Passerine Bird Communities of Northern Calvert Island: Patterns of Diversity Caused by Location

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Abstract. Our group to examine changes in the diversity of passerine bird communities over different types of habitats. The point-count method was used to observe patterns of diversity within three distinct habitat locations: tundra, forest, and forest edge. After performing several multivariate analyses our results revealed that for our research there were in fact three distinct bird communities between the three locations surveyed. Our results showed that the Dark-eyed Junco (*Junco hyemalis*), Golden-crowned Kinglet (*Regulus satrapa*),Townsend's Warbler (*Dendroica townsendi*), and Swainson's Thrush (*Catharus ustulatus*) were the highest contributors to the differences between locations.

Keywords

Central coast, forest, edge, low tundra, point-count method

Introduction

British Columbia is a unique and biodiverse region of Canada, with a greater diversity of vascular plants, breeding birds than any other province or territory in Canada. Birds are the largest vertebrate group in the province containing 353 species. Not only is British Columbia rich with species diversity, containing approximately 50,000 different species without including single celled organisms, but there are a large number of different ecosystems that exist in the province. British Columbia has several biogeoclimactic ecosystem zones, which are large areas of land where both climate and vegetation is comparable. Along the coast there are a few different zones, one of which is the Coastal Western-Hemlock Zone (CWHZ) (Biodiversity BC, 2008).

The Great Bear Rainforest along the coast includes the CWHZ and contains large tracts of intact temperate rainforest; one-fifth of the world's temperate rainforest is located in British Columbia (Biodiversity BC, 2008). Calvert Island is within this unique landscape, comprised of old growth temperate rainforest as well as various ecological communities. These various ecological communities from tidal pools on beaches to forests of Western Redcedar (*Thuja plicata*) and Salal (*Gaultheria shallon)* contain a wide range of flora and fauna. Across the island while walking along the beaches or hiking up past the forest into tundra a variety of birds can be heard calling or singing.

There are well over 5000 identified species of passerine birds, also known as perching birds, that have spread across all continents and occupy almost all terrestrial ecosystems. The suborder Passeri also known as songbirds or oscines represents almost half of all current bird *species (*Ericson *et al*., 2003). The Biodiversity Atlas of British Columbia contains various maps of species richness in the province, one of which looks at richness for 142 perching bird species. Observations from 1961-2006 of perching birds show the species richness on Calvert Island was found to be 10-22, different species, richness varying on different parts of the island (Auston and Eriksson, 2009). A diverse number of birds could potentially be found on the coast such as Golden-crowned Kinglet (*Regulus satrapa)*, American Robin (*Turdus migratorius*), and Dark-eyed Junco *(Junco hyemalis)* that favour different habitats on Calvert Island. Bird diversity and abundance can differ depending on a variety of factors such as habitat. Calvert Island, contains a diverse range of ecological communities within close range of each other, allowing for the opportunity to study bird diversity in dissimilar habitats. With this in mind the answer to the following question is sought:

How will passerine bird diversity vary between three locations: temperate rainforest, beach edge temperate rainforest, and low tundra on Calvert Island?

Study Area

Temperate rainforest (F), beach edge temperate rainforest (E), and low elevation tundra (T) habitats were chosen as study areas in order to potentially observe a change in bird communities when habitat location is changed. F habitat consist of a mixed forest of

Red Alder (*Alnus rubra*), Western Hemlock (*Tsuga heterophylaa),* Western redcedar (*Thuja plicata),*and Sitka Spruce *(Picea sitchensis)* Approximately four different shrubs were seen grow in the forest habitat*,* with Salal *(Gaultheria shallon)* as the dominant species. Unlike F with a medium to high range of estimated vegetation height T has a vegetation height of Low to medium. No Red Alder or Western Hemlock is present in the T habitat. The dominant tree species at T area of study is Shore Pine (*Pinus contorta*), a species not present in the lower elevation sites, Yellow-cedar (*Chamaecyparis nootkatensis*) was another species not present in F or E. E sites also consisted of mixed stands of Sitka Spruce, Redcedar, Western Hemlock, and Red Alder. Shrub cover in E habitat had a greater diversity in species; however, the dominant shrub cover was still salal like the F habitat. All sites had differences in dominant tree species, composistion of trees and shrub cover. These vegetation differences helped each site meet the important criteria of being distinctly different habitats.

