

## Farm Bill Accomplishment Report

**Quarantine Enforcement:** Roadside Blitz, Mulch Inspections and Detection Dogs  
**Award number:** 11-8100-1626-CA

**Final Report:** September 12, 2011 – September 11, 2012

**State:** Minnesota

**Agency:** Minnesota Department of Agriculture

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The primary purpose of this agreement was to assess the feasibility of using detection dogs to identify 1) ash (*Fraxinus sp.*) wood from non-ash wood, and 2) ash wood infested with emerald ash borer (*Agrilus planipennis*) from ash wood not infested with emerald ash borer. The need for this approach became apparent when inspection staff began visiting mulch sites and firewood vendors, and realizing that it was difficult to visually distinguish ash wood in either form.

### Planned:

The work plan indicated that the contract between the Minnesota Department of Agriculture (MDA) and Working Dogs for Conservation Foundation (WDC) would be written and signed during the first two quarters. The work plan indicated that, during the third and fourth quarters, Working Dogs for Conservation would travel to Minnesota from Montana. The primary focus during the third quarter was Working Dogs for Conservation accessing the feasibility of scent recognition of ash wood and emerald ash borer infested wood. WDC would train two teams of handlers and dogs to distinguish between ash wood and non-ash wood and two teams of handlers and dogs to distinguish between emerald ash borer (EAB) infested wood and non-EAB infested wood. WDC must meet agreed upon performance measures determined by USDA APHIS PPQ and MDA. Observation by Minnesota Department of Agriculture staff of daily training activities would also take place. A final report detailing the success of the project was required from WDC after the project's completion. The WDC report must include detailed training data (e.g. number of reps, detection distances), summarized testing/trialing data (e.g. evaluation of dog responses- true positive, true negative, false positive, false negative), discussion of challenges encountered and how resolved, search strategy summary and recommendations, and recommendations for future dog training and deployment program development.

Level K

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Consultant's Report

## **Actual:**

### **First and Second Quarters**

During these quarters, the contract between the MDA and WDC was signed and executed. The last signature was obtained on March 13, 2012.

On February 9, 2012, a conference call between the MDA, WDC and the United States Department of Agriculture National Detector Dog Training Center took place. Performance measures were discussed and agreed upon during the conference call. Mulch and firewood-sized logs were chosen as the specific targets for this project.

On March 5, 2012, a conference call between MDA and WDC took place. During this call, a supply list was discussed and agreed upon. The supplies varied from cinder blocks and canning jars needed for preliminary work with the canines to the species and amounts of wood in the forms of logs and mulch that needed to be collected. Specific handling measures, storage measures, and site preferences were discussed as well.

Special handling and storage measures of the training aids were an essential part of the training process. To prevent human scent transfer all samples needed to be handled with gloves. Leather gloves and disposable poly gloves were purchased and used when the wood, canning jars, cinder blocks, etc. were handled. To ensure no scent was transferred between the different training materials, special storage measures were put in place. All mulch was contained in clean, labeled 32 gallon trash cans with lids. The larvae were stored in a refrigerator in sealed petri dishes when not being used. The infested ash logs were placed in a sealed walk-in cold storage facility and only pulled out on an as need basis. The infested ash logs were transported from the cold storage facility to the training site daily via a designated "infested material" vehicle. Ash logs and non-ash logs were stored in separate locked locations in the MDA laboratory when not being used on site. All training aids were clearly labeled.

The Minnesota Department of Agriculture enlisted the help of local city representatives to help collect the wood samples according to strict handling measures to avoid scent contamination. Saws used to cut the wood were purchased new and only used on specific targets. Ash wood was collected from areas outside the quarantine to ensure that the wood wasn't infested. Ash logs were transported to the storage facility in a designated "ash" vehicle. Non-ash wood was collected on site from city cooperators and transported in a designated "non-ash" vehicle. The City of Rochester harvested ash and non-ash branches and then chipped them separately with different equipment to ensure that only the target was present for the mulch training aids. Infested wood was collected from known infested trees. The bark was intact on all log (1-3 foot lengths) training aids.

The initial training location was selected during these quarters. The Ramsey County Sheriff K-9 Unit training facility located on the county's public works facility property<sup>1</sup> met all the requirements. The training area had a building where materials can be stored and a classroom area that was utilized for the initial stages of training. On March 21, 2012, the property use agreement between the Minnesota Department of Agriculture and Ramsey County was signed. Use of the training facility was scheduled for April 16<sup>th</sup> through May 11<sup>th</sup>.

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<sup>1</sup> 1425 Paul Kirkwold Drive, Arden Hills, MN 55112

### **Third Quarter**

During this quarter, the contract between the Minnesota Department of Agriculture and Working Dogs for Conservation Foundation was amended. It was originally planned that two contracts would be issued for this project. However, it was discovered that two contracts weren't necessary under the state system, and one contract would serve the work needs more efficiently. The contract amount, expiration date, and contractor's duties were altered to reflect this. The last signature on the contract amendment was obtained on June 18, 2012.

WDC made two trips to Minnesota during this reporting period. The first duration was from April 15, 2012 to May 11, 2012. The second duration was June 21, 2012 to June 30, 2012. Details of the training are divided by month.

### **April**

On April 16, 2012 the training officially began. Four dogs were utilized, Wicket (black Labrador) and Pepin (Belgian malinois) on ash wood material and Lily (yellow Labrador) and Denali (German shepherd) on EAB infested material. Among the four dogs, 934 training repetitions were conducted. The handler was "blind" in many of the exercises. Blank exercises, where the dogs had no target to locate, were performed. Indoor and outdoor training areas were used. WDC and MDA staff devised a proficiency evaluation based on USDA APHIS PPQ National Detector Dog Training Center's recommendations.

Ash detection dogs were introduced to the following target types:

- Ash mulch in varying amounts
  - small quantities in mason jars
  - larger quantities in two gallon buckets
  - hide-able amount in one gallon mesh bags
- Ash mulch was placed in varying locations
  - controlled in jars and buckets
  - hidden in the K-9 facility yard
  - hidden in compost and mulch piles at the Ramsey County Arden Hills<sup>2</sup> yard waste site
- Ash mulch in decreasing concentrations in a mix of non-ash mulch
- Ash logs in a line up with non-ash logs
- Ash logs in a brush pile at the yard waste site

Preliminary results: Pepin was able to detect a 37% ash mulch and 63% non-ash mulch mixture. Wicket had not yet been introduced to decreasing dilutions at this point.

EAB detection dogs were introduced to the following target types:

- EAB larvae in varying amounts in a controlled setting<sup>3</sup>
- EAB larvae placed on ash logs
- Infested ash mulch in jars and buckets in a line up
  - non-ash mulch and clean, or not infested, ash mulch were non-targets
- Known infested ash logs in a line up

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<sup>2</sup> 3530 Hudson Avenue, Arden Hills, MN 55112

<sup>3</sup> Controlled setting is defined as inside the Ramsey County Sheriff K-9 training facility building with larvae placed in mason jars.

