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Research and Development

Predicting Effects of an Electric Generating Station on Wetland Passerine Birds

Wisconsin Power Plant Impact Study

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PREDICTING EFFECTS OF AN ELECTRIC GENERATING STATION ON WETLAND PASSERINE BIRDS

Wisconsin Power Plant Impact Study

by

Michael John Jaeger
Institute for Environmental Studies
University of Wisconsin-Madison
Madison, Wisconsin 53706

Grant R803971

Project Officer

Gary E. Glass
Environmental Research Laboratory-Duluth
Duluth, Minnesota

This study was conducted in cooperation with

Wisconsin Power and Light Company,
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Wisconsin Public Service Commission,
and Wisconsin Department of Natural Resources

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FOREWORD

The U.S. Environmental Protection Agency (EPA) was designed to coordinate our country's efforts toward protecting and improving the environment. This extremely complex task requires continuous research in a multitude of scientific and technical areas. Such research is necessary to monitor changes in the environment, to discover relationships within that environment, to determine health standards, and to eliminate potentially hazardous effects.

One project, which the EPA is supporting through its Environmental Research Laboratory in Duluth, Minnesota, is the study "The Impacts of Coal-Fired Power Plants on the Environment." This interdisciplinary study, centered mainly around the Columbia Generating Station near Portage, Wis., involves investigators and experiments from many academic departments at the University of Wisconsin and is being carried out by the Environmental Monitoring and Data Acquisition Group of the Institute for Environmental Studies at the University of Wisconsin-Madison. Several utilities and State agencies are cooperating in the study: Wisconsin Power and Light Company, Madison Gas and Electric Company, Wisconsin Public Service Corporation, Wisconsin Public Service Commission, and Wisconsin Department of Natural Resources.

During the next year reports from this study will be published as a series within the EPA Ecological Research Series. These reports will include topics related to chemical constituents, chemical transport mechanisms, biological effects, social and economic effects, and integration and synthesis.

One pronounced effect of the Columbia Generating Station is an increase in the water levels and water temperatures in a wetland adjoining the site. This report examines the importance to five passerine bird species of specific habitat variables and, on the basis of that examination, predicts how changes in the wetland are likely to affect bird populations and distributions.

J. David Yount
Acting Director
Environmental Research Laboratory-Duluth
Duluth, Minnesota

ABSTRACT

The distribution of breeding passerines (songbirds) was investigated in a wetland in southern Wisconsin to develop a model for use in predicting changes in bird frequencies resulting from environmental alterations. The wetland is adjacent to the cooling lake of a coal-fired electric generating station. The water levels in the wetland are being altered by the cooling lake's effect on the local ground-water system. The model uses information on distributions of bird species along gradients of water depth and vegetation-structure characteristics and information on the relationships between the characteristics to predict changes in bird species' frequencies resulting from increased water levels. The predictions are qualitative, in that they predict only the direction of the change, not its magnitude. The resulting predictions are: (1) the long-billed marsh wren should increase in frequency; and (2) the swamp sparrow, common yellowthroat, and yellow warbler should decrease in frequency. No prediction could be made concerning the frequency of the red-winged blackbird.

This report was prepared with the cooperation of faculty and graduate students in the Department of Zoology at the University of Wisconsin-Madison. Most of the funding for the research reported here was provided by the U.S. Environmental Protection Agency; funds also were granted by the University of Wisconsin-Madison, Wisconsin Power and Light Company, Madison Gas and Electric Company, Wisconsin Public Service Corporation, and the Wisconsin Public Service Commission. This report is submitted toward fulfillment of Grant No. R803971 by the Environmental Monitoring and Data Acquisition Group, Institute for Environmental Studies, University of Wisconsin-Madison, under the partial sponsorship of the U.S. Environmental Protection Agency. The report covers the period May 1975 to December 1977, and work was completed as of December 1978.

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Barbara Bedford and Stephen Brick assisted me in the collection of the field data. I greatly appreciate their help and encouragement and humbly apologize for forcing them to awaken so often in what seemed the middle of the night to collect the data.

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Finally, I thank Daniel Willard for his constant help and encouragement in overseeing this research.

SECTION 1

INTRODUCTION

The Columbia Generating Station, a new coal-fired electric generating station, is located on the Wisconsin River 4 miles south of Portage, Wis. It consists of two 527-MW generating units, one in operation since April 1975 and the second since May 1978. Waste heat from this facility is dissipated to the air by using a 2-km^2 (490-acre) cooling lake and two wet cooling towers. The cooling lake was built in a large riparian wetland of sedge meadow, shallow marsh, shrub carr, and flood-plain forest. Studies have been conducted on the effects of the cooling lake on the local ground-water regime and the effects of the altered ground-water regime on vegetation in the wetland adjacent to the cooling lake (Andrews and Anderson 1978).

Prior to construction of the cooling lake, the wetland was a discharge area of the local ground-water system. The operation of the cooling lake has greatly modified ground-water-flow patterns in this wetland area (Andrews and Anderson 1978). Discharge rates have increased by a factor of 6, and in addition the seasonal temperature profile of the discharging water has been altered. The altered ground-water-flow rates and seasonal temperature patterns have had severe effects on the wetland vegetation, in part because of the altered seasonal phenology of the plants (Bedford 1977). A rapid thinning of sensitive perennials is occurring, and annuals and more tolerant perennials are invading the area.

In the early part of the research program a simple model was constructed to predict the impact of the generating station on the breeding birds found in the wetland. The work previously cited indicates large modifications in both biotic and abiotic components of the nesting habitat of these birds. This investigation uses correlations between water depths, components of vegetation structure, and distributions of breeding birds to predict frequency changes in the nesting birds given the condition of increased water levels.

At the beginning of the nesting season a bird must choose an area suitable for nesting. Any place it attempts to settle will be a complex matrix of environmental factors, both biotic and abiotic. Each species has a range of tolerance, over which it can survive and successfully reproduce, for each environmental factor. When all individual tolerances are plotted together in a space representing the whole environmental range, with each factor on a separate axis, an n-dimensional hypervolume results (Hutchinson 1957). This hypervolume is a graphic representation of the areas suitable for that species.

Hutchinson's hypervolume model can be used to predict the effects of environmental alterations on bird species by comparing the hypervolume of the total area in question with the subset of that hypervolume that is used by a species (Shugart and Patten 1972, Anderson and Shugart 1974).

