Technical support for Ash Meadows National Wildlife Refuge BAER activities on the Longstreet Fire of 2004

Prepared by

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Executive Summary

This report summarizes the technical support that scientists from the USGS, Western Ecological Research Center, provided to Ash Meadows National Wildlife Refuge related to the Longstreet Fire of August, 2004. Staff from the NPS Exotic Plant Management Team, located at Lake Mead National Recreation Area, were also enlisted by the Refuge to provide expertise on weed treatment options. Initial planning discussions between the Refuge, USGS, and NPS began in February 2005. By May an intern was hired at the Refuge to map occurrences of noxious weeds within and adjacent to the perimeter of the Longstreet Fire. This was deemed necessary so that Burned Area Emergency Response (BAER) weed treatment areas could be delineated, and treatment and monitoring plans could be developed. This map was completed in September 2005. In November 2005, the Refuge, USGS, and NPS staff met to finalize the treatment implementation and monitoring plans. The weed map and other spatial data compiled by Refuge staff and USGS were used to guide this process. After surveying the potential study areas in January and February 2006, USGS and NPS staff noted that the continuity of the weed polygons was not as high as originally thought, and that native perennial grass cover had increased since weed mapping during the previous summer. These changes required the project plan to be scaled back and revised. The final plan presented in this report calls for treating all patches of Russian knapweed with herbicide in spring 2006, and conducting basic cover monitoring during the summers of 2006 and 2007 to determine if the treatment objectives are met. The recommended objectives are to limit Russian knapweed cover to less than 5% and to establish saltgrass cover greater than 50% by summer 2007.

Background

Ash Meadows National Wildlife Refuge was created in 1984 to protect 13 threatened and endangered species and at least 24 plants and animals found nowhere else in the world. The Refuge has the distinction of having a greater concentration of endemic species than any other area of its size in the United States, and the second greatest concentration of endemic species in North America. The Refuge's large number of endemic species is directly related to its unique hydrogeology. The Refuge is a major discharge point for a vast underground aquifer with more than 30 major seeps and springs discharging over 17,000 cubic yards of water per acre and supporting a vast network of spring, wetland, and riparian habitat in the Mojave Desert.

According to the U.S. Fish and Wildlife Service, invasive species have become the single greatest threat to the Refuge System. This threat is clearly visible in Ash Meadows NWR where over 60 species of nonnative plants currently occur. The invasive nature of some of these species threatens the listed and endemic plants at the Refuge, and hinders habitat restoration, public access, and construction of public facilities in infested areas.

On 1 August 2004, a lightning strike started the Longstreet Fire, which burned 1,630 acres within the Refuge boundary. A Burned Area Emergency Response (BAER) team was assembled to assess the damage to Refuge resources and recommend emergency stabilization and rehabilitation actions. The BAER team developed an Emergency Stabilization (ES) Plan which identified a number of issues and concerns, including the high potential for spreading of noxious weeds within the fire perimeter and the need to control and monitor invasive weed populations. In general, the BAER Plan recommended mapping and documenting existing and new occurrences of noxious/exotic weeds, controlling weed occurrences utilizing integrated pest management practices, re-establishing native vegetation in areas of moderate to high burn severity and areas encroached by weeds, and monitoring treatment effectiveness.

To carry out these tasks, Refuge staff enlisted the services of scientists from the USGS Las Vegas Field Station and a weed control specialist from the NPS Exotic Plant Management Team located at Lake Mead National Recreation Area. These three parties first met on 23 February 2005 to discuss management objectives, treatment implementation, and effectiveness monitoring for the Longstreet Fire BAER project (Table 1). They agreed on a course of action requiring that weed populations within the Longstreet Fire perimeter be mapped prior to finalizing the treatment and monitoring plans.

A formal agreement for USGS to provide technical support for the Refuge on issues related to the Longstreet Fire was finalized on 29 June 2005 (FWS Agreement #84550-5H005; Table 1). The period of performance for this agreement was 11 April 2005 through 30 September 2009. This timeframe was established to encompass the time nec-

Table 1. Activity timeline for Longstreet Fire BAER treatment implementation and monitoring.

