Songbird Detection in Continuous Daylight
Yukon-Charley Rivers National Preserve

YUCH-99-008
October 11, 1999

Shelli A. Swanson. National Park Service, 201 First Ave., Doyon Building, Fairbanks, AK 99701.

INTRODUCTION

In 1998, Yukon-Charley Rivers National Preserve was selected to receive funding from the National Park Service (NPS) Servicewide Inventory and Monitoring Program to conduct inventory work on birds. Funding was provided in 1998 to begin testing point count methods to be used in the inventory surveys beginning in 1999. In order to determine when to best sample birds in Yukon-Charley Rivers National Preserve, we had to first assess when peak detectability periods occurred at that latitude. To examine this issue, we conducted 24-hour monitoring sessions for birds at 3 sites in the preserve in June 1998. The objectives of this project were to: 1) assess peak singing periods over a 24-hour time period, 2) test point count and distance estimation techniques to be used during the inventory, and 3) gain information on species composition in different habitat types found in the preserve.

Donna DiFolco, Jim Lawler, Chris McKee, and Todd Rinaldi provided valuable field assistance in this project. The NPS Servicewide Inventory and Monitoring Program provided funding.

STUDY AREA

Yukon-Charley Rivers National Preserve is a 2.5 million acre NPS unit located in eastern interior Alaska, just south of the Arctic Circle, and bordering Yukon Territory, Canada (Fig. 1). Elevation in the preserve rises from 220 m at the Yukon River to 2000 m in the mountains to the south. The semi-arid continental climate in the preserve area results in 16.5 cm of mean annual precipitation. Mean daily temperatures range between 15.6°C in July and -25°C in January.

The complex geology, climatic conditions, natural fire regime and discontinuous permafrost soils have produced a diverse mosaic of taiga and tundra habitat types. The sedimentary rock record in the preserve is nearly complete, with layers dating from the Precambrian to the present. North of the Yukon River lies the oldest terrain in Alaska, which is likely part of the original continental margin (G. Mull, Alaska State Division of Geological and Geophysical Surveys, personal communication).

The preserve is within the subarctic boreal forest zone and major tree species include: black spruce (*Picea mariana),* white spruce (*P. glauca*), aspen (*Populus tremuloides*), and balsam poplar (*Populus basamifera*). Willow (*Salix* spp.) and alder (*Alnus* spp.) are the most common shrub species. Major forest communities found in the preserve are spruce forest, mixed spruce-broadleaf forest, and broadleaf deciduous forest. Black spruce woodland, mixed spruce-broadleaf woodland, and broadleaf woodland are the major woodland communities. Wetland (bogs, marshes, and lake/open water areas) and alpine tundra communities are prominent in the preserve.

METHODS

Monitoring sites for this project were set up in open mixed deciduous, woodland needleleaf moss, and woodland needleleaf lichen landcover types; landcover classification follows that developed by Ducks Unlimited, Inc. (1998) for Yukon-Charley Rivers National Preserve. Sites were chosen for ease of access to Coal Creek Camp and to occur in different landcover types. Detailed habitat descriptions for these monitoring sites are located in Appendix I.

At each of the 3 monitoring sites, birds were surveyed every half hour for 24 hours using a variable circular point count technique following the protocol developed by the Alaska Chapter of Partners in Flight (Handel 1999) and modified from Ralph et al. (1993). All birds detected during a 5-minute period were recorded, along with the distance interval of the bird from the observer. Distance intervals used were: 0-10 m, 11-20 m, 21-30 m, 31-40 m, 41-50 m, 51-60 m, 61-70 m, and >70 m. Scientific names for species discussed in this report are listed in Appendix II.

Statistics

A running average was computed to look at 24-hour detection trends. This average was calculated from the counts immediately before, during and after a given point count. From the maximal number of birds detected on the running average line (the highest point on the line), optimal survey periods were defined where at least 70% of the maximal number of birds were detected. The points on the running average line that intersected with the 70% detection line were used to define the time intervals during which at least 70% of the birds possible on the site were detected. A 60% detection line was projected to examine evening peak detection periods. See Fig. 2.

