Effect of Gravel Roads on Tree Swallow (*Tachycineta bicolor*) Nesting Success in Beaverhill Natural Area, Alberta

ABSTRACT

Roads, which are essential for modern transportation, have the potential to disrupt bird reproduction. Collisions with vehicles are a huge source of bird mortalities and result in nest abandonment. As well, vehicles introduce pollutants into the environment which may alter survival of nestlings. Therefore, roads may alter the fitness of adult birds by affecting their clutch size or fledging success. Tree swallows (*Tachycineta bicolor*) are a passerine on which the effects of contaminants are often studied; however, little is known about the influence of roads and vehicles on this species. This study aimed to determine the effect of a gravel road on the reproductive success of tree swallows using nest boxes near Beaverhill Natural Area, Alberta. The clutch size and number of fledglings were recorded from May to August and were used to compare success of swallows nesting along a gravel road to in the natural area. While tree swallows showed a preference for nesting in the natural area, nesting along the road had no effect on clutch size or fledgling success. This suggests that, while the road may not be ideal nesting conditions, it does not appear to negatively affect reproductive output. More research should be completed, however, to determine whether roads affect different aspects of reproduction, such as the health of the nestlings or their survival after fledging.

INTRODUCTION

Human infrastructures create environmental disturbances that can negatively impact many animals, including birds. In developed areas, roads, arguably one of most detrimental infrastructures to wildlife, form a huge network that fragments the landscape, and can cause changes in bird behavior, biology and reproduction. Vehicles account for the deaths of approximately 80 million birds in the

United States per year (Kociolek et al. 2011), and between 350,000 to 27 million per year in various European countries (Erritzoe et al. 2003), resulting in abandoned nests. Meanwhile, vehicle emissions, gas, oil and other road-associated pollutants threaten the health and survival of birds, especially those nesting in close proximity to a road. Many of the world's bird species have declining populations and traffic is likely contributing to this trend (Kociolek et al 2011). In the United States alone, there is over 6.2 million km of roads which ecologically affect approximately one fifth of the country (Forman 2000). Therefore, it is important to study the effects of roads upon reproduction in birds to learn how to mitigate any damage being caused.

Road-kills, most numerous in developed areas, eliminate a portion of the healthy population that would otherwise reproduce (Bujoczek et al 2011). Numerous birds can be found dead on roads every day, with the number of road-kills increasing with traffic density (Orlowski 2008), vehicle speed (Farmer & Brooks 2012), and environment structure and conditions (Orlowski 2005). Bird mortalities are more numerous during breeding season, when adults are distracted, and after fledging, when young birds disperse (Erritzoe et al. 2003). In some species, such as the Mountain White-crowned Sparrow (*Zonotrichia leucophrys oriantha*), roads increase the number of nest abandonments (Dietz et al 2013). Nest abandonments may be caused by one or both of the parents being killed in a collision with a vehicle, leaving the nest uncared for or the remaining adult unable to provide enough food (Mumme et al. 2000). The reduced bird abundance near roads may be explained by traffic mortalities or noise pollution (Benitez-Lopez et al. 2010; Summers et al. 2011).

Additionally, roads bring many types of pollution into environments that birds inhabit. Pollutants that are harmful to exposed individuals can be introduced into the environment by vehicles. Pollutants can cause mortality, reduced health, poor fertility and many other effects on reproduction (Fry 1995). Contaminants can accumulate in adults, and can be passed to their offspring (McCarty 2001). Barn swallows (*Hirundo rustica*) living under a bridge of a Maryland highway (Baltimore-

Washington Parkway) were found to have higher concentrations of lead from car emissions in adult feathers, compared to barn swallows who inhabit barns (Grue et al 1984). While the lead pollutant had accumulated in their bodies, reproductive success seemed unaffected because both colonies had similar numbers of eggs and fledglings (Grue et al 1984). Noise pollution is also produced by vehicles and can mask acoustic communication and interfere with courtship behaviors (Slabbekoorn and Ripmeester 2008). Populations exposed to constant noise can have higher levels of stress which can affect reproductive success (Warren et al 2006; Halfwerk et al 2011).