If a species' hypervolume is identical to the total hypervolume, that species should occur throughout the area. If a species' hypervolume does not lie anywhere within the total hypervolume, that species should not be present at all. Neither of these two cases is of any great value to the present analysis. The more common situation is that part of a species' hypervolume occupies a portion of the total hypervolume. Habitat alterations that shift the total hypervolume in the direction of the species' hypervolume should increase the suitable habitat for that species, and the species should become more abundant. Likewise, a shift away from the species' hypervolume should decrease the available suitable habitat, and the species should become less abundant. These two notions in a simplified form are the basis of the analyses that follow.

SECTION 2

CONCLUSIONS

Five habitat variables--percentage of cover, water-depth deviation, percentage of graminoid stems, percentage of dead stems, and stem density--have significant linear correlations with average water-depth values. A sixth variable, effective height, does not.

Distributions of passerines are correlated with five habitat variables: Average water depth, percentage of cover, percentage of dead stems, percentage of graminoid stems, and stem density. They are not correlated with water-depth deviation or effective height.

A passerine's frequency is related to its distribution along a habitat variable.

The altered water regime predicts a series of vegetation changes, which in turn generate predictions for changes in frequencies of the passerines. The long-billed marsh wren should increase; the swamp sparrow, common yellow-throat, and yellow warbler should decrease. No prediction could be made concerning the red-winged blackbird.

The analyses concern the frequency of occurrence of a species, but not their density. A more complete approach would measure densities or some form of reproductive success; however, the field methods used in this study do not allow these forms of analysis.

SECTION 3

RECOMMENDATIONS

Since the wetland is still in a state of transition, the breeding passerines should be surveyed again when the water regime and the vegetation have reached a new equilibrium to determine if the predicted changes in bird populations have occurred.

This form of analysis could be applied to other situations when a knowledge of the qualitative changes in frequencies of bird species is desired.

This first-order model should be expanded to allow quantitative predictions of changes in frequencies and abundances.

Caution should be exerted when building cooling lakes near wetland areas so that valuable bird-breeding areas are not significantly degraded.

SECTION 4

SAMPLING METHODS

Data on bird distributions, water depths, and vegetation-structure characteristics were collected in 59 sampling plots between 22 May and 2 June 1975 in the wetland adjacent to the cooling lake (Figure 1). The plots were circular with a radius of 20 m and an area of one-eighth ha. They were centered on stakes that mark the corners of an existing 50-m by 50-m grid pattern that covers that section of the wetland.

Bird populations were observed once in each area for a 12-min period. All observations were conducted during the 3 h following sunrise. Data were collected on the number of individuals of each species present, the sex of each individual, and their activity.

Data on seven water-depth and vegetation-structure characteristics were collected in each sample plot: percentage of cover, average water depth, average water-depth deviation, stem density, percentage of graminoid stems, percentage of dead stems, and effective height.

To determine percentage of cover a 10-m line intercept, divided in 100 lengths (10 cm each), was randomly run through each bird-sampling plot. The number of lengths that intercepted open water and the number that intercepted vegetation were recorded, and a value for percentage of cover was calculated.

A water-depth measurement was taken at 0.5-m intervals along the same line intercept, and the mean of the resulting 20 measurements was calculated.

The standard deviation of the water-depth measurements was calculated to acquire a rough estimate of the evenness of the bottom substrate.

To measure stem density five circles, each with an area of 0.5 m^2, were randomly located within each bird-sampling plot. The total number of plant stems located within each circle was counted, and the five values were averaged.

In the same circles the number of plant stems that were of graminoid structure and the number that were of broad-leaved structure were counted. The percentage of all stems that were of graminoid structure was calculated.

The number of dead stems and the number of live stems in each circle were counted, and the percentage of dead stems was calculated.

