
Training of Conservation Detection Dogs to Locate Kincaid's Lupine (*Lupinus sulphureus ssp. kincaidii*)

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Table of Contents

EXECUTIVE SUMMARY	1
INTRODUCTION	1
GOALS AND OBJECTIVES	2
METHODS.....	2
2007 Training Activities	2
2008 Performance Trials	5
RESULTS AND DISCUSSION.....	8
Detection Accuracy	8
Maximum Detection Distance and Search Speed	10
CONCLUSIONS	10
MEDIA CONTACTS AND DEMONSTRATIONS.....	11
LITERATURE CITED	12
FIGURES.....	14

Executive Summary

The USFWS is currently preparing a draft recovery plan for four threatened and endangered prairie species in western Oregon and southwest Washington (USFWS 2006). One of the most important conservation actions identified in the plan is evaluating the status of extant populations for each prairie species. The success of trained dogs in a wide range of conservation detection applications during the last decade suggests that they also may be able to perform reconnaissance searches for rare species of prairie plants, potentially providing valuable assistance to botanists and conservationists engaged in the recovery effort.

In this study, we trained several dogs to recognize the odor of Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*), find Kincaid's lupine plants in prairie-type habitats, and to alert a handler to locations of target plants. In the summer of 2008, we conducted trials designed to simulate actual rare plant surveys and measure detection accuracy and other performance measures of trained dogs.

Three detection dogs were subjected to a combined total of 378 trials. The dogs committed a total of 6 errors during the course of the trials (mean error frequency = 1.6%). Observations during the trials suggest that target plants missed on plots and false alerts resulted from transitory miscommunications between dog and handler, manipulative behaviors by the dog to solicit a reward, or failure of the handler to direct the dog to completely search the transect. We estimated that dogs were able to locate Kincaid's lupine plants up to 15 m from the point they first recognized and oriented toward the scent source. Average search speed by dog/handler teams was 48 m²/min. Given the capabilities that the detection dogs demonstrated during our study, we believe they may offer valuable assistance to botanists conducting reconnaissance surveys for rare plants.

Introduction

Native prairies and savannas are among the most endangered ecosystems in the United States (Noss 1995). Less than 10% of the prairies historically distributed across western Oregon and southwestern Washington remain today (Floberg et al. 2004) and a number of species are imperiled by the loss of grassland communities. Five plants and one butterfly occurring in the Pacific Northwest have been added to the Federal List of Endangered and Threatened Wildlife and Plants since 1988. Five additional plant species are on state T &E lists in Washington or Oregon and are also listed as Species of Concern by the U.S. Fish and Wildlife Service (USFWS 2006).

The USFWS is currently preparing a recovery plan for the four federally listed threatened and endangered prairie species for western Oregon and southwest Washington (USFWS 2006). One of the most important actions identified in the recovery plan is evaluating the status of extant populations for each prairie species. Reconnaissance surveys for rare plants and Fender's blue butterfly (*Icaricia icariodes fenderi*) are labor-intensive and have depended upon a limited number of biologists that possess the requisite skills to identify these species in the field. For Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*) searches, experienced surveyors can usually search 1.5 acres/hour under typical conditions (G. Fitzpatrick, pers. comm.).

The logistics of performing reconnaissance surveys are further complicated by the phenology of each prairie species; most are only observable for a few weeks each year. Clearly, techniques that improve the efficiency or reduce the cost of detecting rare species would allow larger areas to be searched each year without a corresponding increase in expenditures for surveys.

It is widely recognized that dogs (*Canis familiaris*) can reliably discriminate among scents unique to individuals within a single species (i.e., humans). This ability is the basis for tasks performed by tracking and search-and-rescue dogs. Trained dogs have also been used by federal and state agricultural agencies to detect invertebrate pests and smuggled plant material (Cross 2006). For more than a decade, biologists have utilized the olfactory capabilities of trained detection dogs to perform a number of research and conservation tasks (Smith et al. 2001). Detection dogs have been used to locate desert tortoises (Cablak and Heaton 2005), identify scats from different species (Smith et al. 2003), conduct searches for invasive weeds (Goodwin et al. 2006), and perform a number of other research services. The success of trained dogs in such a wide range of detection applications suggests that they also may be able to perform reconnaissance searches for rare species of prairie plants.