- Infested ash mulch in decreasing concentrations

Preliminary results: The dogs started with detecting 20 larvae and decreased to one larva. The dogs did not recognize infested ash logs initially. WDC trainers went back to working with infested mulch and returned periodically to infested logs until the dogs recognized EAB larvae in infested logs. To assist in recognition the bark was peeled back to expose the galleries. The dogs steadily improved. Regarding mulch, Lily was successful in detecting to a ratio of 4% infested mulch to 96% non-target mulch mixture. Denali had not yet been introduced to decreasing dilutions at this point.

## May

Dogs were in training from May 1, 2012 to May 11, 2012. Among the four dogs, 444 repetitions were conducted. The handler was "blind" in many of the exercises. Additional blank exercises were performed where dogs had no targets to locate. Indoor and outdoor training areas were used. Empty mesh bags and insects WDC and MDA staff happened upon were added to some search scenarios as distractors. In addition, some of the non-target logs had obvious wood boring insects (not EAB) in them.

Ash detection dogs worked on the following target types:

- Ash mulch in varying dilutions
- Ash mulch placed around the Ramsey County Sheriff K-9 training facility yard
- Ash mulch placed in actual mulch piles
- Ash logs placed in brush piles
- Infested ash logs in brush piles
- Ash logs that were already occurring in brush piles (i.e. not placed by MDA or WDC)
- Ash sticks with leafy sprouts already occurring in brush piles
- Small ash sprigs among non-ash sprigs in a line up
  - with cut ends accessible
  - cut ends not accessible
- Ash mulch in buckets under layers of non-ash mulch

Preliminary results: WDC and MDA staff observed that ash detection dogs needed to sniff the cut ends directly of logs and twigs before alerting to the target. Ash detection dogs were also observed to not target leafy ash twigs/branches in brush piles. Pepin and Wicket were able to detect approximately 4% ash mulch concentration among non-ash mulch mixture. It became difficult for the dogs to detect the ash mulch target under 3 inches of non-ash mulch and the dogs could not detect ash mulch under 5 inches of non-ash mulch with a 24 hour set up period.

EAB detection dogs worked on the following target types:

- Infested ash mulch in varying dilutions
- Infested ash mulch placed around the Ramsey County Sheriff K-9 training facility yard
- Infested ash mulch placed in actual mulch piles
- Infested ash logs placed in brush piles
- Infested ash logs in line ups with the bark intact and no EAB larvae galleries exposed
- Infested ash mulch in buckets under layers of clean or not infested ash mulch

Preliminary results: Lily and Denali were able to detect a 4% infested ash mulch concentration in buckets. The dogs found it difficult to detect infested ash mulch under 3 inches of clean ash

mulch. The dogs were not able to smell the infested mulch when it was covered with 5 inches of clean ash mulch and given a 24 hour set up period.

May 8, 2012 was a media day where local news stations, papers, and other media outlets could attend to witness a demonstration of the dog's capabilities thus far. An audience of one million was reached by media coverage from that day. To receive the same level of media coverage through paid advertising, MDA media experts estimated the cost would be \$24,000. On May 10, 2012, a demonstration of the dog's capabilities at this point in time for MDA staff and collaborators took place. Level 1 proficiency evaluation was performed, resulting in Denali and Wicket passing.

## June

Training took place from June 21, 2012 to June 30, 2012. Three dogs were used for this segment of training. Wicket (black Labrador) was the only dog on ash wood material. Lily (yellow Labrador) and Tia (German shepherd) were on EAB infested material. Tia was new to the project and came up to speed quicker than previous dogs with the streamlined training process.

Among the three dogs, 407 repetitions were conducted. Handlers were "blind" on many of the exercises. All canines were exposed to blank rounds. All training occurred outdoors. Lily passed her second attempt at the proficiency evaluation. Wicket and Lily continued to work on previous targets.

Tia was introduced to the following target types:

- Infested ash mulch in buckets
- Infested ash mulch in mesh bags in mulch piles
- EAB larvae in mason jars
- EAB larvae placed on ash logs
- Infested ash logs
  - first in line ups
  - then in brush piles
- Infested ash bark in mulch piles

Preliminary results: Tia and Wicket were able to detect less than 5% of the target while working on mulch concentrations in buckets. Lily was able to detect a 6% target concentration of mulch in buckets. WDC and MDA staff observed that soaking wet mulch is less detectable than dry mulch.

During this training session, WDC and MDA staff exposed the dogs to new targets. Wicket was introduced to ash leaves as a new target because she wasn't recognizing them in a brush pile. Ash twigs were used in exercises for Wicket in attempt to get her to alert without having access to the cut ends. Leaf and twig exercises were stopped before mastery because leaves are not considered a regulated article for the emerald ash borer quarantine and leafy twig/branch ends are not a reasonable part of the brush pile to target because there are too many leaves present. Also, regulatory officials can easily identify ash leaves and leafy twigs/branches. At Specialized Environmental Technologies Malcolm site<sup>4</sup>, the dogs experienced infested logs already occurring in brush piles (i.e. not placed by MDA or WDC). The canines were introduced to fallen branches at the base of known infested trees at a different site.

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<sup>4</sup> 630 Malcolm Avenue SE, Minneapolis, MN 55414

On June 26, 2012, a conference call between the Minnesota Department of Agriculture, Working Dogs for Conservation and United States Department of Agriculture National Detector Dog Training Center took place. The agenda for the call included an update on the project, challenges that the trainers were facing, and details of Joe Chopko's visit to Minnesota. One of the challenges mentioned during the conference call was the difficulty of not being able to have the dogs search the whole mulch pile. Joe Chopko suggested using buckets to sample the mulch pile. WDC and MDA staff began devising a bucket sampling protocol for mulch piles following the call.

In addition, WDC trainers observed a roadside blitz on June 27, 2012. The dogs were not used during the blitz. This saturation was scheduled to show the WDC trainers what MDA regulatory officials experience during commercial vehicle inspections and analyze how or if the dogs would be able to assist.

#### **Fourth Quarter**

WDC made two trips to Minnesota during this reporting period. The first duration was from July 5, 2012 to July 11, 2012. The second duration was September 4, 2012 to September 11, 2012. Details of the training are divided by month.

#### **July**

Dogs were in training from July 5, 2012 to July 11, 2012. Wicket (black Labrador) was the only dog on ash wood material. Lily (yellow Labrador) and Tia (German shepherd) were on EAB infested material. Among the three dogs, 296 repetitions were conducted. Handlers were "blind" in many of the exercises.

Exercises continued with mulch as a target during WDC's July visit. Small concentrations of target materials (ash mulch and infested ash mulch) in buckets were frequently worked with. In addition to working with small concentrations, the dogs were exposed to larger amounts of mulch placed in burlap bags. The burlap bags were buried deeper than the small, mesh bags. Detection by the dogs did not look very different between the deeply buried burlap and shallowly placed mesh bags. MDA staff took WDC to Ceres Environmental Services<sup>5</sup> yard waste site in Brooklyn Park, Minnesota to expose the dogs to different mulch piles. MDA and WDC considered how a bucket sampling procedure suggested by Joe Chopko could be implemented.

