Trends in Abundance of Migratory Songbirds at Rocky Point Bird Observatory, Southern Vancouver Island, British Columbia.

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Biology 550 B
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September 30, 2004

Abstract

Due to recent population declines in North America, the conservation of migratory songbirds has been identified as a high priority. Extensive monitoring efforts are needed to assess the population status of migratory birds; however, to date, long-term studies of songbird population trends are rare. In this study, I assess populations of migratory songbirds captured at Rocky Point Bird Observatory, a banding station located on the southern tip of Vancouver Island, British Columbia. I determine population trends for 17 species using eight years of mist-net capture data. Three species showed significant trends over the eight years. Savannah Sparrows (*Passerculus sandwichensis*) declined in abundance, whereas Golden-crowned Kinglets (*Regulus satrapa*) and Pacific-slope Flycatchers (*Empidonax difficilis)* increased in abundance. Most other species fluctuated in numbers and showed brief declines in 1999 and 2000. Likely causes include changes in climate on breeding and wintering grounds in 1999 caused by the El Nino Southern Oscillation. Neotropical migrants did not show a propensity for population declines in this study; however, grassland and riparian-dependent species with specific breeding habitat requirements seem to be more vulnerable to declines.

Introduction

There has been much concern in recent years about songbird conservation in North America. In the past two decades, many studies have revealed songbird population declines, particularly in the neotropical migrants (Robbins et al. 1989, Donovan et al. 2002, Ballard et al. 2003). Migratory birds may be more vulnerable to population declines than residents due to their dependence on different breeding, stopover, and winter locations and consequent susceptibility to habitat alterations in each of these habitats (Newton 2004). In addition, ground-nesters, canopy nesters, and cowbird hosts have shown strong population declines (Bohning-Gaese et al. 1993, Ballard et al. 2003).

Whether migratory conditions on winter or breeding grounds limit songbird populations is under debate. Some research has found that declining status is highly correlated with aspects of breeding biology, suggesting that conditions on breeding grounds may be responsible for declining populations (Bohning-Gaese et al. 1993). Other evidence suggests that winter conditions are better predictors of population trends than breeding conditions and that forest fragmentation in tropical habitats is largely responsible for declines in neotropical migrants (Robbins et al. 1989, Sherry and Holmes 1996). Carry-over effects are likely to be common, where conditions on wintering grounds can affect breeding success on summer grounds (Morse 1980, Newton 2004). It is probable that conditions that limit populations vary within and between years, and fluctuate between winter and summer grounds, thus making it difficult to isolate threats to migrants.

One phenomenon which affects birds on both temperate breeding and tropical wintering habitats is the climatic pattern of the El Nino Southern Oscillation (ENSO) (Sillett et al. 2000, Christman 2002). ENSO is an inter-annual oscillation of tropical sea-surface temperatures in the Pacific Ocean characterized by “El Nino” and “La Nina” events (Latif et al. 1998). The mild, wet conditions created by El Nino in western North America cause insect outbreaks (Swetnam and Lynch 1993) which results in increased fecundity of certain songbird species (Morrison and Bolger 2002). In addition, increased precipitation on tropical wintering grounds during El Nino events creates favorable pre-migration conditions for neo-tropical migrants, thus resulting in greater reproductive success the following summer (Nott et al. 2002). La Nina years, on the other hand, are associated with dry winters in the tropics, and decreased fecundity the following summer for several neo-tropical migrant species (Latif et al. 1998, Nott et al. 2002).

Understanding how climate change and habitat fragmentation affect bird populations is critical, yet very difficult. The North American Breeding Bird Survey (BBS) is a long-term bird monitoring program in which experienced observers detect breeding birds by sight or sound in the spring at various locations throughout North America according to a standardized protocol. Most long-term trends in temperate-breeding songbirds are calculated using this data. This method, however, is biased toward heavily populated regions and primarily surveys roadsides and edge habitats. In addition, it is subject to observer bias, and does not account for non-breeders and females (Hagen et al. 1989). Another method to monitor songbird populations is through migration monitoring using mist-nets. This method captures individuals who are en-route to or from summer breeding grounds. One benefit of mist-netting is that detection does not rely on the skill of the observer or the detectability of a particular species; also, it samples birds that breed in a variety of different locations. Mist-netting ideally should be used in conjunction with the BBS to determine population trends (Hagen et al. 1989, Dunn et al. 1997).

In this study, I assess songbird population trends using mist-netting capture rates at a banding station on southern Vancouver Island during fall migration. I analyzed 17 species of migratory songbirds for population change over an eight-year period using weighted multiple regressions. I grouped species based on taxonomic group, migratory status, and habitat to gain insight into causes of particular trends. To further aid in interpreting trends, I obtained temperature and precipitation data for spring and summer at various locations in British Columbia and the Yukon. I illustrate how songbird population trends at Rocky Point Bird Observatory may be influenced by global climatic processes as well as habitat fragmentation.

Methods

Site Description

Rocky Point Bird Observatory is located on the extreme southern end of Vancouver Island, British Columbia, at the Department of National Defense Rocky Point Ammunition Depot (48º 19' 15"N/123º 32' 30"W). The station encompasses 9km^2 and overlooks the Strait of Juan de Fuca. The terrestrial ecosystem includes Garry Oak woodland, marsh, open meadow, and coniferous forest. Dominant tree species include Garry Oak (*Quercus garryana*), Douglas Fir (*Pseudotsuga menziesii*), Western Hemlock (*Tsuga heterophylla*), Grand Fir (*Abies grandis*), and Arbutus (*Arbutus menziesii*). Dominant shrub species around nets include Salmonberry (*Rubus spectabilis*), Snowberry (*Symphoricarpos mollis*), Oceanspray (*Holodiscus discolor*), Scotch Broom (*Cytisus scoparious*), and European Gorse (*Ulex europaeus*). Nets were located in a variety of microsites including marsh, forest and shrub-dominated habitats. Shrubs were trimmed on a yearly basis to net-height to maintain continuity between years. No drastic changes to the site occurred during the study period other than a tree-fall in 2000 near one net and some senescence of Scotch Broom the same year.

