AN ECOLOGICAL INTEGRITY INDEX TO ASSESS AND MONITOR *LEPIDIUM PAPILLIFERUM* (SLICKSPOT PEPPERGRASS) HABITAT IN SOUTHWESTERN IDAHO

By

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ABSTRACT

Lepidium papilliferum (slickspot peppergrass) is an annual and biennial plant species endemic to southwestern Idaho that has become one of the state's highest priority rare plant conservation concerns. To assist conservation efforts for this species we have developed an index to assess and monitor the ecological integrity of slickspot peppergrass habitat. Monitoring the habitat focuses on the most important factor responsible for the decline of slickspot peppergrass, namely, the loss of high quality habitat due to perturbations in the sagebrush-steppe ecosystem of the western Snake River Plain.

The index, called the Habitat Integrity Index uses community compositional, structural, and functional metrics as a means to evaluate system integrity. Attributes for the index focus on three types of disturbances that are widespread, interrelated, and of management concern in southwestern Idaho - wildfire, livestock grazing, and off-road motorized use. The index is based on a relative scale, with numerical scores providing a means to rank habitat integrity. The index should have several practical conservation applications, such as identifying and analyzing conservation strategies, priorities and research needs.

This is part of a two year project. The first year, 1997, was dedicated to researching, developing, and field testing the index. This report summarizes our 1997 results. The second phase of the project will use the index to collect baseline habitat integrity data at selected extant slickspot peppergrass occurrences.

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INTRODUCTION

Lepidium papilliferum (slickspot peppergrass) is an annual and biennial plant species endemic to southwestern Idaho that has become one of the state's highest priority rare plant conservation concerns. The conservation of slickspot peppergrass is largely dependent on conserving its sagebrush-steppe habitat. Large blocks of the original sagebrush-steppe ecosystem on the western Snake River Plain and nearby foothills have been converted to crop agriculture or urban/suburban centers. Most of the remaining regional sagebrush-steppe is in an impoverished ecological condition due to intensive use dating back to the late 1800's.

Like many short-lived plants growing in arid environments, the above-ground number of slickspot peppergrass individuals can fluctuate widely from year to year depending on seasonal precipitation patterns. Flowering individuals represent only a portion of the population, with the seed bank contributing the remainder, and apparently the majority in many years. Sites with thousands of individuals one year may have none the next year. The reverse is also true. Therefore, estimating the number of above-ground plants is by itself not a reliable measure to evaluate population and species viability. An assessment of habitat quality needs to be part of the monitoring strategy for species like slickspot peppergrass because it is less influenced by annual climate variations. We have developed an index to assess and monitor the ecological integrity of slickspot peppergrass habitat. Monitoring habitat focuses on the most important factor responsible for the decline of slickspot peppergrass, namely, the loss of high quality habitat due to perturbations in the sagebrush-steppe ecosystem of the western Snake River Plain.

This is part of a two year project. The first year, 1997, was dedicated to researching, developing, and field testing the index. This report summarizes our 1997 results. The second phase of the project will be to use the index and collect baseline habitat integrity data at selected extant slickspot peppergrass occurrences. This baseline information can then be used to assess and monitor long-term trends in habitat quality and species conservation. The integrity index is augmented by a viability rank assigned to each occurrence, as well as two other monitoring protocols - vegetation sampling and repeat photo-documentation.

BACKGROUND

Lepidium papilliferum

Lepidium papilliferum is an ephemeral monocarpic species belonging to the mustard (Brassicaceae) family. It is known only from southwestern Idaho, with populations scattered throughout the western Snake River Plain and nearby foothills. There are also a few disjunct populations known from further south on the Owyhee Plateau. Slickspot peppergrass is restricted to visually distinct small-scale openings within the region's sagebrush-steppe ecosystem. These sparsely-vegetated microsites are created by unusual edaphic conditions and known by various names (natric sites, mini-playas, playettes, slick spots).

Slickspot peppergrass is a high priority conservation concern in Idaho largely due to serious and ongoing habitat threats. Degradation, fragmentation, and loss of sagebrush-steppe vegetation has occurred throughout the species' range. Many populations appear to have been extirpated during the last century, while the long-term prospects for many of the extant populations is grim (Moseley 1994). Major land uses throughout the species' range are urbanization, irrigated agriculture, and rangeland livestock grazing. These have all contributed to the cumulative loss of high quality sagebrush-steppe habitat. More detailed distribution, habitat, life history, population, and threat information regarding slickspot peppergrass is discussed elsewhere (Fisher et al. 1996; Meyer 1993; Meyer and Quinney 1993; Moseley 1994).

Integrity Indices

With uses as basic as identifying where to plant crops, biological indices have helped humans assess their environment for centuries (Warren 1971). The idea of using an integrity index for natural resource monitoring purposes is more recent, however. The first one to receive widespread acceptance and use is the Index of Biotic Integrity (IBI) developed over 25 years ago to assess and monitor biological conditions in rivers in the Midwestern United States (Karr 1981). The IBI and similar indices are attempts to quantify quality. They are based on series of assumptions about how assemblages change with increased environmental degradation (Hughes and Ross 1992). Results can be compared to region-specific expectations for a non-degraded reference area (Angermeier and Karr 1994). For example, the IBI integrates information from various fish community attributes such as trophic function, reproductive function, indicator species or guilds, species composition, age structures/growth rates, fish abundance, and/or fish condition. The ordering and interpretation of this information provides the ecological framework for the IBI. Over the years, IBI's have been developed for river and stream fish and invertebrate communities throughout the world (Karr 1990; 1997). Some indices incorporate certain physical and chemical stream parameters into the methodology (Winget and Mangum 1979). The correlation of IBI's with landscape features such as land use and riparian habitats has also been investigated (Roth et al. 1996). In all of its forms, IBI's have played an important role in environmental health assessment and the biological monitoring of environmental degradation (Lyon et al. 1995).

