SUSITNA
HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

WINTER BIRD POPULATIONS IN FOREST HABITATS OF THE MIDDLE SUSITNA RIVER BASIN, ALASKA

PREPARED BY

LGL
Alaska Research Associates

UNDER CONTRACT TO

HARZA-EBASCO
SUSITNA JOINT VENTURE

FINAL REPORT

FEBRUARY 1986
DOCUMENT No. 3327

Alaska Power Authority

Document No. 3327
Susitna File No. 4.3.3.2

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NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

INTRODUCTION

The impacts of the Susitna Hydroelectric Project on terrestrial vertebrates will be greatest for those species dependent on habitats within the impoundment zones. Most of the 135 species of birds recorded in the middle Susitna River basin (Kessel et al. 1982b) are present only during the warmer months, for approximately half of the year or less. Whether these migrant species are more dependent on living space available to them in summer or on the wintering grounds and whether they can relocate to adjacent breeding habitats is unclear (see LGL 1986 [in prep.]; Section 2.26, Terrestrial Birds). For permanent resident species, however, which are dependent on habitats within the middle Susitna River basin for obtaining food and shelter throughout the year, loss of this habitat is more likely to reduce local populations.

Population densities and habitat use of birds in the middle Susitna River basin during the breeding season were documented by Kessel et al. (1982b). Bird use of habitats in the downstream floodplain and in alpine areas were also studied (Kessel et al. 1982a, and Cooper 1984, respectively). However, information on population densities and habitat use by birds in winter has received little attention. Most of the census plots used by Kessel et al. (1982b) were visited once during the winter of 1981, but this short survey provided little quantitative information (see LGL 1986 [in prep.], Table 2.26-3). Data on resident species gathered during the breeding season can be helpful in inferring use levels in winter, but habitat selection and population densities are likely to change from season to season.

The objective of this study was to quantify the populations and habitat affinities of birds during winter in the middle Susitna River basin. Impacts of inundation and removal of vegetation by the Susitna Hydroelectric Project will be most pronounced for forested vegetation types. Project-related losses of shrub habitats will be compensated for by clearing of the transmission corridors and by habitat manipulation on lands designated for mitigation of moose habitat loss. This total available shrub habitats will probably increase as a result of the project. Tundra habitats will be lost in only small amounts in widely scattered areas. Therefore, the surveys discussed in this report were designed to emphasize forest habitats, and to document winter bird use of those forest habitats most common within the proposed impoundment zones of the Devil Canyon and Watana dams. This information will be used to refine the impact assessments and will be incorporated into mitigation plans designed to protect habitats of highest value to birds.

ACKNOWLEDGMENTS

This study was funded by the Alaska Power Authority as part of its baseline research program for environmental impact assessment of the Susitna Hydroelectric Project. Richard Fleming (Alaska Power Authority), Randy Fairbanks (Harza-Ebasco), and Granville Cooey (Harza-Ebasco) provided administrative and logistic support. Bird surveys were conducted with the expert assistance of Philip Martin, Elaine Rhode, and Brian Cooper. Connie Lucas typed the report.

METHODS

Census methods for this study consisted of six transects varying from 4.4 to 6.8 km in length, for a total of 32.0 km of transect per survey. The transects were each censused three times during the winter of 1984-85. Survey periods corresponded to early (29 November-1 December), mid- (23-25 January) and late (27-29 March) winter. Access to the start and end points of transects was via helicopter. Transects followed the form of a triangle, four-sided polygon, or two or three sides of a polygon (see Figure 1). These configurations were adopted to enable observers to return to a helicopter landing site and to position transects through habitats within the proposed impoundment zones.

