Short Communications

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Effects of Perch Location on Wintering Raptor Use of Artificial Perches in a California Vineyard

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Abstract.—Most raptor species rely on perches for hunting, resting, preening, and roosting, and in many agricultural areas the availability of adequate perches can limit raptor abundance and diversity. This has negative implications for both raptor conservation and for the provisioning of natural pest control services for farmers. Installing artificial perches on agricultural lands can therefore benefit both raptors and farmers, but perches must be installed in optimal locations to maximize raptor use and minimize unnecessary costs to farmers. We monitored raptor use of artificial perches in a California vineyard over winter using remote photography to compare two sets of perch types: perches at the top versus perches at the bottom of a steep hill, and perches located among trees versus perches located in an open area. We found that raptors preferred perches on hilltops over perches at the base of hills, and that raptors seem to prefer perches in open habitat over perches located adjacent to trees, although a small sample size for this comparison limited our analysis.

Key Words: *Agriculture; artificial perch; conservation; ecosystem services; habitat; vineyard.*

EFECTOS DE LA UBICACIÓN DE LOS POSADEROS EN EL USO DE POSADEROS ARTIFICIALES POR PARTE DE RAPACES INVERNANTES EN UN VIÑEDO EN CALIFORNIA

Resumen.—La mayoría de las especies de rapaces dependen de los posaderos para la caza, el descanso, el acicalamiento y para dormir, y en muchas áreas agrícolas la disponibilidad de posaderos adecuados puede limitar la abundancia y la diversidad de rapaces. Esto tiene implicaciones negativas tanto para la conservación de rapaces como para la provisión de servicios naturales de control de presas para los agricultores. Por lo tanto, la instalación de posaderos artificiales en tierras agrícolas puede beneficiar a las rapaces y a los agricultores, si bien los posaderos deben ser instalados en ubicaciones óptimas para maximizar su uso por parte de las rapaces y para minimizar los costos innecesarios a los agricultores. Durante el invierno hicimos un seguimiento del uso por parte de las rapaces de posaderos artificiales en un viñedo en California, utilizando fototrampeo para comparar dos tipos de posaderos: posaderos en la cima frente a posaderos situados en la base de una colina empinada, y posaderos ubicados entre árboles frente a posaderos ubicados en áreas abiertas. Encontramos que las rapaces prefirieron los posaderos en las cimas de las colinas frente a los de la base de las mismas y que las rapaces parecen prefirieron los posaderos ubicados en hábitats abiertos que los posaderos ubicados al lado de árboles, aunque el pequeño tamaño muestral para esta comparación limitó nuestro análisis.

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Many raptor species have suffered declines (Butchart et al. 2004) as a result of activities related to agriculture, including habitat loss (Schmutz 1987, Sánchez-Zapata et al. 2003, Swolgaard et al. 2008) and secondary poisoning from pesticides (Erickson and Urban 2004, Stansley et al. 2014). Although agricultural land can have high abundances of raptor prey species, in many cases raptor use of these fields for foraging can be limited by a lack of suitable perch and nesting sites (Preston 1990, Widen 1994). In agricultural landscapes, raptors consume large numbers of vertebrate pests (Moore et al. 1998), although only a handful of studies have quantified whether these services provide economic benefits for farmers or reduce pest animal populations (Kay et al. 1994, Hafidzi and Mohd 2003, Kross et al. 2012).

Raptors readily use human-made perches to roost, hunt, and rest (Hall et al. 1981, Reinert 1984, Askham 1990, Kay et al. 1994, Sheffield et al. 2001, Kim et al. 2003, Witmer et al. 2008), giving farmers the opportunity to increase raptor abundances through installation of artificial perches. Raptors ranging in size from American Kestrels (*Falco sparverius*) to Golden Eagles (*Aquila chrysaetos*) use artificial perches in North America (Reinert 1984). Understanding raptor preferences for artificial perches may also pose opportunities for reducing raptor electrocution on power poles (Dwyer et al. 2016) or enhancing ecosystem services (Pias et al. 2012).

