

**Future management considerations for *Chondrilla juncea* (rush skeletonweed) at
Craters of the Moon National Monument and Preserve**

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INTRODUCTION

Invading plant species are recognized world wide as major threats to both natural and managed ecosystems (Hobbs & Humphries 1995). The environmental, economic and cultural impacts of noxious weeds are indiscriminating. Noxious weeds continuously invade native plant communities, depriving them of their habitat and resources. This ultimately reduces biodiversity, as well as impacts agricultural lands, effectively changing the landscape. In the western United States, the negative impacts of invading plant species are significant, creating a high priority for the development of invasive weed management strategies.

Of the utmost priority for management are those plant invaders given the legal designation of 'noxious.' In the state of Idaho, 'noxious' describes a weed as a 'plant that is present but not native to Idaho, potentially more harmful than beneficial, economically and physically feasible to eradicate and whose impacts exceed the cost of control' (Prather et al. 2002). Idaho has designated 57 plant species as noxious. Craters of the Moon, Idaho's largest National Park unit, has recorded the presence of 12 noxious weeds within the Monument and Preserve.

Craters of the Moon 'contains abundant sagebrush steppe communities, diverse habitats for plants and animals, vegetation communities largely undisturbed by human activities, and the largest remaining land area within the Snake River Plain still retaining its wilderness character' (Craters of the Moon National Monument Planning Team 2004). The Monument and Preserve is managed by the National Park Service (NPS) and the Bureau of Land Management (BLM). For both agencies, controlling noxious weed infestations is important for maintaining and preserving the unique natural character of the area.

Rush skeletonweed (*Chondrilla juncea*) has proven to be one of the most problematic noxious species for resource managers at Craters of the Moon. It is a perennial plant that prefers well drained, light soils, flowers from midsummer to fall, and has a taproot with highly branched extensions (Prather et al. 2002). Lateral roots occurring near the surface of the soil may develop into daughter rosettes, while disturbed root fragments may develop into new plants (Rosenthal et al. 1968). Due to its effective root system and wind dispersal of seeds, it has been successful in establishing, growing and spreading rapidly. Rush skeletonweed has been found in numerous

locations, varying in density, infestation size and number of individual plants throughout the Monument and Preserve.

Efforts to control rush skeletonweed have been in effect since the first known infestation was located in the Monument and Preserve in 2003. Many infestations have been chemically controlled, while some have been left untreated due to time, monetary, or labor constraints. A Global Positioning System (GPS) data recorder is used to survey or inventory areas for infestations and is used to collect locations and other relevant data. This information is then used to compile records of existing noxious weeds in the Monument and Preserve and can also be used to revisit sites for monitoring and further treatment. Collected data is evaluated in Geographical Information System (GIS) which provides the ability to analyze, organize, compare and contrast specific area of interest. Using these tools, a suggested management plan has been created for future control of rush skeletonweed.

The focus of this plan is on prioritizing areas in the Monument and Preserve that are in need of future treatment and survey work. The significance of priority addressed to a particular area is designated by a rating on a scale of ecosystem health. Invasive weed management plans in the past have been criticized for focusing only on the invading species and neglecting to consider a particular area's 'vulnerability and value in terms of production or conservation' (Hobbs & Humphries 1995). Through comparing different geographic areas of the Monument and Preserve for relative degree of disturbance and relative value in terms of conservation, it is our focus to create a management plan that considers the overall system in which rush skeletonweed is only one component but has the potential to greatly impact the entire system.

In this management plan, ecosystem health is determined by five factors chosen to reveal a particular area's degree of disturbance, as well as conservation value. The properties chosen for this project are: fire exposure, native plant diversity, known density of rush skeletonweed infestations, amount of grazing, and percentage of acres surveyed.

Fire is a common disturbance in the Monument and Preserve. It has been observed that following a burn, rush skeletonweed effectively invades an area, making fire an important

disturbance factor for our consideration (Goodwin et al. 2002). Native plant diversity was chosen because healthy ecosystems with high amounts of plant diversity are being considered areas of high conservation value. The known density of infestation and amount of acres surveyed are considered because knowledge of the current extent of infestations in an area is an important tool for 1) predicting potential rate and direction of rush skeletonweed spread and 2) determining the current conservation value of an area, therefore, supporting allocation of resources for its protection. Percentage of acres surveyed is considered as a way to determine which areas need more time dedicated to their survey and treatment. Livestock grazing is a main element of disturbance at Craters of the Moon. Grazing has been shown to impede the growth of native plants and thus encourages the establishment of invasive weeds (Goodwin et al. 2002).

It is important to note that the term 'ecosystem health' is difficult to define because of the vast number of different types of ecosystems and the numerous levels of health each one maintains. The factors chosen for this project were assigned due to their applications to sagebrush-steppe ecology, rush skeletonweed ecology, available data and practical management considerations. Through considering these factors for each particular area, relative levels of disturbance as well as relative value in terms of conservation were able to be determined. Levels of priority were assigned for two important management techniques: surveying and chemical treatment.

METHODS

In order to evaluate the future necessity of treatment and survey work throughout the Monument and Preserve, two prioritization matrices were created. The first prioritizes areas of the Monument and Preserve in need of future treatment and the second prioritizes areas in need of future survey work.

Each part of the park was rated based on five factors: fire exposure, native plant diversity, known infestation density, amount of grazing and percent of acres surveyed. Each of these factors were specifically chosen for this project and were broken down into three degrees of necessity, “1” representing the lowest priority, “2” being medium priority, and “3” representing the highest priority. The Monument and Preserve was divided into eight sections and then analyzed using these prioritization matrices. The areas analyzed were Little Park, Little Deer South, Paddelford Flat, Laidlaw Park North, Laidlaw Park South, Laidlaw Park East, Laidlaw Park West and Laidlaw Park Thumb.

ArcMap GIS was used to compile and visually display data as infestation information, fire history and dominant vegetation types. GIS was also used to define the boundaries of the study areas within the Monument and Preserve.