Transects were used instead of plot surveys because of the desire to cover a large area in a region and season of low bird abundance. The methods used were based on those of Emlen (1971, 1977). During a survey day, two observers independently walked one transect, proceeding slowly on foot or snowshoes down the centerline. Prior to each survey, observers were trained to estimate distances by 10 m intervals up to 100 m. The transect centerlines were flagged at frequent intervals to permit replication. When a bird was detected, the data recorded included number in the flock, species, time of day, estimated perpendicular distance from the transect centerline, activity, cue signal (how the

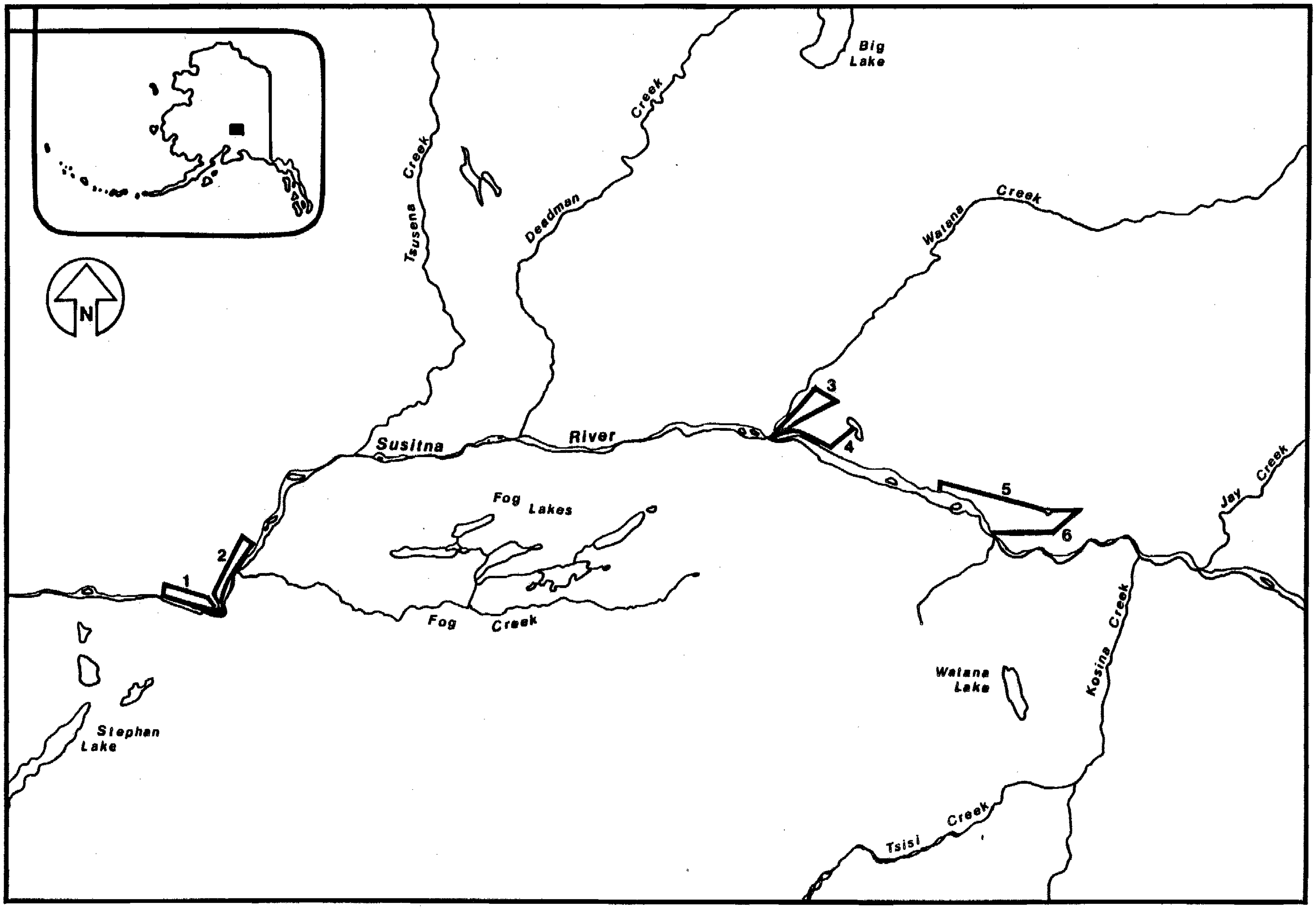

Figure 1. Location and configuration of transects used for censusing winter bird populations.

bird was first detected), habitat type, and other miscellaneous information such as sex, calling frequency, etc. All birds detected were recorded, regardless of their distance from the transect centerline. Birds flying over the transect were not included in density calculations nor habitat use analyses, but the species and number in the flock were recorded for use in calculating mean flock sizes.

