., Pellant 1996, pp. 6, 10, 13). At the same time, livestock use may have negative effects on *L. papilliferum*. Trampling from livestock may result in direct damage or mortality of individual *L. papilliferum* plants, and the mechanical disturbance damages the slickspot soil layers, altering slickspot function and creating conditions conducive to the invasion of weedy nonnative plants.

Trampling damage to individual *L. papilliferum* plants appears to be relatively isolated, and occasional damage or mortality of individual above-ground plants is probably not of much consequence to the species as a whole, because studies and modeling of *L. papilliferum*'s life cycle indicate that the persistence of the plant is largely dependent on the proliferation of the seed bank (Palazzo *et al.* 2005, pp. 2-4, 8-9; Meyer *et al.* 2006, p. 900). If trampling results in the mortality of individual plants prior to seed set, however, that will have a negative impact on the persistence of the seed bank itself by reducing the number of seeds added.

Livestock trampling can also disrupt the soil layers of slickspots, altering slickspot function (Seronko 2004; Colket 2005, p. 34; Meyer *et al.* 2005, pp. 21-22). Trampling when slickspots are dry can lead to mechanical damage to the slickspot soil crust, potentially resulting in the invasion of nonnative plants and altering the hydrologic function of slickspots. In water-saturated slickspot soils, trampling by livestock can break through the restrictive clay layer; this is referred to as penetrating trampling

(State of Idaho *et al.* 2006, p. 9). Trampling that alters the soil structure and the functionality of slickspots (Rengasamy *et al.* 1984, p. 63; Seronko 2004) likely impacts the suitability of these microsites for *L. papilliferum*. Trampling can also negatively affect the seed bank by pushing seeds too deeply into the soil for subsequent successful germination and emergence. Meyer and Allen (2005, pp. 6-8) found that seed emergence success decreased with increasing depth in the soil, from a mean of 54 percent at the shallowest planting depth of 0.1 in (2 mm) to a mean emergence success of 5 percent at 1.2 in (30 mm) planting depth.

Two documented incidents suggest that trampling has the potential to negatively affect *L. papilliferum,* as penetrating livestock-trampling events at sites occupied by *L. papilliferum* were followed by large reductions in plant abundance in subsequent years, in one case going from thousands of plants annually to fewer than 10 plants recurring each year (Robertson 2003b, p. 8; Meyer *et al.* 2005, p. 22). Trampling has been suggested as the likely cause of the ensuing population reductions in these two incidents, but as these were observational reports, it is not known whether other factors may have also acted on these populations. A third incident occurred in 2005 at a HIP transect monitoring in EO 68, in the New Plymouth Management Area of the Boise Foothills region. In this incident, penetrating livestock trampling was observed in 3 of 10 slickspots on the transect to a depth of 3 in (8 cm), but not to the extent that the livestock penetrating-trampling trigger was tripped (the trampling ''trigger'' refers to a threshold for trampling set in the CCA, and is defined as breaking through the restrictive layer under the silt surface area of a slickspot during saturated conditions; State of Idaho *et al.* 2006, p. 9). Since that time, *L. papilliferum* numbers at this transect were substantially reduced, going from between 631 to 1,277 plants observed in 2004 to a total of 9 plants in 2005 and 3 plants in 2006. Similar reductions in plant abundance were not observed in other HIP transects in the New Plymouth MA, indicating that environmental factors shared by these sites were likely not responsible for the observed declines (Colket 2006, pp. 10-11). In 2007 and 2008, *L. papilliferum* numbers in this transect appeared to be slowly increasing (167 plants in 2007 and 224 plants in 2008), but had not reached the levels observed in 2004 prior to the incident (Colket 2009, p. 31).

Penetrating trampling by livestock may have a potentially detrimental effect on *Lepidium papilliferum*; however, these effects appear to be seasonal (most detrimental when soils are wet in the spring) and localized in nature. While we acknowledge that livestock use may have negative impacts on individual slickspots, statistical analyses of monitoring data available at this time have not demonstrated a significant correlation between livestock use and the abundance of *L. papilliferum* on a rangewide basis. In a statistical analysis of HII data from 1998 to 2001, recent livestock use did not appear to have any effect on *Lepidium papilliferum*, slickspot attributes, and plant community attributes (Menke and Kaye 2006a, p. iii). The evidence from this study is not strong, however, as the analysis of grazing impacts were limited to areas that had already been burned and had likely been previously grazed (Menke and Kaye 2006a, pp. 18-19). These researchers recommended additional analysis to confirm their findings (Menke and Kaye 2006a, p. iii). Later statistical analyses using additional years of rangewide HIP data, based on 4 years (2005 to 2008) and 5 years (2004 to 2008) of livestock use, also showed no significant relationships between *L. papilliferum* abundance and penetrating livestock trampling in slickspots (Salo 2009, p. 1; Sullivan and Nations 2009, p. 122), or between *L. papilliferum* abundance and total livestock-print cover or livestock-feces cover in slickspots (Sullivan and Nations 2009, p. 122). Statistical analyses of *L. papilliferum* data from 3 years of surveys on the Owyhee Plateau (2000-2002) showed that sites with low levels of livestock trampling exhibited greater numbers of *L. papilliferum* plants (averaging twice the total number of plants) than sites with high levels of trampling, although these results were statistically significant for only the year 2000. A significant positive relationship was also found between *L. papilliferum* abundance and distance to water and salt stations for use by livestock, with total plant abundance increasing with increasing distance away from water or salt sources (Popovich 2009, pp. 27-28).

A 2–year study designed to examine the relationship between livestock trampling effects and *Lepidium papilliferum* density did not show a significant change in *L. papilliferum* density as a result of the trampling treatment applied. Year-to-year variations in *L. papilliferum* density observed in this 2–year study were attributed to stochastic environmental factors and not trampling events (Young 2007, p. 19). Further research is needed to determine if higher levels of trampling, greater mean hoof print depths, or more frequent trampling treatments may affect *L. papilliferum* abundance (Young 2007, pp. 19-20). The ability to discern any livestock trampling effects was limited since all study areas were grazed 2 to 4 years prior to initiation of the study.

Livestock trampling events most likely to adversely affect *Lepidium papilliferum* usually occur when large numbers of livestock are concentrated on or around slickspots that are saturated with water (Hoffman 2005; Meyer *et al.* 2005, pp. 21-22). Saturated conditions typically exist for short periods each year and may never occur in some (drought) years (Hoffman 2005). Under the CCA, penetrating trampling is monitored to avoid livestock-related impacts to slickspots containing *L. papilliferum*. Penetrating trampling is defined by the CCA as breaking through the restrictive layer (i.e., the middle layer of slickspot soil that supports *L. papilliferum*, as described by Meyer and Allen 2005, p. 3) under the silt surface area of a slickspot during saturated conditions (State of Idaho *et al.* 2006, p. 9). Predicting when soils will be wet in a climate with few and inconsistent precipitation events is difficult. Supplemental salt and watering sites can alter livestock distribution, and depending on location, can increase or decrease trampling of slickspots. As described below, protective measures provided in several of the existing conservation plans for *L. papilliferum* are designed specifically to prevent or minimize the impacts to the species from livestock trampling, particularly during the seasons when slickspot soils are wet and most susceptible to damage.

There are also indirect effects from livestock use that have impacted the sagebrush-steppe ecosystem. Livestock use has been suggested as a contributing factor to the spread of both native and invasive nonnative plant species (e.g., Young *et al.* 1972, pp. 194-201; Hobbs and Huenneke 1992, p. 329; Frost and Launchbaugh 2003, pp. 43-45; Loeser *et al.* 2007, p. 95). The spread of *Bromus tectorum* across portions of the Snake River Plain has been attributed to several causes, including the past practice of intensive livestock use in the late 1800s (Mack 1981, pp. 145-165).

A small number of case studies from western North America suggest that grazing plays an important role in the decrease of native perennial grasses and an increase in dominance by nonnative annual species; however, invasion by nonnative grasses has been found to occur both with and without grazing in

some areas. Today, nonnative annual plants such as *Bromus tectorum* are so widespread that they have been documented spreading into areas not impacted by disturbance (Piemeisel 1951, p. 71; Tisdale *et al.* 1965, pp. 349-351; Stohlgren *et al.* 1999, p. 45); therefore, the absence of livestock use no longer protects the landscape from invasive nonnative weeds (Frost and Launchbaugh 2003, p. 44), at least with respect to *B. tectorum*.

Analysis of 3 years of HII data, from 1999 through 2001, showed no effect of livestock grazing on slickspot perimeter integrity, weedy species density, perennial forb or grass establishment, or organic debris accumulation in slickspots (Menke and Kaye 2006a, p. 10). Cumulative livestock sign (indicators of livestock presence) had a significant negative correlation with exotic grass dominance around slickspots (Menke and Kaye 2006a, p. 11), and with the frequency of slickspots with dense weedy annuals in 2001 (Menke and Kaye 2006a, p. 10). The analysis of grazing effects was limited since the HII data were observational only (no controlled experiments were performed), all areas were likely grazed at some point in the past, and grazing effects could only be observed in habitats that had burned in the past (Menke and Kaye 2006a, p. 18). In addition, there was no significant difference in cover of exotic plant species in slickspots between grazed and ungrazed areas in the 2004 HIP dataset, although soil crust cover was significantly lower in grazed transects (Menke and Kaye 2006b, p. 19). As described above, biological soil crusts are important to the sagebrush-steppe ecosystem and slickspots where *Lepidium papilliferum* occur as they stabilize and protect soil surfaces from wind and water erosion, retain soil moisture, discourage annual weed growth, and fix atmospheric nitrogen (Eldridge and Greene 1994 as cited in Belnap *et al.* 2001, p. 4). Young (2007, p. 19) did not find a significant change in the density of *Bromus tectorum, Ceratocephala testiculata*, and *Lepidium perfoliatum* following the application of a one-time, annual trampling treatment over a 2–year period. Both studies (Menke and Kaye 2006a,b; Young 2007) represent short-term data sets that likely are not capable of reflecting any potential long-term effects to *L. papilliferum* habitat.

The potential benefit of livestock use in reducing wildfire effects through a reduction of fine fuels has generated discussion in recent years (e.g., Pellant 1996; Loeser *et al.* 2007). The introduction of cattle, sheep, and horses to the Great Basin in the 1860s quickly created large ranching operations and grazing pressure. Heavy livestock grazing removed fine fuels and resulted in a substantial reduction in the number of fires and the acres burned. Only 44 fires, burning a total of 11,000 ac (6,875 ha), were reported from 1880 to 1912 in Great Basin rangelands (Miller and Narayanan 2008, p. 9). The number of livestock in Great Basin and sagebrush ecosystems has dropped rapidly since the passage of the Taylor Grazing Act of 1934 (43 USC 315; *http://www.blm.gov/wy/st/en/field_offices/Casper/range/taylor.1.html*, accessed July 23, 2008, as cited in Launchbaugh *et al.* 2008, p. 2). Livestock numbers in Idaho decreased in the 1950s primarily from loss of large sheep operations. Livestock numbers have fluctuated at, or below, this initial decrease through the remainder of the twentieth century, with a steady conversion from sheep to cattle. In the last decade, a substantial decrease in authorized use of livestock grazing on BLM lands in Idaho has been recorded (Launchbaugh *et al.* 2008, p. 2).

With careful management, livestock grazing may potentially be used as a tool to control *B. tectorum* (Frost and Launchbaugh 2003, p. 43) or, at a minimum, retard the rate of invasion (Loeser *et al.* 2007, p. 95). Although the spread of *B. tectorum* has been strongly linked with high-impact grazing, there is some evidence to indicate that grazing at more moderate levels may potentially inhibit the colonization of *B. tectorum* (e.g., Loeser *et al.* 2007, pp. 94-95); the researchers note, however, that experimental study over a longer time period is needed to verify this tentative conclusion. Others, however, have suggested that given the variability in the timing of *B. tectorum* germination and development, and its ability to spread vegetatively, effective control of *B. tectorum* through livestock grazing may be a challenge (Hempy-Mayer and Pyke, 2008, p. 121). While it is difficult to discern the relative importance of grazing, climate, and wildfire in contributing to nonnative plant abundance (D'Antonio *et al.* 1999, as described in Zouhar *et al.* 2008, pp. 23-24), areas with a history of livestock grazing often support a wide variety of nonnative species, especially in areas where nonnatives have been introduced to increase the forage value of rangelands or pastures (Zouhar *et al.* 2008, pp. 23-24).

Following investigations of the 2007 Murphy Wildland Fire Complex, fire-modeling efforts revealed that grazing in grassland vegetation can reduce the surface rate of spread and fire-line intensity to a greater extent than grazing in shrubland vegetation (Launchbaugh *et al.* 2008, pp. 1-2). Under extreme fire conditions (low fuel moisture, high temperatures, and gusty winds), however, grazing applied at moderate utilization levels has limited or negligible effects on fire behavior. When weather and fuel-moisture conditions are less extreme, grazing may reduce the rate of spread and intensity of fires, allowing for patchy burns with low levels of fuel consumption (Launchbaugh *et al.* 2008, pp. 1-2). Some research also indicates that grazed areas have a reduced likelihood of wildfire ignitions, likely by reducing the availability of fine fuels (Romero-Calcerrada *et al.* 2008, p. 351). Launchbaugh *et al.* 2008 (p. 32) state that ''changes in grazing management aimed at managing fuel loads are not appropriate for homogeneous application across large landscapes and multiple management units. Such application of grazing across entire landscapes at rates necessary to reduce fuel loads and affect fire behavior, especially under extreme conditions, could have negative effects on livestock production and habitat goals.'' Targeted grazing to accomplish fuel objectives holds promise, but requires detailed planning that includes clearly defined goals for fuel modification and appropriate monitoring to assess effectiveness (Launchbaugh *et al.* 2008, p. 32).

Existing conservation plans (CCA, U.S. Air Force INRMP, IDARNG INRMP) contain numerous measures to avoid, mitigate, and monitor the effects of livestock use on *Lepidium papilliferum*. Livestock-grazing conservation measures implemented through the State of Idaho CCA and the U.S. Air Force INRMP apply to all Federal and State-managed lands within the occupied range of *Lepidium papilliferum* (98 percent of the acreage). Conservation measures prescribed by the CCA include minimum distances for placement of salt and water troughs away from occurrences of *L. papilliferum*. Several troughs and salt blocks have been moved as a result of these measures (State of Idaho *et al.* 2005; State of Idaho *et al.* 2006, p. 133). The CCA also includes measures to reduce livestock trampling during wet periods, including trailing (moving cattle to, or between, allotments repeatedly on the same path) restrictions (State of Idaho *et al.* 2006, pp. 132-134). High-priority *L. papilliferum* EOs identified in the CCA tend to have more restrictive conservation measures, such as no early spring grazing, fencing to exclude

livestock, and delaying turnout of livestock onto allotments when soils are saturated (State of Idaho *et al.* 2006, pp. 133-134). Delay of turnout is important following a soil-saturating precipitation event in areas containing *L. papilliferum* since it is difficult to avoid trampling effects on saturated slickspot soils. As part of the CCA, high-priority EOs were designated to emphasize protection and restoration of *L. papilliferum* habitats. Criteria for designating these EOs were based on existing habitat quality, geographic location relative to other existing EOs, minimal land-use activities, the absence or presence of resources to address threats, and the need to preserve enough EOs throughout the species' range to prevent extinction in case of a catastrophic event. To protect these high-priority EOs, BLM has shifted the season of livestock use on some allotments from spring to fall, and implemented a deferred-rotation management system on some allotments to protect annual flowering *L. papilliferum* plants from grazing impacts (State of Idaho *et al.* 2006, pp. 133-134).

Under the Juniper Butte Range INRMP, the U.S. Air Force utilizes livestock grazing as the primary means to minimize wildfire risk by reducing the amount of standing grass biomass (U.S. Air Force 2004, pp. 6-37 to 6-39). Livestock use occurs annually for up to 60 days while the Juniper Butte Range is shut down for clean-up and target maintenance. The military training shutdown period lasts a maximum of 60 days within a 90–day period, from April 1 through June 30 (U.S. Air Force 2000, pp. B-18 to B-21). The INRMP avoids livestock turnout onto the range when slickspots are wet in order to reduce trampling impacts to slickspot habitats, and then uses annual monitoring of slickspot soil moisture to determine appropriate livestock turnout dates for the Juniper Butte Range (U.S. Air Force 2000, pp. B-18 to B-21). Additionally, in 2002 the U.S. Air Force established three fenced enclosure areas of 173 ac (70.0 ha), 8 ac (3.2), and 30 ac (12.1 ha), respectively, to preclude all disturbance activities and promote *Lepidium papilliferum* research and seed collection (Binder *in litt.* 2006) compatible with the Air Force mission.

Summary of Livestock Use

Evidence of the direct and indirect potential impacts to *Lepidium papilliferum* and slickspots from livestock use is relatively limited with the data currently available. We recognize the potential for negative impacts to *L. papilliferum* populations and slickspots that may result from seasonal, localized trampling events. However, with the implementation of conservation measures to minimize potential direct and indirect impacts of livestock to *L. papilliferum*, such as restricting livestock access to areas occupied by *L. papilliferum* when slickspot soils are wet and thus most vulnerable to damage, we consider livestock use to be a lesser threat to the species than the primary threats posed by the altered wildfire regime and associated increase in nonnative, invasive plant species within the range of *L. papilliferum*. We acknowledge that current data may not be adequate to detect time-dependent issues associated with livestock use as only 5 years of HIP data are available (Sullivan and Nations 2009, p. 137), and encourage the continued implementation of conservation measures and associated monitoring to ensure potential impacts of livestock trampling to *L. papilliferum* are avoided or minimized. Under current management conditions, we do not consider livestock use to pose a significant threat to *L. papilliferum*.

Wildfire Management and Post-Wildfire Rehabilitation

Some activities associated with wildfire management, including fuel management projects (e.g., greenstrips, prescribed fire), wildfire suppression activities, and post-wildfire rehabilitation, can potentially impact existing *Lepidium papilliferum* occurrences and damage slickspot habitat by mechanical disturbances or by facilitating the establishment of nonnative plant species (ILPG 1999). At the same time, wildfire management and post-wildfire rehabilitation activities have the potential to benefit *L. papilliferum* by reducing the occurrence and extent of wildfire and by revegetating its habitat with native plant species to prevent the encroachment of invasive nonnative grasses and other nonnative plant species, thus reducing two of the most significant threats to the viability of the species.

The direct effects of wildfire management activities may include injury or mortality of individual plants, and possibly damage to or destruction of the seed bank, through mechanical disturbance or direct exposure to herbicides. Indirect effects associated with mechanical disturbance of slickspot soils include an increased probability of establishment of invasive nonnative plants, burial of the seed bank to a depth where seedlings cannot emerge from the soil, and mixing of slickspot soil layers, which affects slickspot function and the suitability of a microsite for successful support of the species.

