**Project Title**: Training and Evaluation of Dogs for Early Detection of Nutria (Myocastor coypus).

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**Report Submission Date**: March 1, 2017

**Project Objectives: This can be an abstract for the project or a description of the project goals and objectives.**

Abstract:

*Early detection of the invasive species nutria (Myocastor coypus) has been determined to be the most effective way of preventing population range expansion. Detecting nutria in a natural marsh can be difficult given the number of biological and environmental variables that can influence the outcome. In efforts to understand the most effective environmental conditions under which to use canines, we trained 2 subjects ("Birdee" and "Jake") and then measured their performance accuracy (sensitivity and specificity) to detect nutria target odors and avoid non-target likely marsh mammal (muskrat, beaver, raccoon, and otter)* odors, and *efficiency by the time it took to locate a target and the distance at which they detected it under various environmental conditions. We measured distance from the "change of behavior" to target, time of search from start to an alert, positive and false positive alerts and environmental variables (temperature, humidity, wind, and target moisture). The test subjects were extremely accurate; across 688 trials conducted either indoors or outdoors under a variety of atmospheric conditions the subjects altogether committed only 6 detection errors (2 misses, and 4 false alarms), for an aggregate accuracy rate of 99.1% and because the subjects' sensitivity- and specificity-scores were so high and do not change under the conditions of the experiment or in co-variation with any atmospheric data, no parametric or correlational analyses are performed on this data. Significant positive correlations were found between ambient temperature and subject time to target (i.e. as ambient* *temperature increased, subjects needed more time to locate the target), relative humidity and subject time to target, wind velocity and alert distance to target, and wind direction and alert distance to target. Significant negative correlations were also found between ambient temperature and alert distance to target (i.e. as temperature increased, subjects needed to get closer to the target to detect it), relative humidity and alert distance to target, wind velocity and time to target, wind direction and time to target, and alert distance to target and time to target. Pearson's product-moment correlation coefficients were calculated to examine the relationship between subject's alert distance and the environment. Data suggest there was a significant negative correlation between relative humidity and ambient temperature to distance to the target and were weak predictors of alert distance as humidity accounting for slightly less than 5%,10% of the variance (r2 = .044,.098), and as ambient temperature accounts for slightly less than 10%,15% of the variance. (r2 = .095, .175) in alert distance. There was a significant positive correlation between wind velocity and alert distance to the target. As such, wind velocity is an excellent predictor of alert distance as wind velocity accounts for over 70% and 85% of the variance in alert distance (r2 = .716, .862). Knowing and using this information we have great confidence in canine accuracy and can increase canine field detection performance efficiency by placing the greatest value to increased wind velocity and although important, less value to lower ambient temperatures and lower relative humidity.*

Keywords: Nutria, Dog, Canine, Detection, Early, Invasive, Aquatic, Mammals

## Introduction

Nutria can be extremely destructive to marsh vegetation, possessing voracious appetites and consuming a quarter of their body weight daily, feeding on the tender roots of marsh grasses and succulent portions of aquatic vegetation. They compete with and displace native muskrats from marsh habitats. Grazing causes root mats to wash away from soil following wind, wave, and tide action, creating "eat outs" and often converting productive wetlands into barren mud flats or open water. Burrowing also results in significant damage to streambanks, dams, and roadbeds. These activities result in significant and substantial adverse impacts upon native wildlife and natural communities.

Nutria exhibit high reproductive potential, reaching sexual maturity at 4-6 months of age, breeding year-round, producing 2-3 litters per year, and averaging 4-6 young per litter. A single breeding pair of nutria could theoretically increase to 16,000 individuals in just three years.

Nutria were first imported into the U.S. (California) from their native South America in 1899, and nutria "ranching" increased substantially through the 1930's. When the market for nutria furs collapsed shortly after WWII, ranchers either released their nutria or did nothing to recapture animals that escaped from inadequate pens or during storm floods. Nutria were first confirmed in Virginia near Back Bay in 1956, and are believed to have entered Virginia from North Carolina via the North Landing River. Through efforts coordinated by the interagency Mid-Atlantic Nutria Management Team, in part funded by MAPAIS, we have over the last few years determined the known range of nutria in Virginia; established management zones for detection, monitored; and developed a cooperative interagency program to address this invasive threat. Our primary current need is to detect low-density nutria populations and incursions characteristic of range expansion or reoccupation within the "Early Detection – Rapid Response" management zone, and to develop a tool and method that can help facilitate "mop up" operations in areas that have nutria removal.

