DIVERSITY OF BIRDS IN PARKS OF VARYING SIZES

REPRORT

TO

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WILDLIFE MANAGEMENT INSTRUCTOR

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ABSTRACT

I examined whether the theory of Island biography or habitat heterogeneity could explain the pattern in diversity of bird species in urban parks of varying sizes (small <60 ha, medium 100-500 ha, and large > 1000 ha) from September 17th to October 15th, 2007 in the lower mainland of British Columbia, Canada The avian community data were sampled using 40-point count stations along four transects in each park. In addition, diversity of vegetation was determined for each park using circular nested plots.

Based on calls and observations, a total average of 663 bird species were observed, including eight common species such as American Robin (*Turdus migratorius*) and Winter Wren (*Troglodytes troglodytes*). Diversity of both bird and vegetation was similar among park sizes; however, there was a trend for higher diversity of both birds and vegetation in medium- sized park than small-sized and large- sized parks.

The results imply that the theory of island biogeography did not support our hypothesis that larger parks have a greater diversity of birds than smaller parks. Habitat heterogeneity appeared to change in a similar pattern to that seen in diversity of birds which connected parks with greater structural diversity than parks with less structural diversity. Vegetation diversity (old growth, shrubs, etc.) and adequate park planning supported the distribution of birds' fauna and overall species diversity to carry out life processes in natural ecosystems.

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ACKNOWLEDGEMENTS

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1.0 Introduction

Bird species can be found almost everywhere within city. Most of these urban species are commonly associated with residential and industrial areas that are expanding dramatically both in number and in size which has reduced productive habitat for wildlife. Most of these species nest on the manmade sites (e.g roof eaves, building ledges, parking lot) and feed on the sources available within the city such as garbage, and bird feeders. Forest fragmentation in urban environment effects bird diversity. Two concepts to examine this theory is island biogeography and habitat heterogeneity. Island biogeography is defined as the number of species inhabiting urban islands with a balance between immigration and emigration of bird species (Diamond *et al.* 1976). Small urban islands tend to have less bird diversity than larger islands, the further island separation, the less immigration and emigration of bird species can occur. To ensure species survival and prevent extinction, Diamond *et.al* (1976) stated in his study on island biogeography, large sanctuaries are essential to wildlife.

The second theory, habitat heterogeneity, involves diversity of habitat where flora and fauna carry out life functions in a natural ecosystem. Forest landscape such as various shrub and canopy vegetation and structural diversity positively influence bird diversity resulting in a healthy ecosystem (MacArthur and Wilson 1967). Spatial heterogeneity of woody vegetation and canopy patches is required for species richness (Blare 2004). Species richness is provided by woodlands with a variety of habitats such as canopy openings and available water source providing nesting and feeding sites for birds (Tilghman 1987). To obtain healthy numbers of bird species, preserving natural shrub layers for niches is imperative (Tilghman 1987). As Canada has such a variety of Neotropical migrants, urban parks are required for migration as corridors for travel. Having a mosaic of large and small green spaces within reasonable travel distance is important to reduce mortality by introducing resting habitat and in turn increasing bird diversity.

Many studies have shown that people would love to see the wildlife within the city specially observing birds (Tilghman 1987). Wide ranges of people consider bird

watching as a sport and others as a form of nature study. Consequently, to improve the overall strategy for management of present and future bird species continuous monitoring and understanding of bird habitat and population dynamic is important to bird fauna and their interactions with urban dweller. This study was designed to test whether larger parks have a greater diversity of birds than smaller parks and if parks with greater structural diversity will have greater diversity of birds than parks with less structural diversity. We compared diversity of birds and vegetation among nine parks of three sizes (small, medium and large) and examined bird diversity.

2.0 Study site

The study was conducted in nine parks in the Lower Mainland (Latitude 49°15'00", Longitude 123°00'00") within the Georgia Basin ecoprovince of British Columbia, Canada from September 17th to October 15th, 2007 (Figure 1). Lower Mainland is characterized as a cool mesothermal climate with cool summers and mild winter (8 °C mean annual temperature). The mean annual precipitation (approximately 2228 mm) is abundant (Meidinger and Pojar 1991).

Lower Mainland has been classified as Coastal Western Hemlock Zone (CWH) that occurs at low to middle elevations along the entire British Columbia Coast covering a total of 16.5 million hectares of forests. Elevation ranges from sea level to 900 m on windward slopes in the south and to 300m in the north (Meidinger and Pojar 1991). Soil nutrient and moisture regimes are variable and generally may be classified as slightly moist and fresh to wet and very rich (Green *et al*. 1994).