Table 1: Priority given to areas for future treatment

Property	Priority		
	1	2	3
Fire Exposure	Past Fire (10-30 years)	Recent Fire (Less than 10 years)	Unaffected by Fire (Greater than 30 years)
Amount of Grazing	Heavily Grazed	Moderately Grazed	Minimally Grazed
Known Infestation Density	High Density	Medium Density	Low Density
Native Plant Diversity	Low Diversity	Medium Diversity	High Diversity
Percent Acres Surveyed	Low	Medium	High

Table 2: Priority given to areas for future survey

Property	Priority		
	1	2	3
Fire Exposure	Unaffected by Fire (Greater than 30 years)	Past Fire (10-30 years)	Recent Fire (Less than 10 years)
Amount of Grazing	Heavily Grazed	Minimally Grazed	Moderately Grazed
Known Infestation	High Density	Low Density	Medium Density
Density			
Native Plant	Low Diversity	High Diversity	Medium Diversity
Diversity			
Percent Acres	High	Medium	Low
Surveyed			

Fire Exposure

For the sake of this management plan it was decided to attribute a priority value based on what the majority of a particular area has experienced. Areas considered “unaffected by fire” have been defined by the absence of fire for the last 30 years. This is based on the findings of Lesica et al. (2005) that most sagebrush communities are fully recovered after 30 years. It has also been observed that sagebrush communities require at least ten years to begin reestablishing (Lesica et al. 2005). Therefore, areas that have been burned within the last 10 years have been defined as areas with “recent fire.” Areas that have been burned between ten and thirty years ago have been given the designation “past fire.” These areas have had enough time to allow sagebrush communities to begin to establish, but are not fully recovered.

Areas with no fire in the past 30 years are a low priority for survey work since weeds do not establish as well in these undisturbed areas. These areas however, are a high priority for treatment if weeds are found, in order to preserve these unaffected communities (Goodwin et al. 2002).

Areas that have had a “recent fire” are of highest priority for survey work so that as soon as noxious weeds begin to establish, they can be eliminated, providing native plants the ability to

reestablish. These areas are medium priority for treatment since they will likely be less ecologically healthy.

Areas that have been exposed to “past fire” are of lowest priority for treatment since they are likely to already have an established community of native vegetation, mixed with infestations of noxious weeds. Because these areas are not ecologically stable, they still maintain a higher priority for survey work since infestations have the potential to spread rapidly.

Amount of Grazing

Areas that have been heavily grazed are likely to contain larger infestations of weeds where livestock have disturbed the soil and created openings in the plant community (Goodwin et al. 2002). These areas typically require extensive amounts of time and resources to control, thus are ranked at lowest priority for both treatment and survey work.

Areas which have been minimally grazed are likely to contain fewer weeds. This is based off the fact that cattle effectively disturb the soil, creating a disturbance that weeds may exploit (Goodwin et al. 2002). These areas hold highest priority for treatment since they have the most potential for maintaining ecological health. These areas are of medium priority for survey work because weeds are found less frequently, but are in need of immediate control when found.

Areas that have been moderately grazed are likely to contain weeds in manageable amounts and are therefore of highest priority for survey work. These areas are only mid-priority for treatment because it may be assumed that their ecological health is already lowered due to disturbance.

Known Infestation Density

Areas with high density infestations are of lowest priority for both survey and treatment due to the overwhelming time and resources it would take to control them.

Areas with medium density infestations are of mid-priority for treatment since they are more difficult to control than the low density areas but are still smaller and more manageable than the

high density infested areas. They are thus given the highest priority for survey work since weeds will likely be found, however in manageable amounts.

Areas with low density infestations are of mid-priority for survey work since there is a lower possibility of finding weeds. In these areas, however, the weeds that are found will likely be of manageable size, unlike the highly infested areas. These areas with low density infestations are of highest priority for treatment since the infestations will likely be small, manageable and thus will have the best chance of being preserved.

Native Plant Diversity

Native plant diversity was calculated by looking at the dominant vegetation map on GIS for the Monument. In each study area, the vegetation communities were analyzed and given a relative vegetation value (Appendix B). Values of 5 and 6 were considered low diversity, 7 and 8 were medium diversity, and 9 and 10 were considered to be high diversity.

Areas that contain highly diverse plant communities are given the highest priority for both treatment and survey work in order to maintain the area's high conservation value.

Areas that contain a medium amount of native plant diversity are given medium priority for both treatment and survey work since their conservation value lies in between that of high and low diversity areas.

Areas that have low native plant diversity are given lowest priority for treatment and survey work since they are of the lowest conservation value.

Percentage of Acres Surveyed

Areas with a high percentage of acres surveyed are a low priority for future survey work since they have the most collected data. These areas are a high priority for treatment work since the greatest amount is known about the scope of the area's infestations.

Areas with a medium percentage of acres surveyed are a medium priority for future survey work and future treatment.

Areas with a low percentage of acres surveyed are a high priority for survey work since they have the least amount of data collected. Conversely, these areas are a low priority for treatment work since the scope of the area's infestations is relatively unknown.

The Matrix

Table 3 shows the matrix that was used to evaluate each of the eight areas based on the factors described above. Spatial data derived from ArcMap GIS, as well as field observations were used to make appropriate decisions regarding each area and the attributed properties. For evaluating fire we used BLM fire data in a GIS layer, to look at time and location of burns over the last 30 years. Livestock grazing was based on direct field observations (June through August 2007) in each specific area. The factors that were taken into consideration when making observations were presence of livestock, as well as evidence of grazing (feces, hoof prints, and trails). We also looked at fire history to determine amount of grazing. The BLM has a 2 year moratorium on grazing rights following a wildfire. Determining the known density of rush skeletonweed was achieved using ArcMap to calculate the total number of infestation points recorded in each location, per acre surveyed over the last five years. Native diversity was determined by using GIS maps of dominant vegetation (PNNL Remote Sensing Vegetation Cover Layer 2001) and from direct field observations. Percent of acres surveyed was determined by analyzing transect lines on GIS and dividing the area surveyed in a specific location by the total area of that location.