Criteria chosen for selecting study areas depends upon what variables are being controlled for and observed (Christie and Reimchen, 2008) (Garwood *et al.,* 2009); therefore, another criteria for choosing F,E, and T sites was close proximity to observers starting location. Reducing travel times for survey locations allows for a greater number of surveys to be completed each morning, reducing the number of survey days in turn reduces the possibility of a temporal bias caused by bird breeding seasons. However, the foremost criterion for site location was selecting habitats with clear differences.

Methods

Four point centers were established in the three study area locations. Each point center was placed a minimum of 150 m apart from each center point count (Wilson and

Comet, 1996). All survey sites were marked with flagging tape and labelled F, E, or T 1-4. Paths to sites removed from trails was also used, this allowed sites to be accessed with a minimum of disturbance when walking off trails to point center. GPS coordinates were also taken at each point center location. Point counts were placed a minimum of 150m away from the next closest point count center reduce the potential of over counting birds (Renfrew and Ribic, 2002), GPS was used to ensure the minimum distance between sites. F sites were placed a minimum of 50ms from the beach edge to prevent overlap with edge habitat. E sites were all located 30m in from the shrub and tree line along the beach to ensure that the sites remained within the edge habitat (Garwood *et al*., 2009). Along the selected beach, West Beach on Calvert Island, several cliffs are located with vegetation and tree cover that differs from vegetation on the beach edge. To prevent including a different habitat all E replicates were placed a minimum of 50ms away from cliffs on the beach edge (Renfrew and Ribic, 2002). T replicates were placed a minimum of 50ms above the stunted tree line, as well as each point center again being separated by 150ms.

A list of possible common and uncommon passerine birds in the region of Calvert Island was compiled from Central Coast check list from the British Columbia Bird Atlas as well as from information ascertained through the National Geographic Field Guide to Birds of North America. Observers then studied calls of birds believed to be in the area. Before surveying began observers underwent 10 days of training before observations in the field began (Christie and Reimchen, 2008), review of bird songs occurred before each day of observation .The website All About Birds created by the Cornell Lab of Ornithology was used as a key resource in learning bird calls before surveys began. Observers underwent distance training, learning to roughly estimate distance of birds from point center. All observations were done by Kali Gehringer and Heather Polowyk, before surveying practiced listening to bird calls with Brian Starzomski in order to reduce potential observer bias (Renfrew and Ribic, 2002).

All point counts were done between Dawn and 8:00 (PST). Observations began five minutes after arrival at point center location, surveys were all eight minutes in length during which observers would record species identified through song and approximate distance of bird from the centre point of a survey location (Christie and Reimchen, 2008) Distance sampling is an approximation, with several critical assumptions made when being preformed such as birds will be observed at their initial locations and all birds in the 50 m survey circle will be detected (Buckland et al., 2008). Distance sampling using transects has a lower bias and higher precision; however, point sampling to distance is preferable when transect lines may be adversely affected by factors such as moving through dense vegetation or over rough terrain (Buckland et al., 2008). Shorter intervals were more variable then 8 minute surveys (Savard and Hooper, 1995). Several studies range for length of point count.; with longer point counts leading to detection of individuals that are initially hard to detect (Wilson and Comet, 1996) It is important to note that longer point count increases chance of overestimation in abundance estimates due to movement of birds during observation time (Buckland et al., 2008).

E,T, and F each had four survey sites where observations occurred, with each site being surveyed twice. A total of twenty four surveys being completed in four survey days. F1-4 and E1-4 point center sites were to be preformed survey day one and T 1-4 point center sights were to be surveyed on survey day two. Surveys would then be repeated at each point center location a second time during survey days three and four. The orders of Surveys were then reversed on days three and four. If T1 was surveyed first in the morning and T4 last the order was reversed. However, no surveys were preformed during heavy rainfall, if rainfall became heavy on a survey day survey sites not yet visited were preformed on a later survey day, this is based (Christie and Reimchen, 2008) (Wang and Finch, 2002). No point center counts were completed if recreational use was occurring near the location during survey hours, point centres would be surveyed on later day when no recreation use is located near the survey location (Garwood *et al*., 2009); this is to minimize human disturbance on point centre counts.   There were a total of five survey days from June 15th to June 21st due to rainfall for several days and recreational use near E1 and E2. Kali Gehringer and Heather Polowyk completed all twenty four surveys of point centre counts and distance sampling. For the first two days of surveys Brian Starzomski accompanied Kali Gehringer and Heather Polowyk.

