DRAFT
PASSERINE
MONITORING HANDBOOK

DENALI NATIONAL PARK & PRESERVE

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INTRODUCTION

There has been increased interest in the population trends of passerines in North America, primarily due to reported declines for over one-third of Nearctic-Neotropical migrants (Terborgh 1989, Hagan and Johnston 1992, Sauer and Droege 1992, Rappole and McDonald 1994, Rappole 1995). There have been a number of hypotheses proposed to explain these declines (Rappole and McDonald 1994), yet there is no consensus among ornithologists concerning specific causes. Some authorities suggest that these declines are the result of habitat limitation on the wintering grounds (Terborgh 1989, Rappole and McDonald 1994), while others believe population declines could also be due to habitat limitations on the breeding grounds (Holmes and Sherry 1992, Sherry and Holmes 1992). The pristine habitats of Denali National Park in central Alaska provide an opportunity to gather empirical data on the population dynamics of migratory birds where the extensive tracts of breeding habitat are relatively unaffected by human influences. Because the North American Breeding Bird Survey has been active in Alaska only for the past 10 years, little is known about population trends of landbirds in the remote regions of central Alaska (Peterjohn and Sauer 1994), where over 80% of avian species are migrants (Newton and Dale 1996).

The National Park Service (NPS) is responsible for managing 21.5 million ha (53 million acres) in 23 national parks in Alaska, or about 66% of the nation's NPS land base. It is NPS policy "to provide accurate scientific data upon which all aspects of planning, development, and management of the units of the System may be based" (Management Policies of the NPS IV-2, 1978). Yet, few national parks have implemented extensive inventory and monitoring programs (Evison et al. 1987), even though at least two federal legislative acts dictate that the NPS initiate inventory and monitoring programs in all parks. The Forest and Rangeland Renewable Resources Planning Acts (RPA) of 1974 and 1976 mandate the inventory and monitoring of natural resources on public lands, while the National Environmental Policy Act (NEPA) of 1969 requires gathering baseline information to assess management options.

The objectives the avian inventory and monitoring program in Denali National Park and Preserve proposed in this manual are threefold:

(1) establish a sampling protocol that can be used to monitor population trends of selected passerines within the Park's boundaries,

(2) collect data that can be used by Boreal Partners in Flight to monitor statewide and regional population trends of passerines (Handel 1993a, b), and

(3) continue to conduct Breeding Bird Survey routes to monitor continent-wide population trends (Droege 1990).

Butcher et al. (1992) proposed national guidelines for all avian monitoring programs for all federal agencies (e.g., National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, and Bureau of land Management), and suggested monitoring programs should be designed to have a 90% probability of detecting a cumulative 50% decline (annual decline = 2.7345%) in a species over a 25-year period. From 1992-1996, Alaska Bird Observatory has been conducting pilot surveys using point counts to determine the sampling intensity necessary to monitor passerine population trends within the Park's boundaries using Butcher et al's guidelines (Pogson et al 1993, Paton et al. 1994, 1995, Paton 1996). In addition, the Institute for Bird Populations (IBP) is managing the constant-effort mist-netting program under the administration of the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante et al. 1993). This latter program is designed to monitor changes in adult survival and in the ratio of adults to juveniles based on capture rates in mist nets, which in turn can be used to assess changes in annual productivity.

This handbook describes the methodology developed by Alaska Bird Observatory personnel to monitor passerine population trends in the Park. Although other taxa are also counted during these surveys (e.g., loons [Gaviiformes], grebes [Podicipediformes], waterfowl [Anseriformes], shorebirds [Charadriiformes], diurnal raptors [Falconiformes], nocturnal raptors [Strigiformes], and grouse/ptarmigan [Galliformes]), the survey methods described here are primarily designed for songbirds (Passeriformes) and similar taxa (e.g., woodpeckers [Piciformes]). Included are specific instructions for data collection and management of the database.

MONITORING DESIGN CONSIDERATIONS

Specific birds that could be monitored in Denali National Park should be a function of observer's ability to adequately sample their population trends. That is, target species need to be selected based on a power analysis of pilot survey data. A power analysis allows researchers to determine how much sampling effort is needed to detect a statistically significant trend, if in fact a trend is occurring. In this particular instance, researchers are probably most interested in detecting population declines. In the case of Denali, research by Alaska Bird Observatory using frequency data (i.e., the proportion of point count stations with a detection) found that only species occurring at ≥14% of all stations could be adequately monitored, assuming 100 point count stations were visited annually over a 25-year period to detect an overall 50% decline (based on program TRENDS [Gerodette 1987] in Paton and Pogson 1995). Species that were less common could be monitored if the number of sampling stations was increased. Based on pilot data collected in spruce forests in Denali, species that could be monitored include: Gray Jay, Boreal Chickadee, Swainson's Thrush, American Robin, Varied Thrush, Yellow-rumped (Myrtle) Warbler, Wilson's Warbler, Orange-crowned Warbler, American Tree Sparrow, Dark-eyed (Slate-colored) Junco, White-crowned Sparrow, White-winged Crossbill, and redpoll (Pogson and Paton 1994; see Appendix A for scientific names for each species). This list encompasses species from a variety of migratory strategies (Hayes 1995), including year-round residents in the Park (Gray Jay and Boreal Chickadee), irruptive species that sometimes winter in central Alaska (White-winged Crossbill and redpoll), species that are Nearctic-Nearctic migrants (Varied Thrush, American Tree Sparrow, Dark-eyed [Slate-colored] Junco, White-crowned Sparrow), short-distance Neotropical migrants (i.e., those that winter south of the Tropic of Cancer and north of South America; American Robin, Orange-crowned Warbler, Myrtle Warbler) and long-distance Neotropical migrants (i.e., those that winter in South America; Swainson's Thrush).

<u>Study area</u>

Denali National Park and Preserve is located in the central Alaska Range, approximately 210 km southwest of Fairbanks, Alaska. The Park encompasses a diversity of habitats including forested habitats (i.e., open and closed needleleaf forests, open and closed mixed deciduous-coniferous forests), shrub habitats (i.e., open and closed shrubs ranging in height from dwarf to tall), and alpine tundra (Viereck et al. 1992). The forests are dominated by white spruce (*Picea glauca*), black spruce *(P. mariana*), quaking aspen (*Populus tremuloides*), balsam poplar (*P. balsamifera*) and paper birch (*Betula papyrifera*). Tall, medium, and dwarf shrub habitats are dominated by a diversity of willows (e.g., *Salix planifolia, S. barcleyi*, *S. glauca*), dwarf birch (*B. glandulosa*), mountain alder (*Alnus crispa*), blueberry (*Vaccinium uliginosum*), and mountain cranberry (*V. vitis-idaea*). Alpine tundra is dominated by sedges, grasses forbs and dwarf ericaceous shrubs at higher elevations. Forest habitats are generally restricted to areas below 600-900 m elevation, and alpine tundra generally occurs above 900 m elevation. The intervening elevations are dominated by shrub habitats. The eastern half is bisected by a 150-km long dirt road. Elevations in the road corridor vary from 490 m (1,600') at the Park Highway to 1,220 m (4,000') at Stony Pass. The growing season is relatively short, with most areas in the road corridor snow-free by mid-late June in most years. Permanent snow fields remain on north-facing slopes at higher elevations. The park road is often closed by snow in September. Mean temperatures at the Park Headquarters for June, July, and August are 11.1°C (52°F), 12.5°C (54.5°F), and 11.1°C (52°F), respectively (National Park Service, unpubl. data).

<u>Sampling technique selection</u>

There are currently three survey techniques used by ornithologists to estimate densities (when used in conjunction with distance estimates, which can be inaccurate) and monitor population trends of landbirds: spot mapping, transects, and point counts (Ralph and Scott 1981, Verner 1985, Bibby et al. 1992, Ralph et al. 1994). Spot mapping is applicable only to relatively small areas (<200 ha) because it is an extremely time-consuming method. Most areas monitored with spot mapping are <40 ha in size and require at least 8 visits per study area per breeding season to census (Butcher et al. 1993). Although most biologists assume that the spot-mapping method results in the most accurate density estimates of the three methods (DeSante 1981), there have been no rigorous tests of this assumption (Verner 1985, Verner and Ritter 1986).

