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ANNUAL PROJECT REPORT

STATUS OF THE BARN SWALLOW (*HIRUNDO RUSTICA*) IN THE LITTLE CAMPBELL RIVER WATERSHED

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Abstract

Despite being the most widespread swallow species in the world, Barn Swallow (*Hirundo rustica*) populations are decreasing on a national and global level. In Canada, the downward population trends have proven to be significant enough for conservation concern and, in 2011, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed Barn Swallows as threatened. In 2014, A Rocha Canada initiated a Barn Swallow monitoring program to examine the current status and long-term trends of Barn Swallows in the Little Campbell River watershed (LCRW), British Columbia. The purpose of this study was to measure Barn Swallow nest success in the LCRW and to examine how land cover, human presence, and livestock affect Barn Swallow nest success. Twenty-five buildings containing active and historic Barn Swallow nests were monitored from May 9 - August 11, 2017. In total, we monitored 28 active nests across 10 buildings. Eleven nests were completely successful (100% clutch survival), six nests failed to fledge any chicks, and eleven had partial failure. We found that the probability of a building having at least one active nest was higher in buildings near livestock and with low human presence. Future research is needed to analyze long-term trends regarding Barn Swallow abundance and reproductive success in the LCRW.

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Introduction

Barn Swallows (*Hirundo rustica*) are medium-sized songbirds identifiable by their metallic blue-black back, rust-coloured throat and forehead, and deeply-forked tail that extends beyond the wingtips. They are passerine, aerial insectivores that are known to forage in open fields and pasture land (COSEWIC, 2011). Barn Swallows, who typically begin breeding at one-year old, are socially monogamous, although extra-pair copulations not unusual (Møller, 1992). While there are six identified Barn Swallow subspecies in the world, only *Hirundo rustica erythrogaster* breeds in North America (Dor et al., 2010).

Barn Swallows are the most widespread swallow species in the world and have been observed to breed in all provinces and territories in Canada (COSEWIC, 2011). Still, Barn Swallow populations are decreasing on both a national and global scale. In Canada, Barn Swallows have declined at a rate of 3.73% per year from 1970 to 2012 (Environment and Climate Change Canada, 2014). Although they are still relatively abundant, the current downward population trends have proven to be significant enough for conservation concern and, in 2011, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed Barn Swallows as threatened.

Although the cause of their decline is not fully understood, it has been speculated that habitat loss is the primary threat facing Barn Swallows (The IUCN Red List of Threatened Species, 2016). For instance, the conversion of traditional milk and beef farms to intensive row crops has resulted in the loss of pasture land in Europe, in turn affecting Barn Swallow foraging (Evans et al., 2007). Pasture fields and farmland are becoming increasingly developed for industry and housing in Canada, resulting in the loss of optimal Barn Swallow foraging habitat (COSEWIC, 2011).

Other threats facing Barn Swallows include climate change, competition for nest sites with House Sparrows and mass declines in insect populations (COSEWIC, 2011). Ectoparasitism, primarily from blowflies and mites, is also a continual concern that threatens Barn Swallow nest success (Merino et al., 1995). Furthermore, direct human intervention has played a role in the decline of the Barn Swallow as people have been known to purposefully destroy nests to avoid mess from droppings and to maintain aesthetic appeal and functionality of buildings.

Before human settlement, Barn Swallows nested primarily in caves, holes, and on ledges (Zink et al., 2006). Unlike most species, however, Barn Swallows have traditionally benefited from human expansion and development, shifting their nesting sites from natural to artificial (barns, sheds, houses, etc.) (Zink et al., 2006). Nesting sites are often located close to pasture land and open fields for optimal foraging habitat (COSEWIC, 2011). Past studies have shown that the preservation of this habitat could have positive implications on Barn Swallow reproductive success in British Columbia (Hereward et al., 2014; Russell et al., 2016).

The purpose of this study is to measure Barn Swallow nest success in the Little Campbell River watershed, British Columbia, and to contribute to a long-term Barn Swallow monitoring program that was initiated by A Rocha Canada in May 2014. Specifically, we ask how several factors at the level of the nest building (e.g., surrounding land cover, human presence, and livestock presence) and the nest (height, exposure) affect Barn Swallow nest success.

Methods

Study Area

We monitored swallow nests within the Little Campbell River watershed (LCRW) in southwestern British Columbia, Canada. The LCRW covers a total area of 75 km^2 and spans the City of Surrey as well as the southern edge of the Township of Langley (City of Surrey, 2017). It also includes regions of the Semiahmoo First Nations Reserve No. 1, the U.S. state of Washington, and the city of White Rock (City of Surrey, 2017). Although it faces continuous pressure from development, the LCRW is chiefly characterized by agricultural land use and rural residential use (City of Surrey, 2017).