Mist-netting Protocol

From 1996 to 2003 the station operated from end of July until the end of October. During this period, mist-nets were opened half an hour before dawn every day for approximately six hours unless weather was unsuitable (excessive rain or wind). In 1996, between 14 and 18 nets were operated and in 1997, 17 to 18 nets were operated. During the 1998 and 1999 seasons, 10 nets were operated and in 2000 and 2001, 10 to 13 nets were in operation. For the 2002 and 2003 seasons, 13 nets were in operation. Nets were nylon, 70 denier/2-ply, 2.6 x 12 meters, with 30 mm mesh and 4 shelves. Upon extraction, birds were identified to species using Pyle (1997) and banded with a CWS aluminum leg band (Permit number: 10365 CA) Recaptures were not considered in the trend analysis.

Statistical Analysis

Methods for calculating population trends were derived from a step-by step instruction guide by Dunn and Hussell (unpublished), which can be obtained through the Canadian Wildife Service and referred to for more details about the analysis. I chose species for analysis if at least 25 individuals were captured annually and if they were captured on at least five days per season. I determined a migration window separately for each species by plotting counts by year and determining the dates within which 95% of birds were captured. Common resident species (such as White-crowned Sparrow (*Zonotrichia leucophrys*) and Song Sparrow (*Melospiza melodia*)) that had no distinct migratory window were excluded from the analysis because it was impossible to separate local breeders from migrating individuals. These methods are most effective for species that do not breed in the area. In this study, certain local breeders were included in the analysis, but only if distinct migratory windows were observed.

I corrected for mist-netting effort by dividing daily counts by the number of net-hours each day. After 1 was added to counts to eliminate zeroes, counts were multiplied by 100 and then log-transformed to normalize the distribution of data. Each day of monitoring was given a weight proportional to daily effort, so that days with low effort had less influence on results. The weighting helped to control for differences in mist-netting effort among days and years. Date and year data was transformed to set the middle day/year of the series to 0, with earlier days/years having negative values and later days having positive values. This step improved statistical tolerance in regressions. Dummy variables were used for year except for one reference year near the middle of the series (for example, Y98=1 if year = 1998, all other years =0). I included $date^2$, $date^3$, $year^2$ and $year^3$ in the analysis to test higher-order polynomials for better fits. A weighted multiple regression was run with mean transformed count as the dependant variable and date and year (1996-2003) as the independent variables. The mean annual index of abundance was derived from coefficients of this regression. Indices were then back-transformed to reflect real bird numbers. Indices of abundance for each year were then regressed against year, where the slope of the regression represented percent annual change in the population and the p-value represented the significance of the trend.

The trend produced by this analysis was in the same units as the Breeding Bird Survey, as well as trends calculated at other migration stations, allowing for comparisons. Both Breeding Bird Survey trend data (http://www.mbr-pwrc.usgs.gov/bbs/trend/tf03.html) and trend data for McKenzie Bird Observatory (http://www.bsc-eoc.org/national/migmain.jsp) were obtained from on-line databases. I also tested correlations in yearly indices of abundance among species captured at Rocky Point using Pearson's correlation analysis. A univariate ANOVA was used to assess the effect of taxonomic group, migratory status (temperate versus neotropical migrants), and breeding habitat (woodland, scrub/successional, and grassland, Table 1). These categorizations were based on Environment Canada migratory bird classifications.

Temperature and precipitation data were obtained from the Meteorological Service of Canada (http://www.msc-smc.ec.gc.ca/information_publications_e.html) for 5 stations in western Canada: Dawson City, Yukon, Dease Lake, BC, Victoria, B.C., Sandspit Airport, Queen Charlotte Islands, and Fort St. John, B.C. I chose these stations because they are representative of the range of conditions that songbirds migrating through Rocky Point would be subjected to during the breeding season. I chose average temperature data for the month of May to represent spring conditions, which often predict nesting success for songbirds (Ehrlich et al. 1988) and I calculated the cumulative precipitation from May to September for each year. I chose to use precipitation data for these months due to the finding by Swetnam and Lynch (1993) that summer precipitation can be correlated to songbird productivity.

Results

Equal proportions of bird species analyzed showed positive and negative trends. Out of 17 species analyzed for population trends over the 8-year period, only three species showed significant trends. The Pacific-slope Flycatcher (*Empidonax difficilis)* increased (9.75%, $p<0.005$), as did the Golden-crowned Kinglet (*Regulus satrapa)* (15.10%, $p<0.005$), and the Savannah Sparrow (*Passerculus sandwichensis*) decreased significantly (-15.80%, $p<0.01$; Table 1). Lincoln's Sparrows (*Melospiza lincolnii)* showed marginally significant declines (-6.86%, $p<0.1$) and Wilson's Warblers (*Wilsonia pusilla)* showed marginal increases (8.48%, $p<0.1$). For the remaining 12 species, six showed net declines and six showed net increases. Warblers were highly variable in trend direction, whereas most sparrows showed negative trends, both flycatchers showed positive trends, and both thrush species showed negative trends (Table 1).

Taxonomic group, wintering location, and breeding habitat had no effect on overall population trends (all $F<1.68$, $p>0.05$). Because many species tended to follow cyclical patterns, showing no net change over the 8-year period, it was more useful to visually inspect trends over the years. Interesting patterns emerged when trends over time were compared among species. Several species declined from 1998 to 2000 and then showed a marked increase from 2001 to 2003 (Figure 1). Within this group, significant correlations in abundance were detected between species (HETH-YRWA; $R=0.758$, GCSP-YRWA; $R=0.795$, GCSP-RCKI; $R=0.751$, GCSP-COYE; $R=0.752$, all $p<0.05$), although significance was not reached when Bonferonni's correction was applied. Winter Wrens (*Troglodytes troglodytes*), Swainson's Thrushes (*Catharus ustulatus)*, and Fox Sparrows *(Passerella iliaca)* experienced sharp declines in 1999 and seemed to recover in 2000 (Figure 2). Trends in abundance over time for these species were significantly correlated (WIWR-FOSP; $R=0.860$, WIWR-SWTH; $R=0.729$, all $p<0.05$), although not when corrected for Bonferonni. Willow Flycatchers (*Empidonax trailii*) and Pacific-slope Flycatchers, as well as Golden-crowned Kinglets showed relatively steady increases in numbers from 1997 to 2003 but were not significantly correlated (Figure 3). Savannah and Lincoln's Sparrows showed steady declines over this time period and were also not significantly correlated (Figure 4). Most warblers showed small fluctuations with no net change over time and were not correlated (Figure 5).