Goals and Objectives

The goal of our program was to evaluate the capability of detection dogs to identify and locate rare, native plants for conservation purposes, a task for which they have not been previously used, to our knowledge. If successful, such dogs could assist botanists performing reconnaissance surveys, and may be particularly useful on difficult terrain or where site conditions prevent surveyors from easily detecting target species by vision alone (e.g., tall vegetation). The two primary objectives of this study were to:

- 1 Evaluate the accuracy of detection dogs to identify target plant species and present testing data and other information that would allow botanists and conservationists to assess the potential opportunities afforded by detection dogs.
- 2 Develop a training protocol and field methods that could guide future projects that are likely to benefit from capabilities of detection dogs.

Our project can serve as a model for validating the use of detection dogs for locating undiscovered populations of threatened and endangered plant species, as well as invertebrates associated with these plants. Improving the understanding of the present extant of federally-listed prairie plants has been identified as a high priority for the recovery of these species (USFWS 2006).

Methods

Our study focused on Kincaid's lupine. Historically, the species was probably widespread across prairies and savannas of Oregon's Willamette Valley and southwest Washington. However, Kincaid's lupine presently is known to exist only at 57 sites (USFWS 2006). Kincaid's lupine is designated as a threatened species under the Endangered Species Act (ESA) and is an important host plant for Fender's blue butterfly, listed as endangered under the ESA. We selected Kincaid's lupine as the target species for this study from among the other species addressed in the draft recovery plan (USFWS 2006) because container specimens were available to us for training and there were several accessible sites occupied by Kincaid's lupine in close proximity to Corvallis, Oregon (where our activities were centered).

2007 Training Activities

Five dogs were trained to detect Kincaid's lupine. Four dogs (Dog 1, Dog 2, Dog 3, Dog 4) were provided by the Working Dogs for Conservation Foundation (WDCF) and one dog (Dog 5) was provided by the Oregon Wildlife Institute (Table 1). All dogs had been trained prior with a combination of standard narcotic, cadaver, and search-and-rescue detection techniques for various purposes. Dogs 1, 2, and 3 had considerable experience conservation detection work and had been professionally deployed on a variety of research and management projects. Some of the target scents that one or all of these dogs had in their scent repertoires were scents of kit fox, grizzly bear, wolf, cougar, and black-footed ferret. Additionally, all three dogs had worked on field projects involving detection of invasive weed species, either spotted knapweed (*Centaurea biebersteinii* D.C.) or Dyer's woad (*Isatis tinctoria* L.) plants. Dog 4 had previous experience in

training for conservation detection work but had not been professionally deployed prior to this study, and Dog 5 had two seasons experience in detecting the nests of Northwestern pond turtles (*Emmys marmorata marmorata*). Thus, at the start of training to detect Kincaid's lupine plants, all dogs possessed a complete understanding of detection work, and in particular how to recognize the scent of a target object, search for that target object in a controlled and natural setting, and indicate to its handler when it found the target source.

Table 1. Summary of dogs trained to detect Kincaid's lupine in the first phase of research efforts.

Dog	Breed	Age	Sex	Years of exposure to scent work for various purposes prior to lupine training	Number of targets in scent repertoire prior to lupine training
Dog 1	German shepherd	10	M	8.5	7
Dog 2	German shepherd	9.5	F	8.5	10
Dog 3	German shepherd	6	M	5	6
Dog 4	Australian shepherd	5.5	M	1	2
Dog 5	Belgian sheepdog	3.3	M	2	1