Drill seeding is a rangeland rehabilitation technique that is often used to restore vegetation after wildfire using a rangeland drill that plants and covers seed simultaneously in furrows. Drill seeding is designed to give the seeds moisture and temperature advantages to enhance their competitive fitness and, consequently, increase their survival rate (Scholten and Bunting 2001, p. 3). Drill seeding has been used on wildfire rehabilitation projects on BLM lands where *Lepidium papilliferum* occurs. It impacts slickspots through mechanical disturbance and introduces other, often nonnative, plant materials. Historically, slickspots were not understood to have any special ecological value, so no attempt was made to avoid them during rehabilitation activities. Although more recent land management actions have established buffers to protect slickspots and *L. papilliferum* from herbicide use, we have no data on how the physical disturbance from past drill seedings has affected *L. papilliferum* habitats. Although drill seeding may have less severe impacts on slickspot habitat than disking the soil, the success of restoring slickspots and *L. papilliferum* plants using drill seeding varies considerably. The benefits of post-fire revegetation to prevent the establishment of *Bromus tectorum* and subsequent recovery of soil surfaces conducive to germination and establishment of native perennial grass and shrub communities may outweigh the impacts from the initial short-term disturbance associated with drill seeding (Young and Allen 1996, pp. 533-534; Bunting *et al.* 2003, pp. 82-85). For further information on the effects of nonnative species used for rehabilitation and restoration efforts in *L. papilliferum* habitats, see the Seeded Nonnative Invasive Plants section above.

Rangewide, disk or drill seeding has occurred on portions of 3 of 16 EOs in the Boise Foothills region, 10 of 43 EOs in the Snake River Plain region, and 9 of 21 EOs on the Owyhee Plateau region (Cole 2009b, Threats Table). The effect of drill seeding is also monitored as part of the rangewide HIP transects monitoring. In 2008, of the 80 *Lepidium papilliferum* transects monitored, 1 transect in the Boise Foothills region, 1 transect in the Snake River Plain region, and 9 transects in the Owyhee Plateau region had evidence of old drill seedings within slickspots (Colket 2009, pp. 66-67). In a 3–year study on the Owyhee Plateau from 2000 through 2002, Popovich (2009, pp. 8, 11) found that unseeded sites supported three

times as many *L. papilliferum* on average as sites that had been seeded. However, it is unclear whether the reduction in *L. papilliferum* numbers at seeded sites is the result of the physical disturbance of slickspot soils associated with drill seeding, competition from the seeded, nonnative invasive grass planted at these sites (*Agropyron cristatum*), or a combination of the two.

In 2006, rangeland emergency stabilization and rehabilitation activities were implemented on the Snake River Plain region in response to seven fires (8,312 ac (5,190 ha)) that burned in 2005, and one fire that burned in 2006 (161 acres (65 ha)). In 2007, rangeland rehabilitation work was implemented for 10 additional wildfires that burned in 2006. The rehabilitation activities included drill seeding utilizing low-impact, no-till drills, herbicide treatment, and aerial seeding (U.S. BLM 2008a, pp. 4, 8, 13, 16). On the Owyhee Plateau, non-ground-disturbing techniques were used following the Murphy Complex Fire for seeding in areas documented to support *Lepidium papilliferum* (U.S. BLM 2008b, Murphy map).

Ground disturbance associated with wildfire control, such as the establishment of fire lines (areas with vegetation removed to break fuel continuity), fire camps, firefighting staging areas, and the use of wildfire-suppression vehicles, can also impact existing *Lepidium papilliferum* occurrences and damage slickspot habitat (ILPG 1999). For example, in 2007, dual-wheel pickup tracks that appeared to have been associated with wildfire suppression efforts in 2006 were observed in 5 slickspots (HIP transect 032 in Management Area 5) during the 2007 HIP transect monitoring in the Snake River Plain region (ICDC 2008, p. 9).

Firefighting crews and their equipment may also indirectly impact *Lepidium papilliferum* through dispersal of invasive-plant propagules (e.g., seeds or vegetative structures) as they travel from other regions to wildfires in southern Idaho, or travel within the local area of the fire. As fire camps are typically set up in large, flat clearings that have been disturbed in the past, these areas often support populations of invasive plants. Propagules of these plants adhere to fire personnel and their equipment, and may be dispersed elsewhere as crews move about (Zouhar *et al.* 2008, p. 273), potentially contributing to nonnative plant invasions in *L. papilliferum* habitat.

The construction of fuel breaks intended to slow the movement of wildfire can benefit *Lepidium papilliferum* by protecting slickspots from burning. However, the construction of fuel breaks may also negatively impact *L. papilliferum* through ground disturbance or the use of native seeded species. Nonnative species (such as *Agropyron cristatum* and *Bassia prostrata*) are planted in fuel breaks as greenstrips. Greenstrips are expected to slow the spread of wildfire as the plants remain green (retain higher fuel moisture so are less flammable) for longer periods than annual plants such as *Bromus tectorum*. Wildfire control lines have been documented in three EOs, one in the Boise Foothills region and two in the Snake River Plain region, although none have documented wildfire control lines within slickspots (Colket *et al.* 2006, Appendix C; ICDC 2008, p. 9; Cole 2009b, Threats Table). In 2004, the Boise District of BLM developed a strategy to assess the feasibility of creating fuel breaks to protect *L. papilliferum*. A field assessment was conducted of over 84,550 ac (22,075 ha) of *L. papilliferum* habitat to identify potential fuel break routes. Nearly 125 mi (78 km) of potential fuel breaks were identified that would utilize existing roads and trails, in areas that could potentially protect up to 10,436 ac (6, 523 ha) containing *L. papilliferum* habitat within the LEPA Consideration Zone. None of these potential fuel breaks have been constructed as of spring 2008. There was one fuel break established in 2006 and 2007 along Interstate 84 from milepost 71 (Mayfield Exit) to milepost 89 (Mountain Home exit) by the Idaho Department of Transportation, a distance of approximately 30 mi (19 km). This fuel break likely reduced the number of wildfires escaping this stretch of Interstate 84, which is a source of frequent fire ignitions threatening several *L. papilliferum* occupied sites located in the Snake River Plain region (U.S. BLM 2008a, p. 20).

Through the 2006 CCA, BLM has implemented conservation measures designed to avoid or minimize impacts to the species from wildfire prevention, wildfire suppression, and post-wildfire, rangeland-rehabilitation activities (State of Idaho *et al.* 2006, Table 5). Rangeland rehabilitation and restoration standard-operating procedures for areas occupied with *Lepidium papilliferum* were first addressed in an Instruction Memorandum in January 2004 (State of Idaho *et al.* 2005, p. 33). Today, the BLM and fire cooperators distribute maps and inform crew members of the location of *L. papilliferum* to maximize wildfire protection in those areas, and to minimize potential impacts from fire-suppression activities (State of Idaho *et al.* 2006, p. 26). One conservation measure of the CCA instructs the BLM to use seeding techniques that minimize soil disturbance, such as no-till drills and rangeland drills equipped with depth bands. Implementation of these measures for rehabilitation and restoration projects have the potential to minimize the impact to *L. papilliferum* and its slickspot habitats (State of Idaho *et al.* 2006, p. 26). The BLM also avoids spraying herbicides within or near known occupied *L. papilliferum* habitat, and conducts pretreatment surveys on at least 5 percent of previously unsurveyed habitat prior to herbicide or ground disturbing treatments associated with emergency wildfire-rehabilitation activities (State of Idaho *et al.* 2006, p. 27). More recently, site-specific conservation measures to avoid or minimize potential impacts to *L. papilliferum* and its slickspot habitat were incorporated as part of a temporary, livestock-control fencing project in response to the Inside Desert Fire (in the Owyhee Plateau region) emergency stabilization and rehabilitation efforts (U.S. BLM 2008b, p. 3).

The U.S. Air Force and IDARNG also have implemented a number of ongoing efforts to minimize the impacts of wildfire-management activities. For example, the U.S. Air Force, like the BLM, uses drill seeders equipped with depth bands to minimize soil disturbance and avoids slickspots to the maximum extent practicable in drill seeding efforts. The U.S. Air Force uses broadcast seeding to the maximum extent practicable consistent with reseeding goals and uses wildfire indices to restrict activities when the wildfire rating hazard is extreme (U.S. Air Force 2004, pp. R-3, R-4). On the OTA, the IDARNG restores wildfire-damaged areas by broadcast seeding native species. As part of their annual training, the IDARNG provides their fire crews with maps of all known *Lepidium papilliferum* occupied habitat, and actively suppresses all wildfires on the OTA. Blading is not permitted in *L. papilliferum* habitat areas on the OTA, and existing roadways serve as fuel breaks and allow for quick access for wildfire management (IDARNG 2004, p. 73). Since 1987, the IDARNG has demonstrated that efforts to suppress wildfire and the use of native species with minimal ground-disturbing activities can be effective in reducing the wildfire threat, as well as in reducing rates of spread of nonnative

invasive species associated with wildfire management activities (IDARNG 2004, p. 73). In 2008, the IDARNG also initiated maintenance on a series of identified fuel breaks on the OTA. These fuel breaks are designed to act as barriers to prevent fires that might be ignited by military-training activities from spreading into adjacent *L. papilliferum* habitat (U.S. BLM 2008a, p. 20).

Summary of Wildfire Management and Post-Wildfire Rehabilitation

Wildfire management may have both positive consequences (the control of wildfires) and negative consequences (the destruction of slickspots or inadvertent introduction of invasive nonnative plants) for *Lepidium papilliferum* and its habitat, depending on how the activity is implemented. The negative consequences of wildfire management and rehabilitation activities appear to be relatively limited in both scope and severity, however, and we do not consider these negative effects to outweigh the positive effects of successful wildfire control, given that we consider frequent wildfires to be one of the primary threats to the species. On balance, wildfire and post-wildfire rehabilitation activities likely improve the status of the species. We therefore do not consider wildfire management or post-wildfire rehabilitation activities to be a significant threat to *L. papilliferum*.

Military Training

Military activities within the range of *Lepidium papilliferum* include ordnance-impact areas, training activities, and military development. Military-training activities occur at, or near, 4 of 80 extant EOs: 3 at the OTA on the Snake River Plain, and a portion of 1 EO at the Juniper Butte Range on the Owyhee Plateau. INRMPs have been developed and implemented for both the Juniper Butte Range and the OTA. The INRMPs provide management direction and conservation measures to address or eliminate the effects from military-training exercises on *L. papilliferum* and its habitat. Both the IDARNG (Quinney 2008; ICDC 2008, p. 21) and the U.S. Air Force (CH2MHill 2008a, pp. 1, 17) conduct annual monitoring to ensure impacts to the species due to training activities are either avoided or minimized. The IDARNG has implemented conservation measures for 18 years on the OTA, which currently supports nearly 60 percent of the highest-quality habitat rangewide (B-ranked, EO 27). This suggests that the conservation measures are effective in maintaining generally intact native plant vegetation and limiting anthropogenic disturbances on the OTA since it contains much of the best remaining habitat for *L. papilliferum* (Sullivan and Nations 2009, p. 91).

Summary of Military Training

The IDARNG and the U.S. Air Force continue to implement conservation efforts to avoid or reduce adverse effects of military training on *Lepidium papilliferum* and its habitat. Since the areas managed by the IDARNG and the U.S. Air Force continue to support some of the highest-quality habitat remaining for *L. papilliferum*, we consider the measures to minimize the impact of military-training exercises on the species and its habitat to have been effective. The IDARNG and U.S. Air Force are committed to continuing the implementation of these conservation measures into the future, through the CCA and their respective INRMPs. The threat of military training is localized in area, and minimal in significance across the range of the species, therefore we do not consider military training to pose a significant threat to *L. papilliferum*.

Recreation

Recreational activities that may affect *Lepidium papilliferum* include hiking, cycling, horseback riding, and the use of ORVs. These activities would be expected to impact the species primarily through mechanical disturbance (e.g., disruption of the slickspot soil layers, resulting in the reduction or loss of slickspot integrity and function) or crushing of individual plants, potentially resulting in injury or mortality. Areas where military training activities occur, such as the Juniper Butte Range and some areas of the OTA, are restricted from recreational activities because of military use.

ORV use has been documented in 22 of the 80 *Lepidium papilliferum* EOs (8 of 16 on the Boise Foothills, 14 of 42 on the Snake River Plain, and none on the Owyhee Plateau) for which habitat information has been collected (Cole 2009b, pp. 1-2). Effects from recreational activities, such as mechanical disturbance of soils from ORV use, are monitored as part of the rangewide HIP monitoring for *L. papilliferum*. ORV tracks were not detected in any EO or Management Area during 2008 HIP monitoring (Colket 2009, p. 9). In 2007, ORV tracks were detected at 2 of the 80 HIP transects sampled (ICDC 2008, p. 9). Dual-wheel truck tracks were also detected at 2 other transects. An earlier analysis of HII transects monitored between 1998-2001, and HIP transects during 2004-2006 indicated that ORV use was detected at only a few transects each year and that impacts appeared to be minimal.

Cycling and pedestrian trails built nearby and through the middle of occupied slickspots in the Boise Foothills are anticipated to impact individual plants and slickspot hydrology through trampling and spread of invasive nonnative plants in EO 38 near the Ada County Landfill (Cole 2008, p. 14). We have no other information to indicate that hiking or horseback riding have resulted in rangewide adverse impacts to *L. papilliferum*.

Summary of Recreation

Although recreational use has the potential for some negative effects on *Lepidium papilliferum*, the evidence indicates that observed impacts to *Lepidium papilliferum* from hiking, cycling, and ORV use have been minimal, and are infrequent and localized. While there is one EO being impacted by cycling and pedestrian trails, there is no information indicating that other recreational activities are impacting the species throughout its range, or that recreational usage within EOs is expected to increase. Recreation does not appear to be a major factor impacting either *L. papilliferum* or its slickspot habitat, therefore we have determined that recreation represents a minor threat to the species.

Conclusion for Factor A

Rationale

Based on the best scientific data currently available, the primary significant threats to *Lepidium papilliferum* are the effects of the modified wildfire regime and invasive nonnative plants, especially *Bromus tectorum*. These threats are impacting the quality and composition of the sagebrush-steppe ecosystem where *L. papilliferum* occurs, and are degrading the species' unique slickspot microsite habitats. These changes are associated with observed, significant decreases in the abundance of *L. papilliferum*. The observed increase in invasive annual grasses such as *B. tectorum* in the Great Basin, which includes the range of *L. papilliferum*, has resulted in increased frequency and extent of wildfires in *L. papilliferum*'s native-sagebrush systems; fires that once naturally occurred every 100 years now occur on the order of every 5 years or less. The frequent return intervals of wildfire prevent the native sagebrush community from regenerating, and the habitat cannot achieve the late seral stage condition that represents high-quality habitat for *L. papilliferum*. The increased

frequency of wildfires also results in the reduction of native plant diversity and species richness, and invasive nonnative plant cover increases in the wake of fire. Not only is this increase in nonnative plants being observed in the surrounding sagebrush matrix, but nonnative plants are increasingly invading the formerly sparsely vegetated slickspots, resulting in competitive exclusion of *L. papilliferum*. The combination of wildfire and nonnative plants additionally impacts slickspots by damaging the microbiotic crust and increasing sedimentation and organic matter, which hinders germination of *L. papilliferum*. Slickspots possess unique edaphic and hydrological properties, and represent a limited habitat resource on the landscape. As *L. papilliferum* is adapted to the specialized properties of slickspots, the degradation of slickspots to the point that they no longer provide the essential functions that support *L. papilliferum* represents a permanent loss of habitat for the species.

We have new information indicating a statistically significant negative association between the abundance of *Lepidium papilliferum* and wildfire, and a significant negative association between *L. papilliferum* abundance and percent cover of *B. tectorum* in the surrounding plant community; these negative associations are consistent throughout the range of the species. Wildfire occurs throughout the range of *L. papilliferum* and has dramatically increased in both frequency and extent, especially where *B. tectorum* is dominant. Furthermore, as *B. tectorum* and other nonnative annual grasses continue to spread and degrade the sagebrush-steppe ecosystem, we expect continued increases in fire frequency and magnitude, with associated negative impacts on *L. papilliferum*. As disturbances such as wildfire remove sagebrush and encourage the spread of nonnative annual grasses, we anticipate that the Owyhee harvester ant will expand into areas occupied by *L. papilliferum,* resulting in an increase in seed predation on *L. papilliferum*, with potential negative consequences for plant reproduction and the maintenance of the persistent seed bank (see Disease and Predation section below). Future development of the sagebrush-steppe habitat also threatens many of the remaining *L. papilliferum* sites, and is of particular concern in the Boise Foothills region, which supports the highest-density populations of *L. papilliferum*. Slickspots are relic Pleistocene formations and possess unique properties that likely cannot be recreated; slickspots lost to development represent a permanent loss of habitat for *L. papilliferum*.

Given the observed negative association between the abundance of *Lepidium papilliferum* and the increased frequency of fire, as well as the demonstrated negative impacts of frequent, recurrent fire on the components that provide high-quality habitat for *L. papilliferum*, such as late seral stage sagebrush and high microbiotic crust cover, we consider the current wildfire regime to pose a significant and primary threat to *L. papilliferum*. Recurrent fire additionally promotes the continued invasion of nonnative annual grasses and other invasive nonnative plants. Given the observed negative association between the abundance of *L. papilliferum* and invasive nonnative plants both within slickspot microsites and in the surrounding plant community, the demonstrated ability of some nonnative plants to displace *L. papilliferum* from slickspots, the potential for nonnative grasses to facilitate the expansion of Owyhee harvester ants and thus increase seed predation on *L. papilliferum*, and the recognized contribution of nonnative plants such as *B. tectorum* to the increased fire frequency that poses a primary threat to the species, we consider invasive nonnative plants to pose a significant and primary threat to *L. papilliferum* as well. Although conservation measures have been implemented in an attempt to protect *L. papilliferum* and its habitat from these threats, at present the challenge of controlling and preventing the further spread of invasive nonnative plants and wildfire is too great for these measures to effectively reduce the degree of threat to the species across its range. Based on the demonstrated increases in nonnative plant cover in areas occupied by *L. papilliferum*, including slickspot microsites, the observed continuing increases in *B. tectorum*, observed increases in the frequency and extent of wildfires through the range of the species, and the lack of effective control mechanisms, we expect the degree of the threat from wildfire and invasive nonnative plant species to continue and likely increase within the foreseeable future.

Development poses a somewhat lesser threat to the species. Although the impact of development can be severe, in that habitat conversion for residential, commercial, or agricultural development most often results in the permanent loss of slickspot habitat, the areas likely to be developed represent a relatively small portion of the species' range. The area most likely to be developed is, however, the area that supports some of the highest-density populations of *Lepidium papilliferum*. Other planned development projects, such as utility rights of way, can impact *L. papilliferum* by facilitating the increase of invasive nonnative plants and increasing the risk of human-caused wildfires, as well as through habitat fragmentation, isolation of populations, and potential reductions in insect pollinators. We consider development to pose a moderate degree of threat to *Lepidium papilliferum*, particularly for those populations in the Boise Foothills and the Snake River Plain physiographic regions.