Trends observed in this study were variably correlated with trends observed at other migration monitoring stations and the Breeding Bird Survey (BBS). Trends for eight species recorded at McKenzie Bird Observatory (a banding station in north-central British Columbia) from 1996-2002 were highly positively correlated with trends for these species at RPBO ($N=10$, $R=0.8287$, $p<0.05$, Figure 6). Savannah Sparrows showed particularly sharp declines at both stations, whereas Golden-crowned Kinglets showed positive trends at the two sites. BBS trends (1996-2003) in British Columbia were not correlated with trends for RPBO during this time period ($N=16$, $R=0.086$, $p>0.05$).

Temperature data, obtained from the Meteorological Service of Canada (MSC), indicated peaks in mean temperatures in 1997 and 1998 and lows in 1999, 2000 and 2001 (Figure 7). Precipitation data from MSC indicated a peak in 1997 at most stations and a dip in 1998 and 1999 compared with other years (Figure 8). Weather variables were not significantly correlated with yearly abundance indices (all $p>0.05$).

Discussion

Many researchers have detected declines in migratory birds over the past two decades, and have attributed them to a host of variables ranging from habitat fragmentation on wintering grounds to cowbird parasitism on breeding grounds (Robbins et al. 1989, Bohning-Gaese et al. 1993, Ballard et al. 2003). It is very difficult to monitor bird populations; however, migration monitoring can provide insight into the status of populations from a wide geographical area. Most species analyzed in this report showed no significant net trend, due to short-term fluctuations possibly correlated with climatic events. However, some species did show declines, and future monitoring will be necessary to determine the severity of population change.

Only three species analyzed showed statistically significant trends, and this is largely due to the peaks and troughs in capture rates. Savannah Sparrows showed a particularly strong negative trend at Rocky Point, which was mirrored at McKenzie Bird Observatory in north-central B.C. The mean trend for Savannah Sparrows in Canada is also negative (-2.5%, $p<0.05$; CWS Canadian Bird Trends Database). This is interesting given that the species is considered to be common and widespread throughout the country and may benefit from human-created landscapes such as cultivated fields and grazed pastures (Wheelwright and Rising 1993). The relatively linear declines in numbers captured at both Rocky Point and McKenzie, however, are cause for concern. These declines may be a result of the reduction of grassland habitats in the province, but may also result from conditions on wintering grounds or during migration. Coastal grasslands and even intertidal zones are considered to be important for this species because they produce "source" populations and provide abundant food and cover during migration (Wheelwright and Rising 1993).

Two species that have a preference for riparian habitat for breeding showed declines. Lincoln's Sparrows showed negative trends at Rocky Point, and followed similar trends at McKenzie and in Breeding Bird Surveys for the province. The tendency of this species to specialize in their breeding habitat may be in part responsible for declines. Lincoln's Sparrows prefer willow or sedge riparian and bog habitats and the alteration of these habitats by grazing has negative effects on breeding populations (Cicero 1997, Ammon 1995). Lincoln's Sparrow populations are relatively isolated and low in density, which increases their vulnerability to population declines (Cicero 1997). Common Yellowthroats declined in numbers at Rocky Point and McKenzie, and throughout the province as evidenced by BBS trends. Similar to Lincoln's Sparrows, Common Yellowthroats also breed in vegetation around swamps and marshes and are therefore susceptible to the loss of wetlands and riparian habitats (Guzy and Ritchison 1999). The draining of agricultural areas in the province likely has a negative impact on both these species.

Golden-crowned Kinglets showed significantly positive trends, which were correlated with trends found at McKenzie. This species is a common resident throughout Canada and the U.S. that requires conifer habitat but can exploit edge and human-altered landscapes (Ingold and Galati 1997). Increases may be due to less severe winters or the maturation of second-growth forests in the Pacific Northwest.

Pacific-slope flycatchers are declining in British Columbia and Canada as a whole (-6.9%, $p>0.05$; CWS Canadian Bird Trends Database). Potential reasons for this discrepancy are many. For example, Rocky point may sample mostly Vancouver Island birds, just a small proportion of the total population of

Pacific-slope Flycatchers in B.C. Pacific-slope Flycatchers are dependent on interior forest habitat and avoid forest edges (Brand and George 2001); however they are not limited to old-growth habitat and will breed in mature second-growth stands (Sakai and Noon 1991). Interior populations of this species are restricted to moist lowland habitats, are more vulnerable to habitat loss than their less selective coastal counterparts (Lowther 2000). Similarly, Willow Flycatchers are less selective in moist coastal regions than inland populations that require close proximity to water (Sedgewick 2000). This may explain why positive trends were observed at Rocky Point whereas the species is considered to be endangered in the southern US (Federal Register 1993). Wilson's Warblers follow a similar pattern, where populations breeding on the Pacific coast are less selective than inland populations, which breed in mesic shrub thickets and riparian areas (Ammon and Gilbert 1999). Rocky Point data indicates that western populations of Wilson's Warblers may be stable or even increasing while BBS data suggests that populations elsewhere in the province are experiencing declines.

It is interesting that such a tight correlation existed between trends at Rocky Point and McKenzie migration stations yet not with provincial BBS trends. One explanation for this is that neither Rocky Point nor McKenzie stations sample southeastern populations of birds, which are included in BBS trends for the province. It is likely that southeastern populations are subject to different environmental conditions than their northwestern counterparts, and therefore do not follow the same patterns over time. Other likely reasons for the discrepancy are that autumn mist-netting detects juvenile and adult birds of both sexes whereas the BBS detects breeding males only. Numbers of breeding males may better represent the previous year's reproductive output than the current year. Also, the BBS is usually conducted along roadsides, which may bias trends to reflect only individuals in edge habitats (Dunn et al. 1997).

Many species experienced declines in 1999 and 2000 following peaks in 1998. No large changes in net number or placement, which would have affected capture rates occurred between 1998 and 1999.