Over the years, integrity indices have been primarily used to assess the condition of aquatic systems. Efforts to apply similar indices to terrestrial systems have lagged far behind (Angermeier and Karr 1994). This may be changing as terrestrial IBI's using plants, insects, and birds are now being tested (Karr 1997). The Habitat Integrity Index (HII) for slickspot peppergrass is an example of the integrity index concept being applied to a terrestrial ecosystem. The HII is related to the IBI concept in several ways. Most basic, is that it uses community compositional, structural, and functional metrics as a means to evaluate system integrity. It differs from the traditional use of the concept in its focus on the habitat of a rare plant species, with attributes based more on habitat characteristics instead of species assemblages or subsets. The HII is also more specific in its applicability, as well as being more simplistic, less sampling intensive, and not as amendable to some statistical analysis.

Development of the Habitat Integrity Index

The proposed HII has been developed to help assess and monitor the ecological integrity of slickspot peppergrass habitat in southwestern Idaho. It was developed with the following criteria in mind:

(1) Use objective habitat attributes as much as possible;
(2) Have broad applicability throughout the range of slickspot peppergrass;
(3) Structured so that the information collected can be used to assess long-term trends;
(4) Can be easily employed by a range of field personnel;
(5) Can be used during most times of the year;
(6) Will be relatively inexpensive and not require special equipment;
(7) Will have wide acceptance by biologists.

The index was developed with the input of several Idaho Army National Guard and Bureau of Land Management (BLM) field biologists. Our own field experience with slickspot peppergrass was also useful. While conducting a search of the published literature to research this project it became clear that using a

habitat integrity index for rare plant monitoring purposes is a novel idea. Many rare plant monitoring studies have a habitat component to them, but they do not incorporate the index concept. The HII is supplemented by an Occurrence Viability Assessment, along with two other monitoring protocols - vegetation sampling and repeat photo-documentation.

The land unit area being assessed with the HII is the Element Occurrence. An Element Occurrence represents a specific geographic location. It is the standard database record used by the Natural Heritage Program/Conservation Data Center network to track elements of conservation concern. Each occurrence is identified by a three-digit code (001, 002, etc.) for purposes of database record keeping at the Idaho Conservation Data Center (CDC). We use this same three-digit identification code to identify and distinguish the slick-spot peppergrass monitoring sites. Each occurrence also has a unique survey site name that usually relates to a nearby geographic reference. Some slickspot peppergrass occurrences correspond to a single (meta)population. In other cases, however, what is biologically a single (meta)population, will be delineated as more than one occurrence. Other than strict biological criteria are often used to delineate Element Occurrence boundaries. In the case of slickspot peppergrass, our incomplete knowledge of the extent of some populations and mapping convenience, are two reasons why a one-to-one relationship between population and occurrence is not always the case.

The initial HII monitoring plan will focus on occurrences located along the western Snake River Plain between the Hammett and Kuna areas. At a later date, the plan can be expanded to include additional extant occurrences located in the Boise/Eagle foothills area and in southeastern Owyhee County. Of the 43 known extant slickspot peppergrass occurrences, 27 of them are part of the initial monitoring plan (Table 1). Five of these occurrences are located within the Orchard Training Area (OTA). The remaining occurrences also occur wholly or partly on BLM land, except for two occurrences (021, 022) on State land. Maps showing the location of each of the 27 selected occurrences are provided in Appendix 1. All known extant occurrences for slickspot peppergrass are listed in Appendix 2, with selected Element Occurrence Records summarizing location, population, habitat, and other information provided in Appendix 3.

A basic assumption underlying the HII is that habitat integrity equates to habitat quality. Certain changes to slickspot microsite and sagebrush-bunchgrass community characteristics, such as annual weed invasion, are indicative of environmental degradation. These changes occur along a continuum and range from imperceptible to wholesale. The HII is a method to position the habitat of a particular slickspot peppergrass occurrence along this continuum for monitoring and comparative purposes.

Integrity attributes for the HII focus on three types of disturbances that are widespread, interrelated, and of management concern in the sagebrush-steppe of southwestern Idaho - wildfire, livestock grazing, and off-road motorized use. The rationale for choosing these attributes is the direct and indirect links between the effects of these disturbances and the quality of slickspot peppergrass habitat. High levels of livestock grazing in the late 1800's and early 1900's degraded the sagebrush-steppe ecosystem to the point where introduced annuals, especially cheatgrass (*Bromus tectorum*), became dominant over large portions of the Intermountain West, including the western Snake River Plain (Yensen 1980). This invasion of weedy annuals changed the character and ecology of the original shrub-bunchgrass vegetation. The invasion has resulted in increased wildfire intensity, and a significant shortening of the fire frequency cycle from between 60-110 years, to less than 5 years (Whisenant 1990). This conversion of native sagebrush-steppe to annual grasslands has apparently reduced suitable habitat for and destroyed populations of slickspot peppergrass, as well as fragmenting and isolating extant populations (Moseley 1994). Another aspect of wildfire is rehabilitation/restoration efforts. Drill-seeding and plantings dominated by crested wheatgrass cultivars are

Table 1. *Lepidium papilliferum* occurrences included in the initial Habitat Integrity Index monitoring plan.

EO #	Name	USGS quadrangle	Size (estimated acreage)
Kuna/Boise area			
018	Kuna Butte SW	Kuna	20
019	Initial Point	Initial Point; Kuna; Coyote Butte	---
022	Pleasant Valley North	Owyhee	---
024	Kuna Butte	Kuna	160+
025	Melba Butte	Kuna	---
026	Initial Point SW	Initial Point	<0.1
032	Tenmile Creek	Cloverdale; Mora	700
048	South Cole Road/ Tenmile Creek	Mora	<0.1
049	Fivemile Creek	Boise South	<0.1
057	Kuna Butte Northwest	Kuna	1+
Orchard Training Area			
027	West of Orchard	Orchard; Christmas Mountain	1920
028	Christmas Mountain N	Christmas Mountain	1700
035	Orchard Southwest	Orchard	480+
041	Orchard SSW	Orchard	240+
053	Christmas Mountain	Christmas Mountain	<0.1
Mountain Home area			
015	Simco Road	Mayfield SW	320
020	Soles Rest Creek	Mayfield SW	---
021	Fraser Reservoir East	Crater Rings	500
029	Mountain Home SE	Mountain Home South	200
030	Soles Rest Creek	Mayfield SW	600

EO #	Name	USGS quadrangle	Size (estimated acreage)
031	Bowns Creek	Mayfield SW	50
050	West Side Canal/Slade Flat West	Mountain Home South	80
060	West of Squaw Creek	Mayfield SW	0.1
Hammett area			
008	Bennett Road	Hammett; Hot Springs Creek Reservoir	800+
010	Chalk Flat	Indian Cove	<0.1
058	Glenns Ferry NW	Glenns Ferry	1
061	SE of Reverse	Reverse	10

common on many fire restoration projects. Although populations of slickspot peppergrass are known to persist in seedings, long-term data are missing.

