SHORT-EARED OWL (*ASIO FLAMMEUS*) AND TOWNSEND'S VOLE (*MICROTUS TOWNSENDII*) DYNAMICS IN GRASSLAND SET-ASIDES

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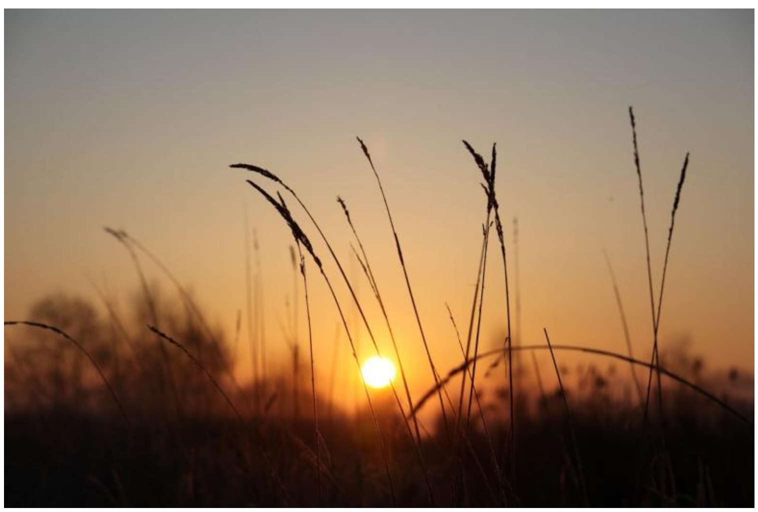

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Abstract

Set-asides are potentially important for short-eared owls (*Asio flammeus*) conservation of which requires specific management practices. A relationship between older set-asides and higher densities of Townsend's voles (*Microtus townsendii*) and higher occurrence of short-eared owls was hypothesized. Throughout the winter of 2009-2010 in Delta, British Columbia, habitat use of Townsend's voles and short-eared owls was investigated on 10 set-asides and old-fields categorized into 3 different age-classes: 2-year-old, 3- to 4-years-old, and old-field. In each field, densities of Townsend's voles were quantified with mark-recapture using live trapping, flight durations of short-eared owls were monitored at dawn and dusk using point-count sampling, and vegetation structure was analyzed with randomized quadrat sampling. Old-fields were found to be the most favourable habitat for both species, with a mean density of 145 Townsend's voles/ha, and a mean flight duration of short-eared owls of 2.0 min/10 ha; both were strongly correlated to thicker and denser thatch. Flight durations of short-eared owls were positively related to densities of Townsend's voles until thatch cover reached approximately 80% and thatch height approximately 11 cm. A further increase beyond these thresholds turned the positive relationships to negative. Management practices for short-eared owl habitat enhancement include stratified mowing to provide thatch accumulation for Townsend's voles and to simultaneously increase prey accessibility for short-eared owls.

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Acknowledgements

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1.0 Introduction

Short-eared owls (*Asio flammeus*) are a grassland-dependent species that contribute to the ecological significance of a region by providing diversity, nutrient cycling, and prey control of small mammals (Bentley and Demarchi 2005). In Delta, British Columbia, the essential wintering grounds for short-eared owls are old-fields, which have changed in the last 100 years due to urbanization, industrial development, and agriculture (Campbell et al. 1990). The alteration of habitat for short-eared owls in this region has partly resulted in the population decline of short-eared owls during the latter half of the 20th century (Holt and Leasure 1993). Short-eared owls are typically associated with open areas that support cyclic small mammal populations (Holt and Leasure 1993) such as Townsend's voles (*Microtus townsendii*)—the primary prey species for the short-eared owl in the Lower Mainland, and an important indicator species for proper grassland vegetation composition and habitat structure (Merkens 2005).

Grassland set-asides are an agricultural crop-rotation that is seeded with a mixture of grasses such as orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), tall fescue (*Festuca arundinacea*), clovers (*Trifolium* spp.), creeping red fescue (*Festuca rubra*), and chewing's fescue (*Festuca rubra commutata*), and are left to grow for a number years. Besides the agricultural values of set-asides for ameliorating soil erosion, improving water quality, and controlling crop overproduction (Delta Farmland and Wildlife Trust 2008), they have also been documented to produce wildlife benefits on landscape and regional scales (Gorman and Rogers 1995, Avundo et al. 2000, Buskirk and Willi 2004). Since they emulate natural grassland habitats, set-asides in Delta host a large population of Townsend's voles, and serve as wintering habitat for short-eared owls (Campbell et al. 1990).

In regards to the conservation status of short-eared owls as a species-of-concern, there are few clear set-aside management criteria addressing their habitat enhancement. A primary factor affecting set-aside suitability as habitat for short-eared owls in both summer and winter is prey abundance (Wiggins 2008), and there may be a critical link in winter habitat preference of short-eared owls and availability of Townsend's voles as a food source (Beauchesne and Cooper 2004).

To determine the age-class of set-aside that provides the best prey availability, density, and accessibility for short-eared owls, the following objectives were conducted to:

1. apply mark-recapture sampling methods to quantify absolute abundance of Townsend's voles in three set-aside age-classes: 2-year-old, 3- to 4-years-old, and old-field (greater than 5-years-old), and individual fields;
2. measure flight durations of short-eared owls within the three set-aside age-classes and individual fields using point count sampling;
3. find a logical correlation between flight durations of short-eared owls and densities of Townsend's voles;
4. find a possible explanation between variations in densities of Townsend's voles and flight duration of short-eared owls along with variations in vegetation characteristics.

We hypothesize a higher density of Townsend's voles in older set-asides. Due to the importance of Townsend's voles as prey for short-eared owls, higher owl activity was also expected in older fields.

2.0 Study Area

Fields were located in the Delta region of the Lower Mainland, in the municipalities of Ladner and Tsawassen, British Columbia, Canada (Figure 1). The region is approximately 3 m above sea level. Mean annual temperature for the region ranges from 8.8°C to 10.5°C, and is located in the CDFmm biogeoclimatic subzone (Green and Klinka 1994). Mean annual precipitation for the region ranges between 636 mm and 1263 mm (Green and Klinka 1994). Delta has a population of approximately 103,000 people, and is located 27 km south of Vancouver and 22 km north of the US border.

The three 2-years-old set-asides (Appendix II) and three 3- to 4-years-old set-asides (Appendix III) in this study were managed and selected by the Delta Farmland and Wildlife Trust, and the four old-fields (Appendix IV) were located in Boundary Bay Regional Park, managed by the Metro Vancouver Regional District (Figure 2). Permission was granted to the Delta Farmland & Wildlife Trust to include old-fields in this study (Appendix I).