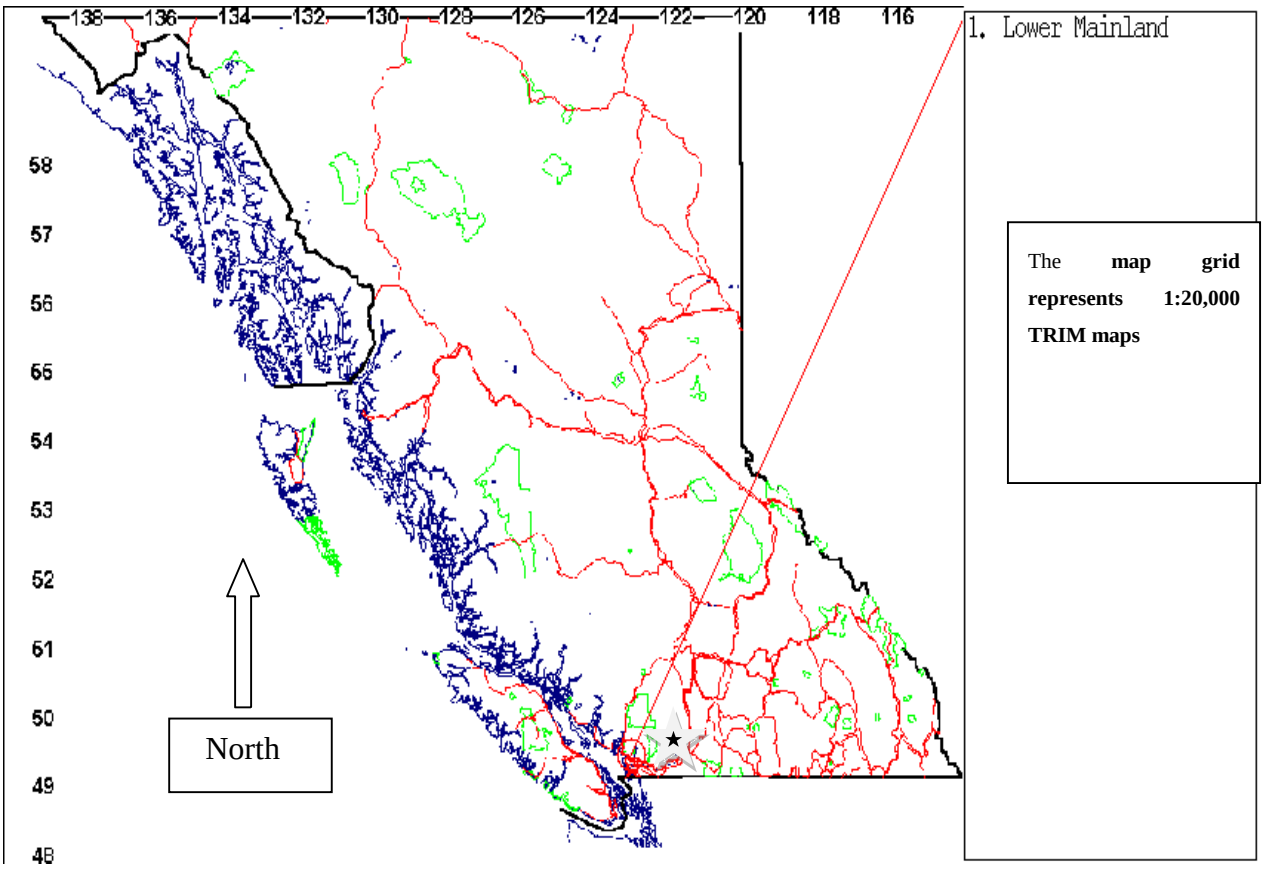


Figure 1. Location of Lower Mainland study area, British Columbia, Canada from September 17 to October 15, 2007.

Study sites mainly covered portions of city parks in varying sizes. The vegetation was consistent to the Coastal Western Hemlock Biogeoclimatic zone dominated by western hemlock (*Tsuga heterophylla*), coastal Douglas-fir (*Pseudotsuga menziesii*), and western redcedar (*Thuja plicata*), sitka spruce (*Picea sitchensis)*, amabilis fir (*Abies amabilis*), and mountain hemlock (*tsuga mertensiana*) with many invasive species, such as English holly (*Ilex aquifolium*), English ivy (*Hedera helix*) and Himalayan blackberry (*Rubus discolor*) (Meidinger and Pojar 1991).

Most of the study sites were also subject to human use. There were trails of various width commonly found on the sites. One group consisting of three people surveyed each park. The parks were separated into 3 categories: small <60 ha, medium 100-500 ha, and large > 1000 ha (Table 1).

Table 1.Desciption of nine parks for bird survey in Lower Mainland of British Columbia, Canada from September 17 to October 15, 2007.

Park Size	Name	Size (Ha)	Established	BGC Zone	Ecology	Location
Small	**Riverview Forest Park**	24	N/A	CWH	Full of Fraser Valley's last old-growth trees	Coquitalm
	Queen's Park	30	1886	CWH	Contains non-native vegetation and home to the Bloedel Floral Conservatory	New Westminister
	Richmond Nature Park	80	N/A	CWH	Peat bog habitat, forest of shore pine and paper birch	Westminster Highway Richmond
Medium	**Stanley Park**	400	N/A	CWH	Coniferous & deciduous stands, second & third-growth forest	Vancouver (Down town)
	Burnaby Mountain Conservation Area	576	N/A	CWH	Mixed second-growth coniferous and deciduous Stands	Burnaby
	Pacific Spirit Regional Park	763	1989	CWH	Varieties of ferns carpet the forest floor and Camosun Bog, a remnant of the most recent ice age.	Vancouver (West)
Large	**Lynn Headwaters Regional Park**	4865	1983	CWH	Sub-alpine meadows, and rugged mountain slopes	North Vancouver Upper Lynn Valley Road
	Lower Seymour Conservation Reserve	5668		CWH	Alpine tundra, dense coniferous forests & lush	North Vancouver Upper Lynn Valley Road (Seymour Mountain)
	Golden Ears Provincial Park	62, 540	1927	CWH	Second-growth forest of western hemlock, western red cedar and Douglas-fir.	Vancouver (East)

3.0 Methodology

3.1 Bird inventory

Bird surveys were conducted from September 17 to October 15, 2007 using the systematic sampling survey technique. This method is chosen because of higher efficiency of use, ability to provide information on relative abundance of bird species in different habitat types, and to survey birds over the large areas of concern (RISC 1999). Individual bird species heard and seen were recorded for five minutes at 10 point- count stations 100m apart on four separate transects totaling 40-point counts. This technique provides the relative abundance of each bird species (i.e., mean number of detection per point or per habitat type).

Bird behavior (song, call, flight, etc per station) for each observation was recorded. All studies were conducted about a half hour after sunrise to approximately 0900 hours. It has been reported (Gates 1995) that after sunrise the rate of singing is reduced substantially. All point centers were located 80 m from roads to reduce potential edge effects.

3.2 Vegetation inventory

Three plots were located 25 m north from the each 5^{th} point count station, and each containing a 1.26-m radius herb plot, a 2.82-m radius shrub-plot and 5.64-m radius tree plot to analyze species richness and percent cover of vegetation (Appendix 1). All data was recorded on Resource Information Standard Committee (RISC 1999) data sheets (Appendix 2). Dominant understory vegetation with ground cover (%) was recorded using visual assessment technique and analyzed using Shannon-Wiener and Simpson's diversity indices to calculate species richness and abundance. A summary of all the data for all points is provided in Appendix 3.