Vineyards often suffer pest damage from vertebrates, including birds (Gebhardt et al. 2011), and rodents such as voles (Giusti et al. 1996), gophers (Moore et al. 1998, Gebhardt et al. 2011) and ground squirrels (Giusti et al. 1996). Raptors are some of the natural predators of these pests. For example, Red-tailed Hawks (*Buteo jamaicensis*) regularly prey on ground squirrels (Steenhof and Kochert 1988), and Barn Owls (*Tyto alba*) can consume large numbers of both gophers and voles (Moore et al. 1998, Van Vuren et al. 1998, Kross et al. 2016).

Installing artificial perches may simultaneously benefit raptors, by offsetting some of the negative effects of habitat loss, and benefit farmers, by attracting species that regularly prey on vertebrate pests. Growers have therefore been encouraged to erect perches by both government (NRCS 2015) and industry-led sustainability schemes (Lodi Winegrape Commission 2013). However, few studies have tested the conditions in which raptors prefer to utilize a perch, leaving growers to speculate as to where perches should be installed (but see Reinert 1984). We conducted an observational study using remote photography in a vineyard to address the following questions: (1) Are the perches in the vineyard being utilized by raptors, and if so, what species are using them?; (2) How often do raptors use the perches?; and (3) Does the location of a perch affect the volume of use?

METHODS

We conducted our study in a conventional vineyard in the Dunnigan Hills area of California (Yolo, CA; 38°48′N, 122°00′W). The vineyard is characterized by rolling hills that descend steeply to a flat area bisected by a narrow riparian strip. At the time of our study, the vineyard had already erected over 40 artificial perches. The artificial perches were supported by a 6.4-m piece of steel pipe (0.02 m in diameter) buried approximately 0.6 m into the ground, so that the top of the pipe was 5.5–5.8 m above the ground. The perch itself was bolted to a steel plate on top of the pole and was made of a piece of wine barrel oak stave that measured 4.5 cm × 3.8 cm × 2.5 cm. We monitored perches in two different environmental situations: (1) perches erected at the top of a steep hill (hereafter "hilltop," $n = 3$) versus perches erected at the bottom of that hill ("hill bottom," $n = 3$); and (2) perches erected among trees ("trees," $n = 6$) versus perches erected in open habitat without trees ("open habitat," $n = 11$, Fig. 1). An area was considered open habitat when the perches were at least 200 m from the nearest tree line. For the hill treatment, the perches were paired, with one on the hilltop and the other at the bottom of the hill. For the tree treatment, there was no obvious way to pair the perches, so we randomly selected a perch from each treatment for monitoring each week (random selection without replacement until all perches in a category had been monitored).

In past studies, data of perch use was primarily collected via visual surveys (e.g., Reinert 1984, Askham 1990, Pandolfino and Smith 2011). This method can lead to missed observations because perches cannot be monitored at all hours of the day and observer presence may alter raptor behavior (Blumstein 2003). We therefore chose to use motion-sensor trail cameras to monitor perches (Bushnell Trophy Cam HD Aggressor Low-Glow Trail Camera, Overland Park, KS, USA). All cameras were placed between 1–3 m away from the perch. Tripods (Davis and Sanford Vista Ranger Tripod Hauppauge, NY, USA) were set 1–2 m high, and the cameras were positioned facing upward at approximately a 45–60° angle. Camera batteries and memory cards were changed weekly. The cameras recorded data from 18 January 2016 through 14 March 2016 to monitor primarily nonbreeding wintering raptors. Cameras were set to take a single image when motion was detected, with an inter-photo minimum time of 1 second if subsequent motion was detected. Photographs were viewed 20 at a time on digital contact sheets (image size approximately 5 cm × 5 cm) to separate images containing birds from false triggers. Images containing birds were then viewed at full size (22 cm × 15 cm) or larger, to identify species and any notable behaviors (See Fig. 2 for example photos).