Some small changes in vegetation structure around net lanes, such as a fallen tree and broom senescence may have affected capture rates; however, it is unlikely that these changes around 2-3 nets would affect capture rates of so many species. One factor that may be linked to declines in 1999 and 2000 was a change in climate associated with ENSO (El Nino Southern Oscillation). 1997 and 1998 were influenced by El Nino, whereas 1999 and 2000 were influenced by La Nina. There is strong evidence for the influence of large-scale climatic phenomena on songbirds (Sillett et al. 2000, Christman 2002); however, effects are complex and depend on the range and migratory status of the species (Nott et al. 2002). El Nino years tend to coincide with greater insect abundance in western North America and the western tropics (Swetnam and Lynch 1993, Nott et al. 2002), which may have resulted in high reproductive success of birds in 1997 and 1998. El Nino conditions likely caused the warm and wet conditions in the Pacific Northwest during the summer of 1997. La Nina, on the other hand, often causes unfavorable winter conditions in the western tropics (Nott et al. 2002) and reproductive success for several species in 1999 and 2000 may have suffered as a result. Studies show that several species of songbird had greatly reduced reproductive success in 1999 due La Nina conditions (Christman 2002, Morrison and Bolger 2002). However, decreases in abundance during these years were not limited to neo-tropical migrants. Winter Wrens and Fox Sparrows, which are temperate migrants, experienced sharp declines in 1999. This may be explained by weather conditions in temperate regions; the cold spring of 1999 may have resulted in lower reproductive success in these species. Without more detailed, species-specific information, it is very difficult to isolate factors that cause fluctuations in bird populations. Whether a migrant population is limited by conditions on winter or breeding grounds probably alternates among years (Morse 1980, Newton 2004) and populations can also be limited by conditions during migration (Sillett and Holmes 2002).

Migratory bird populations moving through Rocky Point Bird Observatory fluctuated in abundance over time, yet few species showed dramatic declines. Most neo-tropical migrants had positive trends throughout the study period, and did not show extreme fluctuations in numbers, suggesting that they are not in decline. This is surprising, considering neo-tropical migrants have been identified as particularly vulnerable to declines due to their dependence on habitats in multiple localities (Robbins et al. 1989, Donovan et al. 2002, Ballard et al. 2003). As previously mentioned, it may be that populations sampled in this study are relatively healthy compared with eastern populations. In addition, this study may not have been of sufficient length to detect trends in species that follow cyclical population fluctuations (Hill and Hagen 1991, Ballard et al. 2003). It is also likely that some species omitted from the analysis (due to insufficiently high capture rates) are currently experiencing population declines. It is often the less common species with limited ranges that are most vulnerable to extinction and are also the most difficult to monitor (Ehrlich et al. 1988). Nevertheless, the trends observed in this study can be used to increase the general understanding of bird populations in British Columbia and to identify potential species of concern. Further long-term mist-netting at this site will prove useful in monitoring songbirds in the Pacific Northwest.

Acknowledgements

I thank the board members (past and present) and volunteers at Rocky Point Bird Observatory who spent many early morning hours of meticulous work to make this project possible. I give special thanks to Ann Nightingale and David Allinson for their valuable advice and for providing me with the data. Thanks to Dr. Alan Burger for supervising this project, and Morgan Hocking and Paula Ramsay for valuable comments on the manuscript. Also thanks to Erica Dunn, who provided the methods for the analysis.

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Table 1. Habitat classifications and migratory status of birds included in trend analysis of birds captured during fall migration at Rocky Point Bird Observatory, 1996-2003. Trends (% change over 8 years) and p-values are reported for Rocky Point, as well as McKenzie Bird Observatory (1996-2002) and the Breeding Bird Survey (1996-2003) for British Columbia

Species with significant trends (p<0.05) at Rocky Point are highlighted.

Species	Habitat type	Migratory status	Rocky Point		McKenzie		BBS B.C.	
			% change	p-value	% change	p-value	% change	p-value
Yellow Warbler	scrub/successional	neotropical	1.313	0.707	-4.580	>0.050	-0.330	0.814
McGillivray's Warbler	scrub/successional	neotropical	1.130	0.725	6.150	>0.050	-1.640	0.304
Orange-crowned Warbler	scrub/successional	neotropical	-2.430	0.541			0.330	0.833
Yellow-rumped Warbler	woodland	temperate	-2.540	0.571	2.629	>0.050	-1.620	0.109
Wilson's Warbler	scrub/successional	neotropical	8.484	0.066	3.770	>0.050	-5.820	0.061
Common Yellowthroat	scrub/successional	neotropical	-7.630	0.174	-6.770	>0.050	-5.160	0.001
Fox Sparrow	scrub/successional	temperate	3.295	0.279			0.890	0.671
Golden-crowned Sparrow	scrub/successional	temperate	-6.530	0.400				
Lincoln's Sparrow	scrub/successional	neotropical	-6.860	0.074	-1.680	>0.050	-4.670	0.081
Savannah Sparrow	**grassland**	**temperate**	**-15.800**	**0.006**	**-11.100**	**>0.050**	**-4.610**	**0.096**
Hermit Thrush	woodland	temperate	-2.760	0.588			3.380	0.256
Swainson's Thrush	woodland	neotropical	-2.410	0.770	2.050	>0.050	-0.010	0.987
Pacific-slope Flycatcher	**woodland**	**neotropical**	**9.750**	**0.003**			**-2.710**	**0.096**
Willow Flycatcher	scrub/successional	neotropical	6.923	0.102			0.920	0.482
Ruby-crowned Kinglet	woodland	temperate	3.550	0.534	6.520	>0.050	1.490	0.282
Golden-crowned Kinglet	**woodland**	**temperate**	**15.100**	**0.001**	**8.470**	**>0.050**	**-4.310**	**0.012**
Winter Wren	woodland	temperate	1.255	0.850			2.510	0.188