Site Selection

Fifteen sites, each containing 1-3 buildings with active or historic Barn Swallow nests (25 buildings total), were selected for monitoring (Fig. 1, Table 1). All buildings were located on private property except for those in Campbell Valley Park and the Hatchery (owned by the Semiahmoo Fish and Game Club). Sites were identified through word-of-mouth (partners or friends of A Rocha) and through an initiative carried out in 2016 in which letters were mailed to 100 landowners with properties that appeared to contain suitable Barn Swallow nesting structures (e.g., barns or sheds with surrounding pasture) (Russell et al., 2016).

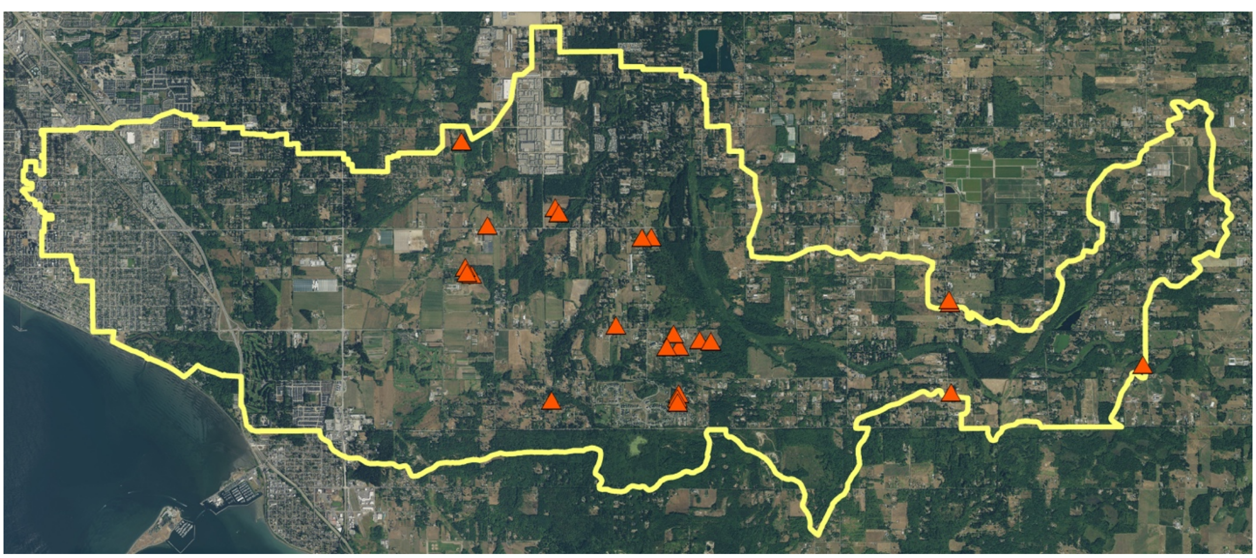

Figure 1. Map of Barn Swallow nest buildings that were surveyed in 2017 (triangles). The outline of the Little Campbell River watershed is shown in yellow.

Site Assessment

At sites that had been monitored in past years, all nests were previously mapped and assigned a number (Hereward et al. 2014, Russell et al. 2016). We updated these maps, adding new nests and noting nests that had fallen or been destroyed. We created new maps for sites and building structures that had not been monitored previously. For each nest, we measured nest height using the same extendable pole used for nest checks. We also measured nest opening as the distance between the top of the nest and the ceiling of the structure. For every building, we noted the number, distance and type of any livestock present, if the structure was open or closed, and the level of human presence within the site. We categorized human presence as: 1 = minimal (no people present within 30 min), or 2 = moderate/heavy (at least person present every 15 min). Livestock and human presence were documented by means of visual observation and communication with landowners.

Table 1. Information about Barn Swallow nest buildings that were monitored in 2017.

			Monitored in		Number of Nests		
Site Code	**Building**	**Structure Type**	**2014 (Y/N)**	**2016 (Y/N)**	**Active**	**Inactive**	**Old/Destroyed**
202-1	Barn	Enclosed	N	Y	1	1	2
Brooksdale	Main Barn	Enclosed	Y	Y	0	4	27
	Pasture Barn	Enclosed	Y	Y	4	4	2
Campbell Valley Main Office	Office Building	Open	Y	Y	0	7	0
Campbell Valley Rowlatt Barn	Barn	Open	Y	Y	0	3	0
	Schoolhouse	Open	Y	Y	0	1	0
Chicken Farm	Barn	Enclosed	Y	Y	0	11	NA
3-1	House	Open	N	N	0	1	0
	Lower Barn	Enclosed	N	N	1	3	21
	Upper Barn	Enclosed	N	N	0	2	0
224-1	Chicken Barn	Enclosed	N	Y	0	2	0
	Lean-to	Open	N	Y	0	1	13
224-2	Lower Barn	Enclosed	N	N	1	0	0
	Main Barn	Enclosed	N	N	3	0	1
Hatchery	Dan's House	Open	Y	Y	1	0	1
	Event Hall	Open	Y	Y	0	2	0
	Fish Fence	Open	Y	Y	2	0	0
24-1	Barn	Enclosed	N	N	0	3	NA
	Lean-to	Open	N	N	1	4	NA
192-1	Garage	Open	N	Y	2	0	0
	Shed	Enclosed	N	Y	0	1	0
202-2	Barn	Enclosed	N	Y	0	NA	NA
Grass Anchor	Barn	Enclosed	Y	Y	12	0	11
240-1	Garage	Open	N	N	1	0	3
202-3	Barn	Open	N	Y	1	0	3