3.0 Methodology

Representative winter vegetation characteristics were obtained by averaging two vegetation analyses that were conducted in October, 2009 during the 2-week period prior to trapping and again in March, 2010, after the completion of trapping. Vegetation was sampled using transects consisting of ten 50 cm X 50 cm quadrats which were spaced at 25-m intervals. Directions of transects were determined by intercepting the field at the greatest possible length to obtain

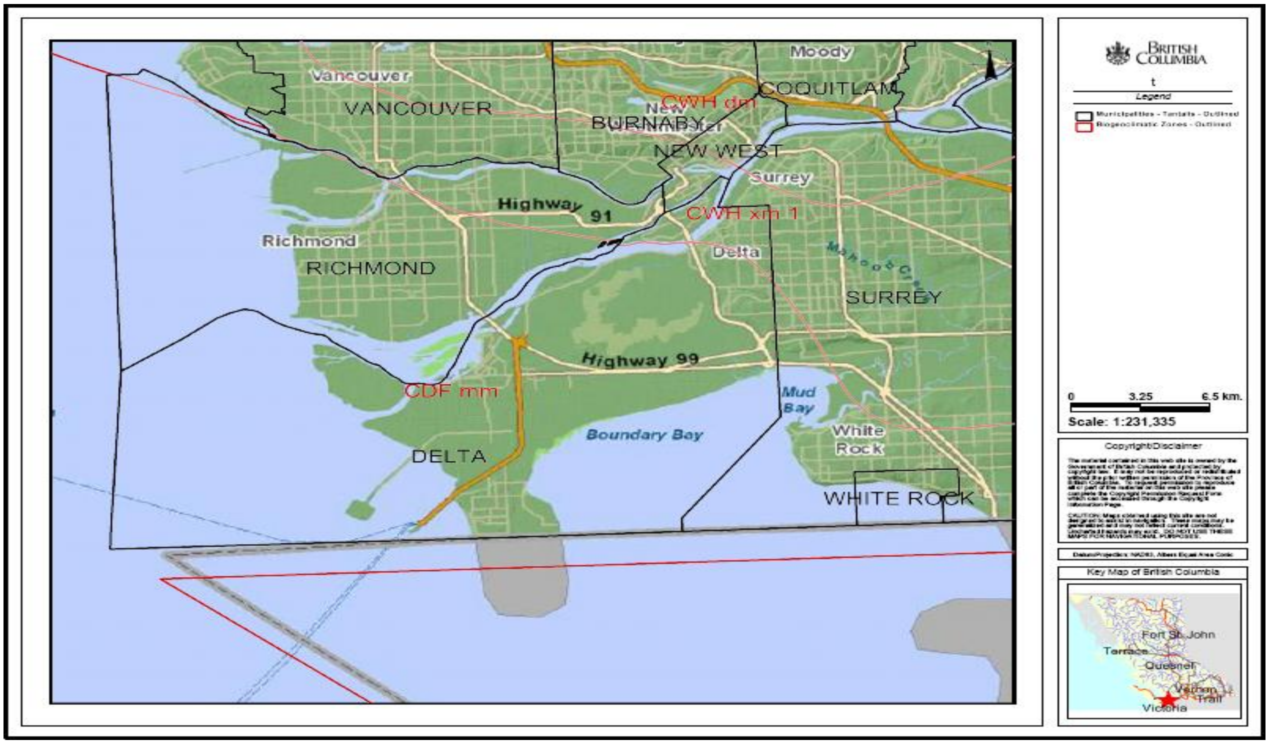

Figure 1. Delta is located at the mouth of the Fraser River, British Columbia, Canada, in the CDFmm biogeoclimatic subzone.

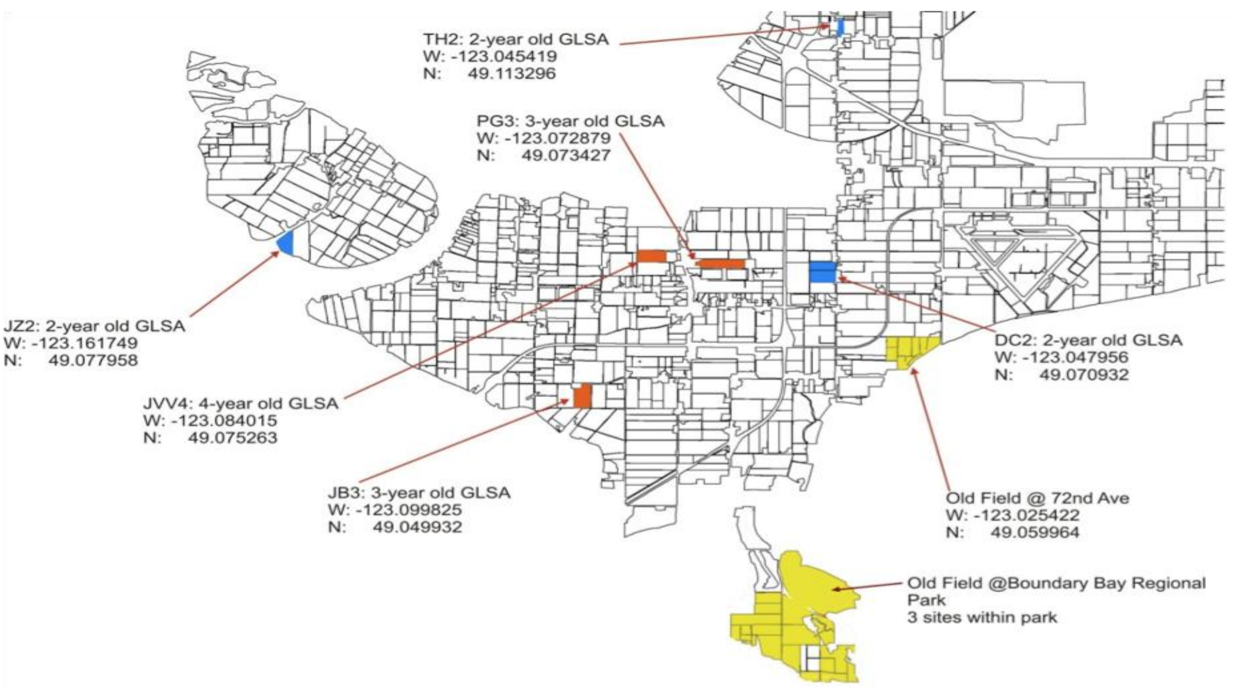

Figure 2. Six grassland set-asides and 4 old-fields (with UTM coordinates) were used to monitor Townsend's voles and short-eared owls in Delta, British Columbia, during winter of 2009-2010.

representative samples. In every quadrat, height of coarse grass, seedhead, clover, and thatch were measured, and percent cover of each was visually estimated. The grid design used for each field was a 5 X 5 grid of 25 Longworth traps, with 5-m intervals between trap stations. High-visibility flags were placed at every station. Positions of stations within the grids were designated with a combination of columns (A-E) and rows (1-5; Figure 3). GPS coordinates were used to determine the location of station A1 for each field. The grid design used for this study was modified from RISC standards (Ministry of Environment, Lands, and Parks 1998).

From November 4th, 2009, trapping surveys were conducted once a week and divided into 3-week intervals, designated as weeks 1, 2, and 3. Fields surveyed on week 1 were JVV4, PG3, OLD72, DC2, and TH2; fields surveyed on week 2 were OLD#1, OLD#2, OLD#3, JB3, and JZ2; week 3 was used for data compilation. Over the course of this study, each field was trapped six times. All traps were pre-baited for a 2-week period prior to the commencement of trapping, and each trap during this period was deactivated, supplied with a handful of oats, and sheltered with a wood coverboard.