Vegetation Surveys

Vegetation surveys were performed at each replicate site within a week of starting bird surveys (Renfrew and Ribic, 2002) At each replicate site a surveyor set their compass due north (magnetic north), surveyors then ran transects 40ms from the point center running North, South, West, and East. One by One meter quadrates were placed along each transect at 20ms and 40ms. Within the quadrates shrub coverage was estimated, snags within a 5m radius of the quadrate were recorded, the species and estimated height of the two tallest trees within a 5m radius of the quadrate were recorded, and the overall vegetation height was classified as low, medium, or high (Christie and Reimchen, 2008)(Schwab et al., 2006)(Lindsey at al., 1958). Surveys were first performed by Kali Gehringer and Amy Hartzenberg to synchronize estimations of tree height, percent cover, and other vegetation estimations preformed by (Renfrew and Ribic, 2002). All vegetation surveys had Kali Gehringer and Amy Hartzenberg present for estimations, with Heather Polowyk recording the majority of estimations. While placing transects the compass was used approximately every 5m to insure transects were run in straight lines along the specified direction. With four transects per point center site and two quadrates per transects 96 quadrate estimations occurred.

Statistical Methods

Statistical tests used on data collected from bird surveys were done using PRIMER. The relationships and similarities between bird communities at different locations were shown using a Nonmetric Multidimensional Scaling (nMDS) method. The STRESS value of 0.19 reflects the level of accuracy in the nMDS map produced, when representing the rank order of similarities between site locations. An Anosim test was then used on data to see if sites are statistically different. Following a Simper test was then used to see which bird species were responsible for the pattern shown by the Anosim test and nMDS map. The patterns and results produced by nMDS, Anosim, and Simper methods are analyzed in the following section.

Results

During our training and collection days spent out in the field, we observed that there was high levels of diversity within the community structures among our three different locations. We were able to quantify our observations by utilizing the power of several multivariate analyses. The results from our analyses are encouraging and support our original idea that varying habitats have an effect on passerine bird communities.

We created the following bar graph, Figure 1.0, from our recorded observational data which was grouped together for each repeated location. It was a good starting point for us and put us in an early position to show that some species are undeniably more prevalent in some locations than others. The issue now was to prove that there was a significant difference between locations so that we could reject our null hypothesis.