Both transects and point counts (Reynolds et al. 1980, Blondel et al. 1981, Hutto et al. 1986) can be used to estimate bird numbers and monitor avian population trends at relatively large scales (>1,800 ha, Verner 1987). Current research suggests that transects have a number of potential problems that make the technique less desirable than point counts (Verner and Milne 1989, but see Anderson and Ohmart 1981). The amount of time an observer spends censusing a particular area can be rigorously controlled during point counts, whereas transect survey times generally increase with the number of detections. This results in observers spending more time in an area recording data, allowing previously undetectable birds to move into the observer's detection range, and leading to a positive bias for transects with relatively large numbers of birds (Verner 1985). Another shortcoming of transects is that they are more expensive for each independent sampling unit than point counts (Butcher et al. 1993). However, some biologists feel that transects are appropriate in some habitat types such as grasslands (Butcher et al. 1993) or in level terrain where vegetation could be cleared to see the transect easily. Most areas in the Park, with the exception of alpine tundra, do not meet these habitat criteria.

Unlimited-distance point counts (Blondel et al. 1981) have been identified as the preferred method to monitor annual population trends in roadless tracts of land (Hamel

1984, Tomiakojc and Verner 1990, Butcher et al. 1992, Ralph et al. 1994). This is because point counts allow researchers to (1) absolutely control the time period for each census, in contrast to spot-mapping or transect methods, (2) monitor a larger number of independent sampling units, thereby increasing sample size and power of statistical tests, (3) place sampling units in relatively small, homogeneous patches, and (4) permit observers to concentrate solely on identifying birds while censusing, as opposed to transect methods that require observers to also pay attention to the path being surveyed (Verner 1985, Verner and Ritter 1986). Another advantage of point counts over other methods is that they provide the most cost-effective method for estimating the abundance of birds in large tracts of land (Ralph et al. 1993).

The Boreal Partners in Flight working group has adopted off-road point counts as the appropriate method for surveying birds in roadless areas in Alaska (Handel 1993a). Guidelines listed by this working group include when to conduct surveys (10-30 June starting at official sunrise), how long to count birds (i.e., 5 minutes, subdivided into the first 3 minutes and the last 2 minutes), and how to count birds (i.e., those ≤50 m and >50 m from plot center). In addition the current Boreal Partners in Flight protocol suggests that survey routes should be placed “roughly in proportion to the area of the strata”, with point count stations at least 250 m apart in forested habitats and 400-500 m apart in open habitats, and 12 stations surveyed per morning. All of these guidelines are necessary to maintain a statistically valid research program. It is also extremely important that researchers adopt the same survey methods, so that comparisons can be made across geographic regions.

Verner (1985) identified four sources of bias inherent to attempting to count birds: (1) observer effects (e.g., experience, acuity, alertness, and the total number of field personnel); (2) bird species effects (e.g., variation in each species' detectability, species density, timing of breeding, flocking habits), (3) site selection effects (e.g., how to select the sampling area [random, stratified random, selective], number of sampling sites, distance between stations, number of stations per transect), and (4) sampling schedule effects (e.g., what months to sample, what time of day, duration of point counts, and the duration of the sampling period). It is crucial to identify and minimize sources of bias to increase the probability of obtaining accurate count data. Some sources of bias can be controlled by experimental design or analysis techniques. For example, observer effects can be minimized by using only experience observers, preferably ones that are already familiar with the birds of the region. In addition, extensive training programs can help minimize observer biases (Kepler and Scott 1981). In contrast, sampling schedule effects are best addressed by conducting a pilot study in the geographic area and habitats of interest, thus allowing researchers to obtain preliminary data to optimize the study design.

Point counts have been used recently by a number of agencies to estimate numbers of birds over relatively large areas. Scott et al. (1986), of the U.S. Fish and Wildlife Service, used point counts to determine the distribution and abundance of birds throughout the Hawaiian Islands. The Hawaiian Island survey in forested habitats used transects with points spaced 100-250 m apart, depending on vegetation and topography, and birds were counted for 8 minutes per point count station. Each counting station was surveyed by two separate observers on the same morning. Ruggerio et al. (1981), in a $2,000,000 U.S. Forest Service project, used point counts to estimate number of birds utilizing different aged stands of Douglas-fir throughout the Pacific Northwest. This latter survey used off-road point counts to survey forest stands, with 12 points spaced at 150 m intervals surveyed each morning. Each point was surveyed for 8 minutes on 6 mornings, at one week intervals. Transects were usually surveyed by a different observer each visit. Observers in both projects estimated distances to birds, so that the data could be used to calculate density estimates (Reynolds et al. 1980).

Neither of these two large-scale projects were designed to monitor population trends. The U.S. Forest Service has a legislative mandate to monitor wildlife populations on all National Forest lands, under the National Forest Management Act of 1976. Yet there are no standardized survey methods used by the Forest Service to monitor avian population trends (Verner 1987). The U.S. Fish and Wildlife Service's Hawaii project objectives were to determine the population size, distribution, density, and habitat characteristics of each species, and to identify the geographic areas where more detailed studies could be conducted (Scott et al. 1986). In contrast, the Forest Service's Pacific Northwest studies were designed to determine habitat association patterns of birds (Ruggerio et al. 1991).

MONITORING PROTOCOL

SAMPLING METHODS

On-road point counts:

On-road point counts follow the protocol developed for the Breeding Bird Survey developed by the U.S. Fish and Wildlife Service (Droege 1990).

Materials--

1	clipboard + pencils for writing
10	data sheets
1	pair of binoculars
1	GPS unit (if new routes are established, or to confirm stop locations)
1	Vehicle to drive between points
1	Bird training tape (see below)

Personnel--1 observer per route. It would be ideal if the same observer surveyed the same routes year after year to minimize observer biases. If this is not feasible, then the number of observers that survey each route should be minimized. Trained observers should not have any difficulty writing down observations, while simultaneously listening for new detections. This should hold true for both on- and off-road counts. Only observers with prior avian census experience should be used to collect these data. Eighty to 90% of all detections will be aural, therefore observers should be familiar with all the calls and songs of the birds in the area (note: Alaska Bird Observatory or Anchorage Audubon Society has available a cassette tape of the calls and songs of the birds of the region for $30 per set; and "Bird Song Master" a Windows-based computer program for use with "Bird Songs of Alaska" or several other audio CDs can develop customize training programs from identifying whatever species are desired {available from Gary Schumacher, Micro Wizard, 5277 Forest Avenue, Columbus, OH 42314-1305, Telephone 800-336-6371. Both projects were funded by Boreal Partners in Flight and copy for individual parks in Alaska are available through the National Park Service's Regional Office). Prior to the initiation of the censuses, observers should undergo a minimum of 3 mornings of censuses to re-familiarize themselves with vocalizations of the birds of the area.

Timing--Data are collected during the peak of the breeding season for migratory passerines, which extends from **5 June to 25 June** in Denali. Researchers should be cautioned, however, that Arctic Warblers do not usually arrive in Denali until 10 June, whereas the peak singing period for other species is May (e.g., Willow Ptarmigan, Ruby-crowned Kinglet, Varied Thrush; Paton unpubl. data).   Therefore, if species other than migratory songbirds are to be monitoring, the survey chronology guidelines need to be changed. Regardless of seasonal chronology, surveys should be **initiated within 30 minutes of official sunrise**, but never before 03:30 ADT.

Distance between points--Stops are always placed 0.5 mile apart to meet the Breeding Bird Survey guidelines (Table 1). Mileages start at the junction of the Park Highway and the main park road correspond to mileposts on the park road when available.

The census period at each point--All birds (recorded as the number of individuals for each species) detected within a **3-minute survey period** are recorded (Table 1, Appendix B has stop locations, see also On-road Route data form).

Observations are subdivided into birds that are first detected as (1) a singing bird, (2) a calling bird, (3) a visual detection (seen but not heard), or (4) a bird flying overhead. The majority of detections will be aural, but observers should be constantly scanning the surrounding vegetation and sky for active birds.

Time required--*On-road routes* usually take about 4.5-5.5 hours to complete.

Number of visits to each point count station: During fieldwork conducted by Alaska Bird Observatory, each *on-road route* was surveyed 2-4 times per field season. However, *on-road routes* only need to be visited once per field season (accounting for 4 total mornings in the field to survey 4 routes). If more observer days are available, no other on-road routes could be added in the Park, with the exception of a possible route along the Park Highway (note: road noise may be too great to allow an effective survey route along this section of highway).   However, additional surveys could be conducted on existing on-road routes to increase the probability of detecting rare species.