Training activities were performed from July 1 to July 24, 2007. Dogs were first introduced to the scent of lupine through clippings of plants. Initial training involved using a scent box method as used nationally by multiple detection dog training units. For clipped plant material, the scent box method consisted of a line of five individual cinder blocks. Each block contained an 8 oz. mason jar with a 6.5 cm hole opening towards the surface. One jar in the line contained clippings of lupine. Each dog was first led down the line up of blocks and asked to sniff within each block above the opening of each jar ([Fig. 1](#)). When the dog reached the block containing the jar of clippings of lupine, he was immediately rewarded with a favorite, particular toy object (e.g. tug-toy) or food. Once the dog learned to associate the scent of these lupine materials with his reward, the dog was trained to alert the handler to his detection by sitting next to the block containing the jar with clippings. The jar containing the lupine target and its associated block were continually rotated in its placement in the line during repetitions. Dogs were exposed to training in the scent box method scenario from 3 to 6 days consisting of 6 to 9 work sessions (Table 2). An average of 45 repetitions was completed by each dog. During this initial training, the dogs appeared to quickly show recognition to this new scent of Kincaid's lupine and offer their handlers alerts to indicate its presence.

Before proceeding to the next scenario of training, overall odor recognition by dogs was assessed. Each dog was worked through 10 trials with two experimental designs (5 trials where one jar/block in the line-up contained clippings of lupine and all other jars/blocks were empty; 5 trials where one jar/block in the line-up contained clippings of lupine and all other jars/blocks contained a non-target object. Two types of mistakes were possible in trials, 1) 'missing a target' (i.e. dog fails to alert to a target object that is present), and

2) ‘false alert’ (i.e. dog alerts to a non-target object that is present). Optimal performance was defined as a dog independently and correctly recognizing and alerting to target clippings at least 80% of the time. In trials, all dogs performed at 100% indicating a high rate of odor recognition. Additionally, an optimal level of performance was expected as a dog independently and correctly *ignoring* blank or non-target jars/blocks greater than 80% of the time (i.e. no more than 20% false alerts). In trials, it is possible for a dog to make more than one false alert mistake because it could give several false indications during each trial. Here, three dogs (Dogs 2, 3, and 4) falsely responded to empty or non-target object jars/blocks, however, their rate of false alert errors was low ranging between 2.5 and 10% compared to the maximum allowed to be considered optimal performance. Interestingly, only one dog (Dog 3) false alerted to a non-target object, while Dogs 2 and 4 false alerted to empty jars/blocks. False alerts most commonly occur in the earliest phase of training when dogs have not yet learned to discriminate the target scent from other odors the dog perceives in the immediate environment. During later training, dogs occasionally perform false alerts in an attempt to manipulate their handler into giving them a reward, even though the dog has not detected the target. The number of errors due to false alert mistakes can be decreased through training corrections. However, it is important to note that such mistakes can be common in odor discrimination work, and need to be adequately addressed both initially and throughout any training program, and especially if errors occur above the maximum level considered for optimal performance.

Table 2. Summary of total number of days worked, work sessions, and repetitions that dogs experienced in training to detect Kincaid’s lupine in the first phase of research efforts.

	Dog 1	Dog 2	Dog 3	Dog 4	Dog 5
<i>Scent box scenario</i>					
total # of days worked	6	3	3	6	3
total # of work sessions	9	6	6	9	6
total # of repetitions	46	42	48	41	46
<i>Search scenario with clipped material</i>					
total # of days worked	2	2	2	2	2
total # of work sessions	5	5	5	5	4
total # of repetitions	7	7	7	7	7
<i>Search scenario in field setting</i>					
total # of days worked	9	9	9	9	5
total # of work sessions	18	11	15	15	7
total # of repetitions	108	69	91	77	62

After completion of odor recognition trials, the next training scenario began and consisted of small area searches for clippings of lupine in an outside setting. During this training process, the clipped lupine material was placed on the ground either on an unpaved road or in vegetation and concealed from the dog. The dog was then asked by the handler to search the area. When the target object was located, the dog gave an indication of locating it through their established alert. If the target object was not located, the handler assisted the dog in locating it, and if necessary prompted the dog to

perform its alert. Dogs were exposed to this type of training for two days consisting of four to five work sessions (Table 2). A total of seven repetitions were completed by each dog. Again, during this training, dogs quickly began to demonstrate their recognition of the clippings of lupine as the target scent despite the presence of a large number of non-target scents in the area. Our prior training of dogs to detect invasive plants in the field indicated that the fewer training repetitions that dogs received on clipped materials in an outside setting, the quicker they appeared to fully recognize natural growing plants on the landscape as the target source (Smith and Whitelaw, unpublished data). Thus, we minimized the number of repetitions that dogs received in small area searches for clippings, and immediately proceeded to the final stage of training in 2007.