Based on histograms of the numbers of flocks detected at 10 m intervals laterally from the transect route, an effective transect width of 50 m either direction from the transect centerline was determined. Numbers of birds detected beyond 50 m dropped off radically for several species. A transect width of 50 m was also found by McLaren and McLaren (1981) to be the effective census zone in boreal forest habitats in northwestern Ontario and northeastern Manitoba. Most birds were in flocks of two or more individuals. Mean flock sizes were calculated from data on all flocks observed, both on and off transects by survey period (i.e., early, mid-, late winter). Means were then multiplied by the number of flocks observed on the transect. This was done to reduce potential random bias of encountering unusually large or small flocks on the transect strip. Densities, expressed as birds/km^2, were calculated as an index of abundance. Densities were minimal for most species because of the uncertainty of complete detection of all birds within the transect strip. Coefficients of detectability based on calling intervals could not be determined because of time restrictions and sample size constraints.

Travel along all transects was maintained at a slow pace with frequent stops to listen for birds. Habitats were sufficiently free of dense brush and steep topography in most areas to facilitate consistent travel speed. Transect lengths were determined by the distance that could be walked during the short winter day (approximately 6 hours). In early and mid-winter, surveys were conducted throughout the day; little variation in bird activity patterns over the daylight hours was expected because of the very short and relatively cold days near the winter solstice. In late winter, surveys were adjusted to start as early as possible to take advantage of the greater activity of most species of small birds during morning hours (Pohl 1972, Kessel 1976).

To determine habitat availability, observer time spent in a given vegetation or habitat type (based on both Viereck et al. 1982 and Kessel 1979) was recorded for each transect. Percent time spent in a given habitat type was converted to square kilometers of habitat following measurement of transect lengths from aerial photographs (scale = 1:24,000) and using the 100 m transect width. Observers were instructed to walk at a consistent pace through all habitats on the transect to ensure accurate distance calculations. Habitat determinations made by observers (based on Viereck et al. 1982) were compared with vegetation maps (1985 versions by R.A. Kreig and Associates) to ensure comparability. Bird sightings were infrequent enough that observers could devote a large portion of their time to recording habitat changes during censuses. The vegetation maps were not used for habitat availability calculations because of the large scale of the maps in relation to the transect lengths (i.e., a finer-grained mosaic of vegetation types was observed on the transects than was detected by the vegetation mapping). A summary of the distance through each habitat and approximate area covered is presented in Table 1.

Differences occur in the two vegetation/habitat classification schemes. These are, however, slight in most cases (e.g., "woodland" is defined as 10-25% tree canopy cover in Viereck et al. 1982, and <20% cover in Kessel 1979). One important difference occurs in determining limits for mixed forest. Viereck et al. (1982) define the mixed forest type as deciduous trees with a coniferous component of 26 to 74%, while Kessel (1979) defines mixed forest habitat as deciduous with a coniferous component of 11 to 89%. These variations can account for several differences seen in the amounts of each habitat sampled (Table 1). Slight discrepancies in habitat determinations (particularly in identification of white and black spruce) by different observers were minimized by taking means whenever possible. Still, some differences in habitats sampled may be due to observer bias. Sightings of birds in locations where two different habitat types were judged to be present by the two classification schemes only occurred in the mixed forest/coniferous forest interface.

Transects were placed near the Susitna River, and each was mostly within either the Devil Canyon (2 transects) or Watana (4 transects) impoundment zone in order to detect possible seasonal shifts of birds to the more wind-protected, lower-elevation forests along the river corridor. One forest habitat, deciduous

Table 1. Area of impoundment zone habitats (based on Kessel 1979, and Viereck et al. 1982) sampled per survey during the 1984-85 Susitna Winter Bird Survey.