Tree swallows are a secondary cavity-nesting species who take advantage of human-built nest boxes often situated in fields or on fence posts along country roads. The proximity of the nest boxes to roads exposes tree swallows, and their offspring, to a variety of road-related dangers. Tree swallows are a species often used to study the effect of environmental stresses and contaminants (McCarty 2001). This makes tree swallows an ideal species on which to study how a gravel road affects reproductive success. Birds nesting along a road are more likely to be hit by a car, causing nest abandonment, or to experience side effects of road pollution, such as smaller clutch sizes. Therefore, I predicted that tree swallows nesting along a road would lay fewer eggs and suffer more nestling mortality than swallows nesting in a field.

METHODS:

The study area was completed in the Beaverhill Natural Area, along Rowan's Route (Highway 626) and along Range Road 183, all of which located in central Alberta, east of Edmonton. Beaverhill Natural Area is located on the southern shore of Beaverhill Lake. The area provides habitat for nesting birds, including tree swallows. Tree swallows are well studied in regards to environmental changes (e.g. PCBs), due to being aerial insectivores, having large populations and using nest boxes (McCarty 2001). In the country, nest boxes are often set up in fields or along fences that are usually near roads. In the

Beaverhill area, tree swallows can use nest boxes that are along the road (Rowan's Route and Range Road 183) or in grids in fields in the natural area.

Rowan's Route and Range Road 183 are both gravel roads. Rowan's route (Highway 626) extends between Tofield and the Beaverhill Natural Area; Range Road 183 intersects with Rowan's Route and extends southward. Both roads are adjacent to agricultural fields and grazing land. A total of 65 nest boxes were set up along the fence running on the north side of Rowan's Route and on the east side of Range Road 183. On Rowan's Route, the nest boxes faced south; on Range Road 183, the boxes faced west. 98 nest boxes were also set up in fields on the northern side of Beaverhill Natural Area. The fields of the natural area are flanked by forest and grazing land. Boxes in the natural area faced east. All boxes were constructed all with the same dimensions, in the same opening-top style.

The nesting of the tree swallows was monitored between May and August. During nest checks, the presence of a nest, eggs and hatchlings, and the nestlings' ages were recorded. Additionally, for each nest checking session along the road, the number of vehicles that passed the boxes was recorded.

Nesting success was calculated by number of eggs/number of fledglings. An F-Test was used to determine variance, and T-tests assuming equal or unequal variance were performed according to the F-test's results. The T-tests were used to compare the number of boxes used, clutch sizes, number of nestlings and nesting success between the natural area and the road.

RESULTS:

In the natural area, tree swallows nested and laid eggs in 67 out of 98 boxes. Four of the boxes were occupied by house wrens (3 boxes) or mountain bluebirds (1 box). The remaining boxes were either unoccupied (14 boxes), or had an abandoned nesting attempt (13 boxes). Tree swallows along the road used 29 out of the available 65 nest boxes. Only one box was occupied by mountain bluebirds, and no boxes were used by house wrens. 11 boxes had partial, unused nests, and the remaining 24

boxes were never used. Tree swallows were more likely to occupy boxes in the natural area than along the road (T-test assuming equal variances: $t = 3.044$, $df = 161$, $p < 0.05$).

Tree swallows nesting in the natural area had an average clutch size of 6.313 eggs (SD = 0.76, n = 67), with a range of 3 to 8 eggs. Along the road, the average clutch size was 6.172 eggs (SD = 0.76, n = 29), with a range of 4 to 7 eggs. Clutch sizes did not differ significantly in nests along the road compared to nests in the natural area (T-test assuming equal variances: $t = 0.722$, $df = 94$, $p = 0.472$).