Weekly Nest Checks

Active nests were monitored on a weekly basis from May 9, 2017 through August 11, 2017. Inactive nests were monitored weekly for approximately the first 3 weeks and every 3-4 weeks throughout the rest of the season to confirm that they remained inactive. To view nest contents, we used a mirror attached to an extendable pole for nests that were approximately 10 ft above the ground or lower and a camera attached to an extendable pole for nests that were higher than 10 ft. These methods allowed observers to see inside the nests while minimizing disturbance. We recorded the number of eggs, live young, and dead young at each nest. We also documented the nestlings' stage of development, evidence of fresh mud or feathers on the nest, the number of eggs and/or young of parasite or other species, and the presence of adult Barn Swallows or other bird species in or around the nests.

In early development, nestlings were difficult to distinguish due to their size and orientation; often feathers or nestlings would shield other nestlings from view. In this case, only distinct nestlings, with visible yellow beaks, were counted. These counts were verified at later nest checks as nestlings matured.

Analysis

Estimating Dates

Incubation time for Barn Swallows is generally 12-17 days (Bird Studies Canada, 2016). Therefore, if eggs were laid before the first check, we estimated laying date by subtracting two weeks from the estimated hatching date.

Laying date, hatching date, and fledging date were estimated as the midpoint between the checks in which the nest was empty or eggs or chicks were observed in the nest (in respect to date being estimated). In cases where eggs and chicks were observed in the nest at the same time, we estimated the hatching date as the date of the nest check, since hatching was still in progress.

Measures of Nest Success

Clutch size (number of eggs laid), number of fledglings (chicks that successfully fledged), and the overall survival of a clutch (number of fledglings / clutch size; Moller 1991) were used as measures of nest success. Ultimately, a nest was considered successful if it fledged at least one chick.

Because nest checks were conducted weekly, the fledging count was less reliable than the clutch-size count. For the purpose of this study, we estimated fledgling numbers by subtracting the number of dead chicks found on or around the nest at any time during the rearing period from the number of nestlings that were recorded in the last nest check prior to fledging. If no dead chicks were observed, all nestlings were assumed to have fledged.

Landcover Classification

Nest building structures were mapped on a 2012 land cover layer of the Little Campbell watershed in ArcGIS. This land cover layer was created using data from the City of Surrey and the Township of Langley and updated based on 2012 aerial imagery in 2013 (Reed, 2013). We further updated the layer based on 2015 aerial imagery from Whatcom County, U.S.A., to account for land cover changes since 2012. Using ArcGIS, two buffers (100m and 400m) were created around each building structure.

Land cover was originally classified into 17 categories (Reed, 2013) that were further grouped into four distinct categories as follows:

1. *Field:* Agricultural Herb and Grass, Agricultural Row Crops, Turf Grass, Unmanaged Herb and Grass, Unmanaged Shrub
2. *Forest:* Mature Forest, Urban Trees, Young Deciduous Forest, Young Evergreen Forest, Young Mixed Forest
3. *Freshwater:* Estuarine Marsh, Freshwater Lake, Freshwater River, Marsh
4. *Urban:* Urban Suburban/Low Density, Urban Suburban/Moderate Density, Urban Suburban/High Density

Using ArcGIS, land cover categories within each buffer were extracted as percentages.

Statistical Analysis

Linear mixed effects models were used to test for associations between continuous measures of nest success (clutch size, number of fledglings, and overall clutch survival) and various nest- and building-level variables. Overall clutch survival was arc-sin square-root transformed to meet assumptions of normality for regression models. Generalized linear models with binomial distribution were used to test for associations between binary response variables (probability of nest success and probability of laying a second brood) and the same set of predictor variables. These response variables were modeled only for active nests (at least one egg laid during the study season). We also used generalized linear models to test for associations between the probability of a building containing at least one active nest and building-level predictor variables. Nest-level variables included nest height (m), opening (cm), and laying date. Building-level variables included surrounding land cover percentages (field, forest, urban, and freshwater) within 100 and 400 m buffers, number of active nests, human presence (categories 1 or 2), structure type (enclosed or open), and distance to livestock. Building ID was included as a random variable in all nest-level models since several buildings contained multiple nests.