	Kessel		Viereck et al.	
	Kilometers	Area (km^2)*	Kilometers	Area (km^2)*
Deciduous Forest (Birch)	1.0	0.10	1.6	0.16
Mixed Forest (Spruce-Birch)	9.0	0.90	8.1	0.81
Coniferous Forest (White Spruce)	9.7	0.97	12.6	1.26
Coniferous Forest (Black Spruce)	4.2	0.42	4.0	0.40
Scattered Woodland (Spruce)	6.2	0.62	3.3	0.33
Dwarf Forest (Black Spruce)	1.9	0.19	2.4	0.24
Total	32.0	3.20	32.0	3.20

* based on a transect width of 100 meters

forest, was not extensively sampled because of its rare occurrence within the impoundment zones and its virtual restriction to very steep, south-facing slopes.

RESULTS

Winter bird abundance and species richness were low, as expected, in all sampled forest habitats in the middle Susitna River basin. Overall densities averaged slightly less than 30 birds/km^2 over the three survey periods (Table 2). Of the 11 species recorded on the transects, by far the most abundant species were boreal chickadees and gray jays (Tables 2 and 3). Data on habitat use are most reliable for these species as they were the only birds for which we regularly recorded greater than 10 flocks per survey period, and over 30 flocks during the study, within the 100 m wide transect band.

Results of habitat preference calculations differed depending on the classification scheme used. However one habitat, white spruce coniferous forest, contained a greater number and a higher density of species than any other habitat. [White spruce woodland of Viereck et al. (1982) contained a slightly higher density, but not number, of bird species.] Because more area of white spruce forest was surveyed than of any other habitat, the number of species encountered in this habitat may have been inflated because of the greater amount of time spent there. Results of habitat selection by individual bird species suffer from lack of adequate sample size for all species encountered and cannot be assumed to represent conclusive results, although general trends are evident.

Habitats chosen by birds in winter were similar to habitat use patterns observed for these species in the same area in summer (Table 4), with minor differences. Most notable was the near absence of boreal chickadees in the coniferous forest (white spruce) plot during the breeding season. This habitat contained the highest densities of boreal chickadees in winter. This difference may be due to the chance absence of boreal chickadees from the single 10 ha plot, or a real shift in habitat preference from summer to winter. [This species did breed on both mixed forest plots (I and II) and the black spruce dwarf forest plot.]

Table 2. Estimated densities of bird species (individuals/km^2) recorded during the 1984-85 Susitna Winter Bird Survey by vegetation type. Vegetation types correspond to level 2 designations of Viereck et al. (1982), except for scattered woodland, a level 3 type within coniferous forest. Coniferous and mixed forests include both open and closed forests of those types.

Species	Deciduous Forest (Birch)	Mixed Forest (Birch-Spruce)	Coniferous Forest (White Spruce)	Coniferous Forest (Black Spruce)	Woodland (White Spruce)	Dwarf Tree (Black Spruce)	Overall Density
Spruce Grouse		0.4	0.8				0.6
Three-toed Woodpecker		0.4	0.3				0.2
Gray Jay		4.8	12.1	4.9	14.2	5.6	8.5
Black-billed Magpie			0.3				0.1
Common Raven			0.3				0.1
Black-capped Chickadee		0.4	0.5				0.3
Boreal Chickadee		11.7	18.8	13.8	8.2	4.4	13.3
Northern Shrike			0.3				0.1
Pine Grosbeak			0.3		3.6	3.3	0.7
White-winged Crossbill		0.8	1.4	7.7	11.7	5.4	3.3
Redpoll	5.3	5.1	2.5				2.5
All Species	5.3	23.6	37.6	26.4	37.7	18.7	29.7

Table 3. Estimated densities of bird species (individuals/km^2) recorded during the 1984-85 Susitna Winter Bird Survey by habitat type. Habitats correspond to those of Kessel (1979).