Single log line-ups and small log pile line-up exercises appeared to be very easy for the dogs; however, there were certain challenges that became apparent during this phase of training. False alerts continued to occur with some regularity. Rain soaked mulch in buckets seemed to be problematic for detection. It seemed to be too challenging for the dogs to start at a very low concentration (4% or less) with mulch in buckets. The dogs were able to reach very low concentrations when introduced to a high concentration of target mulch and then gradually stepped down to a lower concentration.

Joe Chopko with USDA's National Detector Dog Center observed exercises that dealt with mulch in bucket line-ups, logs in brush piles, and mulch in piles during his July 9-11 visit. Joe offered valuable suggestions and guidance during his visit. One thought was to not continue pursuing mulch because it was not confirmable. Firewood was thought to be a practical and easy application. It was also discussed that a real world application for brush would be helpful, especially pertaining to EAB dogs. WDC and MDA took Joe's suggestions into account when planning the next phase of training.

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<sup>5</sup> 3825 85th Ave N, Brooklyn Park, MN 55443

## September

The final visit to Minnesota by WDC was from September 4, 2012 to September 11, 2012. Wicket (black Labrador) was the only dog on ash wood material. Lily (yellow Labrador) and Tia (German shepherd) were on EAB infested material. The primary focus of this phase of training was continued work on brush piles and exposure to firewood. Firewood exercises were conducted at the Ramsey County White Bear Township<sup>6</sup> yard waste site and two facilities in southeastern Minnesota. The facilities in southeastern Minnesota were Firewood Wizard<sup>7</sup>, a firewood producer, and Crystal Valley Hardwoods' sawmill<sup>8</sup>. It was decided that mulch was no longer worth pursuing as a target due to the difficulty associated with the confirmation of the wood being infested.

On September 5, 2012, the feasibility of using dogs at commercial vehicle inspections was tested. Wicket inspected a commercial vehicle with relative ease. It became apparent that not all vehicles would be suitable for a dog to inspect; however, future use for dogs in this setting could be promising.

A media day for local media outlets in Southeastern Minnesota was conducted at Minnesota Wood Recyclers<sup>9</sup> in Winona, MN on September 6, 2012. Lily demonstrated finding infested logs in a brush pile and Wicket alerted when pieces of ash firewood were found in a firewood pile. Attendance at the event was high with local news stations and papers, city and county representatives, state agency officials, and University of Minnesota extension staff present.

During this phase of the training, the dogs were introduced to standing infested trees as a target. On September 6, 2012, WDC and MDA visited Great River Bluffs State Park<sup>10</sup> and presented Lily and Tia to known infested trees. Both dogs alerted to an infested tree that had the bark peeled back and galleries exposed. Due to the promising nature discovered, another exercise was planned at Fort Snelling Golf Course<sup>11</sup>, where a recent infestation was discovered on August 13, 2012. Tia and Lily recognized infested trees (with parts of the bark removed) as targets and alerted.

The last exercise performed was a people vs. dog identification and efficiency test conducted in brush piles at Ramsey County's White Bear Township and Arden Hills yard waste sites. Wicket competed against Paul Haiker, mulch and brush inspector for MDA, in search of ash brush. Mark Abrahamson, MDA entomologist, Lily and Tia searched for EAB infested logs placed in the piles. Please refer to Appendix A for the results. In summary, the dogs on average did better at detection than the people.

The Notice of Award was for \$170,500.00. The total amount of money spent during this project was \$149,584.55, thus leaving an unobligated balance of \$20,915.45. Part of the unobligated balance is due to the difference between the proposed cost of MDA personnel and the actual amount spent. According to the budget in the work plan, the amount allocated to the MDA Project Manager was \$27 per hour. The actual amount the MDA Project Manager received for the majority of the project was \$17 per hour. In addition, funds allocated to MDA travel were not spent. MDA implemented a new

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<sup>6</sup> 5900 Sherwood Road, White Bear Township, MN 55110

<sup>7</sup> 3092 County 249, Brownsville, MN 55919

<sup>8</sup> 12229 Minnesota 16, Houston, MN 55943

<sup>9</sup> 1265 Shive Road, Winona, MN 55987

<sup>10</sup> 43605 Kipp Drive, Winona, MN 55987

<sup>11</sup> 6399 Fort Snelling State Trail #175, Minneapolis, MN

accounting system during this period, invoicing was delayed and fiscal years changed resulting in the travel expenses accrued by MDA being covered by a general fund.

**Assessing the ability of conservation detection dogs to distinguish  
ash wood from non-ash woods  
and  
EAB-infested ash wood from non-infested ash wood**

*April 16 – Sept 11, 2012*



**Working Dogs  
for Conservation**

**Prepared for:**

Minnesota Department of Agriculture

**by**

Aimee Hurt and Ngaio Richards, Ph.D.  
Working Dogs for Conservation

## Introduction

This study investigates whether conservation detection dogs could be incorporated in ongoing and more targeted efforts by the Minnesota Department of Agriculture (MDA) to control the spread of emerald ash borer (EAB; *Agrilus planipennis*). The objective was to explore detection dogs' potential as an additional tool in the State's mitigation and containment strategy. The underlying questions addressed were:

- a) Can detection dogs be trained to distinguish ash wood from non-ash wood in a controlled setting?
- b) Can detection dogs be trained to distinguish ash wood infested by EAB from uninfested ash wood in a controlled setting?
- c) If dogs can be trained to all or any of these targets, can they also detect them under the relevant deployment conditions? i.e. what are the 'real-world' applications of ash wood/EAB infested ash wood detection dogs?

This report summarizes the training and trialing activities conducted by Working Dogs for Conservation (WDC), a non-profit organization dedicated to using conservation detection dogs on some of the most pressing conservation concerns such as the spread of invasive species. We discuss the results thus far, and our recommendations of feasible targets and applications based on these exploratory findings.

## Training Activities

Between April 16 and September 11, 2012, handlers Aimee Hurt, Ngaio Richards, Chris Salisbury, and Alice Whitelaw spent approximately two months on site in Ramsey County, MN with five dogs: Wicket, Lily, Pepin, Denali, and Tia (see Table 1). All dogs and handlers have experience working professionally on conservation targets. Two dogs were trained to ash wood- both infested and non-infested (referred to as "ash" dogs), and three dogs were trained to infested ash wood (referred to as "EAB" dogs). Training began at the Ramsey County K9 training facility in Arden Hills, Minnesota. We started with imprinting the dogs with the scent by presenting the target odors to them in controlled setting (small amounts in jars and buckets) whereupon they received a reward (usually toy, sometimes food) for sniffing the correct container. As all dogs were experienced with detection work, they were soon thereafter asked to "alert" (either sit or down) at the target before receiving the reward. Once successfully completing multiple encounters with that form and presentation of target, we increased the difficulty of the presentation or introduced a new variant of the target.