For each response variable, a full model was constructed with all predictor variables, and a step-wise model simplification procedure was used to eliminate non-significant variables.

Results

Nest Sites

We monitored 28 active nests across all sites during the study season. Twelve buildings across 10 sites contained active nests.

Five sites monitored this year were also monitored in 2014 and 2016 (Fig. 2). Furthermore, five sites that were newly added in 2016 were also monitored in the current study year (Fig. 2). There were more active nests at Grass Anchor and 192-1 this year (11 at Grass Anchor and 2 at 192-1) than in the previous year(s). 202-1 and 202-3 had the same number of active nests in 2016 and 2017. The remaining sites showed a decrease in the number of active nests; there was no nest activity at Campbell Valley Main Office, the Chicken Farm, 224-1, or 202-2 in the current study year.

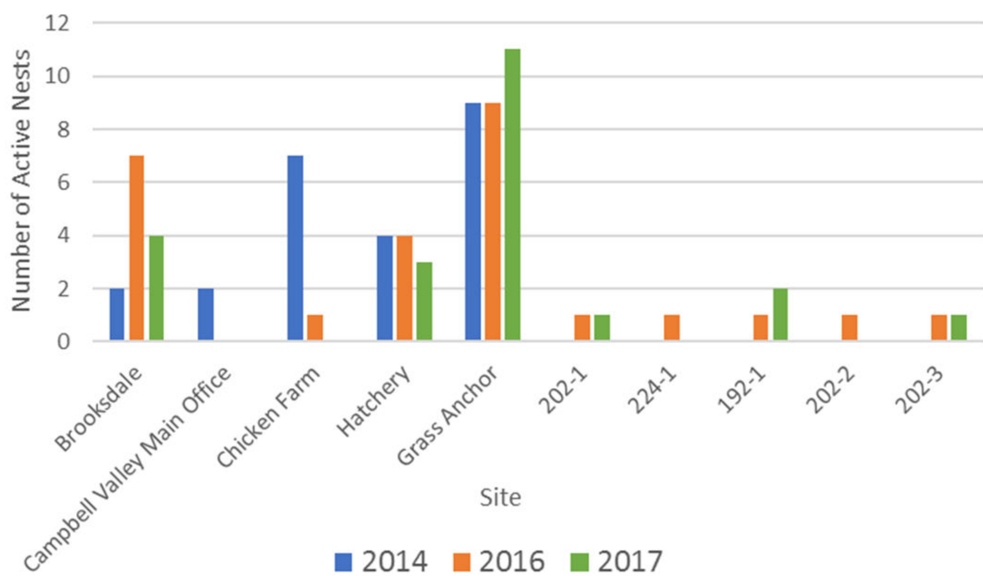

Figure 2. Number of active Barn Swallow nests in 2014, 2016, and 2017. Sites to the right Grass Anchor were not monitored in 2014. For comparison, all buildings at each survey site are combined.

Timing of Nesting

We observed eggs on the first nest check (May 9), at Grass Anchor and at 240-1. The greatest number of nests that were monitored simultaneously throughout the breeding season was 25 in the second week of June (Fig. 3). Pairs began laying second broods in the second week of June (first eggs were observed on June 9) and a third brood was laid at the Hatchery fish fence the first week August. On the date of the last nest check (August 11), ten nests were still active. Two of these nests contained chicks from first broods, one nest contained eggs from a second brood, and six nests had chicks from second broods. The final nest contained the eggs from the third brood that was laid at the Hatchery fish fence.