Timeframe	Major Milestones
Feb 2005	Initial discussions and planning
May 2005	USGS provides training and Refuge staff begins weed mapping USGS staff begins compiling other spatial data
June 2005	FWS Intragovernmental Agreement #84550-5H005 with USGS-WERC signed
Sept 2005	Refuge staff ends weed mapping and sends USGS digital polygons
Nov 2005	USGS staff ends data compilation Meeting to finalize management objectives, implementation and monitoring plans based on weed maps and other spatial data
Jan 2006	USGS delivers geodatabase
Jan-Feb 2006	USGS and NPS staff note discrepancies between weed map and field conditions
Feb 2006	USGS and NPS staff recommend to scale back implementation and monitoring
Mar 2006	Refuge staff concurs with scaled back plan
June 2006	USGS delivers final report and monitoring recommendations

essary to complete 5 specific tasks associated with this fire: 1) develop weed maps and compile other spatial data layers needed to identify weed management objectives and treatment areas; 2) assist Refuge staff in identifying resource management objectives, monitoring objectives, treatment locations, and establishing monitoring plots; 3) evaluate the effectiveness of different treatment strategies; 4) manage monitoring data and synthesize data collected by Refuge staff; and 5) deliver a final report.

This report details activities associated with tasks 1 and 2 above, which were funded in FY05. It contains sufficient information to proceed with tasks 3-5 using Refuge staff or an external contactor such as USGS, University, or other monitoring crews.

Compiling spatial data

Field mapping

In late spring of 2005, USGS and Refuge staff developed a strategy for mapping weeds throughout the Longstreet Fire area (Table 1). The UGGS provided training in mapping protocols for Refuge staff, which included defining weed polygons, using mapping software in the field, and uploading these data into a spatial database where they were stored with other useful spatial information. During that summer, Refuge staff mapped weeds of interest on the ground using a Trimble GeoXM handheld GPS unit running ESRI ArcPad version 6 software. Polygons of continuous weed cover were digitized by capturing GPS positions while walking around the perimeter of a weed patch.

Russian knapweed (*Acroptilon repens*) and five-hook bassia (*Bassia hyssopifolia*) were the primary weed species of interest, but other weed species were mapped opportunistically. These species included annual rabbits foot grass (*Polypogon monspeliensis*), Maltese star-thistle (*Centaurea melitensis*), flixweed (*Descurainia sophia*), and whitetop (*Cardaria draba*). Within and along the Longstreet Fire perimeter, approximately 71 ha of weeds were mapped (Figure 1).

The mapped weed polygons were sent to USGS by Refuge staff on 14 September 2005 (Table 1). These polygons were then displayed on a map to visualize the spatial relationships between weed patches and other landscape features (Figure 1).

Geodatabase design

USGS staff incorporated the weed spatial data into an ESRI Personal Geodatabase using ArcGIS version 9 software. The geodatabase, named “AMweedsGIS”, contains three feature datasets, which are groupings of similar GIS layers (Figure 2). The “WeedLayers” feature dataset contains layers for each weed species mapped. The “BaseLayers” feature dataset contains other layers useful for reference purposes. The “StudyPlots” feature dataset contains layers where monitoring study plots have been or would be installed. The geodatabase also contains weed and monitoring plot information for other areas referred to as “Bradford Springs” and “Warm Springs”, which are not part of the Longstreet Fire BAER activities, but other project areas where the Refuge, USGS, and NPS are collaborating to study weed management strategies.

All metadata elements required by the Federal Geographic Data Committee were added to each data layer. The metadata are within the geodatabase and can be read using ArcCatalog. The geodatabase can be continually updated and modified as weed management activities occur on the Refuge. Additional feature datasets deemed important to the project (such as T&E species occurrences, soils, geology, etc.) can be added for ease of access and integration. The geodatabase was delivered to Refuge staff on 25 January 2006 (Table 1).

Identifying resource managment objectives, monitoring objectives, treatment locations, & monitoring plots

Ash Meadows NWR, USGS, and NPS staff met on 29 November 2005 to finalize implementation plans, based on information generated by the weed mapping and information regarding past land disturbance (i.e., abandoned agricultural fields) (Table 1). During this meeting they agreed upon the following preliminary management objectives: 1) reduce dominance of Russian knapweed and five-hook bassia; 2) increase dominance of native perennial grasses; 3) evaluate the effectiveness of different weed control and native grass revegetation treatments in old-field areas, areas with no