Until 2012, there were no coordinated efforts to monitor the status or distribution of nutria in Virginia. Distribution information was largely based on anecdotal reports and damage complaints. The core of the population appeared to be centered in the Back Bay / Virginia Beach area, with confirmed reports as far west as Southampton County. Their estimated range extended from just west of the Great Dismal Swamp and south of the James River (Rt. 264), southeastward into North Carolina, though there were a few reports of nutria near Saxis on the Delmarva Peninsula. Increasing reports of nutria in southeastern Virginia, documentation of nutria on the Delmarva Peninsula, and recognition of successful population reduction in Maryland through the Chesapeake Bay Nutria Eradication Program has spurred greater interest in addressing the Virginia population of this invasive exotic species. Marsh systems of coastal Virginia north of the James River are assumed to be threatened by nutria which occurs within normal annual range expansion limits. Should nutria establish populations there, early detection would be the greatest asset in control and eradication. Detection is critical before removal or control programs can be initiated. The best known method of detection are the use of platforms and hair snares which have been shown to be effective in high population densities, a method that doesn't address the real concern, which is nutria in low populations a characteristic of range expansion. Scat detection canines have been developed in nutria and many other projects however meaningful evaluations of effectiveness don't exist. This evaluation will be useful in determining the usefulness and effectiveness in using dogs in nutria detection and under what environmental conditions are they best used and what factor contribute or not to their effectiveness.

**Project Description: What was done to achieve the project goals or objectives.**

Methods

With objectives to train and evaluate canine nutria detection effectiveness and performance under different environmental variables we trained and developed 2 dogs to use olfactory abilities to detect and alert on nutria and to avoid false positives of other common marsh mammals. We collected and stored various scats and hair, trained dogs to alert on target odors, not to alert on non-target odors all in the context of blind experimental design.

Scat and Hair Collection and Storage

Scats and hair were collected throughout the year at various times and from various natural conditions that include water, land and on sticks and other natural debris. They were identified easily by shape, color, presence of dietary remains. They included nutria, muskrat, beaver, raccoon and otter. To avoid any human odor contamination of samples, all were collected with tweezers to avoid being handled and were placed in tightly sealed labeled glass jars. They were kept on ice and maintained frozen from collection to experimental day. All target nutria scat and hair were kept separate from other non-target samples. Like species samples were stored, mixed and used together to avoid seasonal, sex and environmentally different samples like male and female, summer and winter diet, wet and dry, cold and warm, exposure to light.

Training and Developing Trainers and Canines

Developing canine trainers and canines to do detection work is a long process. The Virginia Department of Game and Inland Fisheries (VDGIF) had 1 certified canine trainer and one canine (Jake) that has been in the field and training for over 5 years in Wildlife Law Enforcement detection and tracking. In addition, another employee and canine (Birdee) were trained and certified in conservation detection work. Training canines to detect target odors begins with a canine with high drive. High drive is best described as an insatiable behavior to receive a reward for work. Rewards can take many forms but are often playing tug, chasing balls or food treats. For this research the work was identifying target odors by a trained alert like sitting, laying down and/or barking. Target odor (nutria) training was done over 8 weeks by positive reinforcement. This involves paring the target odor with the reward so the canine knows that when they smell and alert on the target they always get their reward. Non-target training was also done over 8 weeks with and without target samples where canines were trained by only positive reinforcement of the target odor alert. Dogs understand context and conducting an experiment requires that the canine subjects understand “the game” or what the trainer/experimenter is interested in finding. Experimental context training was conducted over 4 weeks and involves teaching the canine the way and where the experiment or “game” is played. This contextual exposure was conducted in an indoor school gym and outdoor soccer field facility and was in exact format and procedure of the experiments. In addition, the target and non-target training and experimental context were continually reinforced throughout the study with training and trials.

Experimental Trails

Before, during and after each experimental trial the environmental conditions temperature, relative humidity and wind were measured and recorded. Indoor air handlers were off and so no measurable wind was detected indoors and confirmed by visual powder aerosols. Canine health condition was monitored by stethoscope heart rate and canines were not started unless between 60-100 beats per minute; they were given power bars to maintain blood sugar levels and arousal was documented by a 9 or 10 on scale of 1-10 rating high energy interest and drive behavior traits as 10. Scat moisture was also measured and maintained 39-40% saturation. Scat exposure to light was minimized and limited to only the age time of 15 minutes once placed in the experimental setting. The amount of scat was measured by volume at 1/2 cubic centimeter (cm3). Scat was placed by swabbing samples flat on the floor or ground and was allowed to rest for 15 minutes to reach the ground temperature as confirmed by a laser temperature sensor and for odors to disperse. Target and non-target odors were placed in random positions on a 3 meter square predetermined grid. To avoid human odor bias scent tracking by canines, experimental test and training areas were inundated with human odor (school gym and soccer field) and after planting targets, experimenters walked in various random directions and upwind if outdoors to vacate the experimental area. Canines were released and allowed to search at their various speeds from the greatest random distance and from downwind if outdoors to the target. Their time from release start to alert was calculated. Their distance from change of behavior which is when the canine comes in odor and is characterized as a behavior noticeable to the trainer (i.e. a head snap) to alert on target was measured. Their sensitivity rates as defined mathematically as the ratio of correct detections (“hits”) to the total number of opportunities for detection (“hits” plus “misses”) and specificity as defined mathematically as the ratio of correct rejections to the total number of opportunities for rejection (correct rejections plus false alarms) were recorded and calculated. Trials were replicated only 5 times per canine per event or measured environmental condition and were repeated approximately 35 times both indoors and outdoors resulting in 688 trials to target and non-target odor sources.