Because of camera failures (due to falling over, accidental removal by vineyard staff, and clouding of a camera lens due to moisture), we were not able to compare perches within treatments every week, so we only formally analyzed data for the times when cameras in both environment types within each comparison were running simultaneously. In some cases, the cameras did not trigger to capture a bird landing or taking off, so we made the

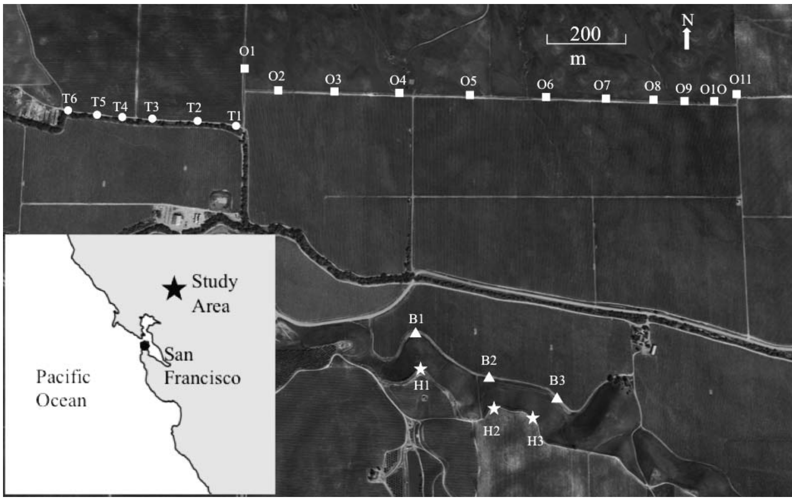

Figure 1. Map of perch placement in a vineyard in California's Central Valley showing tree perches (T1–T6), open habitat perches (O1–O11), hill bottom perches (B1–B3), and hilltop perches (H1–H3).

following assumptions for cases where arrival and departure times were not known: for multiple pictures of one bird, we assumed that photos were from the same perching event if time stamps for the photos were within a range of 5 consecutive minutes, and we assumed the photos were from two different perching events if time stamps were >5 min apart. If only one picture of a bird was taken, we assumed that it stayed on the perch for a minimum of 5 sec.

We included all diurnal and nocturnal raptors as well as Common Raven (*Corvus corax*) in our analysis, because this species also consumes rodents and is capable of providing pest control services to the vineyard. We compared the total time perches were used, the average length of each perching event, the total number of perching events, and the number of species observed each week. We used Wilcoxon signed rank tests for comparing raptor use of perches within each of the two treatments (hilltop versus hill bottom and tree versus open habitat) for all weeks combined. We analyzed data for the two treatments separately because the cameras from each group did not produce the same amount of useable data. To describe individual species' preferences, we calculated the proportion of total perch use by each species within the two treatments. For example, to calculate an indicator of perch preference for American Kestrels for hilltop versus hill bottom perches, we divided the sum of all time that kestrels used either perch by the sum of perch time on hilltop perches. All results are presented as the mean ± 1 standard error.

RESULTS

Species' Use of Perches. We observed American Kestrels (48 perching events), Barn Owls (13 perching events), Great Horned Owls (*Bubo virginianus*; 101 perching events), Golden Eagles (38 perching events), Red-tailed Hawks (183 perching events), and Common Ravens (36 perching events). In addition, the cameras also detected activity from non-raptor species that were not included in our analysis, including: American Robin (*Turdus migratorius*), Brewer's Blackbird (*Euphagus cyanocephalus*), House Finch (*Haemorhous mexicanus*), Loggerhead Shrike (*Lanius ludovicianus*), European Starling (*Sturnus vulgaris*), White-crowned Sparrows (*Zonotrichia leucophrys*), Western Kingbird (*Tyrannus verticalis*), Western Meadowlark (*Sturnella neglecta*), and Yellow-billed Magpie (*Pica nuttalli*).