Table 3: Prioritization Matrix

	Properties					
	Fire	Livestock Grazing	Density of RSW	Native Diversity	Percent Acres Surveyed	Total
Area	Little Deer South					
	Little Park					
	LLP Thumb					
	LLP North					
	LLP South					
	LLP East					
	LLP West					
	Paddleford Flat					

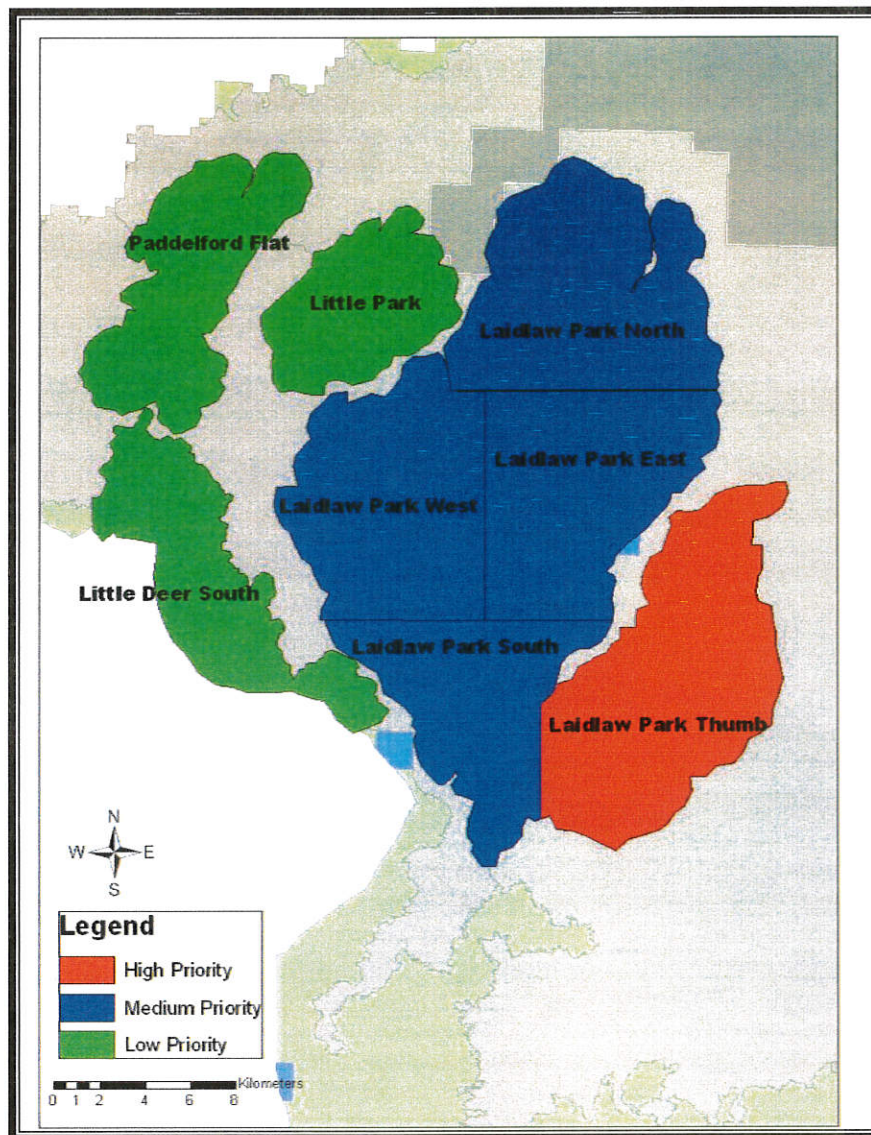
RESULTS

The prioritization matrices can yield a value between 5 and 15. The prioritization matrix for survey work (table 4) yielded a range of relative prioritization values between 7 and 13, with an average of 9.88. After running the survey matrix, the areas considered to be of lowest priority for survey work are Little Park which received a value of 7, and Little Deer South which received a value of 8. Paddelford Flat received a value of 9. Laidlaw Park North attained a value of 10, Laidlaw Park South, Laidlaw Park East and Laidlaw Park West all resulted in a value of 11 making them all medium priority for survey work. Laidlaw Park Thumb received a value of 13, making it the highest priority for survey work. The results for survey prioritization are displayed in Table 4, and shown geospatially in Figure 1.

Table 4: Results for Survey Matrix

	Properties					
	Fire	Livestock Grazing	Density of RSW	Native Diversity	Percent of Acres Surveyed	Total
Area	Little Deer South	2	1	1	2	8
	Little Park	1	1	2	2	7
	LLP Thumb	3	2	2	3	13
	LLP North	2	2	2	3	10
	LLP South	3	2	2	2	11
	LLP East	3	2	2	1	11
	LLP West	1	3	2	2	11
	Paddelford	2	1	2	2	8