Evidence from the OTA and elsewhere suggests that the integrity of slickspot microsites are adversely affected by the trampling of livestock, and tracking by military and off-road vehicles. These disturbances foster the establishment of exotic annuals such as clasping peppergrass (*Lepidium perfoliatum*) and bur buttercup (*Ranunculus testiculatus*), which can apparently displace slickspot peppergrass in the microsites. Trampling and tracking are especially damaging in the spring when sites are wet.

The HII is based on a relative scale, with numerical scores providing a means to rank habitat integrity. Changes in habitat integrity over time will theoretically be captured by changes to the index score. The design of the HII allows occurrences to be assessed individually or as groups. It is meant to be used as a long-term monitoring tool, and has a number of practical conservation applications. The identification and analysis of conservation strategies, priorities, and research needs will benefit from the monitoring information.

A supplemental part of the HII is the Occurrence Viability Rank. The ranking assignment takes into account viability and defensibility factors not directly covered in the HII, such as threats, adjacent land uses, and land ownership. This rank recognizes that long-term population viability often depends on more than just intact habitat. Conservation decisions and actions also need to consider more than simply habitat.

To assist monitoring and conservation planning, all known slickspot peppergrass occurrences (extant, historical, and extirpated) have been digitized and entered into a GIS data base. This was completed by staff at Idaho Department of Fish and Game.

METHODS

Long-term slickspot peppergrass habitat monitoring will consists of three integrated parts - the HII and Occurrence Viability Rank, vegetation sampling, and photo points. Data collected during the first round of monitoring will provide the baseline which subsequent results are compared.

Site selection

There are 43 known extant occurrences for slickspot peppergrass. The initial monitoring plan includes 27 of these occurrences. They were selected based on location (the western Snake River Plain, not the nearby foothills or Owyhee Plateau) and ownership [BLM (including the OTA) and State land only]. They range in size from less than 0.1 acre to over 1,000 acres. The habitat integrity assessment will be made by scoring up to ten sample points along a transect through the occurrence. Assigning an Occurrence Viability Rank, photo points, and vegetation sampling are also part of the monitoring protocol. The transect is simply a bearing path taken from a starting point. No measuring tape is required. The length of the transect is variable and will depend on the size of the occurrence and the density of slickspots. Because slickspot microsites tend to be widely spaced, the transect also has a variable width, so that slickspots within a certain distance of the bearing path are considered "in" and can be sampled. Ten meters on either side of the transect bearing should work at most occurrences.

The person (team) conducting the ecological integrity assessment the first year will determine where to locate the transect. This will be straightforward at small occurrences because the transect will cover most or all of the area. In the case of large occurrences, several criteria will influence where sampling takes place, such as accessibility, ease of relocation, and choosing an area representative of the occurrence as a whole. Based on past inventories, at least some of the slickspots in the sample area are known to have supported slickspot peppergrass, although plants may or may not be evident during sampling.

The start of the transect will be permanently marked using a rebar stake or fencepost hammered into the ground. A GPS reading will also be obtained and the site marked on the appropriate USGS 7.5' topographic quadrangle. Having the start of the transect permanently marked will facilitate future resampling. A nearby fencepost, powerline pole, or other permanent structure can be marked where available to serve as an additional reference for the location of the transect. It is important that detailed notes be kept the first year to accurately document directions to and location of the transect(s). A plot location form (Appendix 4) should be completed for each occurrence. Maps, sketches, mileage logs, and other location information are recorded on this form. Other notes will be important regarding modifications to any of the methods and problems encountered during the first year of sampling.

After the general sample site has been selected, the starting point and azimuth of the transect should be randomly chosen. For some of the largest occurrences covering over a few hundred acres we recommend two or more transects be established. More than one transect is also recommended for occurrences consisting of distinct burned and unburned portions (e.g., EOR #020). A separate transect should be established for the burned and unburned segments of the occurrence. Permanent markers and GPS readings should be recorded for each transect. GPS coordinates can be entered into a GIS system and mapped after the field season.

Various monitoring projects have already been established by BLM or OTA researchers at several slickspot peppergrass occurrences. We recommend the HII transects be established at the same sites as these other studies whenever possible. Superimposing the HII over existing research projects will provide additional site-

specific information and assist interpretation. The five occurrences with ongoing research are listed below. Maps showing the location of the five other monitoring studies are included in Appendix 5, and should be consulted when establishing HII transects at these occurrences.

(1) Kuna Butte (024) - Research focused on slickspot peppergrass population trends in post-burn and post-seeding treatments.
(2) Kuna Butte SW (018) - Research related to slickspot peppergrass population response to treatments with the herbicide Oust.
(3) West of Orchard (027) - Vegetation monitoring and slickspot peppergrass abundance.
(4) Orchard Southwest (035) - Vegetation monitoring and slickspot peppergrass abundance.
(5) Christmas Mountain North (028) - Vegetation monitoring and slickspot peppergrass abundance.

Habitat Integrity Index

The Habitat Integrity Index is determined by completing the *Lepidium papilliferum* Habitat Integrity Index scorecard (Appendix 6). This entails answering eight questions regarding slickspot attributes and six questions concerning attributes of the surrounding vegetation. The index is scored at ten separate slickspots along a transect, representing stations 1 through 10 on the scorecard. A score is tallied at each station. The average score is computed and represents the HII value for the occurrence. Small occurrences containing fewer than ten slickspots will necessarily have less than ten scores. Two or more transects (scoring at 20 or more slickspots) may be necessary for very large occurrences. The first ten slickspots encountered along the transect path can be evaluated for occurrences that are small in size or contain only a few widely scattered slickspots. However, to ensure that a larger area is sampled at large occurrences, a distance (such as 50 or 100 paces) can be measured between slickspot sample stations.