We additionally considered whether livestock use, wildfire management and post-wildfire rehabilitation, military training, or recreation pose a threat to *Lepidium papilliferum* through the present or threatened destruction, modification, or curtailment of its habitat or range. In the case of livestock use, the best available data indicate that although livestock have the potential to pose a threat to *L. papilliferum*, at present this threat appears to be seasonal and localized in nature. The continued maintenance of implemented conservation measures to protect *L. papilliferum* from inappropriate livestock use will be important in ameliorating the effects of this threat. We do not consider livestock use to pose a significant threat to the species at this time. The effects associated with wildfire management and post-wildfire rehabilitation, military training, and recreation are all positive or relatively minimal, and we do not consider any of these activities to pose a significant threat to *L. papilliferum*.

Determination for Factor A

We have evaluated the best available scientific information on the present or threatened destruction, modification or curtailment of *Lepidium papilliferum*'s habitat or range, and determined that this factor poses a significant threat to the viability of the species throughout its range, such that we anticipate *L. papilliferum* is likely to become an endangered species within the foreseeable future.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

We have no data indicating that overutilization for commercial, recreational, scientific, or educational purposes is a threat to *Lepidium papilliferum*.

C. Disease or Predation

We have no data indicating that disease poses a threat to *Lepidium*

papilliferum. On the other hand, though insect and mammal herbivory do not appear to pose a threat to *Lepidium papilliferum*, seed predation by the Owyhee harvester ant may become a significant threat to the species.

Insect herbivory of *Lepidium papilliferum* has been evaluated as part of pollinator and reproductive studies the past several years. The most abundant insect herbivore was a chrysomelid beetle, *Phyllotreta* sp., which chews holes in the flower's petals (Leavitt and Robertson 2006, pp. 658-659). *Lepidium papilliferum* flowers suffering damage from *Phyllotreta* (a hole chewed in a single petal) have been documented to set seed at a significantly lower rate than undamaged flowers on the same plant. Overall, herbivory of *L. papilliferum* petals by chrysomelid beetles reduces the effectiveness of insect-mediated pollination, but does not physically inhibit pollination or seed production. The effect of herbivory by chrysomelid beetles appears to be limited in its impact on the species, and we do have not evidence suggesting that it poses a significant threat to *L. papilliferum* at this time.

The Owyhee harvester ant was recently identified as a potentially important seed predator of *Lepidium papilliferum*. A study initiated in 2006 found that following *L. papilliferum*'s flowering season, Owyhee harvester ants remove the mature, seed-bearing fruits and return them to their nests outside of slickspots (Robertson and White 2007, pp. 8-13). The researchers found that harvester ants can remove up to 90 percent of *L. papilliferum* fruits and seeds, either directly from the plant or by scavenging seeds that drop to the ground (Robertson and White 2009, p. 9). Seventy-five percent of slickspots with flowering *L. papilliferum* located within 66 ft (20 m) of a harvester ant nest showed evidence of seed predation; the researchers suggest this is the maximum foraging distance for the Owyhee harvester ant (Robertson and White 2009, p. 10). Slickspots with high densities of flowering *L. papilliferum* were also observed as more likely to show evidence of seed predation than those with low densities (Robertson and White 2007, p. 13). Because harvester ants consume seeds of other plant species as well, most notably *Bromus tectorum, L. papilliferum* seeds are likely an opportunistic food item rather than an essential part of their diet (Robertson and White 2007, p. 12). Owyhee harvester ants have been observed bypassing seeds of *B. tectorum* in favor of *L. papilliferum* seeds (Robertson and White 2009, pers. comm.), but whether the seeds of *L. papilliferum* are preferred or may just be taken based on relatively greater seasonal availability is not yet known (Robertson 2009, pers. comm.).

The Owyhee harvester ant is a species native to Southwest Idaho; therefore, it might be assumed that *Lepidium papilliferum* co-evolved with the ant and has adapted to adjust for the observed levels of seed predation. Evidence suggests, however, that harvester ant colonies were likely not numerous in the intact sagebrush-steppe habitat that has historically surrounded *L. papilliferum* in its slickspot microsites. White and Robertson (2008, p. 3) found that Owyhee harvester ant colonies are uniformly low in number in areas with high sagebrush cover, while densities are highest in the study areas with little sagebrush cover. By contrast, Owyhee harvester ant colonies range from uncommon to very common in areas dominated by annual grasses (Robertson and White 2009, p. 13), which would include *Bromus tectorum*. The study authors suggest that sites dominated by annual grasses but with low harvester ant numbers may represent areas that the ants have yet to colonize, or the habitat is unsuitable for reasons other than vegetation (Robertson and White 2009, p. 13). They further suggest that the observed shift from sagebrush to annual grasses may enable the ants to colonize areas that were historically not suitable for nesting, with potentially negative consequences for *L. papilliferum* (Robertson and White 2009, p. 13).

Since Owyhee harvester ants are more common in disturbed areas with an abundance of *B. tectorum* (White and Robertson 2008, pp. 3-4), this raises a conservation concern for *Lepidium papilliferum.* As landscape disturbances such as wildfire are contributing to the loss or conversion of sagebrush habitats to annual grasslands, and these grasslands are likely to support higher densities of Owyhee harvester ants, these disturbances are likely contributing to an increase in the abundance and distribution of the harvester ants throughout *L. papilliferum*'s geographic range. Furthermore, since these ants have been observed to harvest up to 90 percent of the seeds produced by *L. papilliferum*, increased predation by harvester ants, even at much lower levels than 90 percent, has the potential to significantly depress the reproductive capacity of the plant, as well as diminish the capacity to replenish the species seedbank. However, as this threat was only recently discovered, we have no information indicating what the actual magnitude or severity of this threat might be. In addition, no conservation measures have yet been attempted to ameliorate the threat of seed predation by the Owyhee harvester ant, and the researchers have urged caution in taking such measures until managers have a better understanding of the threat (Robertson and White 2009, p. 14).

The OTA's ''Red Tie'' population of *Lepidium papilliferum* (EO 27) presents an interesting example of the potential threat posed by Owyhee harvester ants, and their apparent preferred association with grasses. Much of the Red Tie site is currently dominated by sagebrush (*Artemisia tridentata* ssp. *tridentata*), with *L. papilliferum*–occupied slickspots scattered throughout the sagebrush matrix. Currently, there is no evidence of contact between *L. papilliferum* and Owyhee harvester ants throughout most of the site where sagebrush dominates. The exception is at the periphery, where the vegetation transitions from sagebrush to a more open, grassland area. It was at this transition of habitat from sagebrush to grasslands where three active harvester ant colonies were found in 2008 (White and Robertson 2008, p. 4). The authors of this study caution that disturbances such as fire that remove sagebrush and promote the invasion of annual grasses may create conditions that promote the expansion of the harvester ants into areas currently occupied by *L. papilliferum*, resulting in increased seed predation throughout the range of the species (White and Robertson 2008, p. 4). Future HIP monitoring will examine proximity and density of Owyhee harvester ant colonies to *L. papilliferum* transects to track this potential new threat (Colket 2009, pers. comm.).

Herbivory impacts to *Lepidium papilliferum* from large, native ungulates, such as elk, deer, and antelope, have not been observed. Statistical analyses of wild ungulate hoofprint cover in slickspots from 2004-2008 HIP monitoring data showed no relationship with *L. papilliferum* abundance (Sullivan and Nations 2009, p. 122). Sullivan and Nations (2009, p. 122) likewise found no association between the cover of livestock hoof prints and *L. papilliferum* abundance. Domestic cattle are not known to feed upon *L. papilliferum*, and domestic sheep have been observed pulling plants from the ground and spitting them out (Quinney and Weaver 1998, pers. comm.). Herbivory by large ungulates, whether wild or domestic, thus does not appear to pose a threat to *L. papilliferum*.

Summary of Disease or Predation

Herbivory by chrysomelid beetles and by large ungulates, whether wild or domestic, does not appear to pose a significant threat to *Lepidium papilliferum*. Herbivory in the form of seed predation by Owyhee harvester ants, which was only recently discovered, appears to pose a potentially significant threat to the species. In one study, ants were observed to be capable of removing up to 90 percent of *L. papilliferum* fruits or seeds from slickspots within 66 ft (20 m) of a nest (Robertson and White 2009, p. 9). As the ants appear to favor the conditions created by the introduction of annual grasses, and the cover of annual grasses is expanding in *L. papilliferum* habitat, the increase in seed predation as a consequence of harvester ants moving into areas adjacent to occupied slickspots has the potential to significantly impact *L. papilliferum* recruitment and the replenishment of the seed bank. While this may be a minor threat at this point in time, given the projected increase in nonnative annual grasslands within the range of *L. papilliferum* and the apparent positive association between Owyhee harvester ants and grasslands, we believe this has the potential to become a significant threat to *L. papilliferum* in the foreseeable future.

Conclusion for Factor C

Rationale

The effect of seed predation by Owyhee harvester ants is an emerging threat potentially affecting the long-term viability of *Lepidium papilliferum*. In areas where Owyhee harvester ants have become established, *L. papilliferum* could be depleted through lack of seedling recruitment. However, at this point in time we do not yet have enough research to determine whether the seed bank is being negatively affected by seed predation from harvester ants. The fact that harvester ant colonies appear to be found in higher numbers in annual grasslands, which are in turn increasing as the result of increased wildfire and the spread of nonnative grasses such as *Bromus tectorum*, suggests that the degree of this potential threat is likely to increase in the future. Our current understanding of how pervasive harvester ant colonies have become within the range of *L. papilliferum*, and their overall significance on the long-term viability of the species, is limited due to the short-term nature of the study results available thus far. The evidence suggests, however, that significant levels of seed predation associated with increased abundance and range of Owyhee harvester ants has the potential to pose a significant threat to *L. papilliferum* in the foreseeable future. This potential threat is pervasive throughout the range of *L. papilliferum*.

Determination for Factor C

We have evaluated the best available scientific information on the effects of disease or predation on *Lepidium papilliferum*, and determined that this factor poses a significant threat to the viability of the species throughout its range, such that we anticipate that *L. papilliferum* is likely to become an endangered species within the foreseeable future, when we consider this factor in concert with the other factors impacting the species.

D. Inadequacy of Existing Regulatory Mechanisms

Few existing regulatory mechanisms apply to *Lepidium papilliferum*. At the Federal level, *Lepidium papilliferum* is currently categorized as a Type 1 sensitive species by BLM (U.S. BLM 2003, p. 1; Rinkes 2009, pers. comm.). The BLM has regulations that address the need to protect sensitive, candidate, and federally listed species. The BLM is the primary land-management agency implementing conservation efforts for this species, and continues to monitor *L. papilliferum* on the Federal lands it manages.

At the State level, Idaho Code 18-3911 protects a selected list of wildflowers, but *Lepidium papilliferum* is not one of the species listed. The protection allowed under Idaho Code 18-3911 basically makes it unlawful to export or offer for sale plants or parts of plants that are on the list of protected plants. As we have no information indicating that the export or sale of *L. papilliferum* poses a threat to the species, we do not consider the fact that *L. papilliferum* is not protected under Idaho Code 18-3911 to pose a significant threat to the species.

Conclusion for Factor D

Rationale

The inadequacy of existing regulatory mechanisms does not appear to pose a threat to *Lepidium papilliferum*. The BLM manages *L. papilliferum* as a sensitive species, according to that agency's regulations, and continues to implement conservation efforts, as well as monitor the species, on lands under its management. Although the State of Idaho does not extend protections against export or sale to *L. papilliferum* under Idaho Code 18-3911, the lack of protection not appear to pose a significant threat to the species, as we have no information indicating that the species is subject to export or sale. However, we note that Idaho Code 18-3913 provides the Idaho Department of Fish and Game with authority to amend the list of protected wildflowers, so *L. papilliferum* could be protected as specified in Idaho Code 18-3911.

Determination for Factor D

We have evaluated the best available information regarding the potential inadequacy of existing regulatory mechanisms and their effect on *Lepidium papilliferum*, and determined that this factor does not pose a significant threat to the viability of the species.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

Precipitation Patterns

Studies have indicated that the density and abundance of *Lepidium papilliferum* is positively correlated with levels of winter-spring (roughly January to March) precipitation (Palazzo *et al.* 2005, p. 9; Meyer *et al.* 2005, p. 15; Menke and Kaye 2006a, p. 8, 2006b pp. 10-11; CH2MHill 2007a, p. 14; Sullivan and Nations 2009, pp. 40-41), and negatively correlated with fall-winter (roughly October to December) precipitation (Meyer *et al.* 2005, pp. 15-16; Sullivan and Nations 2009, pp. 37-45). To assess the possibility that the negative trend in *L. papilliferum* density observed on the rough census plots at the OTA by Sullivan and Nations (2009, p. 39) may be due, at least in part, to either a corresponding negative trend in spring precipitation or a corresponding positive trend in winter precipitation at the OTA, we performed a least squares linear regression analysis (a statistical method to discern a potentially significant relationship between two variables, in this case whether there was any trend in rainfall over time) on monthly precipitation data available for the years 1991 through 2007 (Zwartjes 2009). Similar to the simple linear model employed by Sullivan and Nations (2009, p. 38) in their analysis to assess whether there was any general, overall trend in population numbers over time, this exercise was intended only to determine whether there might have been any significant general trend in precipitation levels during the time period of interest, not to explain the potentially complex patterns of precipitation over time. According to the results, none of the precipitation parameters utilized (modeled to be consistent with those utilized by Sullivan and Nations 2009)—total annual precipitation, total precipitation for the spring months (analyzed in three

time blocks as the sum of precipitation in February through May, February through June, and March through May), total precipitation for the winter months (October through December), or monthly precipitation based on 3–month moving averages from January to March through December to February — produced results suggesting that any of the precipitation trends over these years were significantly different statistically from a slope of zero (Zwartjes 2009, Figures 1-17, Appendix). Based on this simple model, there does not appear to be any general trend in precipitation over the years 1991 through 2007, either positive or negative, that corresponds with the observed negative trend in *L. papilliferum* density at the OTA over the years 1990 through 2008 as identified by Sullivan and Nations (2009) (Zwartjes 2009, p. 1).

Summary of Precipitation Patterns

The annual abundance of *Lepidium papilliferum* varies annually in concert with the level of precipitation; there appears to be a negative relationship between high winter precipitation and *L. papilliferum* abundance the following spring, and a positive relationship between spring precipitation and *L. papilliferum* abundance. One possible explanation for the observed significant decline in *L. papilliferum* abundance over time at the OTA rough census areas is that there was a similar trend in precipitation over that same time period (a decrease in spring precipitation, an increase in winter precipitation, or both). We did not, however, find any significant trend in precipitation in the same time frame. Thus, any changes in the abundance or density of *L. papilliferum* appear to have occurred independently of any trend in precipitation. Therefore, similar to our 2007 finding, we do not consider the current precipitation pattern to pose an extinction risk to the species.

Habitat Fragmentation and Isolation of Small Populations

Due to its occupancy of patchily distributed slickspots, the habitat of *Lepidium papilliferum* is somewhat naturally fragmented. Fragmentation at a larger scale, however, can pose problems for *L. papilliferum* by creating barriers in the landscape that prevent effective genetic exchange between populations. Seed dispersal for *L. papilliferum* likely occurs only over very short distances; thus, pollinators and pollen dispersal are the primary means for reproductive and genetic exchange between *L. papilliferum* sites (Robertson and Ulappa 2004, pp. 1705, 1708; Stillman *et al.* 2005, pp. 1, 6-8). Research indicates that seeds generated by the pollination of nearby plants have reduced viability, and that *L. papilliferum* seed viability increases as the distance to the contributing pollination source increases (Robertson and Ulappa 2004, pp 1705, 1708). The ability to exchange pollen with distant populations is therefore an advantage for *L. papilliferum*. Barriers or too much distance between slickspots and pollinating insect habitats can reduce the effective range of insects important to *L. papilliferum* pollination (Robertson *et al.* 2004, pp. 2-4). Barriers can include agricultural fields, urban development, and large areas of annual and perennial grass monocultures that do not support diversity and suitable floral resources such as nectar or edible pollen for pollinators. *Lepidium papilliferum* habitats separated by distances greater than the effective range of available pollinating insects are at a genetic disadvantage, and may become vulnerable to the effects of loss of genetic diversity (Stillman *et al.* 2005, pp. 1, 6-8) and a reduction in seed production (Robertson *et al.* 2004, p. 1705). A genetic analysis of *L. papilliferum* suggested that populations in the Snake River Plain and the Owyhee Plateau ''may have reduced genetic diversity'' (Larson *et al.* 2006, p. 17; note the Boise Foothills were not analyzed separately in this study).

Many of the remaining occurrences of *Lepidium papilliferum,* particularly in the Snake River Plain near urban centers, are restricted to small, remnant patches of suitable sagebrush-steppe habitat. When last surveyed, 31 EOs (37 percent) each had fewer than 50 plants (Colket *et al.* 2006, Tables 1 to 13). Many of these small remnant EOs exist within habitat that is degraded by the factors identified above. Small *L. papilliferum* populations have likely persisted due to their long-lived seed bank, but the potential risk of depletion of each population's seed bank with no new genetic input makes the persistence of these small populations uncertain. Providing suitable habitats and foraging habitats for the species' insect pollinators is important for maintaining *L. papilliferum* genetic diversity. Small populations are vulnerable to relatively minor environmental disturbances such as wildfire, herbicide drift, and nonnative plant invasions (Given 1994, pp. 66-67), and are subject to the loss of genetic diversity from genetic drift and inbreeding (Ellstrand and Elam 1993, pp. 217-237). Populations with lowered genetic diversity are more prone to local extinction (Barrett and Kohn 1991, pp. 4, 28). Smaller populations generally have lower genetic diversity, and lower genetic diversity may in turn lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Newman and Pilson 1997, p. 360).

Fragmentation (either by development or wildfires) has occurred in 62 of the 79 EOs for which habitat information is known (15 of 16 on the Boise Foothills, 35 of 42 on the Snake River Plain and 12 of 21 on the Owyhee Plateau), and 78 EOs (all except one on the Owyhee Plateau) have fragmentation occurring within 0.31 mi (500 m) of the EOs (Cole 2009b, Threats Table). Additionally, as described above in Factor A, *Development*, several development projects are planned within the occupied range of *Lepidium papilliferum* that would contribute to further large-scale fragmentation of its habitat, potentially resulting in decreased viability of populations through decreased seed production, reduced genetic diversity, and the increased inherent vulnerability of small populations to localized extirpation.