A Chi-square test (X^2) was used to compare the distributions of the number of birds detected in each distance category between the 3 monitoring sites. Individual contingency table cell contributions to the X^2 test statistic were used to determine where the observed number of detections varied significantly from the expected number. This test was also used to examine the differences in distance estimation between observers.

RESULTS

Detection by Species

During the 24-hour monitoring sessions, 21 bird species were detected on the woodland needleleaf moss site, 19 species on the open mixed deciduous site, and 15 species on the woodland needleleaf lichen site (Table 1). Swainson's thrushes were most consistently detected during the half-hourly point counts over the 24-hour monitoring period on all three sample sites. Other consistently detected species included dark-eyed juncos (on the woodland needleleaf moss and woodland needleleaf lichen sites), orange-crowned warblers (open mixed deciduous), and white-crowned sparrows (open mixed deciduous; Table 1).

On the open mixed deciduous site, a mean of 7 species was detected during each of the 13 point counts conducted between 0300 h and 0900 h [the peak singing period targeted for sampling in the Boreal Partners in Flight protocol for off-road point count transects (Handel 1999)]; this represents 36% of the total number of species detected at the site over the 24-hour monitoring period ($n = 19$). Similarly, means of 6 species on the woodland needleleaf moss site (36% of the species detected; $n = 17$) and 5 species on the woodland needleleaf lichen site (31% of the species detected; $n = 15$) were recorded during this period.

Lower species detection on the woodland needleleaf lichen site can be partially attributed to weather and habitat composition. During the sampling period, weather was variable, rainy, cool and windy. Individual birds detected and areas being sampled varied markedly with changes in wind direction during the monitoring session, resulting in an inability to survey consistently on either side

of the sample site during the 24-hour period. In addition, habitat diversity in the vicinity of the other two sites was greater, probably supporting a more diverse bird population.

Detection by Time

Bird detection patterns on the 3 sites consisted of a prominent morning peak and a weaker evening peak (Fig. 2). The morning detectability peak occurred between 0200 h and 1130 h, using a 70% detectability level (Fig. 3). Species richness (number of species detected; range 10-15 species) was highest between 0530 h and 1200 h, corresponding to the when the most number of birds were detected (Fig. 2). A bimodal evening peak was defined using a 60% detectability level and occurred from 1900 h to 2230 h (Fig. 2). Species richness also corresponded to this evening peak of bird activity, with a range of 10-15 species detected.

This bimodal bird detectability pattern was most noticeable on the open mixed deciduous and the woodland needleleaf moss sites (Fig. 3). Detectability on the woodland needleleaf lichen site was highly impacted by changing wind direction and rain. Since the site was located on a ridge, birds were often sampled from the north side of the hill and then from the south as the wind changed. In addition, the sampling period started after an 8-hour rainstorm and bird activity seemed to increase in response to the clearing weather; this likely accounts for the >70% detectability level between 2100 h and 2430 h at the beginning of the monitoring session on this site. Light rain also fell between 0500 h and 0930 h, potentially depressing singing rates during this portion of the peak morning detection period. Birds stopped singing during an afternoon rainstorm on the woodland needleleaf moss site, further emphasizing the damping impact of rain on singing rates (Fig. 3).

Several species detected on the sites were not detected during the 0300h-0900h period, which is the peak singing period targeted for sampling in the Boreal Partners in Flight protocol for off-road point count transects (Handel 1999; Table 2).

Singing patterns varied between species over the course of 24 hours. The alder flycatcher and northern waterthrush exhibited a strong morning peak singing period (Fig. 4). A bimodal singing pattern was found for the myrtle warbler, orange-crowned warbler, and dark-eyed junco, though the morning singing period was more pronounced than the evening peak (Fig. 5). While singing patterns were similar for the myrtle warbler and the orange-crowned warbler, they were offset in time; orange-crowned warblers appeared to become active later in the morning than myrtle warblers and sang later into the evening (Fig. 5b). Swainson's thrush, varied thrush, and white-crowned sparrows were consistent singers and showed little variation in song detection throughout the 24-hour period (Fig. 6).