Figure 1: GIS map of Priority Areas for Survey Work

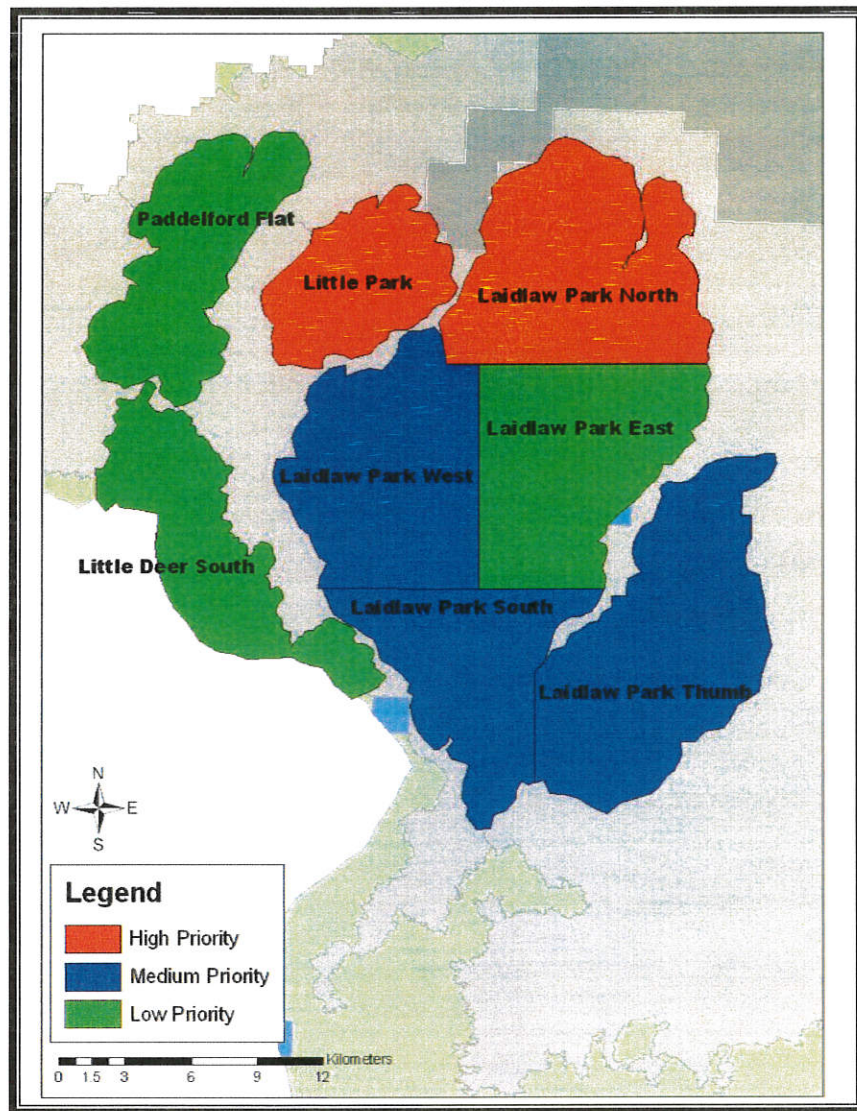


The prioritization matrix for treatment work (Table 5) yielded a range of relative prioritization values between 8 and 15 with an average of 10.75. For treatment, Little Deer South received a value of 8. Paddelford Flat and Laidlaw Park East both received a value of 9 making all three considered the lowest priority. Areas of medium priority are Laidlaw Park West which received a value of 11, Laidlaw Park Thumb, Laidlaw Park South and Little Park all received a value of 12. The area of highest treatment priority was Laidlaw Park North which received the highest priority value of a 13. Table 5 displays the results for treatment prioritization, and Figure 2 displays these results geospatially.

Table 5: Results for Treatment Matrix

	Properties					
	Fire	Livestock Grazing	Density of RSW	Native Diversity	Time Surveyed	Total
Area	Little Deer South	1	1	1	2	7
	Little Park	3	1	3	2	12
	LLP Thumb	2	3	3	3	12
	LLP North	1	3	3	3	13
	LLP South	2	3	3	2	12
	LLP East	2	3	3	1	10
	LLP West	3	2	3	2	11
	Paddleford	1	1	2	2	9

Figure 2: GIS Map of Priority Areas for Treatment



Little Deer South (Survey = 8; Treatment = 7)

Survey

Little Deer South was given a value of 2 based on fire. This area was exposed to a major wildfire in 1992. The priority based on livestock grazing was represented by a value of 1. Considerable evidence of grazing can be seen in this area. A value of 1 was assigned based on the known density of rush skeletonweed. Little Deer South has a density of 0.7993 infestation points per acre. This is the highest known density of rush skeletonweed in our study. For native plant diversity, a prioritization value of 2 was assigned. Little Deer South has a vegetation value of 8

based off of the aerial vegetation map and field observations. For percent of acres surveyed, a value of 2 was applied. This area has had 1.1% of its total area surveyed.

Treatment

Little Deer South was analyzed using the prioritization matrix for treatment work. A value of 1 was used to represent the priority based on fire. This was based on the fact that a fire burned a large portion of Little Deer South in 1992, making it likely that large infestations of noxious weeds will be present. The priority based on livestock grazing was represented by a value of 1. This was based on physical evidence observed in this area as well as the fact that grazing has been allowed since 1994. A priority value of 1 was used to represent treatment priority based on the 0.7993 points per acre surveyed density of rush skeletonweed infestations. For native plant diversity a prioritization value of 2 was used. Based on the dominant vegetation map used for the Monument and Preserve, a vegetation diversity rating of 8 was applied. For percent of acres surveyed, a value of 2 was applied. A total of 1.1% of Little Deer South has been surveyed at this time.

Laidlaw Park East (Survey = 11; Treatment = 10)

Survey

Based on fire history, Laidlaw Park East was given a priority value of 3. This area was exposed to a wild fire in 2005. Based on livestock grazing this area was given a priority value of 2 because there is minimal evidence of grazing. The known density of rush skeletonweed in this area is 0.2282 infestations per acre giving it a survey value of 2. This is considered a low density. When considering native plant diversity, this area is given a priority value of 1. Laidlaw Park East has a vegetation value of 5 based on field observations and the dominant vegetation map. Based on the available data, this is the least diverse area studied, and is therefore of the least conservation value. Laidlaw Park East has only had 0.96% of its total area surveyed, which is a low amount of surveyed area. Due to this, it has been given a survey priority value of 3 because the extent of the infestations in this area needs to be more accurately identified.

Treatment

The priority for treatment work based on fire was represented by a value of 2. A wildfire burned in this area in 1992 and again in 2005. This means that there is likely to be a high amount of infestations present as well as a state of lower ecological health. A value of 3 was used to represent the priority based on livestock grazing. There was little evidence of grazing in this area. In addition, grazing rights were suspended from 2005 to 2007 due to the fire in 2005. A value of 3 was used to represent the priority based on known density of rush skeletonweed which is calculated at 0.2282 infestations per acre. Native biodiversity was represented by a value of 1. A vegetation value of 5 was calculated based on the dominant vegetation map. This was the lowest vegetation diversity rating for any area in our study. Based on percent of acres surveyed, this area received a priority value of 1. Only 0.96% of this area has been surveyed. This is the second lowest of any area under study.