Scoring the attributes is done by determining which of the score choices best fits the slickspot or surrounding vegetation being evaluated. The index score column provides numerical or other descriptive guidelines to assist the scoring process. A review and explanation of the slickspot and sagebrush-steppe attribute questions comprising the HII are provided below.

During our 1997 field testing we began to take photographs representing examples of the attributes comprising the HII. It is our intent to continue taking pictures in 1998. These will be used for a set of reference photos showing examples of as many attributes and their ranges as possible.

Slickspot microsite attributes

1. Is organic debris or soil being deposited and accumulating within the slickspot?

Refers to the deposition and accumulation of organic debris within the slickspot. This is uncommon in undisturbed slickspots. It is most common along the base of established vegetation, or in cracks, hoof prints, depressions, and other surface irregularities within the slickspot or its margin. Weedy annual species are often established in these strips/patches of organic material.

2. Are the slickspot boundaries (perimeter) compromised?

Compromise equates to a loss in the distinct demarcation of the slickspot from the adjacent sagebrush (or former sagebrush) vegetation. One result is the encroachment of moss or other vegetation into the slickspot

from points along the perimeter, often in places where soil or organic material are accumulating. Another result is the leveling or loss of the depressed microtopography characterizing some slickspots. This can be associated with the breakup/trampling of the soil rim along the slickspot margin, or the breaching of the margin with a channel(s) that increases drainage from the slickspot, or other reasons.

3. Are weedy annual species present in the slickspot (list those present)?

Common weedy annuals include *Lepidium perfoliatum, Ranunculus testiculatus,* and *Bromus tectorum.* Other weedy species may also occur. Those present should be listed on the form.

4. What is the average density of weedy annual species?

The density is averaged from three readings taken within the slickspot. A 1 sq. ft. (0.3 sq. m) plot frame is used. Sample the two far ends and the center of the slickspot. The plot frames are centered along the slickspot's equator.

5. Are rabbitbrush or other shrub species established within the slickspot?

Shrub establishment includes seedlings as well as larger plants. Undisturbed slickspots usually have few or no shrubs established. In some cases, slickspots occur as a series of more or less interconnected bare areas pinched or separated by the surrounding vegetation. When evaluating these slickspot complexes the intervening islands or peninsulas of "surrounding" vegetation are discounted.

6. Are perennial forbs or grasses established within the slickspot?

This includes either native or introduced plant species. Undisturbed slickspots usually have few or no perennials.

7. How much livestock disturbance sign (tracks and/or scats) is present within the slickspot?

Livestock (cattle or sheep) evidence includes signs of trampling (hoof prints or tracks) and scats. These signs usually persist for months or longer. The amount of livestock sign is counted (or estimated) and used to score this attribute. The index scorecard provides a field to more precisely quantify the amount of livestock disturbance sign at the slickspot.

8. Are ORV or other vehicle tracks present across the slickspot?

A single track constitutes a "yes" score. The number of tracks can be recorded on the field form to help quantify this disturbance.

<u>Sagebrush-steppe attributes</u>

9. Fire History
   a) immediately adjacent to slickspot
   b) scale of surrounding 3 acres
   c) scale of surrounding 3-50 acres
   d) scale of entire occurrence (or surrounding 50+ acres)

The fire history attribute has been divided into a series of four size scales. When considering surrounding acreage, the sampling station is the reference centerpoint. The area surrounding the centerpoint is used to assess the fire history attribute at the four size scales. Immediately adjacent to the slickspot implies within a 50 ft (15 m) radius of the centerpoint. Three acres equals about a 204 ft (62 m) radius, and 50 acres equals approximately a 833 ft (254 m) radius. Assessing the fire history of the entire occurrence may prove difficult for some very large occurrences. In such cases, the 50+ acre scale should be used. For small occurrences less than 50 acres in size answer the attribute based on the condition of the surrounding landscape. Where possible, an estimate should be made for each size scale for the percentage of burned and unburned areas rated as a mosaic burn.

10. Do livestock use the general occurrence area?

Light to moderate use implies only scattered or short-term use is evident. Anything more than this is considered heavy use.

11. Is there evidence of cross country, off-road motorized vehicle use in the area?

When making this evaluation discount off-road activity adjacent to existing open roads. Heavy use implies widespread tracks and evidence of resource damage. Consider less evident use light or moderate.

12. The grass layer associated with the sagebrush habitat is - ?

Choices range from the grass layer clearly dominated by native bunchgrasses, to clearly dominated by exotic annual or seeded grasses. The degree of degradation or impoverishment to the bunchgrass component is important when judging the ecological condition of sagebrush habitats. Although determining this score is somewhat subjective, the three classes are broad enough so that selection should be pretty straightforward. Data collected during the vegetation sampling part of the monitoring regime may be helpful to score this attribute.

13. Are weedy annual or seeded forbs present?

This attribute is based on the overall abundance and distribution of the vegetation's weedy annual forb component. The three scoring classes are broad enough to minimize problems of subjectivity. Data collected during the vegetation sampling part of the monitoring regime may be helpful to score this attribute. Common weedy forbs include *Lepidium perfoliatum, Ranunculus testiculatus, Sisymbrium altissimum, Descurainia* spp. and *Salsola iberica*.

14. How much microbiotic crust cover is there?

The microbiotic crust includes bryophytes, lichens, algae, and cyanobacteria covering the soil. Many crust species are more noticeable during cool/wet periods. Data collected during the vegetation sampling part of the monitoring regime may be helpful to score this attribute.

In addition to scoring the attributes, there is a field on the scorecard asking if any slickspot peppergrass plants are present at the slickspot station. Four abundance classes are listed (0 plants; <10 plants; 10-100 plants; and >100 plants), so a precise tally taking a lot of time is not neccesary. Although abundance of slickspot peppergrass is not an integral feature of the monitoring plan, it seems advantageous to collect this

information to help interpret the habitat data and document fluxes in population numbers. The abundance classes are scored at each station along the transect.