Detection by Distance

Sixty-three percent of the detections were classified to be within 70 m of the observer (Fig. 7). However, the distance estimation patterns differed between the 3 habitat types monitored ($X^2 = 140.62$; $\underline{P} = 0.000$; Fig. 8). On the woodland needleleaf lichen site 54% of the detections were classified as >70 m, while only 20% of the detections on the open mixed deciduous site were classified as >70 m. More birds than expected were detected in the 20-30 m and 30-40 m categories on the open mixed deciduous site, based on individual cell chi-square

values; also, fewer birds than expected were detected in the >70 m category on this site (Table 3). On the woodland needleleaf lichen site, more birds than expected were detected in the >70 m category.

Detection distances varied by species. Thrushes (varied thrush, Swainson's thrush, hermit thrush, and American robin) were commonly heard at distances classified as greater than 70 m; over 50% of the detections for these species were classified as >70 m from the observer. Hermit thrushes were calling from an aspen stand at least 300 m up the hill from the woodland needleleaf moss site and were clearly heard during most of the 24-hour period. Conversely, detections of yellow warblers, orange-crowned warblers, myrtle warblers, Hammond's flycatchers, gray jays, Bohemian waxwings, common redpolls, boreal chickadees, and arctic warblers (quieter species) were classified within 70 m of the observer during >80% of their total detections. Gray jays, though not known for having quiet calls, were classified as <70 m during 83% of their detections; this may have resulted from a natural curiosity about our presence, causing them to fly in and investigate.

Distance estimation differences were found between observers ($X^2 = 65.41$, df = 21, P=0.000). Based on individual cell chi-square values >4.0, one observer had more detections in the 60 and 70 m classes than expected and fewer detections in the 20 m and 40 m classes than expected, thus appearing to estimate longer detection distances than other observers. A second observer called more than expected in the 20 m and 30 m categories and less than expected in the 70 m class; this observer appears to have estimated shorter detection distances. A third observer classified fewer detections than expected in the 60 m distance class.

Weather Influences on Detectability

Insufficient weather data was obtained to evaluate trends or correlations with bird detection data.

DISCUSSION

Activity Patterns

During the breeding season, birds are more active and have higher detection rates in the early morning hours immediately after sunrise (Holmes and Dirks 1978, Robbins 1981, Blake 1992, Smith and Twedt 1999). However, there is nearly continuous daylight (civil daylength plus civil twilight) in the Arctic during the breeding season and sunrise is not clearly defined. Armstrong (1954) found that even in the arctic, the general level of bird activity is affected by change in light intensity and elevation of the sun; bird activity levels corresponded closely with morning light intensities. Temperature and humidity may also impact bird activity levels, though in the Arctic that often coincides with dim light and the relative importance of these factors cannot be assessed (Armstrong 1954). Day length and temperature were identified as having a significant bearing on female tree sparrow activity at 65° N latitude (Weeden 1966); temperature was found to correlate with increased insect activity. Since insects are a major food source for nestlings, female tree sparrow activity levels directly corresponded to insect activity levels.

Several single-species studies conducted at high latitudes also found peak bird detection/activity times that correspond with the morning peak found in this study. A study of tree sparrows 175 km (105 miles) northeast of Fairbanks, AK found that male tree sparrows produced the greatest number of songs between 0200-0600 h but were still appreciably high from 0600 h to 1000 h (Weeden 1966). White-crowned sparrows in Fairbanks, AK (65° N latitude) were heard singing at nearly all times of the day during the nesting season but reached peak singing intensity at 0300 h; they also maintained high singing rates for approximately 3 hours longer than at middle latitudes (King 1986). Golden-crowned sparrows at 62°N latitude [80 km (48 miles) north of Anchorage, AK] engaged in maximum singing rates from 0100 h to 0400 h (Holmes and Dirks 1978). Singing rates for these golden-crowned sparrows peaked at 0300 h (>10 songs/minute) and a moderate rate (4-6 songs per minute) was maintained from approximately 0400-2100 h; a period of inactivity occurred from 2100 - 0100 h (Holmes and Dirks 1978). Armstrong (1954) observed that the period of maximum singing for passerines lies between midnight and 0430 h at 68° N latitude in Lapland.