Off-road point counts:

Materials--

1	clipboard + pencils for writing
6	data sheets
1	compass
1	tally meter
1	pair of binoculars
1	GPS unit (if new routes are established, or to confirm stop locations)
1	Directions describing each transect (e.g., how to get to first point, compass bearings to get between stations).
1	bird training tape

Personnel--1 observer per route

Timing--Data are collected during the peak of the breeding season for migratory passerines, which extends from **5 June to 25 June** in Denali. Individual survey routes should be sampled on approximately the same date each year. Researchers should be cautioned, however, that Arctic Warblers do not usually arrive in Denali until 10 June, whereas the peak singing period for other species is May (e.g., Willow Ptarmigan, Ruby-crowned Kinglet, Varied Thrush; Paton unpubl. data). Surveys should be **initiated within 30 minutes of official sunrise**, but never before 03:30 ADT.

Distance between points: On *off-road routes*, stations should be spaced at least 250 m apart in forested habitats. If new off-road routes are established in more open terrain, stops should be spaced farther apart to maintain the independence of each sampling point. Stations should be spaced as far as 500 m apart in alpine tundra. This is because birds can be detected at much farther distances in more open terrain (Paton unpubl. data). Although researchers could use fixed-distance point counts (e.g., 100 m), rather than unlimited distance point counts, we urge observers to conduct unlimited distance point counts. Estimating distances can be extremely inaccurate and takes an extensive training period.

The census period at each stop-- For *off-road routes*, all birds within a **5-minute survey period** are recorded, with the data subdivided into those individuals detected during the first 3-minutes, and those individuals detected during minutes 4-5 (Appendix C has stop locations, see also Off-road Routes data form).

Observations are subdivided into birds that are first detected as (1) a singing bird, (2) a calling bird, (3) a visual detection (seen but not heard), or (4) a bird flying overhead. The majority of detections will be aural, but observers should be constantly scanning the surrounding vegetation and sky for active birds.

Time required- *Off-road routes* take approximately 3-4 hours to collect the data, but may take an hour to return to the vehicle depending on the route.

Number of visits to each point count station: During fieldwork conducted by Alaska Bird Observatory, stops on nine *off-road routes* were visited one time per field season (9 total mornings). If more observer days were available, more *off-road routes* could be added in the Park in habitat other than spruce forest (e.g., shrublands or alpine tundra). In addition, since other researchers in other disciplines (e.g., hydrology, mammalogy, soils) are concentrating their efforts in the Rock Creek watershed, more off-road routes could be added in that drainage. It should be noted, however, that pilot data suggest that bird densities were relatively low in Rock Creek watershed, which is why Alaska Bird Observatory expanded the avian monitoring scheme to other areas of the Park. For example, species richness and abundance tends to be relatively high on the west side of the Park and adding more transects on that side of the Park could be useful.

Table 1. Summary of sampling protocols during on- and off-road routes.

Technique	No. of stops per morning	Distance between stops	Time surveying at each stop	Transportation between stops
On-road	50	0.5 mile	3 min	driving
Off-road	12	≥250 m	5 min	walking

Note: in Denali, we pooled survey data for Common (*Carduelis flammea*) and Hoary Redpolls (*C. hornemanni*) into the taxon redpoll because of identification problems separating the two species (Troy 1985). In addition, we sometimes had difficulty identifying ducks because they were too far away to classify to species. In 1993, we were not able to identify some woodpeckers to species because we were unable to distinguish the vocalizations of Hairy (*Picoides villosus*) and Three-toed Woodpeckers (*P. tridactylus*). However, based on our subsequent experience in the park in 1994 and 1995, all unidentified woodpeckers were probably *P. tridactylus*; *P. villosus* was never observed in the park during the four years of our working there (P. Paton, pers. obs.).

The data form: Other researchers (e.g., Handel 1993b, Ralph et al. 1994) have designed and used data forms for point counts that include a circular diagram of the point count station. Observers in those studies used special symbols to record the presumed location of each individual of each species and their associated behavior. However, it is my experience that is very time consuming and cumbersome to do while conducting a point count, and I feel that it detracts from the observer's ability to concentrate on obtaining new detections because so much effort is expended recording data. In addition, little could be done with these visual data for further analysis, so they are somewhat obsolete. Therefore, our data form does not incorporate a visual diagram of the point count station, but they could be added to data form if future researchers felt that they were necessary.

FIELDS ON DATA FORMS--

<u>Off-road routes data form</u>:

Observer: Name of the observer collecting data, only their initials are entered into database.
Date: placed in the order day, month, year
Route: Designated name of the survey route
Temperature: ambient air temperature in degrees F
Wind: estimated speed in miles per hour (note the Beaufort Scale could be used to estimate wind speeds). Surveys should not take place under fresh breeze conditions and above (19-24 mph; small trees in leaf begin to sway, crested wavelets form in inland waterways) because it is too difficult for observers to detect birds.
Cloud cover: estimated percent of the sky covered in clouds (0-100%)
Precipitation: e.g., dry, mist, slight drizzle etc. Observers should not survey when it is raining or snowing enough to reduce significantly detection probabilities
Stop: The survey station stop number on the route (range = 1-12)
Time: 24-hr clock time for when survey at that stop was initiated
Species: 4-letter BBL alpha code for species (see Appendix A).

0-3 minutes heading: tally of the number of individuals, by species, detected within the first three minutes (180 seconds) of the survey period. Each row on the data form represents a different species for that stop. Detections are subdivided into observations that were ≤50 m and >50 m from plot center, and then further subdivided within the distance categories into how the individual was first detected (either singing, calling, visual [seen before heard], or flying over the stop).
3-5 minutes heading: Individuals that a first detected during the fourth and fifth minutes (i.e., in seconds from 181-300) of the survey period. Detection are subdivided by distance and then into song, call, visual, and flyovers as in the previous 4 fields.
NOTES: Space is allowed at the bottom of the data form for any unusual, noteworthy observations.

On-road route data form:

Observer: Name of the observer collecting data, initials are entered into database.
Date: placed in the order day, month, year
Survey Route Number: Mile 0-24.5 = **1**; Mile 25-49.5=**2**, Mile 50-74.5 = **3**; Mile 75-93 = **4**.
Temperature: in degrees F
Wind: estimated speed in miles per hour (note the Beaufort Scale could be used to estimate wind speeds). Surveys should not take place under fresh breeze conditions and above (19-24 mph; small trees in leaf begin to sway, crested wavelets form in inland waterways) because it is too difficult for observers to detect birds.
Cloud cover: estimated percent of the sky covered in clouds (0-100%)
Precipitation: e.g., dry, mist, slight drizzle etc. Observers should not survey when it is raining or snowing enough to reduce detection probabilities
Stop: The survey station stop number on the route (range = 1-50 for Routes 1-3 and 1-37 for Route 4).
Mileage: Mile post from the Park Highway (mile 0.0) headed west, the route is 93 miles long.
Time: 24-hr clock time for when survey at that stop was initiated
Species: 4-letter alpha code for species (see Appendix A).
Sing: Number of individuals first detected singing at that stop for the species listed on the row.
Call: Number of individuals first detected calling at that stop for the species listed on the row.
Visual: Number of individuals first detected by sight (not aural) for the species listed on the row.
Flyovers: Number of individuals first detected flying over the stop for the species listed on the row.

DATA MANAGEMENT

Information on data entry is presented in this section. The database management system Paradox is used for data entry (dBase could be used in place of this system) and SAS programs are used to analyze the data.

Off-road Route Data

A new data file is created for each year off-road routes are conducted. This data file is named OFFRD**.DB (**=year). Data should be verified and backup copies made once data are entered.