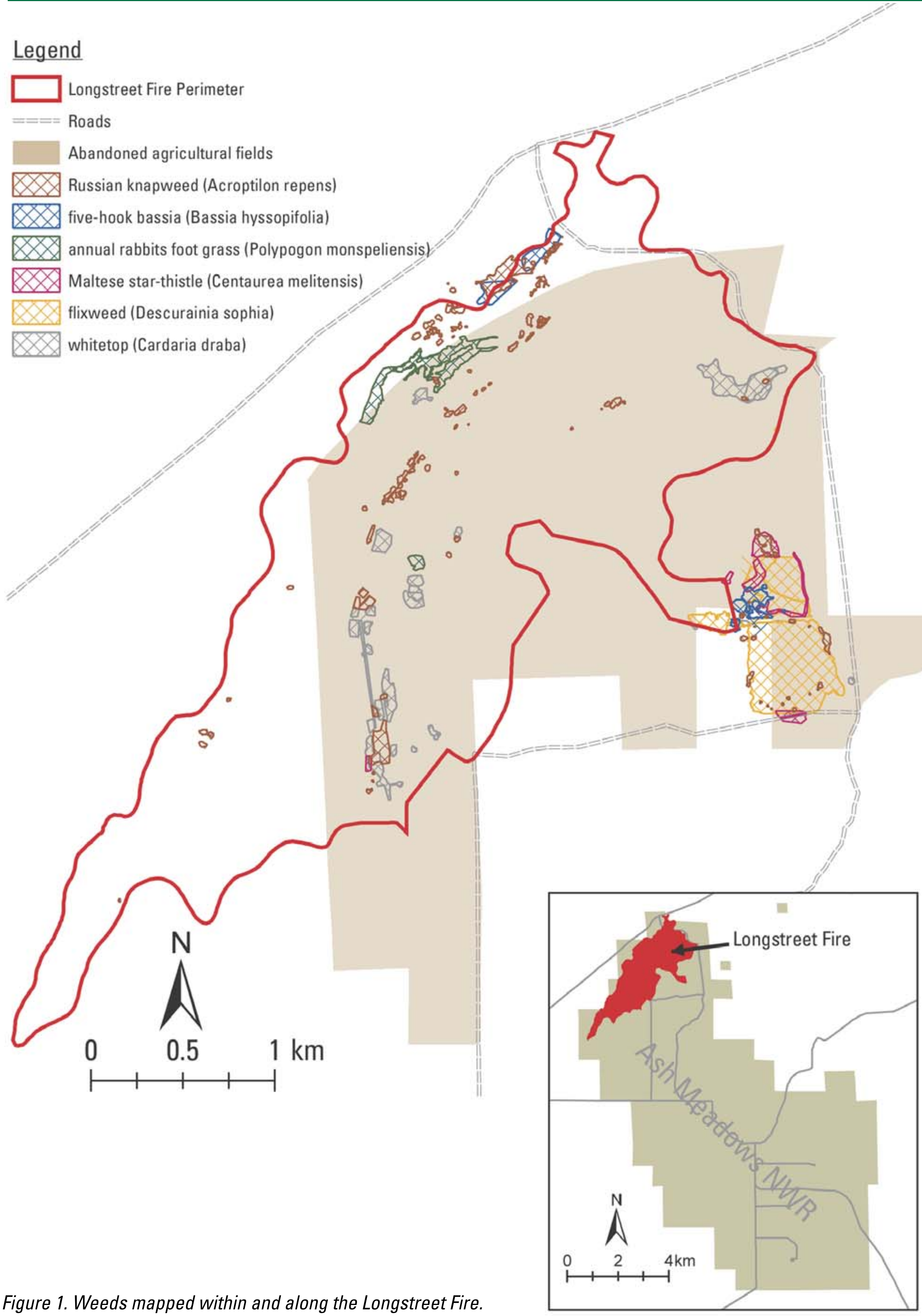

Figure 1. Weeds mapped within and along the Longstreet Fire.

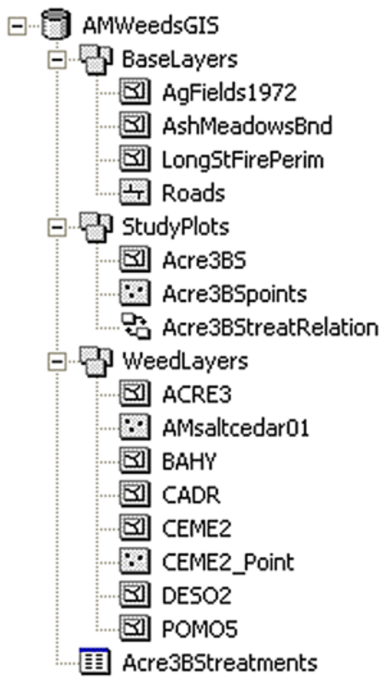

Figure 2. Geodatabase contents.

cropping history, and unburned areas adjacent to the fire perimeter. They also identified three study areas where specific management treatments would be implemented to address the different management objectives.