On each trapping day, all traps were set between approximately 7:00 am and 9:00 am, checked for small mammals, and disabled between approximately 2:00 pm and 4:00 pm. Total trapping time for all traps was 5 to 6 hours. Traps were baited with oats, filled with an appropriate amount of cotton, and covered with wood coverboards to protect the animals. One overnight trapping was conducted to confirm presence of other small mammals on field DC2.

The station number, tag number, species, weight, sex, and breeding condition of each captured Townsend's vole were recorded. The station number of each captured shrew (*Sorex* spp.) was recorded. Newly captured Townsend's voles were tagged with serially numbered National Band and Co. ear tags on the right ear using pliers, and tag numbers of recaptured voles were recorded. In the case of a rip in the right ear, a new tag was applied to the left ear, and the animal was recorded as a recapture. Data was carefully analyzed to determine which previously tagged individual was subject to tag loss. Species were identified with a field guide (Nagorsen 2005), and weights were measured using a Pesola scale to the nearest gram. Sex was observed as male (M) or female (F), and breeding condition for each gender was identified. Reproductive and non-reproductive conditions for males were classified as having scrotal (S) or abdominal (A) testes, and for females as having large (L) or small (S) nipples.

Starting on November 28th, 2009, short-eared owl surveys were conducted to coincide with small mammal surveys. Depending on light levels, surveys were conducted for half an hour before dawn and half an hour after dusk, according to the exact sunrise and sunset times provided by the Weather Network website. Five dawn surveys and five dusk surveys were conducted on each field for a total of five hours of observation per field. Using binoculars and stopwatch, duration of short-eared owl events, number of individuals, their behaviours, and time spent in the field were observed and recorded from a clear vantage point. Areas of fields were calculated by the Delta Farmland and Wildlife Trust with the use of a Geographic Information System (GIS; Table 1). Upon identification of a short-eared owl, specific codes were used to classify behaviours exhibited during an event: F (flying), R (resting), FR (flight from resting), and RP (resting on pole/branch). Time for each observed behaviour was recorded to the second. Presence of any other raptors events was counted.

MNA (minimum number known alive) adjustment was used for analyzing Townsend's vole multiple-recapture data. To investigate the effects of vegetation characteristics on densities of Townsend's voles and mean flight durations of short-eared owls, Pearson Correlation in the Statistical Package for the Social Sciences (SPSS) computer program was used. ANOVA was applied to test the difference of vegetation characteristics in age-classes, and *t*-tests were used to test the difference of mean densities of Townsend's voles and short-eared owls in age-classes. All standard errors were calculated with a α=0.05.

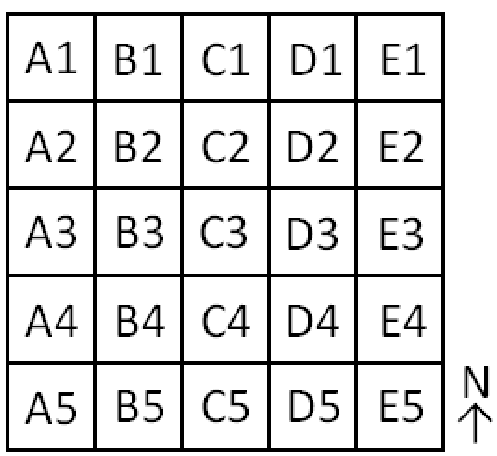

Figure 3. Grid design includes 25 stations at 5-m intervals oriented northerly, to monitor Townsend's voles in 10 fields in Delta, British Columbia, during winter of 2009-2010.

Table 1. Sizes of 10 fields used to monitor Townsend's voles and short-eared owls in Delta, British Columbia, during winter of 2009-2010.

Field	DC2	JZ2	TH2	JB3	PG3	JVV4	OLD#1	OLD#2	OLD#3	OLD72
Size (ha)	5.3	6.1	4.0	7.1	11.7	8.1	2.9	3.4	2.1	8.1

4.0 Results

4.1 Densities of Townsend's Voles

Highest mean densities of Townsend's voles were found within old-fields at 145±36 voles/ha (*df*=3, $p<0.05$), and were found to be significantly different from 2-year-old fields ($t=3.72$, *df*=4, $p=0.01$) and 3- to 4-year-old fields ($t=5.12$, *df*=5, $p<0.01$; Figure 4). However, there was no significant difference between 2-year-old fields and 3- to 4- year-old fields ($t=0.11$, *df*=4, $p>0.05$); mean density of 2-year-old fields was 45±42 voles/ha (*df*=2, $p<0.05$), and 43±24 voles/ha (*df*=2, $p<0.05$) for 3- to 4-year-old fields.

Old-fields were found to have the highest mean densities of voles ranging from 187±36 voles/ha (*df* =5, $p<0.05$) in OLD#2 to 112±32 voles/ha (*df* =5 $p<0.05$) in field OLD#3, which despite being the lowest among old-fields, was still higher than any other site in other age-classes (Figure 5). Three- and 4-year old sites displayed mean densities that ranged from the highest found in field PG3 at 67±27 voles/ha (*df* =5, $p<0.05$) to 27±17 voles/ha (*df* =5, $p<0.05$) in field JVV4. Among 2-year-old fields, JZ2 and TH2 were found to have slightly over 60 voles/ha, although a huge discrepancy was displayed in field DC2 which had only 3±5 voles/ha (*df* =5, $p<0.05$).

4.2 Flight Durations of Short-eared Owls

Old-fields had the longest mean flight durations of short-eared owls at approximately 2.0±2.0 min/10 ha (*df* =3, $p<0.05$), and were found to be not significantly different from 3- to 4-year-old fields ($t=0.32$, *df*=5, $p>0.05$), which had mean flight durations of short-eared owls of approximately 1.5±1.7 min/10 ha (*df* =2, $p<0.05$; Figure 4). Two-year-old fields had the shortest mean flight durations of short-eared owls with less than 0.1±0.1 min/10 ha (*df* =2, $p<0.05$) (Figure 7), and they were found to be different from 3- to 4-year-old fields ($t=1.73$, *df*=4, $0.1>p>0.05$) as well as old-fields ($t=1.59$, *df*=5, $0.1>p>0.05$).

Field OLD#3 had the longest mean flight duration of short-eared owls out of any field at 4.9±5.8 min/10 ha (*df* =9, $p<0.05$) which was at least twice as long as any other old-field, although other old-fields generally had longer mean flight durations than fields in other age-classes (Figure 5). The exception for longer mean flight durations of short-eared owls in old-fields was field OLD#1, which was 0.1±0.1 min/10 ha (*df* =9, $p<0.05$).

Among 3- to 4-year-old fields, JB3 had the longest mean flight duration of short-eared owls at 3.1±2.5 min/10 ha (*df* =9, $p<0.05$) which had one of the longest flight durations among all fields.