With the HII, the lower the index score, the higher the occurrence's ecological integrity. Possible scores for the slickspot attributes part of the index range from 0 to 14, while sagebrush-steppe attributes scores have a 0 to 23 score range. The combined scores can therefore range from 0 to 37. The HII provides independent slickspot attribute and sagebrush-steppe attribute scores. Occurrences can be evaluated, compared and rated based on these distinct scores. However, the final index score is assigned by adding the two subscores together, and is called the combined average score on the scoresheet.

Based on preliminary field testing of the HII in October, 1997, we determined the range of scores for rating sagebrush-steppe and slickspot microsites into three broad categories - good, fair, or poor. These general categories help put the scores into a habitat condition context. A "good" rating requires relatively intact sagebrush and slickspot microsite habitat for all or most of the occurrence. A "fair" rating requires at least a portion of the occurrence habitat to be intact, while a "poor" rating will be the case if large segments of habitat have been destroyed, such as by wildfire. Table 2 outlines the scores and associated ratings.

A matrix of the sagebrush-steppe versus slickspot microsite scores shows there are nine possible permutations (Table 3). The matrix is not a distinct score, but only a way to help interpret the HII scores. During our field testing, we observed three permutations - #3 (poor sagebrush-steppe integrity/good slickspot integrity), #5 fair sagebrush-steppe integrity/fair slickspot integrity), and #9 (poor sagebrush-steppe integrity/poor slickspot integrity). Other matrix classes undoubtedly exist at other occurrences. The nine classes apply to individual occurrences, but the matrix also provides a method to classify habitat conditions for all or selected occurrences grouped together. Keep in mind that these ratings are preliminary. The second phase of the HII involves field data collection, and adjustments to the scoring system and associated correlations will be made after completing this second phase.

Table 2. Scores for determining integrity ratings for sagebrush-steppe, slickspot microsite, and a combination of the two habitats using the Habitat Integrity Index. The way the HII is designed, the lower the score the higher the integrity rating.

Rating	Sagebrush-steppe attributes average score	Slickspot microsite attributes average score	Combined average score
Good	0 - 3	0 - 3	0-8
Fair	4 - 11	4 - 7	9-18
Poor	12 - 22	8 - 14	19-37

Table 3. Integrity matrix for sagebrush-steppe and slickspot microsite habitats. The matrix cells are numbered in a rank order that reflects overall habitat integrity.

	Sagebrush-steppe Integrity		
Slickspot Integrity	High	Fair	Poor
Good	1	2	4
Fair	3	5	7
Poor	6	8	9

Occurrence Viability Rank

Occurrence viability concerns the prospects of a slickspot peppergrass population persisting at a particular location. The Occurrence Viability Rank (OVR) is meant to augment the HII by considering additional criteria important for conservation purposes. It is related to the Element Occurrence Rank used by the Natural Heritage Program/Conservation Data Center network. The main difference being population numbers (which in the case of slickspot peppergrass are subject to wide fluctuations related to precipitation patterns) are not a consideration for the OVR. The OVR range from A (the highest) to D (the lowest). The viability of A-ranked occurrences is high and reflect good quality sites not facing serious and imminent threats. They tend to be relatively large in size and in good years probably support many slickspot peppergrass plants. B- to D-ranked occurrences reflect habitat that is progressively more disturbed, threatened, and difficult to protect. The number of slickspot peppergrass plants likely decreases from B to D ranks.

The OVR is determined by completing the *Lepidium papilliferum* Occurrence Viability Rank form (Appendix 7). One form is completed at each occurrence regardless of the number of transects. It should be completed each year monitoring takes place. The OVR uses subjectively rated viability and defensibility criteria, along with a habitat integrity rating generated by the HII. A score is determined for each of these three criteria. The combined scores are then used to determine the OVR. Factors used to score the viability and defensibility criteria are explained on the ranking form.

Photo Points

Photo points will furnish long-term visual records for the sites. Comparing photographs of the same site taken over a period of years provides visual evidence of changes to landscape features such as the vegetation, and will help with the interpretation of long-term monitoring data. The photo point is located at the permanent stake used to mark the start of the HII transect. There will be the same number of photo points as transects at any given occurrence. The photo points will be established during the first year of monitoring, and repeat photographs should be taken each time the monitoring cycle returns to a site.

1. The starting point of the transect used to collect the HII data also marks the photo point location for each occurrence.
2. The transect bearing will also serve as the reference bearing for the photo point. There will be four photographs taken at each photo point. One photograph is taken in the direction of the transect bearing. The other three photographs are taken at bearings 90^0, 180^0, and 270^0 from the reference bearing. Photographs are

taken while standing at the photo point location.
3. The photo points are meant to be general view photographs. The photographs should include a reference point in the foreground (fenceline, large rock or shrub, etc.) along with a distinct landmark on the skyline whenever possible. A photo label should be placed in the foreground of the picture.
4. Take photographs using a SLR camera, wide angle (28-35 mm) lens, and color film.
5. Repeat photographs should be taken roughly the same time each year to make interpreting any changes to the vegetation easier.
6. To facilitate photo point relocation and taking repeat photos, take copies of the original photos into the field.

Vegetation Sampling

Sampling should be a part of the monitoring protocol to help quantify any changes in the composition and structure of the vegetation. A rapid vegetation sampling method developed by The Nature Conservancy (Bourgeron et al. 1992) should work well. This method entails two field forms. One is called the Community Survey Form (Form II; Appendix 8). It is used to note location, physical and environmental features, and a general description of the monitoring site. This form will be completed at only one sample site/occurrence. Many fields on this form (e.g., elevation; aspect) will have to be completed only during the first year of monitoring. The second form is the Ocular Plant Species Data form (Form III; Appendix 9). This is where ocular plant cover class estimates are tallied. Species composition and community structure data are collected using this method. To facilitate plant identification in the field, we have provided a list of species commonly encountered within slickspot peppergrass habitat (Table 4).

To conduct the vegetation sampling, we recommend one 11.3 m (37 ft) radius circular plot (equals 0.1 acre) be established for each transect. The plot can be randomly located along one of the transect stations. Using temporary plots will remove the burden of establishing permanent plots and trying to relocate them in the future.