Paddelford Flat (Survey = 8; Treatment = 9)

Survey

Paddelford Flat was given a priority value of 2 based on fire exposure. This area was exposed to a wildfire in 1990. The priority based on livestock grazing was represented by a value of 1. Considerable evidence of grazing can be seen in this area. Recorded evidence included grazed vegetation, livestock trails and feces. This value was also based on the fact that grazing has been allowed by the BLM since 1992. A priority value of 2 was given to Paddelford Flat based on the known density of rush skeletonweed. This area has 0.4573 infestations per acre. This is the second highest density recorded in any of our study areas. Based on native plant diversity, Paddelford Flat was given a priority value of 2. This area has a moderate vegetation diversity rating of 8 based on the dominant vegetation map that was analyzed with GIS. Field observations support this rating. When considering percent of acres surveyed, Paddelford received a rating of 1, due to the fact that it already has a relatively high 1.91% of its total acres surveyed.

Treatment

Paddelford Flat received a priority value of 1 based on fire because the east side was exposed to a burn in 1990. For livestock grazing, a priority value of 1 was applied. Paddelford Flat receives the second highest amount of grazing for any of the areas in our study. The priority value, based

on known density of rush skeletonweed, was a 2. The density of rush skeletonweed points was 0.4573 per acre. The priority value based on native plant diversity was a 2. Based on the dominant vegetation map, a vegetation diversity rating of 8 was given. A priority value of 3 was given to this area based on 1.91% of acres surveyed.

Laidlaw Park West (Survey = 11; Treatment = 11)

Survey

When considering fire history, Laidlaw Park West has been given a priority value of 1 because the majority of the area has been unaffected by fire for at least 30 years. This area has been moderately grazed and received a priority value of 3. Laidlaw Park West has a known rush skeletonweed density of 0, giving it a priority value of 2. This area has not been surveyed for rush skeletonweed and so it is impossible to know the current extent of rush skeletonweed proliferation. Based on cursory observations of native plant diversity, this area has been given a survey priority value of 2. This area received a diversity rating of 7 based on field observations and dominant vegetation map, making it moderately diverse. This area has had 0% of its total area surveyed, giving it a priority value of 3.

Treatment

Laidlaw Park West received a priority value of 3 based on fire. More than 50% of this area has not been affected by fires in the past 30 years; however, a large amount of the east side was burned in 2005. A priority value of 2 was given based on livestock grazing. Due to time constraints, survey work was not completed in this area. This priority value was primarily based on an estimate of moderate grazing levels provided by Paige Wolken, the Vegetation Ecologist for Craters of the Moon (Personal Communication). We also noted that the East side of Laidlaw Park West was exposed to a large wild fire in 2005 which excludes grazing in at least this part of the study area. The remainder of the area, however, is subject to grazing. Based on the limited knowledge of the extent of rush skeletonweed infestation, a priority value of 3 was given to this area for the density of rush skeletonweed. It should be noted, no off-road survey work has been completed in this area. There are three recorded infestation points in this area, all of which were found while driving through Laidlaw Park West in order to reach other areas of the Monument. A priority value of 2 was given based on native plant diversity. Based on the dominant

vegetation map, a vegetation value of 7 was given. Based on percent of acres surveyed, a priority value of 1 was given. 0% of this area has been surveyed.

Laidlaw Park Thumb (Survey = 13; Treatment = 12)

Survey

Based on fire history, Laidlaw Park Thumb was given a priority value of 3. This area was exposed to a major wild fire in 2007. For livestock grazing, this area was given a priority value of 2 because there was minimal evidence of grazing. The known density of rush skeletonweed in this area is 0.3023 infestations per acre giving it a survey value of 2. This is the lowest number recorded for all areas. When considering native plant diversity, Laidlaw Park Thumb received a priority value of 3. Based on dominant vegetation maps and field observations, this area was given a vegetation diversity rating of 9, which represents high native plant diversity. This area has had 0.79% of its total area surveyed, resulting in a survey priority of 3.

Treatment

Laidlaw Park Thumb received a priority value of 2 based on fire. In the late summer of 2007, a large fire completely burned this study area. This recent fire designates it as only a medium priority area for treatment work. A priority value of 3 was given to this area for livestock grazing. Based on our field observations, there was little evidence of livestock grazing in Laidlaw Park Thumb. With the 2007 fire, this area is guaranteed to remain free of domestic livestock for at least two years. Based on current survey levels and the known density of rush skeletonweed, this area received a priority value of 3. Laidlaw Park Thumb has a relatively low density of 0.3023 rush skeletonweed infestations per acre. A priority value of 3 was given to this area for native plant diversity. Based on the dominant vegetation map a diversity rating of 9 was applied. This was the second highest value given to an area. Laidlaw Park Thumb received a priority value of 1 based on area surveyed. Only 0.79% of this area has been surveyed. This is the second lowest amount of any area in our study.

Laidlaw Park South (Survey = 11; Treatment = 12)

Survey

Laidlaw Park South was given a fire history priority value of 3. This area was exposed to a wild fire in 2007. Based on minimal observed evidence of livestock grazing, this area was given a priority value of 2. The known density of rush skeletonweed in this area is 0.3142 infestations per acre surveyed resulting in a priority value of 2. This is considered to be a low density. When considering native plant diversity, this area was given a priority value of 2. Laidlaw Park South was given a diversity rating of 7 based on field observations and the dominant vegetation map; comparatively this area is moderately diverse. Laidlaw Park South has had 1.12% of its total area surveyed; this is considered moderate when compared to other areas. Based on this, it has been given a priority value of 2, because more survey work is still needed to determine the extent of infestations.