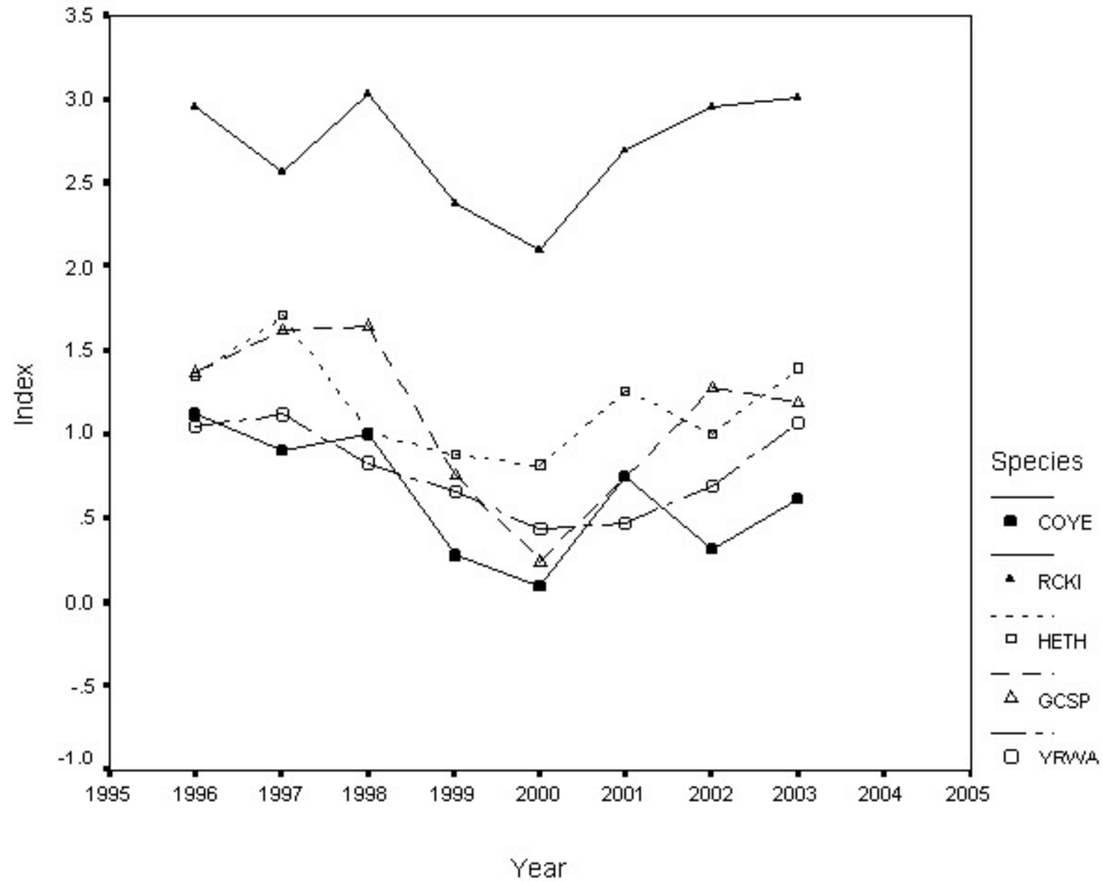

Figure 1. Index of abundance over time (Log captures per 100 net hours) for Common Yellowthroats (COYE), Ruby-crowned Kinglets (RCKI), Hermit Thrushes (HETH), Golden-crowned Sparrows (GCSP), and Yellow-rumped Warblers (YRWA). Birds were captured at Rocky Point Bird Observatory, Vancouver Island, British Columbia from 1996 to 2003.

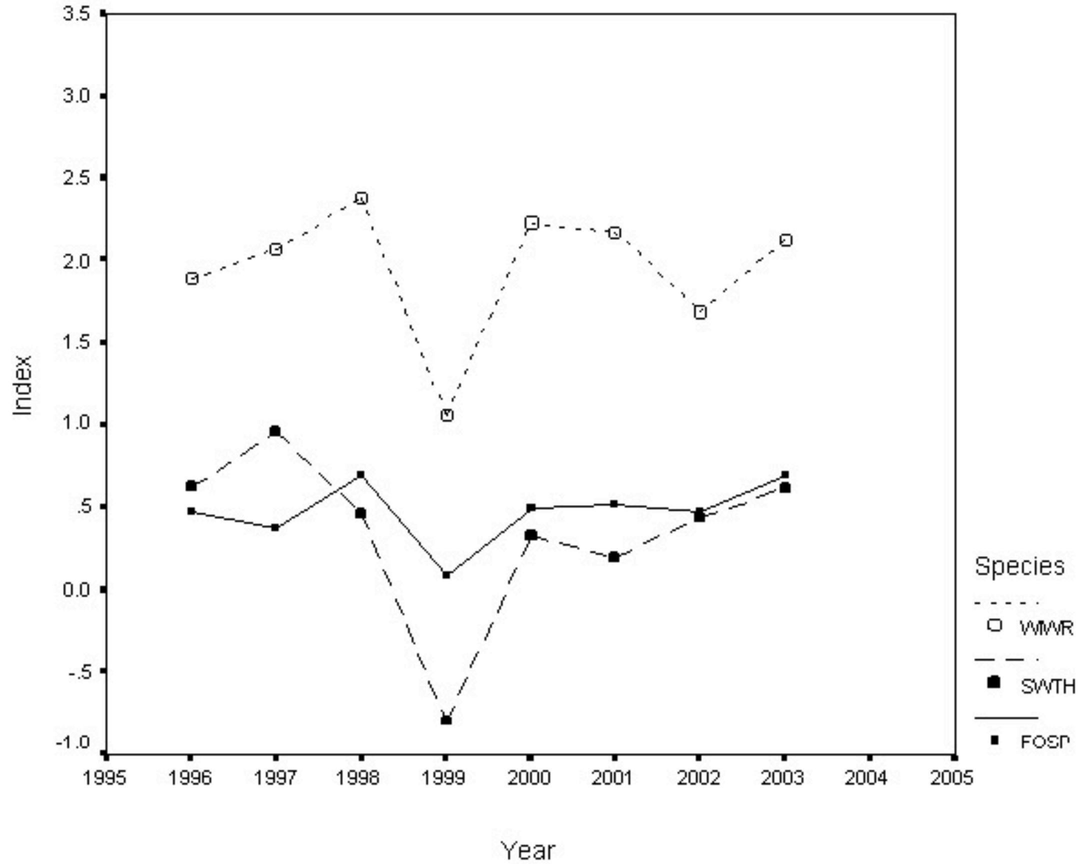

Figure 2. Index of abundance over time (Log captures per 100 net hours) for Winter Wrens (WIWR), Swainson's Thrushes (SWTH), and Fox Sparrows (FOSP). Birds were captured at Rocky Point Bird Observatory, Vancouver Island, British Columbia from 1996 to 2003.