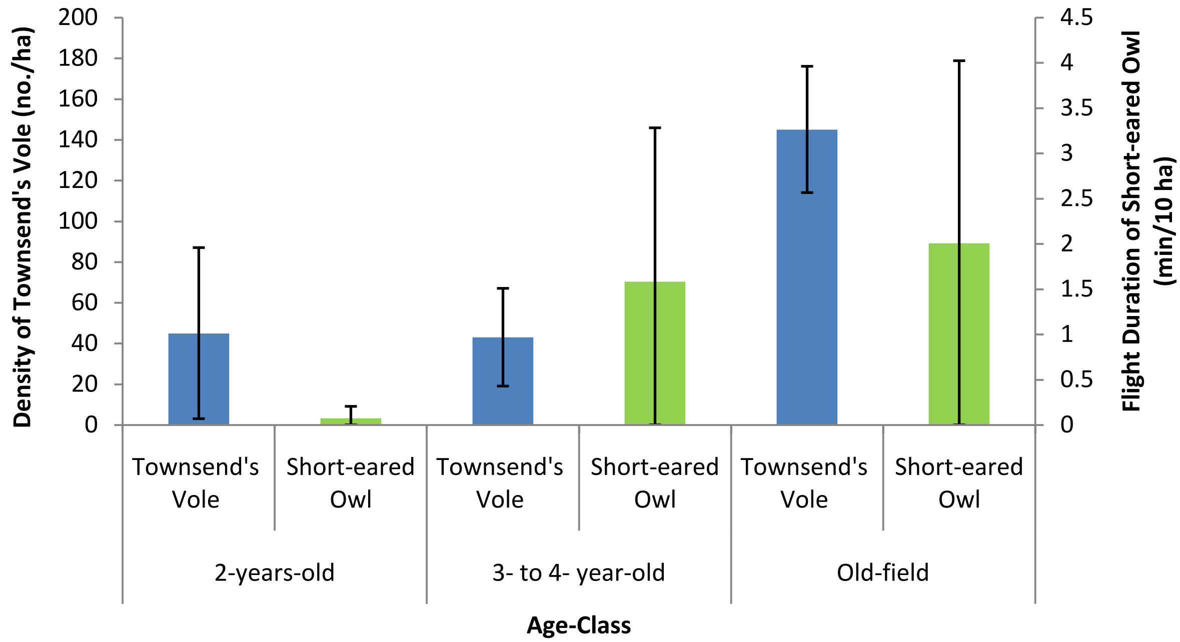

Figure 4. Mean (± SE) densities of Townsend's voles and mean (± SE) flight durations of short-eared owls in 10 fields categorized into 3 age-classes, in Delta, British Columbia, during winter of 2009-2010.

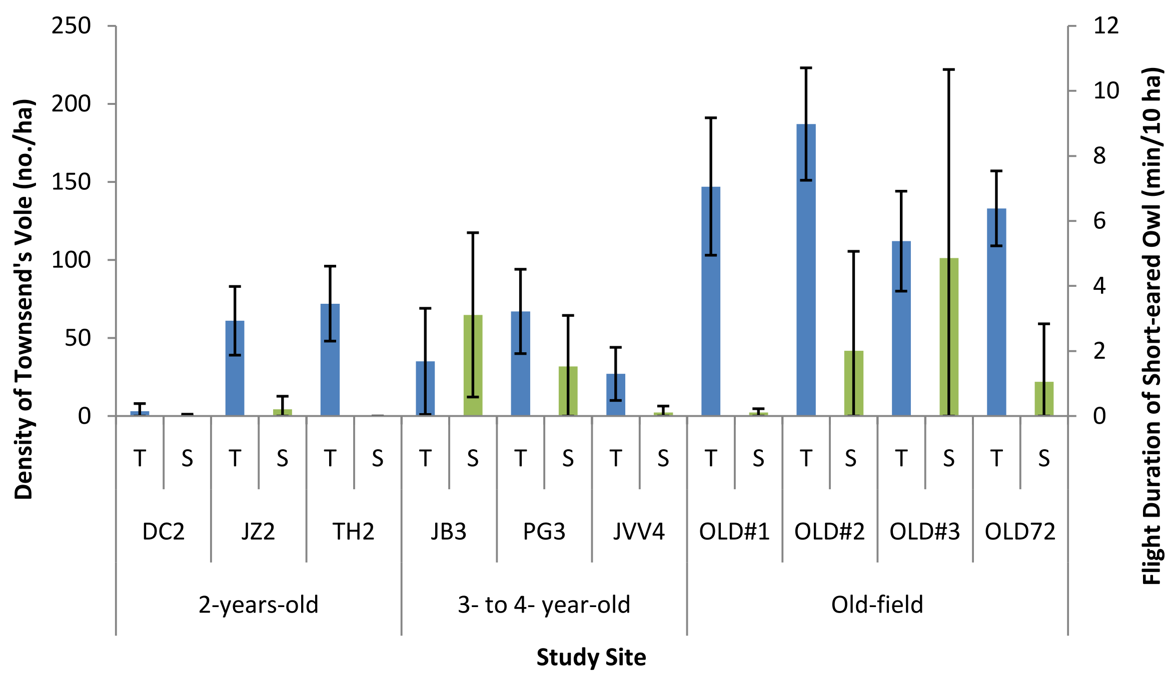

Figure 5. Mean (± SE) densities of Townsend's voles (T) and mean (± SE) flight durations of short-eared owls (S) in 10 fields, in Delta, British Columbia, during winter of 2009-2010.

On the contrary, field JVV4 had a minimal flight duration compared to other fields in this age-class at 0.1±0.2 min/10 ha (*df* =9, $p<0.05$). Field PG3 showed shorter flight duration than field JB3, but still a much longer flight duration than any 2-year-old fields. The longest mean flight duration of short-eared owls among 2-year-old fields was observed in JZ2 at 0.2±0.4 min/10 ha (*df* =9, $p<0.05$), which was slightly longer than the shortest duration among 3- to 4-year-old fields. No observations were recorded in field TH2, and field DC2 had the shortest duration of recorded flight with less than 0.1 min/10 ha (Figure 8).

4.3 Vegetation Characteristics

Vegetative characteristics of age-classes were not significantly different in coarse grass percent cover (F=0.74, *df*=2,7, p=0.51), coarse grass height (F=1.12, *df*=2,7, p=0.38), clover percent cover (F=2.66, *df*=2,7, p=0.14), and seedhead percent cover (F=0.37, *df*=2,7, p=0.70); vegetative characteristics of age-classes were significantly different in clover height (F=6.01, *df*=2,7, p=0.03), seedhead height (F=4.81, *df*=2,7, p=0.05), thatch percent cover (F=10.10, *df*=2,7, p=0.01), and thatch height (F=5.67, *df*=2,7, p=0.03; Figure 6).

A significant negative correlation was found between age-class and clover percent cover (r=-1.00, *df*=2, $p<0.01$) as well as clover height (r=-0.99, *df*=2, $p<0.01$). A significant positive correlation was found between age-class and thatch percent cover (r=1.00, *df*=2, $p<0.01$) and an insignificant positive correlation with thatch height (r=0.72, *df*=2, $p>0.05$; Figure 7).