**Project Results: What were the significant results from the actions you took?**

There were three project results that included the training and certification of two canines “Birdee” and “Jake” to detect nutria in the field as well as in experimental research, the evaluation of these canines to determine the best environmental conditions to use them, the deployment of them on 8 sightings in the “Early Detection, Rapid Response” nutria management zone and the use of them in 6 presentations and demonstrations to educate the public.

Experimental Research

Please note: The following tables display the results of a series of correlational analyses, where positive values indicate a positive correlation (as one variable increased, the other increased), and negative values indicate a negative correlation (as one variable increased, the other decreased). Correlation coefficient (r) values nearest 1 and -1 are considered strong, while correlation coefficient values near 0 are considered weak.

*Table 1.* This table displays Pearson’s correlation coefficient (r) values between all variables. Significant positive correlations were found between ambient temperature and subject time to target (i.e. as ambient temperature increased, subjects needed more time to locate the target), ambient temperature and relative humidity, relative humidity and subject time to target, wind velocity and wind direction, wind velocity and alert distance to target, and wind direction and alert distance to target. Significant negative correlations were also found between ambient temperature and alert distance to target (i.e. as temperature increased, subjects needed to get closer to the target to detect it), ambient temperature and wind velocity, ambient temperature and wind direction, relative humidity and wind direction, relative humidity and alert distance to target, wind velocity and time to target, wind direction and time to target, and alert distance to target and time to target.

| | Relative Humidity | Wind Velocity | Wind Direction | Alert Distance to Target | Time to Target |
|---|---|---|---|---|---|
| Ambient Temperature | 0.398** | -0.307** | -0.189** | -0.394** | 0.360** |
| Relative Humidity | | -0.174** | -0.153** | -0.155** | 0.312** |
| Wind Velocity | | | 0.615** | 0.862** | -0.924** |
| Wind Direction | | | | 0.474** | -0.456** |
| Alert Distance to Target | | | | | -0.748** |

*Table 1. Pearson’s correlation coefficient (r) values between variables, where ** indicates significance at the 0.01 level (two-tailed).*

*Table 2.* This table displays Pearson's correlation coefficient (r) values between variables for subject "Birdee" and location "inside" only. Significant positive correlations were found between ambient temperature and time to target (i.e. as temperature increased, Birdee needed more time to locate the target), ambient temperature and relative humidity, and relative humidity and time to target. Significant negative correlations were found between ambient temperature and alert distance to target (i.e. as temperature increased, Birdee needed to get closer to the target to detect it), relative humidity and alert distance to target, and alert distance to target and time to target.

| | Relative Humidity | Alert Distance to Target | Time to Target |
|---|---|---|---|
| Ambient Temperature | 0.390** | -0.399** | 0.328** |
| Relative Humidity | | -0.806** | 0.922** |
| Alert Distance to Target | | | -0.728** |

*Table 2. Pearson's correlation coefficient (r) values between variables for subject "Birdee" and location "inside," where ** indicates significance at the 0.01 level (two-tailed).*

*Table 3.* This table displays Pearson's correlation coefficients (r) values between variables for subject "Birdee" and location "outside" only. Significant positive correlations were found between ambient temperature and time to target (i.e. as temperature increased, Birdee needed more time to locate the target), ambient temperature and relative humidity, relative humidity and time to target, wind velocity and wind direction, wind velocity and alert distance to target (i.e. as wind velocity increased, Birdee was able to locate the target from further away), and wind direction and alert distance to target. Significant negative correlations were found between ambient temperature and wind velocity, ambient temperature and wind direction, ambient temperature and alert distance to target, relative humidity and wind velocity, relative humidity and alert distance to target, wind velocity and alert distance to target, wind direction and time to target, and alert distance to target and time to target. A non-significant negative correlation was found between relative humidity and wind direction.