Summary of Habitat Fragmentation and Isolation of Small Populations

Even though *Lepidium papilliferum* occurs in naturally patchy microsite habitats, the increasing degree of fragmentation produced by wildfires and development may result in the separation of populations beyond the distance that its insect pollinators are capable of traveling. Genetic exchange in *L. papilliferum* is achieved through either seed dispersal or insect-mediated pollination, and plants that receive pollen from more distant sources demonstrate greater reproductive success in terms of seed production. As all indications are that seeds are dispersed over only a very small distance and insect pollinators are also limited in their dispersal capabilities, habitat fragmentation and isolation of populations poses a threat to *L. papilliferum* in terms of decreased reproductive success (lower seed set), reduced genetic variability, and greater local extinction risk. For these reasons we consider habitat fragmentation resulting from wildfires and development to pose a moderate degree of threat to *Lepidium papilliferum*. We consider this threat to be significant, but not as severe as the threats posed by the modified wildfire regime and invasive nonnative plant species. The threat of habitat fragmentation and isolation of small populations is pervasive throughout the range of *L. papilliferum*.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environment Program in response to growing concerns about climate change and, in particular, the effects of global warming. Although the extent of warming likely to occur is not known with certainty at this time, the IPCC has concluded that warming of the climate is unequivocal, and that continued greenhouse gas emissions at or above current rates will cause further warming (IPCC 2007, p. 30). Eleven of the 12 years from 1995 through 2006 rank among the 12 warmest years in the instrumental record of global surface temperature since 1850 (ISAB 2007). Climate-change scenarios estimate that the mean air temperature could increase by over 3 degrees Celsius (5.4 degrees Fahrenheit) by 2100 (IPCC 2007, p. 46). The IPCC also projects that there will very likely be regional increases in the frequency of hot extremes, heat waves, and heavy precipitation (IPCC 2007, p. 46), as well as increases in atmospheric carbon dioxide (IPCC 2007, p. 36).

We recognize that there are scientific differences of opinion on many aspects of climate change, including the role of natural variability in climate. In our analysis, we rely primarily on synthesis documents (e.g., IPCC 2007, Karl *et al.* 2009) that present the consensus view of a very large number of experts on climate change from around the world. We have found that these synthesis reports, as well as the scientific papers used in those reports or resulting from those reports, represent the best available scientific information we can use to inform our decision and have relied upon them and provided citation within our analysis. In addition, where possible we have utilized projections specific to the region of interest, the Great Basin, which includes the range of *Lepidium papilliferum*.

Projected climate change and its associated consequences have the potential to affect *Lepidium papilliferum* and may increase its risk of extinction, as the impacts of climate change interact with other stressors such as habitat degradation and loss that are already affecting the species (Karl *et al.* 2009, p. 81). In the Pacific Northwest, regionally averaged temperatures have risen 0.8 degrees Celsius (1.5 degrees Fahrenheit) over the last century (as much as 2 degrees Celsius (4 degrees Fahrenheit) in some areas), and are projected to increase by another 1.5 to 5.5 degrees Celsius (3 to 10 degrees Fahrenheit) over the next 100 years (Mote *et al.* 2003, p. 54; Karl *et al.* 2009, p. 135). Arid regions such as the Great Basin where *L. papilliferum* occurs are likely to become hotter and drier; fire frequency is expected to accelerate, and fires may become larger and more severe (Brown *et al.* 2004, pp. 382-383; Neilson *et al.* 2005, p. 150; Chambers and Pellant 2008, p. 31; Karl *et al.* 2009, p. 83). Under projected future temperature conditions, the cover of sagebrush in the Great Basin region is anticipated to be dramatically reduced (Neilson *et al.* 2005, p. 154). Warmer temperatures and greater concentrations of atmospheric carbon dioxide create conditions favorable to *Bromus tectorum*, as described below, thus continuing the positive feedback cycle between the invasive annual grass and fire frequency that poses a significant threat to *L. papilliferum* (Chambers and Pellant 2008, p. 32; Karl *et al.* 2009, p. 83).

Emissions of carbon dioxide, considered to be the most important anthropogenic greenhouse gas, increased due to human activities by approximately 80 percent between 1970 and 2004 (IPCC 2007, p. 36). Future carbon dioxide emissions from energy use are projected to increase by 40 to 110 percent over the next few decades, between 2000 and 2030 (IPCC 2007, p. 44). An increase in the atmospheric concentration of carbon dioxide has important implications for *Lepidium papilliferum*, beyond those associated with warming temperatures, because higher concentrations of carbon dioxide are favorable for the growth and productivity of *Bromus tectorum* (Smith *et al.* 1987, p. 142; Smith *et al.* 2000, p. 81). Although most plants respond positively to increased carbon dioxide levels, many invasive nonnative plants respond with greater growth rates than native plants, including *B. tectorum* (Smith *et al.* 1987, p. 142; Smith *et al.* 2000, p. 81; Karl *et al.* 2009, p. 83). Laboratory research results illustrated that *B. tectorum* grown at carbon dioxide levels representative of current climatic conditions matured more quickly, produced more seed and greater biomass, and produced significantly more heat per unit biomass when burned than *B. tectorum* grown at ''pre-industrial'' carbon dioxide levels (Blank *et al.* 2006, pp. 231, 234). These responses to increasing carbon dioxide may have increased the flammability in *B. tectorum* communities during the past century (Ziska *et al.* 2005, as cited in Zouhar *et al.* 2008, p. 30; Blank *et al.* 2006, p. 234).

Field studies likewise demonstrate that *Bromus* species demonstrate significantly higher plant density, biomass, and seed rain (dispersed seeds) at elevated carbon dioxide levels relative to native annuals (Smith *et al.* 2000, pp. 79-81). The researchers conclude that ''the results from this study * * * confirm experimentally in an intact ecosystem that elevated carbon dioxide may enhance the invasive success of *Bromus* spp. in arid ecosystems,'' and suggest that this enhanced success will then expose these areas to accelerated fire cycles (Smith *et al.* 2000, p. 81). Chambers and Pellant (2008, p. 32) also suggest that higher carbon dioxide levels are likely increasing *B. tectorum* fuel loads due to increased productivity, with a resulting increase in fire frequency and extent. Based on the best available information, we therefore expect continuing production of atmospheric carbon dioxide at or above current levels, as predicted, to increase the threat posed to *L. papilliferum* by *B. tectorum* and from more frequent, expansive, and severe wildfires (Smith *et al.* 1987, p. 143; Smith *et al.* 2000, p. 81; Brown *et al.* 2004, p. 384; Neilson *et al.* 2005, pp. 150, 156; Chambers and Pellant 2008, pp. 31-32).

Bradley *et al.* (in press, pp. 1-11) predict that nonnative invasive species in the sagebrush-steppe ecosystem may either expand or contract under climate change, depending on the current and projected future range of a particular invasive plant species. They developed a bioclimatic model for *Bromus tectorum* based on maps of invaded range derived from remote sensing and on the climate variables that best predict species presence, and found that the best predictors of *B. tectorum* occurrence are summer, annual, and spring precipitation, followed by winter temperature (Bradley *et al.*, in press, p. 5). They then used projections of 10 atmosphere-ocean, general-circulation models for the year 2100. Depending primarily on future precipitation conditions, the model predicts *B. tectorum* is likely to shift northwards, leading to expanded risk of *B. tectorum* invasion in Idaho, Montana, and Wyoming, but reduced risk of invasion in southern Nevada and Utah, which currently have large areas dominated by this nonnative grass (Bradley *et al.*, in press, p. 5). Although the authors note that their models also predict some range contractions by *B. tectorum* by 2100, much of southern Idaho where *Lepidium papilliferum* occurs appears to maintain large populations of *B. tectorum* (Figure 4, p. 7). The threat posed to *L. papilliferum* by the greater frequency and geographic extent of wildfires and other associated negative

impacts from the presence of *B. tectorum* is therefore expected to continue into the foreseeable future.

An additional potential threat to *Lepidium papilliferum* resulting from climate change is the predicted change in precipitation patterns. Current projections for the Pacific Northwest region are that precipitation will increase in the winter but decrease in the summer months (Karl *et al.* 2009, p. 135). The survivorship of *L. papilliferum* rosettes to flower the following spring is favored by greater summer precipitation (Meyer *et al.* 2005, p. 15; CH2MHill 2007a, p. 14; Sullivan and Nations 2009, pp. 33, 41), and increased winter precipitation appears to decrease survivorship (Meyer *et al.* 2005, pp. 15-16; Sullivan and Nations 2009, pp. 39, 43-44). As the projected rainfall pattern under climate change would follow the opposite pattern, this alteration in seasonal precipitation could result in decreased survivorship of *L. papilliferum*. Alterations in precipitation patterns, however, are more uncertain than predicted changes in temperature for the Great Basin region (Neilson *et al.* 2005, p. 153).

Summary of Climate Change

The direct, long-term impact from climate change to *Lepidium papilliferum* is yet to be determined. However, as described under Factor A, above, the invasion of *Bromus tectorum* and the associated changes in fire regime currently pose one of the most significant threats to *Lepidium papilliferum*, the sagebrush-steppe ecosystem, and the slickspot habitats where *L. papilliferum* resides. Under current climate-change projections, we anticipate that future climatic conditions will favor further invasion by *B. tectorum*, that fire frequency will continue to increase, and the extent and severity of fires may increase as well. Precipitation patterns may also be altered as a result of climate change, resulting in potential decreased survivorship of *L. papilliferum*, although the projections for future precipitation patterns are less certain. The consequences of climate change, if current projections are realized, are therefore likely to exacerbate the existing primary threats to *L. papilliferum* of frequent wildfire and invasive nonnative plants, particularly *B. tectorum*. As the IPCC projects that the changes to the global climate system in the 21st century will likely be greater than those observed in the 20th century (IPCC 2007, p. 45), we anticipate that these effects will continue and likely increase into the foreseeable future. As there is some degree of uncertainty regarding the potential effects of climate change on *L. papilliferum* specifically, climate change in and of itself was not considered a significant factor in our determination to list *L. papilliferum* as a threatened species. However, we recognize that the severity and scope of the primary threats to *L. papilliferum* of frequent wildfire and *B. tectorum* are likely to magnify depending on the realized outcome of climate change within the foreseeable future; thus, we consider climate change as playing a potentially important supporting role in intensifying the primary current threats to the species.

Conclusion for Factor E

Rationale

Habitat fragmentation that results from wildfires and development may result in the separation of *Lepidium papilliferum* populations beyond the distance that its insect pollinators can travel, and likely limits the ability for seeds to travel between populations as well. Limited genetic exchange due to fragmentation can result in reduced seed production for this species, as well as a loss of genetic diversity. Small, isolated populations with lowered genetic diversity are at increased risk of local extinction. Habitat fragmentation due to wildfires and various forms of development is occurring throughout the range of the species, and is expected to increase in the future. As the insect pollinators of *L. papilliferum* traverse relatively short distances, and evidence suggests that seed dispersal is limited as well, we consider the consequences of limited genetic exchange as a result of habitat fragmentation to pose a significant and moderate degree of threat to *L. papilliferum* throughout its range. Although significant, we do not consider the severity of this threat to reach the level of threat posed to *L. papilliferum* by the primary threats of the modified wildfire regime and invasive nonnative plant species.

Current climate-change models predict future climatic conditions within the range of *Lepidium papilliferum* will favor further invasion by *Bromus tectorum*. These models also project that fire frequency will continue to increase and that the extent and severity of wildfires may increase as well. Thus, the consequences of projected, future climate change, if realized, are likely to further magnify the severity and scope of the primary significant threats to *L. papilliferum*. Due to the uncertainty associated with climate change projections, we do not consider climate change in and of itself to represent a significant threat to *L. papilliferum*. However, we acknowledge that climate change will likely play a potentially important supporting role in intensifying the most significant current threats to the species in the foreseeable future. The projected consequences of climate change would act to exacerbate the primary threats of frequent wildfire and invasive nonnative plant species to *L. papilliferum* throughout its range.

The abundance of *Lepidium papilliferum* is closely associated with levels of rainfall, showing a positive association with high levels of spring precipitation and a negative association with high levels of winter precipitation. We thus considered whether the declining population trend in *L. papilliferum* might be a consequence of a corresponding trend in precipitation. We did not find evidence of any trend in precipitation for *L. papilliferum* for the time period for which we have evidence of the declining trend in density at the OTA; thus, we conclude that any population trend in *L. papilliferum* is independent of any trend in precipitation. Precipitation patterns were therefore not considered to pose a threat to the species.

Determination for Factor E

We have evaluated the best available scientific information on other natural or manmade factors affecting the continued existence of *Lepidium papilliferum*, including precipitation patterns, habitat fragmentation and isolation of small populations, and climate change, and determined that this factor poses a significant threat to the viability of the species throughout its range when considered in concert with Factor A, such that we anticipate that *L. papilliferum* is likely to become an endangered species within the foreseeable future.

Evaluation of Conservation Efforts

In making a determination as to whether any species is an endangered species or a threatened species, Section 4(b)(1)(A) of the Act mandates that the Secretary shall make such determinations ''solely on the basis of the best scientific and commercial data available to him after conducting a review of the status of the species and after taking into account those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species.'' Here, we describe and evaluate those conservation efforts being made by the State of Idaho and other entities to protect *Lepidium papilliferum*; we also consider conservation efforts that are formally

planned but have not yet been implemented, as per the Service's Policy for the Evaluation of Conservation Efforts (68 FR 15100; March 28, 2003). These conservation efforts were briefly described in our earlier evaluation of the threat factors affecting the species. Here we present a single summary of the conservation efforts implemented or planned for the benefit of *L. papilliferum*, which we considered in the course of our listing determination. Any management actions that were only planned at the time of our withdrawal of the proposal to list *Lepidium papilliferum* in 2007 (72 FR 1622; January 12, 2007) but have since been implemented were considered in our evaluation of ongoing conservation efforts in this rule.

Ongoing Conservation Efforts

Currently, there are four formalized plans that contain conservation measures for *Lepidium papilliferum*. The four plans include: (1) the CCA for Slickspot Peppergrass with the State of Idaho, BLM, Idaho Army National Guard, and nongovernmental cooperators (private landowners who also hold livestock grazing permits on BLM lands) (State of Idaho *et al.* 2003, 2006); (2) the Idaho Army National Guard Integrated Natural Resource Management Plan for Gowen Field/ Orchard Training Area (IDARNG 2004); (3) the U.S. Air Force Integrated Natural Resource Management Plan for the Juniper Butte Range (Mountain Home Air Force Base) (U.S. Air Force 2004); and (4) the Conservation Agreement for Slickspot Peppergrass (*Lepidium papilliferum*) at the Boise Airport, Ada County, Idaho (Boise Airport 2003). A fifth plan that expired in October of 2006 is a Conservation Agreement by, and between, Boise City and the U.S. Fish and Wildlife Service for *Allium aasea* (Aase's onion), *Astragalus mulfordiae* (Mulford's milkvetch) and *L. papilliferum* (Hull's Gulch Agreement) (U.S. Fish and Wildlife Service 1996). A new agreement is currently being crafted to update the expired agreement and will include conservation measures for portions of four small *L. papilliferum* EOs in the Boise Foothills region on lands administered by both the City of Boise and Ada County. This new agreement is expected to be completed by September of 2009.

The majority of the individual conservation efforts being implemented for *Lepidium papilliferum* are contained in the State of Idaho CCA, which was originally drafted in 2003, and updated in 2006; it is scheduled to expire in 2013. The CCA represents an important milestone in the cooperative conservation of *Lepidium papilliferum* given its rangewide scope and coordinated management across Federal and State of Idaho managed lands. The CCA includes rangewide efforts that are intended to address the need to: Maintain and enhance *L. papilliferum* habitat; reduce intensity, frequency, and size of natural- and human-caused wildfires; minimize loss of habitat associated with wildfire-suppression activities; reduce the potential for invasion of nonnative plant species from wildfire; minimize the loss of habitat associated with rehabilitation and restoration techniques; minimize the establishment of invasive nonnative species; minimize the degradation or loss of habitat from ORV use; mitigate the negative effects of military training and other associated activities on the OTA; and minimize the impact of ground disturbances caused by livestock penetrating trampling during periods when soils are saturated.

As a signatory of the CCA (State of Idaho *et al.* 2003, 2006), the BLM is the primary land management agency implementing conservation efforts for *Lepidium papilliferum* on their lands. Implementation of the conservation measures in the CCA represents a major commitment on behalf of the BLM, which has management authority for the majority of the range where *L. papilliferum* occurs (i.e., 87 percent of the total EO area (13,470 ac (5,451 ha)) and portions of 69 of the 80 extant EOs). Conservation measures for ongoing activities from the CCA that were appropriate for land-use plan programs were included in an August 22, 2006, Conservation Agreement between the Service and the BLM to avoid or minimize impacts to *L. papilliferum* during the BLM's implementation of existing land-use plans. This Conservation Agreement between Idaho BLM and the Service is scheduled to expire on December 31, 2010, at which time it may be reviewed for renewal or expiration.

Until recently, the CCA also represented an effort by nongovernmental cooperators (private landowners who also hold BLM livestock grazing permits) for the conservation of *Lepidium papilliferum* on private lands. Six Memoranda of Understanding (MOUs) between nongovernmental cooperators and the State of Idaho for conservation of *L. papilliferum* on private lands were in place from 2004 through December 2007. We are not aware that these MOUs have been reissued at this time. The size and habitat condition of *L. papilliferum* locations on these private lands are also unknown to the Service. The MOUs included 17,045 ac (6,898 ha) of private lands; however, less than 2 percent of the currently known area occupied by *L. papilliferum* (260 ac (105 ha)) is documented as occurring on private lands.

Although a majority of the conservation measures identified in the CCA have been implemented to date, relatively few have been determined at this time to be measurably effective for conserving *Lepidium papilliferum*. For example, many of the implemented measures are conducting surveys, monitoring, or providing for public outreach and education, which have limited direct or long-term conservation benefits to the species. With the exception of several conservation efforts implemented at the OTA that have been successful in controlling the effects of wildfire on *L. papilliferum* habitats, many of the remaining conservation efforts and adaptive management provisions identified in the CCA have not been implemented over a long enough period of time to have sufficient certainty they can be effective in reducing threats. Furthermore, the conservation measures identified in the CCA are concentrated on *L. papilliferum* EOs. While this is helpful, the effective control of the most significant threats to *L. papilliferum*, wildfire and invasive nonnative plant species, requires efforts that extend well beyond the boundaries of the EOs, since by their nature these are expansive threats that occur throughout the Great Basin. We recognize the conservation efforts identified in the CCA as having a conservation benefit for *L. papilliferum,* but rangewide their effectiveness in reducing or eliminating the most significant threats has not been demonstrated at this time.

The IDARNG, another signatory to the CCA, also implements conservation efforts for *Lepidium papilliferum* on the OTA through its INRMP (IDARNG 2004, Chapter 4.4.2). The IDARNG's OTA contains 7,213 ac (2,919 ha) of occupied *L. papilliferum* habitat, 7,163 ac (2,899 ha) of which represents some of the highest-quality occupied *L. papilliferum* habitat in the Snake River Plain region. Many of the conservation efforts, such as prohibiting military training activities within areas reserved for conservation of *L. papilliferum*, have been implemented by the IDARNG for more than 18 years and have been demonstrated to be effective in minimizing military training impacts to the species. The INRMP for the OTA expired in September 2008, and is currently being updated (Quinney 2008, pers. comm.).