**Table 1. Participant summary**

dog	breed/sex	handler	target	participated in what session*	# exposures to target during training	level 1 proficiency % (mulch in buckets)	advanced level proficiency % (logs in brush pile)
Wicket	black lab x/F	Aimee Hurt	all ash	1,2,3	629	100%	69.6%
Pepin <sup>1</sup>	Belgian malinois/M	Ngaio Richards	all ash	1	352	62.5%	n/a
Denali <sup>2</sup>	GSD/F	Chris Salisbury	infested ash	1	285	70.0%	n/a
Lily	yellow lab x /F	Aimee Hurt	infested ash	1,2,3	571	62.5%, 100% re-test	90.5%
Tia <sup>3</sup>	GSD/F	Alice Whitelaw	infested ash	2,3	284	n/a**	81.0%
<sup>1</sup> scheduled only for first session due to previous work commitments, no opportunity to re-test level 1 proficiency							
<sup>2</sup> injury prevented her from returning							
<sup>3</sup> started in second session to replace Denali							
* session 1: Apr 16-May 11; session 2: June 21-June 30, July 5-11; session 3: Sept 4-Sept 11, 2012							
** Level 1 proficiencies all evaluated using mulch, by the time Tia ready for mulch evaluation we shifted targets to focus on logs. No dogs were re-tested at level 1 proficiency with logs, instead we focused on more realistic scenarios							

Over the course of the study, the dogs achieved a combined total of 2,202 repetitions with 18 variations of the targets in eight different types of presentations. Variants included mulch, logs, twigs, branches, larvae and others. Presentations ranged from small amounts in containers indoors to varying amounts in brush piles, mulch piles, stacks of wood, etc. (see Appendix 1). We had the opportunity to work in multiple county compost facilities, firewood facilities, and parks around Ramsey and Winona counties.

Non-ash wood (mostly hardwoods such as maple, cherry, oak and box elder) was used as an ever-present non-target material to ensure that dogs were not seeking out wood material in general. Non-target insects and other distracters were added opportunistically as they were found in the environment. All wood material and EAB larvae were provided by MDA, with the exception of ash deposited in compost sites by county residents.

Mulched wood was kept in three separate sealed labeled containers in the garage of the K9 training facility. Clean ash and non-ash wood logs were assembled into separate piles. EAB-infested logs were brought to and removed from the site each day by MDA's Katy Longen, who oversaw all training activity.

### *Highlights and Challenges*

- This project represents the first time that any dogs have been trained to detect ash wood, or that infested with EAB. WDC was given a lot of leeway by MDA and USDA APHIS to pursue the training of these targets in ways consistent with other plant and invasive work that WDC has done in the past. USDA APHIS has been training detection dogs to Asian longhorn beetle (ALB; *Anoplophora glabripennis*) over the last two years, and we benefitted from the advice of Joseph Chopko and Lisa Beckett from USDA APHIS National Detector Dog Training Center (NDDTC) regarding some tactics and challenges faced in the ALB project. ALB presents a much different target to EAB in many respects. First, it is a much larger insect. The female digs into the wood and makes an egg sac about half the size of a dime. The exit hole is the size of a dime and ALB infestations have been likened to Swiss cheese and the beetles leave copious frass in the galleries and accumulated at the base of the infested tree. By contrast, EAB exit holes are much smaller and it is necessary to peel back tree bark to see whether or not galleries are present. Also, while ALB seeks trees to infest by following the pheromones of other ALB, EAB do not emit pheromones. EAB find new trees by targeting trees that are distressed.
- We were pleased to note throughout that the dogs could discern most variants of the targets quite soon after being introduced to the target, at rates in accord with other plant targets with which WDC has worked.
- Tia came to the program to replace Denali (after Denali suffered an injury while at home between sessions 1 and 2). We noted that Tia was quickly able to get up to speed and performed similarly to the dogs who had been present during the first session. We believe that during the first session we determined which training exercises were most useful for dogs efficiently learning the targets, and this insight benefited Tia's training, and would likewise benefit new dogs coming into the program.
- We believe that dogs become familiar with training targets over time. This need for many training targets is further complicated with EAB by the care required when dealing with infested material during

the flight season, and the need to work with large brush piles in order to prepare for the “real world” at the proper scale. Though we worked with many variants of the targets, we still would have benefitted from more weathered wood, split firewood, and the ability (machinery) to move brush piles so we could create and dismantle them at will and bury targets to different depths to assess detectability. However, we’d like to note that MDA and in particular, Katy Longen, was exceedingly compliant in providing us with requested targets and supplies.

- While it’s very rarely understood what volatilizing compounds dogs use to recognize a trained target as “correct”, the fact that EAB infestations are guided by tree-based scent instead of EAB-based scent raised some questions:
  - Does the entire tree emit the stress pheromone once infestation occurs?
  - For how long does the distress pheromone occur/persist once the tree has been felled?
  - Will the dogs confuse the scent of an EAB- infested tree with that of a tree stressed for other reasons?

We still don’t know the answer to some of these questions, but at least among cut wood material, dogs demonstrated the ability to detect infested material and not readily confuse it with other wood, including that which is host to native tree boring beetles. We don’t know what constitutes the scent that dogs recognize as “infested ash”, or “ash” in general, but it does appear to be distinct in almost all variants (exception: ash leaves (without stems) sometimes appeared indistinct from other leaves). It’s worth noting that it’s somewhat of a misnomer to describe these dogs as “EAB dogs” because adult EAB were never used in training and larvae were only used in the early stages. The bulk of training occurred with infested material which could presumably contain frass, galleries, live or dead larvae, and eggs, in combination with whatever distress chemicals the ash itself is emitting. The dogs are targeting infested material, not larvae.

- All dogs had occasions of “false alerts” or “false finds”, which is when they indicated the presence of the target when no target was actually known to be present. Because in a regulatory setting it’s very important to not indicate a target when there is none, it’s critical to work with targets that can then be visually confirmed. This was taken into consideration in our recommendations of which targets are likely viable for ongoing EAB/Ash detection dog activities.

- This project garnered a great deal of media attention. We were able to host two media days, resulting in numerous local and regional print and TV pieces. The first media day was estimated by MDA to reach one million viewers/readers and be worth \$24,000 in media coverage. Additionally, we demonstrated the dogs one day for MDA staff and affiliated agencies, and conducted additional magazine and radio interviews.

WDC believes that this study resulted in sufficient promise to merit the continued use of dogs in some settings for some variants of the targets. Given the lack of funding for the current fiscal year for this project, we have not discussed with MDA how dogs might be best incorporated into the inspection program. In the hopes that funding will once again be available, we propose two broad options for continuing with the EAB detector dog program: 1) Given the high turnover of material at firewood and other wood products producers, and county brush piles, MDA might desire to have a team on-staff who would be available all year for inspections. In that case, WDC could assist in locating a suitable dog and train the dog and MDA employee as a team, and offer ongoing long-term support. Serendipitously, Katy Longen showed a strong aptitude for dog handling and would be an excellent candidate to consider in that position. Or, 2) there may be value in having a WDC team(s) work with MDA for a shorter time during a season of frequent inspections.

### **Proficiency Testing and Dog/Human searcher comparison**

#### *Level 1 Proficiency testing*

Teams underwent proficiency evaluations relatively early in the process (27 April 2012) to evaluate that the teams were appropriately selected, understood their targets, and were ready to move on to other forms of the target and more complex presentations (i.e. detection scenarios) Furthermore, level 1 proficiency evaluations contribute to the “proof of concept” and answer the first two underlying questions in the project:

- a) Can detection dogs be trained to distinguish ash wood from non-ash wood in a controlled setting?
- b) Can detection dogs be trained to distinguish ash wood infested by EAB from uninfested ash wood in a controlled setting?