| | Relative Humidity | Wind Velocity | Wind Direction | Alert Distance to Target | Time to Target |
|---|---|---|---|---|---|
| Ambient Temperature | 0.630** | -0.307** | -0.194* | -0.344** | 0.298** |
| Relative Humidity | | -0.174* | -0.122 | -0.238** | 0.172* |
| Wind Velocity | | | 0.691** | 0.928** | -0.909** |
| Wind Direction | | | | .620** | -.487** |
| Alert Distance to Target | | | | | -0.862** |

*Table 3. Pearson's correlation coefficient (r) values between variables for subject "Birdee" and location "outside," where * indicates significance at the 0.05 level (two-tailed) and ** indicates significance at the 0.01 level (two-tailed).*

*Table 4*. This table displays Pearson's correlation coefficients (r) values between variables for subject "Jake" and location "inside" only. Significant positive correlations were found between ambient temperature and time to target (i.e. as temperature increased, Jake needed more time to locate the target), ambient temperature and relative humidity, and relative humidity and time to target. Significant negative correlations were found between relative humidity and alert distance to target (i.e. as humidity increased, Jake needed to be closer to the target to detect it), ambient temperature and alert distance to target, and alert distance to target and time to target.

| | Relative Humidity | Alert Distance to Target | Time to Target |
|---|---|---|---|
| Ambient Temperature | 0.390** | -0.387** | 0.275** |
| Relative Humidity | | -0.777** | 0.949** |
| Alert Distance to Target | | | -0.734** |

*Table 4. Pearson's correlation coefficient (r) values between variables for subject "Jake" and location "inside," where ** indicates significance at the 0.01 level (two-tailed).*

*Table 5*. This table displays Pearson's correlation coefficients (r) values between variables for subject "Jake" and location "outside" only. Significant positive correlations were found between ambient temperature and time to target (i.e. as temperature increased, Jake needed more time to locate the target), ambient temperature and relative humidity, relative humidity and time to target, wind velocity and wind direction, wind velocity and alert distance to target, and wind direction and alert distance to target. Significant negative correlations were found between ambient temperature and alert distance to target (i.e. as temperature increased, Jake needed to get closer to the target to detect it), ambient temperature and wind velocity, ambient temperature and wind direction, relative humidity and wind velocity, relative humidity and wind direction, relative humidity and alert distance to target, wind velocity and time to target, wind direction and time to target, and alert distance to target and time to target.

| | Relative Humidity | Wind Velocity | Wind Direction | Alert Distance to Target | Time to Target |
|---|---|---|---|---|---|
| Ambient Temperature | 0.630** | -0.307** | -0.196* | -0.308** | 0.291** |
| Relative Humidity | | -0.174* | -0.218** | -0.211** | 0.173* |
| Wind Velocity | | | 0.543** | 0.846** | -0.951** |
| Wind Direction | | | | 0.397** | -0.411** |
| Alert Distance to Target | | | | | -0.873** |

*Table 5. Pearson's correlation coefficient (r) values between variables while controlling for data within subject "Jake" and location "outside," where * indicates significance at the 0.05 level (two-tailed) and ** indicates significance at the 0.01 level*