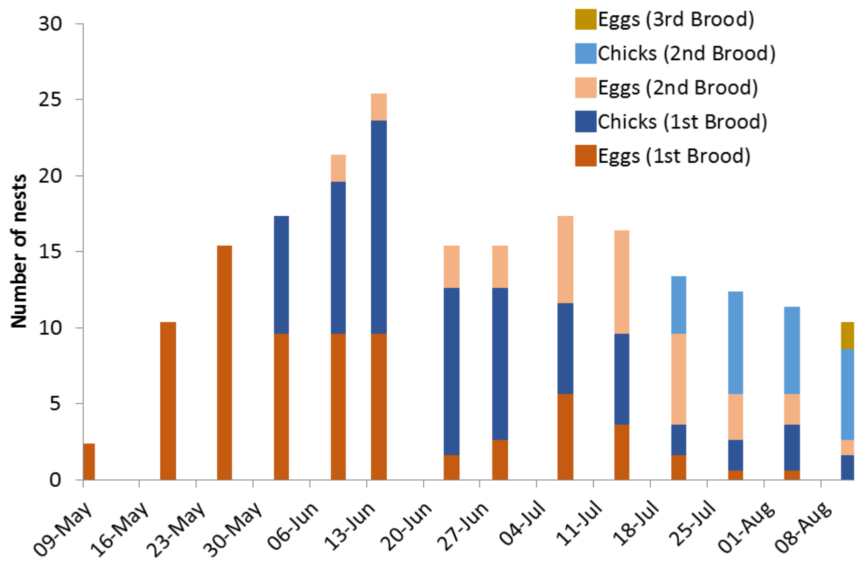

Figure 3. Number of nests containing eggs and chicks for first, second, and third broods at different stages of the breeding season.

Clutch Size and Number of Fledglings

Clutch size varied from two to six eggs for the first clutch (average = 4.4; Table 2) and two to five for the second clutch (average = 4.0). Number of fledglings varied from zero to five for the first clutch (average = 2.6) and three to five for the second clutch (average = 4.3). Overall clutch survival varied from 0 - 100% (average = 62% for first broods and 96% for second broods; Table 2). Twenty-two out of 28 active nests (79%) were successful (fledged at least one chick). Eleven Barn Swallow pairs laid second clutches and one pair laid a third clutch during the breeding season (Fig. 4).

Nest success was varied for first broods in the current study year (Fig. 5). Eleven nests had complete success (all chicks fledged) but six experienced complete failure (no chicks fledged). Complete nest failure occurred at the hatchery, 224-2, Brooksdale, 240-1, and 202-1. Eleven nests experienced partial failure (at least one nestling death) with overall clutch survival varying from 20-80% for these nests.

Table 2. Clutch size, number of fledglings, and overall nest success for first and second broods.

Brood	Variable	Range	Mean	Standard Deviation
First Brood	Clutch Size	2-6	4.4	1.0
	Number of Fledglings	0-5	2.6	1.8
	Overall Clutch Survival	0-1	0.62	0.41
Second Brood	Clutch Size	2-5	4.0	0.89
	Number of Fledglings	3-5	4.3	0.82
	Overall Clutch Survival	0-1	0.96	0.10

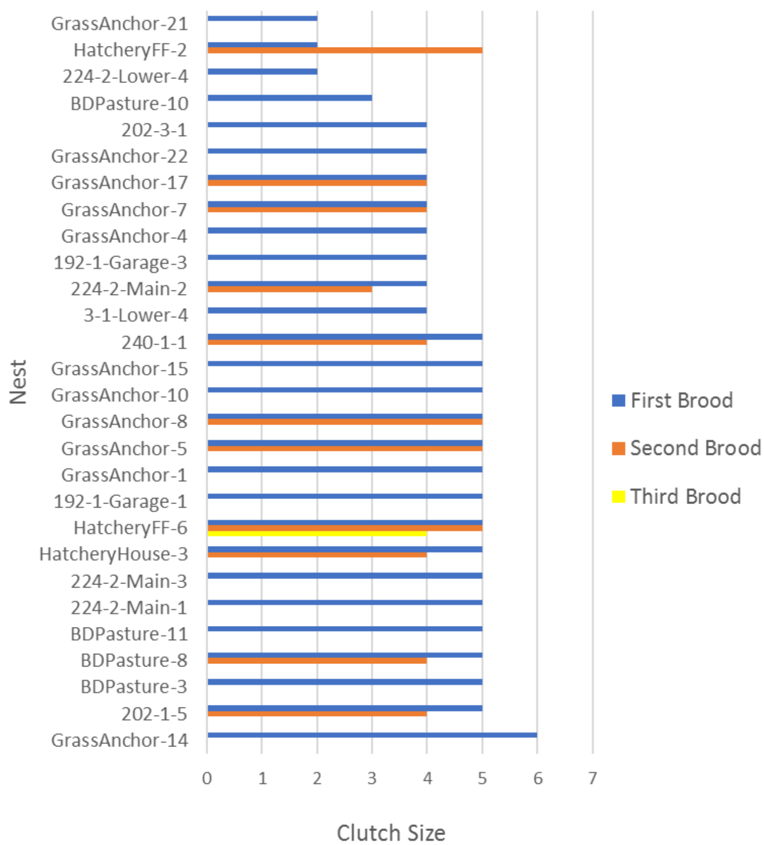

Figure 4. Clutch size (number of eggs) for first, second, and third broods in every active nest.