In this third and final stage, a field setting with naturally growing lupine plants was identified and used for training purposes (Figs. 2,3). Initially, the dog was brought to the approximate area of a natural plant and asked to search for it. The handler assisted the dog in locating plants, and if necessary prompted the dog to perform its alert, until each dog was able to make a clear association that the scent of naturally growing lupine was the target object. Once a dog showed a clear understanding of the target to be detected, it was expected to independently and correctly recognize and alert to natural plants in small area searches. Dogs were exposed to this type of training from five to nine days consisting of seven to 18 work sessions (Table 2). An average of 81 repetitions was completed by each dog. Dogs varied in the number of repetitions needed to fully recognize natural lupine plants as the target object (mean: 18 repetitions, range: 2 – 31 repetitions), but once natural plants were clearly understood to be the target, all dogs proceeded to correctly and independently alerted to natural plants in the remaining small area searches (mean: 63 repetitions, range: 42 – 77 repetitions).

By July 24 we determined that the dogs were sufficiently prepared to begin formal performance assessments. However, most Kincaid's lupine plants had become dormant this late in the season and we decided to postpone testing until summer 2008.

2008 Performance Trials

We began 2008 activities on June 14 with three dogs (Dogs 2, 3, and 5) that participated in the 2007 training program. Prior to performance trials, the three remaining dogs and their handlers conducted six days of "refresher" training on *in situ* Kincaid's lupine plants very similar to the final phase of 2007 training.

To insure that performance trials reflect the actual survey work detection dogs will face when deployed, we interviewed botanists experienced with rare plant inventories in the Willamette Valley. We were primarily interested in gaining their professional opinion as to how detection dogs could best assist botanists on plant surveys. Two different perspectives emerged from these discussions. The first was that dogs might be able to cover large survey areas and steep terrain much faster than a human. In this scenario, a dog would be required to search for target plants and alert their location to the handler at considerable distance. The second perspective expressed was that their olfactory capability could allow dogs to detect small plants or plants hidden in tall vegetation that would likely go unobserved by human surveyors. Under this scenario, a dog would work

more methodically and under close direction by the handler to ensure that all hidden plants were detected. Since it was not feasible to simultaneously test these alternative survey strategies, we decided to test the latter approach in this study. Our decision was determined by the limited area of test sites available to us. We were able to fit many more small plots onto the test sites than the large plots that would have been required to evaluate dog performance in searching large fields.

Trial Site Selection & Plot Layout

Detection dogs were tested in prairie-type habitats located in Lane, Benton, and Yamhill Counties in Oregon. Test sites were primarily selected based on the presence of Kincaid's lupine. We also selected sites to represent different types of terrain, plant community composition, and vegetation structure that the dogs are likely to encounter during actual surveys ([Figs. 4, 5](#)). We excluded several available test sites because of the co-occurrence of Kellogg's spurred lupine (*Lupinus caudatus*), a congener known to commonly hybridize with Kincaid's lupine (Severins pers. comm.).

Detection dog performance was evaluated on 5- X 10-m plots that were laid out in belt transects 10-m wide and 70-m long whenever possible ([Fig. 6](#)). However, 60-, 50-, or 40-m lengths were used when obstacles (e.g., fences, impenetrable shrubs) were encountered or when we were unable to maintain a predetermined spacing criterion (30-m) between transects. The corners of each plot were marked with a pin flag. All transects were oriented so that at least one plot on each transect contained at least one Kincaid's lupine plant and at least one plot was devoid of lupine. In each plot, we classified Kincaid's lupine abundance by estimating the total number of stems (i.e., 0 stems, 1-49 stems, 50-199 stems, 200+ stems). We also wrote a short narrative for each transect that described the current growth state of lupine plants on the transect, distribution of tall shrubs and tree stems, and estimated average heights of vegetation layers. Transects were aged for at least 30 hours prior to detection dog testing to allow potentially distracting human scent left during transect layout to degrade.