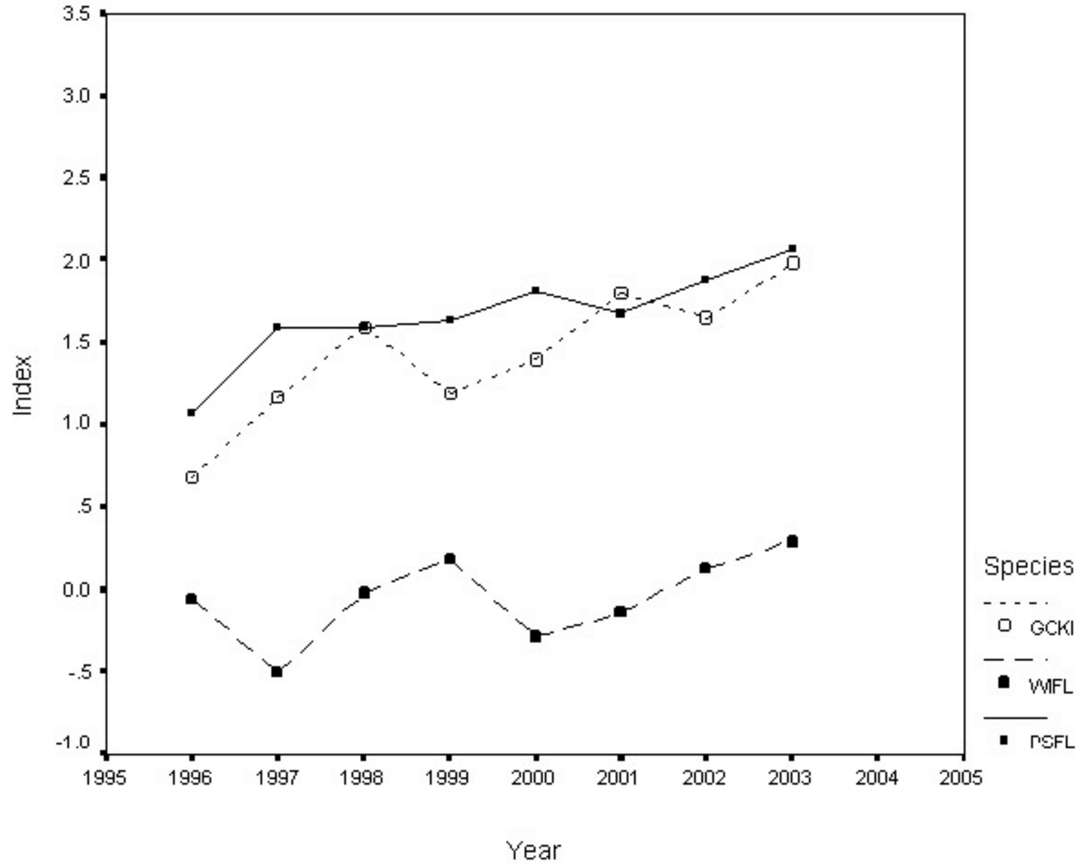

Figure 3. Index of abundance over time (Log captures per 100 net hours) for Golden-crowned Kinglets (GCKI), Willow Flycatchers (WIFL), and Pacific-slope Flycatchers (PSFL). Birds were captured at Rocky Point Bird Observatory, Vancouver Island, British Columbia from 1996 to 2003.

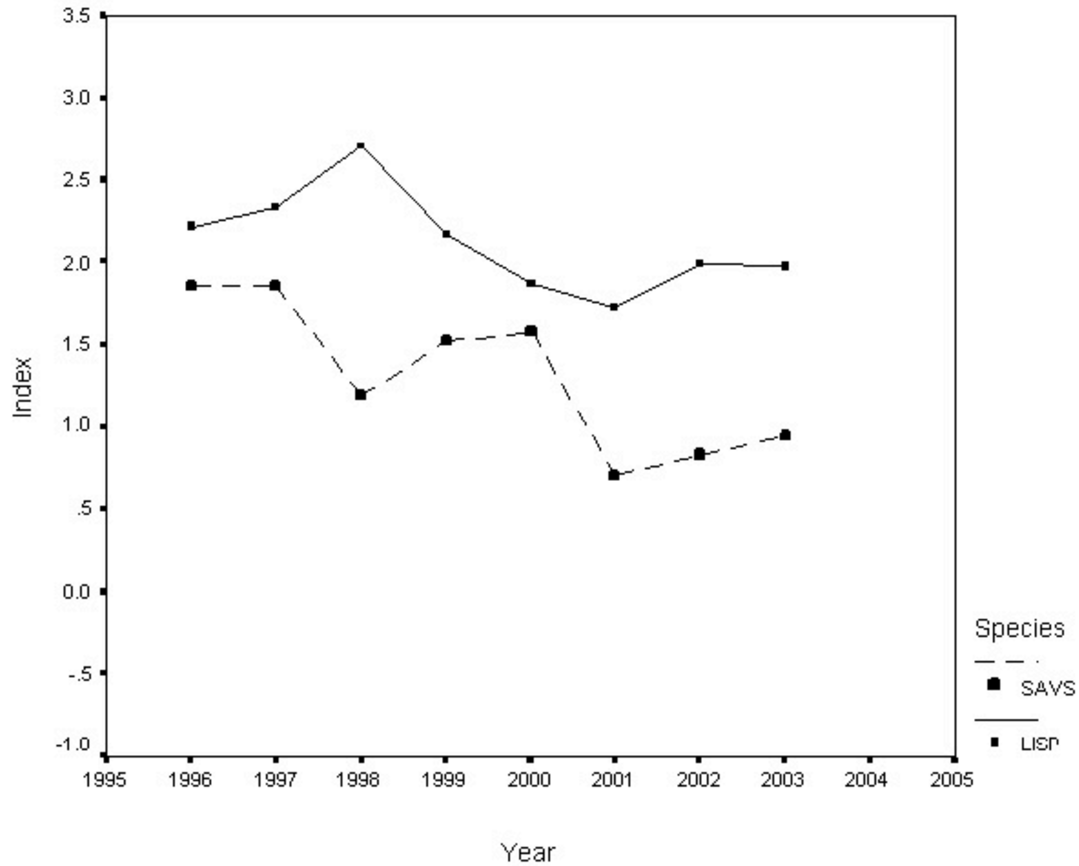

Figure 4. Index of abundance over time (Log captures per 100 net hours) for Savannah Sparrows (SAVS) and Lincoln's Sparrows (LISP). Birds were captured at Rocky Point Bird Observatory, Vancouver Island, British Columbia from 1996 to 2003.