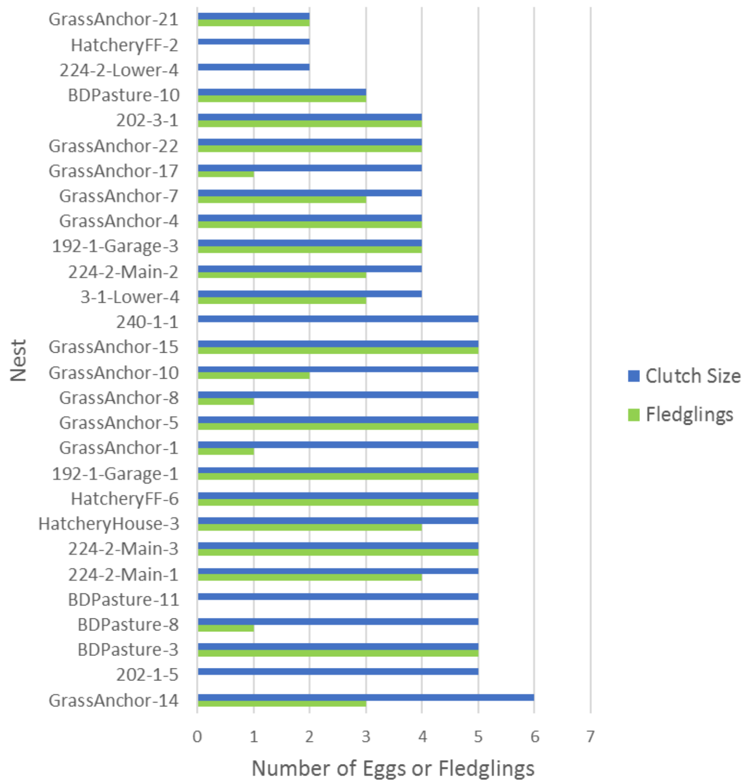

Figure 5. Clutch size and number of fledglings for first broods in every active nest.

Results from Statistical Models

None of the response variables associated with nest success were significantly associated with any of the nest- or building-level predictor variables. The probability of a building containing an active nest was higher for buildings close to livestock ($p = 0.07$; Fig. 6) and when human presence was minimal ($p = 0.04$; Fig. 7). Nests with earlier laying dates had a higher probability of having a second brood ($p = 0.04$).

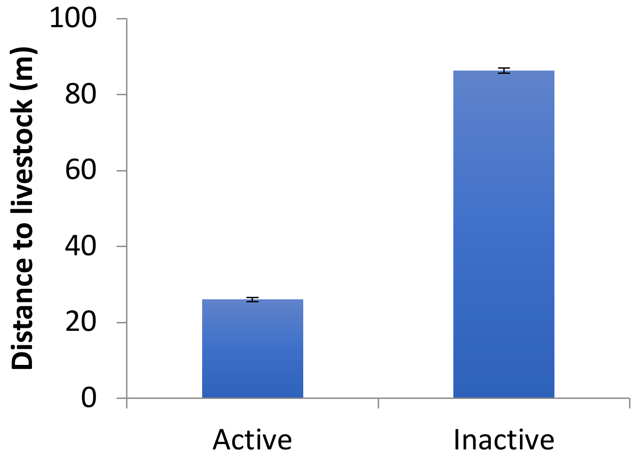

Figure 6. Average distance to livestock from buildings with at least one active nest (active) and buildings with no active nests (inactive).

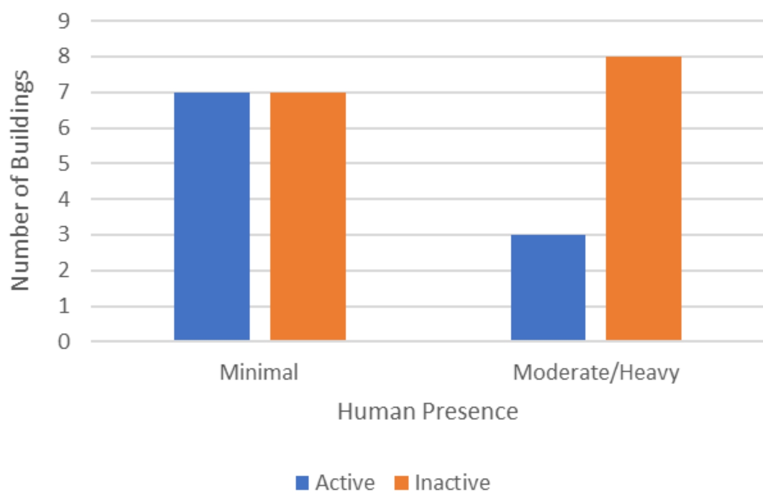

Figure 7. Number of buildings with at least one active nest (active) and no active nests (inactive) at sites where human presence was minimal and moderate/heavy.

Discussion

Distribution of Sites

Four sites (24-1, 3-1, 224-2, and 240-1) were added to the Barn Swallow nest monitoring program this year. The addition of 240-1 and 3-1 expanded the boundary of the study area to the east (240-10 and south (3-1).