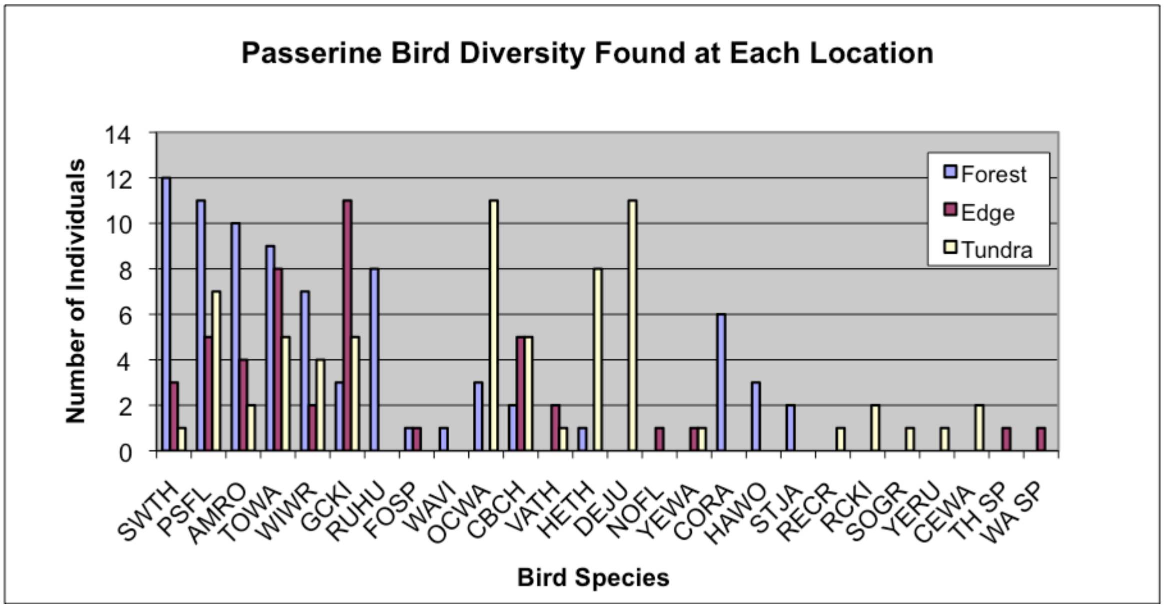

Figure 1.0

Various multivariate analyses were used to determine the actual structure of passerine bird diversity in order to interpret our main question that was constructed prior starting our research; we wanted to see if and how passerine bird community diversity changed within our three locations. In order to do this we began analyzing our data by utilizing an nMDS analysis. This particular analysis gives the user the ability to visualize the relationship similarties between samples. Upon conducting an nMDS test of our data collection (refer to Figure 1.1) we were able to interpret that there are similarities between and within each surveyed location.

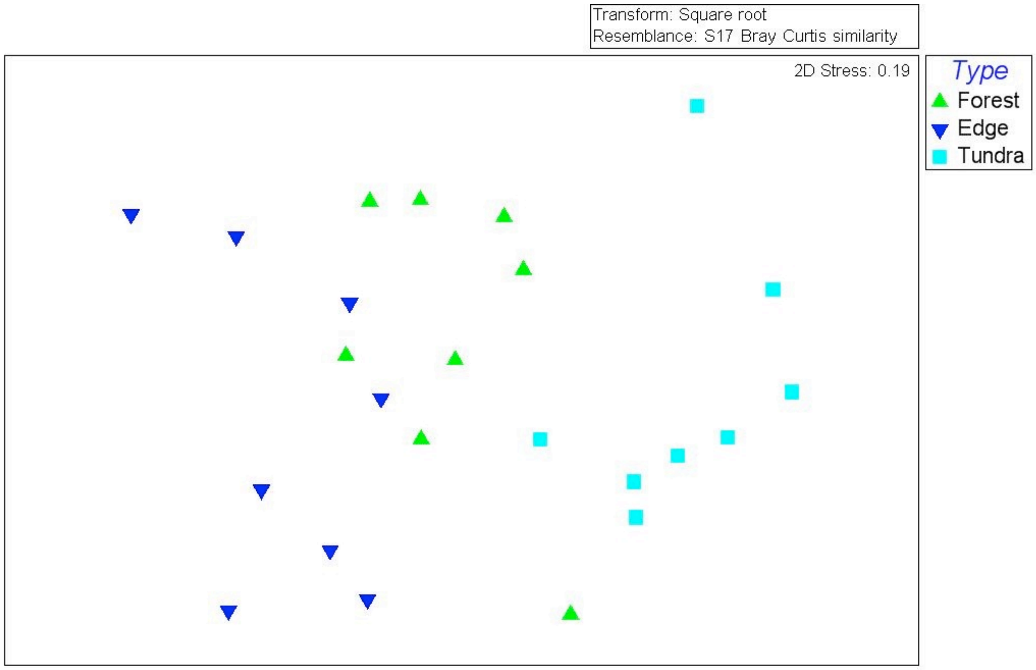

Figure 1.1: nMDS Analysis

Figure 1.1 demonstrates how the tundra has the least similarities when compared to both the edge and the forest locations. Though this analysis is valuable for visualizing the similarities between the sample communities, testing the significance value of these figures is crucial in order to properly interpret the results.

An ANOSIM test was developed to analyze the significance between the different groups. The idea is relatively simple, where if the assigned groups are meaningful, samples within groups should be more similar in composition than samples from different groups (PISCES Conservation Ltd., 2011).The calculated R-value was 0.619. This indicates that there is a strong similarity within the same groups at each different location.