3.3 Diversity Calculation

Diversity indices (Simpson's and Shannon –Wiener) were calculated for each park using Krebswin(http:// *www2.biology.ualberta.ca/jbrzusto/ftp/krebs/index.htm).* For birds the numbers of individual were averaged for each park. For vegetation the proportion of each plot was used to estimate diversity and averaged. Diversity indices were averaged for parks within each sized category.

4.0 Results

An average of 663 bird species was recorded during the survey from September 17 to October 15, 2007. There were nine common species found within the parks; Black-capped Chickadee (*Poecile atricapillus*), Golden-crowned Kinglet (*Regulus satrapa*), and Winter Wren (*Troglodytes troglodytes*) represented the average highest number of species respectively (Table 2-Appendix 4).The most abundant tree species was western hemlock (*Tsuga heterophylla*) and the less abundant was English holly (*Ilex aquifolium)* (Table 3- Appendix 5).

Table 2. Nine most abundant species of birds found in each of small, medium and large parks in Lower Mainland of British Columbia from September 17 to October 15, 2007.

	Average Number		
Species	**Small**	**Medium**	**Large**
Golden-crowned Kinglet	13.5	6.75	20.5
North American Crow	16	10.5	<1
House Sparrow	17.25	12.75	<1
Dark eye Junko	5.75	4.75	17.75
Red breasted Nuthatch	6.25	18.25	16.75
Varied Thrush	<1	5.75	5.5
Black-capped Chickadee	23.75	17.75	1
American Robin	8.5	9.75	15.25
Winter Wren	8.5	19.25	6.75

Table 3. Comparison of common vegetation in nine parks of varying sizes.

Species	% Cover		
	Small	Medium	Large
Trees			
Douglas-fir	35	43	9
Western hemlock	21	71	65
Western red cedar	12.8	52	33
English holly	16	9	1
Shrubs			
Salmonberry	38	54	19
red huckleberry	16	5	34
Herbs			
bracken fern	1	22	2

Comparison between medium, small and large size parks indicated that diversity of birds in medium parks was slightly higher than small and large parks where as the diversity of vegetation was similar in all parks (Figure 2 and Figure 3).

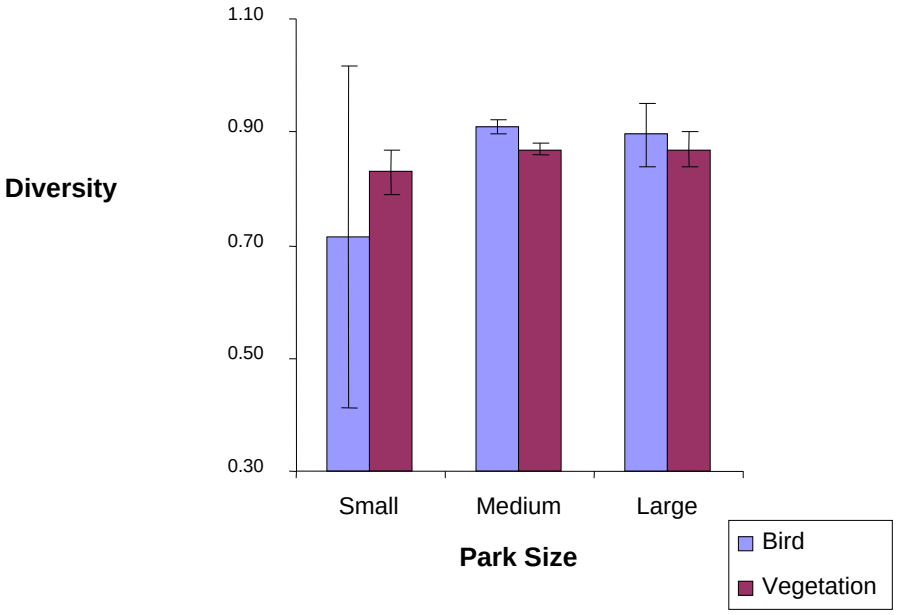


Figure 2. Mean(n=3, 95% confidence interval) diversity of birds using Simpson's index for nine parks of varying sizes (small, medium, large) in Lower Mainland of British Columbia from September 17 to October 15, 2007.

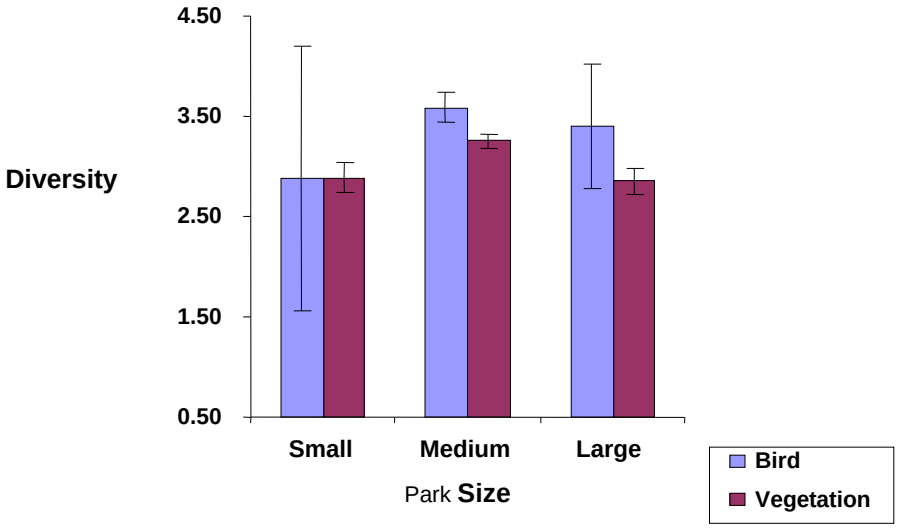


Figure 3. Mean(n=3. 95% confidence interval), diversity of birds using Shannon-Wiener index for nine parks of varying sizes (small, medium,, large) in Lower Mainland of British Columbia from September 17 to October 15.

5.0 Discussion/Management Implications

An island biogeography hypothesis predicates that large parks and reserves may support high [bird] species diversity (Diamond *et al.* 1976). Tilghman (1987) indicated that several research have shown the size of the forest can also be a limiting factor in distribution of residing individual bird species. According to our data diversity of bird species was almost similar among nine parks regardless of sizes, however; diversity in medium sized park was slightly higher than small and large parks. This means that the larger parks do not always support higher diversity of species. This result may be explained in several reasons.