Two-year-old fields were found to have the lowest mean percent cover of thatch with 40.9±55.0% (*df*=1, $p<0.05$), and a mean thatch height of 5.2±8.0 cm (*df*=1, $p<0.05$), which was among the lowest (Table 2). Three- to 4-year-old fields had a mean percent cover of thatch of 72.7±19.1% (*df*=1, $p<0.05$),which was greater than that found in 2-year-old fields, but 3- to 4-year-old fields had a mean thatch height of 4.7±2.4 cm (*df*=1, $p<0.05$) that did not differ greatly from that found in 2-year-old fields. Old-fields had the greatest percent covers of thatch with 88.2±2.0% (*df*=1, $p<0.05$) and more than twofold increase of thatch height compared to 3- to 4-year-old fields with 13.1±6.2 cm (*df*=1, $p<0.05$).

4.4 Correlation among Vegetation, Townsend's Voles, and Short-eared Owls

Comparison of mean flight durations of short-eared owls and mean densities of Townsend's voles indicated a positive relationship of low significance (r=0.66, *df*=1, $p>0.05$) and this same comparison among individual fields also displayed a positive relationship of low significance (r=0.24, *df*=8, $p>0.05$; Figure 8).

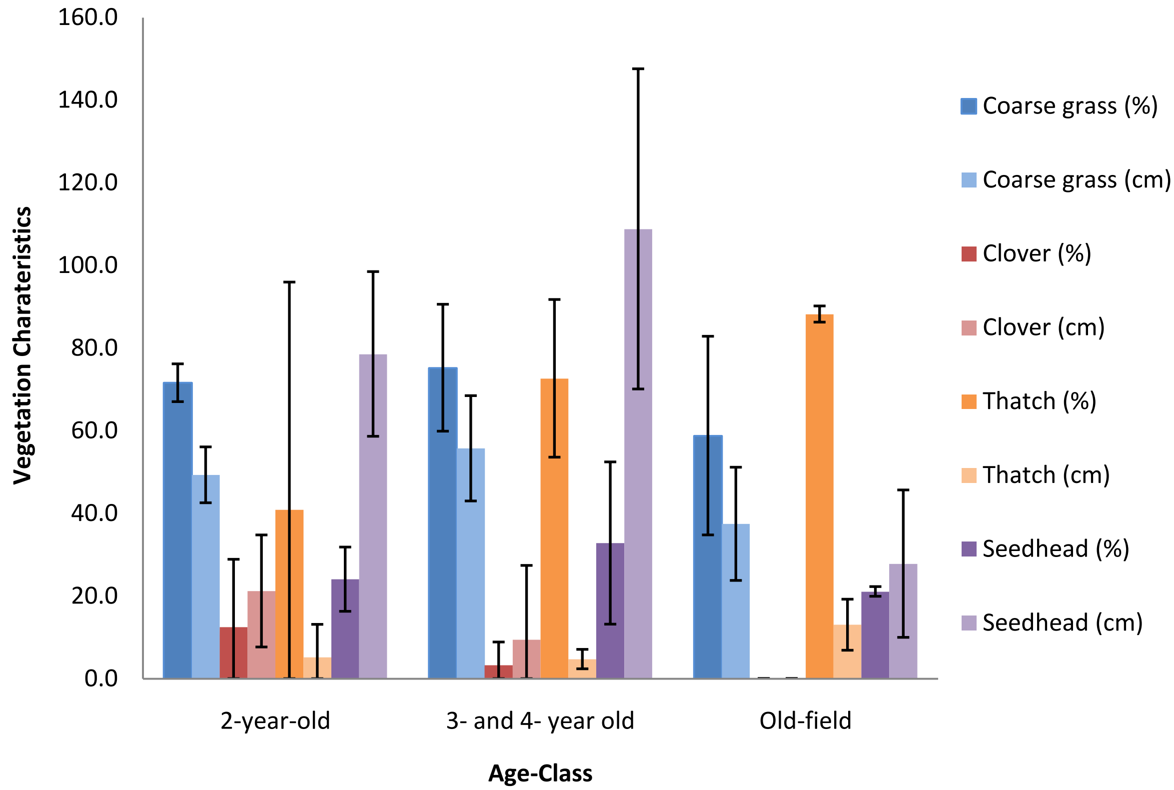

Figure 6. Mean (± SE) vegetative characteristics in 10 fields, in Delta, British Columbia, during winter of 2009-2010.

Table 2. Mean (± SE) percent cover and height of each vegetation group sampled pre- and post-trapping, in 10 fields used to monitor Townsend's voles in Delta, British Columbia, during winter of 2009-2010.

Age classes	Study sites	Coarse grass (%)	Coarse grass (cm)	Clover (%)	Clover (cm)	Thatch (%)	Thatch (cm)	Seedhead (%)	Seedhead (cm)
2-years-old	DC2	78.4±35.2	54.7±24.6	0.8±0.4	11.3±5.1	25.8±11.6	2.0±0.9	45.5±20.5	122.2±54.9
	JZ2	85.4±38.4	50.5±22.7	10.4±4.7	22.6±10.2	28.7±12.8	3.4±1.5	16.1±7.2	79.5±35.7
	TH2	51.1±23.0	42.8±19.2	26.2±11.8	29.8±13.4	68.3±30.7	10.2±4.6	10.7±4.8	34.1±15.3
3- to 4-year-old	JB3	79.3±35.6	59.7±26.8	1.8±0.8	5.8±2.6	73.3±32.9	2.7±1.2	46.5±20.9	146.2±65.7
	PG3	75.8±34.1	26.6±12.0	0.0±0.0	42.2±19.0	39.3±17.6	10.3±4.6	58.9±26.5	15.5±7.0
	JVV4	54.3±24.4	51.0±22.9	7.9±3.6	22.6±10.1	65.7±29.5	4.4±2.0	37.5±16.9	121.9±54.8
Old-field	OLD#1	76.4±34.4	73.9±33.2	0.0±0.0	0.0±0.0	96.6±43.4	18.0±8.1	6.0±2.7	34.8±15.6
	OLD#2	54.8±24.6	26.3±11.8	0.0±0.0	0.0±0.0	90.1±40.5	14.5±6.5	39.5±17.8	27.5±12.4
	OLD#3	33.3±15.0	23.4±10.5	0.0±0.0	0.0±0.0	82.5±37.1	10.8±4.8	4.1±1.8	8.6±3.8
	OLD72	70.8±31.8	26.3±11.8	0.0±0.0	0.0±0.0	83.8±37.7	9.0±4.0	34.9±15.7	40.5±18.2

A high correlation was found between estimated thatch covers and mean densities of Townsend's voles (r=0.73, df=8, p<0.01). The single most significant feature in vegetation characteristics was the strong relationship between thatch height and mean density of Townsend's voles (r=0.88, df=8, P<0.01). An increase in thatch height generally showed a respective increase in vole density. Due to the high level of fluctuation in other vegetative characteristics with mean densities of Townsend's voles, no other significant relationships were discerned.

