An Analysis of the Baseline Breeding Passerine Data for Godaleich Pond Delta; Upper Salmon Hydroelectrical Project.

CANADIAN WILDLIFE SERVICE

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Introduction

Baseline data of passerines breeding on a 100 ha study area on the Godaleich Pond delta were collected in 1983 (Linegar, 1983 interim report). Locations of singing males were plotted on base maps over a 10 day period in June-July by approximating locations to stratified transects spaced at 50 m intervals. These points were summarized as polygons or ellipses which are assumed to approximate the territory of the individual in question since the male "advertises" by song and defends a species-specific area within which a selected mate places the nest. Goudie (1982, interim report) considered that passerines should be particularly appropriate to monitor faunal and vegetational change on the 1 km^2 delta following the hydroelectrical development because:

1) changes in vegetation in the short term (1-5 years) would likely be of a small scale.
2) passerines have small home ranges and territories, i.e. $<$ 1 ha, and would be less affected by habitat/climate external to the study area.
3) it was expected that species would demonstrate preferences for various macrohabitats within the delta, and that hypotheses of changes in passerine species composition and density could be generated once habitat use was quantified.

In this paper we analyze the passerine baseline data, using multivariate techniques, to demonstrate the habitat gradients and positions of the observed species along these gradients. The resulting visual display clarifies which species can best reflect the hypothesized habitat changes.

Methods

The 100 ha study area was subdivided into 8 major habitats which reflected the main vegetational zones namely:

1) Marsh
2) Marsh-meadow
3) Low Alder ($\leq$ 1 m)
4) Medium Alder (1-2 m)
5) High Alder ($>$ 2 m)
6) Conifers
7) Deciduous trees
8) Open water

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The 32 ha study area containing the transects was outlined on colour air photos, scale 1:3125, and superimposed with a transparent acetate divisioned into 1 ha grids. Grids were serially numbered and 20 were selected using a random number table. Selected grids were observed in three-dimension using a stereoscope and the area of each habitat type was quantified using dot grids. These values were later converted to proportions which were subjected to an angular transformation (after Zar, 1974) to meet the assumptions of a normal distribution.

The a priori habitat data were analyzed using Principal Component Analysis (PCA) of the correlation matrix. The resulting principal components (eigen vectors) defined the habitat gradients within the study area. PCA is a descriptive multivariate statistical technique which reduces a large multivariable data set into a fewer linear combinations of variables. These new variables or principal components are described by coefficients, the magnitude of which can indicate their importance to that axis. The analysis is especially important in that each principal component is orthogonal and hence unrelated to the others, and account for decreasing amounts of variance (or information) in the data set. Furthermore, James (1971) pointed out that these analyses provide a tool for describing bird distributions objectively as ordinations of continuously - varying phenomena along gradients of vegetational structure. Obviously such an ordination presentation should better approximate the real responses of species to habitat.

To better highlight interspecific differences in macrohabitat use we subjected the data to a multivariate discriminant analysis (DA). Unlike PCA which defines orthogonal axes describing as much information as possible, DA defines linear axes through the data set which maximizes the differences among groups (in this case species). The new axes serves as a better discriminant than do any of the variables taken singly (Williams, 1981). We felt this analysis would aid in interpretation of the principal component plots from the former analysis.

Results

(i) Principal Component Analysis

The raw a priori habitat data represented 20 randomly selected 1 ha plots from a matrix of 32 ha (appendix 1). The first 3 principal components, defining habitat gradients, accounted for 79.8% of the variance (or information) in the multidimensional habitat space. Simple correlations of the variables to each axis (or component) are the best means for interpreting direction and contribution of each variable (table 1). Principal component I contrasted meadow and small alder with high alder and conifer-hardwoods. This represented the gradient from meadow to coniferous forest and accounted for 39.7% of the variance. PC2 contrasted marsh with meadow, low alder and medium alder and accounted for 29.7% of the variance. Principal component 3 was a hardwood component and accounted for 10.4% of the variance.

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Table 1 Principal components of *a priori* habitat data at Godaleich Pond delta

Variable (n = 20)	Correlation Coefficients PCI	PC2	PC3
Marsh	.248	-.741***	.178
Meadow	.479*	.693**	.336
Low Alder	.667**	.531*	.327
Medium Alder	-.285	.821***	-.265
High Alder	-.773***	.306	-.240
Conifer	-.836***	.013	.363
Hardwood	-.815***	.025	.467*
Proportion of variance accounted for	39.7%	29.7%	10.4%

* $P < .05$
** $P < .01$
*** $P < .001$

The resulting principal components (eigen vectors) were used to generate component scores for the passerine species along these gradients (see appendix 2 for raw data). Plots in component score space suggested distinct habitat use along our defined gradients namely: Swamp sparrows (n = 31) extensively utilized meadow/low alder zone. Yellow warblers (n = 16) predominated in the low alder-medium alder zone overlapping with Wilson's warbler (n = 11) which seemed to prefer the medium alder zone and extended into the conifer-hardwood habitats. Patterns for the remaining 6 species were less clear because of few territories but all were distributed in the high alder-conifer/hardwood end of the habitat gradient, i.e., Myrtle Warbler (n = 4), Blackpoll warbler (n = 2), Black and white warbler (n = 4), Northern Waterthrush (n = 7), Fox Sparrow (n = 3), American Redstart (n = 2) (fig. 1).