Hilltop Versus Hill Bottom Perches. We were able to compare raptor use of hilltop versus hill bottom perches for 8 wk. Raptors perched on the hilltop perches (mean time per perching event = 500 sec ± 78 sec) for longer lengths of time than birds on the hill bottom perches (157 sec ± 49 sec; $P = 0.008$, Fig. 3a). Raptors used the hilltop perches (2.6% ± 0.8%) for a greater percent of total recording time compared to the hill bottom perches (0.5% ± 0.3%; $P = 0.05$, Fig. 3b). Hilltop and hill bottom perches did not differ in the total number of times each perch was used per hour of recording ($P = 0.11$, Fig. 3c) or in the total number of raptor species observed on the perches each week ($P = 0.25$, Fig. 3d).

Tree Versus Open Habitat Perches. Due to recording failures, we were able to compare data from only 3 wk of photographs for the tree versus open habitat perches. We found no difference in the average length of each perching event by raptors on open habitat perches (195 sec ± 22 sec) compared to perches among trees (506 sec ± 387 sec; Fig. 3a). Similarly, there were no differences in the proportion of total time raptors used the open habitat perches (0.83% ± 0.16%) compared to the perches among trees (0.33% ± 0.26%; $P = 0.25$, Fig. 3b), the frequency of use (open habitat: 0.15 ± 0.01 perches/hour; trees: 0.026 ± 0.01 perches/hour, $P = 0.25$, Fig. 3c), or the number of raptor species using the perches (open habitat: 3.67 ± 0.33 species/week; trees: 2.0 ± 0.58 species/week; $P = 0.25$, Fig. 3d).

Location and Use. We did not record American Kestrels using either hilltop or tree perches during our study; they apparently preferred open habitat and hill bottom perches (Fig. 4). Conversely, Barn Owls utilized perches among trees and along the hilltop more, although the number of Barn Owls recorded was relatively low compared to other species (Fig. 4). Great Horned Owls used hill bottom and hilltop perches similarly, but used open habitat perches more than tree perches (Fig. 4). Golden Eagles, Red-tailed Hawks, and Common Ravens all were recorded utilizing hilltop perches most often (Fig. 4).

DISCUSSION

We found that several diurnal and nocturnal raptor species utilize artificial perches in a California vineyard. Many raptor species, including the ones that utilized the perches in this study, often hunt from elevated locations (Reinert 1984, Pandolfino and Smith 2011). Hunting behavior may explain why raptors used the perches in open habitat and hilltop more frequently. In the open habitat location, the artificial perches were the only elevated place from which to hunt, and in the hilltop location, the artificial perches were the tallest objects on the landscape. The Central Valley provides critical habitat for wintering raptor species, but the role of these perches may differ during the breeding season (Root 1988, Pandolfino 2006). In general, raptors preferred hilltop perches over hill bottom perches; the American Kestrel appeared to be one exception. However, camera failures led to low sample sizes, particularly for the tree versus open habitat treatment and we studied only one particular vineyard, so we recommend more trials in this and additional locations.

Because our study design focused solely on the use of artificial perches, these results may not offer an indication of the use of the study site by species that are more commonly seen in flight during winter. For example, Pandolfino and Smith (2011) observed Turkey Vulture, Bald Eagle, Golden Eagle, and Northern Harrier in flight more than 50% of the time they were observed in winter surveys in the Central Valley of California. The presence of