A negative correlation was found between mean flight durations of short-eared owls and percent covers of coarse grass (r=-0.41, df=8, p>0.05) as well as for coarse grass height (r=-0.47, df=8, p>0.05). All other vegetative characteristics were subject to high levels of fluctuation compared to mean flight durations of short-eared owls, with no other significant relationships determined.

Comparing trends of mean densities of Townsend's voles and mean flight durations of short-eared owls along with thatch cover indicated a positive relationship (r= 0.59, df=5, p>0.05) as thatch cover increased, although this positive relationship reached a threshold when thatch cover was approximately 80% (Figure 9). Further increase beyond this threshold for the positive relationship between mean flight durations of short-eared owls and mean densities of Townsend's voles resulted in a negative correlation (r=-0.45, df=2, p>0.05), with mean flight durations of short-eared owls decreasing as mean densities of Townsend's voles continued to increase and remained high.

Analogous to thatch cover, similar comparison of thatch height with trends of mean densities of Townsend's voles and mean flight durations of short-eared owls indicated a positive relationship between owl flight duration and vole density as thatch height increased to a threshold that was reached at roughly 11 cm (r= 0.40, df=6, p>0.05; Figure 10). Thatch heights greater than approximately 11 cm showed a negative relationship between mean densities of Townsend's voles and mean flight durations of short-eared owls (r= -0.56, df=1, p>0.05); vole densities continued to grow and maintain high numbers as owl flight durations plummeted with increasing thatch height.

5.0 Discussion

Our hypothesis of older set-asides favouring higher densities of Townsend's voles was supported by our results. There was a significantly higher vole density found in old-fields compared to other age-classes, which were found to parallel the results of Avundo et al. (2000), as well as the results of Schwartz and Whitson (1987) in reconstructed tallgrass prairies.

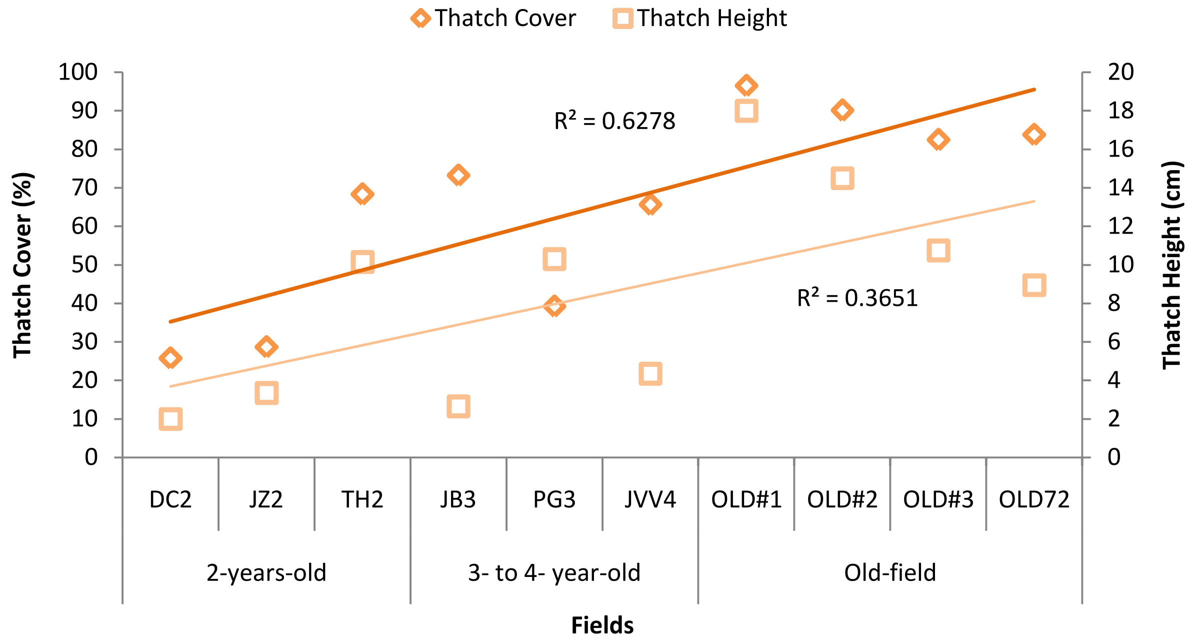

Figure 7. Relationship of mean thatch cover and mean thatch height in 10 fields categorized into 3 age-classes, in Delta, British Columbia, during winter of 2009-2010.

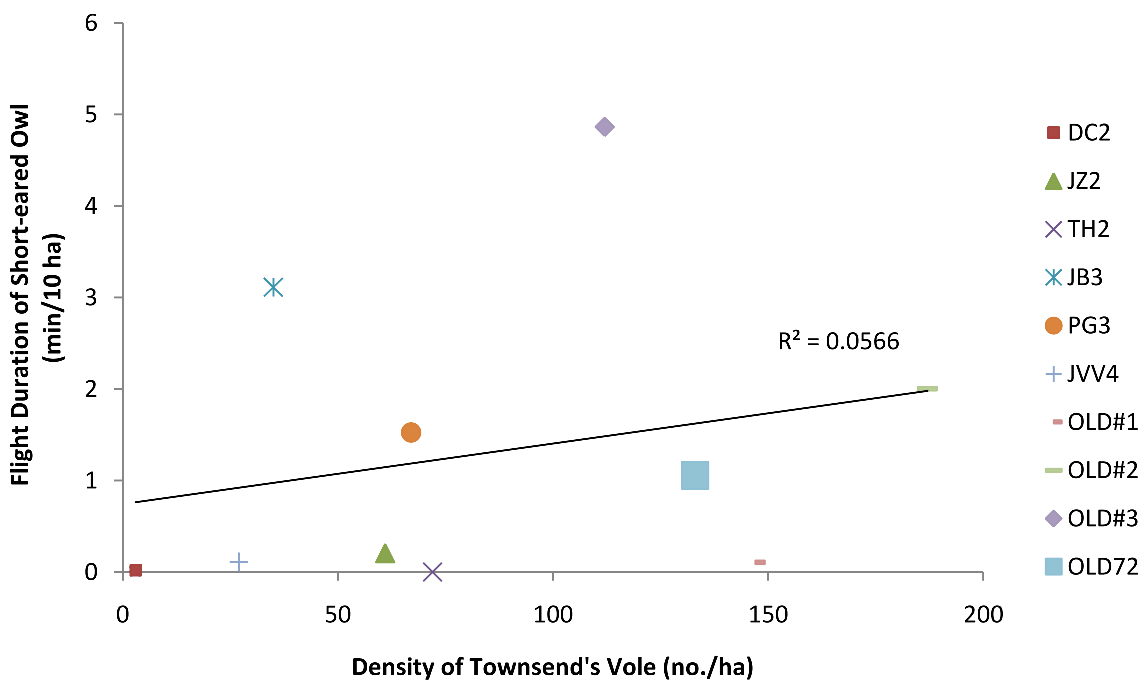

Figure 8. Relationship of mean flight durations of short-eared owls to mean densities of Townsend's voles in 10 fields, in Delta, British Columbia, during winter of 2009-2010.