PARADOX FILE STRUCTURE

FIELD	FIELD NAME	TYPE	WIDTH	NOTES
1	OBS	ALPHA	2	INITIALS
2	DATE	DATE	8	D-M-Y
3	ROUTE	ALPHA	15	NAME OF ROUTE
4	TEMP	NUMERIC	2	DEGREES F
5	WIND	NUMERIC	2	MPH
6	CLDCVR	NUMERIC	3	%
7	PRECIP	ALPHA	5	WEATHER COND.
8	STOP	NUMERIC	2	ASSIGNED # (1-12)
9	TIME	NUMERIC	4	24-hr clock
10	SPECIES	ALPHA	4	BBL codes
11	SLT5003	NUMERIC	2	SING, <50 M, 3 MIN
12	CLT5003	NUMERIC	2	CALL, <50 M, 3 MIN
13	VLT5003	NUMERIC	2	VISUAL, <50M, 3 M
14	FLT5003	NUMERIC	2	FLY, <50M, 3 MIN
15	SGT5003	NUMERIC	2	SING, >50 M, 3 MIN
16	CGT5003	NUMERIC	2	CALL, >50 M, 3 MIN
17	VGT5003	NUMERIC	2	VISU, >50 M, 3 MIN
18	FGT5035	NUMERIC	2	FLY, >50 M, 3 MIN
19	SLT5035	NUMERIC	2	SING, <50 M, 3-5 m
20	CLT5035	NUMERIC	2	CALL, <50 M, 3-5 m
21	VLT5035	NUMERIC	2	VISUAL, <50 M, 3-5
22	FLT5035	NUMERIC	2	FLY, <50 M, 3-5 m
23	SGT5035	NUMERIC	2	SING, >50 M, 3-5 m
24	CGT5035	NUMERIC	2	CALL, >50 M, 3-5 m
25	VGT5035	NUMERIC	2	VISUAL, >50 M, 3-5
26	FGT5035	NUMERIC	2	FLY, >50 M, 3-5 m
27	NOTES	ALPHA	50	MISC. NOTES

On-road Route Data

A new data file is created for each year off-road routes are conducted. This data file is named ONRD**.DB (**=year). Data should be verified and backup copies made once data are entered.

PARADOX FILE STRUCTURE

FIELD	FIELD NAME	TYPE	WIDTH	NOTES
1	OBS	ALPHA	2	INITIALS
2	DATE	DATE	8	D-M-Y
3	ROUTE	NUMERIC	1	NAME OF RT
4	TEMP	NUMERIC	2	F
5	WIND	NUMERIC	2	MPH
6	CLDCVR	NUMERIC	3	%
7	PRECIP	ALPHA	5	WEATHER
8	STOP	NUMERIC	2	STOP NUMBER
9	MILEAGE	NUMERIC	4	MILE MARKER
10	TIME	NUMERIC	4	24-hr clock
11	SPECIES	ALPHA	4	BBL codes
12	SING	NUMERIC	2	NO. SINGING
13	CALL	NUMERIC	2	NO. CALLING
14	VISUAL	NUMERIC	2	NO. VISUAL
15	FLYBY	NUMERIC	2	NO. FLYOVER
16	NOTES	ALPHA	30	MISC. NOTES

CREATING A NEW DATA FILE AND ENTERING DATA IN PARADOX

The following instructions are written for people who have familiarity with this spreadsheet, and for most people these instructions will not be necessary. You can copy the structure of an old data file and append data. In PARADOX, select the Create toolbar, enter the name of the new table, and select Borrow (under Borrow, enter the name of the table whose structure you want to use). Alternatively, you can enter the field names, type, and width for the new database.

Once the database is created, you can View the new table and press F9 to start data entry. Data entry is very straightforward in PARADOX. One hint, you can use Control-D to duplicate the field above, which helps expedite data entry. Use the tab key to move between fields. Once the data entry is complete, press F10 to get back to the main menu bar, and then press DO-IT to save your work.

If data are entered using PARADOX, then data need to be exported to a dBase file (under Tools, Export, dBase). The filename will stay the same, but the extension will change (i.e., filename.db will be exported to filename.dbf). SAS will only work easily with dBase files.

LITERATURE CITED

American Ornithologists' Union. 1983. Checklist of North American Birds. Allen Press, lawrence, Kansas. 877 pp.

Blondel, J., C. Ferry, and B. Frochot. 1981. Point counts with unlimited distance. Stud. Avian Biol. 6:414-420.

Butcher, G.S., S. Droege, and C.J. Ralph. 1992. Needs Assessment: Monitoring Neotropical Migratory Birds. Cornell laboratory of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850. 58 pp.

Butcher, G.S., B. Peterjohn, and C.J. Ralph. 1993. Overview of national bird population monitoring programs and databases. Pages 192-203 in D. M. Finch and P. W. Stangel. (eds). Status and management of neotropical migratory birds. U. S. Forest Service Gen. Tech. Rept. RM-229, Fort Collins, Colorado. 422 pp.

DeSante, D.F., and K.M. Burton. 1993. The 1992 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) program in Denali National Park. Unpubl. rept. Institute for Bird Populations, P.O. Box 1346, Point Reyes Station, California 94956.

Droege, S. 1990. The North American Breeding Bird Survey. Pages 1-4 in J. R. Sauer and S. Droege (eds.). Survey designs and statistical methods for the estimation of avian population trends. U.S. Fish and Wildl. Serv., Biol. Rep. 90(1). 166 pp.

Emlen, J.T. and M.J. DeJong. 1981. The application of song detection threshold distance to census operation. Stud. Avian Biol. 6:346-352.

Evison, B. and others. 1987. Draft natural resources inventory and monitoring initiative. USDI, National Park Service, Washington, D.C. 14 p.

Gerodette, T. 1987. A power analysis for detecting trends. Ecology 68:1364-1372.

Hagan, J.M. III and D.W. Johnston. 1992. Ecology and conservation of Neotropical migrant landbirds. Smithsonian Instit. Press, Washington, D.C. 608 pp.

Handel, C. M. 1993a. Instructions for conducting off-road breeding bird point counts in Alaska. Unpubl. Rept., U. S. Fish Wildl. Serv., Alaska Fish and Wildl. Res. Center, 1011 E. Tudor Rd., Anchorage, AK.

Handel, C. M. 1993b. Instructions for conducting habitat data off-road breeding bird point counts. Unpub. Rept. U. S. Fish and Wildl. Serv., Alaska Fish and Wildl. Res. Center, 1011 E. Tudor Rd., Anchorage, AK.

Hayes, F.E. 1995. Definitions for migrant birds: what is a Neotropical migrant? Auk 112:521-523.

Holmes, R. T. and T. W. Sherry. 1992. Site fidelity of migratory warblers in temperate breeding and Neotropical wintering areas: implications for population dynamics, habitat selection, and conservation. Pages 563-575 *in* Ecology and conservation of Neotropical migrant landbirds (J. M. Hagan II and D. W. Johnston, eds). Smithsonian Institution Press, Washington, D.C.

Hutto, R.L., S.M. Pletschet, and P. Hendricks. 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 103:593-602.

National Park Service. 1992. Long-term ecological monitoring, Denali National Park and Preserve. Ann. Admin. Rept., Alaska Regional Office, Natl. Park Serv., Anchorage, AK. 48 pp.

Newton, I. and L.C. Dale. 1996. Bird migration at different latitudes in eastern North America. Auk 113:626-635.

Paton, P.W.C., T. H. Pogson, and E. Rexstad. 1994. Development of landbird monitoring protocols for national parks in Alaska. Unpubl. Annual Rept., Biol. Res. Div., Anchorage AK.

Paton, P.W.C. and T. H. Pogson. 1995. Development of landbird monitoring protocols for national parks in Alaska. Unpubl. Annual Rept., Biol. Res. Div., Anchorage AK.

Paton, P.W.C. 1996. Development of landbird monitoring protocols for national parks in Alaska. Unpubl. Annual Rept., Biol. Res. Div., Anchorage AK.

Pogson, T.H., J. Bouton, T.D. Eskelin, and E. Rexstad. 1993. Development of landbird monitoring protocols for National Parks in Alaska. Final Annual Rept. to Biol. Res. Div., Anchorage AK.

Peterjohn, B.G. and J.R. Sauer. 1994. Population trends of woodland birds from the North American Breeding Bird Survey. Wildl. Soc. Bull. 22:155-164.

Ralph, C.J. 1993. Designing and implementing a monitoring program and the standards for conducting point counts. Page 204-207 in D. M. Finch and P.W. Stangel. (eds). Status and management of Neotropical Migratory Birds. U. S. Forest Serv. Gen. Tech. Rept. RM-229. Fort Collins, Colorado. 422 pp.