Species	Deciduous Forest (Birch)	Mixed Forest (Birch-Spruce)	Coniferous Forest (White Spruce)	Coniferous Forest (Black Spruce)	Scattered Woodland (Spruce)	Dwarf Forest (Black Spruce)	Overall Density
Spruce Grouse		0.4	1.4				0.6
Three-toed Woodpecker		0.4	0.3				0.2
Gray Jay		5.0	14.3	4.7	7.6	7.1	8.5
Black-billed Magpie			0.3				0.1
Common Raven			0.3				0.1
Black-capped Chickadee		0.4	0.7				0.3
Boreal Chickadee		15.9	19.5	13.2	4.4	5.6	13.3
Northern Shrike			0.3				0.1
Pine Grosbeak			0.3		1.9	4.2	0.7
White-winged Crossbill		0.8	1.8	7.3	6.2	6.8	3.3
Redpoll	8.4	5.3	2.8				2.5
All Species	8.4	28.1	42.0	25.2	20.1	23.7	29.7

Table 4. Comparison of densities of resident bird species (individuals/km^2) as determined from breeding season surveys (1981 and 1982) (Kessel et al. 1982b, Kessel unpubl. tables) and winter bird surveys (1984-85) (this study). Habitat types are those defined by Kessel (1979).

	Density by Habitat Type						
		Mixed Forest		Coniferous Forest			
Species	Deciduous Forest	Mixed I	Mixed II	White Spruce	Black Spruce	Scattered Woodland	Dwarf Forest
<u>Spruce Grouse</u>							
Summer 1981	V	10	10	V	*	V	
Summer 1982	+		5	+	*		
Winter 1984-85		0.4		1.4			
<u>Three-toed Woodpecker</u>							
Summer 1981		V	3	10	*	V	V
Summer 1982				5	*		
Winter 1984-85		0.4		0.3			
<u>Gray Jay</u>							
Summer 1981	V	5	5	10	*	+	V
Summer 1982		8	10	5	*	V	
Winter 1984-85		5.0		14.3	4.7	7.6	7.1
<u>Black-billed Magpie</u>							
Summer 1981					*		
Summer 1982					*		
Winter 1984-85				0.3			
<u>Common Raven</u>							
Summer 1981					*		V
Summer 1982					*		
Winter 1984-85				0.3			
<u>Black-capped Chickadee</u>							
Summer 1981	V	V	V		*		
Summer 1982					*		
Summer 1984-85		0.4		0.6			

Table 4 (cont.)

Species	Deciduous Forest	Mixed Forest: Mixed I	Mixed Forest: Mixed II	Coniferous Forest: White Spruce	Coniferous Forest: Black Spruce	Scattered Woodland	Dwarf Forest
			Density by Habitat Type				
Boreal Chickadee							
Summer 1981	V	17	10	V	*	V	10
Summer 1982	V	10	20	V	*		
Winter 1984-85		15.9		19.5	13.2	4.4	5.6
Northern Shrike							
Summer 1981					*		
Summer 1982					*		
Winter 1984-85				0.3			
Pine Grosbeak							
Summer 1981					*		
Summer 1982			V	V	*		
Winter 1984-85				0.3		1.9	4.2
White-winged Crossbill							
Summer 1981		V	V	V	*	V	V
Summer 1982				V	*		
Winter 1984-85		0.8		1.8	7.3	6.2	6.8
Redpoll							
Summer 1981	20	20	30	V	*	5	10
Summer 1982		V	V	10	*		5
Winter 1984-85	8.4	5.3		2.8			

V = vagrant on plot
+ = partial territory on plot
* = habitat not sampled during the breeding season

Sample sizes for other species were too low to observe trends in habitat shifts from summer to winter, although coniferous habitats tended to be used more in winter than in summer by most species (Table 4).

Densities of all bird species varied over the three winter survey periods (Table 5). The most common species observed on the surveys showed some seasonal differences in abundance patterns. Gray jays varied relatively little over the winter, showing somewhat higher densities in mid-winter, in tandem with other species. Average flock sizes of gray jays remained constant over the winter (Table 6, Kruskal-Wallis H = 0.14). The beginning of breeding activity was noted during the late winter survey (birds carrying nest material on 27 and 29 March), although flocks of 3-5 birds were still present during this period.