Treatment

Laidlaw Park South received a priority value of 2 for fire. This is due to the fact that a large part of this area burned in 2007. A priority value of 3 was given for livestock grazing. Based on field observations it was determined that this area receives little grazing impact. Based on the known density of rush skeletonweed, a priority value of 3 was given. This area had 0.3142 infestation points per acre surveyed. This is considered to be low density. Laidlaw Park South received a priority value of 2 for native plant diversity. Based on the dominant vegetation map, a diversity rating of 7 was issued. This is considered to be a medium diversity area. Based on the amount of survey work done in this area, a priority value of 2 was given. 1.12% of Laidlaw Park South has been surveyed. Relative to the other study areas, this is considered to be a moderate amount of survey work. Laidlaw Park South has been given an overall survey priority of 11, making it a medium priority for future survey work.

Little Park (Survey = 7; Treatment = 12)

Survey

A value of 1 was used to represent the priority based on fire. The last recorded fire in this area was over 30 years ago. The priority based on livestock grazing was represented by a value of 1. Considerable evidence of grazing can be seen in this area. A value of 2 was assigned to Little

Park based on the known density of rush skeletonweed. This area has a known density of 0.1057 infestations per acre, which is low when compared to other sites. For native plant diversity, a prioritization value of 2 was applied. Little Park was given a vegetation value of 7 based on the vegetation map and field observations; comparatively, it is moderately diverse and thus of moderate conservation value. For percent of acres surveyed, a value of 1 was assigned. Little Park has 3% of its total area surveyed, which is the highest amount of any area.

Treatment

Based on fire exposure, Little Park received a priority value of 3. This area has not burned in the last 30 years. Little park received a priority value of 1 for livestock grazing. This was based on direct field observations. No direct observation of animals in Little Park was recorded, but a large number of trails, droppings and grazed plants were recorded. This higher level of soil disturbance increases the likelihood of noxious weed colonization in this area. This makes the area a low priority for treatment. A priority value of 3 was given based on the known density of infestation points. A density of 0.1057 points per acre was calculated. This was the second lowest density found in all of our study areas. For native plant diversity, a priority value of 2 was applied. Based on the dominant vegetation map, a diversity rating of 7 was applied. A priority value of 3 was given based on percent of acres surveyed. 3.10% of Little Park has been surveyed, by far the most surveyed of any of the study areas.

Laidlaw Park North (Survey = 10; Treatment = 13)

Survey

Based on fire history, Laidlaw Park North was given a priority value of 2. This area was exposed to wild fires in 1986 as well as 1992. This area was given a priority value of 2 for livestock grazing because there was minimal evidence of grazing observed. The known density of rush skeletonweed in this area is 0.0161 infestations per acre resulting in a survey value of 2. Given the abundant survey work completed, this is the lowest known density of rush skeletonweed recorded for all areas. When considering native plant diversity, Laidlaw Park North received a priority value of 3. Based on the dominant vegetation map and field observations, this area was given a vegetation diversity rating of 10, the highest recorded.

Laidlaw Park North has had 1.64% of its total area surveyed; this is considered high when compared to other areas. Based on this, it has been given a priority value of 1.

Treatment

Based on fire exposure, Laidlaw Park North received a priority value of 1. This area burned in 1986 and again in 1992. A priority value of 3 was applied for the livestock grazing category. Field observations indicated that this area is minimally used for grazing. This results in low soil disturbance and susceptibility to weed invasion, as well as a high conservation value. Laidlaw Park North received a priority value of 3 based on the known density of infestation points. A density of 0.0161 infestation points per acre was calculated. This was the lowest density of rush skeletonweed infestations in any of our study areas. Based on the dominant vegetation map a priority value of 3 was received for native diversity. The diversity rating was calculated to be 10, the highest of any of our study areas. Field observations confirmed that this area was the most diverse. 1.64% of North Laidlaw Park has been surveyed, resulting in a surveyed area priority value of 3. The higher percentage of area surveyed in North Laidlaw Park increases our knowledge of this area relative to the other areas in our study.

DISCUSSION

The existing and potential problem of invasive species is a well documented threat to both ecosystem biodiversity, as well as the conservation and production value of a particular area. Hobbs and Humphrey (1995), argue that three important components should be considered for any particular invasion; ‘the spatial and temporal dynamics of the invading species, the structure and dynamics of the ecosystem being invaded, and the effects of human activities on these components’ (1995). In order for resource managers to make effective decisions regarding the management of invasive weeds it is important to consider these elements, and in most cases prioritize certain areas where management of a particular species is economically, socially, and environmentally appropriate.