Rappole, J.H. 1995. The ecology of migrant birds: a Neotropical perspective. Smithsonian Institute Press, Washington, D.C.269pp.

Rappole, J.H., and M.V. McDonald. 1994. Cause and effect in population declines of migratory birds. Auk 111: 652-660.

Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor 82:309-313.

Scott, J.M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler. 1986. Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Stud. Avian Biol. 9:1-431.

Sherry, T. W. and R. T. Holmes. 1992. Population fluctuations in a long-distance Neotropical migrant: demographic evidence for the importance of breeding season events in the American Redstart. Pages 431-442 *in* Ecology and conservation of Neotropical migrant landbirds (J. M. Hagan II and D. W. Johnston, eds). Smithsonian Institution Press, Washington, D.C.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W. H. Freeman and Co., San Francisco.

Troy, D. M. 1985. A phenetic analysis of the redpolls Carduelis flammea flammea and C. hornimanni exilipes. Auk 102:82-96.

Verner, J. 1985. Assessment of counting techniques. Pages 247-302. in R. F. Johnston (ed). Current Ornithology. Vol. 2. Plenum Press, New York. 364 pp.

Verner, J. 1987. Preliminary results from a system for monitoring trends of bird populations in oak-pine woodlands. Pages 214-222. U. S. Forest Serv. Gen. Tech. Rept. PSW-100, Berkeley, California.

Verner, J. and K.A. Milne. 1990. Analyst and observer variability in density estimates from spot mapping. Condor 92:313-325.

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

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska vegetation classification. U.S. Forest Serv. Gen. Tech. Rept. PNW-GTR-286, Portland, OR. 278 p.

APPENDIX A. Scientific names and Bird Banding lab alpha codes for birds potentially seen in Denali National Park during the breeding season

Common name	Scientific name	Alpha code
Common Loon	*Gavia immer*	COLO
Pacific Loon	*Gavia pacifica*	PALO
Red-throated Loon	*Gavia stellata*	RTLO
Red-necked Grebe	*Podiceps grisegena*	RNGR
Horned Grebe	*Podiceps auritus*	HOGR
Sandhill Crane	*Grus canadensis*	SACR
Tundra Swan	*Cygnus columbianus*	WHSW
Trumpeter Swan	*Cygnus buccinator*	TRUS
G. White-fronted Goose	*Anser aSDifrons*	GWFG
Canada Goose	*Branta canadensis*	CAGO
Mallard	*Anas platyrhynchos*	MALL
Am. Green-winged Teal	*Anas crecca*	AGWT
American Wigeon	*Anas americana*	AMWI
Northern Pintail	*Anas acuta*	NOPI
Northern Shoveler	*Anas clypeata*	NSHO
Canvasback	*Aythya valisineria*	CANV
Redhead	*Aythya americana*	REDH
Ring-necked Duck	*Aythya collaris*	RNDU
Greater Scaup	*Aythya marila*	GRSC
Lesser Scaup	*Aythya affinis*	LESC
Black Scoter	*Melanitta nigra*	BLSC
White-winged Scoter	*Melanitta fusca*	WWSC
Surf Scoter	*Melanitta perspicillata*	SUSC
Harlequin Duck	*Histrionicus histrionicus*	HARD
Oldsquaw	*Clangula hyemalis*	OLDS
Barrow’s Goldeneye	*Bucephala islandica*	BAGO
Common Goldeneye	*Bucephala clangula*	COGO
Bufflehead	*Bucephala aSDeola*	BUFF
Common Merganser	*Mergus merganser*	COME
Red-breasted Merganser	*Mergus serrator*	RBME
Semipalmated Plover	*Charadrius semipalmatus*	SEPL
Killdeer	*Charadrius vociferus*	KILL
American Golden-Plover	*Pluvialis squatarola*	LEGP
Whimbrel	*Numenius phaeopus*	WHIM
Greater Yellowlegs	*Tringa melanoleuca*	GRYE
Lesser Yellowlegs	*Tringa flavipes*	LEYE
Solitary Sandpiper	*Tringa solitaria*	SOSA
Spotted Sandpiper	*Actitis macularia*	SPSA
Wandering Tattler	*Heteroscelus incanus*	WATA
Red-necked Phalarope	*Phalaropus lobatus*	RNPH

Common name	Scientific name	Alpha code
Long-billed Dowitcher	*Limnodromus scolopaceus*	SDDO
Common Snipe	*Gallinago gallinago*	COSN
Surfbird	*Aphriza virgata*	SURF
Least Sandpiper	*Calidris minutilla*	LESA
Baird’s Sandpiper	*Calidris bairdii*	BASA
Upland Sandpiper	*Bartramia longicauda*	UPSA
Long-tailed Jaeger	*Stercorarius longicaudus*	LTJA
Bonaparte’s Gull	*Larus phidelphia*	BOGU
Mew Gull	*Larus canus*	MEGU
Herring Gull	*Larus argentatus*	HEGU
Arctic Tern	*Sterna paradisaea*	ARTE
Golden Eagle	*AquiLD chrysaetos*	GOEA
Bald Eagle	*Haliaeetus leucocephalus*	BAEA
Northern Harrier	*Circus cyaneus*	NOHA
Sharp-shinned Hawk	*Accipiter striatus*	SSHA
Northern Goshawk	*Accipiter gentilis*	NOGO
Red-tailed Hawk	*Buteo jamaicensis*	RTHA
Rough-legged Hawk	*Buteo regalis*	RLHA
Osprey	*Pandion haliaetus*	OSPR
American Kestrel	*Falco sparverius*	AMKE
Merlin	*Falco columbarius*	MERL
Peregrine Falcon	*Falco peregrinus*	PEFA
Gyrfalcon	*Falco rusticolus*	GYRF
Ruffed Grouse	*Bonasa umbellus*	RUGR
Spruce Grouse	*Dendragapus canadensis*	SPGR
White-tailed Ptarmigan	*Lagopus leucurus*	WTPT
Rock Ptarmigan	*Lagopus mutus*	ROPT
Willow Ptarmigan	*Lagopus lagopus*	WIPT
Short-eared Owl	*Asio flammeus*	SEOW
Great Horned Owl	*Bubo virginianus*	GHOW
Great Gray Owl	*Strix nebulosa*	GGOW
Northern Hawk Owl	*Surnia ulula*	NOHO
Boreal Owl	*Aegolius funereus*	BOOW
Belted Kingfisher	*Ceryle alcyon*	BEKI
Northern Flicker	*Colaptes auratus*	YSFL
Downy Woodpecker	*Picoides pubescens*	DOWO
Hairy Woodpecker	*Picoides villosus*	HAWO
Three-toed Woodpecker	*Picoides tridactylus*	TTWO
Black-backed Woodpecker	*Picoides arcticus*	BBWO
Olive-sided Flycatcher	*Contopus borealis*	OSFL
Western Wood-Pewee	*Contopus sordidulus*	WEWP
Say’s Phoebe	*Sayornis saya*	SAPH
Hammond’s Flycatcher	*Empidonax hammondii*	HAFL