Quiescent periods have been observed for passerine species in northern latitudes starting at approximately 2100 h (Armstrong 1954, Holmes and Dirks 1978, King 1986); this period, when detectability was very low, was not observed in our combined dataset (Fig. 2). Lowest activity, in terms of bird detections, on this study appeared to occur in midafternoon (1400-1830 h; Fig. 2). The open mixed forest site did have the lowest detection rates between 2100 h and 0100 h (Fig. 3a), which agrees with the above studies. In concurrence with the combined dataset for this project, Robbins (1981) also found that bird activity reached a low point in midday with activity either ceasing or continuing at reduced rates during this time.

Though there are quiescent periods and low detectability times during the 24 hour period, it appears that sampling may be extended beyond the peak singing hours depending on the acceptable level of detection for the study. Birds in this study generally continued to sing throughout the morning hours with no clearly defined peak occurring during a 3-4 hour block. With 70% detectability rates surveys in the preserve could be conducted between 0200 h and 1130 h. Even if singing rates (frequency of song) were reduced during the latter portion of this period, birds still appear to have a high likelihood of being detected during a point count of sufficient length. Robbins (1981) maintained that by lengthening the listening periods, productive censusing of many species could be extended to midday. Count times greater than 6 minutes were recommended by Thompson and Schwalbach (1995) to increase chances of detectability with travel times longer than 8 minutes between points.

Smith and Twedt (1999) found that no bird species were detected more often in evening counts than in morning counts in Missouri bottomland hardwood forests (33° N latitude). Furthermore, they believed that evening bird counts during winter or the breeding season likely underestimated species richness, overall avian abundance, and abundance of some individual species. In this study, species richness during the bimodal evening activity period equaled that of the morning peak activity time, but for a greatly reduced time period (1900-2000 h and 2130-2230 h). The detectability level used to define an evening peak in our data (60%) was also lower than that used in the morning (70%). Given the time constraints and lower detectability levels in the evening activity peaks, sampling for birds should not target this time period.

Detectability

Bird detectability patterns differed by species in this study. This has also been documented in Lapland (Armstrong 1954), Costa Rica (Blake 1992), the eastern U.S. (Robbins 1981), and California (Verner and Ritter 1986). Verner and Ritter (1986) recommend determining optimal sampling hours for each species if specific ones are being targeted for monitoring. Variation between species is likely in response to breeding stage, nesting stage, foraging activities, and habitat conditions. In addition, light, ambient air temperatures, predation, and social stimuli have been suggested as external factors governing diurnal bird activity (Armstrong 1954); these issues were not addressed in this study.

Best (1981) found dramatic declines in singing after pairing in bird species where the main function of song is mate attraction; song is more persistent when the function is primarily territorial. Nest stage has also been correlated with frequency of singing (Armstrong 1954, Wilson and Bart 1985, King 1986). Singing rates are lower during incubation and nestling stages. Arrival time on the breeding grounds may also impact detection levels of singing birds. Birds will be establishing territories, building nests and laying eggs relative to their arrival time. It would be possible to have one species where most of the individuals are paired and singing infrequently or not at all; another species that has just arrived and is singing frequently to establish a territory or attract a mate; and another species that is feeding nestlings and being secretive and nonvocal. Similarly, birds within the same species can be at different stages in the breeding cycle. In Gates of the Arctic National Park and Preserve, Alaska, white-crowned sparrows were found on eggs, with nestlings, and with fledglings on the same day (Swanson 1998). These types of asynchrony could impact both species detection and the number of birds detected during a point count.

With increasing ambient temperatures, Verner and Ritter (1986) recorded increases in the number of species sampled that foraged on the wing, such as swallows and swifts. Airborne insects are less active at cold temperatures, so aerial foragers may not be as active and hence, not consistently detected during early morning hours when temperatures are low. Thermals (which develop later in the day) may be important to flight dynamics of soaring raptors and may influence their peak detection times. Temperature data in this study was not sufficient to examine detection trends, though bank swallows, violet-green swallows, a red-tailed hawk, and an unidentified raptor were all detected after 1000h.