Nest Failure

Six nests experienced complete failure (no chicks fledged from the nest) in the current study year. Because nest checks were only conducted weekly, the causes of nest failure are unknown.

Five nests had clutches in which no eggs hatched. Two nests (HatcheryFF-2 and HatcheryFF-6) had first-brood clutch sizes of two and five, respectively. Subsequent nest checks (June 2) revealed that there were no eggs either nest. It is possible, considering that the nests were built on an open structure, that they were predated on by other birds or mammals such as Northwestern Crows, Common Ravens, Owls, European Starlings, rats, or mice (Ferguson, 2016). Second broods were laid in both nests within two weeks (June 9) and had 100% clutch survival. HatcheryFF-6 was the only nest this season to have a third clutch. Similarly, three nests (BDPasture-11, 240-1-Garage-1, and 224-2-Lower) had clutches in which no eggs hatched and were eventually removed from the nests. It likely, considering these eggs remained in the nests for multiple weeks, that parents removed these eggs. These failures could be due to a variety of reasons including genetic defects, extreme temperature fluctuations, or lack of fertilization or incubation (Russell et al., 2016). This year, there was a cold-snap that occurred throughout the watershed in mid-June (roughly June 13-19). BDPasture-11 had an approximate laying date of June 6, so it is possible that the cold-snap was a factor in the failure of this nest. The laying dates for 240-1-Garage-1 and 224-2-Lower-4 are unknown, as the eggs were laid before the first nest check. Nest 240-1-Garage-1 was the only nest in this group to have a second brood which had 75% clutch survival.

On June 23, dead chicks were found below several nests (202-1-5, BDPasture-8, 224-2-Main-1, HatcheryHouse-3, NB-10, NB-14, NB-17). One nest (202-1-1) experienced complete failure (all chicks died) during this episode. One June 21, we also found 21 dead Cliff Swallow chicks below nests at the Brooksdale Main Barn. It is likely that the cold snap from June 13-19 caused these deaths. Low temperatures may have led to reduced insect activity for a prolonged period in which parents were unable to feed their chicks.

Nest Activity Across Years

Grass Anchor had more active nests in the current study year (11) than in the past (9 in both 2014 and 2016). Grass Anchor appears to contain high quality nesting and foraging habitat, as it has had the most active Barn Swallow nests out of all the sites in each study year. The barn on this site is mostly abandoned, with doors and windows left open. Therefore, swallows have unrestricted access to the barn and can easily fly in and out. Cattle are occasionally grazed in the fields adjacent to the barn, and are sometimes allowed to wander through the barn. This has resulted in abundant piles of manure both within the barn and in surroundings fields that attract insects. The barn also contains many beams and old light fixtures on which Barn Swallows can builds nests. Because the barn is mostly abandoned, old nests are never removed by people and there are many old nests in different stages (from undamaged to only imprints left on walls) that can serve as social cues for Barn Swallows selecting nest sites (Ringhofer et al., 2013).

Site 192-1 had one additional active nest this year than in 2016, but the number of breeding pairs (one) remained the same. In the current study year, the Barn Swallow pair at this site laid their first brood in the same nest (192-1-Garage-1) as in 2016. After the chicks from the first brood fledged, the breeding pair built a new nest in the same building to lay a second brood (192-1-Garage-3). This could be because the first nest contained nest parasites (such as blowflies or mites), although the first brood fledged with an overall clutch survival of 100%. It is possible that the breeding pair simply moved because the nest was old, as conversation with the landowner revealed that the nest had been used for many years prior to 2017.

The number of active nests at the chicken farm decreased significantly from 2014-2017. In 2014, there were seven active nests (Hereward et al, 2014). Russell et al. (2016) noted that many of the nests had fallen by 2016 and only one nest was active. In the current study year, there were no active nests at the chicken farm. It is unknown why breeding pairs are not returning to reuse or build new nests at this site, although it has been speculated that the decline in the number of chickens (and, therefore, a decline in manure and insect availability) has contributed to decrease in nest activity over the years. Russell et al. (2016) also observed that the barn doors, which had largely been left open in 2014, were closed at the start of the surveys in 2016 and remained closed for subsequent surveys.

While 202-1 and 202-3 each had one active nest in 2016 and 2017, all remaining sites showed a decrease in the number of active nests. In addition to the chicken farm, there was no nest activity at Campbell Valley, 224-1, or 202-2 in the current study year.