ii) Discriminant Analysis

The first two canonical variables (or discriminant axes) accounted for 92% of variance in the data set. Canonical variable 1 accounted for 75.6% of the variance and similar to PCI contrasted meadow with hardwood habitat. CV2 accounted for 16.5% of the variance and described conifer habitats (table 2). Plots of species in discriminant score space provided a linear segregation similar to the PC plots. However additional separation was achieved for the Myrtle warbler and Blackpoll warbler on CVI suggesting the former chose a higher component of hardwoods in their predominantly forested territories. American Redstarts segregated entirely along the CV2 suggesting unique hardwood territories. Swamp sparrow, Yellow warbler, and Wilson's warbler were intermediate on this axes suggesting no conifers or hardwoods in their territories, as well, these species orientated in a similar fashion along CVI as was evident in the PCA (figure 2).

Both the PCA and DA were complimentary and strengthened the interpretation of the data in the above manner. With the species orientated along defineable habitat gradients it was then possible to predict the species composition and density changes which might occur under a given directional habitat change.

Discussion

A draw-down channel was constructed at the outlet of Godaleich Pond during the construction phase of the Upper Salmon hydroelectrical development. The environmental impact study identified Godaleich Pond delta (= West Salmon Marsh) as an enriched ecological site that should be preserved if possible. The draw-down channel was a mitigative procedure to prevent inundation, and to stabilize water levels on the delta. The implications to the ecosystem of the delta are that the area will progress over time toward more terrestrial communities. The frequent flooding and sedimentation that historically took place on this dynamic site were the major factors maintaining the extensive meadow communities and preventing invasion by shrubs and trees. We expect that the meadow complex will rapidly be invaded by alders and the entire delta will shift, over time, toward a more boreal forest community.

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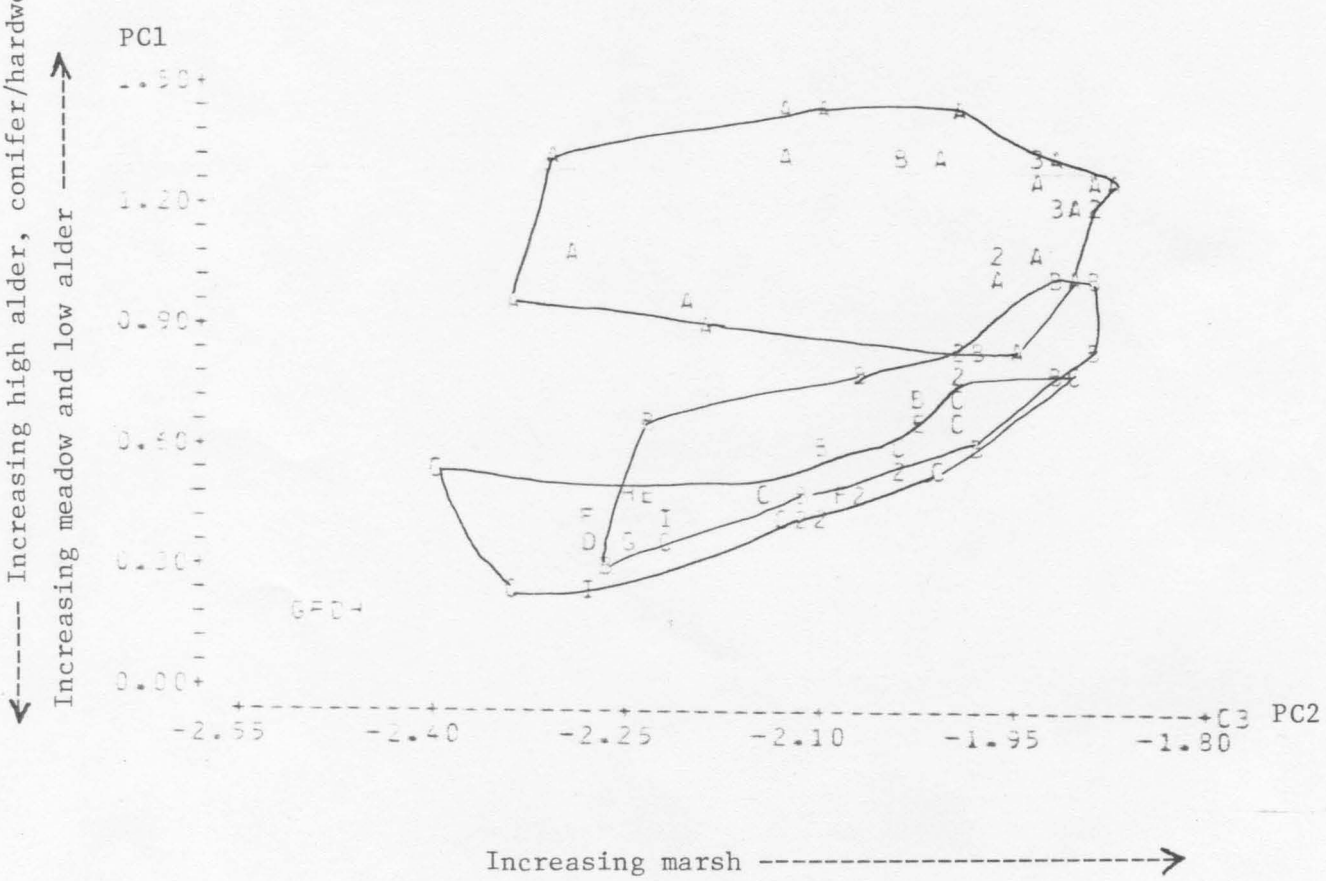