Canopy closure and vegetation density likely influence both observer visibility to birds (potentially affecting bird behaviors during a point count) and bird visibility to the observer (primarily affecting the observer's ability to detect non-singing birds). Some bird species were more visible and/or vocal in response to seeing study observers. In the relatively open woodland needleleaf moss and woodland needleleaf lichen sites (where study observers were more visible), Townsend's solitaires, varied thrushes, boreal chickadees, and gray jays flew in close to the observers to scold and investigate them. These birds were easily detected, but they may not have been closely associated with the area being surveyed, thus inflating species richness and relative abundance estimates for the sites. Similarly, during a 1999 winter point count transect in Yukon-Charley Rivers National Preserve, a pair of gray jays followed a survey crew for approximately 1 mile through open needleleaf forest habitat and was detected on 4 points; this could have resulted in an inflated gray jay relative abundance estimate on that transect had the observers not known they were being followed.

In contrast to this assertive behavior, some bird species became secretive and less vocal when observers were visible (particularly at close distances). Though tree canopy closure and stem density was greater on the open mixed deciduous site than on the other 2 sites, the understory was minimal and observers were still visible to birds beneath the canopy. During one point count event at this site, two yellow warblers were visually detected at 20 m but they did not sing. Had the understory vegetation been denser in the area, these birds likely would not have been seen. On the other hand, had the birds been unable to see the observer due to denser vegetation, they may have been singing and thus detected.

MANAGEMENT IMPLICATIONS

1. Variable circular plot transects on the Inventory project in Yukon-Charley Rivers National Preserve can begin as early as 0200 h. The surveys could continue as late as 1130 h, but physical constraints for inventory crews conducting the transects will likely result in an earlier sampling cutoff time.
2. Count periods longer than the 5-minute interval specified in the Boreal Partners in Flight protocol will be necessary to maximize species detection for those species or individuals that are exhibiting reduced activity levels. This will also help offset the amount of time spent traveling between points on the transect; hiking conditions will vary considerably between the various habitat types being traversed in the survey. Recommend splitting an 8-minute count period into the first 5 minutes and the second 3 minutes in the first year of the study. This will allow comparison with the Boreal Partners in Flight data as well as maximize bird detections on the inventory project.
3. Rain can significantly impact bird detection and surveys should not occur if rain is constant and shows no signs of letting up. Wind can also impact detection rates. Late starts on bad weather days will still produce useable results.
4. Extensive training in distance estimation is a critical component of this sampling scheme. Variance in distance estimation between observers should be minimized and estimations should be recalibrated periodically while in the field. Distance estimation training should occur in different habitats since observers may loose their distance perspective when moving between heavily vegetated and open habitats.
5. Observers may need to avoid bright colors (such as orange or red) when conducting point count transects to minimize visibility and avoid influencing behavior responses of birds to those colors. Gutzwiller and Marcum (1993) found lower detection probabilities for three species of birds when orange vests were worn. They suggested that knowledge about chromotropic responses to observer apparel might be critical in designing more accurate surveys.

LITERATURE CITED

Armstrong, E.A. 1954. The behavior of birds in continuous daylight. Ibis 96:1-30.

Best, L.B. 1981. Seasonal changes in detection of individual bird species. *In* Estimating the numbers of terrestrial birds. Studies in Avian Biology 6:252-261.

Blake, J.G. 1992. Temporal variation in point counts of birds in a lowland wet forest in Costa Rica. The Condor 94:265-275.

Ducks Unlimited, Inc. 1998. Yukon-Charley/Black River/40 Mile Earth cover classification: user's guide. Project Number AK-0024-002. Ducks Unlimited, Inc. 3074 Gold Canal Driver, Rancho Cordova, CA 95670. 56 pp.

Gutzwiller, K.J. and H.A. Marcum. 1993. Avian responses to observer clothing color: caveats from winter point counts. Wilson Bulletin 105(4): 628-636.