Boreal chickadees, however, decreased in density by approximately half from mid-winter to late winter. This difference was significant ($\chi^2_{(2,\ 0.05)}$, $p<0.01$). The decrease in density occurred along with a significant decrease in flock size over the winter (Table 6, Kruskal-Wallis H = 19.9, $\chi^2_{(2,\ 0.05)}$, $p<0.005$). The winter season is probably a stressful time for small birds; mortality of flock members could have caused both observed declines. Breakup of flocks prior to breeding may also have played a part in the small flock sizes observed in March (Odum 1941, Smith 1967).

Populations of the two smaller finches, although recorded too seldom to permit testing, tended to increase over the winter. Flocks of these species flying over the transects were also more frequent in late winter than in early or mid-winter (Table 6). This increase paralleled a decrease in numbers seen in urban areas of Alaska (D.D. Gibson, University of Alaska, pers. comm., 1985).

The occurrence of a northern shrike on the March survey may represent a spring migrant bird since this species frequently retreats southward in winter, but migrates north early, often by March; or it may have been an overwintering individual. Other species observed in the middle Susitna River basin but not seen on the transects included ptarmigan (possibly all three species) during the early and mid-winter periods in low willow shrub habitat near transects 5 and 6, and a single golden eagle and snow bunting on the late winter survey, both of

Table 5. Densities of birds (individuals/km^2) recorded during the three winter bird surveys, corresponding to early, mid-, and late winter periods.

Species	Densities by Survey Period		
	Early Winter (29 Nov.- 1 Dec.)	Mid-Winter (23-25 Jan.)	Late Winter (27-29 Mar.)
Spruce Grouse	0.6	0.6	0.6
Three-toed Woodpecker	0.3	0.0	0.3
Gray Jay	7.0	11.0	7.2
Black-billed Magpie	0.0	0.3	0.0
Common Raven	0.0	0.3	0.0
Black-capped Chickadee	0.6	0.0	0.3
Boreal Chickadee	13.1	17.7	8.9
Northern Shrike	0.0	0.0	0.3
Pine Grosbeak	0.3	1.5	0.4
White-winged Crossbill	0.6	3.3	6.0
Redpoll	0.5	1.5	5.5
All Species	23.0	36.2	29.5

Table 6. Average flock sizes of the five most common winter resident bird species and number of sightings used in their calculation.

Species	Early Winter		Mid-Winter		Late Winter		Overall	
Gray Jay	1.88	(17)	2.09	(22)	1.93	(14)	1.98	(53)
Boreal Chickadee	4.67	(9)	4.06	(16)	3.18	(11)	3.94	(36)
Pine Grosbeak	1.00	(3)	2.40	(10)	1.17	(6)	1.79	(19)
White-winged Crossbill	2.00	(4)	5.33	(9)	3.86	(14)	4.07	(27)
Redpoll	1.75	(4)	2.43	(7)	2.53	(17)	2.39	(28)

which were probably early spring migrants. Other resident or overwintering species known to occur in the area (based on Kessel et al. 1982b) but not recorded during this study include northern goshawk, gyrfalcon, great horned owl, snowy owl, northern hawk-owl, great gray owl, boreal owl, hairy woodpecker, downy woodpecker, black-backed woodpecker, brown creeper, and American dipper. All of these species probably occur at such low densities (and/or are nocturnal) that it is not surprising they were not recorded during the 1984-85 surveys.

DISCUSSION

Populations of terrestrial birds in winter in the middle Susitna River basin were low. The survey method allowed a large area to be censused rather efficiently, and the addition of two-stage sampling enabled use of the method for flocking species. Most of the species present were detected by aural cues, given at fairly regular intervals in several species (gray jay, chickadees, and redpoll). Flocks of birds were called-in to determine flock composition after the observer had estimated lateral distance of the flock center to the transect. Bias may have occurred in estimating densities of some species due to attraction to observers. Gray jays were particularly curious and very often flew to within 10 m to investigate observers. Gray jay densities are therefore probably inflated from real densities (see also Salter and Davis 1974), but are comparable to those of other studies because this behavior is largely unavoidable by all observers. Other species were not noted to follow observers, and it was not obvious that they were attracted by field personnel when first seen or heard.