Based on the theory of Island biogeography, the shorter distance between Islands is an important factor in diversity of bird species, as some avian species prefer to travel shorter distances through mosaic small, medium and large parks. Having geographic areas with varying park sizes with the reasonable distance would assist in immigration and migration which is important to bird community composition or abundance. Based on habitat heterogeneity particular refuges may have higher diversity of species regardless of size than other refuges due to habitat characteristics that are kept in natural state. Variety of microhabitat habitat by layers and composition of vegetation and level of human activity around parks influence bird diversity and abundance. Preserving of natural vegetation in the shrub layers and good cover would increase number of niches which in turn increase in number of bird species (Tilghman 1987).

Limitation to edge habitat and size of the forest areas (e.g clearcuts or windthrow areas) can affect the “bird community composition, abundance and ecology. Some edge habitat provides a good foraging ground for birds (e.g. Hermit Thrush) in various seasons of the years. Having an understanding of the bird’s edge habitat characteristics during migration and non-migration seasons would be beneficial to increase number of birds that inhabit parks and reduce the impact of human disturbance in natural areas (Diamond *et a*l. 1976).

Inadequate park design may cause fragmentation of habitat resulting in dispersed bird species among habitat patches. For example, some species found to be confined to patches much larger than territory size of a single pair so, depending on species pool size and relative areas of refuges, small or medium size parks would have more species than an equivalent area in one large park (Watson *et al.* 2005). Diamond (1976) stated that having a reasonable strategy and planning for diverse park sizes would assist to protect the urban corridors and sensitive species from the effect of human disturbance especially adjacent to the city. The forest wood lands' characteristics, such as mixed coniferous and deciduous trees and dominant native vegetation species, appear to have a positive impact on abundance of bird species compared to isolated woodlands. Some bird species are more "dependent on forest successional stage" (Manning 2000). For instance, Winter Wren, White Breasted- Nuthatch were more abundant in mature forest habitats and some such as woodpeckers, and Song Sparrow, were more in younger forests habitat (Manning 2000). Others such as Black-capped Chickadee, Varied Thrush, and American Robin were found in most habitats associated with Costal Western Hemlock but may preferred early to mid- successional clear cut and hardwood areas (Manning, 2000). Having patches of western hemlock or western red cedar and some form of water within the woods can increase the number of birds in the area (Tilghman 1987).

Ultimately, availability of suitable foraging and nesting habitat is more likely the most important variables that influence forests bird diversity, abundance and distribution. Replacing non-native vegetation species by native vegetation may provide healthier habitat and will bring more bird species to foraging ground at any time of the year regardless of park size. (Gates 1995) . Consequently, more research is required on habitat features of bird species, composition, migration pattern and park design in all seasons to find out how we can improve habitat heterogeneity among parks in varying sizes.

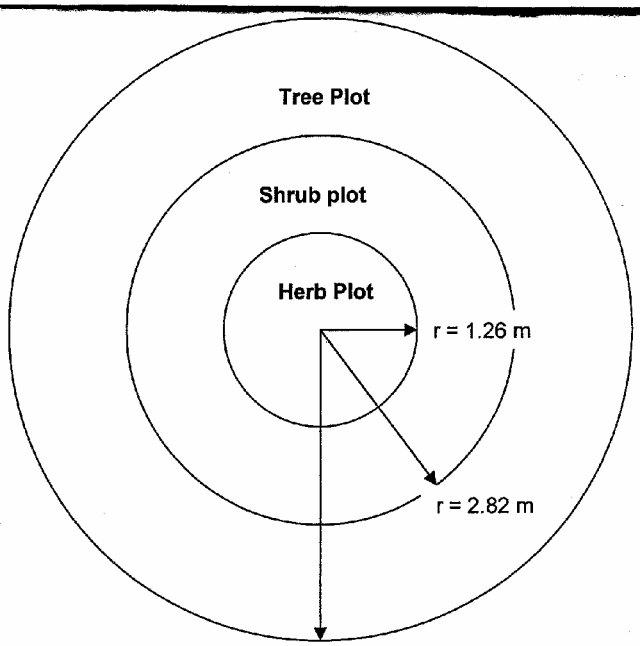
6.0 Literature Cited

- Diamond, J. M., Terborgh, J., Whitcomb R. F., Lynch, J.F., Opler ,P. A., Robbins C. S., Simberloff, D. S., Abele, L.G. 1976. Island Biogeography and Conservation: Strategy and Limitations. Science 193: 1024-1032
- Gates, J. E. 1995. Point count modifications and breeding bird abundances in Central Appalachian Forests. USDA Forest Service Gen. Tech. Rep. PSW-GTR-149
- Green, R. N. Klinka, K. 1994. A Field guide to site identification and interpretation for the Vancouver Forest Region. Research Branch Ministry of Forests, Victoria, British Columbia. Land management handbook number 28.
- MacArthur, R. H. Wilson, E. O. 1967. The Theory of Island Biogeography. Princeton University Press Princeton, New Jersey, United State of America. [Online].Available: http://www.stanford.edu/group/stanfordbirds/text/essays/Island_Biogeography.html
- Manning, E. T. 2000. Inventory and preliminary habitat relationships of forest songbirds and other invertebrates in the Tofino Creek Watershed, Vancouver Island, British Columbia. Ministry of Forest Research Program, 712 Yates Street, Victoria, BC, V8W 3E7. Working paper 48.
- Meidinger, D., Pojar, J. 1991. Ecosystem of British Columbia: Coastal Western Hemlock Zone. BC Ministry of Forests. Series. 6, 95-113.
- Melles, S, S. Glenn, Martin, K. 2003. Urban bird diversity and landscape complexity: species environment associations along a multiscale habitat gradient. Conservation Ecology vol.7 issue 1. [Online]. Available: http://www.consecol.org/vol7/iss1/art5
- RISC (Resource Information Standards Committee), 1999. Inventory Methods for Forest and Grassland Songbirds: Standards for Components of British Columbia's Biodiversity No.15. [Online]. Available: http://ilmbwww.gov.bc.ca/risc/pubs/tebiodiv/songbird/assets/songml20.pdf