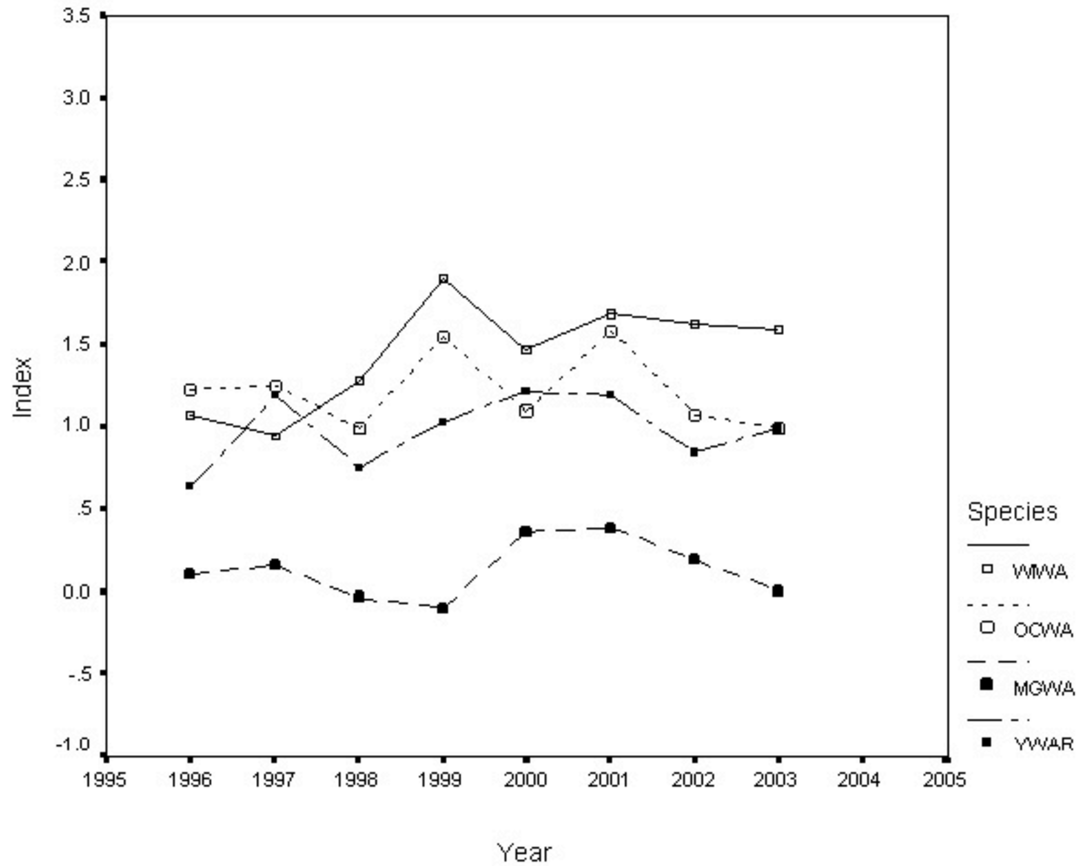

Figure 5. Index of abundance over time (Log captures per 100 net hours) for Wilson's Warblers (WIWA), Orange-crowned Warblers (OCWA), MacGillivray's Warblers (MGWA), and Yellow Warblers (YWAR). Birds were captured at Rocky Point Bird Observatory, Vancouver Island, British Columbia from 1996 to 2003.

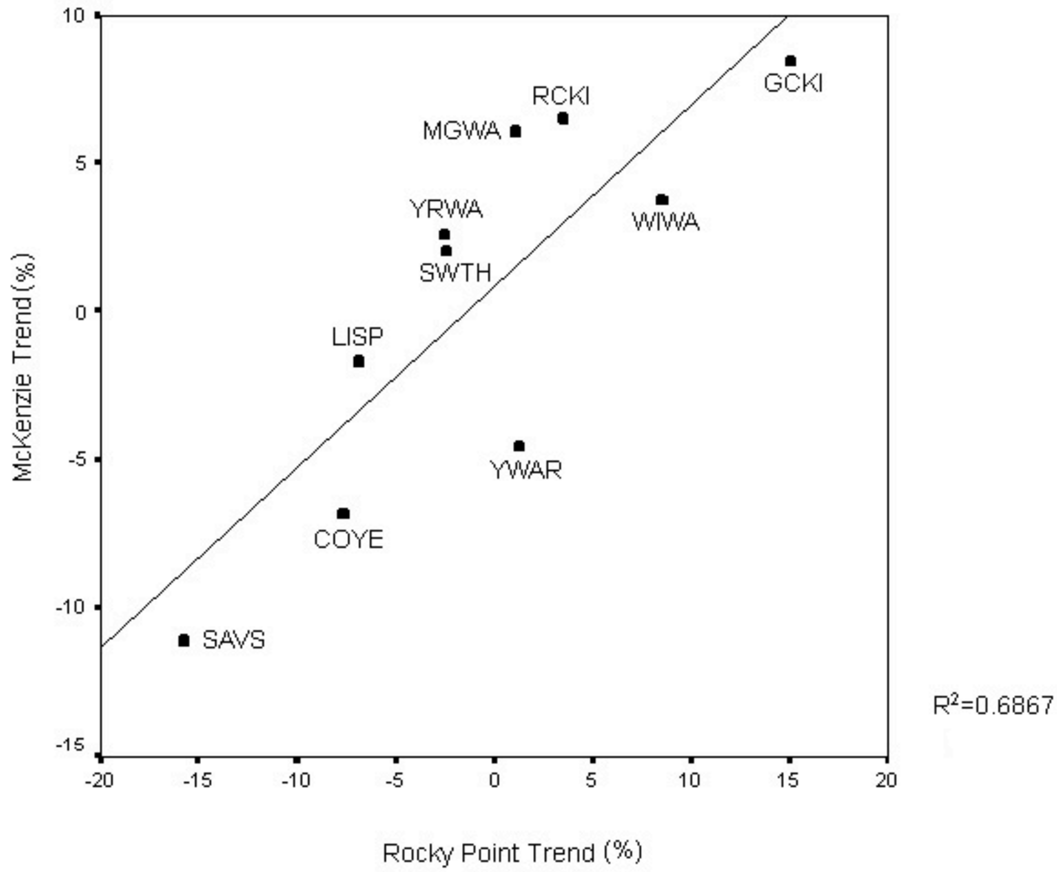

Figure 6. Correlation in trends in songbird abundance between two migration monitoring stations: Rocky Point Bird Observatory on southern Vancouver Island, and McKenzie Bird Observatory in north-central British Columbia.