Handel, C.M. 1999. Instructions for conducting off-road breeding bird point counts in Alaska. Boreal Partners in Flight, Alaska Fish and Wildlife Research Center, 1011 E. Tudor Rd., Anchorage, AK, 99503. 4pp.

Holmes, W.G. and S.J. Dirks. 1978. Daily song patterns in golden-crowned sparrows at 62° N Latitude. The Condor 80:92-94.

Kessel, B. 1979. Avian habitat classification for Alaska. The Murrelet 60:86-94.

King, J.R. 1986. The daily activity period of nesting white-crowned sparrows in continuous daylight at 65°N compared with activity period at lower latitudes. The Condor 88: 382-384.

Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. U.S.D.A., Forest Serv., Pacific Southwest Research Station, Albany, CA. 41 pp.

Robbins, C.S. 1981. Effect of time of day on bird activity. *In* Estimating the numbers of terrestrial birds. Studies in Avian Biology 6:275-286.

Smith, W.P. and D.J. Twedt. 1999. Temporal differences in point counts of bottomland forest landbirds. Wilson Bulletin 111(1): 139-143.

Thompson, F.R. and M.J. Schwalbach. 1999. Analysis of sample size, counting time, and plot size. In Ralph, C.J., J.R. Sauer, and S. Droege, eds. Monitoring bird populations by point count. Gen. Tech. Rep. PSW-GTR-149. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. of Agriculture. Pp. 45-48.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska vegetation classification. Gen. Tech. Rep. PNW-GTR-86. U.S.D.A. Forest Serv., Pacific Northwest Research Station, Portland, OR. 278 pp.

Verner, J. and L.V. Ritter. 1986. Hourly variation in morning point counts of birds. The Auk 103: 117-124.

Weeden, J. S. 1966. Diurnal rhythm of attentiveness of incubating female tree sparrows (*Spizella arborea*) at a northern latitude. The Auk 83:368-388.

Wilson, D.M. and J. Bart. 1985. Reliability of singing bird surveys: effects of song phenology during the breeding season. The Condor 87(1): 69-73.

Appendix I. Habitat descriptions for three 24-hour bird monitoring sites, Yukon-Charley Rivers National Preserve, Alaska, June 20-24, 1998.

Open Mixed Deciduous Site (65°18'15.5" N Latitude, 143° 09' 07.7" W Longitude)

Tree canopy cover on this site was 25-59% and was composed primarily of paper birch (*Betula papyrifera*) 9-21 m in height and willow (*Salix* spp.) 5-9 m in height; coniferous trees [white spruce (*Picea glauca*)—3-5 m in height] composed less than 10% of the canopy cover. Dwarf tree/sapling cover was <10% and consisted of willow (*Salix* spp.) and paper birch trees averaging 1.0 m in height.

Shrub cover was less than 25% and was comprised of willow, rose (*Rosa acicularis*), highbush cranberry (*Viburnum edule*), and raspberry (*Rubus idaeus*), all averaging 0.5 m in height. The herbaceous layer consisted of Bluejoint grass [*Calamogrostis canadensis*); 25-74% cover], herbs (<25% cover), and horsetails (*Equisetum* spp.; <25% cover). Litter accounted for 25-74% cover and bare ground/talus provided <25% cover.

This east-facing site has been highly disturbed in the past by dredge mining activities. Coal Creek and several small tributaries are located within 100 m of this site. The site was classified as Open Mixed Forest by the Alaskan vegetation classification system presented in Viereck et al. (1992) and as Mixed Deciduous-coniferous Forest by Kessel (1979).

Woodland Needleleaf Moss Site (65°18'12.5" N Latitude, 143°10'11.3" W Longitude)

Tree canopy cover on this site was 10-24% and was composed primarily of black spruce (*Picea mariana*) 5-9 m in height and paper birch 5-9 m in height; coniferous trees composed 75-89% of the canopy cover. Dwarf tree/sapling cover was <10% and consisted of black spruce trees averaging 0.2 m in height.