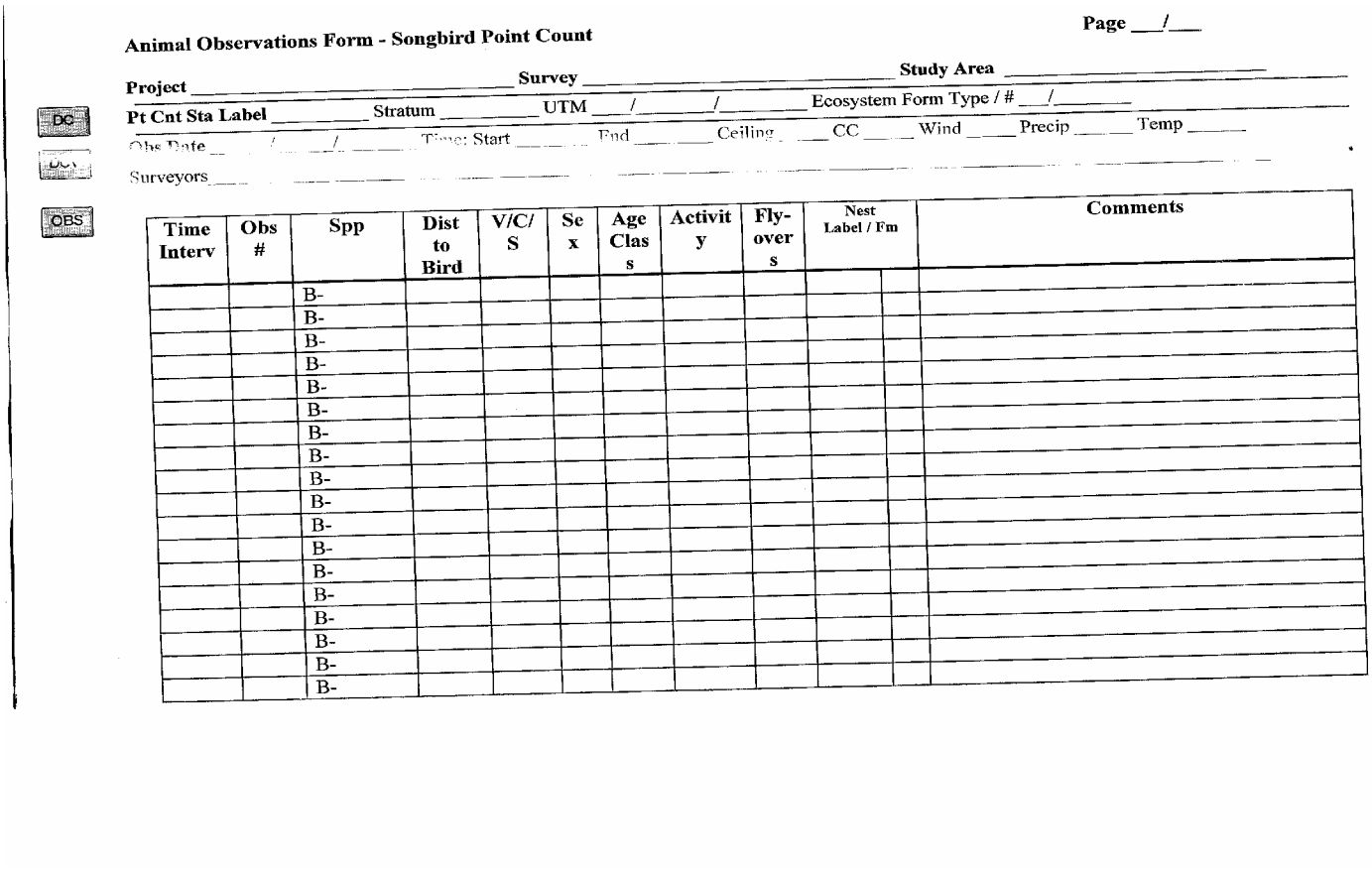
- Tilghman N.C., 1987. Characteristics of urban woodlands affecting breeding bird diversity and abundance: Landscape Urban Plann., 14: 481-495, USDA Forest Service. Northeastern Forest Experiment Station, University of Massachusetts, MA, USA.
- Watson J. Whittaker R. Freudenberger D. 2005. Bird community responses to habitat fragmentation: how consistent are they across landscapes? Journal of Biogeography 32:1353-1370.

Appendices

Appendix 1- Vegetation Plot Radius



Appendix 2- RISC Inventory Form



Animal Observations Form - Songbird Point Count Page ___/___

Project _____ **Survey** _____ **Study Area** _____

Pt Cnt Sta Label _____ Stratum _____ UTM ___/_____/_____ Ecosystem Form Type / # ___/_____

Obs Date ___/___/___ Time: Start _____ End _____ Ceiling ___ CC ____ Wind ____ Precip ____ Temp ____

Surveyors _____

Time Interv	Obs #	Spp	Dist to Bird	V/C/S	Sex	Age Class	Activity	Fly-overs	Nest Label / Fm		Comments
		B-									
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Appendix 3- Diversity data based on the Simpson's (first chart) Shannon-Wiener (second chart) and indices and corresponding averages and confidence intervals

SD=Standard Deviation, CI=Confidence Interval

	Birds				Veg			
Park Size	Diversity	Average	SD	CI	Diversity	Average	SD	CI
Small	0.901	0.714	0.267	0.302	0.86	0.830	0.034	0.039
	0.832				0.79			
	0.408				0.83			
Medium	0.898	0.909	0.011	0.012	0.87	0.869	0.008	0.009
	0.92				0.86			
	0.909				0.88			
Large	0.929	0.896	0.050	0.056	0.84	0.869	0.028	0.032
	0.839				0.80			
	0.92				0.79			

	Birds				Veg			
Park Size	Diversity	Average	SD	CI	Diversity	Average	SD	CI
Small	1.54	2.883	1.169	1.323	2.98	2.890	0.139	0.157
	3.44				2.73			
	3.67				2.96			
Medium	3.44	3.587	0.127	0.144	3.33	3.253	0.067	0.075
	3.67				3.21			
	3.65				3.22			
Large	3.18	3.397	0.548	0.620	2.95	2.857	0.114	0.129
	2.99				2.89			
	4.02				2.73			

Appendix 4-List of bird species recorded for nine parks of varying sizes in Lower Mainland of British Columbia, Canada from September 17 to October 15, 2007.