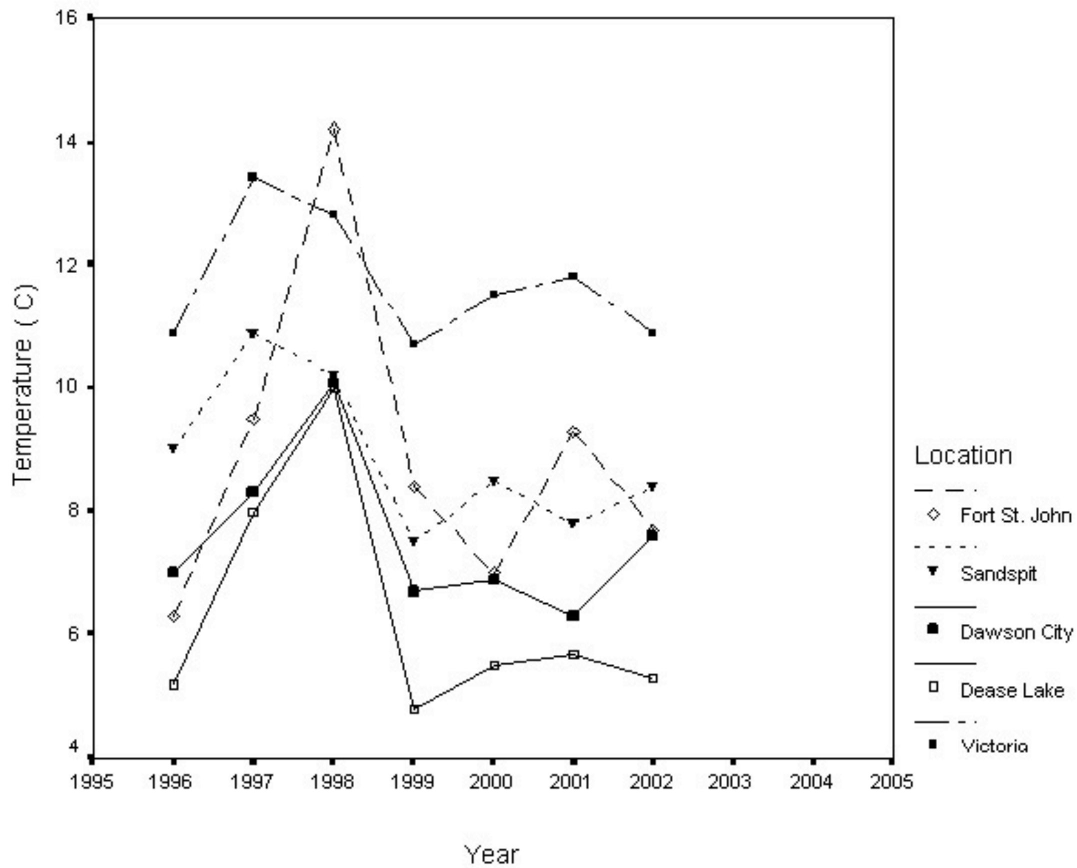

Figure 7. Mean May temperature (°C) at various locations in British Columbia and the Yukon Territory from 1996 to 2003. Temperatures were obtained from the Meteorological Society of Canada.

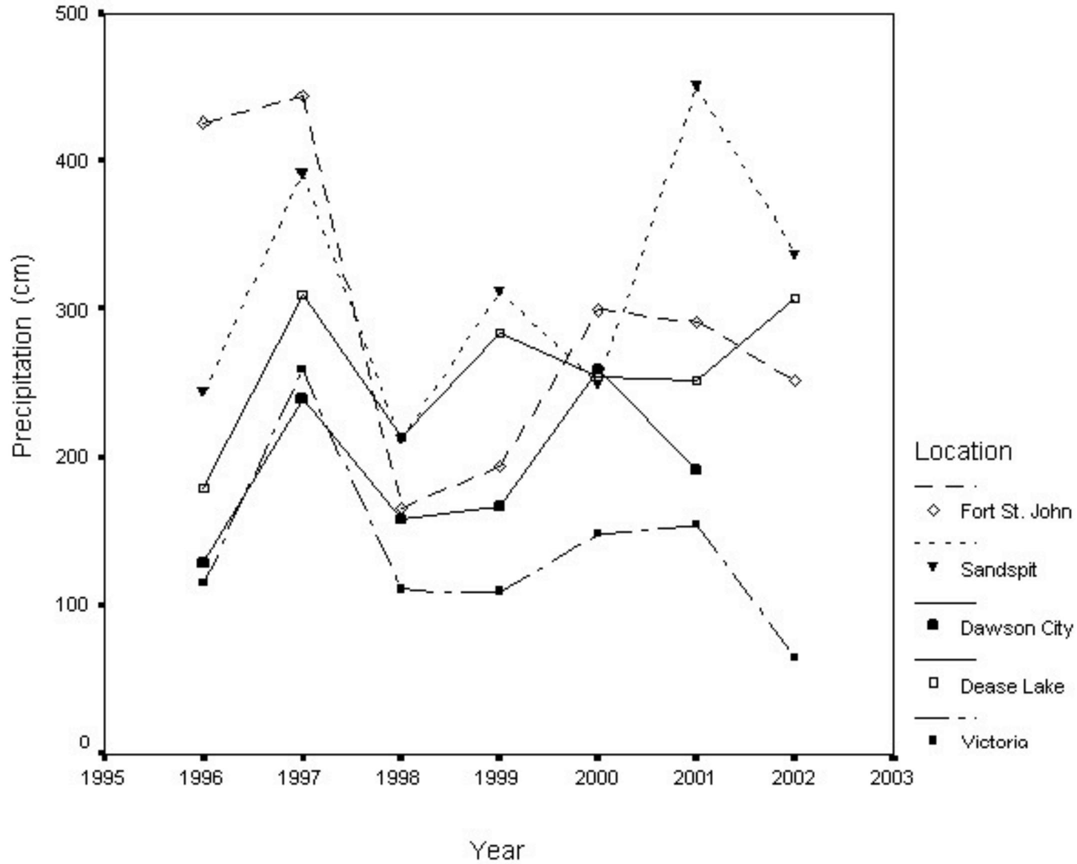

Figure 8. Cumulative precipitation (cm) from May to September, 1996-2002 at various locations in British Columbia and the Yukon Territory. Precipitation values were obtained from the Meteorological Society of Canada.