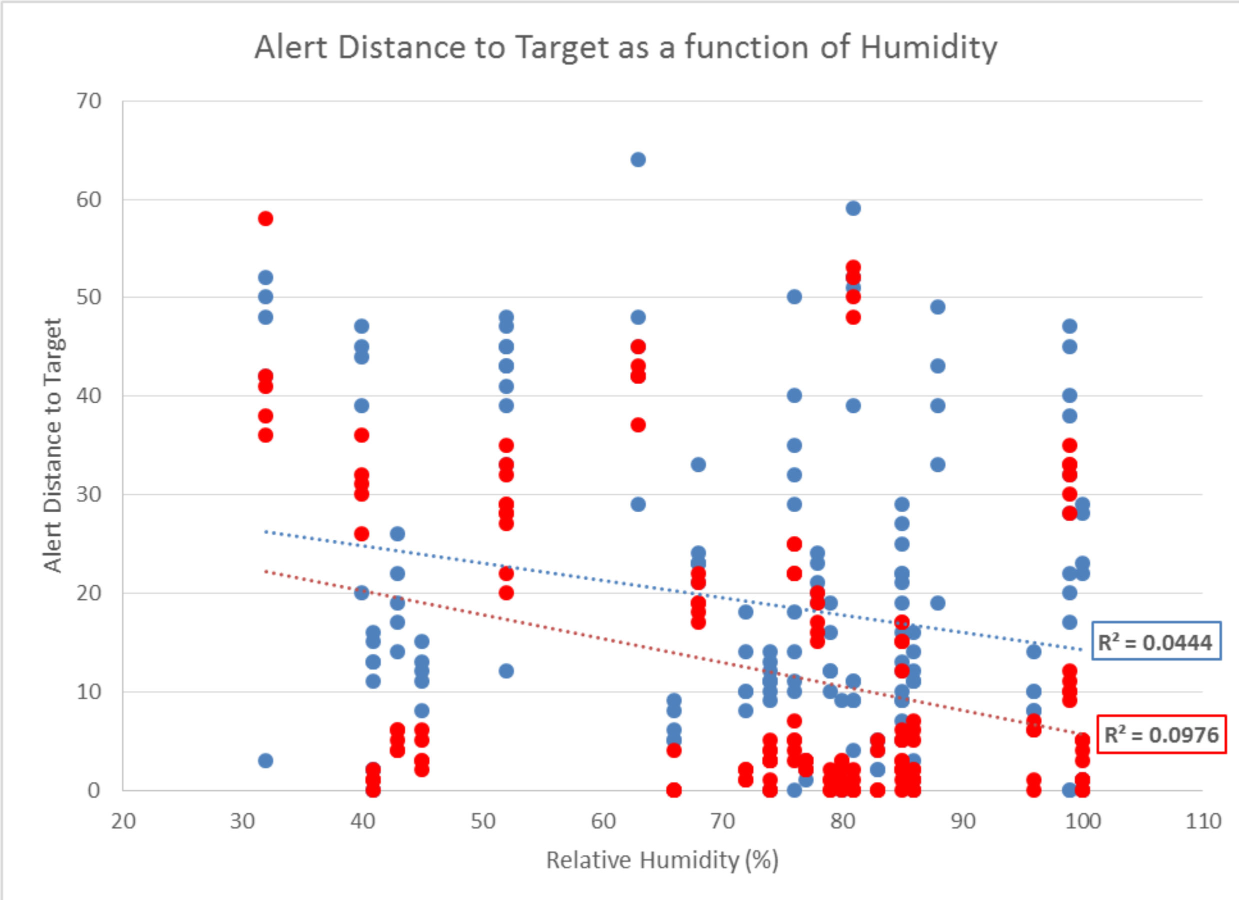


*Figure 1.* Alert Distance to Target as a function of Relative Humidity

To examine the relationship between relative humidity and alert distance to target for each subject, Pearson's product-moment correlation coefficients were calculated on each subject's data as represented in Figure 1. As Jake worked outside, there was a significant negative correlation between relative humidity and Jake's distance to the target upon his alert response, $r = -.211$, $p \leq .001$. As such, humidity is a weak predictor of alert distance as humidity accounts for slightly less than 5% of the variance in Jake's alert distance ($r^2 = .044$). Similarly, as Birdee worked outside, there was a significant negative correlation between relative humidity and Birdee's distance to the target upon her alert response, $r = -.238$, $p \leq .001$. For Birdee, humidity was a small-moderate predictor of alert distance as humidity accounts for nearly 10% of the variance in Birdee's alert distance ($r^2 = .098$).