DISCUSSION

The HII evaluates the integrity (quality) of both sagebrush-steppe and slickspot microsite habitats. The intent of the HII and associated protocols is to assess baseline habitat conditions and monitor future trends. Trend data are important in determining the effectiveness of on-the-ground management actions, as well as evaluating progress toward meeting management objectives (Bureau of Land Management 1985). HII scores can be analyzed on an attribute by attribute basis, as a cumulative tally of all 14 attributes, or by any subset of attributes. As a result, trend can be evaluated based on the combined condition of the slickspot microsite and sagebrush-steppe attributes, on either of these two habitats separately, or on the contribution of any individual attribute.

From a conservation perspective, it is important that long-term monitoring of sagebrush-steppe habitats in the western Snake River Plain begin. This would be the case irrespective of the presence of rare plant populations. In this light, the HII and associated protocols are documenting more than habitat supporting slickspot peppergrass, it is an opportunity to monitor selected attributes of one of the most endangered plant community types in Idaho. The HII is too simplistic to provide in-depth monitoring detail, but it can be part of a more comprehensive monitoring plan for the western Snake River Plain. One that includes plant community, wildlife, open space, reference areas and other elements of management and conservation concern.

Table 4. List of vascular plant species commonly encountered within the sagebrush-steppe habitats of *Lepidium papilliferum*.

Scientific name	**Common name**
Shrubs	
Artemisia tridentata wyomingensis	Wyoming big sagebrush
Artemisia tridentata tridentata	basin big sagebrush
Chrysothamnus nauseosus	gray rabbitbrush
Chrysothamnus viridiflorus	green rabbitbrush
Eriogonum strictum	strict buckwheat
Purshia tridentata	bitterbrush
Tetradymia glabrata	little-leaved horsebrush
Forbs	
Achillea millefolium	common yarrow
Astragalus eremeticus	hermit milkvetch
Astragalus purshii	Pursh's milkvetch
Balsamorhiza sagittata	arrowleaf balsamroot
Crepis sp.	hawksbeard
Descurainia pinnata	western tansymustard
Erodium cicutarium	storksbill
Helianthus annuus	common sunflower
Lepidium perfoliatum	clasping peppergrass
Machaeranthera canescens	hoary aster
Phacelia heterophylla	varileaf phacelia
Phlox hoodii	Hood's phlox
Phlox longifolia	long-leaved phlox
Ranunculus testiculatus	bur buttercup
Salsola iberica	tumbleweed
Sisymbrium altissimum	tumble mustard
Graminoids	
Agropyron spicatum	bluebunch wheatgrass
Aristida longiseta	red threeawn
Bromus tectorum	cheatgrass
Elymus caput-medusae	medusahead rye
Oryzopsis hymenoides	Indian ricegrass
Sitanion hystrix	squirreltail
Stipa comata	needle-and-thread
Stipa thurberiana	Thurber's needlegrass
Vulpia octoflora	six-week vulpia

A number of biologists involved with rare plant conservation issues in Idaho view slickspot peppergrass as one of the most endangered plant species in the state. The identification and analysis of conservation strategies, priorities, and research needs will benefit from the trend information collected with the HII. The HII protocol also provides a way to document threats on an occurrence by occurrence basis. This sort of information is needed by the U.S. Fish and Wildlife Service to assist their rare plant conservation efforts. Slickspot peppergrass is already the subject of relatively intensive research efforts by the BLM and Idaho Army National Guard. The HII should serve to supplement these other studies.

The long-term conservation of slickspot peppergrass will require coordination and commitment from various agencies such as the BLM, Idaho Army National Guard, and U.S. Fish and Wildlife Service. Part of this coordination and commitment should concern the sagebrush-steppe habitats of the western Snake River Plain. The HII is a way to move forward with this coordination and commitment.

GENERAL RECOMMENDATIONS

1. Baseline assessments and monitoring should be completed in 1998 for the selected 27 occurrences along the western Snake River Plain. The HII should be expanded to other slickspot peppergrass occurrences in the Boise/Eagle foothills and Owyhee County in the future.

2. Occurrences should all be monitored the same year. Sampling can be conducted during most times of the year, but late spring would be the best season.

3. Monitoring should be frequent enough so that pertinent management actions/decisions have timely trend information.

4. Monitoring can entail the cooperation of biologists from several agencies such as the Idaho Army National Guard, BLM, U.S. Fish and Wildlife Service, and CDC.

5. Funding for monitoring should include money to tabulate, analyze, and distribute each year's results.

6. We recommend original data sheets, photographs, and maps be filed at the CDC in Boise. Because all the details regarding future monitoring responsibilities have not been worked out yet, it is prudent the monitoring data be archived at a convenient and accessible place like the CDC. Other partners in the monitoring effort should also have copies of the original files at their respective offices.

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Appendix 1

Map locations for *Lepidium papilliferum* occurrences included in the initial Habitat Integrity Index monitoring plan.

Note: The three digit code number corresponds to the occurrence number for *Lepidium papilliferum* in the Conservation Data Center's data base. The survey site name is also part of the data base record.

Kuna/Boise area

Map 1. Kuna Butte SW (018) and Melba Butte (025) occurrences. Portion of the USGS 7.5' Kuna quadrangle.

Map 2. Part of Initial Point (019) occurrence. Portion of the USGS 7.5' Kuna quadrangle.

Map 3. Part of Initial Point (019) occurrence. Portion of the USGS 7.5' Initial Point quadrangle.

Map 4. Part of Initial Point (019), and the Initial Point SW (026) occurrences. Portion of the USGS 7.5' Initial Point quadrangle.

Map 5. Part of Initial Point (019) occurrence. Portion of the USGS 7.5' Coyote Butte quadrangle.

Map 6. Pleasant Valley North (022) occurrence. Portion of the USGS 7.5' Owyhee, Idaho quadrangle.

Map 7. Kuna Butte (024) and Kuna Butte NW (057) occurrences. Portion of the USGS 7.5' Kuna quadrangle.

Map 8. Part of Tenmile Creek (032) occurrence. Portion of the USGS 7.5' Cloverdale quadrangle.