Small Parks

UNK = unknown

Riverview Forest Park (24 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session				Average
		1	2	3	4	
1	**GOKI**	19	12	10	9	12.50
2	**DEJU**	7	1	4	2	3.50
3	**RBNU**	10	5	0	2	4.25

4	**HOSP**	9	6	2	4	5.25
5	**BCCH**	10	6	4	4	6.00
6	**AMRO**	9	5	5	1	5.00
7	**DOWO**	1	2	1	4	2.00
8	**RBSA**	1	0	0	0	0.25
9	**WIWR**	6	7	10	8	7.75
10	**SPTO**	1	0	0	0	0.25
11	**BEKE**	1	0	0	0	0.25
12	**NOCR**	1	1	0	0	0.50
13	**BAEA**	1	0	0	0	0.25
14	**STJA**	0	3	0	0	0.75
15	**VGSW**	0	2	0	0	0.50
16	**BUSH**	0	1	0	0	0.25
17	**NOFL**	0	6	2	6	3.50
18	**PIWO**	0	1	0	0	0.25
19	**UNK1**	1	0	0	0	0.25
20	**UNK2**	0	1	0	0	0.25
21	**UNK3**	0	3	0	0	0.75
22	**UNK4**	0	1	0	0	0.25
23	**UNK5**	0	1	0	0	0.25
24	**UNK6**	0	1	0	0	0.25
25	**UNK7**	0	0	1	0	0.25
26	**UNK8**	0	0	1	0	0.25

Queen's Park (30 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session				Average
		1	2	3	4	
1	BCCH	8	0	3	6	4.25
2	HOSP	6	4	11	5	6.50
3	NOCR	11	12	4	11	9.50
4	NOFL	5	0	0	1	1.50
5	RBNU	4	0	0	3	1.75
6	AMRO	1	0	0	0	0.25
7	WEGU	0	3	5	3	2.75
8	GCKI	0	1	1	0	0.50
9	DEJU	0	0	4	4	2.00
10	UNK1	0	0	0	1	0.25

Richmond Nature Park (80 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session				Average
		1	2	3	4	
1	AMRO	6	1	6	0	3.25
2	BCCH	25	4	6	19	13.50
3	SPTO	5	8	20	6	9.75
4	HOSP	21	8	13	1	10.75
5	NOCR	2	3	12	9	6.50
6	BUSH	17	19	0	10	11.50
7	HETH	1	0	0	0	0.25
8	BASW	4	5	10	751	192.50
9	GWGU	1	0	0	1	0.50
10	BNOW	1	0	0	0	0.25
11	EUST	1	1	1	2	1.25
12	CEWA	1	1	0	0	0.50
13	PISI	0	6	9	4	4.75
14	STJA	0	9	0	0	2.25
15	DEJU	0	1	0	0	0.25
16	GCKI	0	2	0	0	0.50
17	VATH	0	3	0	0	0.75
18	WIWR	0	0	3	0	0.75
19	BHCO	0	0	2	0	0.50
20	RBNU	0	0	1	0	0.25

Medium Parks

Stanley Park (400 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session				Average
		1	2	3	4	
1	PISI	3	0	0	0	0.75
2	SPTO	6	5	6	1	4.50
3	BCCH	14	13	14	3	11.00
4	GCKI	5	11	2	9	6.75
5	RBNU	8	1	1	5	3.75
6	CAGO	2	0	0	0	0.50
7	HETH	1	3	3	0	1.75
8	VATH	1	1	1	2	1.25
9	WETA	1	0	0	0	0.25
10	NOCR	5	6	7	2	5.00
11	WIWR	3	8	10	15	9.00
12	DEJU	2	2	2	1	1.75
13	PSFL	0	4	4	2	2.50
14	NOFL	0	2	3	0	1.25
15	UNK1	2	0	0	4	1.50
16	STJA	0	0	1	0	0.25
17	AMRO	0	0	0	1	0.25
18	BRCR	0	0	0	1	0.25

UK1 = Unknown Woodpecker
PSFL = Pacific-slope Flycatcher
BRCR = Brown Creeper

Burnaby Mountain Conservation Area (576 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session				Average
		1	2	3	4	
1	AMRO	3	6	10	12	7.75
2	BCCH	9	0	1	0	2.50
3	RBNU	21	0	4	5	7.50
4	SPTO	4	11	2	13	7.50
5	HOSP	13	12	7	6	9.50
6	DEJU	9	1	0	6	4.00
7	NOCR	4	2	12	4	5.50
8	DOWO	1	5	0	1	1.75
9	SOSP	1	0	0	0	0.25
10	WIWR	2	1	4	10	4.25
11	VATH	2	7	0	3	3.00
12	NOFL	1	0	0	0	0.25
13	EVGR	0	1	1	0	0.50
14	BUSH	0	2	11	4	4.25
15	PISI	0	1	0	0	0.25
16	WCSP	0	2	0	0	0.50
17	VGSW	0	1	0	0	0.25
18	HOFI	0		1	0	0.33
19	CBCH	0	0	1	0	0.25
20	STJA	0	0	4	2	1.50
21	HETH	0	0	0	1	0.25

22	**CGSP**	0	0	0	1	0.25

Pacific Spirit Regional Park (763 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session 1	2	3	4	Average
1	**DEJU**	3	0	0	0	0.75
2	**BCCH**	7	3	2	5	4.25
3	**VATH**	1	0	1	4	1.50
4	**RBNU**	10	5	2	11	7.00
5	**NOFL**	1	0	1	1	0.75
6	**CBCH**	9	3	8	2	5.50
7	**WIWR**	6	6	3	9	6.00
8	**AMRO**	1	0	1	0	0.50
9	**STJA**	1	3	0	1	1.25
10	**SWTH**	1	2	0	0	0.75
11	**CEWA**	0	13	16	18	11.75
12	**SPTO**	0	0	4	0	1.00
13	**HOSP**	0	0	13	0	3.25
14	**RUTU**	0	0	0	3	0.75
15	**UNKA**	4	3	0	0	1.75
16	**UNKB**	4	3	0	0	1.75
17	**UNKC**	0	2	0	0	0.50
18	**UNKD**	0	1	0	0	0.25
19	**UNKE**	0	0	8	0	2.00
20	**UNKF**	6	0	0	0	1.50