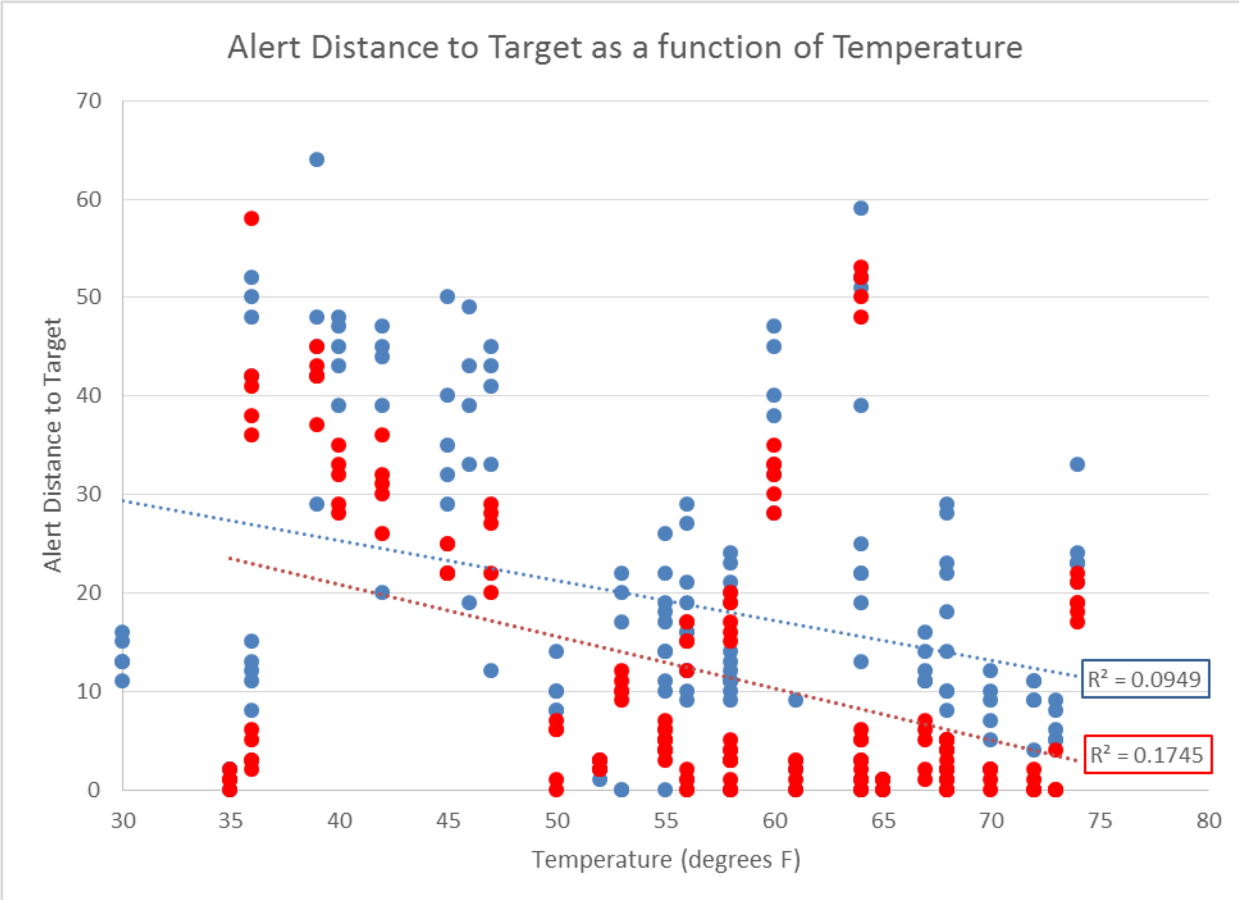


*Figure 2.* Alert Distance as a Function of Ambient Temperature

To examine the relationship between ambient temperature and alert distance to target for each subject, Pearson's product-moment correlation coefficients were calculated on each subject's data as represented in Figure 2. As Jake worked outside, there was a significant negative correlation between ambient temperature and Jake's distance to the target upon his alert response, $r$ = -.308, $p \leq .001$. As such, ambient temperature is a small-moderate predictor of alert distance as temperature accounts for nearly 10% of the variance in Jake's alert distance ($r^2$ = .095). Similarly, as Birdee worked outside, there was a significant negative correlation between ambient temperature and Birdee's distance to the target upon her alert response, $r$ = -.344, $p \leq .001$. Again, temperature is a moderate predictor of alert distance as wind velocity accounts for over 15% of the variance in Birdee's alert distance ($r^2$ = .175).