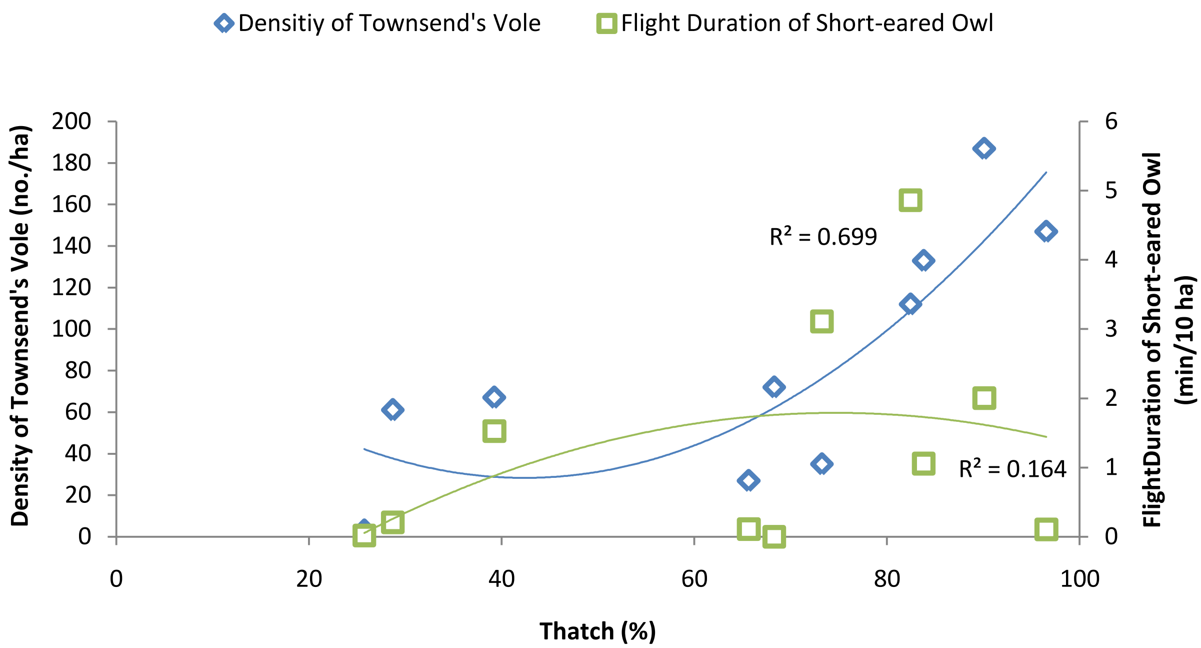

Figure 9. Relationships of mean densities of Townsend's voles and mean flight durations of short-eared owls along with mean percent covers of thatch sampled in 10 fields, in Delta, British Columbia, during winter of 2009-2010.

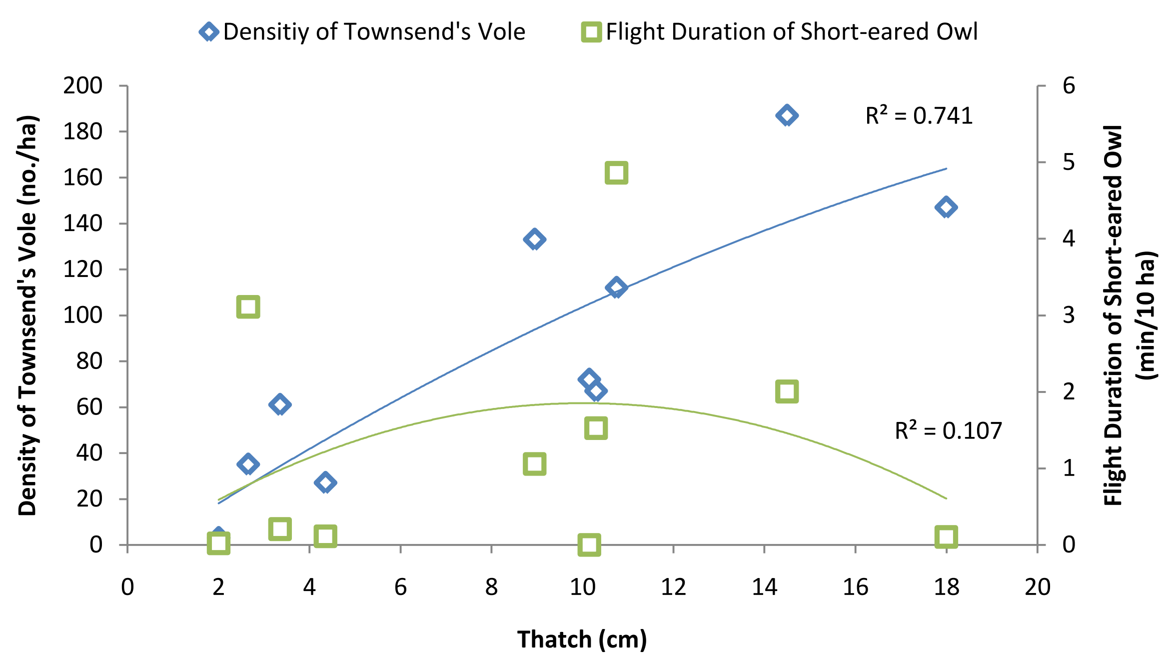

Figure 10. Relationships of mean densities of Townsend's voles and mean flight durations of short-eared owls along with mean thatch heights sampled in 10 fields, in Delta, British Columbia, during winter of 2009-2010.

Comparatively thicker and denser thatch found in old-fields was speculated to be a significant contributor to Townsend's vole abundance due to the possibility of providing them with thermal cover, a food source, and refuge from raptors (Keene 2009). Age-class was strongly associated with higher percent cover of thatch and nutrient levels through seasonal accumulation of decomposed and decomposing vegetation, and remains an indicator of the level of thatch found within a set-aside (Huntly and Inouye 1987). Set-aside age-class and Townsend's vole abundance did not appear to be directly related and may not always be beneficial as an indicator for suitability for Townsend's voles (Avundo et al. 2000). However, tall grasses would accumulate thicker thatch over a greater period of time and greater nutrient load through the decomposition of accumulated vegetation, which was considered a predictor of small mammal density including *Microtus* (Huntly and Inouye 1987).

Researchers have indicated that short-eared owls in Delta, British Columbia, have been found to prefer old-field habitats (Campbell et al. 1990); our hypothesis that old-fields were favoured by short-eared owls has been confirmed by the results, which also indicated a relationship between Townsend's vole density and short-eared owl activity. Short-eared owls were known to be prey specialists of primarily *Microtus* (Clark 1975). Short-eared owl activity was strongly associated with vole abundance, displaying occupancy and maintenance of winter territory that was most prominent with high vole abundance (Village 1987). Furthermore, habitat choice was highly influenced by food abundance (Wiggins 2008). Typical north-south winter migration of the short-eared owl was suggested as following vole populations with sufficient winter survival (Clark 1975).