The use of at least three replicate sets of transects has been recommended by Steele et al. (1984) for monitoring populations of small birds. Some significant differences in bird numbers were found among the three surveys (e.g., boreal chickadee). These differences could have been related to overwinter mortality, seasonal movements, or simply chance occurrence of individuals among surveys. Other sources of variation, particularly those associated with interannual population fluctuations (Jarvinen 1979) and observer differences (Smith 1984), cannot be estimated by this study.

Although the density and diversity of bird species overwintering in the middle Susitna River Basin are low, forest habitats there support a community of birds well adapted to exploit the scarce resources present. The two most commonly encountered species, gray jay and boreal chickadee, both showed marked habitat preferences. Table 7 presents the result of a chi-square analysis of habitat selection for these two species, based on a comparison of observed habitat use and the distribution expected if flocks were distributed in proportion to the amounts of habitat sampled. Both species showed a strong selection for and occurred in highest densities in white spruce forest. Gray jays appeared to prefer habitats in which white spruce was the dominant tree species (white spruce forest and woodland), occurring in lower densities where black spruce dominated, or where white spruce was mixed with deciduous trees. Boreal chickadees, while also preferring white spruce forest, appeared to be responding to the structure of the habitat. This species occurred in higher densities in the densest forest types (mixed, white and black spruce), and avoided the more open-canopied (at least in winter) deciduous forests, scattered woodlands, and dwarf forests. Chickadees, a branch and foliage gleaning species, would be expected to occur where foraging sites are most dense (i.e. in forest, particularly in spruce trees, which hold their leaves through the winter). Gray jays, an opportunistic species, take a variety of prey depending on availability. During surveys, gray jays were most frequently observed perched at or near the tops of spruce trees, and were observed taking food only from the large branches and trunks of trees. This food may have included overwintering insects, their larvae or egg cases, or previously cached food.

The other species of birds recorded during surveys occurred in too small numbers to discuss conclusively their habitat preferences, although for most birds, habitat affinities observed in this study followed known characteristics of the species. Spruce grouse and three-toed woodpeckers were encountered only in forests containing large spruce, the preferred food source and habitat of both species in northern regions (Martin et al. 1951, Ellison 1966, Hogstad 1976). Black-billed magpies, common ravens, and northern shrikes were uncommonly encountered, and they were probably recorded in the white spruce forest habitat because observers spent more time in this habitat than in any other.

Table 7. Selection of habitats by the two most common winter resident bird species, based on chi-square analysis over all sample periods. A plus (+) indicates positive selection for that habitat, a minus (-) indicates avoidance, and a zero indicates the habitat was used in proportion to its availability. Double signs (++ or --) indicate strong selection for or avoidance of the indicated habitat (i.e., $\geq$ 25% of χ^2 value). (Number of flocks observed was 41 for gray jay and 32 for boreal chickadee, $\chi^2 < 0.005$ for all tests).

Species	Deciduous Forest	Mixed Forest	Coniferous Forest: White Spruce	Coniferous Forest: Black Spruce	Scattered Woodland	Dwarf Forest
Gray Jay						
Viereck et al.	-	-	++	-	+	-
Kessel	-	-	++	-	o	o
Boreal Chickadee						
Viereck et al.	--	o	++	o	-	-
Kessel	-	+	++	o	--	-

Black-capped chickadees, although common over much of central and southcentral Alaska, were rare in the middle Susitna Basin. They are primarily birds of deciduous forest (Spindler and Kessel 1980), and during the summer bird studies, they were found breeding only in the lower Susitna River cottonwood plot by Kessel et al. (1982b). In winter they were found on transects 1 and 2, the only transects that included very small amounts of mixed cottonwood and white spruce. It is likely that this species, along with hairy and downy woodpeckers and brown creepers, is most abundant in the more productive deciduous-dominated forest types, such as the riparian cottonwood forests, lowland birch, and mixed spruce and birch stands of the lower Susitna Basin, downstream of the impoundment zones.

The seed-eating finches (pine grosbeak, white-winged crossbill, and redpoll) were generally uncommon in the study area, although most increased in abundance as the winter progressed. They were present in small flocks (means of less than 3 birds/flock for grosbeaks and redpolls, less than 6 for crossbills, Table 7), and were more frequently seen flying over observers than actually perched on the transects.