The first area would be where contiguous Russian knapweed patches occurred on old-fields within the Longstreet Fire perimeter. This site would be appropriate for evaluating different herbicides for controlling Russian knapweed and follow-up revegetation techniques. The second area would be where contiguous patches of Russian knapweed and five-hook bassia occurred and where there was no history of cropping in burned and unburned areas along the edge of the fire perimeter. This site would be used for evaluating the effects of a single herbicide on both weed species. The third area would encompass most of the scattered patches of Russian knapweed distributed throughout the fire. These areas would be amenable to spot treatments and cursory monitoring. Details for each of these three areas are described below.

Preliminary treatment area 1: Contiguous patches of Russian knapweed within the fire perimeter

Large contiguous areas lend themselves to comparisons of different management treatments. Since little is known about the effectiveness of herbicides for controlling Russian knapweed at Ash Meadows NWR, the study was designed to evaluate the effects of different herbicides on Russian knapweed. Following herbicide application, different revegetation treatments would be applied, which included 3 different species combinations (saltgrass [*Distichlis spicata*], alkali sacaton [*Sporobolos airoides*], and both species together) planted at 4 different densities (low, medium, high, and none). The combinations of different herbicides and vegetation treatments would be applied to 6×12 m plots (a common size used in herbicide effectiveness trials).

A large polygon of knapweed cover located in the southwestern part of the Longstreet Fire was identified on the weed map as suitable for containing test plots (a total of 144 treatment plots: 3 herbicides × 3 revegetation species × 4 revegetation densities × 4 replicates). Treatment effectiveness would be monitored within each treatment plot during the summers of 2006 and 2007 by measuring plant density within 0.5×0.5 m quadrats, plant biomass within 0.25×0.25 m quadrats, and plant cover along a 10 m point-intercept transect. Photographs would also be taken from the two ends of each transect.

Preliminary treatment area 2: Contiguous patches of Russian knapweed and five-hook bassia along the edge of the fire perimeter

An area along the northern edge of the burn perimeter was identified for testing herbicide effects on mixtures of knapweed and five-hook bassia. Effectiveness monitoring would include measuring plant density, biomass, and cover as described for preliminary treatment area 1.

Preliminary treatment area 3: Small Russian knapweed patches throughout the burned area

The mapping effort identified a large number of smaller knapweed patches scattered throughout the burned area. It was determined that these areas would be most efficiently treated by applying a single herbicide. Effectiveness monitoring would include measuring plant density and cover, but not biomass.

Monitoring plan refinement

The three initial treatment areas for the Longstreet Fire were developed based upon results of the weed mapping and beliefs about the degree to which Russian knapweed had displaced native vegetation following the fire. In late January and early February 2006, USGS and NPS staff visited the mapped weed locations to delineate treatment plots preceding herbicide applications in the spring. It was observed that many of the areas of knapweed and bassia infestation that were thought to be contiguous polygons (preliminary treatment areas 1 and 2) were actually composed of much smaller patches. The size of the patches would not be sufficient for the number of plots originally proposed. Furthermore, it was observed that there was substantial native grass cover (predominately saltgrass) that had expanded since the initial weed mapping, especially in areas outside of abandoned agricultural fields (Fig. 1). This brought into question the necessity for immediate revegetation treatments in the Russian knapweed patches since existing native vegetation may respond relatively rapidly once the knapweed is killed. USGS and NPS staff therefore recommended that the multiple herbicide and revegetation testing at preliminary treatment areas 1 and 2 be modifed to focus on one herbicide applied over the patches throughout the burned area.

Monitoring the response of knapweed and native grasses to herbicide treatment could be conducted over all areas using the simple point cover transects along with photographic documentation proposed for Treatment area 3. If that monitoring revealed that native grasses were either failing to respond to less knapweed competition or were detrimentally affected by the herbicide, revegetation could then be applied where necessary in the knapweed patches.