Common name	**Scientific name**	**Alpha code**
Alder Flycatcher	*Empidonax alnorum*	ALFL
Horned Lark	*EremophiLD alpestris*	HOLD
Tree Swallow	*Tachycineta bicolor*	TRES
Violet-green Swallow	*Tachycineta thalassina*	VGSW
Bank Swallow	*Riparia riparia*	BANS
Cliff Swallow	*Hirundo pyrrhonota*	CLSW
Gray Jay	*Perisoreus canadensis*	GRAJ
Common Raven	*Corvus corax*	CORA
Black-capped Chickadee	*Parus atricapillus*	BCCH
Boreal Chickadee	*Parus hudsonicus*	BOCH
Brown Creeper	*Certhia americana*	BRCR
Arctic Warbler	*Phylloscopus borealis*	ARWA
Ruby-crowned Kinglet	*Regulus calendula*	RCKI
Townsend’s Solitaire	*Myadestes townsendi*	TOWO
Swainson’s Thrush	*Catharus ustulatus*	SWTH
Gray-cheeked Thrush	*Catharus minimus*	GCTH
Hermit Thrush	*Catharus guttatus*	HETH
Varied Thrush	*Ixoreus naevius*	VATH
American Robin	*Turdus migratorius*	AMRO
Northern Wheatear	*Oenanthe oenanthe*	NOWH
Northern Shrike	*Lanius excubitor*	NSHR
American Pipit	*Anthus rubescens*	WAPI
American Dipper	*Cinculus mexicanus*	AMDI
Bohemian Waxwing	*Bombycilla garrulus*	BOWA
Orange-crowned Warbler	*Vermivora celata*	OCWA
Myrtle Warbler	*Dendroica c. coronata*	MYWA
Townsend’s Warbler	*Dendroica townsendi*	TOWA
Yellow Warbler	*Dendroica petechia*	YWAR
Wilson’s Warbler	*Wilsonia pusilla*	WIWA
Northern Waterthrush	*Seiurus noveboracensis*	NOWA
Savannah Sparrow	*Passerculus sandwichensis*	SAVS
American Tree Sparrow	*Spizella arborea*	ATSP
Chipping Sparrow	*Spizella pallida*	CHSP
Slate-colored Junco	*Junco hyemalis*	SCJU
White-crowned Sparrow	*Zonotrichia leucophrys*	WCSP
Golden-crowned Sparrow	*Zonotrichia atricapilla*	GCSP
Fox Sparrow	*Passerella iliaca*	FOSP
Lincoln’s Sparrow	*Melospiza lincolnii*	LISP
Lapland Longspur	*Calcarius Lapponicus*	LALO
Snow Bunting	*Plectrophenax nivalis*	SNBU
Rusty Blackbird	*Euphagus carolinus*	RUBL
Pine Siskin	*Carduelis pinus*	PISI
White-winged Crossbill	*Loxia leucoptera*	WWCR

Common name	Scientific name	Alpha code
Pine Grosbeak	*Pinicola enucleator*	PIGR
redpoll species	*Carduelis spp*	REDP
Rosy Finch	*Leucosticte arctoa*	GCRF

Denali National Park--Off-road point count data form (5 min count) Page ___ of ___

Observer:________________ Date (D/M/Y):____/____/____ Route:__________________________________

Temp:________°F Wind:_________mph Cld cvr:_______% Precipitation:_____________

			0-3 Minutes								***3-5 Minutes***							
			≤50 m				**>50 m**				**≤50m**				**>50m**			
Stop	**Time**	**Species**	Sing	**Call**	**Visl**	**Fly**	Sing	**Call**	**Visl**	**Fly**	Sing	**Call**	**Visl**	**Fly**	Sing	**Call**	**Visl**	**Fly**

Notes:____

____

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Denali National Park-On-road point count data form (3 min count)   Page _____ of ______

Date (D/M/Y): ___/___/___   Survey Route Number:______

Temp:________°F   Wind:_______mph   Cld cover:_______%   Precip:___________

Stop	Mileage	Time	Species	Sing	Call	Visual	Flyover

Notes:____

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Appendix B. Description of on-road routes in Denali National Park and Preserve Bird Monitoring sites. Mileages are from the Park Highway to the Kantishna Airport. All surveys on these routes were initiated in 1993. UTMs are based on GPS estimates, as are errors estimates.

ROUTE	POINT	MILE	UTM EAST	UTM NORTH	ELEVATION	ERROR
1	1	0.0	0406923e	7068063n	490m	34ft
1	2	0.5	0406470e	7068797n	512m	29ft
1	3	1.0	0405683e	7068983n	529m	19ft
1	4	1.5	0405593e	7068326n	536m	20ft
1	5	2.0	0405184e	7067888n	545m	20ft
1	6	2.5	0404350e	7067648n	601m	21ft
1	7	3.0	0403620e	7067471n	633m	19ft
1	8	3.5	0402883e	7067375n	652m	20ft
1	9	4.0	0402122e	7067110n	670m	20ft
1	10	4.5	0401378e	7066885n	685m	20ft
1	11	5.0	0400830e	7066921n	712m	20ft
1	12	5.5	0400087e	7066766n	731m	21ft
1	13	6.0	0399222e	7066819n	771m	21ft
1	14	6.5	0398462e	7066932n	800m	21ft
1	15	7.0	0397631e	7066978n	827m	22ft
1	16	7.5	0396885e	7066657n	861m	22ft
1	17	8.0	0396145e	7066511n	883m	22ft
1	18	8.5	0395284e	7066311n	910m	22ft
1	19	9.0	0394587e	7066446n	934m	23ft
1	20	9.5	0393867e	7066605n	935m	23ft
1	21	10.0	0393001e	7066584n	919m	29ft
1	22	10.5	0392269e	7066477n	923m	29ft
1	23	11.0	0391404e	7066552n	913m	29ft
1	24	11.5	0390661e	7066632n	890m	29ft
1	25	12.0	0389836e	7066824n	860m	35ft
1	26	12.5	0389061e	7067134n	849m	34ft
1	27	13.0	0388440e	7067512n	849m	34ft
1	28	13.5	0387912e	7068064n	833m	33ft
1	29	14.0	0387436e	7068703n	813m	33ft
1	30	14.5	0387126e	7069348n	825m	33ft
1	31	15.0	0386627e	7069756n	812m	38ft
1	32	15.5	0386088e	7069302n	853m	37ft
1	33	16.0	0385451e	7068828n	902m	37ft
1	34	16.5	0384745e	7068962n	935m	37ft
1	35	17.0	0383971e	7068965n	966m	37ft
1	36	17.5	0383366e	7068880n	955m	37ft
1	37	18.0	0383126e	7068447n	952m	23ft
1	38	18.5	0382562e	7068067n	948m	22ft
1	39	19.0	0382066e	7067706n	951m	21ft
1	40	19.5	0381464e	7067717n	922m	30ft
1	41	20.0	0381121e	7068290n	885m	30ft
1	42	20.5	0380945e	7068757n	852m	31ft
1	43	21.0	0380346e	7068262n	817m	50ft
1	44	21.5	0379671e	7068450n	780m	48ft
1	45	22.0	0379053e	7068921n	761m	46ft
1	46	22.5	0378384e	7068631n	755m	46ft
1	47	23.0	0377770e	7068167n	762m	44ft

ROUTE	POINT	MILE	UTM EAST	UTM NORTH	ELEVATION	ERROR
1	48	23.5	0377416e	7067408n	767m	77ft
1	49	24.0	0377023e	7066851n	804m	28ft
1	50	24.5	0376230e	7066962n	818m	27ft
2	1	25.0	0375520e	7067327n	790m	27ft
2	2	25.5	0374785e	7067709n	741m	27ft
2	3	26.0	0374348e	7067277n	731m	27ft
2	4	26.5	0374027e	7066583n	735m	27ft
2	5	27.0	0373628e	7065871n	743m	27ft
2	6	27.5	0373146e	7065169n	756m	27ft
2	7	28.0	0372736e	7064522n	764m	31ft
2	8	28.5	0372462e	7063726n	771m	31ft
2	9	29.0	0372563e	7062963n	789m	33ft
2	10	29.5	0372663e	7062165n	793m	33ft
2	11	30.0	0372834e	7061428n	815m	41ft
2	12	30.5	0373075e	7060617n	841m	40ft
2	13	31.0	0373258e	7060056n	847m	40ft
2	14	31.5	0372955e	7059563n	822m	57ft
2	15	32.0	0372346e	7059091n	843m	40ft
2	16	32.5	0372388e	7058370n	855m	39ft
2	17	33.0	0372406e	7057566n	879m	55ft
2	18	33.5	0372250e	7056814n	892m	55ft
2	19	34.0	0371919e	7056071n	910m	56ft
2	20	34.5	0371579e	7055448n	924m	56ft
2	21	35.0	0371002e	7054851n	946m	58ft
2	22	35.5	0370545e	7054186n	961m	59ft
2	23	36.0	0370226e	7053518n	984m	60ft
2	24	36.5	0369943e	7052846n	1000m	86ft
2	25	37.0	0369552e	7052116n	1020m	87ft
2	26	37.5	0369085e	7051517n	1110m	84ft
2	27	38.0	0368836e	7050825n	1110m	170ft
2	28	38.5	0368590e	7050147n	1126m	56ft
2	29	39.0	0367773e	7049935n	1188m	55ft
2	30	39.5	0367024e	7050090n	1171m	46ft
2	31	40.0	0366265e	7050021n	1149m	36ft
2	32	40.5	0365312e	7049757n	1115m	36ft
2	33	41.0	0364557e	7049921n	1084m	37ft
2	34	41.5	0363919e	7050231n	1078m	37ft
2	35	42.0	0363392e	7050343n	1045m	41ft
2	36	42.5	0362734e	7050613n	1017m	41ft
2	37	43.0	0361970e	7050781n	975m	41ft
2	38	43.5	0361329e	7050683n	945m	41ft
2	39	44.0	0361171e	7049856n	1005m	42ft
2	40	44.5	0361000e	7049130n	1033m	42ft
2	41	45.0	0360665e	7048512n	1075m	44ft
2	42	45.5	0359875e	7048332n	111m	10m
2	43	46.0	0359293e	7048172n	1131m	11m
2	44	46.5	0358506e	7047912n	1148m	13m
2	45	47.0	0357958e	7047767n	1133m	12m
2	46	47.5	0357158e	7047597n	1098m	12m
2	47	48.0	0356407e	7047449n	1114m	12m
2	48	48.5	0355615e	7047330n	1140m	12m
2	49	49.0	0354841e	7046998n	1136m	12m
2	50	49.5	0354085e	7046732n	1125m	11m