Figure 1 Principal component score plot showing position of passerine species along the a priori habitat gradient for Godaleich Pd. delta. Swamp Sparrow (A), Yellow Warbler (B), and Wilson's Warbler (C) are outlined.

Table 2 Discriminant analyses of bird territory habitat data at Godaleich Pond

Variable (n = 77)	Standardized Coefficients CVI	CV2
Marsh	.267	.423
Meadow	.489	.939
Low Alder	.164	1.04
Medium Alder	-.048	.231
High Alder	-.124	.225
Conifer	-.013	1.60
Hardwood	-1.64	.091
Proportion of variance accounted for	75.6%	16.5%

Figure 2 Discriminant score plot for passerine territory plots Godaleich Pond delta, 1983.

GROUP	MEAN COORDINATES		SYMBOL FOR CASES	SYMBOL FOR MEAN
SWAMP	2.29	0.1+	A	
YELLOW	-0.17	-0.32	B	
WILSONS	-1.[illegible]	-1.21	C	
MYRTLE	-3.01	1.13	D	
BLACKPOL	-1.37	1.64	E	
SNOW	-[illegible]	1.[illegible]	F	
WATERTHR	-[illegible]	0.97	G	
FOX	-[illegible]	1.[illegible]	H	
REDSTART	-2.38	-3.25	I	

Our present analysis suggested that the Swamp sparrow, Yellow warbler, and Wilson's warbler will be the best initial indicator species of the short term alder invasion of the floodplain. In the long term the remaining "forest" species would be expected to increase in importance. At present meadows are the most prevalent habitat type and not surprisingly the Swamp sparrow which prefers this zone is the most abundant passerine breeding on the delta. We predict that alder habitat has increased at the sacrifice of meadow habitats and Swamp sparrow will decrease in importance while initially Yellow warblers and perhaps Wilson's warblers will increase in abundance. The predicted changes favoring the "forest" species are anticipated to take at least3-5 years.

James, F.C. 1971. Ordinations of habitat relationships among breeding birds, Wilson Bull. 83(3): 215-235.

Williams, B.K. 1981. Discriminant analysis in wildlife research: theory and applications pp 59-71 In D.E. Capen ed. The use of multivariate statistics in studies of Wildlife habitat. Rocky mountain forest and range experiment station. General technical Report Rm-87.

Appendix 1 Raw data for 20 random 1 ha grids for habitat on the Godaleich Pond delta study area.

Grid	Marsh	Meadow	Low Alder	Medium Alder	High Alder	Conifer	Hard-wood
34	0.000	0.188	0.093	0.109	0.001	0.001	.001
2	0.207	0.198	0.022	0.007	0.001	0.001	.001
22	0.039	0.109	0.001	0.124	0.001	0.039	.001
12	0.024	0.380	0.221	0.291	0.001	0.001	.001
15	0.079	0.111	0.024	0.357	0.001	0.116	.001
30	0.001	0.260	0.129	0.290	0.001	0.001	.001
26	0.001	0.271	0.023	0.376	0.045	0.150	.008
18	0.040	0.206	0.001	0.333	0.079	0.162	.008
21	0.001	0.228	0.016	0.512	0.095	0.024	.001
22	0.039	0.109	0.001	0.124	0.001	0.039	.001
2	0.207	0.198	0.022	0.007	0.001	0.001	.001
28	0.001	0.016	0.016	0.001	0.001	0.001	.001
11	0.109	0.449	0.037	0.202	0.015	0.008	.001
3	0.068	0.045	0.023	0.099	0.278	0.138	.008
31	0.001	0.108	0.001	0.643	0.235	0.001	.001
5	0.297	0.015	0.001	0.022	0.001	0.001	.001
12	0.024	0.380	0.221	0.291	0.001	0.001	.001
18	0.040	0.206	0.001	0.333	0.079	0.162	.008
14	0.008	0.474	0.068	0.338	0.060	0.001	.001
27	0.001	0.031	0.001	0.125	0.056	0.096	.023

Appendix 2 Raw data for proportion of habitat types in passerine territories

Species	Marsh	Meadow	Low Alder	Med Alder	High Alder	Conifer	Hardwood

Coudie, R Ian

DATA FILE

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Name Date