Summary and final recommendations

We present our final recommendations based on the spatial data we compiled and our field observations as of March 2006. We recommend using imazapyr (Habitat, BASF) herbicide for control of Russian knapweed. This is an aquatic approved herbicide that can be applied throughout the Refuge. We also recommend that native plant revegetation not be implemented at this time within the Russian knapweed patches. This is based on observations that the distribution of Russian knapweed and other weeds is relatively patchy, and there is evidence that native saltgrass is re-establishing in many of those areas. If native plant revegetation is implemented by the Refuge staff, we recommend that they focus on areas within areas of past human disturbances where native grass cover is currently the lowest (e.g. abdandoned fields, tanks, ponds, and ditches). Also, we recommend follow-up native plant revegetation within knapweed patches if native cover declines following herbicide treatments. We did not evaluate saltgrass dominance in areas outside of the Russian knapweed patches within the Longstreet fire perimeter, so our recommendations only apply to these patches within the burned area.

Imazapyr herbicide treatments were applied in May 2006, largely due to scheduling and funding constraints. For maximium effectiveness, we recommend that future imazapyr herbicide treatments be applied during the fall (Oct-Dec). Other non-aquatic approved herbicides to consider for Russian knapweed control include clopyralid (Transline, Dow AgriSciences) or chlorsulfuron (Telar, DuPont) applied in the fall, or aminopyralid (Milestone, Dow AgriSciences) applied during dormancy in the winter (Dec-Feb).

Management objectives

The nature of the scaled-back treatment plan requires the Refuge staff to re-evaluate the management objectives identified at the November 2005 meeting. The first objective—reducing dominance of Russian knapweed and five-hook bassia—is still attainable, although the focus should primarilly be on Russian knapweed since its negative ecological effects are well documented and its distribution is still somewhat patchy within the Longstreet fire perimeter. The second objective—increasing the dominance of native perennial grasses—no longer seems necessary within Russian knapweed patches and may be acheived within those areas through the process of natural recovery given the strong response of saltgrass up through the second post-fire spring of 2006. If this postfire trend in saltgrass cover changes, then revegegation may be necessary in the future. The third objective—evaluating the effectiveness of different weed control and native plant revegetation treatments in old-field areas, areas with no cropping history, and unburned areas adjacent to the fire perimeter—is not feasible given what we now know about the post-fire landscape; specifically, the patchy distribution of Russian knapweed and the strong reponse of saltgrass call for the simple treatment plan proposed above.

We therefore recommend two revised managemement objectives: 1) limit cover of Russian knapweed to below 5% and re-treat if that level is exceeded; and 2) establish 50% or greater cover of saltgrass and/or other native perennial grasses. Both objectives should be achieved by the second post-treatment summer of 2007 (note that this is also the third post-fire year). We do not phrase these objectives in terms of decreasing or increasing levels, because without untreated controls there is no way to determine when these relative treatment objectives would be attained.

The percent cover thresholds we identified are somewhat arbitrary, but they are based on appropriate land management concepts. First, the threshold of 5% cover for Russian knapweed to trigger retreatment seems reasonable considering the aggressiveness of this species and its potential to spread rapidly if left unchecked. Ideally, the presence of any Russian knapweed should trigger re-treatment, but within the scope of BAER plans, complete eradication is probably unrealistic. Second, the threshold of 50% cover of saltgrass seems attainable given what has occurred within other fires in Ash Meadows NWR and other similar landscapes in the Mojave Desert (Matt Brooks personal observations). This level may seem particularly high, but considering that the primary purpose of saltgrass recovery is to hinder the dominance and spread of Russian knapweed, high cover of saltgrass is considered necessary to effectively compete with this weed species.

We did not include thresholds of density in our objectives since the two primary target species, Russian knapweed and saltgrass are rhizomatous and individuals are impossible to distinguish using standard field methods. Furthermore, basic stem density data would not significantly add information not already included in point intercept cover measurements.

Monitoring design

In the absence of multiple treatments or untreated controls, effectiveness monitoring options for the Longstreet Fire BAER project are very limited. For example, if one herbicide type is used on all Russian knapweed patches, and none are left untreated, then there would be only one type of treatment plot and no reference condition with which to compare. If more than one herbicide treatment is used, then there would be two or more treatments that could be statistically compared, but it still would not provide information about whether the treated plots were different than they would have been in the absence of any treatment.

Rather than evaluate the relative effectiveness of the herbicide treatments, we recommend that a basic monitoring plan focus on the absolute thresholds of effectiveness identified in the managment objectives.

We recommend a monitoring plan consisting of a single 15 m point transect within each contiguous patch of treated Russian knapweed that is 30 m or more in its minimal width. The origin and compass direction of each transect should be randomly determined, as long as the entire length of the transect remains within the treatment polygon. Cover should be determined by the point intercept method (USDI National Park Service 2003). Starting at the end of each transect and repeated every 30 cm, a sampling rod (a rigid plumb bob) will be lowered to the ground. If the rod tip contacts any part of the two target species, it is recorded as a "hit." The total number of hits, divided by the total number of rod drops, and multiplied by 100 will equal the percent cover for each transect. Sampling should occcur during the summers of 2006 and 2007. Photographs should be taken looking back over the transect from each end.