ROUTE	POINT	MILE	UTM EAST	UTM NORTH	ELEVATION	ERROR
3	1	50.0	0353420e	7046465n	1107m	11m
3	2	50.5	0352706e	7046186n	1080m	10m
3	3	51.0	0352121e	7045904n	1045m	10m
3	4	51.5	0351464e	7045938n	1002m	17m
3	5	52.0	0350999e	7046378n	1000m	13m
3	6	52.5	0648676e	7046588n	953m	13m
3	7	53.0	0647875e	7046653n	940m	17m
3	8	53.5	0647045e	7046650n	941m	16m
3	9	54.0	0646972e	7045910n	960m	16m
3	10	54.5	0646669e	7045198n	997m	16m
3	11	55.0	0646062e	7044657n	1041m	15m
3	12	55.5	0645348e	7044259n	1050m	15m
3	13	56.0	0644793e	7043709n	1080m	18m
3	14	56.5	0644051e	7043848n	1115m	10m
3	15	57.0	0643501e	7043254n	1161m	10m
3	16	57.5	0643174e	7042784n	1196m	7.8m
3	17	58.0	0642730e	7042619n	1210m	12m
3	18	58.5	0642371e	7041922n	1218m	9.5m
3	19	59.0	0641845e	7041361n	1178m	7.8m
3	20	59.5	0641252e	7040833n	1147m	8.1m
3	21	60.0	0640551e	7040495n	1132m	12m
3	22	60.5	0639753e	7040304n	1117m	13m
3	23	61.0	0639065e	7040316n	1128m	9.1m
3	24	61.5	0638738e	7040107n	1181m	7.2m
3	25	62.0	0638416e	7039528n	1205m	7.5m
3	26	62.5	0638276e	7039205n	1160m	7.8m
3	27	63.0	0637980e	7039067n	1119m	7.9m
3	28	63.5	0637314e	7038630n	1119m	8.2m
3	29	64.0	0636740e	7038034n	1163m	8.4m
3	30	64.5	0636225e	7037508n	1201m	8.7m
3	31	65.0	0635663e	7037007n	1196m	9.1m
3	32	65.5	0634946e	7036555n	1174m	8.5m
3	33	66.0	0634358e	7036362n	1151m	8.5m
3	34	66.5	0633676e	7036080n	1124m	8.6m
3	35	67.0	0632977e	7035868n	1074m	14m
3	36	67.5	0632252e	7035771n	1030m	15m
3	37	68.0	0631672e	7035765n	1041m	15m
3	38	68.5	0630998e	7035763n	1016m	15m
3	39	69.0	0630369e	7035941n	996m	8.9m
3	40	69.5	0629618e	7035787n	960m	8.9m
3	41	70.0	0628797e	7035575n	937m	8.9m
3	42	70.5	0628066e	7035724n	931m	9m
3	43	71.0	0627361e	7036047n	924m	8.9m
3	44	71.5	0626571e	7036279n	909m	8.9m
3	45	72.0	0625966e	7036320n	916m	8.9m
3	46	72.5	0625152e	7036529n	916m	7.4m
3	47	73.0	0624484e	7036577n	907m	8m
3	48	73.5	0623701e	7036830n	909m	8.1m
3	49	74.0	0622915e	7036853n	911m	8.1m
3	50	74.5	0622143e	7036827n	895m	8m
4	1	75.0	0621400e	7036654n	876m	8m
4	2	75.5	0620583e	7036572n	861m	8m
4	3	76.0	0619792e	7036669n	861m	8.1m

ROUTE	POINT	MILE	UTM EAST	UTM NORTH	ELEVATION	ERROR
4	4	76.5	0619105e	7036784n	876m	8.8m
4	5	77.0	0618312e	7036840n	874m	8.2m
4	6	77.5	0617545e	7036905n	864m	8.3m
4	7	78.0	0616743e	7036905n	857m	8.3m
4	8	78.5	0616160e	7036999n	852m	8.4m
4	9	79.0	0615462e	7036971n	830m	8.5m
4	10	79.5	0614633e	7036955n	815m	8.5m
4	11	80.0	0613862e	7037013n	810m	7m
4	12	80.5	0613067e	7037154n	811m	6.9m
4	13	81.0	0612296e	7037291n	796m	6.8m
4	14	81.5	0611493e	7037269n	776m	7m
4	15	82.0	0610903e	7037400n	773m	7m
4	16	82.5	0610119e	7037682n	792m	6.9m
4	17	83.0	0609361e	7037601n	781m	6.9m
4	18	83.5	0608568e	7037739n	753m	7m
4	19	84.0	0608026e	7038272n	729m	7m
4	20	84.5	0607744e	7039062n	715m	6.9m
4	21	85.0	0607525e	7039761n	721m	6.9m
4	22	85.5	0607120e	7040434n	715m	6.9m
4	23	86.0	0606611e	7041009n	670m	7.1m
4	24	86.5	0606224e	7041668n	636m	7m
4	25	87.0	0605908e	7042322n	641m	7m
4	26	87.5	0605172e	7042585n	627m	7m
4	27	88.0	0604775e	7043167n	615m	8.6m
4	28	88.5	0604636e	7043945n	590m	8.8m
4	29	89.0	0604293e	7044591n	567m	9m
4	30	89.5	0603626e	7045013n	557m	8.2m
4	31	90.0	0602869e	7045134n	556m	8.5m
4	32	90.5	0601978e	7045277n	550m	8.7m
4	33	91.0	0601395e	7045831n	516m	9.2m
4	34	91.5	0600922e	7046412n	557m	9.6m
4	35	92.0	0600499e	7046991n	526m	8.1m
4	36	92.5	0600007e	7047115n	496m	13m
4	37	93.0	0599772e	7047314n	489m	10m
4	38	93.5	0599558e	7047474n	484m	8.6m

Appendix C. Descriptions of off-road routes in Denali National Park and Preserve. Each route has 12 point count stations (or stops). UTM coordinates are for the first stop on each route, and are based on GPS locations (as are error estimates). All routes were first censused in 1993.

Route Name	UTM east	UTM north	Elevation	Error
Rock Creek West	402568e	7067540n	676m	?
Rock Creek #2	403583e	7067903n	667m	?
East Hines Creek	402106e	7067292n	?	340ft
Permafrost	402475e	7067299n	659m	?
Sanctuary South	377570e	7067966n	763m	?
Sanctuary North	377588e	7068481n	793m	?
Teklanika	372378e	7062969n	772m	34ft
Camp Denali	603724e	7045026n	565m	10m
Spruce Triangle	608020e	7036546n	613m	23ft

Appendix D. SAS subroutine to determine migratory strategy for each species.