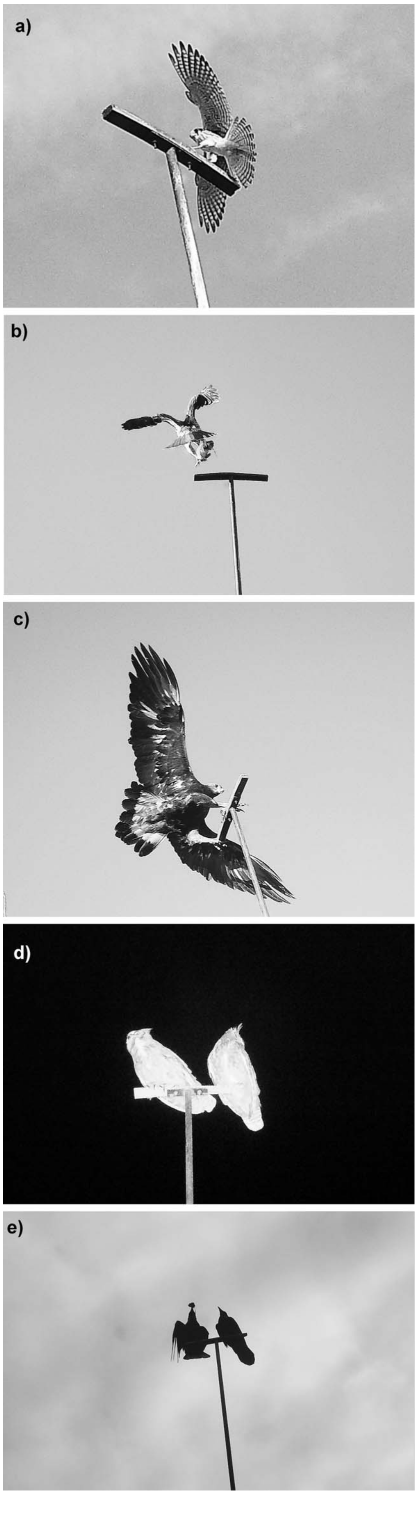

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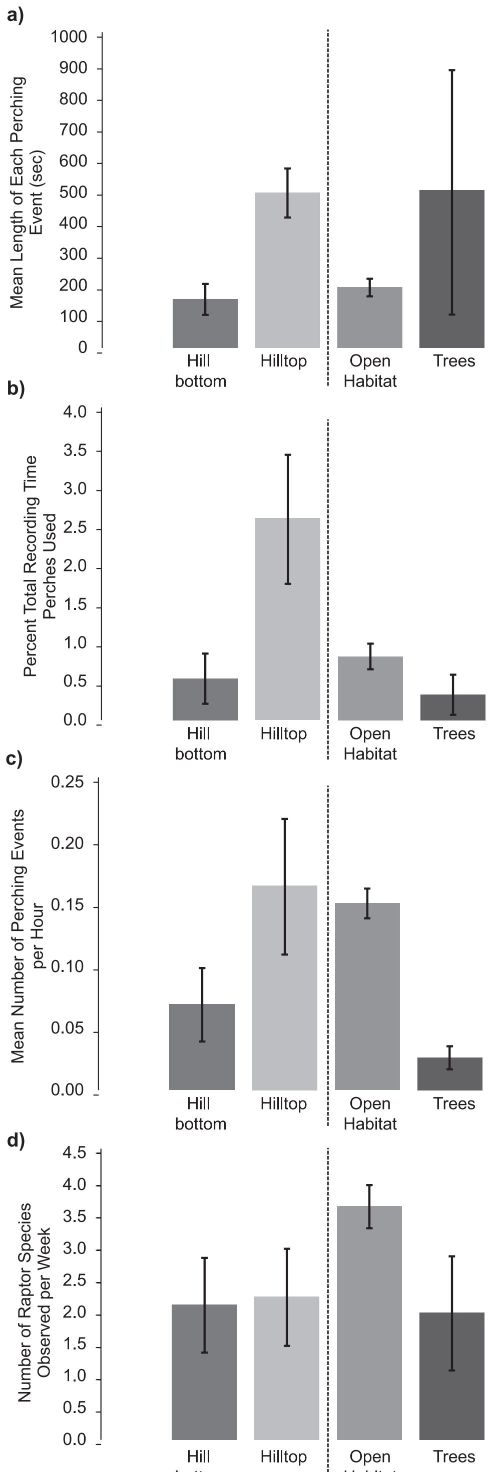
Figure 2. Example photos from trail cameras monitoring artificial raptor perches showing (a) American Kestrel, (b) Red-tailed Hawk with rabbit, (c) Golden Eagle, (d) pair of Great Horned Owls, (e) pair of Common Ravens with a mouse. Images have been cropped to show detail.