Shrub cover was >25%. Labrador tea (*Ledum palustre*), shrubby cinquefoil (*Potentilla fruticosa*), crowberry (*Empetrum nigrens*), and lingonberry (*Vaccinium vitis-idaea*) accounted for 25-74% cover. Willow and alder (*Alnus crispa*) shrubs averaged 0.5 m in height; each contributed <25% cover. The herbaceous layer consisted of grasses (*Poa* spp.), wintergreen (*Pyrola* spp.), and horsetails (*Equisetum* spp.), all with <25% cover. Mosses had >75% cover and included *Sphagnum* spp., *Hylocomium splendens, Pleurozium schreberi*, and *Tomenthypnum nitens*. Litter and lichen components of the habitat were each <25% cover.

This east-facing site was classified as Needleleaf Woodland by the Alaskan vegetation classification system presented in Viereck et al. (1992) and as Mixed Deciduous-coniferous Forest by Kessel (1979).

Woodland Needleleaf Lichen (65°17'21.1" N Latitude, 143°16'51.7" W Longitude)

Tree canopy cover on this site was 1-9% and was composed primarily of white spruce, paper birch, and trembling aspen (*Populus tremuloides*); the average height of each tree species was 3-5 m. Coniferous trees composed 26-74% of the canopy cover. Dwarf tree/sapling cover was >10% and consisted of trembling aspen and white spruce <1.5 m in height.

Shrub cover was >25% and shrubs all averaged <0.4 m in height. Labrador tea (*Ledum palustre*), blueberry (*Vaccinium uliginosum*), crowberry, lingonberry, club mosses (Lycopodium spp.), and kinnikinnick (*Arctostaphylos uva-ursi*) each comprised <25% cover. The herbaceous layer consisted of grasses (*Poa* spp.) and

herbs (Geocaulon lividum and *Pedicularis labradorica*), all with <25% cover. Lichens represented >75% cover and included *Cladina stellaris, Cladina mitis, Cetraria nivalis, Stereocaulon* spp., and *Cladonia* spp. Mosses (Polytrichum spp., and Sphagnum spp.) accounted for <25% cover. Litter and bare ground/talus contributed <25% cover.

This hilltop site had a thin soil layer over rock and was well-drained. The site was classified as Mixed Woodland under the Alaskan vegetation classification system presented in Viereck et al. (1992) and as Dwarf Forest under Kessel's system (Kessel 1979).

Appendix II. Scientific and common names for birds detected during a 24-hour bird monitoring project in Yukon-Charley Rivers National Preserve, AK, June 20-24, 1998.

Common Names	Scientific Names
Solitary Sandpiper	*Tringa solitaria*
Lesser Yellowlegs	*Tringa flavipes*
Red-tailed Hawk	*Buteo jamaicensis*
Olive-sided Flycatcher	*Contopus cooperi*
Say's Phoebe	*Sayornis saya*
Hammond's Flycatcher	*Empidonax hammondii*
Alder Flycatcher	*Empidonax alnorum*
Bank Swallow	*Riparia riparia*
Violet-green Swallow	*Tachycineta thalassina*
Gray Jay	*Perisoreus canadensis*
Black-capped Chickadee	*Poecile atricapillus*
Boreal Chickadee	*Poecile hudsonicus*
Arctic Warbler	*Phylloscopus borealis*
Townsend's Solitaire	*Myadestes townsendi*
Swainson's Thrush	*Catharus ustulatus*
Gray-cheeked Thrush	*Catharus minimus*
Hermit Thrush	*Catharus guttatus*
Varied Thrush	*Ixoreus naevius*
American Robin	*Turdus migratorius*
Bohemian Waxwing	*Bombycilla garrulus*
Orange-crowned Warbler	*Vermivora celata*
Myrtle Warbler	*Dendroica coronata*
Yellow Warbler	*Wilsonia pusilla*
Northern Waterthrush	*Seiurus noveboracensis*
Chipping Sparrow	*Spizella passerina*
Fox Sparrow	*Passerella iliaca*
Dark-eyed Junco	*Junco hyemalis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Pine Grosbeak	*Pinicola enucleator*
Common Redpoll	*Carduelis flammea*

Table 1. Frequency of detection by bird species for 5-minute point counts (*n*) conducted every half hour during 24-hour monitoring sessions in three different habitat types, Yukon-Charley Rivers National Preserve, Alaska, June 20-24, 1998.