Redpolls typically favored habitats in which paper birch was a dominant tree canopy species, undoubtedly because of their dependence on birch seeds for a large proportion of their food (Kennard 1976, White and West 1977). Pine grosbeaks and crossbills were most abundant in black spruce forest, dwarf forest, and spruce woodland. We did not observe abundant cone crops on either spruce species, which may partially explain the low populations of these finches. White spruce seed has been shown to be more nutritious than that of black spruce (Brink and Dean 1966). The crossbills and possibly grosbeaks may have been dependent on the latter food source out of necessity (both were observed feeding on black spruce cones). A shortage of winter food may have explained their low abundance here in relation to the relatively large populations of both species observed in Fairbanks and Anchorage during the winter of 1984-85 (D.D. Gibson, University of Alaska, pers. comm., 1985). Redpolls and crossbills (and to a lesser extent, pine grosbeaks) are erratic winter residents throughout their breeding ranges; they may be abundant in some years and nearly absent the next (Reinikainen 1973, Svärdson 1957). Hence, population indices from a single year are unlikely to indicate long-term use levels of winter habitat for these species.

Use of habitats by resident birds during the winter shows many similarities and some differences from breeding season distributions. It is difficult to compare in detail the present study with that of Kessel et al. (1982b) because of the different sampling schemes used (transects vs. plots), and the wider geographic coverage of the latter study. Generally, resident species in winter were found in most of the habitats they use in summer, with some apparent shift away from deciduous and mixed forests, and consequently greater abundance in coniferous habitats (except for redpolls, see Table 4). The white spruce coniferous forest plot of Kessel et al. (1982b) contained low densities of breeding birds. The relative importance of this type in winter may reflect a real habitat shift by some common resident birds (notably gray jays and boreal chickadees). Similar habitat preference between summer and winter and importance of white spruce stands to permanent resident bird species were previously noted by Spindler and Kessel (1980) in Interior Alaska.

The observed seasonal variations in bird populations during early, mid-, and late winter periods were not extreme. The high densities recorded during mid-winter may reflect the relatively warm temperatures encountered during this survey period (25-35°F) relative to the other surveys (10-30°F). Winter resident birds become more active during warm spells and move less in colder weather, presumably to conserve energy (Kessel 1976, Alatalo 1982). Greater activity by birds may have made them more visible to observers during mid-winter surveys, so this survey may more closely reflect the real densities of birds present. Emlen (1977) also suggested that the highest densities recorded over replicate surveys may be a closer estimate of real densities than the average, because of the primary difficulty in detecting all birds present on the transects.

Impact Assessment and Mitigation Considerations

The assessment of project-related impacts on terrestrial birds must consider the effects of winter habitat removal as well as effects on habitat for breeding birds. The impacts of habitat removal (primarily inundation) for shrub and tundra habitats and the birds that use them will be minimal (see LGL 1986 [in prep.]). All forest types provide some habitat for birds in winter. Deciduous and mixed forests (particularly those containing birch) are important for redpolls; black spruce types may be important (in some years) for the seed-eating pine grosbeaks and white-winged crossbills; and white spruce forests are used by a variety of species. All species recorded on the winter survey were at some time recorded in the white spruce forest type.

On mitigation lands managed to enhance moose browse production, preservation of white spruce forest near openings would provide the double benefit of preserving resident bird habitat and maintaining adequate forest cover for moose. Areas selected for clearing would have less adverse effect on resident birds if they included greater proportions of lightly used habitats (e.g., black spruce forest and dwarf forest, and possibly deciduous and mixed forests).

Mitigation strategies that will be affected by winter bird population data are primarily those related to selection of compensation and/or replacement lands to offset habitat loss. Selection of land areas for mitigation should consider the relative value of white spruce-dominated forest stands as winter habitat for birds. Although including a variety of habitat types will help ensure that a greater diversity of birds use them, preservation of white spruce-dominated forest would appear to benefit the largest overall number of birds in winter. An interspersion of white spruce types with mixed forest and possibly some black spruce would provide a wide range of habitats of use to birds in winter.

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