Large Parks

Lynn Headwaters Regional Park (4865 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session 1	2	3	4	Average
1	**DEJU**	4	1	3	3	2.75
2	**WIWR**	2	0	0	2	1.00
3	**VATH**	1	0	0	4	1.25
4	**STJA**	1	0	0	0	0.25
5	**CORA**	1	0	0	0	0.25
6	**RBNU**	3	0	0	1	1.00
7	**PIWO**	1	0	0	0	0.25
8	**AMRO**	2	0	1	3	1.50
9	**UNK1**	3	7	0	3	3.25
10	**HOSP**	0	1	0	0	0.25
11	**CHSP**	0	1	0	0	0.25
12	**UNK2**	0	3	0	1	1.00
13	**NOFL**	0	2	0	0	0.50

Lower Seymour Conservation Reserve (5668 ha)

Bird Number	Bird Species Code	Total Number of Encounters During Each Session 1	2	3	4	Average
1	**EUST**	11	0	0	0	2.75
2	**GCKI**	18	20	13	31	20.50
3	**BCCH**	3	0	1	0	1.00

4	**NOCR**	1	1	0	1	0.75
5	**RBNU**	20	11	1	18	12.50
6	**AMRO**	11	19	9	13	13.00
7	**MALL**	2	0	0	0	0.50
8	**WIWR**	2	6	7	8	5.75
9	**NOFL**	0	5	2	0	1.75
10	**DEJU**	0	1	6	0	1.75
11	**STJA**	0	1	2	4	1.75
12	**VATH**	0	3	2	10	3.75
13	**COGU**	0	1	0	1	0.50
14	**CHSP**	0	0	9	0	2.25
15	**PIWO**	0	0	0	1	0.25

Golden Ears Provincial Park (62, 540 ha)

Bird Number	**Bird Species Code**	**Total Number of Encounters During Each Session**				**Average**
		1	**2**	**3**	**4**	
1	**DEJU**	15	0	15	30	15.00
2	**RECR**	2	15	7	5	7.25
3	**COCR**	1	0	0	0	0.25
4	**RBNU**	13	0	0	0	3.25
5	**AMRO**	3	0	0	0	0.75
6	**BIRDC**	11	0	0	0	2.75
7	**BIRD D**	24	0	0	0	6.00
8	**BIRD E**	8	0	0	0	2.00
9	**BIRD F**	17	0	0	0	4.25
10	**BIRD G**	3	0	0	0	0.75
11	**BIRD H**	1	0	0	0	0.25
12	**BIRD I**	1	0	0	0	0.25
13	**BIRD J**	1	0	0	0	0.25
14	**BIRD K**	2	0	0	0	0.50
15	**BIRD L**	1	0	0	0	0.25
16	**BIRD M**	2	0	0	0	0.50
17	**BIRD N**	17	0	0	0	4.25
18	**BIRD O**	14	0	0	0	3.50
19	**BIRD Q**	2	0	0	0	0.50
20	**BIRD R**	1	0	0	0	0.25
21	**BIRD AA**	3	0	0	0	0.75
22	**BIRD BB**	3	0	0	0	0.75
23	**BIRD CC**	1	0	0	0	0.25
24	**BIRD DD**	1	0	0	0	0.25
25	**PIWO**	0	0	4	20	6.00
26	**VATH**	0	0	2	0	0.50
27	**HOWR**	0	0	3	0	0.75
28	**CAGO**	0	0	15	0	3.75
29	**SWOW**	0	0	1	1	0.50
30	**BIRD X**	0	0	1	0	0.25
31	**BIRD Y**	0	0	1	0	0.25
32	**BOCH**	0	0	0	3	0.75
33	**BIRD S**	0	0	0	2	0.50
34	**BIRD T**	0	0	0	1	0.25
35	**BIRD U**	0	0	0	1	0.25

Bird AA =	**Bird chip**
Bird BB =	**Bird schep**
Bird CC =	**Bird cherp chip**
Bird DD =	**Bird P2**

Appendix 5-List of vegetation species recorded in nine parks of varying sizes, Lower Mainland, British Columbia from September 17 to October 15, 2007.

Small Parks

Queen's Park	**Common name**	**Scientific Name**	**%Cover**	**%Average**
Shrubs	English Ivy	*Hedera helix*	20	5
	red huckleberry	*Vaccinium parvifolium*	5	1.25
	Salmonberry	*Rubus spectabilis*	1	0.25
Trees	Douglas-fir	*Pseudotsuga menziesii*	55	13.8
	English holly	*Ilex aquifolium*	40	10
	western redcedar	*Thuja plicata*	35	8.8
	Unknown		35	8.8
Herbs	false lily of the valley	*Maianthemum racemosum*	11	2.75
	robert		52	13
	dandelions	*Taraxacum officinale*	38	9.5
Riverview Forest Park				
Shrubs	English holly	*Ilex aquifolium*	23.5	5.86
	red huckleberry	*Vaccinium parvifolium*	22	5.5
	salmonberry	*Rubus spectabilis*	137	34.25
	salal	*Gaultheria salal*	3	0.75
Trees	Douglas-fir	*Pseudotsuga menziesii*	85	21.25
	western hemlock	*Tsuga heterophylla*	47	11.75
	western redcedar	*Thuja plicata*	11	2.75
	wine maple	*Acer circinatum*	5	1.25
	bigleaf maple	*Acer macrophyllum*	30	7.5
	beaked hazelnut	*Corylus cornuta*	3	0.75
Herbs	wall lettuce	*Lactuca muralis*	17	4.25
	bunchberry	*Cornus canadensis*	1	0.25
	foamflower	*Tiarella spp.*	1.05	0.26
Richmod Park				
Shrubs	ovalleaved blueberry	*Vaccinium ovalifolium*	50	12.5
	red huckleberry	*Vaccinium*	35	8.75

		parvifolium		
	salmonberry	*Rubus spectabilis*	15	3.75
	Salal	*Gaultheria salal*	120	30
	Himalayan blackberry	*Rubus discolor*	2	0.5
	Alaskan blueberry	*Vaccinium alaskensis*	70	1.75
	braken fern	*Dryopteris*	5	1.25
	unknown		40	1
Trees	paper birch	*Betula spp.*	60	15
	western hemlock	*Tsuga heterophylla*	35	8.75
	shorepine	*Pinus contorta var contorta*	5	1.25
Herbs	labrador tea	*Ledum groenlandicum*	50	12.5
	sitka mountain ash	*Sorbus sitchensis*	5	1.25
	Unknown		1	0.25