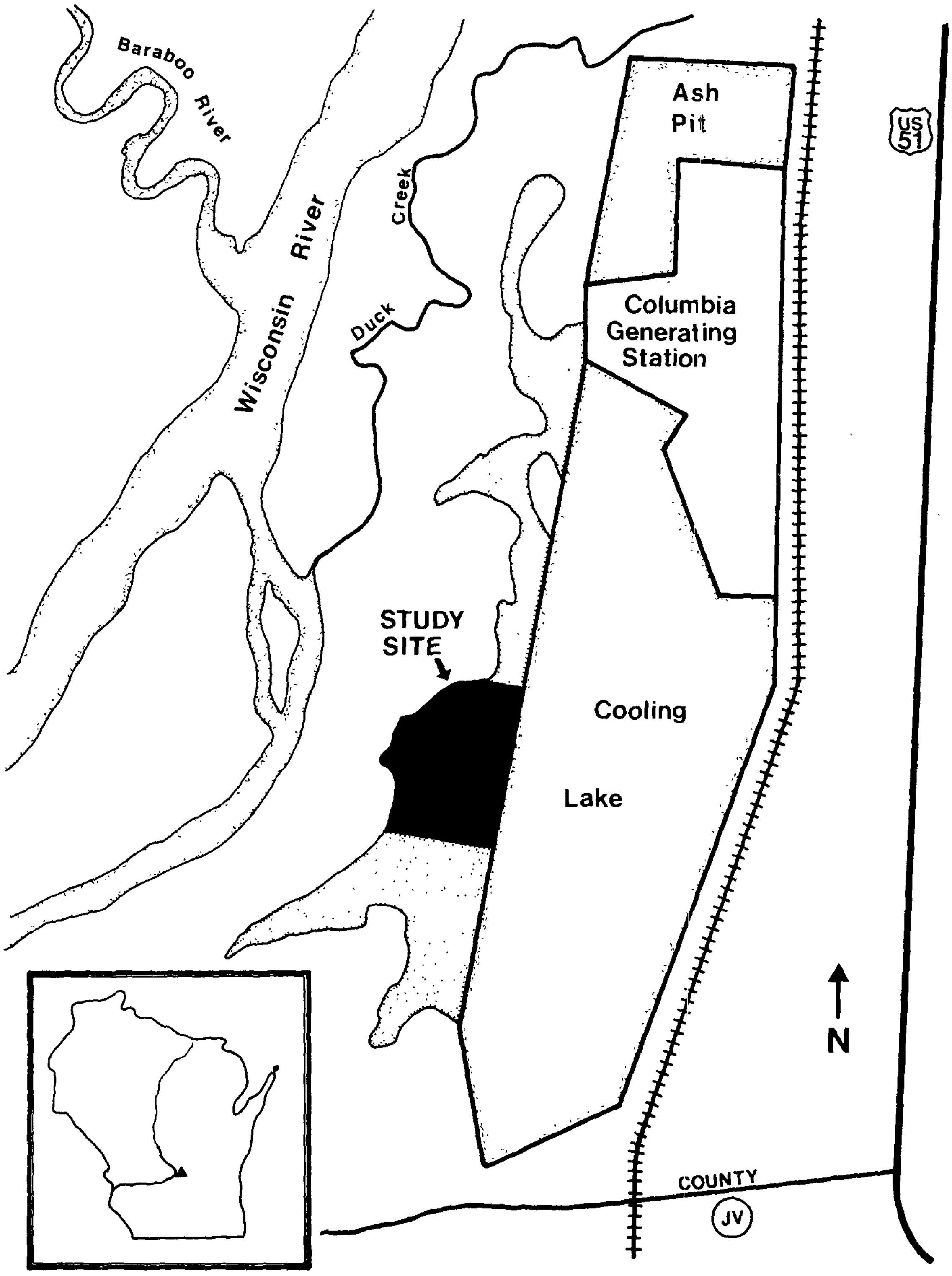

Figure 1. Columbia Generating Station and location of wetland study site adjacent to the cooling lake. Insert shows location of generating station.

To determine the effective height of the vegetation, a wooded stake, marked off in decimeters, was placed at the center of each circle. The height to which the vegetation covered each stake when viewed from approximately 1 m was recorded and these values were averaged.

SECTION 5

RESULTS

This paper examines the distribution patterns along gradients of water depth and vegetation-structure variables of five wetland passerine species: the red-winged blackbird, long-billed marsh wren, swamp sparrow, common yellowthroat, and yellow warbler. These species compose the vast majority of the birds observed in the sampling plots. Although the sampling technique was well suited for conspicuous birds, such as singing passerines, it did not adequately sample many inconspicuous species, such as rails and bitterns. The distribution patterns of the less conspicuous species are relevant to the problem at hand, but analysis of the data collected on them could be very misleading.

The bird-distribution analyses are divided into four sections. First, the bird distributions were compared to gradients of habitat variables, to determine if the birds were using only portions of the available habitat, at least portions that could be characterized by the water regime and vegetation structure. Second, the frequencies of occurrence of the bird species were analyzed with respect to their distributions along habitat gradients. Third, the correlations between average water depth and the other habitat variables were determined. Fourth, the previous analyses were combined to generate predictions on frequency changes in the birds that would result from the increasing water levels in the wetland.

DISTRIBUTIONS ALONG HABITAT VARIABLES

The values of a particular variable for all sample plots in which a particular bird species was present were compared with the values of that variable in all the sample plots in which the bird species was not found. This comparison was done both graphically and with the Mann-Whitney U-test. The tests showed if a bird species was found in areas that represent only a portion of the total range of a habitat feature. The null hypothesis for the Mann-Whitney test was that the mean value of the habitat variable in the areas where a species was found was equal to the mean value in the areas where the species was not found.

Two patterns were evident in the graphic representations of distributions along habitat gradients. The first pattern is illustrated by the distribution of the long-billed marsh wren along the effective height variable (Figure 2). The distribution of the sample plots with marsh wrens is almost identical to the distribution of the sample plots lacking marsh wrens, which indicates that marsh wrens apparently make no preferential use of any particular range of this variable. In the second pattern the distribution of the values of stem density in the sample plots with marsh wrens is different from the distribution of the values in sample plots lacking marsh wrens (Figure 3). Marsh wrens were found more often in areas with low stem-density values and were infrequently found in areas with higher values.

Statistical tests were performed to determine significant differences between the "present" and "absent" distributions. These tests compared the means of the two distributions, with the null hypothesis stating that they were equal (Table 1).

For the red-winged blackbird the only significant difference between the present and absent values was along the percentage graminoid-stems variable. The red-wing was found in almost all the sample plots, so these analyses are not very conclusive.

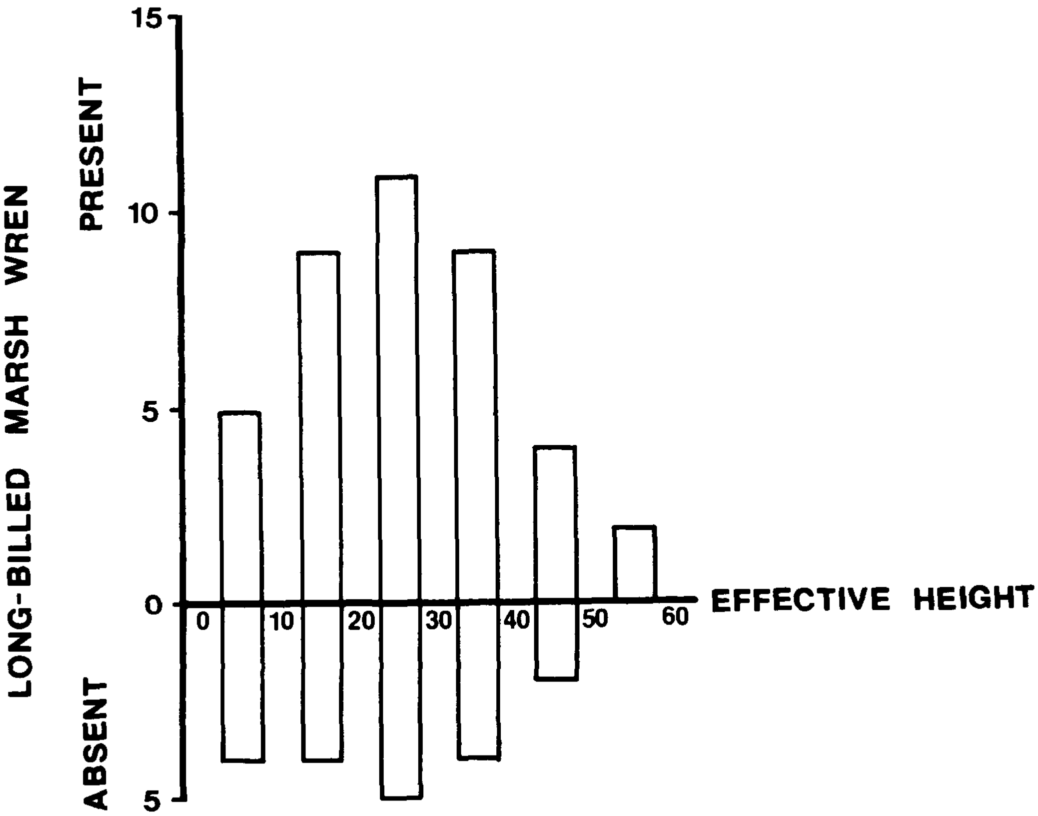

Figure 2. Distribution of effective height values in sample plots where long-billed marsh wrens were present and where they were absent.