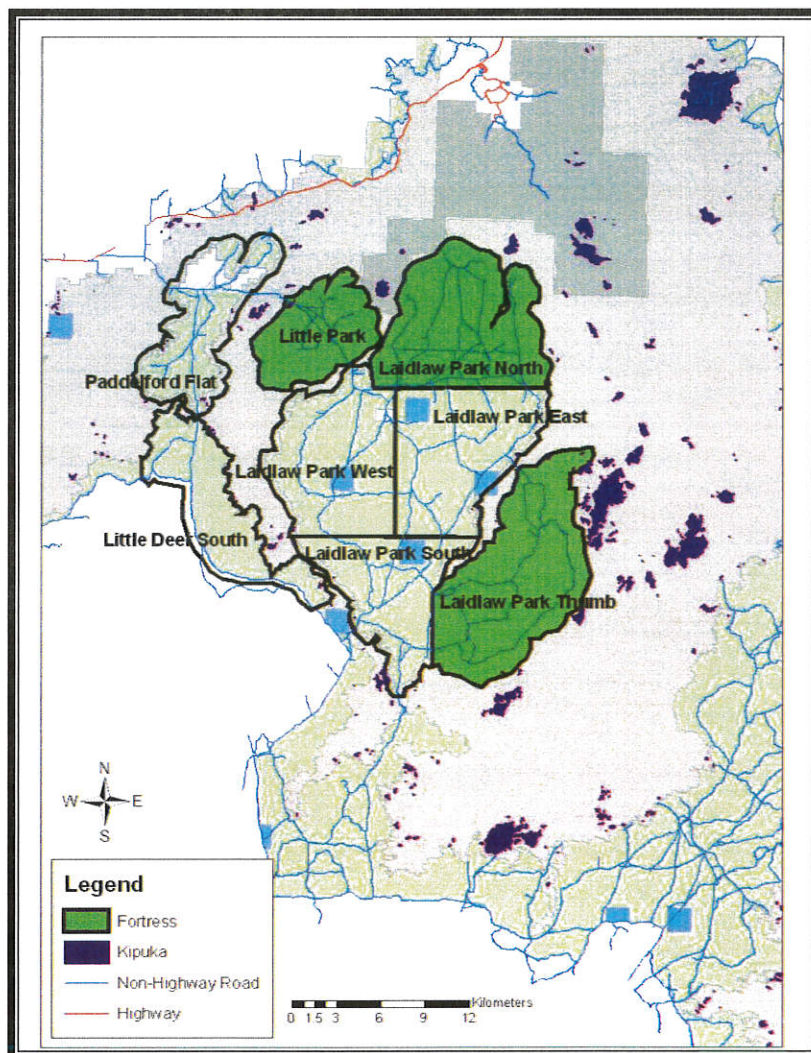
Rush skeletonweed is a prolific noxious weed in Idaho. It not only produces many viable wind dispersed seeds, but also has the potential to reproduce when the crown or root is damaged (Rosenthal et al 1968). These reproductive traits allow rush skeletonweed to successfully establish and compete for native resources. Resource managers at Craters of the Moon National Monument and Preserve first discovered rush skeletonweed in 2003, and have since been allocating resources to determine the extent of the infestations and control where possible. After five field season of collecting data on rush skeletonweed in various portions of the Monument and Preserve, it is now reasonable to develop a management plan outlining areas of priority based on relative levels of disturbance, as well as conservation and production value.

Using the matrix approach to develop priority areas for management, our results indicate that there are particular priority areas where resources should be allocated. Coupled with our results, we have also considered the resource management objective of kipuka resource protection, as well as relative geographic locations of each area in proximity to these kipukas, to denote three areas where management of rush skeletonweed is a priority. Kipukas are features of vegetation where a more recent lava flow has diverged and then rejoined downstream to effectively isolate and create an ‘island of vegetation’ (Craters Management Plan). These three areas, Little Park , Laidlaw Park North, and Laidlaw Park Thumb, are given the term ‘fortresses.’ For this management plan, we define fortress as a stronghold against unmanageable rush skeletonweed infestations. Paddelford Flat and Little Deer South represent the opposite situation, where we

have determined that allocating resources to managing the infestations is not economically feasible, and would not achieve a high level of success.

The geographic location of the fortress areas, as well as the location of the kipukas in the Monument and Preserve, are shown in Figure 3. Kipukas represent some of the last undisturbed sagebrush steppe communities in the Snake River Plain, making them an extremely valuable natural resource. It is primary Monument objective and priority for resource managers to maintain their ecological integrity. If the areas designated as fortresses were to be lost to high populations of rush skeletonweed, the kipukas downwind of these areas would be severely threatened.

Figure 3: GIS map of ‘fortresses’ and their relative location to kipukas.



Although only three areas have been designated fortresses, it is important to consider the other areas for particular management options. It is a common statement that ‘weeds know no boundaries’ and therefore we recommend the following management options for each of the chosen work sites.

Laidlaw Park North (Fortress)

Laidlaw Park North represents a diverse area in relatively good ecological condition and therefore should be considered highly important to conserve. This area’s geographic location was also important in this special designation. Laidlaw Park North is located within close proximity to a number of kipukas. In order to protect these ecologically unique areas, it is very important to keep this area in a healthy condition. Laidlaw Park North received an overall prioritization value of 10 for survey work and a value for treatment of 13. This is the highest priority for treatment work given to an area, and the second highest for survey work. Survey work is needed in this area in order to find the infestations before they get too large, compromise existing healthy plant communities, and become major sources of seed. Effective treatment is equally important in order to limit their growth. With so few known rush skeleton weed points, along with high native plant diversity and high conservation value, this area should be successfully managed and maintained.

Little Park (Fortress)

Maintaining this Little Park’s ecological health is considered to be a high priority and a plausible goal. Overall, Little Park received a prioritization value of 7 for survey work, and a value of 12 for treatment. The low value for survey work is due to the high amount of survey work already completed in the area, along with no presence of fire in the last 30 years. Based on the matrices, it would appear that this area is not a high priority, but it has been determined that this area should be given the special designation as a fortress. Its geographic location offers support for this designation. It is located upwind of Laidlaw Park North, another fortress, high value kipukas, and Craters of the Moon Wilderness. If Little Park were to become heavily infested, it would create a large seed source for these high resource value areas. Little Park is a virtual ‘island’ surrounded by lava beds. This provides some natural protection from rush skeletonweed seeds. Although it is more heavily grazed than other areas, with proper treatment, it would still

be relatively easy to keep this distinct area pristine. Resources should be spent on treating sites in this area rather than surveying for new ones.

Laidlaw Park Thumb (Fortress)

The third area designated as a ‘fortress’ is Laidlaw Park Thumb. Overall, Laidlaw Park Thumb received a survey priority value of 13, making it the highest priority for survey work, and for treatment a value of 12. Due to its unique geographic location, this area should be considered a high conservation priority. It is located in proximity to a number of kipukas, and in order to protect these unique locations from noxious weed infestations, Laidlaw Park Thumb needs to remain in good ecological condition. With an extensive fire in 2007, survey work is highly critical to document any invasions of rush skeletonweed. Likewise, infestations found in this area should be treated with a high priority. The recent fire creates a situation where infestations found in this area need to be eradicated quickly to ensure that native vegetation can reestablish.