As this project was overseen by NDDTC, we used NDDTC's description of what Level 1 proficiency aims to assess, which is "to measure a canine's ability to distinguish target odor from non-target odor under semi-controlled conditions". Furthermore, we used NDDTC's equation for numerically representing this ability:

$$\text{Proficiency \%} = \frac{\text{Total number of correct responses}}{\text{Total correct responses} + \text{Total false responses} + \text{Total missed}} (100)$$

We note here that "total number of correct responses" means the dog indicates correctly that a target is present. As a testing scenario we created a circle or line-up of 15 two-gallon buckets each containing either target or non-target mulch (see Figure 1). The dog would be directed to sniff each bucket and was expected to ignore non-target mulch and indicate (by sitting or downing next to the bucket) to those buckets containing



**Figure 1. Mulch buckets ready for level 1 proficiency evaluation**

target mulch (see Figure 2). Dogs attaining 70% proficiency were deemed level 1 proficient. The NDDTC equation does not take into account the dog correctly ignoring the buckets which contain non-target mulch. Alternative equations could be used which would equally demonstrate proficiency and which would allow "credit" for the dog correctly ignoring the non-target buckets. Given the increased sample size and opportunity to be correct, the proficiency percentage would be greater than 70% in order to convey the same level of proficiency as the NDDTC equation. WDC typically takes into consideration when dogs correctly ignore non-target

buckets/samples, but deferred to NDDTC standards because this project was under NDDTC guidance. See Appendix 2 and Appendix 3 for NDDTC's suggestions in setting up the evaluation and the protocol WDC created (as approved by NDDTC), respectively.

Two (Wicket and Denali) of the four dogs who underwent proficiency testing during the first session met or exceeded the 70% standard. A third dog (Lily) re-tested at the beginning of the second session, and exceeded the standard. The fourth dog (Pepin) was not scheduled to return to subsequent sessions given previous work

commitments and so did not have the opportunity to re-test. The fifth dog (Tia) began the project once we had



**Figure 2. During proficiency level 1 trials dogs encountered buckets either in a line or circle, sniffed each bucket, then indicated the presence of a target (demonstrated here by Denali, who is sitting at a target bucket) or ignore non-target mulch.**

moved on from mulch (the level 1 testing material) and so did not undergo the level 1 trial (see Table 1).

Level 1 proficiency was used as a proof of concept—to show that in *some* form dogs could distinguish between ash/non-ash and infested/non-infested. We did not conduct proficiency trials for each of the many variants of the targets with which we trained. Once viable targets are selected and the applications within which dogs will be used are determined, teams ought to be evaluated for proficiency on that variation of the target prior to deployment.

*Infested ash logs in brush pile: comparing human and dog searchers*

As the final exercise of the final session, to assess if dogs might be

able to offer an advantage over visual searches conducted by unaided humans, we placed infested ash logs into brush piles at two compost facilities (White Bear Township and Arden Hills).

Target placement ranged from on the ground to above human head height, with various degrees of buried or obscured, but never more

than an arm's depth into the pile. Four search areas were created, and neither dog/handler teams nor visual searchers were privy to the location or number of placed logs, with the exception of handler, Aimee Hurt, who was handling two dogs and therefore unavoidably had some knowledge of the brush pile when searching with the second dog. The search order was rotated among the three dogs. Additionally, two humans familiar with identifying ash wood and searching for signs of EAB infestation searched the four areas. Two dogs and one human searched the piles for the infested ash logs which had been placed in the piles. One dog and a different human searched the piles for the placed infested ash logs, but also to indicate the presence of any ash wood which happened to be in the pile. We report the percentage of placed infested ash logs located by all parties, and in the case of the dog and human searching for additional ash wood we report the number of clumps of ash wood located. Note that because we could not know how much ash wood “naturally” occurred in the pile, we could not say what percentage of non-placed ash material was located. Also, the brush piles get populated by homeowners dumping truck and trailer loads of branches in a single spot, so when ash wood is present there

tends to be many branches or logs in one large cluster. Once a cluster was located by dog or human, the searcher then moved on to look for additional clusters rather than identifying or counting individual logs within the cluster.

Ultimately, dogs would need to be either faster or find more targets in a brush pile than human searchers in order to convey a search advantage and warrant their use in this inspection application. Therefore, to compare the performance of the dogs and the human searchers we considered the following:

- total search time
- elapsed time until the first target was located
- number of false finds (i.e. the searcher indicates a probable target when in fact the target isn't present)
- percent of placed infested ash logs located
- number of non-placed ash located (for dog and human looking for ALL ash)

We predicted that the dog trained to detect all ash wood would not convey a search advantage over the human searcher. This prediction was based on the observations throughout training that the dog had to sniff the cut end of a branch or log directly in order to be certain that it was ash wood. At the time of the trial (September) the brush piles consist primarily of leafy branches and often relatively large piles of branches. We expected that by the time the dog got near enough to the cut end of the branches to sniff them, it would be visually obvious to a trained searcher that it was ash wood.

We predicted that the dogs detecting infested ash logs would confer an advantage over a human searcher because 1) the logs were small and isolated in the brush piles and not necessarily part of an obvious and large clump of leafy ash branches thereby harder to see, and 2) we observed throughout training that the dogs cued into infested logs even when we could not readily see the signs of infestation (D-shaped exit holes, woodpecker damage, galleries). Therefore, we supposed that a dog might correctly indicate on an infested log that a visual searcher might inspect but not notice the tell-tale signs of infestation, and therefore overlook.

Results from the four areas are in Appendix 4. The occasions where one searcher performed better than the other searcher are reported. For the searchers looking for EAB-infested logs, this comparison is made by combining the individual performance of the two dogs (though the results from each dog are also reported). Our sample size was small and therefore these differences were not analyzed for statistical significance.

In searching for all ash wood, among 20 metrics used for comparison (five metrics for each of the four different search areas), the dog outperformed the human searcher eight times and the human outperformed the dog eight times. The remaining four times the dog and human performed equally. The human consistently completed the search faster than the dog, which is consistent with our observation that people can see ash leaves and clusters from a distance rather than having to inspect them closely, whereas the dog required close inspection. The dog always located more of the placed infested ash logs than the human, most likely because the logs were not necessarily placed as part of an obvious and large clump of leafy ash branches and were thereby harder to see. In short, when considering both search time and accuracy, at least when leafy a visual scan of the area by a trained human searcher was equally as effective as a dog searching by scent to locate ash branches and logs in a brush pile. For leafless brush piles, or those with considerable weathered (gray, barkless) wood it would be worth re-evaluating performance.

Dogs did show some advantageous performance while searching for infested ash logs (and branches) in brush piles. Of the 16 metrics used for comparison, dogs outperformed the human searcher in nine instances, the human outperformed in two instances, and the remaining five indicate equal performance. Half of the time the dogs located more of the placed targets than the human searcher, and dogs always performed the search more quickly than the human searcher.