Performance Trial Procedures

Dog/handler teams were assigned to transects they had not previously visited nor had any foreknowledge about lupine abundance or distribution. All testing was done when air temperatures were <24° C. Handlers carried water that was frequently offered to their dog during testing. Teams conducted searches in the following manner: handlers walked a prescribed path that started at one corner of a transect, followed along the length of one side, then returned down the centerline of the transect, then reverse direction again to walk the far side of the transect, ending at the corner opposite from the start. Handlers decided at which corner to start the search and were given some latitude to deviate from the prescribed path so they could best position their dog downwind of the plot they were searching. Detection dog handlers typically adjust their search strategies to variations in terrain, microclimate, and vegetation, which are environmental factors known to affect the direction and intensity of scent. Dogs worked off-leash during trials and their handlers determined the distance dogs were allowed to cast out during searches. Typically, handlers kept their dogs within 5-6 m of their path to focus search effort on the plots. However, handlers sometimes allowed their dogs to cast out at greater distances if the

dog appeared to be deliberately working toward an isolated plant (or cluster of plants) off of the transect. These events allowed us to estimate the potential maximum distance that dogs are able to detect the target species. Detection distances were determined by measuring the distance from the point at which the trial supervisor observed the dog make a distinctive change of behavior to the target plant. This change of behavior occurs as the dog enters and recognizes a plume of scent emitted by a target plant, then immediately changes direction toward the scent source.

The objective of dog/handler team during a trial was to determine presence/absence of Kincaid's lupine in each plot. The dog indicated the location of a lupine plant by their trained alert behavior ([Figs. 7, 8](#)). Plots frequently contained multiple plants or clusters of plants, so the dogs often displayed more than one alert per plot. However, once lupine presence was confirmed, the handler usually signaled the dog to move on to the next plot. It was unnecessary for the dog to identify the location of every plant in a plot to satisfy the test objective. Kincaid's lupine often formed large (area $>1\text{m}^2$), contiguous clusters of plants. An alert by a dog on any portion of a cluster was scored as a correct alert on all individual plants in the cluster. Handlers were allowed to guide their dog toward particular areas of a plot using a verbal or hand signal so that the plot was thoroughly searched. However, handlers were not allowed to guide their dog to specific lupine plants that the handler detected before the dog. The trial supervisor continuously observed the handler for evidence of intentional or unintentional guidance toward target plants. The dog/handler team continued searching the transect along the prescribed path until all plots on the transect were completed.

All trials were supervised by a co-investigator (D. Smith) who did not handle a detection dog in 2008. The supervisor was responsible for determining and recording trial outcomes, ensuring correct trial procedures were followed, and describing search behaviors and causes of trial errors. Such information could be used improve training and survey protocols in the future. A testing assistant with a stopwatch recorded the times at which the dog/handler team started and completed each transect. The trial supervisor informed the handler of the trial results immediately after the transect was concluded and all personnel were able to discuss strengths and weaknesses that were observed in team's performance. Individual dogs were tested on no more than three transects in a 24-hour period.

Analytical Methods

For purpose of accuracy testing, a trial consisted of a search for Kincaid's lupine on a 5-X 10-m plot by a dog/handler team. There were four possible outcomes to each trial (Table 3). For each dog, we tallied the total number of plots searched among all transects on which they worked, and distinguished counts of plots with lupine present from plots where lupine was absent. We calculated error frequencies for each dog and dogs in aggregate by dividing the total number of errors by the total number of trials. We performed a qualitative error analysis by evaluating handler and dog behaviors that were recorded during the trial, as well as environmental factors that were believed by co-investigators to have affected the trial outcome.

Table 3. All possible outcomes for trials designed to test the detection accuracy of dogs trained to identify and locate Kincaid's lupine.

	Correct Outcome	Incorrect Outcome (Errors)
Lupine present	Alert behavior	Missed target
Lupine absent	Pass w/o alert	False alert

To determine the potential range at which a dog can detect a scent plume from a Kincaid's lupine and locate its source, we identified the maximum detection distance recorded for each dog on each transect and summarized the data for graphical analysis. Finally, we calculated an average search speed (m^2/minute) for each dog by adding the total area of all trial plots and dividing the sum of the area by the total number of minutes taken to search the plots.