The long-billed marsh wren, swamp sparrow, and common yellowthroat had significant differences between the means for five habitat variables: average water depth, percentage cover, percentage graminoid stems, percentage dead stems, and stem density. The yellow warbler, the most infrequent species in the wetland, had significant differences for only three variables: average water depth, percentage cover, and percentage graminoid stems.

No species showed a significant distribution pattern on the water-depth-deviation variable. Only the swamp sparrow had a significant difference between means on the effective height variable.

FREQUENCY RELATIONSHIPS

The values of a habitat variable in the sample plots that contained a species were averaged, which resulted in a specific mean for that variable. The overall mean for a variable was calculated by averaging the values

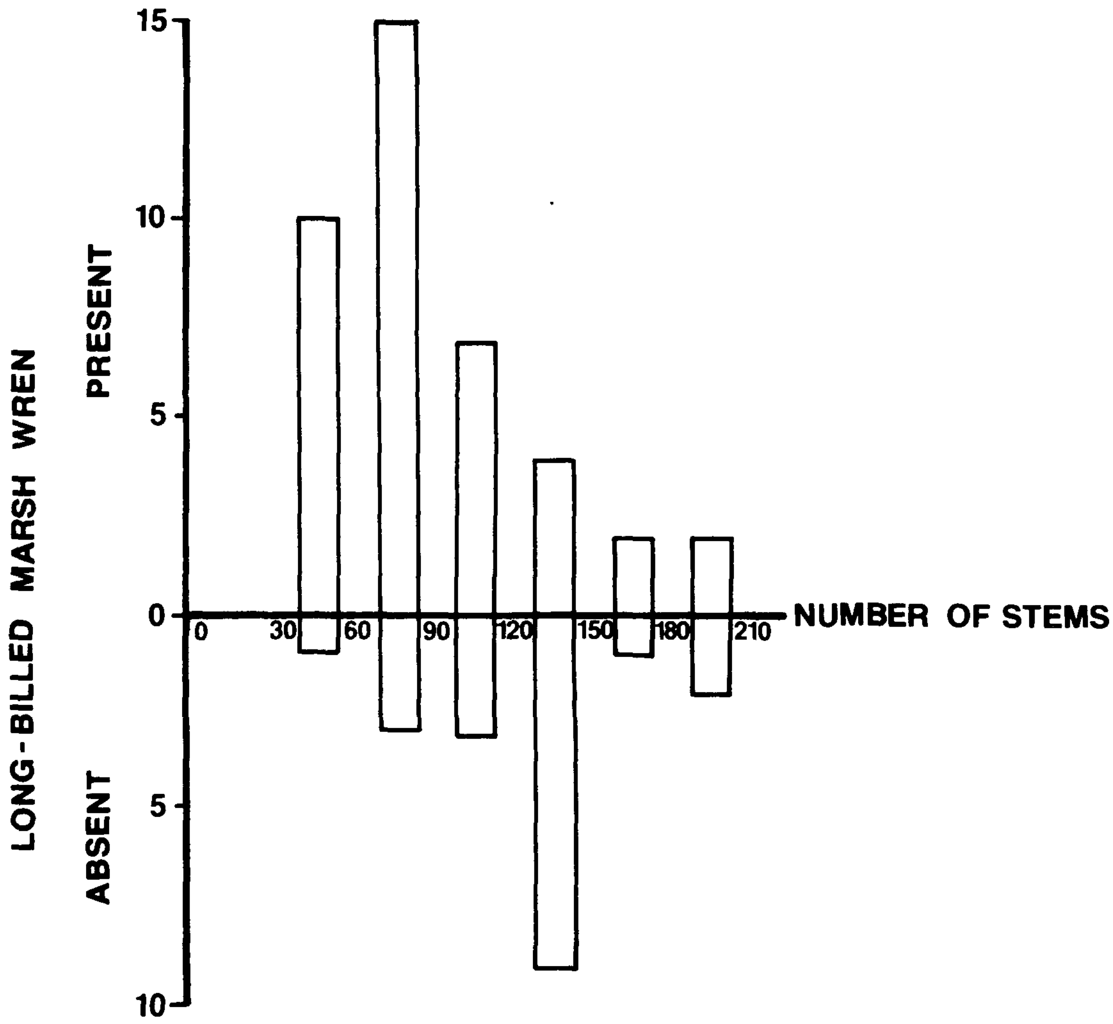

Figure 3. Distribution of stem-density values in sample plots where long-billed marsh wrens were present and where they were absent.

TABLE 1. RESULTS OF MANN-WHITNEY U-STATISTIC WHEN COMPARING MEAN OF "PRESENT" VALUES AND MEAN OF "ABSENT" VALUES OF FIVE BIRD SPECIES AND SEVEN HABITAT VARIABLES

Habitat variable	Year	Red-winged blackbird	Swamp sparrow	Long-billed marsh wren	Common yellow-throat	Yellow warbler
Average water depth	1975	0[a]	++[b]	++	++	+[c]
Percentage cover	1975	0	++	+	+	0
Water-depth variation	1975	0	0	0	0	0
Percentage graminoid stems	1975	+	+	++	++	+
Percentage dead stems	1975	0	++	++	++	0
Stem density	1975	0	+	++	+	0
Effective height	1975	0	+	0	0	0

[a] 0 indicates no significance.

[b] ++ indicates significance level of $p < 0.01$.

[c] + indicates significance level of $p < 0.05$.

measured in all sample plots. The five specific means, one for each bird species, were then compared to the overall mean for each variable. The deviation (D) of each specific mean from the overall mean was calculated by: $D = |\overline{X} - \overline{S}|$, where $\overline{X}$ is the overall mean and $\overline{S}$ is the specific mean.

The frequency of each species was regressed on the species' deviation value (Figure 4). A significant linear correlation ($p < 0.05$) for this regression occurred with four habitat variables: average water depth, percentage cover, percentage graminoid stems, and percentage dead stems. The correlation coefficient was negative in each case; in other words, the further a specific mean deviated from the overall mean, the less frequent the species was. No significant linear correlations occurred for three variables: water-depth deviation, stem density, and effective height. In these cases deviation of the specific mean from the overall mean cannot be used to predict the frequency of the species.