Large parks

Lynn Headwaters

Shrubs	elderberry	*Sambucus racemosa ssp*	35	8.75
	red huckleberry	*Vaccinium parvifolium*	3	0.75
	salmonberry	*Rubus spectabilis*	50	12.5
	timbelberry	*Rubus parviflorus*	1	0.25
Trees	redaleder	*Alnus rubra*	21	5.25
	wetern Hemlock	*Tsuga heterophylla*	28	7.00
	western redcedar	*Thuja plicata*	11	2.75
	vine maple	*Acer circinatum*	1	0.25

Herbs	sword fern	*Nephrolepis exaltata*	2	0.5
	lady Fern	*Athyrium filix-femina*	2	0.5
	braken Fern	*Dryopteris*	8	2
	deer Fern	*Blechnum spicant*	5	1.25
	sitka Mountain ash	*Sorbus sitchensis*	35	8.75
Lower Seymour Conservation				
Shrubs	salal	*Sambucus racemosa ssp*	120	30
	red huckleberry	*Vaccinium parvifolium*	100	25
	salmonberry	*Rubus spectabilis*	11	2.75
	trailing blackberry	*Rubus ursinus*	1	0.25
	sword fern	*Nephrolepis exaltata*	11	2.75
	wild rose	*Rosa acicularis*	1	0.25
	ovalleaved blueberry	*Vaccinium ovalifolium*	20	5.00
	deer fern	*Blechnum spicant*	1	0.25
	bracken fern	*Dryopteris*	1	0.25
	lady fern	*Athyrium filix-femina*	5	1.25
	vine maple	*Acer circinatum*	30	7.50
Trees	Douglas-fir	*Pseudotsuga menziesii*	35	8.75
	western hemlock	*Tsuga heterophylla*	230	57.50
	western redcedar	*Thuja plicata*	50	12.50
Herbs	false lily of the valley	*Maianthemum racemosum*	10	2.50
	twisted stalk	*Streptopus amplexifolius*	1	0.25
Golden Ears Park				
Shrubs	english Holly	*Ilex aquifolium*	5.2	1.3
	red huckleberry	*Vaccinium parvifolium*	31	7.75
	salmonberry	*Rubus spectabilis*	15.2	3.8
	vine maple	*Acer circinatum*	1	0.25
	salal	*Gaultheria salal*	21	5.25

	Rhododendron	*Rhododendron albiflorum*	2	0.5
Trees	red alder	*Alnus rubra*	29	7.25
	western red cedar	*Thuja plicata*	70	17.5
	Western hemlock	*Tsuga heterophylla*	12	0.3
	bigleaf maple	*Acer macrophyllum*	20	0.5
	mountain hemlock	*Tsuga mertensiana*	15	3.75
	paper birch	*Betula spp.*	2	0.5
	vine maple	*Acer circinatum*	58	14.5
Herbs	Spiny wood fern	*Dryopteris expansa*	35	8.75
	Sword fern	*Nephrolepis exaltata*	180	45
	Parsley	*Petroselinum crispum*	1	0.25
	Licorice fern	*Polypodium glycyrrhiza*	3	0.75

Medium Parks

Pacific Spirit Park

Shrubs	salal	*Gaultheria salal*	111	27.75
	red huckel berry	*Vaccinium parvifolium*	4	1
	Salmonberry	*Rubus spectabilis*	20	5
	trailing blackberry	*Rubus ursinus*	30	7.5
	sword fern	*Nephrolepis exaltata*	25	6.25
	Oregan grape	*Mahonia spp*	10	2.5
	English holly	*Ilex aquifolium*	15	3.75
	English ivy	*Hedera helix*	80	20
	bracken fern	*Dryopteris*	29	7.25
	lady fern	*Athyrium filix-femina*	1	0.25
	vine maple	*Acer circinatum*	5	1.25
Trees	Douglas-fir	*Pseudotsuga menziesii*	80	20
	western hemlock	*Tsuga heterophylla*	165	41.25
	western redcedar	*Thuja plicata*	40	10
	bigleaf maple	*Acer macrophyllum*	90	22.5
	red alder	*Alnus rubra*	5	1.25
	sitka mountain	*Sorbus sitchensis*	6	1.5

Shrubs	red huckel berry	*Vaccinium parvifolium*	11	2.75
	Salmonberry	*Rubus spectabilis*	130	32.50
	trailing blackberry	*Rubus ursinus*	65	16.25
	sed elderberry	*Sambucus racemosa ssp*	5	1.25
Trees	Douglas-fir	*Pseudotsuga menziesii*	45	11.25
	western hemlock	*Tsuga heterophylla*	53	13.25
	western redcedar	*Thuja plicata*	2	0.50
	bigleaf maple	*Acer macrophyllum*	5	1.25
	red alder	*Alnus rubra*	8	2.00
	black cottonwood	*Populus trichocarpa*	40	10.00
	vine maple	*Acer circinatum*	49	12.25
Herb	sword fern	*Nephrolepis exaltata*	55	13.75
	lady fern	*Athyrium filix-femina*	5	1.25
	bracken fern	*Dryopteris*	7	1.75
	deer fern	*Blechnum spicant*	5	1.25
	wall lettuce	*Mycelis muralis)*	1	0.25
	large leaved		2	0.50