The U.S. Air Force's INRMP completed in 2004 includes conservation efforts for *Lepidium papilliferum*. The U.S. Air Force manages 2,028 ac (810 ha) of occupied *L. papilliferum* habitat within the Juniper Butte Range in the Owyhee Plateau region. The INRMP contains specific measures developed to minimize the impacts from military training and the associated indirect effects from wildfire, nonnative invasive weeds, and livestock use on *L. papilliferum*. For example, the U.S. Air Force has a number of ongoing efforts to address wildfire suppression on the entire 11,500 ac (4,800 ha) Juniper Butte Range. The U.S. Air Force addresses wildfire prevention through reducing standing fuels and weeds, planting fire-resistant vegetation in areas with a higher potential for ignition sources such as along roads, and using wildfire indices to determine when to restrict military activities when the wildfire hazard rating is extreme (U.S. Air Force 2004, p. 6-55). As a result, the threat from wildfire to *L. papilliferum* associated with U.S. Air Force training activities is expected to be reduced within the Juniper Butte Range. The INRMP that includes the Juniper Butte Range is scheduled to expire in 2009 and is currently being updated (EES 2008).

A Conservation Agreement between the Service and the City of Boise Airport was completed in 2003 for the conservation of two *Lepidium papilliferum* EOs located on the southern portion of Boise Airport lands (Boise Airport 2003). Using the latest Idaho Natural Heritage Program *L. papilliferum* EO ranks, these two EOs include a C-ranked site (2.8 ac (1.2 ha)) and a D-ranked site (0.5 ac (0.2 ha)), with low documented plant numbers and very poor habitat condition (Colket *et al.* 2006, Appendix C). Both EOs included in this Conservation Agreement are also susceptible to impacts from invasive nonnative weeds and wildfire. The primary conservation actions identified in this agreement included the construction of fuel breaks around *L. papilliferum* populations, the preclusion of livestock use, minimizing the use of herbicides, and signing areas to prevent access. We have not received documentation of implementation or effectiveness of the conservation efforts identified in this Conservation Agreement. This agreement is scheduled to expire in December 2015. We acknowledge the positive conservation intent of this agreement, and although the status of the efforts are unknown, even if they were known to be implemented and effective, the area covered by the City of Boise Conservation Agreement is so small that it would have little effect on our ultimate finding in this rule.

Planned Conservation Efforts

Prior to our 2007 withdrawal notice (72 FR 1622; January 12, 2007), we reviewed the available information for all of the individual conservation efforts contained in five conservation plans developed for *Lepidium papilliferum* (State of Idaho CCA, IDARNG INRMP, U.S. Air Force INRMP, Boise Airport CA, and Hull's Gulch Agreement) to evaluate how many were implemented or certain to be implemented in the future; and how many efforts were so effective as to have contributed to the elimination or reduction of one or more threats to the species. Based upon our review at that time, we determined that 373 of the nearly 600 individual conservation efforts identified in the 5 plans were currently implemented and that 35 of these efforts were determined to be both certain to be implemented and effective in reducing threats to *L. papilliferum* or were already known to be implemented and effective in reducing threats to the species. Since that time, we have received additional information from the implementing agencies that describe the status of at least 152 conservation measures included in 3 of the 5 conservation plans (State of Idaho CCA, IDARNG INRMP, and US Air Force INRMP) that were implemented in 2007 and 2008 (CH2MHill 2007a, p. 16; CH2MHill 2007b, pp. 1-6; Quinney 2007 pp.1-3; USBLM 2007, p. 2-4; CH2MHill 2008a, p. 17; CH2MHill 2008b, pp. 1-6; Quinney 2008 pp.1-3; USBLM 2008a, pp. 2-38; USBLM 2008c, pp. 1-15; Colket 2009, pp. 65-72). We have not received specific information regarding conservation measures contained in the Boise Airport conservation agreement that have been implemented, or how effective these measures have been in reducing threats to *L. papilliferum* for 2007 or 2008. The fifth conservation plan, the Hull's Gulch Agreement between Boise City and the Service, expired in October 2006 and has yet to be renewed.

Our latest evaluation of planned future conservation efforts, taking into consideration the most recent information provided by the implementing agencies, again concludes that 35 out of roughly 600 individual management actions identified in the 5 formalized conservation plans for *Lepidium papilliferum* are certain to be implemented and effective. However, these 35 conservation efforts determined to be implemented and effective are from the CCA, Air Force INRMP and OTA INRMP, and are not applicable rangewide. For example, 20 of the 35 conservation efforts are primarily directed at conserving *L. papilliferum* at 1 of 3 EOs located on the OTA. Therefore, these 35 measures would not prevent the species from becoming endangered in the foreseeable future either rangewide or on a significant portion of the species' range. We thus do not consider these 35 actions sufficient to offset the threats posed to *L. papilliferum* across its range by the modified wildfire regime; invasive nonnative plants; development; potential seed predation by harvester ants; and habitat fragmentation and isolation, to the point that we would consider it unlikely that *L. papilliferum* will become endangered within the foreseeable future.

Summary of Ongoing and Planned Conservation Efforts

We recognize the long list of ongoing and proposed conservation efforts by the State of Idaho, IDARNG, U.S. Air Force, and other non-governmental cooperators being put forth to conserve *Lepidium papilliferum*. All parties should be commended for their conservation efforts. Our review of conservation efforts indicates that not all of the measures identified in the conservation plans have been implemented and most have not been demonstrated at this time to effectively reduce or eliminate the most significant threats to the species. Many of these conservation efforts are limited in their ability to effectively reduce the long-term habitat degradation and destruction occurring within the sagebrush-steppe ecosystem and *L. papilliferum* habitats across the range of the species from the effects of a changed wildfire regime and nonnative plant invasions, in addition to other threats. In many cases, effective control measures for these threats are not yet known, financially or technically feasible, or logistically possible to implement on the scale that would be necessary to successfully ameliorate the threat throughout the range of *L. papilliferum*. Although the ongoing conservation efforts demonstrated to be effective are a positive step toward the conservation of *L. papilliferum*, and a few, such as those designed to reduce the impact of ground disturbances caused by livestock when soils are saturated in the spring, described under **Livestock Use**, above, have likely reduced the severity of some threats to the species, on the whole we find that the conservation efforts in place at this

time are not sufficient to offset the degree of threat posed to the species by the modified wildfire regime; invasive nonnative plants; development; potential seed predation by harvester ants; and habitat fragmentation and isolation, to the point that we would consider it unlikely that *L. papilliferum* will become endangered within the foreseeable future.

We have also considered all formally planned conservation efforts, by evaluating the individual conservation efforts contained in five conservation plans developed for *Lepidium papilliferum* to evaluate how many were implemented or certain to be implemented in the future; and how many efforts were so effective as to have contributed to the elimination or reduction of one or more threats to the species. We have no information indicating that there are any new conservation efforts planned for the future that we have not already evaluated in the course of applying our Policy for the Evaluation of Conservation Efforts (68 FR 15100; March 28, 2003) to management actions planned for the benefit of *L. papilliferum*, as described in past actions for this species (69 FR 3094; 72 FR 1622). We recognize the benefit of these planned conservation measures and acknowledge the efforts of the entities engaged in planning these measures for the benefit of *L. papilliferum*. However, as with ongoing conservation efforts, in most cases the measures are simply not logistically feasible for implementation at the scale that would be required to effectively reduce the threats to the species across its range. Based on our most recent evaluation, we conclude that those planned conservations efforts that we consider likely to be implemented and effective are not sufficient to offset the threats posed to *L. papilliferum* by the modified wildfire regime; invasive nonnative plants; development; potential seed predation by harvester ants; and habitat fragmentation and isolation, to the point that we would consider it unlikely that *L. papilliferum* will become endangered within the foreseeable future.

In summary, all ongoing conservation efforts have been considered and evaluated in terms of their effectiveness in ameliorating the threats to *Lepidium papilliferum* as described in this rule. We have additionally considered all formally planned future conservation efforts for the species, and evaluated those efforts in terms of the certainty of their implementation and their potential for effectiveness in ameliorating the threats to *L. papilliferum*. We recognize and acknowledge the efforts of the many entities participating in conservation efforts for the protection of *L. papilliferum*. However, our evaluation of the ongoing and planned conservation efforts for the species concludes that these efforts are not sufficient to offset the threats described in this rule to the point that we consider it unlikely that *L. papilliferum* will become endangered within the foreseeable future.

Finding

We have carefully assessed the best scientific and commercial information available regarding the present and future threats to *Lepidium papilliferum*. This plant is endemic to southwest Idaho and occurs within a limited geographical range that totals approximately 16,000 ac (6,475 ha). The species predominantly occurs in highly specialized and unique microsite habitats called slickspots within the sagebrush-steppe ecosystem. The specialized slickspot habitats were formed during the Pleistocene period and are considered a finite resource; the fact that these slickspots likely cannot be recreated or restored once they have been lost was an important consideration in our evaluation of the threats to *L. papilliferum*. In addition, the species' limited geographical range makes it particularly vulnerable to the many threats affecting its habitat. We have evidence indicating that the finite slickspot habitats of the species are continuing to degrade in quality from a variety of threats. Based on the best scientific data currently available, the primary significant threats to the species are the effects of wildfire and invasive nonnative plants, especially *Bromus tectorum*.

In our 2007 finding (72 FR 1622; January 12, 2007), we concluded: ''The best available data for *Lepidium papilliferum* indicate that while the broad scale habitat in which the species exists is degraded, we have no data that correlates this with species abundance.'' We now have new information indicating a statistically significant negative association between *L. papilliferum* abundance and wildfire, and between *L. papilliferum* abundance and cover of *B. tectorum* in the surrounding plant community; these negative associations are consistent throughout the range of the species. Wildfire occurs throughout the range of *L. papilliferum* and has dramatically increased in both frequency and extent over historical levels, especially where *B. tectorum* is dominant. We expect this trend to continue and possibly increase due to the projected effects of climate change. Furthermore, as *B. tectorum* and other nonnative annual grasses continue to spread and degrade the sagebrush-steppe ecosystem, we expect continued increases in fire frequency and magnitude, with associated negative impacts on *L. papilliferum*.

As wildfire continues to promote the conversion of sagebrush to nonnative annual grasslands, we also anticipate that Owyhee harvester ants will expand into areas occupied by *L. papilliferum,* as the density of harvester ants is negatively associated with sagebrush cover, and they appear to readily colonize grassland habitats that are replacing sagebrush. Seed predation on *L. papilliferum* is thus expected to increase, with negative consequences for plant reproduction and the maintenance of the persistent seed bank.

Additionally, future development threatens many of the remaining *L. papilliferum* occupied sites, primarily in the Snake River Plain and Boise Foothills. Development can result in the permanent loss of slickspot microsite habitats, and contributes to the problems associated with habitat fragmentation and the isolation of small populations. The loss of slickspots, particularly those slickspots occupied by the species and thus clearly providing the requisite conditions to support *L. papilliferum*, is of great concern due to the finite nature of this resource. Habitat fragmentation and isolation potentially reduces the long-term viability of populations by impeding genetic exchange through insect pollination or pollen dispersal, resulting in decreased seed production and possibly reduced genetic diversity.

As with the 2007 finding (72 FR 1622; January 12, 2007), we do not see strong evidence of a steep negative population trend for the species. However, recent analysis of the best available scientific data suggests that *Lepidium papilliferum* numbers may be trending downward, and the dataset from the rough census areas on the OTA, which we consider to be the most reliable, shows a statistically significant downward trend in density over the last 18 years. The evidence suggests this negative trend is independent of any trend in precipitation over the same period of time. The extreme variability in annual abundance makes the detection of any such trend statistically challenging; not all monitoring data have shown consistently significant results, and, as described earlier, there are numerous factors that serve to complicate the confident detection of a population trend in this species. We do now have evidence, however, that the primary threats of wildfire and invasive

nonnative plants, especially *B. tectorum*, are currently acting on the species and its habitat throughout its limited range, and furthermore we now have evidence of a significant negative association between the abundance of *L. papilliferum* and these two threats. Indications are that all of the significant threats to *L. papilliferum* identified in this rule, including development and habitat fragmentation, but especially wildfire and invasive nonnative plants, will continue and likely increase into the foreseeable future. The projected future consequences of climate change, if realized, will further magnify the primary threats posed by wildfire and *B. tectorum*. Furthermore, we conclude from our evaluation of the ongoing and planned conservation efforts for *Lepidium papilliferum* that, despite the best efforts of the State and other management agencies, there is no information leading us to believe that sufficient management tools are currently being implemented that are capable of effectively reducing or ameliorating the primary threats of wildfire and invasive nonnative plants, particularly *B. tectorum,* across the range of *L. papilliferum*, to a point where the species is not likely to become endangered in the foreseeable future. As we can reasonably anticipate the continuation or increase of all of the significant threats to *L. papilliferum* into the foreseeable future, even after accounting for ongoing and planned conservation efforts, and based on the observed significant negative correlation between the primary threats of wildfire and invasive nonnative plants, particularly *B. tectorum*, and the abundance of *L. papilliferum*, we can reasonably infer that the negative consequences of these threats on the species will continue, and, under current conditions, population declines will likely be observed within the foreseeable future to the point at which *L. papilliferum* will become an endangered species.

Section 3 of the Act defines an endangered species as ''any species which is in danger of extinction throughout all or a significant portion of its range'' and a threatened species as ''any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' *Lepidium papilliferum* is currently affected by a variety of threats across its entire geographic range. As we have not yet observed the extirpation of local populations or steep declines in the abundance of the species, we do not believe the status of the species is such that it is presently in danger of extinction. Therefore, we do not believe *L. papilliferum* meets the definition of an endangered species. We additionally considered whether any significant portion of the species' range meets the definition of endangered (see **Significant Portion of the Range Evaluation**, below); however, we could not determine that any significant portion of the species' range is presently in danger of extinction, thus no significant portion of the species range warrants listing as endangered. We can, however, reasonably anticipate the impacts of the threats on *L. papilliferum* rangewide, and we believe those threats acting in combination are likely to result in the species becoming endangered within the foreseeable future. Therefore, we are listing *L. papilliferum* as a threatened species throughout all of its range under the Act.

Significant Portion of the Range (SPR) Evaluation

Section 3 of the Act defines an endangered species as a species in danger of extinction throughout all or a significant portion of its range, and a threatened species as a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

In our analysis for this final rule, we initially evaluated the status of and threats to the species throughout its entire range. *Lepidium papilliferum* is restricted to a relatively small range in southwestern Idaho. The range of the species has been divided into three physiographic regions, based on differences in topography, soil, and relative abundance of *L. papilliferum*. These three physiographic regions, shown in Figure 1, are the Boise Foothills, Snake River Plain, and Owyhee Plateau. In our evaluation of threats to *L. papilliferum*, we determined that the threats acting on the species may differ in severity to some degree between these physiographic regions, as demonstrated by Sullivan and Nations (2009, Chapter 8, pp. 97-138). On the basis of this evaluation, we determined that the entire species meets the definition of threatened under the Act due to the loss or degradation of its habitat, due primarily to the modified wildfire regime and invasive nonnative plant species. The basis of this determination is captured within the analysis of each of the five listing factors, and the **Finding** immediately preceding this section.

Recognizing the potential differences in the magnitude of threats, we evaluated whether there were any specific areas or populations that may be disproportionately threatened such that they currently meet the definition of an endangered species versus a threatened species. Our evaluation of whether there are any significant portions of *Lepidium papilliferum*'s range (SPR) where listing the species as endangered may be warranted follows.

On March 16, 2007, a formal opinion was issued by the Solicitor of the Department of the Interior, ''The Meaning of 'In Danger of Extinction Throughout All or a Significant Portion of Its Range''' (USDI 2007). We have summarized our interpretation of that opinion and the underlying statutory language below.

In determining whether a species is threatened or endangered in a significant portion of its range, we first identify any portions of the range of the species that warrant further consideration. The range of a species can theoretically be divided into portions in an infinite number of ways. However, there is no purpose to analyzing portions of the range that are not reasonably likely to be significant and threatened or endangered. To identify those portions that warrant further consideration, we determine whether there is substantial information indicating that (i) the portions may be significant and (ii) the species may be in danger of extinction there or likely to become so within the foreseeable future. In practice, a key part of this analysis is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats applies only to portions of the range that are unimportant to the conservation of the species, such portions will not warrant further consideration.

If we identify any portions that warrant further consideration, we then determine whether in fact the species is threatened or endangered in any significant portion of its range. Depending on the biology of the species, its range, and the threats it faces, it may be more efficient for the Service to address the significance question first, or the status question first. Thus, if the Service determines that a portion of the range is not significant, the Service need not determine whether the species is threatened or endangered there. Alternatively, if the Service determines that the species is not threatened or endangered in a portion of its range, the Service need not determine if that portion is significant. If the Service determines that both a portion of the range of a species is significant and the

species is threatened or endangered there, the Service will specify that portion of the range as threatened or endangered pursuant to section 4(c)(1) of the Act.

To determine whether any portions of the range of *Lepidium papilliferum* warrant further consideration as possible endangered significant portions of the range, we reviewed the entire supporting record for this final listing determination with respect to the geographic concentration of threats and the significance of portions of the range to the conservation of the species. In this case, we first evaluated whether substantial information indicated (i) the threats are so concentrated in any portion of the species' range that the species may be currently in danger of extinction in that portion; and (ii) if so, whether those portions may be significant to the conservation of the species.

Our rangewide review of the species concluded that *Lepidium papilliferum* is likely to become endangered within the foreseeable future. Therefore, the species meets the definition of threatened under the Act. As described above, to establish whether any areas may warrant further consideration, we reviewed our analysis of the five listing factors to determine whether any of the significant threats identified were so concentrated that some portion of *L. papilliferum*'s range may currently be in danger of extinction. All of the significant threats identified in this rule, the primary threats of modified wildfire regime and invasive nonnative plant species, and the lesser threats of development and habitat fragmentation and isolation, act on the species throughout its range. The threat of development is somewhat greater in the Boise Foothills and Snake River Plain physiographic regions relative to the Owyhee Plateau, but as discussed in our analysis under Factor A, we have no information indicating that this threat is so imminent or disproportionately severe as to place the species in danger of extinction within those physiographic regions at present. In addition, the analysis of Sullivan and Nations (2009) demonstrated that the magnitude of the threats to *L. papilliferum* from some factors, such as individual species of invasive nonnative plants (e.g., *Agropyron cristatum*) may vary to some degree between physiographic regions. However, based on our review of the record, we did not find substantial information indicating that any of the significant threats to the species were so severe or so concentrated as to indicate that some portions of *L. papilliferum*'s range qualify as endangered. As described in our **Finding** above, the threats are such that we anticipate *L. papilliferum* will become endangered within the foreseeable future across its range. However, at present we have no evidence of any recent localized population extirpations, nor is there evidence of any localized precipitous population declines indicating that *L. papilliferum* is currently in danger of extinction in any portion of its range. As a result, while the best scientific data available allows us to make a determination as to the rangewide status of *L. papilliferum*, we have determined that the best available data show that there are no portions of the range in which the threats are so concentrated as to place the species currently in danger of extinction. Because we find that *L. papilliferum* is not endangered in any portion of its range, we need not address the question of whether any portion may be significant.