The relative locations of the specific means with respect to the overall means reveal an interesting pattern (Figure 5). The red-winged blackbird's specific mean is always near the overall mean, probably because the red-wing was found in a high percentage of the sample plots. The long-billed marsh wren's specific mean is always located on one extreme of the gradients, while the means of the other three species are found at the other end of the gradients.

RELATION BETWEEN WATER DEPTH AND HABITAT VARIABLES

Previous sections have shown the relationships between species distributions and the values of the habitat variables. The following analysis will examine relationships between the habitat variables to determine whether or not they are independent. The variables will be compared to average water-depth values, because one major effect of the cooling lake on the wetland is an alteration of water levels.

The values for each variable were regressed on the values of average water depth (Figure 6). Except for effective height, all variables resulted in a statistically significant linear correlation with average water depth, and the slopes of the regression lines are significantly different from zero.

These correlations, however, are not always very strong. The r^2 value, which represents the percentage of the variation of the dependent variable that is accounted for by the independent variable, is often low, and in no case exceeds 60%.

The significant linear correlations between the variables and the water-depth values can be taken to mean that a change in the values of water depth can predict changes in the other variables.

In some cases a curvilinear relationship would fit the data better than a linear one. A curvilinear function would predict the same direction of change as the linear one, but would predict a different magnitude of that

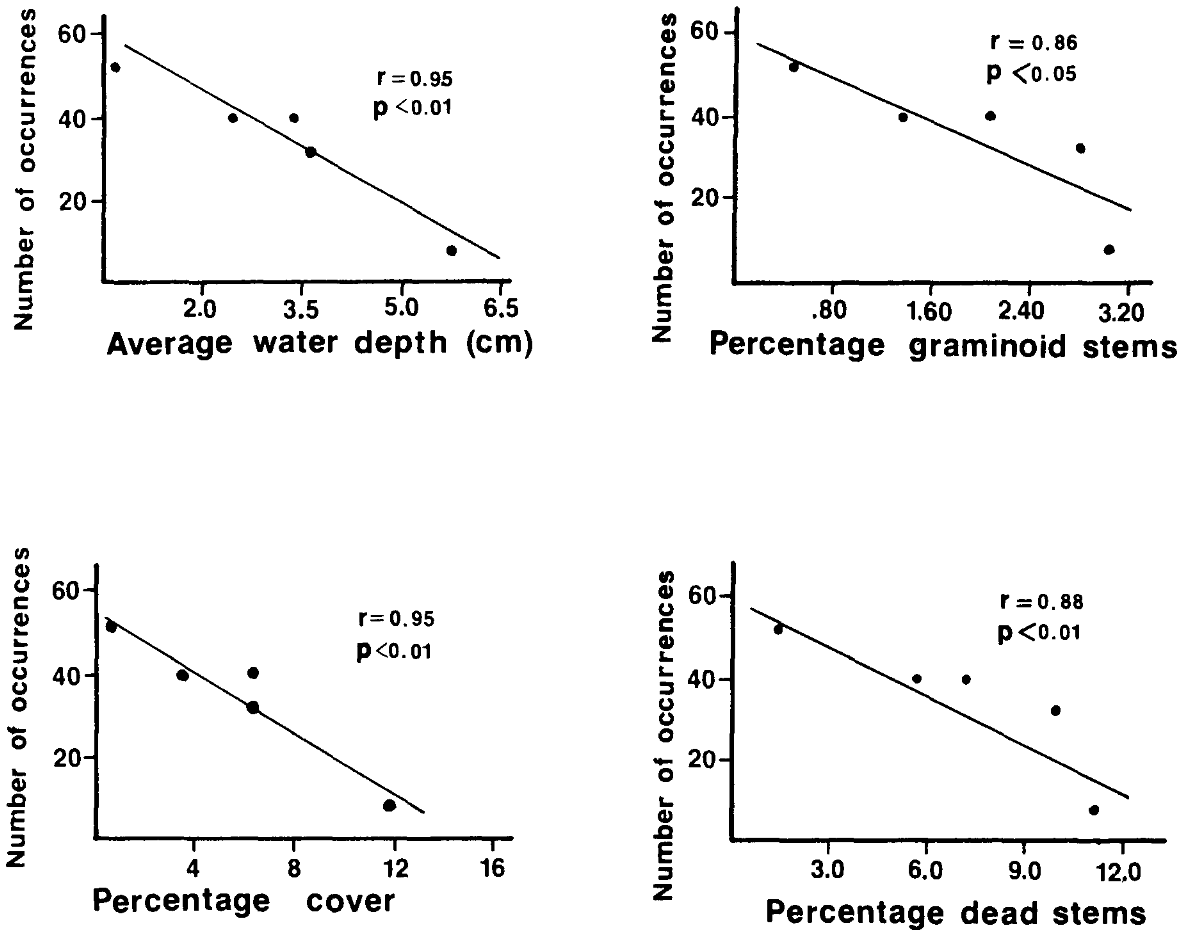

Figure 4. Regression of frequency (number of occurrences) of five passerines on the deviation of specific means from overall mean for the water-regime and vegetation-structure variables. (continued)

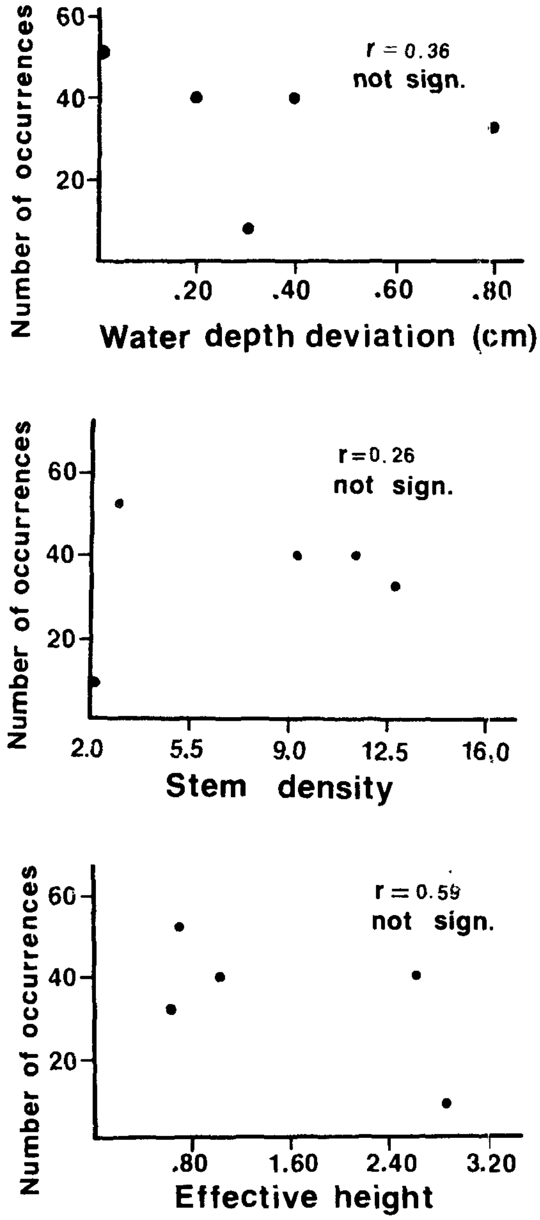

Figure 4. (continued)

change. Since the goal of this analysis is the prediction of direction, not of magnitude, the linear function provides adequate approximations of the relationships among the variables.