Despite prevalence of voles indicating presence of short-eared owls, their activity was higher in habitats with low vegetation cover than any other habitats measured. An increase in vegetation cover, specifically thatch, corresponded to a decrease in short-eared owl activity, and this relationship has been found to be similar in other avian predators of voles (Bakers and Brooks 1981, 1982). Although avian predators concentrated search efforts in areas of high prey density, increased prey density may not necessarily indicate increased raptor activity. This relationship was not found statistically significant in the results of our study, but a biological trend of the dynamics among the two species with thatch characteristics was clearly demonstrated. Prey accessibility has been suggested as a determining factor for avian hunting effort in an area, with the ability to detect and capture prey being decreased in areas of greater vegetation cover (Bakers and Brooks 1981). The threshold for the positive relationship of mean densities of Townsend's voles and mean flight durations of short-eared owls compared to increasing thatch cover and height indicated the importance of prey abundance in relation to short-eared owl activity. However, as thatch cover and height exceeded this threshold for the positive correlation of mean flight durations of short-eared owls and mean densities of

Townsend's voles, the two species became negatively correlated and indicated the importance of prey accessibility for short-eared owl activity.

6.0 Recommendations

Continuous monitoring of study sites as well as sufficient replicates is recommended for future studies in order to obtain a sample size that would generate statistically significant relationships among short-eared owls and Townsend's voles with vegetation characteristics.

With increased set-aside age, there is a closer resemblance to natural grassland ecosystems and a higher preferrence by associated wildlife, therefore management implications for early stages of set-aside should be focused on providing habitat for wildlife, if habitat enhancement for wildlife is an objective. Acceleration and establishment of vegetation structures that provide ideal habitat for Townsend's voles would be advantageous for other species because of their value as prey and as an indicator species.

In regards to the preference of thatch as habitat for Townsend's vole and short-eared owl activity in areas of low vegetation cover, stratified mowing in strips is recommended. Strip mowing would create a thatch layer that would increase Townsend's voles abundance, while simultaneously providing adjacent areas of low vegetation cover that would increase short-eared owls accessibility to their prey.

Invasive species such as reedcanary grass spread at an unprecedented rate, and can become a predominant species in set-asides and old-fields. As with any naturally occurring ecosystem in British Columbia, invasive species should be closely monitored to avoid infestation.

7.0 Reference

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Appendix I. Trapping Permits

metro vancouver

RESEARCH PERMIT

YEAR 2009

APPLICANT INFORMATION

First Name: DAVID Last Name: BRADBEER
Organization: Delta Farmland & Wildlife Trust
Address: 205 - 4882 Delta Street
City: Delta Prov.: BC P.C.: V4K 2T8
Tel. #: 604-940-3392 Fax #: 604 - 946 - 7820
Other Contact: Doug Ransome (BCIT) Contact Tel.#: 604-431-4985

RESEARCH INFORMATION

Type of Research: Small mammal & Raptor monitoring # of Researchers: max 5 (Avg. 3)

Purpose:
Quantify availability of small mammals & relate to abundance of SEOW

Method:
• 25 Longworth style live traps in 25m grid (5x5). Traps baited in early Oct and set starting in late Oct. Trapping every 3 weeks until March. Small mammal id, weight, sex, breeding condition recorded. Mammals (except shrews) tagged with serialed ear marker. Raptor surveys every 3 weeks (observer in field).

After-hour requirements ☒ No ☐ Yes

# of days required to complete research: 16 Date(s) of Visit: Oct 7, 14, 28; Nov 9, 18, 25; Dec 9, 16, 30; Jan 4, 16, 25; Feb 8, 15; Mar 1, 8

PARK INFORMATION

Parks: Boundary Bay Regional Park
Specific Location: Old field site @ 72nd Ave; Wildlife Management Area

GENERAL CONDITIONS

1. Researchers must comply with Metro Vancouver (MV) Parks' rules and regulations.
2. Research must be conducted during park hours only; or comply with after-hours guidelines noted in this permit.
3. All flagging or marking materials must be inconspicuous, kept to a minimum and removed when the research is completed. If flagging tape must be used, it should be dated and initialed to ensure that it remains in place for the duration of the research.
4. A report summarizing the research and its findings will be submitted to MV Parks.
5. While conducting research, researchers will respond to inquiries from park visitors in a friendly manner so that they are informed about the research and its importance, and understand that the impacts on the park are minimal.
6. Researchers will be a resource for MV Parks in the development of educational/ interpretive programs that highlight the findings of the research.
7. Researcher safety must comply with WCB guidelines.

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Appendix I. Trapping Permits

SPECIAL CONDITIONS

Trapping grid locations to be subject to MV guidance and approval.
No overnight trapping.
All trap mortalities to be collected and deposited into the Cowan Vertebrate Museum (UBC) if the museum is willing to accept specimens. MV is to receive a final report.

PERMIT PROCEDURES

1. Application must be received fourteen days prior to the date on which the research will begin.
2. Applicants must be 19 years or older. Groups must have adult supervision at all times.
3. A signed copy of this permit may be required to gain access to the research area and may be inspected by MV Parks staff and the public at any time.
4. This permit may be cancelled if:
   a) the permit holder fails to observe, perform or keep his/her agreements under this permit;
   b) the permit holder has willfully misrepresented information in the application process which led to the granting of this permit;
   c) the permit area is damaged or destroyed; or
   d) the park is closed by MV Parks.

WAIVER OF LIABILITY

In consideration of being permitted to use certain lands and premises owned by or under the control of the Metro Vancouver known as Regional Park(s) (the premises) and other good and valuable consideration, the undersigned agrees: To save harmless and indemnify the Metro Vancouver and their directors, officers, servants, employees and agents (the "Indemnified Parties"") from and against all actions, claims, demands, proceedings, suits, losses, damages, costs and expenses of whatsoever kind or nature (including without limiting the generality of the foregoing, in respect of death, injury, loss or damage to any person or property) arising in any way out of or connected with the use of the Premises by the undersigned (the "Users") notwithstanding that the same may have been caused by or contributed to by the negligence of any or all of the Indemnified Parties.

I, David Bradbeer, being the duly designated representative, hereby indicate that I have read and understand the terms of this Research Permit and the Waiver of Liability as it appears above.

Signature: [signature] Date: Sept 24 2009

APPROVAL

Name: Markus Merkens Signature: [signature]

Permit Issued Date: Sept. 30, 2009 Permit Expiry Date: April 30 2010

Mail to: Metro Vancouver Regional Parks, West Area
4330 Kingsway, Burnaby, B.C., V5H 4G8
Tel: 224-5739 Fax: 224-5841

Hand Deliver to: Metro Vancouver Regional Parks, West Area
4915 West 16th Avenue, Vancouver, B.C.
Tel: 224-5739 Fax: 224-5841

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Appendix II. Photographs of 2-year-old set-asides: TH2 (a), JZ2 (b), DC2 (c)

(a)


(b)


(c)


Appendix III. Photographs of 3- to 4-year-old set-asides: JVV4 (a), JB3 (b), PG3 (c)


(a)


(b)


(c)

Appendix IV. Photographs of old-field set-asides: OLD#1 (a), OLD#2 (b), OLD#3 (c), OLD72 (d)

(a)

(b)

(c)

(d)