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Proceedings of the Vertebrate Pest Conference

Title

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Permalink

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Journal

Proceedings of the Vertebrate Pest Conference, 22(22)

ISSN

0507-6773

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Publication Date

2006

DOI

10.5070/V422110004

Using GPS and GIS Technology to Track Rabbit Damage in Southern California Nursery

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ABSTRACT: Cottontail rabbits cause serious damage to ornamental plant production in Southern California. We used a 300-acre Southern California tree nursery as a cottontail CDFG vertebrate pest study site. We evaluated the relationship between nursery practices and the incidence of rabbit damage. GPS technology in combination with GIS software was employed to map and ascribe descriptive characteristics to the growing practices within each nursery bed. To understand the pattern of rabbit damage to irrigation, handheld GPS units were utilized by nursery staff conducting irrigation repair to assess damage caused by vertebrate pests. The waypoints taken by the irrigators superimposed on the map of the nursery had numerous benefits to the study, including demonstrating which growing conditions were most vulnerable to rabbit damage and elucidating if measures to reduce rabbit damage were successful. The same methodology may be helpful to researchers in many IPM fields.

KEY WORDS: cottontail rabbit, damage, GIS, GPS, horticulture, irrigation, monitoring, *Sylvilagus audubonii*

Proc. 22nd Vertebr. Pest Conf. (R. M. Timm and J. M. O'Brien, Eds.)
Published at Univ. of Calif., Davis. 2006. Pp. 527-529.

INTRODUCTION

Global Positioning System (GPS) and Geographic Information Systems (GIS) technology have become useful tools in many ecological studies, providing an objective way to look at animal movement patterns. They have been used to analyze habitat quality and use (McKinney *et al.* 2003, Palmer and Bacon 2000), to assist with translocation efforts to conserve species (Niemuth 2003), and to locate harborages of species that cause damage to crops (Wimberly *et al.* 2004). The pest management field has also benefited from this technology, utilizing it for planning and monitoring of control strategies (von Wahlde and Colvin 1994).

Cottontail rabbits (*Sylvilagus audubonii*) are a pest to nurseries in Southern California, causing economic losses through vegetation destruction and damage to irrigation lines. One challenge to large-scale growers is assessing where, how, and why rabbit damage occurs. It is important to understand the patterns of damage in order to implement effective control strategies and to ascertain whether these strategies provide a decrease in damage. Breached irrigation lines provided an easily recordable measure of damage, which could be tracked using GPS devices and analyzed using GIS software. The goal of this study was to use this technology to identify areas with high levels of damage, understand why these areas were targeted, and subsequently to monitor successes of control strategies.

METHODS AND RESULTS

Hardware and Software

To create the map of the nursery, we used a backpack mounted Trimble Model Ag132 in association with HGIS™ software (StarPal, Inc., Fort Collins, CO) and a handheld Trimble GeoExplorer3 in association with GPS Pathfinder Office™ software (Trimble Navigation Limited, Westminster, CO). GPS devices given to nursery staff for damage waypoint collection were

Garmin eTrex Legend™ GPS receivers used in association with DNR Garmin™ software (Minnesota Dept. of Natural Resources, St. Paul, MN). The GIS program used was ArcView™ 8.3 (Environmental Systems Research Institute, Redlands, CA).

Mapping the Nursery and Gathering Damage Waypoints

This study was conducted at a wholesale container ornamental tree nursery, located in rural San Diego County, which experienced approximately \$12,000 annual costs solely from repairing irrigation damage caused by rabbits. This 300-acre tree nursery used cultural practices common to the nursery industry in Southern California.

We employed GPS technology to map the entire nursery, which we could view and manipulate with ArcGIS™ software. The map of the nursery served as the foundation layer onto which irrigation damage points were placed. The areas mapped included nursery production beds and buildings. Additionally, we identified non-crop, riparian, and brush areas in and directly around the nursery. We also mapped roads, fences, and drainage channels. We transferred layers created with the GPS devices into our GIS software with the projection NAD 1983 StatePlane Calif VI FIPS 0406.

Starting in August 2004, we trained the irrigation staff at the nursery to use the small handheld GPS devices to record waypoints at locations of irrigation damage. Damage from rabbits to plant materials is easily recognized by characteristic 45°-angle cuts caused by feeding (Orr 1940). A complication arose in the beginning of the study that resulted in data inaccuracies: some irrigators were unable to use the GPS devices due to language barriers or technical difficulties. In addition, areas that usually experienced high amounts of damage were showing 1 or 2 damage points. This was confirmed when research staff walked with the irrigators through

high damage areas and saw that the irrigators were not recording all of the damage points. Due to these problems, the damage-repairing schedule at the nursery changed so that reliable irrigators were the only group collecting data, resulting in a more precise measure of the damage. In response to the assumed inaccuracy of some of the data and the learning curve for the irrigators, only waypoint data after December 13, 2004 were used in our analysis.