PREDICTIONS OF FREQUENCY CHANGE

The foregoing analyses can be connected to make a set of predictions concerning changes in frequencies of the bird species resulting from an increase in overall water levels in the wetland. Since the red-winged

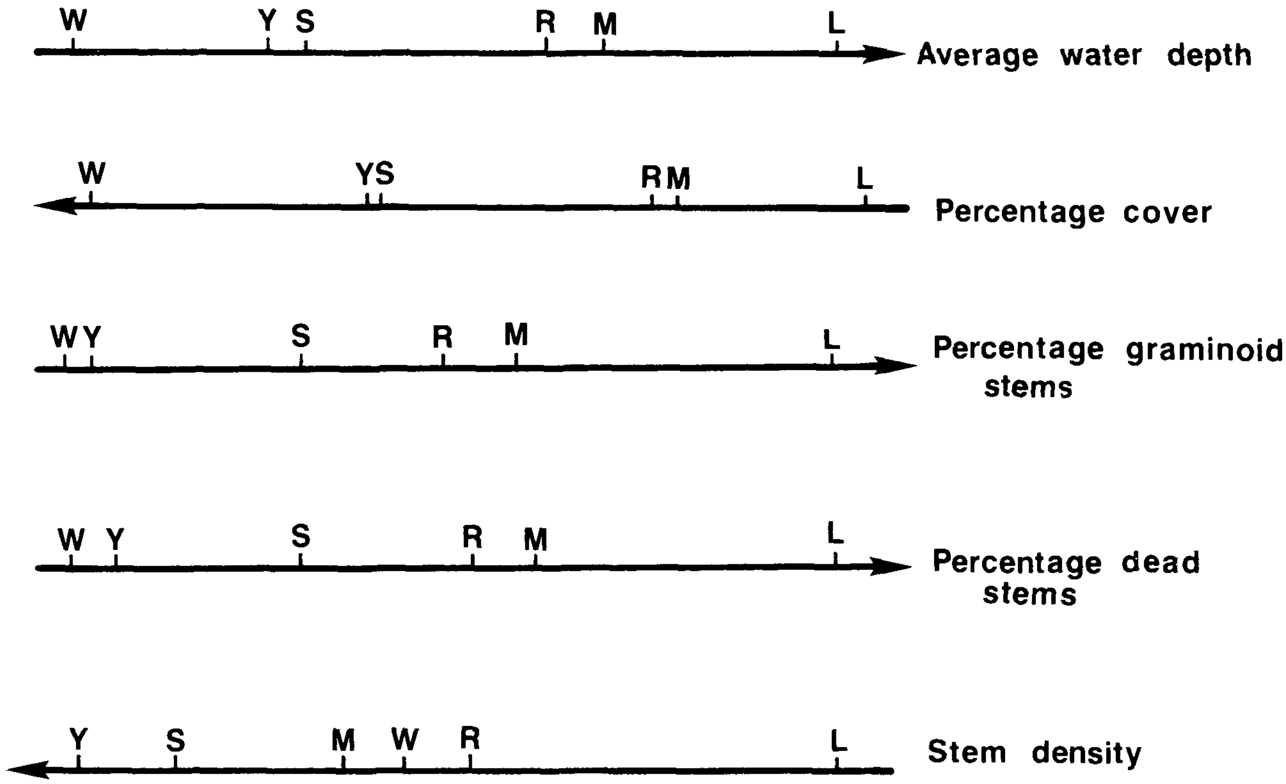

Figure 5. Relative positions of specific means and the overall mean for habitat features along which bird-distribution patterns were significant. M is the overall mean, W is the yellow warbler, Y is the common yellowthroat, S is the swamp sparrow, R is the red-winged blackbird, and L is the long-billed marsh wren. Arrows point towards larger values.

blackbird was present in most of the sample plots, no predictions about its distribution can be made, and it is left out of the analysis. Predictions about frequency changes can be made for the other species, whose distributions are centered toward an extreme of the habitat variable. Their frequency in the wetland is negatively correlated with the deviation of their specific mean from the overall mean. A shift in the overall mean of a variable toward a specific mean should increase the habitat used by that species, and its frequency should increase (Shugart and Patten 1972, Anderson and Shugart 1974). A shift in the overall mean of a variable away from the specific mean should decrease the habitat usable by that species, and it should become less frequent (Figure 7).

The groundwater hydrology modeling of the Columbia site has shown an increase in ground-water flow into the wetland (Andrews and Anderson 1978). The increased ground-water flow is raising the surface water levels in the wetland. The overall mean of the average water depth is shifting towards the