Results and Discussion

Detection Accuracy

The three detection dogs were subjected to a combined total of 378 trials (Table 4). The dogs committed a total of 6 errors during the course of the trials. One hundred sixty-one trials were performed on plots that contained *in situ* Kincaid's lupine plants and dogs correctly alerted their presence on 159 plots (Table 4). The two errors were committed by different dogs (i.e., Dog 2 and Dog 5) at different test sites. Observations by the trial supervisor provide likely explanations for both events. In the first case, Dog 2 failed to detect lupine presence on a plot that contained a total of 3 stems of the target species. Two adjacent plots had a much greater abundance of lupine, which the dog correctly detected. It seems likely that the scent plume from the surrounding lupine masked the weaker scent emitted by the three plants on the missed plot, causing the dog to alert on the more significant scent source on the adjacent plots. In the second case, Dog 5 and his handler had already completed 30 m of searching, when the dog back-tracked to the first plot, where he alerted on a target plant he previously found a few minutes earlier. The handler and test supervisor considered this as a manipulative tactic by the dog to solicit a reward from the handler. The handler sent the dog back to work (without reward), but then allowed the dog to follow a scent plume from an off-transect cluster of target plants. The dog returned to the transect several meters past the point from where he originally back-tracked and the handler failed to call the dog back to search the plot, thereby causing target plants to be missed.

Table 4. Results of trials conducted to test the performance of detection dogs trained to identify and locate Kincaid's lupine.

	Dog ID			
	2	3	5	Combined Dogs
Total number of trials	124	122	132	378
Plots with lupine present (absent)	58(66)	56(66)	47(85)	161(217)
Correct alert	57	56	46	159
Correct pass w/o alert	66	64	84	213
Missed targets	1	0	1	2
False alerts	0	3	1	4
Error frequency (%)	1.0	2.4	1.5	1.6
Average search speed	48 m ² /min	45 m ² /min	50 m ² /min	48 m ² /min

Two hundred seventeen of the plots on which trials were conducted did not contain Kincaid's lupine. The dogs correctly passed through 213 these plots without giving an alert, but four trials resulted in false alerts by two different dogs. Again, observations by the trial supervisor provide possible explanations as to cause of these errors. The trial supervisor determined that two of the three false alerts by Dog 3 resulted from manipulative behaviors by the dog. Evidence suggested that the dog may indeed have detected a scent plume, but alerted prematurely to solicit a reward without clearly indicating the location of scent source. The third false alert by Dog 3 occurred when his handler used a hand signal near the ground intending to guide his search toward a particular area. Instead, the dog sat down (i.e., alerted) in close proximity to the handler's hand. The trial supervisor and handler believe the dog incorrectly interpreted the handler's gesture and behaved as if the handler was actually indicating a target. Dog 5 committed one false alert when he sat down at a non-target plant species (i.e., a tall specimen of tansy ragwort). The event occurred near the conclusion of the dog's third trial. The trial supervisor noted that the dog appeared to be insecure during much of the test and worked very close to his handler. Just prior to this trial, Dog 5 alerted on the handler's backpack which was laying on the ground near the transect. Indiscriminatory alerting behaviors commonly occur when dogs are under stress and seek to engage their handler in reassuring activities, such as being rewarded with a food treat. Dog 5 and his handler had much less detection experience than the other dogs and personnel in this study. The event occurred relatively early in the trial program and we surmise that the dog may still have been confused as to his detection role. Furthermore, any anxiety the handler may have felt about the test would have almost certainly been perceived by the dog, magnifying his own stress.

The frequency of all errors among the three dogs ranged from 1.0% (Dog 2) to 2.4% (Dog 3). We did not conduct quantitative analyses to identify patterns or causes of error. Given the low, absolute number of errors during the trials (6 errors), it seems unlikely that statistical methods would have more explanatory power than observations by the trial supervisor and handlers present above. These observations suggest that target plants missed on plots and false alerts resulted from transitory miscommunications between dog

and handler, manipulative behaviors by the dog to solicit a reward, or failure of the handler to direct the dog to completely search the transect. All of these problems are likely to diminish as dogs and handlers gain field experience in rare plant surveys.