Species	Woodland Needleleaf Moss Frequency (n =44)	Open Mixed Deciduous Frequency (n =48)	Woodland Needleleaf Lichen Frequency (n =48)
Solitary Sandpiper		.04	
Lesser Yellowlegs	.02		
Red-tailed Hawk	.04		
Olive-sided Flycatcher	.02	.02	
Say's Phoebe	.02		
Hammond's Flycatcher		.33	.12
Alder Flycatcher	.17	.37	
Bank Swallow		.10	
Violet-green Swallow		.18	.02
Gray Jay	.37	.02	.22
Black-capped Chickadee	.04		
Boreal Chickadee	.11		
Arctic Warbler	.09		.02
Townsend's Solitaire	.47	.04	.10
Swainson's Thrush	.85	.92	.94
Gray-cheeked Thrush			.14
Hermit Thrush	.52		
Varied Thrush	.41	.12	.45
American Robin	.15	.20	.41
Bohemian Waxwing		.02	.45
Orange-crowned Warbler	.28	.67	.06
Myrtle Warbler	.28	.29	.18
Yellow Warbler	.02	.33	
Northern Waterthrush		.29	
Chipping Sparrow	.07		
Fox Sparrow		.08	
Dark-eyed Junco	.87	.31	.71
White-crowned Sparrow	.11	.61	
Pine Grosbeak			.02
Common Redpoll	.02		.12

Table 2. Bird species detected at three 24-hour monitoring sites that were not detected between 0300 h and 0900 h, the period targeted for sampling in the Boreal Partners in Flight protocol for off-road point counts. Monitoring sites were located in Yukon-Charley Rivers National Preserve, Alaska, June 20-24, 1998.

Woodland Needleleaf Moss	Open Mixed Deciduous	Woodland Needleleaf Lichen
Red-tailed hawk	Olive-sided flycatcher	Violet-green swallow
Olive-sided flycatcher	Violet-green swallow	Townsend's solitaire
Black-capped chickadee	Bank swallow	Pine grosbeak
Ruby-crowned kinglet	Gray jay	Common redpoll
Yellow warbler	Townsend's solitaire	
Common redpoll	Bohemian waxwing	

Table 3. Chi-square contingency table comparing the number of bird detections (*n*) in each distance category between three 24-hour monitoring sites in Yukon-Charley Rivers National Preserve, Alaska, June 20-24, 1998. [Chi-square test statistic (X^2) = 140.62, df = 14, P = 0.000]

Distance category	Values	Open Mixed Deciduous	Woodland Needleleaf Moss	Woodland Needleleaf Lichen
0-10 m	Observed (*n*)	11	3	3
	Expected	6.29	5.80	4.91
	Cell X^2 contribution	3.59	1.35	0.75
11-20 m	Observed (*n*)	39	9	4
	Expected	19.23	17.74	15.03
	Cell X^2 contribution	20.31	4.30	8.09
21-30 m	Observed (*n*)	55	16	15
	Expected	31.81	29.33	24.86
	Cell X^2 contribution	16.91	6.06	3.91
31-40 m	Observed (*n*)	59	59	28
	Expected	54	49.80	42.2
	Cell X^2 contribution	0.46	1.70	4.28
41-50 m	Observed (*n*)	69	56	36
	Expected	59.55	54.91	46.53
	Cell X^2 contribution	1.50	0.02	2.38
51-60 m	Observed (*n*)	62	58	49
	Expected	62.51	57.64	48.85
	Cell X^2 contribution	0.00	0.00	0.00
61-70 m	Observed (*n*)	21	25	6
	Expected	19.23	17.74	15.03
	Cell X^2 contribution	0.16	2.98	5.42
>70 m	Observed (*n*)	82	141	170
	Expected	145.37	134.04	113.59
	Cell X^2 contribution	27.62	0.36	28.01
	Total bird detections per site	398	367	311