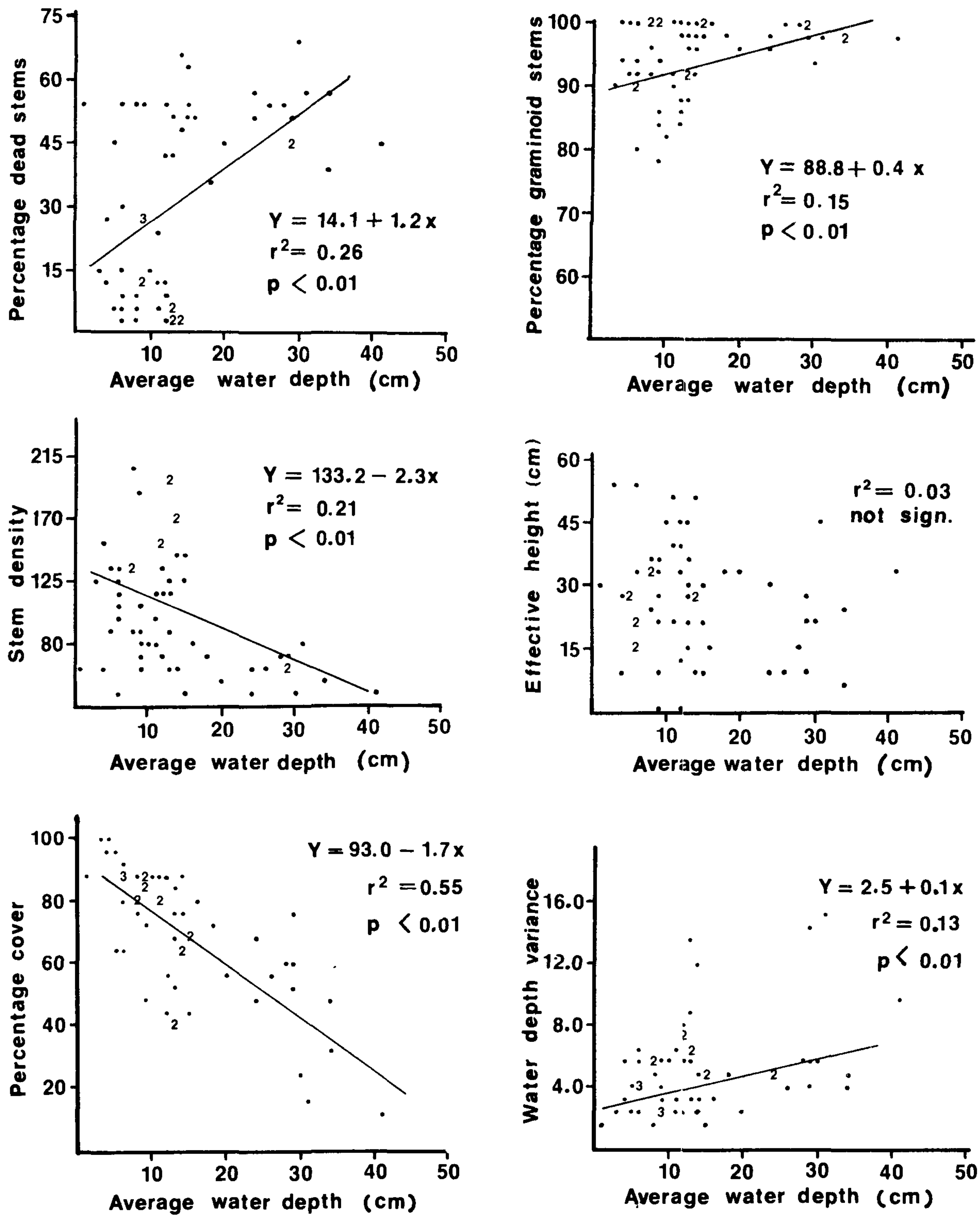

Figure 6. Regression of the values of each habitat variable on average water-depth values.

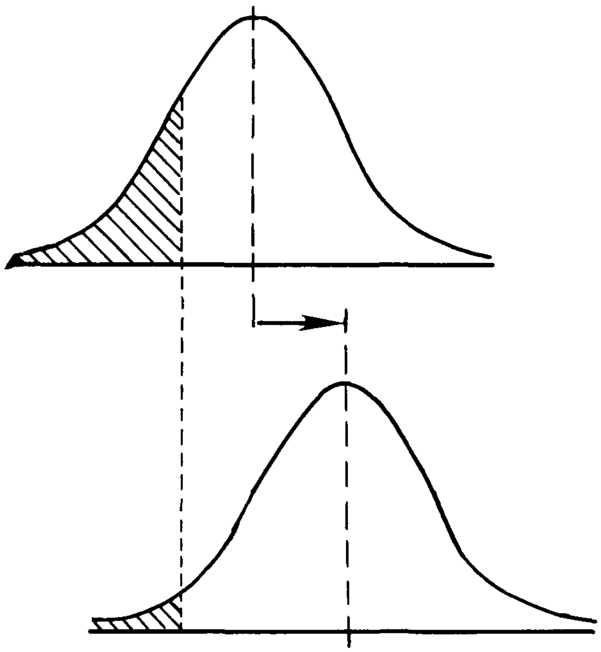

Figure 7. Loss of available suitable breeding areas (cross hatched) as environment shifts away from that used by a species. Horizontal dimension is an environmental factor gradient, vertical dimension is a frequency of that given factor value.

long-billed marsh wren's specific mean and away from the means of the swamp sparrow, common yellowthroat, and yellow warbler. The increase in water levels thus predicts an increase in frequency of the marsh wren and decreases in frequencies of the other three species.

Values of percentage cover are negatively correlated with values of average water depth. An increase in water depth thus predicts a decrease in percentage cover values in the wetland. A decrease in percentage cover shifts the overall mean for percentage cover towards the specific mean of the marsh wren and away from the specific means of the swamp sparrow, common yellowthroat, and yellow warbler. These shifts predict an increase in long-billed marsh wrens and decreased frequencies of the other three species.

Values of percentage of graminoid stems are positively correlated with values of average water depth. An increase in water depths thus predicts an increase in values of percentage of graminoid stems in the wetland. An increase in values of percentage of graminoid stems shifts the overall mean towards the specific mean of the marsh wren and away from the means of the other three species. This shift also predicts increased frequencies of marsh wrens and decreased frequencies of the others.

Values of percentage of dead stems are positively correlated with values of average water depth. An increase in water levels thus predicts an increase in values of percentage of dead stems in the wetland. An increase in values of percentage of dead stems shifts the overall mean towards the specific mean of the marsh wren and away from the specific means of the swamp sparrow, common yellowthroat, and yellow warbler. These shifts also predict an increase in frequency of the marsh wren and decreased frequencies of the swamp sparrow, common yellowthroat, and yellow warbler.

The results of these analyses are four sets of identical predictions concerning frequency changes of four wetland passerine species (Table 2).