Peer review

In accordance with our peer review policy published on July 1, 1994 (59 FR 4270), and current Department of the Interior guidance, we solicited seven individuals with scientific expertise on *Lepidium papilliferum*, its habitat, and the geographic region in which the species occurs to provide their expert opinion and to review and interpret available information on the species' status and threats. Four of the seven peer reviewers had previously participated on a May 2006 expert panel of independent scientists convened to evaluate the available data and threats to *L. papilliferum* as part of our 2007 listing determination. Although all seven of the original expert panelists were invited to participate in the current evaluation, not all were available to do so. The peer reviewers were asked for their expert opinion on the best available information by responding to a series of questions posed by the Service regarding *L. papilliferum* population trends, threat factors, and their effects on *L. papilliferum* population viability. We received responses and comments from six of the seven peer reviewers, which are provided in the following summary and incorporated into the final rule as appropriate.

Peer Review Comments and Responses

Population Trend

(1) *Comment*: The peer reviewers differed in their explanation for describing a population trend for *Lepidium papilliferum*. One peer reviewer stated they have ''no confidence in any trend data due to small sample size and lack of independence between years,'' and asserted that there are no data to indicate that the population is in decline. Two peer reviewers agreed that the available information revealed a significant declining trend that was not strong for the years analyzed, but expressed a lack of confidence that this trend could be reliably projected into the future. Another peer reviewer did not see strong evidence for a declining population and believed that viable populations would be maintained over the next 50 years if current conservation efforts continue. One peer reviewer offered that ''ultimately, the availability and quality of suitable habitat, not past population trends, will determine *L. papilliferum*'s population trajectory.''

Our Response: In our 2007 withdrawal of the proposed rule to list *Lepidium papilliferum* as endangered (72 FR 1622; January 12, 2007), we stated that data on overall population trends for *L. papilliferum* were inconsistent. Since that time we have received and evaluated new information, including independent statistical analyses of long-term plant monitoring data, in an attempt to discern any long-term trend in the abundance of the species. We acknowledge that forming a reliable estimate of trend in the abundance of *L. papilliferum* over time is complicated by multiple factors; however, we are mandated by the Act to use the best available scientific and commercial data in our assessment. Therefore, we have relied upon that data we have determined to be most reliable for the discernment of population trend. As described above in the section **Population Abundance and Trend**, one complicating factor is that individual plants may act as either an annual or a biennial form in any given year, and there can be varying numbers of plants acting as either spring-flowering annuals or overwintering rosettes. The relative proportions of these two life-history forms can fluctuate annually depending on a variety of factors, including precipitation, temperature, and the abundance of rosettes produced the previous year (Unnasch 2008, pp. 14-15; Sullivan and Nations 2009, pp. 43-44, 134-135). Another factor is that *L. papilliferum* has a seed bank with a longevity of approximately 12 years, likely as an adaptation to a highly variable environment. Years of good rainfall favorable for germination and survival may be followed by periods of drought; a persistent seed bank provides a population buffer against years of poor

reproductive performance in a highly variable environment (Meyer *et al.* 2005, p. 21). The tendency of only a small percentage of a single year's seed cohort to germinate in any given year over a 12–year period results in a significant lag effect in detecting any real underlying change in total population abundance over the long term.

Further complications are posed by the extreme annual variability observed in plant numbers. This challenge was recognized by Mancuso and Moseley (1998, p. 1), who noted the difficulty in discerning any real trend in population abundance of above-ground individuals of *Lepidium papilliferum*, since in many years the majority of the population is represented by the seed bank, hence sites that ''have thousands of individuals one year may have none the next year.'' Some of the variability in yearly plant numbers is likely due to the relationship between *L. papilliferum* and precipitation. The annual abundance or density of *L. papilliferum* plants shows a significant positive association with the levels of spring rainfall, roughly from March through May (Meyer *et al.* 2005, p. 15; Palazzo *et al.* 2005, p. 9; Sullivan and Nations 2009, pp. 39-41), and the survival of biennials is associated with increased summer rainfall (Meyer *et al.* 2005, p. 15). In addition, temperature appears to play a role in annual abundance of *L. papilliferum* in concert with precipitation, although the exact nature of that relationship is complex and not well understood (Sullivan and Nations 2009, p. 57).

We contracted with independent consultants to analyze the available population data for *Lepidium papilliferum*, to assist us in determining which datasets represent the best available information and to provide an independent assessment of any population trend in the species, if possible. The resulting report, cited in this document as Sullivan and Nations 2009, was prepared to evaluate monitoring and survey methodologies and conduct statistical analyses on *Lepidium papilliferum* data collected on the OTA since 1990, as well as to analyze the rangewide Habitat Integrity and Population (HIP) monitoring data collected over the past 5 years (see our response to the **State of Idaho Comments**, below, for more information on the Sullivan and Nations 2009 report). This report was made available to the peer reviewers. The evaluation of Sullivan and Nations was based on a simple model of *L. papilliferum* abundance or density as a linear function of time, intended only to discern whether there was any general trend in the population; the authors acknowledge that the dynamics are complicated, and note that their model is not intended to describe (nor explain) the details of the temporal pattern of abundance or density of *L. papilliferum* (Sullivan and Nations 2009, p. 38). The authors concluded that the population data from the rough census monitoring on the OTA represents the most reliable dataset for the species, and that there is ''limited evidence for declining populations,'' in that trends on the OTA are negative but only statistically significant for the rough census areas (Sullivan and Nations 2009, pp. 2, 44).

The extreme variability in annual counts of the species makes it difficult to discern a trend in numbers with statistical confidence; for this reason for the purposes of modeling a trend through time, we place greater confidence in the longest time series of monitoring data available, which is from the OTA (up to 18 years of data for some rough census areas and all special-use plots). This is in agreement with the independent assessment of Sullivan and Nations (2009, pp. 3, 36, 93). In addition, those authors had slightly greater confidence in the data from the rough census areas on the OTA, since they are larger than the special-use plots and have multiple slickspots; therefore, the counts are less susceptible to localized impacts (Sullivan and Nations 2009, p. 55).

Because the OTA data on *Lepidium papilliferum* abundance and density results from a standardized collection effort over a period of nearly 20 years, we consider the information from the OTA to be the best available data with which to detect any general long-term population trend for *L. papilliferum*. The analysis of this dataset from the rough census areas on the OTA shows a statistically significant downward trend in density of *L. papilliferum* over the last 18 years. This trend appears to be independent of any trend in precipitation over the same time period, indicating this decline is occurring due to factors other than precipitation pattern (Zwartjes 2009, p. 1). We therefore conclude that the best available data suggest that *Lepidium papilliferum* numbers are probably trending downward. Furthermore, since this significant downward trend has been detected on the OTA, which represents some of the highest quality habitat remaining for *L. papilliferum*, we believe it is reasonable to infer that this negative trend is similar or possibly even greater rangewide, in areas of lower quality habitat.

We note that one peer reviewer questioned whether a decline in *Lepidium papilliferum* abundance is really occurring, based on high numbers of plants recorded in 2008. Another peer reviewer, however, had little confidence that this one-time observation was indicative of any long-term increasing trend. We note that the increase in numbers of *L. papilliferum* in 2008 is largely based on substantial increases at only 6 out of 80 HIP transects; 66 percent of all *L. papilliferum* counted in 2008 were found at these 6 transects (Colket 2009, p. 26). Furthermore, the plant community where these six transects are located has not been burned, and is dominated by native sagebrush (*Artemisia tridentata*). These six transects therefore represent some of the highest-quality habitat remaining for *L. papilliferum*. Since the increases observed in 2008 were highly localized and occurred in remnant high-quality habitats, and considering that rangewide most *L. papilliferum* occurrences are in degraded habitats and counts tend to be highly variable from year to year, we do not believe it is reasonable to infer that this one-time increase in abundance portends any future rangewide increases in abundance of the species. Please also see ''2008 HIP Survey Results'' under our response to public comments number 12, below.

Data Quality

(2) *Comment*: One peer reviewer stated that information contained in many of the study reports is based on data that were not collected for specific analysis, but instead represents an analysis that was performed on data whose accuracy is unknown or from small data sets comprised of interdependent data. Another peer reviewer noted the difficulty in comparing different data sets as well as data sets with differing collection methodologies; while another reviewer identified that several of the data sets examined were collected over such short periods (2 to 3 years) that the study results were of limited value. In contrast, another peer reviewer stated that it is important to make conclusions based on available information when unequivocal data is lacking.

Our Response: The Act requires us to make listing decisions based solely on the best scientific and commercial information available at the time the decision is being made (section 4(b)(1)(A)). We thoroughly reviewed and evaluated all available scientific and commercial data for *Lepidium papilliferum* in preparing this final listing determination. We reviewed historical and recent publications, as well as unpublished reports concerning *L. papilliferum* and sagebrush-steppe

habitats of southwestern Idaho. As part of our process, the seven peer reviewers were asked to provide a critical examination of the new scientific information pertaining to *L. papilliferum*. This information included both long-term and recent HII/HIP rangewide survey and monitoring data, the statistical analyses of long-term OTA monitoring data, and the 5 years of available HIP monitoring data completed by an independent consultant. In addition, we received an independent critique of the methodologies of several recent reports or analyses of L. *papilliferum* data (Sullivan and Nations 2009, pp. 139-148), to assist in our assessment of the best available data.

We agree that the differing methodologies and lack of standardization present challenges in evaluating the data relevant to *Lepidium papilliferum*. Furthermore, much of the data are observational in nature; that is, the data were not collected based on controlled experiments, but are primarily based on observations of the relative conditions or abundance of various environmental variables, such as livestock print cover and the relative abundance of *L. papilliferum*. However, as noted above, we have a legal obligation under the Act to make a determination based upon the best scientific and commercial data available at the time; the statute does not provide for additional research, nor does it provide the option of not making a determination. We must therefore evaluate all of the scientific and commercial data before us to determine which data we consider to be the best available. As part of our evaluation, we carefully considered factors such as the time series of data collection, the variability of the data, and standardization of data-collection procedures in weighing the relative value or reliability of study results. We considered all of these factors in considering the relative quality of the data available, and in determining which data to rely upon in our determination. Throughout our review and evaluation, we followed the Service's Information Quality Guidelines (USFWS 2007) to prepare this final determination.

Threats to the Species

(3) *Comment*: The peer reviewers varied in describing which threats they considered to be of primary importance to the population viability of *Lepidium papilliferum*. Three of the six peer reviewers expressed concern regarding the impact of wildfire on *L. papilliferum* and its habitat, while four of six peer reviewers mentioned habitat degradation and loss of the sagebrush-steppe habitat from exotic and invasive nonnative grasses to be of concern or a primary threat. Other threats identified included development (two reviewers), seed predation by harvester ants (two reviewers), and habitat fragmentation (two reviewers). One reviewer identified livestock as a potential threat, one reviewer asserted that there are no good data to suggest that livestock are a threat, and one reviewer suggested that, if managed appropriately, livestock could be utilized to manage the threat of nonnative invasive grasses and the associated increase in fire frequency. One peer reviewer stated that there are few reliable scientific studies to show any cause-and-effect relationships to *L. papilliferum*, and stated that the species continues to exist in areas of supposed threats, including ''burned over areas.''

Our Response: In making this determination, we evaluated several potential threat factors including the effects of wildfire; invasive nonnative plants; development; seed predation; livestock use; wildfire management; habitat fragmentation and small populations; military training; recreation; and climate change. Of all the threat factors examined, we determined that the modified wildfire regime affecting the species' sagebrush-steppe habitat in combination with the spread of nonnative invasive annual plants such as *Bromus tectorum* and *Taeniatherum caput-medusae* are likely the primary factors affecting abundance and the long-term persistence of *Lepidium papilliferum*. Tightly controlled experiments that demonstrate clear causal relationships between variables examined are rare. Studies that demonstrate a significant or non-significant correlation between variables are prevalent in the scientific literature, and in many cases, depending on factors such as the quality of the data and analysis, constitute the best information available. For example, such analyses have demonstrated a significant negative relationship between the density or abundance of *L. papilliferum* and the occurrence of fire and cover of *B. tectorum* (Sullivan and Nations 2009, pp. 116-118, 130-131, 135-137). Based on this observed significant relationship, we infer that as the occurrence of fire and the cover of *B. tectorum* increase, we will observe a decrease in the density or abundance of *L. papilliferum*. A complete review and evaluation of the threats affecting *L. papilliferum*, including a discussion of our rationale in assessing those threats, is presented in the **Summary of Factors Affecting the Species** section of this rule.

(4) *Comment*: The peer reviewers varied in their estimates of a time period over which they could reliably predict the effects of threats, both individually and synergistically, on the population viability and survival of *Lepidium papilliferum*. One peer reviewer could not ''reliably predict the effect of each of the primary threats to the species, based on the data before me since the data does not exist.'' Another peer reviewer suggested that given current trends in habitat loss and degradation, *Lepidium papilliferum* ''is likely at a tipping point in terms of its prospect for survival,'' and doubted that the species would persist in sustainable numbers beyond the next 50 to 75 years. Most peer reviewers did not project a time period for predicting threat effects or extinction risk, stating that future projections were likely speculative.

Our Response: As described above, the Act requires us to make listing decisions based solely on the best scientific and commercial data available at the time the decision is being made (section 4(b)(1)(A)). Based upon the best scientific and commercial data available, we must make a determination as to whether the species under consideration is in danger of extinction throughout all or a significant portion of its range (endangered), or if the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (threatened). We consider the ''foreseeable future'' to be that period of time over which events can reasonably be anticipated. In considering threats to the species and whether they rise to the level such that listing the species as threatened or endangered is warranted, we assess factors such as the imminence of the threat (is it currently impacting the species, and is it reasonable to expect the threat to continue into the future?), the scope or extent of the threat, the severity of the threat, and the synergistic effects of all threats combined. If we determine that the species is not currently in danger of extinction, then we must determine whether, based upon the nature of the threats, it is reasonable to anticipate that the species may become in danger of extinction within the foreseeable future.

We have identified the present or threatened destruction, modification, or curtailment of *Lepidium papilliferum*'s habitat or range as a threat to the species, based on the observed negative association between the abundance or density of the plant and the current, frequent fire regime and invasion of

Bromus tectorum and other nonnative plants, as well as the direct loss of limited slickspot microsite habitats to development. Predation is an additional threat to the persistence of the species, as seed predation by harvester ants has potentially significant consequences for the plant's seed bank, and the presence of harvester ants appears to be associated with the observed conversion of sagebrush-steppe to nonnative annual grasslands. Habitat fragmentation and isolation resulting from development and associated infrastructure, such as utility lines, contributes to the threats of wildfire and nonnative plant invasion, and may additionally impact *L. papilliferum* by limiting genetic exchange between populations via insect pollination. Climate change may further accelerate the conversion of intact sagebrush-steppe habitat to invasive nonnative annual grasslands, with subsequent associated increases in wildfire frequency and, potentially, harvester ant expansion. These threats are all occurring at present, and based on the evidence before us, we believe it is reasonable to anticipate that the current regime of frequently recurring wildfires, the invasion of nonnative grasses and other plants, development, and the expansion of harvester ants will continue and likely increase into the foreseeable future. Although conservation measures to address some of these threats have been considered and in some cases implemented, effective controls throughout the range of the *L. papilliferum* are simply not available in many cases. For example, it is not anticipated that landscapes dominated by *B. tectorum* can feasibly be restored to intact sagebrush-steppe habitat within the foreseeable future, as restoration of *L. papilliferum*'s native sagebrush-steppe ecosystem is considered one of the greatest restoration challenges in the Great Basin (Bunting *et al.* 2003, pp. 82-84). Moreover, the threats to *L. papilliferum* can reasonably be anticipated to continue or increase. This information, in concert with the observed negative association between these threats and the abundance of the species (in the further context of considerations such as the limited geographic extent of the species' range and the finite nature of its slickspot microhabitats), lead us to the conclusion that it is reasonable to anticipate that *L. papilliferum* is likely to become endangered in the foreseeable future. Based on our assessment of the best scientific and commercial data available regarding the past, present, and future threats faced by the species, we have therefore determined that *L. papilliferum* is a threatened species, as defined by the Act.

Seed Dispersal

(5) *Comment*: One peer reviewer suggested that the seeds of *L. papilliferum* can be widely dispersed by high winds, in addition to potential dispersal by animals. This reviewer stated that the seeds produce mucilage when wet and may likely have been dispersed by clinging to the wool of sheep, citing Rollins 1993, and suggests that *L. papilliferum* is not necessarily so highly specialized in its habitat requirements, but that the current distribution of *L. papilliferum* may be due to the past activities of Basque sheep herders.

Our Response: We acknowledge that the seeds of *Lepidium papilliferum* may occasionally be dispersed by wind. However, the species does not demonstrate any of the usual adaptations to assist in wind dispersal, such as winged seeds, that would indicate wind as the usual mode of dispersal for the species. In the paper cited by the reviewer, Rollins (1993, p. 535) suggests that the seeds of plants in the genus *Lepidium* may potentially be dispersed by sheep; this study was not specific to *L. papilliferum*, but appears to be more relevant to weedy *Lepidium* species of Europe and Asia, such as *L. perfoliatum*. In evaluating whether the present range of *L. papilliferum* may be due to the activities of either wind or Basque sheepherders, we considered both the current knowledge of the range of *L. papilliferum* and the results of recent genetic studies. *Lepidium papilliferum* is endemic to southwest Idaho, and the best available information indicates that there are no populations reported in other States where the Basques from Idaho would have also ranged with their sheep, thus indicating that sheep were likely not the primary vectors for seed dispersal that resulted in the current range of the species. In addition, if wind dispersal defined the range of the species, we would not expect the species to be confined to this limited range in southwest Idaho, as the wind would certainly be capable of carrying seeds beyond the present boundaries within which *L. papilliferum* is found. Finally, genetic studies showing that smaller populations of *L. papilliferum* have reduced genetic variability (Larson *et al.* 2006, p. 17) is not consistent with the theory that the seeds are wind-dispersed, which would provide a consistent source of genetic mixing and reduce the genetic isolation of these small populations, thereby maintaining genetic diversity. We therefore conclude that seed dispersal by wind or sheep is most likely not responsible for the current distribution of *L. papilliferum*, nor are these processes currently occurring at a level that is significant to the life history of the species.