Population Trends

Population counts were beyond the scope of this study. However, anecdotal evidence suggests that Barn Swallow populations are declining in the LCRW. The number of active nests decreased at six of the ten sites that were surveyed in both 2016 and this year. Furthermore, while they might not have all been active at the same time, the number of inactive and old nests (see Table 1) reveals the capacity of each site to provide nesting habitat for Barn Swallows. Conversation with multiple landowners further affirmed that there are significantly fewer active nests than have been observed in prior years. For example, the owner of site 24-1, a large horse boarding facility, mentioned regularly seeing at least 10 active Barn Swallow nests in past years, but in the past two years there have been no active nests on the property.

Future studies will provide greater insight on long-term trends regarding Barn Swallow abundance and reproductive success in the LCRW.

Land-cover Associations with Reproductive Success

In previous years, significant positive correlations were found between amount of surrounding pasture and number of fledglings within a 400 m buffer (Hereward et al., 2014) and clutch size and number of fledglings within a 100 m buffer (Russell et al., 2016). However, we found no significant correlations between land cover and any measure of nest success in 2017.

This difference could be due to the non-overlapping sites that were surveyed in 2014, 2016, and 2017. The addition of 4 sites (24-1, 3-1, 224-2, and 240-1) this year may have influenced the observed relationship between surrounding land cover and nest success, making comparison across years difficult. It is also possible that the differences in results across years were influenced by the updates made this year to the 2012 land cover map (based on updated 2015 aerial imagery from Whatcom County).

Livestock and Human Presence Associations with Nest Activity

We found that the probability of a building having at least one active nest was higher in buildings near livestock. This association with livestock may be indicative of the fact that insect availability is higher around livestock due to the presence of manure (Grüebler et al., 2010), and that livestock presence might buffer the effects of weather conditions on insect availability (Ambrosini et al., 2002). Moller (2001) found that aerial insect abundance on farms with livestock was five times larger than on farms with no livestock in Europe. Greater insect abundance close to nests would mean that Barn Swallows would not have to travel far to forage for food. Therefore, sites close to livestock would be optimal for nesting. It is also possible that Barn Swallows benefit from the warmer and more constant temperatures that livestock provide to farm buildings (Grüebler et al., 2010). Ambrosini et al. (2002) found that Barn Swallows were more likely to be present on farms that contained livestock in the past 2-5 years. They also found that onset of reproduction was earlier on farms with cattle (Ambrosini et al., 2002). In contrast, we found no significant relationship between laying date and livestock presence or distance. Livestock presence was not quantified in A Rocha's previous studies (Hereward et al., 2014 and Russell et al., 2016), so correlations between livestock presence and nest activity cannot be compared across years.

We also found that the probability of a building having at least one active nest was higher in buildings with low human presence. Eldredge and Hester (2013) found the opposite result, in which Barn Swallow nest site selection was positively correlated with human presence (Eldredge and Hester, 2013). This result was attributed to the association between human presence and open barns and low abundance of Barn Swallow predators. Ringhofer et al. (2013) found no association between Barn Swallow site selection and presence of people, but they hypothesized that proximity of people would reduce risk of nest predation. Our contrasting results may be explained by the fact that, in some cases, direct human disturbance to nests may result in lower nest activity in buildings with high human presence. Sometimes people intentionally remove Barn Swallow nests when they are built in undesirable places; for example, on light fixtures or in high-use areas where droppings piles would be inconvenient. Ringhofer et al. (2013) found that breeding site selection in Barn Swallows was best predicted by the presence of undamaged old nests, likely because old nests indicate past breeding success. Therefore, Barn Swallows might avoid buildings in which old nests are removed by people because they would lack this social cue. However, our sample size is not large enough to make strong claims about the association between human presence and nest activity, and our method for classifying human presence within buildings was subjective. In the future we could use a more objective method for classifying human presence, such as that used by Ringhofer et al. (2013). Longer-term studies are needed to understand the relationship between human presence and nest activity in the LCRW.

Future Research

This year we were limited by our capacity to check nests only once per week. Subsequent studies could benefit from more frequent nest checks which would allow for more accurate nestling/fledgling counts. More frequent nest checks could also provide a clearer understanding regarding the factors that contribute to the nest failure of specific sites. This could be done by working with landowners who would be willing to conduct nest checks and record data (using a standardized monitoring template) throughout the summer season. It could also be achieved by using motion-sensor trail cameras in front of nests to capture instances of nest predation, such as those piloted in 2016 (Russell et al., 2016).

Two nests that experienced failure were theorized to have been the result of the cold-snap that occurred mid-June this year. In future studies, monitoring air temperature throughout the breeding season would provide insight as to how temperature affects nest success.

Conclusion

We found that the probability of a building containing an active nest was higher for buildings close to livestock and when human presence was minimal. Given that Barn Swallow populations are declining, we recommend preserving livestock pasture in conservation efforts to protect this threatened species. Our study provides information on Barn Swallow nest success and contributes to a monitoring program that will give insight regarding long-term trends in Barn Swallow abundance and reproductive success in the LCRW.

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