To test for significance, similarity was ranked within and between groups then was compared with the similarity that would be generated by random chance (PISCES Conservation Ltd., 2011). Based on the results from the above analyses we expected to see evidence that the sample within groups were more similar than what would be expected by random chance. Statistics values are only considered significant if they have a p-value of < 0.05. This means that 1 out of 20 times the pattern will happen randomly; therefore, the lower the value the higher the significance level. Our significance value for the diversity of birds compared by differing locations is 0.01. This is an exciting find as it proves there is a direct correlation between the different locations and bird diversity.

We then used a SIMPER analysis to calculate similarity percentages and species contributions to each Location. This indicated what species were the most responsible for the community patterns that we saw. The following Tables 1.0-1.2 illustrate the top contributing percentage of passerine species that account for the similarity at each location. Using this data it is easy to compare the dominant species from one location to another. For example the Dark-eyed Junco *(Junco hyemalis*) was not found in the forest or edge habitat but was found in the tundra.

Group Forest

Average similarity: 46.41

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
AMRO	1.02	10.15	1.56	21.87	21.87
SWTH	1.04	8.87	0.90	19.11	40.98
PSFL	1.00	8.42	1.02	18.15	59.13
TOWA	0.89	7.01	1.03	15.11	74.24
RUHU	0.78	4.42	0.71	9.52	83.76
WIWR	0.66	2.92	0.50	6.30	90.06

Table 1.0

Group Edge					
Average similarity: 40.78					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
GCKI	1.14	21.53	6.23	52.79	52.79
AMRO	0.50	4.76	0.51	11.68	64.47
TOWA	0.70	4.66	0.50	11.43	75.89
PSFL	0.55	4.56	0.51	11.18	87.07
CBCH	0.48	2.42	0.34	5.92	93.00

Table 1.1

Group Tundra					
Average similarity: 49.31					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
DEJU	1.16	15.76	4.03	31.96	31.96
OCWA	1.07	11.76	1.61	23.84	55.80
HETH	0.85	7.56	1.03	15.34	71.14
PSFL	0.80	7.21	1.05	14.62	85.77
TOWA	0.55	2.72	0.51	5.52	91.29

Table 1.2

From this data we were also able to calculate and compare the contribution percentages between locations. For each of the following Tables (1.3-1.5) we only kept the top 5 species that contributed to the percent of dissimilarity. The Golden-crowned Kinglet (GOKI;*Regulus satrapa*) accounted for the biggest dissimilarity between the forest and the edge. The Dark-eyed Junco (DAJU; *Junco hyemalis*) accounted for the biggest dissimilarity between the forest and tundra, and between the edge and tundra.

Groups Forest & Edge

Average dissimilarity = 67.10

	Group Forest	Group Edge				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
GCKI	0.30	1.14	7.67	1.70	11.44	11.44
SWTH	1.04	0.38	7.44	1.19	11.09	22.53
TOWA	0.89	0.70	6.20	1.24	9.24	31.77
PSFL	1.00	0.55	6.07	1.24	9.05	40.82
RUHU	0.78	0.00	5.68	1.21	8.46	49.28
AMRO	1.02	0.50	5.26	1.08	7.83	57.11
WIWR	0.66	0.25	5.07	1.05	7.55	64.66
CORA	0.60	0.00	4.53	0.93	6.76	71.42
CBCH	0.25	0.48	4.33	0.88	6.45	77.87
HAWO	0.30	0.00	2.05	0.57	3.05	80.93
OCWA	0.30	0.00	1.98	0.56	2.95	83.88
STJA	0.25	0.00	1.86	0.57	2.77	86.64
FOSP	0.13	0.13	1.61	0.52	2.39	89.04
VATH	0.00	0.18	1.30	0.37	1.93	90.97