Summary of Public Comments and Recommendations

Since the proposed rule was reinstated by the Court, there have been two public comment periods. During the September 19, 2008, 30–day comment period for the proposed rule, we received a total of seven comment letters in response to our request for new information: two from Federal agencies and five from organizations or individuals. The State of Idaho submitted comments and new information after the close of the comment period. During the March 17, 2009, 30–day comment period, we received 14 comments, including 6 solicited from peer reviewers. Of the public comments, all were received either in written form or through the portal at: *http://www.regulations.gov*.

Two public commenters generally supported the proposed rule to list the species; seven were opposed to the proposed rule, and the remaining were either neutral or provided new information regarding the proposed rule. Comments that provided new information were incorporated into this final determination, or are addressed below. Public comments received were grouped into six general issues, and are addressed in the following summary.

Public Comments

New Information

(6) *Comment*: Several commenters provided new data and information regarding the biology, ecology, life history, and threat factors affecting *Lepidium papilliferum*, and requested it be incorporated into the body of existing information the Service has on the species and be considered by us in making any future listing determinations.

Our Response: We thank the commenters who provided new data and information for our consideration in making this final listing determination. We have considered scientific and commercial information regarding *Lepidium papilliferum* contained in over 100 technical documents, published journal articles, and other general literature documents, including over 50 documents we have received since the January 2007 withdrawal of the proposed rule to list *L. papilliferum* (72 FR 1622; January 12, 2007). The body of available information specific to

L. papilliferum has increased since 2007, including new scientific information regarding the species' biology, ecology, and distribution; habitat quality monitoring; the implementation and effectiveness of ongoing conservation efforts; and information pertaining to threat factors affecting the species. This information was contained in State Agency reports (ICDC 2007a; ICDC 2007b; Quinney 2007; ICDC 2008; IDFG 2008; State of Idaho 2008; Unnasch 2008; Colket 2009; Robertson and White 2009) and other scientific reports and peer-reviewed articles (Billinge and Robertson 2008; Palazzo *et al*. 2008; Smith *et al*. in press). We also considered information contained in population survey and monitoring reports (Boise Airport 2003; Hoffman 2005; ICDC 2007b; Quinney 2007; U.S. Air Force (CH2MHill 2007a,b, 2008a,b); U.S. BLM 2007, 2008a; Cole 2008; Colket 2009). Additionally, to gain a better understanding of existing monitoring data, we contracted with independent consultants to conduct several analyses, including: a statistical analysis on long-term monitoring data collected at the OTA, an analysis of rangewide HIP data, and an assessment of the methodologies of other recent analyses (Sullivan and Nations 2009); a statistical and geospatial analysis of data collected during 2000-2002 field surveys at the Inside Desert of the Owyhee Plateau (Popovich 2009); and a geospatial analysis of wildfire and vegetation types within the range of *L. papilliferum* (Stoner 2009). Finally, in order to assess any potential relationship between abundance or density of *L. papilliferum* and precipitation trends over time, we conducted our own analysis of precipitation patterns at the OTA (Zwartjes 2009). All of the documents were made available to the public and provided to the six peer reviewers.

Appropriate Listing Status of Lepidium papilliferum

(7) *Comment*: One commenter stated that the Service should immediately move to list *Lepidium papilliferum* as endangered and simultaneously designate critical habitat. Conversely, the State of Idaho ''remains steadfast in its belief that the species does not warrant this protection'' (see State of Idaho comments, below). One other commenter agreed with this position and two commenters indicated that there is inadequate scientific information to make a decision to list *L. papilliferum* at this time, and requested additional studies be completed.

Our Response: Section 4(b)(1)(A) of the Act requires us to make listing decisions based solely on the best scientific and commercial data available. The Service has a legal obligation to make a determination based on the best available data before us at the time the decision is being made; the statute does not provide for additional research, nor does it provide the option of not making a determination. We have thoroughly reviewed all available scientific and commercial data for *Lepidium papilliferum* in preparing this final listing determination. We reviewed historical and recent publications as well as unpublished reports concerning *L. papilliferum* and the sagebrush-steppe habitat where it occurs in southwestern Idaho. In addition, we utilized peer review to provide a more focused, independent examination of the available scientific information and its application to the current status of the species. Finally, we contracted with independent consultants to assist us in analyzing *L. papilliferum* abundance and habitat quality monitoring data. As described in our response to peer review comments above (number 2), as part of our evaluation, we carefully consider the quality and reliability of all data to decide which constitutes the best available data for our consideration in making our final determination.

Our evaluation of the significance of the threat factors across the range of *Lepidium papilliferum* is presented in the **Summary of Factors Affecting the Species** section of this final determination. Additional discussion of our application of the standards of the Act in making our determination is provided in our response to peer review comment number 4, above. *Lepidium papilliferum* is currently affected by threat factors across its entire geographic range. Based on our evaluation, we believe it is reasonable to anticipate that the negative impacts of these threats on *L. papilliferum* rangewide will continue and even increase. Although we consider the impacts of these threats to be foreseeable and likely to result in the species becoming endangered within the foreseeable future, we do not consider *L. papilliferum* to be currently in danger of extinction. Furthermore, while we acknowledge the efforts of the State and other entities to implement conservation measures for the species, the best available information leads us to believe that currently available management tools are not capable of effectively reducing or ameliorating these threats across the range of the species. Based on our assessment of the best scientific and commercial data available regarding the threats faced by the species, we have determined that *L. papilliferum* meets the definition of a threatened species under the Act. We have also determined that designating critical habitat for *L. papilliferum* is prudent but not determinable at this time (see **Critical Habitat Determinability,** below).

Taxonomic Status of Lepidium papilliferum

(8) *Comment*: One commenter suggested that *Lepidium papilliferum* is a local variation of *Lepidium montanum*, and therefore is not a species or subspecies as defined under the Act. Another commenter stated that considerable uncertainty remains regarding the taxonomy of *L. papilliferum* and suggested that the Service conduct a genetic study to resolve any taxonomic disputes.

Our Response: *Lepidium papilliferum* was originally described as *L. montanum* var. *papilliferum* in 1900 by Louis Henderson. It was renamed *L. papilliferum* by Aven Nelson and J. Francis Macbride in 1913 based on its distinctive growth habit, short lifespan, and unusual pubescence (Nelson and Macbride 1913, p. 474). Hitchcock regarded *L. papilliferum* as *L. montanum* var. *papilliferum*, influencing several publications, including Flora of Idaho and Flora of the Pacific Northwest (Hitchcock *et al*. 1964, p. 516; Hitchcock and Cronquist 1973, p. 170; Steele 1981, p. 55; Moseley 1994, p. 2). In a 1993 review of taxa in the mustard family (Brassicaceae), Rollins maintained the species as *L. papilliferum* based on differences in the physical features between the two species such as:

(1) *L. papilliferum* has trichomes (hair-like structures) occurring on the filaments of stamens (the part of flower that produces pollen), but *L. montanum* does not;

(2) All the leaves on *L. papilliferum* are pinnately divided whereas *L. montanum* has some leaves that are not divided;

(3) The shape of the seed capsule (silicle [silique]) of *L. papilliferum* is different from that of *L. montanum*; and

(4) The silicle of *L. papilliferum* has no wings, or even vestiges of wings, at its apex (end of the capsule), unlike that of *L. montanum* (Rollins 1993, p. 578; Moseley 1994, p. 2). A review of the taxonomic status by Lichvar (2002), using classic morphological features and study of herbarium specimens, concluded that *L. papilliferum* has distinct morphological features that warrant species recognition. In addition, Meyer *et al*. (2005, p. 17) describe a

contrast in life history when compared to *L. montanum* regarding seed dormancy and the seed bank. *Lepidium papilliferum* seeds can remain dormant (and viable) and persist in the seed bank for up to 12 years; in contrast, *L. montanum* has largely nondormant seeds (Meyer *et al.* 2005, p. 17). Resolving one commenter's concern, a recent genetic study compared *L. montanum, L. papilliferum, and L. fremontii.* Results of the study indicated that *L. fremontii* and *L. papilliferum* are morphologically and ecologically distinct from *L. montanum,* with apparently little gene flow between *L. fremontii* and *L. papilliferum*, and *L. montanum* (Smith *et al.* in press, p. 18). *Lepidium papilliferum* is recognized as a distinct species by Intermountain Flora (Holmgren *et al.* 2005, p. 259), the U.S. Department of Agriculture's ''PLANTS Database'' (USDA 2006), and the Biota of North America Project (ITIS 2009). After considering all of this information, we believe that *L. papilliferum* is properly recognized as a full species, separate from *L. montanum*.

The Act requires the Service to use the best scientific data available when making listing determinations under section 4 of the Act. The Act, therefore, does not require the Service to conduct its own studies on species it is considering for protection under the Act, including genetic studies on the taxonomy of those species.

Conservation Agreements

(9) *Comment:* One commenter stated that the 2003 Candidate Conservation Agreement for Slickspot Peppergrass (CCA) by the State of Idaho, BLM, and others ''falsely assured'' readers that it would protect *Lepidium papilliferum* and its habitat. We also received information from the State of Idaho and the BLM describing ongoing conservation actions they are implementing under the CCA.

Our Response: We strongly support a collaborative conservation effort to address factors affecting species being considered for listing under the Act. Since February 2000, we have worked with numerous agencies and individuals to assess the status of *Lepidium papilliferum* and to identify and implement conservation actions on its behalf. We continue to participate as a technical advisor to an interagency group of biologists and stakeholders to share scientific information and coordinate conservation actions for *L. papilliferum* and its habitat.

In 2006, as part of a previous status review for *Lepidium papilliferum,* we conducted an evaluation of individual conservation efforts contained in five different plans, or conservation strategies, developed for *L. papilliferum*. These five plans were: (1) the 2003 CCA; (2) the Idaho Army National Guard (IARNG) Integrated Natural Resource Management Plan (INRMP) for Gowen Field/Orchard Training Area; (3) the U.S. Air Force INRMP for Mountain Home Air Force Base; (4) the Conservation Agreement by and between the City of Boise and the Service for *Allium aasea* (Aase's onion), *Astragalus mulfordiae* (Mulford's milkvetch) and *L. papilliferum*, also known as the Hull's Gulch Agreement; and (5) the Conservation Agreement for slickspot peppergrass (*Lepidium papilliferum*) at the Boise Airport, Ada County, Idaho.

The majority of the conservation efforts developed on behalf of *Lepidium papilliferum* that we examined are contained in the 2003 State of Idaho CCA, which was updated in 2006. The CCA includes efforts that are intended to address the need to maintain and enhance *L. papilliferum* habitat; reduce the intensity, frequency, and size of natural and human-caused wildfires; reduce the potential for invasion of nonnative plant species from wildfire; minimize the loss of the species' habitat associated with rehabilitation and restoration techniques; minimize the establishment of invasive nonnative species; mitigate the negative effects of military training and other associated activities; and minimize the impact of ground disturbances caused by livestock penetrating trampling during periods when soils are saturated. The IDARNG and U.S. Air Force are also implementing conservation efforts on lands they manage to potentially avoid or reduce adverse effects of military training on *L. papilliferum* and its habitat. For example, the IDARNG has been implementing conservation efforts at the OTA since 1991 that promote the conservation of *L. papilliferum*, while still providing for military training activities. These actions include intensive wildfire suppression efforts, and restricting ground operated military training to areas where the plants are not found. The U.S. Air Force INRMP was modified in 2004 and contains more measures that promote the conservation of *L. papilliferum* than the 2000 version. The current INRMP includes measures developed to minimize the effects of threats such as wildfire, nonnative invasive weeds, and livestock use on *L. papilliferum*. The Boise Airport Conservation Agreement lays out measures to protect and conserve the known occurrences of *L. papilliferum* at the airport, while the Hull's Gulch Conservation Agreement focuses on coordinating and planning activities with the Service in Hull's Gulch in the Boise Foothills.

With the exception of conservation efforts implemented by the IDARNG over the past 18 years, many of the conservation efforts presented in the conservation plans, although laudable, have not been implemented over a period of time long enough for effectiveness to be adequately demonstrated. Similarly, the adaptive management provisions in the 2003 State of Idaho CCA have not been implemented long enough to have sufficient certainty of their effectiveness in addressing the long-term conservation of *L. papilliferum*. We recognize the conservation efforts identified in the conservation plans can have benefits for the species and its habitat, particularly with limiting the effects of wildfire and livestock use. Despite the best intentions, however, many of the measures identified in the conservation plans are limited in their ability to effectively reduce long-term habitat degradation or loss in the sagebrush-steppe ecosystem, including the negative impacts observed on slickspots and *L. papilliferum* associated with that degradation or loss. For example, there is currently no effective control of *Bromus tectorum* available to mitigate its effect on *L. papilliferum* and its synergistic interactions with frequent wildfires to a degree sufficient that we would consider it no longer a threat to the species.

Climate Change

(10) *Comment:* One commenter indicated that the effects of global warming and climate change on the species must be considered in our analyses of potential threats to the species and its habitat.

Our Response: We agree, and have provided a discussion of the potential impacts of climate change on *Lepidium papilliferum* in this rule. In brief, there is compelling scientific evidence that we are living in a time of rapid, worldwide climate change. For example, 11 of the last 12 years evaluated (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850) (ISAB 2007, p. iii). While the effects of global climate change are uncertain, it has the potential to affect rare plants and their habitats, including *L. papilliferum*. Although the Service cannot identify specific potential effects on the species at this time, some models indicate that climate change may

provide an environment conducive to further conversion of the sagebrush-steppe ecosystem by invasive nonnative annual grasslands, which would have negative consequences for *L. papilliferum*; fire frequency and extent is predicted to increase as well. Although we do not consider climate change to pose a significant threat to *L. papilliferum* in and of itself, we do consider climate change to be a potentially important contributing factor to the primary threats of frequent wildfire and invasive nonnative plants, particularly *B. tectorum*, and especially in regard to our evaluation of the likelihood of the continuation of these threats into the foreseeable future. A complete description of the potential effects from climate change and our evaluation of this threat is found in Factor E of the **Summary of Factors Affecting the Species** discussion.

Livestock Grazing

(11) *Comment*: Two commenters provided information to support the argument that livestock grazing is detrimental to *Lepidium papilliferum*. Four commenters provided comment or new information to support the countering view, indicating that livestock grazing is not detrimental or could be beneficial to the species.

Our Response: Livestock use in areas that contain *Lepidium papilliferum* has the potential to result in either positive or negative effects on the species, depending on a variety of factors such as stocking rates and season of use. The most visible negative effect on *L. papilliferum* and its slickspot habitat is from mechanical disturbance due to trampling, which can affect the fragile soil layers of slickspots and compromise their integrity and function (Seronko 2004; Meyer *et al.* 2005, pp. 21-22). Livestock trampling and compaction of slickspots may also bury seeds to such a depth that germination is no longer possible (Meyer *et al.* 2005, pp. 21-22). We are aware of three incidents where livestock trampling events have apparently resulted in a dramatic decrease in *L. papilliferum* numbers at sites where the plants were formerly abundant, while reduced plant numbers were not observed at similar adjacent sites within the same year (Robertson 2003b, p. 8; Meyer *et al.* 2005, p.22; Colket 2006, pp. 10-11). *Lepidium papilliferum* numbers are slowly recovering at the site in the Boise Foothills (Colket 2009, p. 31), the site at the OTA has shown no apparent recovery over time (Meyer *et al.* 2005, p.22), and the fate of the third site at Glenns Ferry is unknown, as it has not been revisited since the event.

Conversely, it is hypothesized that livestock use, at an appropriate level and season, may reduce the effect of invasive nonnative annual grasses at some *L. papilliferum* sites by reducing fine fuel loads, thereby decreasing the risk of wildfire (e.g., Loeser *et al.* 2007, p. 94, and references therein; Launchbaugh *et al.* 2008; Romero-Calcerrada *et al.* 2008, p. 351). Data limitations currently make it difficult to establish effect thresholds from livestock management activities on *L. papilliferum* and its habitat. There have been adaptive management techniques implemented for livestock use in some areas occupied by *L. papilliferum*, and several recent studies have examined the relationship between livestock trampling effects and *L. papilliferum* abundance (Popovich 2009; Salo 2009; Sullivan and Nations 2009). As described in detail in ''*Livestock Use*'' under Factor A in the **Summary of Factors Affecting the Species** section, above, we consider the risks associated with livestock use, as currently practiced, to be a lesser threat than other factors that have been demonstrated to adversely impact the species rangewide. We encourage the continued implementation of conservation measures and associated monitoring to ensure potential impacts of livestock trampling to the species are avoided or minimized.

Data Quality and Interpretation

(12) *Comment*: There were several comments regarding the use of available monitoring and survey data in determining the historical and existing distribution, population size, and trend information for *Lepidium papilliferum.* One commenter and one peer reviewer stated that there have been no comprehensive systematic surveys for *L. papilliferum,* and therefore, we do not fully understand the distribution or status of the species. In addition, the peer reviewer indicated that the number of element occurrences has increased between 1998 (45 extant EOs) and 2008 and will continue to increase. One commenter suggested that the data demonstrate a negative population trend for *L. papilliferum;* other commenters suggested the data are inconclusive, and no trend can be determined. Several commenters cited information relating *L. papilliferum* annual abundance to precipitation. One commenter and one peer reviewer stated that the Service's determination that there is evidence of a statistically significant population decline ignores the fact that 2008 was the highest population year on record. Another peer reviewer expressed a lack of confidence that the high number of plants in 2008 portends any long-term increase in the population. One commenter stated that the high *L. papilliferum* numbers documented in 2008 agree with the Service's 2007 conclusion that the overall population trend for the species is inconsistent. Two commenters and one peer reviewer stated that the Service should be transparent in the quality and source of the data used in making our determination.

Our Response: As previously stated, we have reviewed and considered scientific and commercial data contained in numerous technical reports, published journal articles, and other documents. We must base our listing determination for *Lepidium papilliferum* on the best available data regarding the plant's current known population status, the known condition of its habitat, and the current factors affecting the species, along with ongoing conservation efforts, as described in the Summary of Factors Affecting the Species section of this final determination. We acknowledge that uncertainties exist; however, section 4 of the Act mandates that we make a listing determination based on the best scientific and commercial available at the time of our determination.

Our response is grouped by the following topics: Survey efforts, population trends, 2008 HIP survey results, and data quality and transparency.

Survey Efforts: As systematic rangewide surveys have not occurred, we agree that undiscovered sites occupied by *L. papilliferum* likely exist. Inventories for *L. papilliferum* have not been completed on the majority of private lands within its range due to restricted access. However, occupied slickspot sites and EOs discovered since 1998 have not added substantially to our knowledge of where the species exists; these new sites have all been within the known range of the species. For example, an inventory survey on BLM lands in the Owyhee Plateau physiographic region in 2007 documented 200 slickspots containing *L. papilliferum* plants within the known range of the plant (ERO 2008, p. 7). See our response to State of Idaho comments for additional information on potential *L. papilliferum* survey areas based on a recent modeling effort.

Population Trends: Please see our response to peer review comments, number 1, above.