Irrigation damage waypoints were downloaded on a weekly basis and superimposed onto the map of the nursery. This was used to determine 1) where regular damage by rabbits occurred and how this correlated to the characteristics of nursery production, 2) if an extensive trapping and removal program within nursery beds had an impact on irrigation damage at those locations, and 3) whether an experiment using irrigation line covers protected irrigation lines from damage.

Identifying Nursery Production Characteristics Related to Damage

Characteristics of beds were recorded at the time of mapping and updated throughout the study as necessary. The beds were characterized by irrigation type (hand watered, drip lines hanging from above by post and wire, or drip lines running along the ground), container size and type (1, 5, and 15-gal containers or 24, 36, 48, and 60-in boxes), planting density (low, medium, or high, based on average distances of containers), canopy width, and canopy height. We determined which production characteristics were associated with damage by correlating the characteristics of beds with the number of waypoints received.

Results from this mapping showed that irrigation damage waypoints were found to be concentrated primarily on beds with ¼-in spaghetti tubing running from the ground into the containers. Beds with hanging drip lines or ¾-in tubing received significantly less damage. In addition, 15-gal containers were associated with the highest level of damage among all container types. We believe these 18-in-tall containers provided cover and protection for the rabbits due to the low vegetation canopy. The rabbits were also able to jump into the containers, allowing even further opportunity to bite the drip lines. Medium and high planting density also tended to be associated with irrigation damage.

Trapping and Removal of Rabbits

GPS waypoints showed that two beds in the nursery continually received especially large amounts of irrigation damage, beds 128 and 129. Both beds are approximately 1 ac, have 15-gal containers planted at high density, and have ¼-in drip irrigation running along the ground.

We wanted to determine if rabbit removal would reduce irrigation damage in these beds. We removed rabbits with oat-baited live traps set on the ground throughout the beds. We removed 4 rabbits from bed 128 over 88 trap-nights (June 8 to July 6, 2005) and 11 rabbits from bed 129 over 338 trap-nights (June 7 to July 20, 2005). Waypoints were analyzed before (May 10 to May 30, 2005) and after (July 30 to August 15, 2005) the trapping program. We found that the damage as tracked by GPS waypoints did not decrease as a result of rabbit removal. In bed 128, damage waypoints increased from 9 to 27, a 50% increase in damage (Table 1). In bed 129, irrigation damage waypoints increased from 64 to 101, a 22% increase in damage (Table 1).

Protective Irrigation Line Covers

Cottontail rabbits can easily bite through the standard ¼-in drip lines used at the nursery, and studies showed ¾-in drip lines, although rarely used, received less damage. In an attempt to prevent damage, we protected the ¼-in drip lines with covers made from ¾-in recycled poly hose. We placed 2 feet of poly hose over the standard drip lines in a bed receiving large amounts of damage, after damage waypoints were collected for 2 weeks (March 28 to April 13, 2005). Covers were put on the drip lines on April 15, 2005 and then damage waypoints were collected for a 3-week period (May 1 to May 21, 2005).

Waypoint data demonstrated the irrigation line covers were effective in providing a lower amount of damage points in the trial area (Table 2). The damage decreased from 27 waypoints before covers to only 1 waypoint after covers, a 96% decrease in damage.

DISCUSSION

The use of this tracking technology allowed us to obtain clear and objective results. We were able to identify the cultural practices at the nursery that encouraged rabbit damage to irrigation lines. In addition, the irrigation damage waypoints clearly showed when

Table 1. Irrigation damage waypoints before and after trapping in beds 128 and 129.

Bed	Waypoints Before Trapping (dates taken)	# Rabbits Removed (trap-nights / dates)	Waypoints After Trapping (dates taken)	Percent Change in Damage
128	9 (5-10 to 5-30-05)	4 (88 Trap-nights from 6-8 to 7-9-05)	27 (7-30 to 8-15-05)	50% Increase
129	64 (5-10 to 5-30-05)	11 (338 Trap-nights from 6-7 to 7-20-05)	101 (7-30 to 8-15-05)	22% Increase

Table 2. Irrigation damage waypoints before and after installing protective covers in trial bed.

Waypoints Before Covers (dates taken)	Date Covers Put in Place	Waypoints After Covers (dates taken)	Percent Change in Damage
27 (3-28 to 4-13-05)	4-15-05	1 (5-1 to 5-21-05)	96% Decrease

control strategies were effective. We found that trapping and removing rabbits within two nursery beds receiving high amounts of damage did not reduce irrigation damage. Covering existing drip lines with larger tubing was shown to have potential for curbing damage from rabbits. By quantifying damage as a measure of success, nursery managers can avoid wasted time and effort on ineffective control methods.

Cottontail rabbit damage continues to be a major economic consideration of growers at southern California nurseries. However, the use of GPS technology has assisted in characterizing the types of nursery production practices most vulnerable to damage and given researchers an additional objective tool to measure the impact of IPM experimental control strategies.

ACKNOWLEDGEMENTS

Research funding for this project was awarded by the California Dept. of Food & Agriculture's Vertebrate Pest Control Research Advisory Committee from the Rodenticide Surcharge Program. Special thanks to Pardee Tree Nursery of Oceanside, California.

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