Table 1.3

Groups Forest & Tundra						
Average dissimilarity = 74.47						
	Group Forest	Group Tundra				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
DEJU	0.00	1.16	8.32	3.01	11.17	11.17
SWTH	1.04	0.13	7.09	1.35	9.52	20.69
OCWA	0.30	1.07	6.53	1.52	8.77	29.46
AMRO	1.02	0.25	5.92	1.38	7.95	37.41
HETH	0.13	0.85	5.45	1.38	7.32	44.72
RUHU	0.78	0.00	4.97	1.20	6.68	51.40
TOWA	0.89	0.55	4.80	1.13	6.44	57.84
WIWR	0.66	0.43	4.55	1.06	6.11	63.95
PSFL	1.00	0.80	4.46	1.08	5.99	69.95
CORA	0.60	0.00	3.96	0.93	5.31	75.26
CBCH	0.25	0.47	3.60	0.84	4.84	80.10
GCKI	0.30	0.00	2.20	0.54	2.96	83.06
HAWO	0.30	0.00	1.81	0.56	2.43	85.49
CEWA	0.00	0.25	1.78	0.56	2.39	87.88
STJA	0.25	0.00	1.62	0.56	2.18	90.06

Table 1.4

Groups Edge & Tundra

Average dissimilarity = 81.84

	Group Edge	Group Tundra				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
DEJU	0.00	1.16	10.35	3.14	12.65	12.65
GCKI	1.14	0.00	10.17	3.05	12.43	25.08
OCWA	0.00	1.07	9.31	2.20	11.38	36.46
HETH	0.00	0.85	7.16	1.55	8.75	45.21
TOWA	0.70	0.55	6.10	1.11	7.45	52.67
CBCH	0.48	0.47	5.47	0.98	6.68	59.35
PSFL	0.55	0.80	5.24	1.07	6.40	65.75
AMRO	0.50	0.25	4.47	0.96	5.46	71.21
WIWR	0.25	0.43	4.07	0.89	4.97	76.18
SWTH	0.38	0.13	3.67	0.79	4.49	80.67
VATH	0.18	0.13	2.25	0.53	2.75	83.42
CEWA	0.00	0.25	2.20	0.57	2.69	86.12
YEWA	0.13	0.13	2.01	0.52	2.45	88.57
RCKI	0.00	0.25	1.90	0.57	2.33	90.89

Table 1.5

Trying to determine how these results can be interpreted and discussed is important to applying these findings and characterizing what makes each habitat unique. We believe that a lot of the reasoning behind the change in diversity from each location varies with vegetation and several other factors. In the next section, Discussion, these tables are looked at more closely in order to explain why specific birds inhabit and account for more of a contribution to our results than others.

Patterns of Diversity: Edge and Forest; Forest and Tundra

Many studies have found a difference in relative abundance of bird species across various vegetation types (Willson and Comet, 1996). This is because birds have behavioural adaptations for utilizing habitat features like food resources and places to nest (Matsuoak et al., 1997). Townsend's warbler (TOWA; *Dendroica townsendi*) for example, prefers mature, coniferous or mixed forests through out its breeding range (Matsuoak et al. 1997). Territorial males especially prefer high densities of large spruce and lower densities of Alder (Matsuoak et al. 1997). This preference was reflected in our results as TOWA's were heard more commonly at our forest sites than at our edge sites. Swainson's thrush (SWTH; *Catharus ustulatus*), which is a major contributor to differences between both forest and edge and forest and tundra, are commonly found in mature mixed woods (Sibley, 2009). Furthermore, Shirley (2005) found that Swainson's Thrush abundance was positively related to the density of deciduous trees and negatively related to density of coniferous trees. Our study shows that SWTH was most common in forest habitats which could be considered mature mixed woods as the trial that dissects the forest allows Alder to take advantage of the edge and the conifers to grow in behind..

Patterns of Diversity: Edge and Tundra

The most significant difference in diversity occurs between the edge and the tundra. Several studies have found a strong correlation between the diversity of passerines and the amount of deciduous tree cover (Christie and Reimchen, 2008). The GOKI and the DAJU were mainly responsible for these differences. The edge sites consist of Western Hemlock, Red Alder and Sikta Spruce which are known to be favoured by GOKI (Christie and Reimchen, 2008; Sibley, 2003). Red Alder and Sitka Alder (Alnus crispa spp. sinuata) are the only deciduous trees found in our study area occurring in narrow bands along the edges of the path (for forest site) and the beach (for edge site) making it a perfect habitat for GOKI.

DAJU were only heard at the tundra sites. This could mean they prefer higher elevation habitat or low lying trees. Sibley (2003) states that DAJU's nest in mixed woods and prefer clearings or open coniferous areas for foraging (Easton and Martin, 1998). The low lying Shore Pine (Pinus contorta contorta) is sparse in most areas making it an ideal habitat for foraging.