TABLE 2. PREDICTIONS OF FREQUENCY CHANGES FOR FOUR PASSERINE SPECIES BASED ON AN INCREASE IN WATER LEVELS IN THE MARSH

Environmental feature	Correlation to average water depth	Predicted change in environmental feature	Predicted frequency change of long-billed marsh wren	Predicted frequency change of swamp sparrow	Predicted frequency change of common yellow-throat	Predicted frequency change of yellow warbler
Average water depth	----	Increase	Increase	Decrease	Decrease	Decrease
Percentage cover	Negative	Decrease	Increase	Decrease	Decrease	Decrease
Percentage graminoid stems	Postive	Increase	Increase	Decrease	Decrease	Decrease
Percentage dead stems	Postive	Increase	Increase	Decrease	Decrease	Decrease

SECTION 6

DISCUSSION

The study of the distributions and abundances of nesting birds is complex. A species is a genetic unit that has evolved the ability to locate its members in places that allow successful reproduction. To reproduce successfully a bird must accomplish a number of tasks: for example, feed itself, associate with a mate, find shelter from adverse conditions, escape predators, build a suitable nest, adequately feed its young. Many environmental features contribute to each of these factors. The study of how various environmental features contribute to the successful reproduction of a bird is difficult for a number of reasons: no factor is completely independent of others; the study on one factor in isolation can be misleading; the interactions of many factors are poorly understood, if at all; and no two individual birds have identical requirements and tolerances.

Earlier studies have suggested three major influences on the distribution and abundance of breeding marsh birds. Beecher (1942) found that the structure of the vegetation, not the plant species, was the major determinant of marsh-bird distribution. Weller and his associates (Weller and Spatcher 1965, Weller and Fredrickson 1973) argue that distributions are determined primarily by vegetation structure, water depth, and their interactions. The availability of suitable food, generally invertebrates with aquatic life stages, has also been suggested as being important (Verner 1964, Willson 1966).

The difficulty in understanding how these three major factors, water regime, vegetation, and availability of food, affect breeding-bird distributions is compounded by their interactions. The water regime is an important determinant in the distribution of plant species (Walker and Coupland 1968, Walker and Wehrhahn 1971, Stewart and Kantrud 1972, Millar 1973). The plant-species composition of the wetland, in part determined by the water regime, influences the structural characteristics of the vegetation. Finally, the plant-species composition and the vegetation structure all influence the distribution and abundance of aquatic invertebrates, although these relationships are still not well understood (Voigts 1976). Thus, the three important features of the marsh bird's environment form a complex, interacting unit.

The interaction of the environmental features, and the poor understanding thereof, make it difficult to understand the habitat requirements of marsh birds. The relationships investigated in this report represent a simplification of the true relationships between the birds and their environment and between the various aspects of the environment.

BIRD DISTRIBUTIONS AND HABITAT STRUCTURE

The distributions of birds within the wetland have been described with respect to a number of features of the wetland, including water regime and vegetation structure. These features have been shown to be related to the distributions of the birds. An emphasis was placed on investigating bird distributions with respect to the water regime and vegetation structure rather than plant-species composition. Human taxonomic methods are designed to differentiate separate genetic units. A bird, however, is not concerned whether two plants are the same species or different; what matters is how those plants contribute to the environment. From the point of view of nesting birds, two genetically distinct species of plants can contribute identically to the environment. Birds and human taxonomists do not classify for the same purposes.

An alteration of the composition of plant species of the wetland resulting from the altered water regime will affect bird populations by altering the physical structure of their environment. Why birds choose the particular parts of the environment that they do is not yet known. The structure of the vegetation can affect the availability of song perches, nest sites, foraging sites, and escape cover. The physical structure of the vegetation also affects the type of food resources present.

PREDICTION OF BIRD CHANGES

The ultimate goal of this study is to predict some of the effects of the power plant on bird populations. This report covers only a portion of the total effect of the Columbia Generating Station.

Since the impact occurs by way of a number of intermediate steps, prediction of changes in wetland bird populations that result from the altered water regime is not easy. The changing water levels affect birds primarily because of the effects of these changes on other aspects of the environment. The relationships between water levels, vegetation, and invertebrates are statistical and are poorly understood. The distribution of birds across vegetation gradients is also statistical. The final analysis between water levels and bird populations is therefore a combination of several poorly understood relationships. As one adds more statistical links to a chain, the relationships between the endpoints become less determinable.

Despite these difficulties several predictions could be made concerning changes in bird-species frequencies. Each prediction is based on an oversimplification of the ecological system, and by itself each prediction is suspect. When a number of these individual predictions are similar, however, more confidence is justified as to future distributions in the study area. Many relationships among water level, vegetation, and birds all suggest the same changes in bird populations resulting from the increased water levels: long-billed marsh wrens should become more frequent in the area, and the swamp sparrow, common yellowthroat, and yellow warbler should become less frequent.

APPLICATIONS

Current interest in the environmental effects of man's actions is intense. In many instances Federal and State laws require that these effects be examined and discussed during the planning stages of projects. Although methods of analysis for many forms of environmental effects are well established, methods of analyzing and predicting effects on bird populations are still poorly developed. Examination of environmental assessments reveals two general forms of analysis with respect to bird populations. First, the text refers the reader to an appendix that describes observations of birds on the project site, often no more than a list of species. Second, a tabulation is given of the number of acres of different habitat types that would be eliminated by the project. Along with a list of the densities of birds inhabiting each habitat type, this tabulation is used to predict the total number of birds lost through destruction of habitat. The question of the effects on bird populations in areas that the proposed project would alter but not destroy is seldom addressed. Many projects affect bird habitats to an extent less than total destruction. The current study is an attempt to analyze such a situation.

At the Columbia site the water regime of a wetland next to a generating station has been altered. A set of relationships between the water regime and vegetation structure was investigated. These relationships were combined to generate predictions of frequency changes in bird species that would result from the altered water regime. The form of analysis used in this study should be applicable to other locations where a project is altering the physical features of an area in a known way. In such situations the effects of those alterations on bird populations can often be predicted, if such predictions are considered desirable. Such predictions can increase the thoroughness of the environmental assessment procedure.

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16. ABSTRACT

The distribution of breeding passerines (songbirds) was investigated in a wetland in southern Wisconsin to develop a model for use in predicting changes in bird frequencies resulting from environmental alterations. The wetland is adjacent to the cooling lake of a coal-fired electric generating station. The water levels in the wetland are being altered by the cooling lake's effect on the local ground-water system. The model uses information on distributions of bird species along gradients of water depth and vegetation-structure characteristics and information on the relationships between the characteristics to predict changes in bird species' frequencies resulting from increased water levels. The predictions are qualitative, in that they predict only the direction of the change, not its magnitude. The resulting predictions are: (1) the long-billed marsh wren should increase in frequency; and (2) the swamp sparrow, common yellowthroat, and yellow warbler should decrease in frequency. No prediction could be made concerning the frequency of the red-winged blackbird.

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