Maximum Detection Distance and Search Speed

In addition to testing detection accuracy, we collected performance data to estimate maximum detection distances and the average speed of dog/handler teams during searches. Such information will be useful in assessing the role detection dogs may play in rare plant surveys.

[Figure 9](#) presents the maximum distance estimated on each transect, between the point at which the supervisor noted a change of behavior indicating the dog had detected a target scent, to the location of a target plant. Transect numbers correspond to the chronological order of transects. Maximum distances ranged from 10-m (Dog 5) to 15-m (Dog 3). Handlers usually limited the distance that their dog was allowed to cast out toward off-transect target plants so as to concentrate their search effort on the 5- X 10-m test plots. We occasionally observed the dogs working upwind for even greater distances than the recorded maximums, apparently toward target plants, before being recalled back to the transect without an alert. Therefore, we believe the results presented in [Figure 9](#) underestimate the actual range that trained dogs are capable of detecting Kincaid's lupine.

The average search speed among the three dogs was 48 m²/minute (Table 4). At this speed a dog/handler team could search a 1 ha (2.47 ac) area in 200 minutes. Three aspects of the trial protocol seemed to limit the search speed of teams. First, handlers kept their dogs working relatively close to be able to precisely direct the dog's search pattern. Therefore, the pace of the handler usually limited the dog's search speed. Secondly, the protocol required the handler to walk a prescribed path along both sides and the centerline of each transect, even when lupine were easily detectable on the plots by handlers and dogs. In an actual rare plant survey, a botanist would have more flexibility to adjust her speed according to the detectability of target plants in different conditions. Finally, dog/handler teams had unlimited time to conduct each search. In the absence of a time limit or an objective to complete searches as quickly as possible, handlers worked at a conservative pace in order to maximize detection accuracy.

Conclusions

Our study results indicate that conservation detection dogs can be trained to recognize the scent of Kincaid's lupine and alert their handlers to the location of lupine plants under realistic field conditions. Our experienced detection dogs required approximately 25 half-days of training specifically designed for this study to achieve our trial results. The measures of detector dog performance presented above must be interpreted in light of the circumstances under which the trials were performed. Our trials were designed to simulate a survey scenario in which dogs work under close supervision, and in close proximity to their handlers. Such an approach may be necessary when the target plant is

particularly difficult for dogs or humans to detect. As we gained working experience during the course of the trial program, we found that clusters of Kincaid's lupine were often easy for us to detect by vision on the 5- X 10-m plots. Our estimates of maximum detection distances of which dogs are capable of by olfaction suggest that they could have been allowed to work at greater distances from the handler and we recommend that future trials be conducted on larger plots when Kincaid's lupine is the target. However, surveys for more inconspicuous plant species may require the high level of supervision we used to control the dogs during this study.

Dogs can undoubtedly travel faster than humans, and if further testing demonstrates that detection accuracy is not greatly diminished when dogs are allowed to work faster and at greater distances, then they may be able to perform reconnaissance surveys more efficiently than a botanist working alone. Our observations during the trials also indicated that dogs were able to detect and locate lupine even when surrounding vegetation visually obscured target plants or when the aboveground parts of lupine were dead and desiccated.

Our study was designed to provide botanists and conservationists a set of performance data and observations taken while detection dogs were searching for a rare prairie plant under realistic survey conditions. Given the capabilities that the detection dogs demonstrated during our study, we believe they may offer valuable assistance to botanists conducting reconnaissance surveys for rare plants.

Media Contacts and Demonstrations

October 9, 2007—*Bozeman Daily Chronicle*, *Big Sky* section, "Three Forks Nonprofit Receives \$20K grant".

October 28, 2007—*Bozeman Daily Chronicle*, front page of "Sunday" section, "Nosy Dogs, a big help to conservationists".