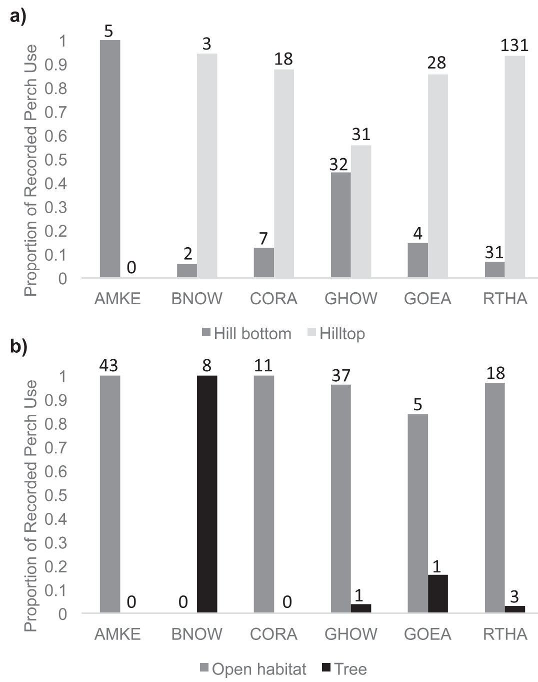


Figure 4. Species use of (a) artificial perches at the bottom of hills compared to perches on hilltops, and (b) artificial perches in open habitat compared to those among trees. Bar charts show proportion of total perch time within each two-habitat comparison that raptors spent on each perch. Numbers above each bar show the total number of perching events per species per perch type. Species codes are as follows: AMKE, American Kestrel; BNOW, Barn Owl; CORA, Common Raven; GHOW, Great Horned Owl; GOEA, Golden Eagle; and RTHA, Red-tailed Hawk. Hill bottom and hilltop values represent 8 wk of data, and open habitat and tree values represent 3 wk of data.

these species may therefore be less affected by artificial perch availability at a site, although Golden Eagles were detected utilizing the perches at our study site.

Our study site may support more raptor diversity than many vineyards and other farms in the Central Valley because of its proximity to a mountain range and the

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Figure 3. Use of artificial perches in a California vineyard: (a and b) time spent perching, (c) number of perching events, and (d) and number of species on hill bottom versus hilltop perches and on perches in open habitat versus perches among trees. Hill bottom and hilltop values represent 8 wk of data, and open habitat and tree values represent 3 wk of data.

presence of a riparian corridor. Perches erected in locations with less diverse habitat nearby may be less successful at attracting raptors. Importantly, although our results suggested that erecting perches in open habitat would likely be more successful than erecting them among trees, the open habitat perches in our study were still close to a riparian area that likely provided other habitat needs such as roost sites, cover from the elements/predators, prey resources, and nest sites. Furthermore, our low sample size for comparing between open habitat and tree perches is a likely explanation for the lack of statistically significant differences between the two, so we recommend additional research.

Additionally, we found that raptors sometimes consumed prey on the perches and we documented raptors and ravens with rabbits and mice. However, these observations were not adequate for demonstrating that raptors can actually control vertebrate pest populations in a vineyard. Future studies that monitor and document the pest populations before and after the installation of perches are necessary. If it could be documented that raptors provide a natural pest control, more farmers would be likely to install artificial perches on their land (Brodt et al. 2009, Kross et al. 2017). For vineyard managers considering installing artificial perches and for those who want to put up more, we suggest that placing perches in areas that are at the highest elevation in the vineyard and/or that have few to no trees is the best option.

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