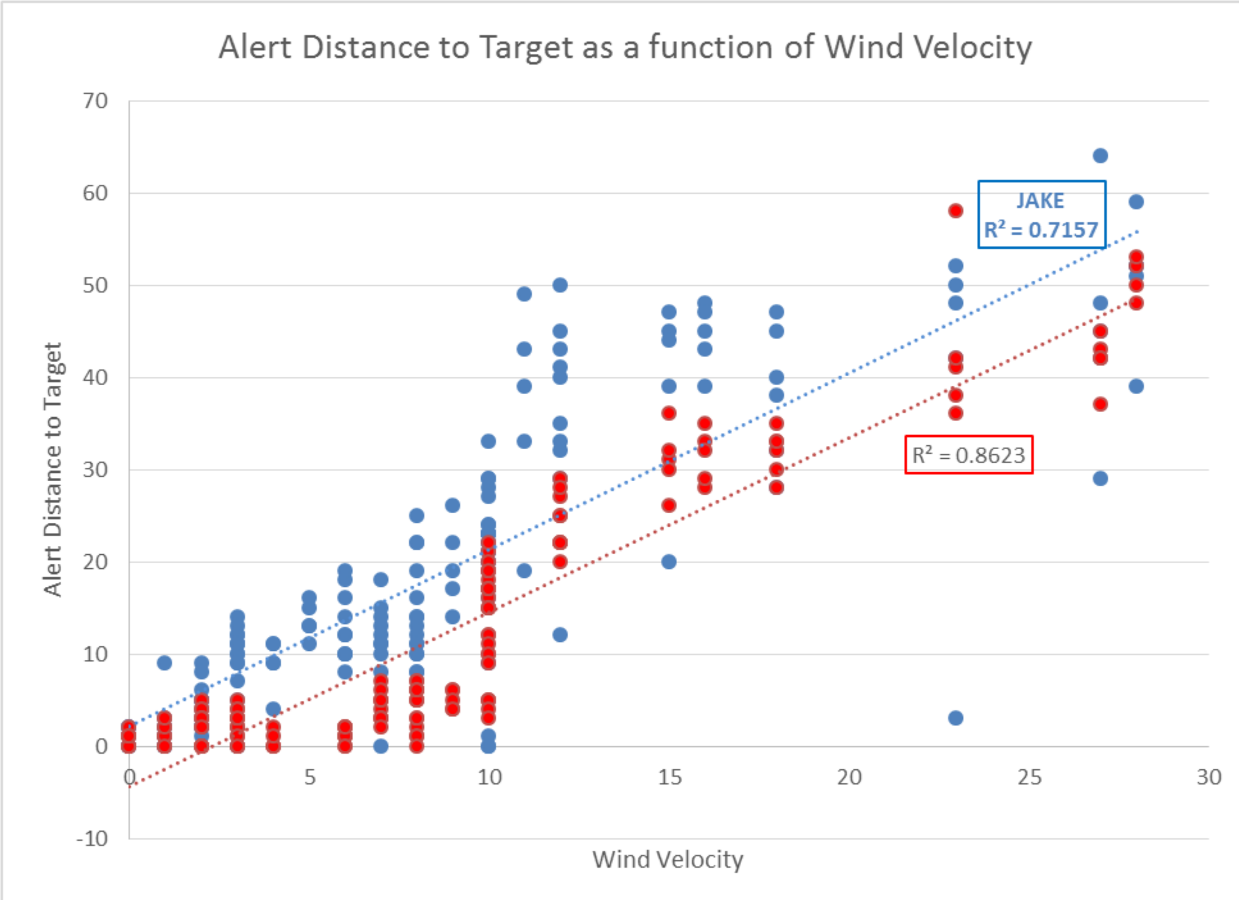


*Figure 3*. Alert Distance as a Function of Wind Velocity

To examine the relationship between wind velocity and alert distance to target for each subject, Pearson's product-moment correlation coefficients were calculated on each subject's data as represented in Figure 3. As Jake worked outside, there was a significant positive correlation between wind velocity and Jake's distance to the target upon his alert response, $r = +.846$, $p \leq .001$. As such, wind velocity is an excellent predictor of alert distance as wind velocity accounts for over 70% of the variance in Jake's alert distance ($\underline{r}^2 = .716$). Similarly, as Birdee worked outside, there was a significant positive correlation between wind velocity and Birdee's distance to the target upon her alert response, $r = +.928$, $p \leq .001$. Again, wind velocity is an excellent predictor of alert distance as wind velocity accounts for over 85% of the variance in Birdee's alert distance ($\underline{r}^2 = .862$).

Performance Measurements

Statistical measures of the performance include sensitivity and specificity. Sensitivity is defined mathematically as the ratio of correct detections ("hits") to the total number of opportunities for detection ("hits" plus "misses"). Both subjects performed remarkably well under both indoor and outdoor conditions. Indoor, neither "Birdee" nor "Jake" had any misses for sensitivity-scores of 100% for both subjects. In the outdoor trials, "Birdee" had 2 misses out of 172 trials for a sensitivity -score of 98.8%. "Jake" had no misses for a sensitivity-score of 100%. Specificity is defined mathematically as the ratio of correct rejections to the total number of opportunities for rejection (correct rejections plus false alarms). Again, both subjects performed remarkably well under both indoor and outdoor conditions. Indoor, “Birdee” had no false alert for a specificity-score of 100% while “Jake” had one false alert for a specificity-score of 99.4%. In the outdoor trials, “Birdee” had one false alarm for a sensitivity-score of 99.4%, while “Jake” had two false alarms for a specificity-score of 98.8%.

Because the subjects’ sensitivity- and specificity-scores are so high and do not change under the conditions of the experiment or in co-variation with any atmospheric data, no parametric or correlational analyses are performed on these data. The test subjects are extremely accurate; across 688 trials conducted either indoors or outdoors under a variety of atmospheric conditions the subjects altogether committed only 6 detection errors (2 misses, and 4 false alarms), for an aggregate accuracy rate of 99.1%.

Research Results Summary

We evaluated efficiency by the time it took to locate a target and the distance at which they detected it. We evaluated performance as sensitivity and specificity. We measured distance from the “change of behavior” to target, time of search from start to an alert, positive and false positive alerts, environmental variables (temperature, humidity, wind, and target moisture).

The subjects’ sensitivity- and specificity-scores were so high and do not change under the conditions of the experiment or in co-variation with any atmospheric data, no parametric or correlational analyses are performed on this data. The test subjects are extremely accurate; across 688 trials conducted either indoors or outdoors under a variety of atmospheric conditions the subjects altogether committed only 6 detection errors (2 misses, and 4 false alarms), for an aggregate accuracy rate of 99.1%.