<u>Overall Pattern of Diversity</u>

The diversity of passerines was highest in forest sites. This is likely due to the high diversity of tree species making appropriate niches for a variety of bird species.

The tundra sites had the second highest levels of biodiversity. Similar to the forest, the high diversity of trees likely played a role. Also the high density of snags are important for nesting of many species like the Chestnut-backed Chickadee (*Poecile rufescens*) which is a obligate cavity nester (Christie and Reimchen, 2008).

The edge sites had the least amount of species. Although tree diversity is still high, the disturbance level is probably too great for some species. Shirley (2005) also found that tundra sites have more diversity than edge sites. This was especially true when the high elevation site is undisturbed with high annual precipitation (Shirley, 2005). Our results are likely more skewed to lower diversity on the edge because 20m of each site was beach which would support no passerines.

It should be noted, however, that all sites had some overlap in tree species; cedar was found throughout each site, Alder at both forest and edge sites, etc. This is important because diversity is presumably higher at each location than if the stand was uniform (Willson and Comet, 1996). The average vegetation cover that was estimated in our surveys assumes uniform cover; however it is evident that though the tundra location seems isolated it is surrounded by non-stunted coniferous trees within 50 m of some sites.

Potential Errors and Bias

There is a myriad of evidence showing that point-count methods used for surveying birds have numerous factors that limit the ability of observers to achieve accurate results (Pacifici, Simons, and Pollock, 2008; Selmi and Boulinier, 2003). These factors include weather conditions, time of day, background noise, breeding phenology, and observer ability (Pacifici et al. 2008).

In our study we tried to make factors related to the weather as non-impacting as possible. We avoided collecting data on days of heavy rain or strong wind (Christie and Reimchen, 2008). We also tried to make the time of day have minimal affects on our results as each site was observed at alternate times; if forest site 1 was done first on day 1 it was done last on day 2. The most productive times of day are dusk and dawn. Doing our surveys during this time gave us a higher probability of detection a variety of species as well as achieving less variable data (Lynch, 1995).

Background noise varied from site to site but a general pattern occurred with the edge sites having the most noise and the forest sites having the least. The sound of the ocean likely had an affect on our ability to hear far away species, creating response errors or lack of recording a bird that is in the area (Thompson, 2003).

Breeding phenology, with one exception, likely skewed the data. Most passerines breed seasonally usually early May to beginning of July (Hahn, 1998; Starzomski, personal communication, June 23, 2011). This means that we likely missed the breeding season for several species. Furthermore, it is commonly believed that surveys carried out earlier in the breeding season have a high probability of identifying single species (Selmi and Boulinier, 2003). This is because territories have likely not been established yet making vocalizations more frequent and intense (Selmi and Boulinier, 2003). The songs and calls we did hear were relatively sharp and easy to recognize, however the frequency of songs could have been reduced. At several sites some birds would sing only once or twice and then stop for the rest of our collection time. It is possible we missed species that did this. The Red Crossbill (*Loxia curvirostra*) is the exception to seasonal breeding as they are known to breed all year round (Hahn, 1998). It is believed that their primary cue is related to food supply and not seasonal weather. We heard only one Red Crossbill on the second last field day, so their breeding period is likey just beginning or ending.

Observer ability likely created some errors. The 10 day call and song memorization period was effective, however when on the field calls were shortened or difficult to hear; it is possible we confused some species for others. To limit the chance of this occurring the first two collection days, as well as two practice days, were done with assistance from Professor Starzomski. After the completion of data collection, an ANOSIM test was carried out using the time factor (day 1 versus day 2). This showed that there was no significant difference between the days when Starzomski was out and the days we were out alone. If error did occur it was likely a negative basis; it was often difficult to differentiate between two individuals of the same species that were in close proximity of each other. This is a nonresponse error meaning we heard the bird species but did not record it (Thompson, 2003). Despite all these possible errors and biases, point-count technique is considered a suitable way to document patterns of distribution (Lynch, 1995).

Conclusion

Biodiversity of passerine birds varied significantly between our three locations: tundra, edge, and forest. This trend was confirmed using multivariate analysis tools including nMDS, ANOSIM, and SIMPER.

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