Additionally, we applied the proficiency equation used by NDDTC to these searches (for description of equation, see Level 1 Proficiency, above). This equation only considers the number of placed logs located and the number of false finds, and does not take into account search time. Therefore, in comparing ash detection the dog came out much stronger (69.6% proficient) than the human (35.0% proficient). Both dog and human found 22 non-placed ash logs or clusters of logs. In the detection of only infested ash logs, the dogs were slightly more proficient (average 85.7%) than the human searcher (77.3%).

Overall, dogs met or exceeded human detection performance in both ash and infested wood searches with a viable, confirmable target (logs and branches) in a realistic setting (brush piles).

## Recommendations

### *'Real World' applications*

The third underlying question of this study is whether dogs can detect these targets under the relevant and prevailing deployment conditions. In addition to the brush pile exercise just reported, we observed that detection dogs could do so in some applications and as such may be able to contribute to ongoing efforts by MDA against EAB and its spread. Here we discuss observations and trends over the course of the study that advise which target variants and presentations are likely the most realistic focus of search dog deployment.

### Mulch

Considerable attention was paid to contemplating mulch as a viable target. In training, we performed many trials of target material in buckets ranging from "full strength" (though, in the case of infested material the degree of infestation in trees prior to their being mulched was not known) to homogeneously mixed, to very small amount of target material (e.g. around 2% of target material and 98% non-target wood). Also in buckets we put a layer of target material 1" deep and covered it inch by inch with non-target mulch. In this highly controlled setting, dogs could regularly detect 5% and less target mixture in the homogenous mix. Though to facilitate this, it appeared helpful to start with a higher concentration and reduce it in subsequent rounds, rather than starting the day with very low concentrations. Also, if the mixture became saturated (e.g. rainwater) detection appeared hampered. One inch of target mulch became difficult to detect once it was covered by 3" of non-target mulch, and undetectable once covered by 5" of non-target mulch. Allowing these layers to "set up" for over 24 hours did not make it more detectable. The above results for homogenous mixes and layered materials were consistent for both ash wood and infested ash wood material.



Mulch piles, which are common inspection targets, typically exist in mounds up to four meters tall, and many meters in diameter (see Figure 3). Though the dogs were performing well with line-ups of two-gallon buckets we had to consider how they might feasibly search these massive mulch piles. Joseph Chopko, Training Specialist with NDDTC, proposed the idea of "bucket sampling" large piles where scoops of the

**Figure 3. Mulch pile of typical size. Target material deep inside would not be accessible to the dogs, thus the idea of "bucket sampling". Even so, mulch is not a viable target from a regulatory standpoint.**

mulch pile would be put into buckets in line-ups, thereby *sampling* and not *comprehensively searching* the entire pile. Note that sampling is consistent with the inspection practices already employed by human searchers with MDA. By devising protocol incorporating confirmed target mulch, multiple dogs, and multiple checks of the same sample we propose that it's feasible to calibrate dog performance and achieve a certain level of agreement among dogs across samples. In addition, dogs could climb around on the pile to search for target material near the surface but which may have escaped the random grab while filling the sampling buckets.

Ultimately, however, the search for target mulch material is a regulatory issue, whereupon violations bring legal consequences. Because mulch is so small, there is usually no way to visually confirm the presence of EAB or even confirm the presence of ash wood (note that experts can examine wood grain to determine species, but not with mulch-sized pieces). At best then, dogs could be used to suggest that MDA inspectors need to seek additional proof of target presence but could never be relied upon to prove target presence. This is consistent with other detection disciplines where dogs indicating the presence of a target is only sufficient to allow the officer/inspector to continue a search. No "proof" by detection dogs alone is an adequate measure for finding guilt in any US court of law. Given these considerations, and under USDA APHIS advisement, MDA chose to stop pursuing mulch as a viable target.

### Logs and branches

In general, logs and branches are viable targets because they are large enough to be visually confirmed by a human after a dog indicates that the target is present. The practicality of these targets is more dependent on the application in which the dogs would search for logs and branches. Throughout training, dogs preferred to make contact with the material before alerting. The EAB dogs wanted to sniff the bark surface, and ash dogs sniffed the cut end of the log or branch (not the leaves, bud tips, or bark surface; see Figure 4). Very small branches (i.e. twigs) present more of a challenge because, in the case of infested material, small diameter twigs are not known to support EAB. In the case of ash wood in general, twigs offer less of the preferential cut-end surface area for a dog to sniff. Given this, we review the viability of logs and branches in several search applications:



**Figure 4. Typical brush pile after resident has deposited load, but before county pushes brush up into tall mound. Here Wicket shows that despite being surrounded by leaves, twigs, and bark, she preferentially targets the cut end of a branch before alerting.**

#### Logs/branches- in brush piles

We observed detection distances of up to three meters for logs in brush piles. However, by far, most of the time the dogs had to be within a meter of the target before detecting it and they always attempted to press their nose to it before alerting. To have any detection distance of note, it's imperative that the dog be downwind of the target and that there is sufficient air flow in or along the pile in order for the scent to travel. Brush piles can be very tall and deep and compacted. All of our training and trials had logs and branches within an arm's reach into the pile. At no point did we get the indication that there were targets deeper in the pile that the dogs could detect. We suspect that this detection limitation is due to airflow and large pile size. However, even with these limitations (which could be somewhat mitigated by machinery during important inspections, and possibly by ramps allowing dogs better access to more surface area of the piles) dogs were able to meet or outperform human searchers in this context. Thus, we recommend logs and branches in brush piles as a viable target and application.

#### Logs/branches in vehicles

We observed two commercial vehicle inspection "blitzes". The viability of this application depends on the access to the vehicle. Dogs must be able to get into the cargo area and move around safely without the risk of load shift. Given the vehicles and loads we observed, it did not appear that dogs would convey a strong advantage over humans searching visually. However, we did not see all vehicles or load

types and expect there is some combination in which dogs would be advantageous. Thus, we do not recommend logs and branches in vehicles as the primary reason for incorporating EAB/ash detection dogs, but if they are already being brought into the inspection program then vehicles may be a worthwhile component of their work.

#### Logs in firewood piles

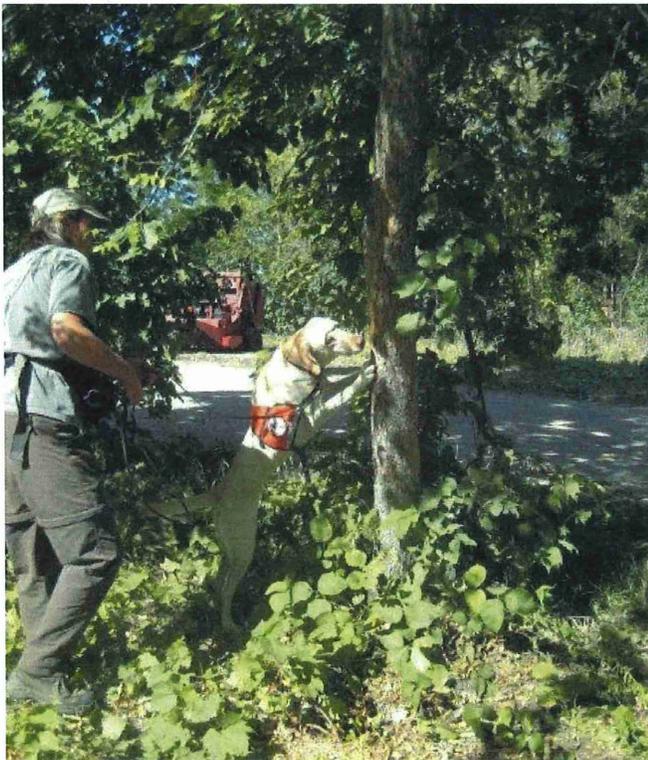
Logs in firewood piles appear to be a viable application, although we worked much less with this application than logs in brush piles. Properly training a dog for this task should involve more weathered wood, and split wood than we had access to during this project (see Figure 5). Logs on or near the surface would be most likely to be detected.