Map 9. Part of Tenmile Creek (032), and the South Cole Road/Tenmile Creek South (048) occurrences. Portion of the USGS 7.5' Mora quadrangle.

Map 10. Fivemile Creek (049) occurrence. Portion of the USGS 7.5' Boise South quadrangle.

Orchard Training Area

Map 11. Part of West of Orchard (027) occurrence. Portion of the USGS 7.5' Orchard quadrangle.

Map 12. Part of West of Orchard (027) occurrence. Portion of the USGS 7.5' Christmas Mountain quadrangle.

Map 13. Christmas Mountain North (028) and Christmas Mountain (053) occurrences. Portion of the USGS 7.5' Christmas Mountain quadrangle.

Map 14. Orchard Southwest (035) and Orchard SSW (041) occurrences. Portion of the USGS 7.5' Orchard quadrangle.

Mountain Home area

Map 15. Simco Road (015) occurrence. Portion of the USGS 7.5' Mayfield SW quadrangle.

Map 16. Soles Rest Creek (020) and West of Squaw Creek (060) occurrences. Portion of the USGS 7.5' Mayfield SW quadrangle.

Map 17. Fraser Reservoir East (021) occurrence. Portion of the USGS 7.5' Crater Rings quadrangle.

Map 18. Mountain Home SE (029) and West Side Canal/Slade Flat West (050) occurrences. Portion of the USGS 7.5' Mountain Home South quadrangle.

Map 19. Soles Rest Creek (030) and Bowns Creek (031) occurrences. Portion of the USGS 7.5' Mayfield SW quadrangle.

Hammett area

Map 20. Part of Bennett Road (008) occurrence. Portion of the USGS 7.5' Hot Springs Creek Reservoir quadrangle.

Map 21. Part of Bennett Road (008) occurrence. Portion of the USGS 7.5' Hammett quadrangle.

Map 22. Chalk Flat (010) occurrence. Portion of the USGS 7.5' Indian Cove quadrangle.

Map 23. Glenns Ferry NW (058) occurrence. Portion of the USGS 7.5' Glenns Ferry quadrangle.

Map 24. SE of Reverse (061) occurrence. Portion of the USGS 7.5' Reverse quadrangle.

Appendix 2

Summary list for known extant occurrences of *Lepidium papilliferum*.

Summary list for known extant occurrences of *Lepidium papilliferum*.

EO #	Name	USGS quadrangle	Ownership	Size (ca acre)	EO Rank
008	Bennett Road	Hammett; Hot Springs Creek Resv.	BLM; Pvt.	800+	A
010	Chalk Flat	Indian Cove	BLM	<0.1	C
012	Military Reserve Park	Boise South	City of Boise	<0.1	D
015	Simco Road	Mayfield SW	BLM; Pvt.	320	A
018	Kuna Butte SW	Kuna	BLM	20	B
019	Initial Point	Initial Point; Kuna; Coyote Butte	BLM; State	-- (large)	A
020	Soles Rest Creek	Mayfield SW	BLM	--	C
021	Fraser Reservoir East	Crater Rings	State; Pvt.	500	B
022	Pleasant Valley North	Owyhee	State; Pvt.	--	B
023	Lower Hulls Gulch	Boise North	Private	<0.1	D
024	Kuna Butte	Kuna	BLM	160+	A
025	Melba Butte	Kuna	BLM	--	D
026	Initial Point SW	Initial Point	BLM	<0.1	C
027	West of Orchard	Orchard; Christmas Mountain	BLM; State	1920	A
028	Christmas Mountain N	Christmas Mountain	BLM; State	1700	C
029	Mountain Home SE	Mountain Home South	BLM	200	B
030	Soles Rest Creek	Mayfield SW	BLM; Pvt.	600	B
031	Bowns Creek	Mayfield SW	BLM; Pvt.	50	C
032	Tenmile Creek	Cloverdale; Mora	BLM; Pvt.	700	A
035	Orchard Southwest	Orchard	BLM	--	D
036	Hackberry Divide	Boise North	Private	<0.1	D
037	Horse	Boise North	Private	<0.1	C
038	Goose Creek	Eagle	Ada County	<0.1	D
039	Woods Gulch	Eagle	Private	<0.1	D
040	Woods Gulch	Eagle	BLM; Pvt.	<0.1	B

EO #	Name	USGS quadrangle	Ownership	Size (ca acre)	EO Rank
041	Orchard SSW	Orchard	BLM	240+	C
047	Willow Creek	Southeast Emmett	BLM	<0.1	D
048	South Cole Road/ Tenmile Creek South	Mora	BLM	<0.1	BC
049	Fivemile Creek	Boise South	BLM	<0.1	B
050	West Side Canal/ Slade Flat West	Mountain Home South	BLM	80	C
051	Post Office Reservoir	Poison Butte	BLM	3	B
052	Woods Gulch	Pearl	BLM	200	B
053	Christmas Mountain	Christmas Mountain	BLM	<0.1	D
056	Willow Creek	Southeast Emmett	BLM	<0.1	B
057	Kuna Butte Northwest	Kuna	BLM	1+	C
058	Glenns Ferry NW	Glenns Ferry	BLM	1	D
059	Poison Creek North	Clover Butte South	BLM	5	B
060	West of Squaw Creek	Mayfield SW	BLM; Pvt.	0.1	D
061	SE of Reverse	Reverse	BLM	10	D
062	Juniper Butte	Juniper Butte	State	2	D
063	Flat Draw Reservoir W	Poison Butte	BLM; State	90	B
064	Juniper Butte N	Juniper Butte	BLM	<0.1	C

Appendix 3

Conservation Data Center records for extant occurrences of *Lepidium papilliferum* included in the initial Habitat Integrity Index monitoring plan.

Appendix 4

Lepidium papilliferum Habitat Integrity Index transect location form.

***Lepidium papilliferum* Habitat Integrity Index transect location form**

Element Occurrence # _____ Survey site name _____

USGS quad _____ GPS coordinates _____

Directions:

Sketch a map showing roads, mileages, landmarks, landmark bearings, and other details that will help relocate the HII transect in the future.