June 19, 2008—Project personnel and detection dogs are videotaped at Lupine Meadows for an episode on the Oregon Public Broadcasting series *Oregon Field Guide* that will cover oak savanna conservation in the Willamette Valley. Scheduled to be aired in October 2008.

June 29, 2008—"Science Goes to the Dogs". Story about the detector dogs/Kincaid's lupine project by Lily Raff, *Bend Bulletin*. Pick up by AP and widely distributed.

July 7, 2008—"A Nose for Rare Plants". Front page story by Nancy Raskauskas, *Corvallis Gazette-Times*. Kincaid's lupine detector dog project. Picked up by AP.

July 9, 2008—Vesely and detection dog Rogue provide a Kincaid's lupine search demonstration on Oregon State University agricultural lands for OSU Research Forest staff.

August 5, 2008—"Dogs Sniff Out Native Plant To Aid Butterfly Conservation Effort". Story by Carrie Nugent, *The Oregonian*.

August, 2008—A story written about the project by Jen Newlin Bell will run in the *Nature News and Features* section of The Nature Conservancy website.
<http://www.nature.org/>.

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Figures

Figure 1. Dog 5 is being led along a row of scent boxes during initial training. The method is used to develop learned associations between the target scent (Kincaid's lupine), an alert behavior, and a reward. Corvallis, Oregon.



Figure 2. The final phase of training in 2007 was conducted under realistic field conditions. Lupine Meadows, Benton County Oregon.



Figure 3. 2007 training demonstrated that detection dogs were able to distinguish Kincaid's lupine from all other plant species they encountered in field settings. Lupine Meadows, Benton County, Oregon.



Figure 4. Dog 3 and his handler performing a trial on a prairie restoration site. Odors from native and non-native flowering plants were overwhelming even to the human personnel at this test site. West Eugene Wetlands, Lane County, Oregon.



Figure 5. Some test sites had high levels of shrub cover and frequently including blackberry and hawthorn. Yamhill Oaks TNC Preserve, Yamhill County, Oregon.



Figure 6. Diagram of a 70-m belt-transect sub-divided into 14 trial plots used for testing detection dog performance.

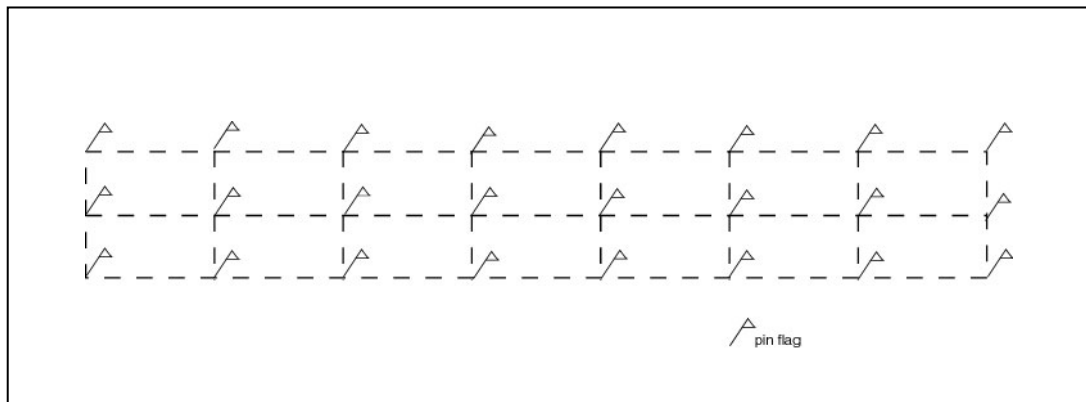


Figure 7. Dog 5 alerting his handler to the location of a Kincaid's lupine plant. Yamhill Oaks TNC Preserve, Yamhill County, Oregon.



Figure 8. Dog 3 performing an alert. He will be rewarded with a brief play session with his handler for finding a target plant. Wren, Oregon.



Figure 9. Maximum distance estimated from the point of recognition/orientation to the location of the target plant. Transect numbers represent chronological order. The number of transects worked by each dog was unequal (Dog 2 = 11 transects, Dog 3 = 10 transects, Dog 5 = 12 transects).