**Figure 5. Dogs encountered some firewood piles. Because pile size, wood types, and age of firewood are so variable, it's vital to be exposed to numerous examples during training.**

### Live-growing trees

During our last few days of the project, we visited two stands of growing infested trees (Great River Bluffs State Park and Fort Snelling Golf Course). Live growing trees present a very different target than cut wood material. Primarily the scent may be less accessible (if scent from infestation in the canopy is not detectable at dog-nose height). Also, dogs must become practiced in casting their heads high and smelling vertically up the trunk of a tree (see Figure 6). Finally, a tree still growing likely emits volatiles that cut wood does not. We wanted to see if dogs trained to surrogate, cut-wood material would be able to generalize the scent and recognize an infested live growing tree, without having specifically been trained with growing material. Both dogs showed “on-scent” behavior in the presence of live trees but initially did not alert to the tree unless bark was pulled back and galleries were exposed. Tia eventually alerted to the trunk of infested trees (where the infestation was observed to be low enough for her to reach). It is unknown if dogs would have been able to detect infestation that only occurred in the canopy. We consider these responses encouraging and find it advisable to continue training to live trees, although we recognize the challenge of locating live infested trees that would be required for training.



**Figure 6. Checking live trees for infestation requires different search behavior than scrambling over brush and firewood piles. Even so, dogs indicated that pursuing infested live growing trees may be a worthwhile pursuit.**

## **Conclusions**

Based on our findings reported here combined with the performance pattern we saw throughout training, we feel confident stating that dogs trained to detect infested ash logs and branches may offer a worthwhile advantage when inspecting for infested material. Furthermore, dogs trained to detect all ash wood might be beneficial, particularly in the case of weathered or leafless logs and branches. Live trees appear to be a target worth continued training. Both short term (contracted dogs and handlers) and long term (employees paired with detection dogs) seem reasonable options for incorporating the use of EAB and Ash detection dogs into inspection programs. We at WDC look forward to continuing to work with MDA to bring these resources into its inspection program.

## **Acknowledgements**

We thank MDA and USDA APHIS for this opportunity. Thanks to Katy Longen (and Mark and Paul) from MDA, Chris and Denali and the Patagonia Employee Internship Program, Ramsey County K9 Training Facility, and all of the gracious compost site hosts and wood product producers for welcoming us so warmly.

**Appendix 1:** A total of 2,202 repetitions during training were conducted with 19 different target variations, presented in 8 different ways. Based on our experience with these combinations of variables, we advise on whether the target is viable for pursuit in any continued EAB/Ash detection dog program.

Target type	rationale for target	target presentation									dog(s) worked with this target	cumulative exposures during training	viability as target
		jars/buckets line up	container, hidden	loose in environment	small piles	big piles	vehicles	brush piles- up to arm's depth	brush piles- deep	naturally occurring			
infested ash mulch	common product for inspection	X	X	X	X	X		X			Wicket, Pepin, Denali, Lily, Tia	402	not viable- no way to confirm
ash mulch	common product for inspection	X	X	X	X	X		X			Wicket, Pepin	391	not viable- no way to confirm
EAB larvae	enhance understanding of target scent	X		X							Denali, Lily, Tia	279	relevant during training, not as ultimate target
"diluted"* infested ash mulch	determine if dogs will recognize small amount of target material among non-target	X	X								Wicket, Pepin, Denali, Lily, Tia	253	not viable- no way to confirm
infested ash firewood (rounds/split <4')	common product for inspection			X	X			X			Wicket, Pepin, Denali, Lily, Tia	241	viable
ash firewood (rounds/split <4')	common product for inspection			X	X	X		X			Wicket, Pepin	145	viable
"diluted"* infested ash bark	determine if dogs will recognize small amount of target material among non-target	X									Wicket, Pepin, Denali, Lily, Tia	111	not viable- no way to confirm
"diluted"* ash mulch	determine if dogs will recognize small amount of target material among non-target	X	X								Wicket, Pepin	108	not viable- no way to confirm

**Appendix 1 continued**

Target type	rationale for target	target presentation									dog(s) worked with this target	cumulative exposures during training	viability as target
		jars/buckets line up	container, hidden	loose in environment	small piles	big piles	vehicles	brush piles- up to arm's depth	brush piles- deep	naturally occurring			
none	practice concept of searching when there's nothing to find	X			X			X			Wicket, Pepin, Denali, Lily, Tia	81	n/a
ash leafy-twigs	enhance understanding of target scent	X		X	X					X	Wicket, Pepin	58	relevant during training, not as ultimate target
ash leaves	enhance understanding of target scent									X	Wicket	42	relevant during training, not as ultimate target
naturally occurring ash branches/sticks/logs	ensure dogs find targets even when haven't been placed by trainer					X		X		X	Wicket, Pepin	41	viable
infested ash bark	enhance understanding of target scent	X	X	X				X			Wicket, Pepin, Denali, Lily, Tia	23	relevant during training, not as ultimate target
infested ash leafy-twigs and branches	Common product for inspection. Also, can dogs recognize it, if this particular piece may/may not be infested?			X	X			X		X	Denali, Lily, Tia	12	viable- to a point, likely dependent on degree of infestation and size of twig/branch
standing infested ash trees	can dogs recognize it without being previously trained to live trees?									X	Lily, Tia	8	likely viable
ash branches	common product for inspection			X	X			X		X	Wicket, Pepin	7	viable
ash lumber	possible product for inspection										none	0	unknown
weathered ash logs	possible product for inspection				X	X		X			Wicket	few	likely viable
ash logs (>4')	common product for inspection					X	X				Wicket	few	viable
infested ash logs (>4')	common product for inspection					X					Wicket, Lily, Tia	very few	viable
TOTAL												2,202	

\* "diluted" refers to target mixed with non-target material at different concentrations within containers- either under layers of non-target or homogeneously mixed with non-target

## Appendix 2

### National Detector Dog Training Center - Canine Domestic Initiatives, NDDTC Proficiency Trials

#### *Introduction*

Scent Association: Canines may be sent associated to the desired target material by placing target material in boxes or containers or placing target material on sterile logs. The number of trials and repetitions to establish the initial scent association to target odor varies between canines. The NDDTC considers a canine to be scent associated after the canine offers 20 consecutive positive responses on target and avoids responding to non-target odor.