Significant positive correlations were found between ambient temperature and subject time to target (i.e. as ambient temperature increased, subjects needed more time to locate the target), relative humidity and subject time to target, wind velocity and alert distance to target, and wind direction and alert distance to target. Significant negative correlations were also found between ambient temperature and alert distance to target (i.e. as temperature increased, subjects needed to get closer to the target to detect it), relative humidity and alert distance to target, wind velocity and time to target, wind direction and time to target, and alert distance to target and time to target. Pearson’s product-moment correlation coefficients were calculated to examine the relationship between subject’s alert distance and the environment. Data suggest there was a significant negative correlation between relative humidity and ambient temperature to distance to the target and were weak predictors of alert distance as humidity accounting for slightly less than 5-10% of the variance (r2 = .044,.098), and as ambient temperature accounts for slightly less than 10-15% of the variance. (r2 = .095, .175) in alert distance. There was a significant positive correlation between wind velocity and alert distance to the target. As such, wind velocity is an excellent predictor of alert distance as wind velocity accounts for over 70% and 85% of the variance in alert distance (r2 = .716, .862).

The performance of Jake and Birdee is incredibly accurate and gives us great confidence in their ability. Knowing and using this information we can increase canine field detection efficiency by placing the greatest value to increased wind velocity and although important, less value to lower ambient temperatures and lower relative humidity.

Deployment Summary

A conservation canine was deployed 8 sightings in the “Early Detection, Rapid Response” nutria management zone and confirmed the absence of nutria. Using a canine has given us a great deal of confidence in knowing that these sightings are false. When working canines "live" in the field trainers often place evidence or targets for their dogs to find after or sometimes during the search. This provides the reinforcement that dogs sometimes need especially when looking for something rare that requires a lot of perseverance. In all 8 sighting cases we placed hidden both known and unknown scat on the site and in all cases the dogs found and alerted on them.

Outreach Summary
This project enabled the development of staff and canine to present and conduct demonstrations to the public and local conservation groups to include, The Gloucester County Master Gardner’s, Friends of the Dragon Run, The Virginia Living Museum Earth Day twice and the Seaford Yacht Club.

**Project (Anticipated) Outcomes and Outreach: Please discuss how your project helped address your particular AIS problem and how that is leading or can lead to changes in AIS management. Clarify, how this project is making a difference in mid-Atlantic aquatic invasive species management.**

Nutria were first imported into the U.S. (California) from their native South America in 1899, and were first confirmed in Virginia near Back Bay in 1956. Nutria exhibit high reproductive potential and can be extremely destructive to marsh vegetation. Marsh systems of coastal states including Virginia are assumed threatened by nutria. Early detection is considered the greatest asset in preventing population range expansion, control and eradication. Detection is critical before removal or control programs can be initiated. The best known methods of detection in low populations that are characteristic of range expansion are the use of canines. Scat detection canines are considered very valuable however meaningful evaluations of performance and effectiveness don’t exist. Detecting nutria in a natural marsh can be difficult given the number of biological and environmental variables that can influence the outcome. In efforts to understand the most effective environmental conditions under which to use canines, we trained 2 subjects (“Birdee” and “Jake”) and then measured their performance to detect nutria target odors and avoid non-target mammal (muskrat, beaver, raccoon, and otter) odors under various environmental conditions. We evaluated efficiency by the time it took to locate a target and the distance at which they detected it.

The performance evaluation of Jake and Birdee has revealed incredibly accuracy and gives us great confidence in their ability. With the information that this project has provided we can increase canine field detection efficiency by placing the greatest value to moderate wind velocity with low directional variability and although important, less value to lower ambient temperatures and lower relative humidity. We also now recognize the distance to detect target odors required and therefor on any given environmental condition we can monitor live working GPS data maps and ensure proper investigation efforts are given to an area on that day.

The Virginia Department of Game and Inland Fisheries is committed to aquatic invasive species management. The department intends to use conservation canines for early detection of nutria in its early detection rapid response management zone and for demonstrations for public educational presentations. In this project, we deployed them on 8 sightings in the “Early Detection, Rapid Response” nutria management zone and used them in 6 presentations and demonstrations to educate the public.

**Future Directions: What has yet to be accomplished? What are the next steps as a result of this work?**

This research has and will continue to produce results in controlling nutria populations. The next steps are to increase education and solicit the public for nutria sighting reports. We are designing nutria identification signs and intend to post them at high probability sighting water access areas and department owned boat ramps. We plan continued response to public sightings with a canine to confirm presence or absence and initiate removal immediately if found.  In addition we plan to continue to use canines in public education outreach and to present these research findings at formal conferences.