Cover using point intercepts is one of the two primary monitoring techniques recommended for effectiveness monitoring of post-fire treatments, the other being stem density (Wirth and Pyke 2006). The other two recommended techniques, basal gap intercept of perennial plants and erosion fences, are both designed to evalute soil loss, and soil conservation is not a primary objective of the Longstreet Fire BAER Plan.

Quantitative measurements of cover will produce data that can be combined with, and compared to, other data that is currently being collected in association with recent Mojave Desert fires. Some of these fires include the Southern Nevada Complex in Nevada, the Hackberry Complex in California, and various other fires in southwestern Utah and northwestern Arizona. The USGS authors of this report are involved in collecting cover and other types of data associated with post-fire management treatments and natural regeneration on these fires, and will be able to merge the data collected for the Longstreet Fire into their larger dataset.

Statistical analyses

Analyses should focus on determining if the threshold value for 5% cover of Russian knapweed is exceeded and 50% cover of saltgrass/perennial grasses is met. This can be evaluated by testing the deviation of average measured values from these targets. If they are significantly higher (for knapweed) or lower (for saltgrass) than their respective criterion levels by the summer 2007, then the treatments can be considered to have failed.

A one-tailed Z-test should be used to analyze the monitoring data. This test is included in most spreadsheet and statistical programs. In Microsoft Excel, the Z-test function can be accessed through the following sequences of tabs: Insert/Function/ZTEST. You will be asked to enter the data "array," which are the monitoring data values for the cover transects. You will also be asked to enter the "X" value, which is your criterion, which in this case would be either 5 or 50 (%), depending if you are analyzing knapweed or saltgrass data. Finally, you will be asked to enter "sigma," which is the population standard deviation. Since this is typically unknown, leave this field blank and the software will automatically use the sample standard deviation of the monitoring data instead. The number that is generated is the p-value, otherwise known as the probability that another random sample would produce a more signficant sample mean than what was observed, given that the criterion is met. For Russian knapweed, it is the probability that a random sample is equal to or greater than the observed mean, given that the criterion for area-wide cover is met at 5%. Similarly, for the saltgrass and native perennials, it is the probability that a random sample is equal to or less than the observed sample, given that the criterion for area-wide cover is met at 50%. Smaller p-values correspond to greater evidence that the cover objectives were not met. In order to have a standard 95% confidence level when identifying sample means that fail to meet the criterion, then any p-value less than 5% can be considered as signfiant evidence.

An alternative to the Z-test, especially if the sample size is <50, is the one-sample t-test. Although this feature is not currently available in Microsoft Excel, a macro is available to run this test at http://www.maths.murdoch.edu.au/units/statsnotes/inference/excelprocs2.html. However, most statistical programs do include a t-test function.

Monitoring of future fires at Ash Meadows NWR

The Longstreet Fire BAER treatments do not require a comprehensive monitoring plan, but this may not always be the case for future fires at Ash Meadows NWR. If there is signficant discontinuous variation on the landscape and areas that will remain untreated, and resources to stratify sampling and include untreated controls, than a wider range of monitoring questions can be addressed.

Ideally, comprehensive monitoring plans should include six major elements: objectives, stratification, controls, random sampling, sample adequacy, and statistical analyses. Monitoring of the Longstreet Fire treatments focused only on objectives, random sampling, and statistical analyses. A recent review document provides excellent guidance on how to incorporate all elements into effectiveness monitoring plans for post-fire management projects (Wirth and Pyke 2006).

Literature cited

Interagency Burned Area Emergency Response Handbook. 2005. Accessed online 4 April, 2006. http://www.nps.gov/policy/DOrders/DraftHandbook.htm.

USDI National Park Service. 2003. Fire Monitoring Handbook. Boise, ID: Fire Management Program Center, National Intergency Fire Center. 274pp. Accessed online 4 April, 2006. www.nps.gov/fire/download/fir_eco_FEMHandbook2003.pdf.

Wirth, T.A.and D.A. Pyke. 2006. Monitoring Post-fire Vegetation Rehabilitation Projects: Current Approaches, Techniques, and Recommendations for a Common Monitoring Strategy in Non-forested Ecosystems. USGS Report in preparation. 24 pp.