**Phase 1 Proficiency Trials** are to be conducted under semi- controlled conditions. Canines must indicate at least an 80% proficiency in their ability to locate and respond to target odor. (AH Notes: per phone conversation on 11 May 2012 with Lisa Beckett and Joe Chopko, USDA APHIS NDDTC, the proficiency percentage for this EAB/ash study was amended to 70%). Proficiency is calculated following the formula below:

$$\text{Proficiency \%} = \frac{\text{Total number of correct responses}}{\text{Total correct responses} + \text{Total false responses} + \text{Total missed}} (100)$$

#### *Methodology Blind Proficiency Trials*

##### Sample Collection and Storage

To avoid cross contamination all training material (EAB infested logs or alternatively frass from the insect) should be collected using sterile gloves and stored separate from non-infested material.

##### Sample and Exercise Preparation

The NDDTC recommends several exercises (3-5) containing (15-25 logs each) to ensure an adequate sample size that will yield valid results.

##### Blind Proficiency Trials

All exercises must be conducted using a double blind methodology in which neither the handler nor the canine knows the location of target odor.

##### Test Construction

The NDDTC recommends the following guidelines:

1. Begin at the simplest level first using single logs laid out in simple line patterns spaced 1-2 feet apart
2. Initially, avoid the use of non-target material to simplify the exercise
3. Vary the number of targets in each exercise from (0 -4) but not to exceed 20% of the number of aids in each exercise. For example, an exercise containing 20 aids should contain no more than 4 targets
4. Number each aid (log) for ease of target and non-target identification
5. If placing target material in containers, allow at least 1 hour set time
6. Conduct the exercises inside under semi-controlled conditions to minimize the effects of environmental variables such as (wind, temperature, humidity, etc.)

7. Another handler or trainer should set up the exercise and record the location of all target aids on a simple schematic

### ***Exercise Protocol***

The handlers should be given the following instructions: "This is your first exercise consisting of X number of training aids") - Your objective is to search the area and clear the area of all targets. If your canine responds to a target you will call out the number on the aid. I will respond yes, your canine has indicated correctly, or no, your canine has indicated incorrectly. Let me know when you are ready to start and upon completion of the exercise".

The canine should investigate each aid and the observer (another trainer/handler should record the following responses (positive (+) negative (-) and false positive response (i) on a separate data sheet.

**Note:** A false positive response is indicated when the canine delivers the final response when no target is present.

### ***Conclusion***

Phase I Proficiency trails are a means in which to measure a canine's ability to distinguish target odor from non-target odor under semi-controlled conditions. Upon successful completion of Phase 1 Proficiency Trials the canine is ready to advance to Phase II.

Phase II Proficiency trails may involve conducting exercises in a semi-controlled scenario in which the canine will be working. Exercise complexity is increased by changing one variable at a time. For example, increase the number of logs in a pile, the size of the searchable area, vary the target odor concentration, position, increase the number of aids searched, conceal the target odor, increase search time.

Phase III Proficiency trials are conducted in the environment in which the canine is to be deployed and may involve all of the variables the canine will encounter. To maintain validity, target aids are placed following the methodology of the previous two phases.

## Appendix 3

### Proficiency I evaluation procedure of EAB detection dogs by Working Dogs for Conservation (approved by USDA APHIS NDDTC)

We have two sets of dogs- 2 training on EAB infestation scent and 2 training to ash wood scent.

**Material set up:** Indoors, if vehicles can be moved, otherwise outdoors. Three or more sessions of 15-20 white 2-gallon buckets (for a minimum of n=45). Buckets labeled on underside (no writing visible). Each bucket filled  $\frac{3}{4}$  full (1.5 gallons) with wood mulch (up to 20% of the buckets containing the target mulch, remaining buckets containing non-target mulch) for at least 1 hour prior to evaluation. Containers not lidded. Buckets patterned in either lines or a circle. Number of targets and position generated by a random number table.

Mulch to be used as a target instead of logs because-

- 1) Infested ash mulch, "clean" ash mulch, and non-ash hardwood mulch are visually indistinguishable ensuring both dog and handler blind, while still allowing the dog to come into close contact with the material
- 2) Mulch is a priority target for MDA this initial season
- 3) We have access to more mulch material than logs which are verified to be either infested or free from infestation
- 4) Infested logs- though known to be from infested trees- may not have an infested area within that log therefore the "target" may not actually exist within that log

#### Exercise conduct:

Test administrator- Record target locations (and schematic). Read the instructions provided by NDDTC ("This is your first exercise consisting of X number of training aids. Your objective is to search the area and clear the area of all targets. If your canine responds to a target you will call out "alert". I will respond yes, your canine has indicated correctly, or no, your canine has indicated incorrectly. Let me know when you are ready to start and upon completion of the exercise").

Handler and dog team- Handler tells recorder that they're starting. Handler will determine how to best ensure that the dog "investigates each aid (i.e. bucket)". Choices available to the handler to ensure this include working on or off lead, presenting each bucket to the dog or allowing independent discovery of the buckets, standing still or walking along the line/circle, and re-walking the line/circle to give the dog the opportunity to investigate buckets/aids that were not investigated during the first pass. When the dog indicates a target the handler will say "alert", and will then reward the dog or continue on depending on the reply from the test administrator. Should handler become disoriented upon stepping away from the test to reward the dog, an assistant is available to confirm to handler which bucket they last checked. Handler and dog will be out of sight while the administrator and assistants set up the next session.

**Appendix 4.** Results from four brush pile searches, where both dogs and people searched the same areas and compared targets found and time searched. Blue background indicates the best performance in those categories. For EAB (i.e. infested wood detection) the person was compared against the average of the two dogs, though for interest the individual dog performance is also displayed. Proficiency percentages (derived from an equation which takes into account targets correctly and falsely identified, but does not incorporate search time) are also reported. Note that across both ash and EAB target types, dogs either match or exceed the performance of human searchers.

TARGET	SEARCHER	AREA 1 (WBT front)					AREA 2 (WBT back)					AREA 3 (AH right)					AREA 4 (AH left)					# of categories outperformed other searcher	% proficiency
		search time (mins)	time to first find (mins)	% of placed targets located	# unplaced targets found	# false finds	search time (mins)	time to first find (mins)	% of placed targets located	# unplaced targets found	# false finds	search time (mins)	time to first find (mins)	% of placed targets located	# unplaced targets found	# false finds	search time (mins)	time to first find (mins)	% of placed targets located	# unplaced targets found	# false finds		
ASH	DOG (Wicket)	25	1	100	5	2	13	6	75	4	0	18	2	67	8	1	11	1	80	5	0	8	69.6%
	PERSON (Paul)	15	0	60	7	0	13	10	25	4	0	6	0	33	7	0	4	3	20	4	0	8	35.0%
EAB	DOG (Tia)	20	1	100	N/A	1	15	2	75	N/A	0	14	0	83	N/A	0	13	3	80	N/A	0		81.0%
	DOG (Lily)	13	0	100	N/A	1	14	3	100	N/A	0	12	0	100	N/A	0	8	1	80	N/A	0		90.5%
	PERSON (Mark)	24	2	100	N/A	0	24	2	75	N/A	0	19	1	83	N/A	2	16	2	80	N/A	0	2	77.3%
	DOG (avg Tia & Lily)	17	0.5	100	N/A	1	15	2.5	88	N/A	0	13	0	92	N/A	0	11	2	80	N/A	0	9	85.7%