In the natural area, tree swallow nests had an average of 5.761 fledglings (SD = 0.146, range: 2 to 8). Along the road, an average of 5.857 fledglings was produced per nest (SD = 0.143, range: 3 to 7). The number of fledglings did not differ significantly between nesting sites (T-test assuming unequal variances: $t = -0.470$, $df = 78$, $p = 0.640$). Nesting success along the road was 0.914 (n = 67); in the natural area, nesting success was 0.915 (n = 67). Overall, the success of each nest along the road and in the natural area did not differ (T-test assuming unequal variances: $t = -0.015$, $df = 42$, $p = 0.988$).

DISCUSSION:

Nesting along the road does not significantly affect the reproductive success of tree swallows, as clutch sizes, numbers of fledglings and nesting success did not vary between sites. This could simply be due to the lower number of vehicles using the roads in this study. With less traffic, the road would introduce less pollution into the environment and cause fewer traffic mortalities. However, the results of this study are similar to Grue et al's (1984) results on barn swallows, another member of Hirundinidae, who showed no difference in clutch size or fledging success when nesting near a busy highway. Therefore, roads may not affect the reproductive success in swallows. Conversely, studies of other species have found that nesting success is reduced when closer to a road. The reproductive success of mountain white-crowned sparrows declines with increasing proximity to a gravel road (Dietz et al 2013) and Halfwerk et al (2011) found that great tits (*Parus major*) had smaller clutches when close

to noisier roads. Perhaps swallows are more tolerant to environmental disturbances, which might be a necessary adaptation to using human structures (e.g. nest boxes, bridges, barns) to nest.

Reproductive success of tree swallows did not seem to be affected by proximity to the road; however, fewer boxes being occupied along the road suggests that there is a preference being shown for nesting sites away from the road. Numerous studies have found that breeding birds avoid roads (e.g. Reijnen et al 1995; Brotons & Herrando 2001). Preference for the natural area may suggest that there is a negative aspect to nesting along a road. Noise pollution produced by vehicles may inhibit courtship activities or increase stress levels (Summers et al 2011; Warren et al 2006). Offspring change their begging intensity when exposed to loud traffic noise which could affect growth of offspring by increasing their energy needs and create stress for nestlings (Leonard and Horn 2008). Vehicles, especially on dirt and gravel roads, can create dust clouds that could cause breathing and other health problems. Pollution and traffic mortalities may also affect where swallows prefer to nest.

The trend of preferring nest sites further from roads is represented in many other bird species, causing fewer birds to utilize areas adjacent to roads (Summers et al. 2011). Previous research on roads has found that traffic mortalities play a large role in shaping the bird community by a road (Summers et al. 2011). Nest abandonment may be caused by traffic-caused adult swallow mortalities. Tree swallow females are the only adult that brood the nest, but both the male and female partake in feeding nestlings (McCarty 2001). Therefore, if one of the pair dies, a single adult may not be enough to care for the nest. This may have been the case for one of the boxes along the road, the only nest in which eggs were laid but no offspring were fledged.

Reproductive success may not be the ideal way to measure the effects of a road. While clutch size and fledging success approximate fitness of the adults, these measures do not resolve more subtle effects of a road. Pollutant contamination can cause behavior changes, nest abandonment, body deformities, reduced eggshell thickness, and many other effects (McCarty 2001). Noise pollution can

create stress and change acoustic communication used for reproductive behavior (Leonard and Horn 2008). To improve this study, nestling size, growth, stress, and accumulated contaminants should be measured to help discern the effects of the road upon reproduction. A nesting grid could be set up extending perpendicular to the road, to determine at what distance swallows are not disturbed by the road. As well, nest box grids could be set up near busier roads to identify whether busier roads have stronger effects on reproductive success.

In North America, aerial insectivores, such as tree swallows, are at an increased risk to having a declining population (Shutler et al. 2012). Studying the effects of vehicles and roads will help determine ways to reduce population declines of birds. Whether or not traffic affects reproductive success, an effort should be made to make vehicles as avian and environmentally friendly as possible. This could include solutions such as slowing down in areas highly used by birds, or reducing the amount of noise produced by vehicles. It is important to learn about the effects of roads and implement solutions now before populations of birds, including ones who are abundant like tree swallows, begin to decline.

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