2008 HIP Survey Results: Rangewide, more slickspot peppergrass plants were counted in 2008 than in any other of the 5 years of HIP monitoring (Colket 2009, p. 26). This result was largely based on

substantial increases in the number of slickspot peppergrass plants at only 6 of the 80 HIP transects (008A, 027A, 027D, 066, 067, and 070). Sixty-six percent of all slickspot peppergrass plants counted in 2008 (27,544 out of 41,672 plants) occurred at these 6 HIP transects, which represent only 8 percent of the total number of HIP transects rangewide (Colket 2009, p. 26). Two of the HIP transects with high plant numbers in 2008 (066 and 070) are located in the Boise Foothills physiographic region. The four remaining HIP transects with high plant numbers in 2008 were located on the Snake River Plain physiographic region, with three of these transects being located on the OTA (027A, 027D, 067). We cannot explain why these six transects exhibited such high plant numbers in 2008, but it should be noted that each of these six HIP transects are located in areas where the plant community is unburned and is dominated by the native sagebrush *Artemisia tridentata* (Colket 2009, p. 26). Sites exhibiting these characteristics are considered high quality habitat for *L. papilliferum*.

Data Quality and Transparency: In compiling this document, we tried to present the information in an accurate, clear, complete, and unbiased manner. Given that the data available on this species covered a wide spectrum from peer-reviewed literature to personal communications, we developed this document with the goal of providing a high degree of transparency regarding the source of data. We followed the Service's Information Quality Act Guidelines in developing this document (USFWS 2007. These guidelines provide direction for ensuring and maximizing the quality of information disseminated to the public. The guidelines define quality as an encompassing term that includes utility, objectivity, and integrity. Utility refers to the usefulness of the information to its intended users, including the public. Objectivity includes disseminating information in an accurate, clear, complete, and unbiased manner and ensuring accurate, reliable, and unbiased information. If data and analytic results have been subjected to formal, independent peer review, we generally presume that the information is of acceptable objectivity. Integrity refers to the security of information, i.e., protection of the information from unauthorized access or revision to ensure that the information is not compromised through corruption or falsification. One of our goals in obtaining public comment and peer review of new information available on *Lepidium papilliferum* since January 2007 was to ensure that we were considering the best available data while accurately representing the source of the information. Background information on the taxonomy, distribution, abundance, life history, conservation actions, and needs of *L. papilliferum,* and threats affecting the species, were derived from previous petition findings, previous **Federal Register** notices, Idaho's Natural Heritage Program (formerly Idaho Conservation Data Center) EO records, and other pertinent references from 1897 (when the species was first collected) through April of 2009.

State of Idaho Comments

(13) *Comment:* The State of Idaho requested the Service conduct an independent review of available information, including: a third-party audit of the monitoring and survey information collected by the IDARNG and other researchers at the OTA; re-examine the prior inferences the Service has drawn from available information; apply statistical analysis to the available information; and evaluate whether there are more, currently undiscovered populations.

Our Response: Prior to making our determination in this final rule, the Service has considered all of these issues and conducted the reviews suggested by the State; the results of all of these reviews were made available during the most recent comment period on the proposed rule to list *Lepidium papilliferum.* During the fall of 2008, the Service contracted with independent consultants to evaluate the various monitoring and survey methodologies for *L. papilliferum* and conduct statistical analyses on data collected on the OTA since 1990. The consultants also analyzed the rangewide HIP data collected over the past 5 years to examine any trends in *L. papilliferum* abundance in relation to environmental parameters measured as part of the HIP monitoring. In total, the consultants examined the four ongoing *L. papilliferum* survey programs conducted on the OTA. Three of the survey programs are conducted solely on the OTA, and two of these (rough census and special-use plots) have been implemented at the same locations since the early 1990s. The third program is a block search that looks at both new and previously surveyed areas for unknown populations of *L. papilliferum*. The fourth survey and monitoring program, partially conducted at the OTA, is the rangewide HII and HIP monitoring that has been performed by the INHP since the late 1990s. The results of this independent analysis were reported in a document titled: *Analysis of slickspot peppergrass (Lepidium papilliferum) population trends on Orchard Training Area and Rangewide Implications*, cited here as Sullivan and Nations (2009). The Sullivan and Nations (2009) report, as well as a report on the statistical and geospatial analysis of data collected during the 2000-2002 field surveys at the Inside Desert of the Owyhee Plateau (Popovich 2009), and a contracted geospatial analysis of wildfire and vegetation types within the range of *L. papilliferum* (Stoner 2009), were provided to the six peer reviewers and made available to the public for consideration and evaluation of all best available scientific and commercial data during the second comment period, and the results of these independent reports and reviews were incorporated into this final rule.

In an effort to evaluate the probability that *Lepidium papilliferum* may be found in other areas, the Service requested the INHP develop a model for predicting *L. papilliferum* distribution based on factors such as elevation, soil types, precipitation, and underlying geology (Colket 2008, p. 2). This model identified several potential areas in southwest Idaho with a relatively high probability of supporting *L. papilliferum* in areas outside the known range of the species. Although preliminary surveys of these areas did not result in the discovery of additional *L. papilliferum* sites (Colket 2008, pp. 4-6), we believe that this model can be used as a tool to prioritize areas targeted for future surveys and conservation planning efforts for *L. papilliferum* (Colket 2008, p. 7). Past searches have occurred for this species in Oregon (Findley 2003) and outside of its known range in Idaho (BLM 2000), but the species has never been found in these areas. The BLM is aware of our interest in the possible location of *L. papilliferum* in Oregon, and their botanists continue to look for the species during the course of their surveys (Foss 2009), but to date it has not been found. The best currently available information does not indicate that there has been a significant increase in the known range of *L. papilliferum* since our 2007 decision.

In the past, questions were raised regarding why expanded surveys on the OTA conducted by URS in 2005 recorded higher numbers of *Lepidium papilliferum* than had been previously observed. Sullivan and Nations (2009) were able to clarify that the large number of *L. papilliferum* plants counted by URS likely resulted from a more intensive search effort over a larger area in 2005 compared to what is normally examined during the rough

census or special-use plot monitoring efforts (Sullivan and Nations 2009, p. 2). Although this survey indicated that there were more *L. papilliferum* on the OTA than previously documented, it did not increase the known range of the species.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition of the status, increased priority for research and conservation funding, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness and conservation by Federal, State, and local agencies, private organizations, and individuals. The listing of *Lepidium papilliferum* will lead to the development of a recovery plan for the species. Under section 6 of the Act, we would be able to grant funds to the State of Idaho for management actions promoting the conservation of *L. papilliferum*. A full discussion of the ongoing conservation actions by Federal, State, and local entities involved with *Lepidium papilliferum* conservation is described elsewhere in this document (see **Evaluation of Conservation Efforts**, above).

The Act requires Federal agencies to implement recovery actions, as well as encourages non-Federal entities to support and carry out recovery goals for listed species. The protection measures required of Federal agencies and the prohibitions against certain activities involving listed plants are discussed, in part, below.

Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated or proposed for designation. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(2) requires Federal agencies, including the Service, to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat if any has been designated. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must consult with us under the provisions of section 7(a)(2) of the Act.

For *Lepidium papilliferum,* Federal agency actions that may require consultation as described in the preceding paragraph may include actions that would affect slickspot soil integrity or function, individual *L. papilliferum* plants, or the seed bank of the plant. Such actions may include, but are not limited to: soil stabilization and rehabilitation activities; wildfire suppression and rehabilitation activities; construction and maintenance of infrastructure such as roads, electronic transmission lines, radio towers, and buildings; livestock grazing permits and other Federal permitting actions; livestock range improvements by the BLM; or actions undertaken by branches of the Department of Defense, U.S. Army Corps of Engineers, Federal Emergency Management Agency, and the Federal Highways Administration. Section 7 consultation may also be required by the provision of Federal funds to State and private entities through Federal programs such as the Service's Partners for Fish and Wildlife Program and Federal Aid in Wildlife Restoration Program, and a variety of grants administered by the U.S. Department of Agriculture, Natural Resources Conservation Service, the Federal Housing Administration, and the Farm Services Agency. Other activities that may require consultation include military training activities by the Air Force or the Idaho Army National Guard. Federal actions not affecting the species, as well as actions on non-Federal lands that are not federally funded, authorized, or permitted, do not require section 7 consultation, although the latter are still potentially subject to section 9's prohibitions.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all threatened plants. All prohibitions of section 9(a)(2) of the Act, implemented by 50 CFR 17.71, apply to both endangered and threatened species. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to import or export, transport in interstate or foreign commerce in the course of a commercial activity, sell or offer for sale in interstate or foreign commerce, or remove and reduce the species to possession from areas under Federal jurisdiction. In addition, for plants listed as endangered, the Act prohibits the malicious damage or destruction on areas under Federal jurisdiction and the removal, cutting, digging up, or damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. Section 4(d) of the Act allows for the provision of such protection to threatened species through regulation. This protection may apply to this species in the future if regulations are promulgated. Seeds from cultivated specimens of threatened plants are exempt from these prohibitions provided that their containers are marked ''Of Cultivated Origin.'' Certain exceptions to the prohibitions apply to agents of the Service and State conservation agencies.

The Act and 50 CFR 17.72 also provide for the issuance of permits to carry out otherwise prohibited activities involving threatened plants under certain circumstances. Such permits are available for scientific purposes and to enhance the propagation or survival of the species. For threatened plants, permits also are available for botanical or horticultural exhibition, educational purposes, or special purposes consistent with the purposes of the Act. We anticipate that few trade permits will ever be sought or issued for *Lepidium papilliferum* because the species is not in cultivation or common in the wild. Requests for copies of the regulations regarding listed species and inquiries about prohibitions and permits may be addressed to U.S. Fish and Wildlife Service, Endangered Species Permits, 911 NE. 11th Avenue, Portland, OR 97232-4181.

We adopted a policy on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of the listing on future and ongoing activities within a species' range. We believe that based upon the best available information, the actions listed below would not result in a violation of section 9 of the Act provided these activities are carried out in accordance with existing regulation and permit requirements:

(1) Activities authorized, funded, or carried out by Federal agencies (e.g., grazing management, agricultural conversions, range management, rodent control, mineral development, road construction, human recreation, pesticide application, controlled burns) and construction/maintenance of facilities (e.g., fences, power lines, pipelines, utility lines) when such activity is conducted according to any reasonable and prudent measures prescribed by the Service in a consultation conducted under section 7 of the Act; and

(2) Casual, dispersed human activities on foot (e.g., bird watching, sightseeing, photography, and hiking).

The actions listed below may potentially result in a violation of

section 9 of the Act; however, possible violations are not limited to these actions alone:

(1) Unauthorized collecting of the species on Federal Lands;

(2) Interstate or foreign commerce and import/export without previously obtaining an appropriate permit.

Permits to conduct activities are available for purposes of scientific research and enhancement of propagation or survival of the species.

Questions regarding whether specific activities, such as changes in land use, will constitute a violation of section 9 should be directed to the Idaho Field Office (see **ADDRESSES** section).

Critical Habitat

Critical habitat is defined in section 3 of the Act as: ''(i) The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the Act, upon a determination by the Secretary of the Interior that such areas are essential for the conservation of the species'' (16 U.S.C. 1532(5)(A)).

Conservation, as defined under section 3(3) of the Act, means ''the use of all methods and procedures which are necessary to bring any endangered or threatened species to the point at which the measures provided under this Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking'' (16 U.S.C. 1532(3)).

The primary regulatory effect of critical habitat is the requirement, under section 7(a)(2) of the Act, that Federal agencies shall ensure that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of designated critical habitat. Section 7(a)(2) of the Act requires consultation on Federal actions that may affect critical habitat. The designation of critical habitat does not affect land ownership or establish a refuge, wilderness, reserve, preserve, or other conservation area. Such designation does not allow the government or public to access private lands. Such designation does not require implementation of restoration, recovery, or enhancement measures by private landowners. Where a landowner requests Federal agency funding or authorization for an action that may affect a listed species or critical habitat, the consultation requirements of section 7(a)(2) of the Act would apply, but even in the event of a destruction or adverse modification finding, the landowner's obligation is not to restore or recover the species, but to implement reasonable and prudent alternatives to avoid destruction or adverse modification of critical habitat.

For inclusion in a critical habitat designation, the habitat within the geographical area occupied by the species at the time of listing must contain the physical and biological features essential to the conservation of the species, and be included only if those features may require special management considerations or protection. Critical habitat designations identify, to the extent known using the best scientific data available, habitat areas that provide essential life cycle needs of the species (i.e., areas on which are found the primary constituent elements (PCEs) laid out in the appropriate quantity and spatial arrangement for the conservation of the species). Under the Act, we can designate critical habitat in areas outside the geographical area occupied by the species at the time it is listed only when we determine that those areas are essential for the conservation of the species.

Section 4 of the Act requires that we designate critical habitat on the basis of the best scientific and commercial data available. Further, our Policy on Information Standards Under the Endangered Species Act (59 FR 34271; July 1, 1994), the Information Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Pub. L. 106-554; H.R. 5658)), and our associated Information Quality Guidelines issued by the Service, provide criteria, establish procedures, and provide guidance to ensure that our decisions are based on the best scientific data available. They require our biologists, to the extent consistent with the Act and with the use of the best scientific data available, to use primary and original sources of information as the basis for recommendations to designate critical habitat.

When we are determining which areas should be designated as critical habitat, our primary source of information is generally the information developed during the listing process for the species. Additional information sources may include the recovery plan for the species, articles in peer-reviewed journals, conservation plans developed by States and counties, scientific status surveys and studies, biological assessments, or other unpublished materials and expert opinion or personal knowledge.

Prudency Determination

Section 4(a)(3) of the Act, as amended, and implementing regulations (50 CFR 424.12), require that, to the maximum extent prudent and determinable, the Secretary designate critical habitat at the time a species is determined to be endangered or threatened. Our regulations (50 CFR 424.12(a)(1)) state that the designation of critical habitat is not prudent when one or both of the following situations exist: ''(i) [t]he species is threatened by taking or other human activity, and identification of critical habitat can be expected to increase the degree of such threat to the species, or ii) [s]uch designation of critical habitat would not be beneficial to the species.''

There is no documentation that *Lepidium papilliferum* is threatened by taking or other human activity. In the absence of finding that the designation of critical habitat would increase threats to a species, if there are any benefits to a critical habitat designation, then a prudent finding is warranted. The potential benefits include: (1) Triggering consultation under section 7 of the Act for actions in which there may be a Federal nexus where it would not otherwise occur because, for example, the area is or has become unoccupied or the occupancy is in question; (2) focusing conservation activities on the most essential features and areas; (3) providing educational benefits to State or county governments or private entities; and (4) preventing people from causing inadvertent harm to the species.

The primary regulatory effect of a critical habitat designation is the section 7(a)(2) requirement that Federal agencies refrain from taking any action that destroys or adversely affects critical habitat. At present, the known extant individuals of *Lepidium papilliferum* occur on Federal, State, and private land, and all previously known occurrences have been on Federal, State, and private lands. State and private lands that may be designated as critical habitat in the future for this species may be subject to Federal actions that trigger

the section 7 consultation requirement, such as the granting of Federal monies for conservation projects or the need for Federal permits for projects. Therefore, since we have determined that the designation of critical habitat will not likely increase the degree of threat to the species and may provide some measure of benefit, we find that designation of critical habitat is prudent for *L. papilliferum*.

Critical Habitat Determinability

As stated above, section 4(a)(3) of the Act requires the designation of critical habitat concurrently with the species' listing ''to the maximum extent prudent and determinable'' (16 U.S.C. 1533(a)(3)). Our regulations at 50 CFR 424.12(a)(2) state that critical habitat is not determinable when one or both of the following situations exist:

(i) Information sufficient to perform required analyses of the impacts of the designation is lacking, or

(ii) The biological needs of the species are not sufficiently well known to permit identification of an area as critical habitat.

When critical habitat is not determinable, the Act provides for an additional year to publish a critical habitat designation (16 U.S.C. 1533(b)(6)(C)(ii)).

In accordance with section 3(5)(A)(i) of the Act and regulations at 50 CFR 424.12, in determining which areas occupied by the species at the time of listing to designate as critical habitat, we consider those physical and biological features essential to the conservation of the species that may require special management considerations or protection. We consider the physical or biological features to be the PCEs laid out in the appropriate quantity and spatial arrangement for the conservation of the species. The PCEs listed at 50 CFR 424.12(b) include, but are not limited to:

(1) Space for individual and population growth and for normal behavior;

(2) Food, water, air, light, minerals, or other nutritional or physiological requirements;

(3) Cover or shelter;

(4) Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally

(5) Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

Although we have determined that the designation of critical habitat is prudent for *Lepidium papilliferum,* new and revised information received since the 2007 withdrawal notice (72 FR 1622) has to be evaluated to determine the physical and biological features that may be essential for the conservation of the species in those areas that were occupied at the time of listing, or areas that may be essential to the conservation of the species outside of the area occupied at the time of listing. For example, we have received new information regarding the effects of seed predation indicating that this emerging threat may have a serious impact on the long-term viability of *L. papilliferum.* However, our current understanding of the overall significance of this threat is limited by its recent discovery and having only short-term evaluation results available. We also have new information indicating that competition with nonnative plants in slickspots has a significant impact on the ability of *L. papilliferum* to persist in these specialized microsites. A thoughtful assessment of the designation of critical habitat will require additional time to evaluate the physical and biological features essential to the conservation of the species in light of our new understanding of these emerging threats. Therefore, we find that critical habitat for *L. papilliferum* is not determinable at this time.

Required Determinations

Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*)

This rule does not contain any new collections of information that require approval by Office of Management and Budget (OMB) under the Paperwork Reduction Act. This rule will not impose recordkeeping or reporting requirements on State or local governments, individuals, businesses, or organizations. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

National Environmental Policy Act

We have determined that we do not have to prepare environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*), in connection with regulations we issued under section 4(a) of the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A complete list of all references cited herein is available on the Internet at *http://www.regulations.gov*. In addition, a complete list of all references cited herein, as well as others, is available upon request from the Idaho Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this document are staff members of the Idaho Fish and Wildlife Office, U.S. Fish and Wildlife Service (see **ADDRESSES**).

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting, and recordkeeping requirements, Transportation.

Regulation Promulgation

■ Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as follows:

PART 17—[AMENDED]

■ 1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361-1407; 16 U.S.C. 1531-1544; 16 U.S.C. 4201-4245; Pub. L. No. 99-625, 100 Stat. 3500; unless otherwise noted.

■ 2. Amend § 17.12(h) by adding the following entry to the List of Endangered and Threatened Plants in alphabetical order under ''Flowering Plants'':

§ 17.12 Endangered and threatened plants.

* * * * *

(h) * * *

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
FLOWERING PLANTS							
*	*	*	*	*	*	*	

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
Lepidium papilliferum	Slickspot peppergrass	U.S.A. (ID)	Brassicaceae	T	765	NA	NA

* * * * *

Dated: September 24, 2009

Daniel M. Ashe

Deputy Director, Fish and Wildlife Service

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