Appendix 5

Map locations of selected BLM and Idaho Army National Guard
Lepidium papilliferum research study sites.

Note: The location of research sampling areas are depicted on the maps.

Map 1. Kuna Butte (024) occurrence. Research associated with *Lepidium papilliferum* population trends in post-burn and post-seeding treatments.

Map 2. Kuna Butte SW (018) occurrence. Research related to *Lepidium papilliferum* population response to treatments with the herbicide Oust.

Map 3. West of Orchard (027) occurrence. Research associated with vegetation monitoring and *Lepidium papilliferum* abundance.

Map 4. Orchard Southwest (035) occurrence. Research associated with vegetation monitoring and *Lepidium papilliferum* abundance.

Map 5. Christmas Mountain North (028) occurrence. Research associated with vegetation monitoring and *Lepidium papilliferum* abundance.

Appendix 6

Lepidium papilliferum Habitat Integrity Index scorecard.

***Lepidium papilliferum* Habitat Integrity Index**

Element Occurrence # _____ Survey site name _____
Date _____ Examiner(s)_____

Slickspot microsite attributes	**Score**
1. Is organic debris or soil being deposited and accumulating within the slickspot?	0 (none) 1 (minimal; <10%) 2 (yes; >10%)
2. Are the slickspot boundaries (perimeter) compromised?	0 (no) 1 (minimal, <10%) 2 (yes, >10%)
3. Are weedy annual species present in slickspot (list those present)?	0 (none) 1 (one or more species)
4. What is the average density of weedy annual species?	0 (<10 plants/sq. ft.) 1 (10-50 plants/sq.ft.) 2 (>50 plants /sq.ft.)
5. Are rabbitbrush or other shrub species established within the slickspot?	0 (no) 1 (yes)
6. Are perennial forbs or grasses established within the slickspot?	0 (3 or fewer plants) 1 (more than 3 plants)
7. How much livestock disturbance sign (tracks and/or scat) is present within the slickspot?	0 (none) 1 (1-10 tracks and/or scats) 2 (>10 tracks and/or scats)
8. Are ORV or other vehicle tracks present across the slickspot?	0 (no) 1 (yes)

Sagebrush-steppe attributes	**Score**
9. Fire History a) immediately adjacent to slickspot	0 (unburned) 2 (mosaic of burn and unburned) 3 (burned)
b) scale of surrounding 3 acres	0 (unburned) 2 (mosaic of burn and unburned) 3 (burned)
c) scale of surrounding 3-50 acres	0 (unburned) 2 (mosaic of burn and unburned) 3 (burned)
d) scale of entire occurrence (or surrounding 50+ acres)	0 (unburned) 2 (mosaic of burn and unburned) 3 (burned)
10. Do livestock use the general occurrence area?	0 (no evidence) 1 (light to moderate use) 2 (heavy use)
11. Do ORV's or other vehicles go off-road in cross country fashion?	0 (no, or rare) 1 (light to moderate use) 2 (heavy use)
12. The grass layer associated with the sagebrush habitat is:	0 (clearly dominated by native bunchgrasses) 1 (both bunchgrasses and exotic annual grasses common) 3 (clearly dominated by exotic annual or seeded grasses; native bunchgrasses reduced to remnant status or largely extirpated)
13. Are weedy annual or seeded forbs present?	0 (sparse or absent) 1 (patchy) 2 (widespread and abundant)
14. How much microbiotic crust cover is there?	0 (high/moderate; >10%) 1 (low; 1-10%) 2 (trace or absent; <1%)

***Lepidium papilliferum* Habitat Integrity Index Scorecard**

Element Occurrence # _____ Date _____

Slickspot attributes	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10
1										
2										
3										
4										
5										
6										
7										
8										
TOTALS										
AVERAGE TOTAL (Sum of Totals ÷ 10) =										
tally of livestock track and/or scats in slickspots										
Is LepPap present? 0=0 plants 1=<10 plants 2=10-100 plants 3= >100 plants										
Sagebrush- steppe attributes										
9a										
9b										
9c										
9d										
10										
11										
12										
13										
14										
TOTALS										
AVERAGE TOTAL (Sum of Totals ÷ 10) =										

Slickspot microsite attributes average score _____
Sagebrush-steppe attributes average score _____
Combined average score _____

Comments:

Appendix 7

Lepidium papilliferum Occurrence Viability Rank form.

***Lepidium papilliferum* Occurrence Viability Rank form**

Element Occurrence # _____ Date _____ Examiner_____

Grade the occurrences viability, defensibility, and habitat integrity according to the following scale:

0 = high 1 = fair 2 = marginal 3 = poor

Occurrence Viability - base grade on the long-term prospects for continued existence of *Lepidium papilliferum* habitat at the occurrence site. Provide comments as needed. Some factors to consider include: fire history, fire restoration/rehabilitation efforts and success; threats such as urban development, weed invasion, and increased recreational use; condition of the surrounding landscape; problems with habitat fragmentation; and extent of suitable habitat.

Grade = _____ (0 - 3)

Comments -

Occurrence Defensibility - base grade on the extent to which the occurrence can be protected from extrinsic human factors that might otherwise degrade or destroy it. Provide comments as needed. Some factors to consider include: protection from fire; land ownership (public versus private land); condition and ownership of surrounding land; special protection measures or designations conferred to all or part of the occurrence; manageability.

Grade = _____ (0 -3)

Comments -

Occurrence Habitat Integrity - base grade on the Habitat Integrity Index score for the occurrence. The index score reflects habitat quality. It includes factors such as fire effects and pattern; the occurrence of invasive weedy species; fragmentation; and native plant species composition and structure.

Grade _____ (HII scores 0 - 9 = grade 0; HII scores 10 -18 = grade 1; HII scores >18 = grade 3

Comments -

TOTAL _____ (Viability grade + Defensibility grade + HII grade)

RANK _____ (A-rank = 0 - 2; B-rank = 3 - 4; C-rank = 5 - 6; D-rank = 7 - 9)

Appendix 8

WHTF Form II - Community Survey Form.

(Instructions for completing this form are available from the CDC)

Appendix 9

WHTF Form III - Ocular Plant Species Data form.

(Instructions for completing this form are available from the CDC)