Laidlaw Park South (Medium Priority)

Laidlaw Park South received an overall prioritization value of 11 for survey work and a value of 12 for treatment. This makes it an area of medium priority. It is important to survey this area to increase our knowledge of the level of infestation, as well as treat the known infestations. The drier weather patterns and geographic location of this area makes it more prone to grazing disturbances. This area has been targeted by the BLM for proactive restoration efforts. If not managed and treated properly, post restoration, it has the potential to again become degraded. With the recent fire of 2007, it is important to survey this area quickly in order to locate rush skeletonweed infestations and prevent them from completely establishing in this disturbed area. Although few kipukas are located downwind of this area, Laidlaw Park Thumb is located downwind, making it necessary to spend resources in Laidlaw Park South.

Laidlaw Park East (Medium priority)

Laidlaw Park East has received an overall priority value for survey work of 11 and a value of 10 for treatment work. We have determined that it would be more efficient to spend resources in this area on survey work which would add valuable knowledge in order to better allocate resources. However, Laidlaw Park East is located downwind to a number of kipukas as well as

Laidlaw Park Thumb, one of our three designated fortresses. In order to protect the integrity of these locations, infestations found in Laidlaw Park East may be considered to be of a higher priority for treatment than other medium priority areas.

Laidlaw Park West (Medium Priority)

Laidlaw Park West received an overall prioritization value of 11 for both survey and treatment work. This area is considered to be of medium priority. The geographic location of this study area does not make it a direct threat to kipukas or areas deemed as fortresses. Based on the definitions given by our prioritization matrix and lack of survey information, this area has been classified as having a low density of rush skeletonweed infestations. However, based on the points that were found, it is possible that this area is densely infested. There is a severe lack of attention paid to this location and therefore is in need of survey work in order to understand the extent of the present infestation. It must be considered that any area left unattended by either survey or treatment creates the opportunity for a large seed bank to be produced.

Paddelford Flat (Low Priority)

The overall priority value for survey work in this area is an 8, and for treatment work is a 9. This is considered to be a low priority area for both management actions. When compared with other areas, there is a high amount of surveyed acres and therefore more is known about the extent of Paddelford's infestations. It would be an inefficient use of resources to conduct more survey work in this area. With this extensive amount of survey work completed, it has been determined that resources in this area are more appropriately spent treating known sites than surveying for new sites. There are numerous reasons for the low value of ecosystem health in this area. The relatively easy access for cattle ranchers provides an adequate vector for transportation and weed seed, as well as supplying a disturbance that effectively increases suitable habitat for weed infestations. The history of fire exposure adds to the suitability for weed infestations in this area. It is worth noting that the geographic location of this area makes it a very suitable seed bank for a majority of the Monument. It is also close to a small number of kipukas. For these reasons, Paddelford Flat should be considered for some treatment work in each field season when appropriate.

Little Deer South (Lowest priority)

Little Deer South has received an overall treatment prioritization value of 7, and a survey prioritization value of 8. This is the lowest priority given to an area in our study. Based on the current survey information, this area is heavily infested with noxious weeds. It has been determined that, at this current time, the limited resources available should not be spent at this location. Although this area is a wilderness study area (WSA), the geographic position of this area adds to the lack of priority. Of the areas under study, Little Deer South is the most easily accessed by ranchers via the Carey Kimama Road, making it highly prone to overgrazing. There are prevailing easterly winds which provide an excellent vector for seed transportation into this area. This is compounded by a lack of natural barriers to prevent seeds from reaching this area. The presence of a lava flow on the east side seems to be stemming the spread of rush skeletonweed seeds further east, although there is little substantial proof of this. It is worth noting that this area provides an incredibly large and healthy seed source for rush skeletonweed. Despite the lava flow barrier, these seeds are capable of reaching further into the Monument. If extra resources are available in a given field season, it is advisable that some time is dedicated to treating these large infestations.

CONCLUSION

Establishing the designated areas as fortresses against rush skeletonweed invasion will help direct the future allocation of resources, and essentially create a front where the battle may be fought. Those areas not designated as fortresses however, should not be ignored. Both Paddelford Flat and Little Deer South present considerable sources of seed which should be minimized each season, depending on available resources. With such large infestations in these areas, considerations for using all available tools to fight these infestations could dramatically reduce the time and energy needed. Such options should include the use of all terrain vehicles (ATVs) which would greatly increase the efficiency with which managers would be able to access, inventory and treat infestations. The use of ATVs is not recommended for all areas, particularly in WSAs, because they can create soil and vegetation disturbances if used improperly. In areas such as Little Deer South and portions of Laidlaw Park South and Laidlaw Park East where infestations are extensive, grazing is already severely trampling the system, and the overall health of the ecosystem is hampered, the use of an ATV would be advisable and would likely meet minimum tool requirements for WSAs under these degraded ecological conditions.

Through the additional survey efforts conducted in 2007, it has been determined that rush skeletonweed at Craters of the Moon is much more extensive than expected. This is quite overwhelming for resource managers, and it may be concluded that some infestations are unmanageable with current technology and funding levels. However, we believe that certain areas are manageable and maintainable. Focusing resources in the fortresses may allow these areas to sustain their ecological integrity and remain important for conservation. Additional management actions should be considered to ensure success and investment in these areas; fighting a weed infestation problem cannot be successful if certain cultural habits and land use practices are not adjusted. For instance, it is advised that grazing be limited in the areas denoted as fortresses. Limiting this disturbance will assist in effective management of these areas. It is our belief that focusing resources in fortress areas along with appropriate and commensurable change in cultural habits, the NPS and BLM can preserve this extremely unique landscape, and prevent the impending ecosystem takeover by rush skeletonweed. We also look to the future in hopes that other means such as a biological control may be developed to effectively reduce the

population densities of noxious weed infestations. By protecting our designated areas, we will preserve the ecological integrity of Craters of the Moon National Monument and Preserve, and with the future hope for a biological control, we may be able to truly turn the tide on the invasion of rush skeletonweed.

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Appendix A: Known infestation points of Rush skeletonweed, and current survey data