Author: Peter Paton

Discussion This subroutine program can be used to determine the migratory strategy (i.e., wintering grounds) for birds breeding in Denali National Park.

```
*Migratory status for birds observed in central Alaska;
* see DeGraaf and Rappole 1995 for listing of Neotropical migrants.and  AOU checklist 1983;
*PR=Permanent resident, stays near park boundaries year round;
*IR=short-distance, irruptive migrant, migrates within Alaska;
*NA=nearctic migrant;
*LA=long-distance neotropical migrant, ‘A’ list species; all or part of population winters in South America,
*SD=short-distance neotropical migrant, 'B' list species; all or part of population winters south of tropic of Cancer, but all winter north of South American border;
*PA=Palearctic;

IF SPECIES = 'COLO' THEN MIGRANT = 'NA';
IF SPECIES = 'ARLO' THEN MIGRANT = 'NA';
IF SPECIES = 'YBLO' THEN MIGRANT = 'NA';
IF SPECIES = 'RTLO' THEN MIGRANT = 'NA';
IF SPECIES = 'RNGR' THEN MIGRANT =  'NA';
IF SPECIES = 'HOGR' THEN MIGRANT =  'NA';
IF SPECIES = 'TUNS' THEN MIGRANT =  'NA';
IF SPECIES = 'TRUS' THEN MIGRANT =  'NA';
IF SPECIES = 'WFGO' THEN MIGRANT =  'SD';
IF SPECIES = 'GWFG' THEN MIGRANT =  'SD';
IF SPECIES = 'SNGO' THEN MIGRANT =  'SD';
IF SPECIES = 'CAGO' THEN MIGRANT =  'NA';
IF SPECIES = 'BRAN' THEN MIGRANT = 'NA';
IF SPECIES = 'MALL' THEN MIGRANT = 'SD';
IF SPECIES = 'GWTE' THEN MIGRANT = 'SD';
IF SPECIES = 'AGWT' THEN MIGRANT = 'SD';
IF SPECIES = 'AMWI' THEN MIGRANT = 'SD';
IF SPECIES = 'EUWI' THEN MIGRANT = 'PA';
IF SPECIES = 'NOPI' THEN MIGRANT = 'SD';
IF SPECIES = 'NSHO' THEN MIGRANT =  'SD';
IF SPECIES = 'BWTE' THEN MIGRANT =  ‘LD’;
IF SPECIES = 'CANV' THEN MIGRANT = 'SD';
IF SPECIES = 'REDH' THEN MIGRANT = 'SD';
IF SPECIES = 'RNDU' THEN MIGRANT = 'SD';
IF SPECIES = 'GRSC' THEN MIGRANT = 'NA';
IF SPECIES = 'LESC' THEN MIGRANT = 'SD';
IF SPECIES = 'SCSP' THEN MIGRANT = 'SD';
IF SPECIES = 'BLSC' THEN MIGRANT = 'NA';
IF SPECIES = 'WWSC' THEN MIGRANT = 'NA';
IF SPECIES = 'SUSC' THEN MIGRANT = 'NA';
IF SPECIES = 'HADU' THEN MIGRANT = 'NA';
```

```
IF SPECIES = 'OLDS' THEN MIGRANT = 'NA';
IF SPECIES = 'BAGO' THEN MIGRANT = 'NA';
IF SPECIES = 'COGO' THEN MIGRANT = 'NA';
IF SPECIES = 'BUFF' THEN MIGRANT ='NA';
IF SPECIES = 'COME' THEN MIGRANT ='NA';
IF SPECIES = 'RBME' THEN MIGRANT ='SD';
IF SPECIES = 'OSPR' THEN MIGRANT ='LD';
IF SPECIES = 'GOEA' THEN MIGRANT ='NA';
IF SPECIES = 'BAEA' THEN MIGRANT ='NA';
IF SPECIES = 'NOHA' THEN MIGRANT ='LD';
IF SPECIES = 'SSHA' THEN MIGRANT ='SD';
IF SPECIES = 'NOGO' THEN MIGRANT ='NA';
IF SPECIES = 'RTHA' THEN MIGRANT ='SD';
IF SPECIES = 'HAHA' THEN MIGRANT ='NA';
IF SPECIES = 'RLHA' THEN MIGRANT ='NA';
IF SPECIES = 'AMKE' THEN MIGRANT ='LD';
IF SPECIES = 'MERL' THEN MIGRANT =‘LD’;
IF SPECIES = 'PEFA' THEN MIGRANT =‘LD’;
IF SPECIES = 'GYRF' THEN MIGRANT ='NA';
IF SPECIES = 'SACR' THEN MIGRANT =  'SD';
IF SPECIES = 'SEPL' THEN MIGRANT =‘LD’;
IF SPECIES = 'KILL' THEN MIGRANT ='LD';
IF SPECIES = 'BBPL' THEN MIGRANT =‘LD’;
IF SPECIES = 'AGPL' THEN MIGRANT =‘LD’;
IF SPECIES = 'LGPL' THEN MIGRANT =‘LD’;
IF SPECIES = 'WHIM' THEN MIGRANT = 'LD';
IF SPECIES = 'GRYE' THEN MIGRANT = 'LD';
IF SPECIES = 'LEYE' THEN MIGRANT =‘LD’;
IF SPECIES = 'SOSA' THEN MIGRANT =‘LD’;
IF SPECIES = 'SPSA' THEN MIGRANT = ‘LD’;
IF SPECIES = 'WATA' THEN MIGRANT = ‘SD’;
IF SPECIES = 'RNPH' THEN MIGRANT ='LD';
IF SPECIES = 'REPH' THEN MIGRANT ='LD';
IF SPECIES = 'LBDO' THEN MIGRANT ='SD';
IF SPECIES = 'SBDO' THEN MIGRANT ='LD';
IF SPECIES = 'STSA' THEN MIGRANT =‘LD’;
IF SPECIES = 'COSN' THEN MIGRANT ='SD';
IF SPECIES = 'RUTU' THEN MIGRANT = 'LD';
IF SPECIES = 'SURF' THEN MIGRANT = 'LD';
IF SPECIES = 'DUNL' THEN MIGRANT ='SD';
IF SPECIES = 'SESA' THEN MIGRANT = ‘LD’;
IF SPECIES = 'WESA' THEN MIGRANT = 'LD';
IF SPECIES = 'LESA' THEN MIGRANT ='LD';
IF SPECIES = 'BASA' THEN MIGRANT =‘LD’;
IF SPECIES = 'PESA' THEN MIGRANT =‘LD’;
IF SPECIES = 'UPSA' THEN MIGRANT = ‘LD’;
IF SPECIES = 'LTJA' THEN MIGRANT =‘LD’;
IF SPECIES = 'BOGU' THEN MIGRANT ='SD';
IF SPECIES = 'RBGU' THEN MIGRANT ='SD';
```

```
IF SPECIES = 'MEGU' THEN MIGRANT ='NA';
IF SPECIES = 'HEGU' THEN MIGRANT ='SD';
IF SPECIES = 'GLGU' THEN MIGRANT ='NA';
IF SPECIES = 'ARTE' THEN MIGRANT =‘LD’;
IF SPECIES = 'RUGR' THEN MIGRANT ='PR';
IF SPECIES = 'SPGR' THEN MIGRANT ='PR';
IF SPECIES = 'WTPT' THEN MIGRANT ='PR';
IF SPECIES = 'ROPT' THEN MIGRANT ='PR';
IF SPECIES = 'WIPT' THEN MIGRANT ='PR';
IF SPECIES = 'SEOW' THEN MIGRANT ='SD';
IF SPECIES = 'GHOW' THEN MIGRANT ='PR';
IF SPECIES = 'GGOW' THEN MIGRANT ='PR';
IF SPECIES = 'BOOW' THEN MIGRANT ='PR';
IF SPECIES = 'SNOW' THEN MIGRANT ='IR';
IF SPECIES = 'NHOW' THEN MIGRANT ='PR';
IF SPECIES = 'BEKI' THEN MIGRANT ='SD';
IF SPECIES = 'NOFL' THEN MIGRANT = 'NA';
IF SPECIES = 'YSFL' THEN MIGRANT = 'NA';
IF SPECIES = 'DOWO' THEN MIGRANT = 'NA';
IF SPECIES = 'HAWO' THEN MIGRANT = 'NA';
IF SPECIES = 'TTWO' THEN MIGRANT = 'PR';
IF SPECIES = 'BBWO' THEN MIGRANT = 'PR';
IF SPECIES = 'OSFL' THEN MIGRANT = ‘LD’;
IF SPECIES = 'WWPE' THEN MIGRANT = ‘LD’;
IF SPECIES = 'SAPH' THEN MIGRANT = 'SD';
IF SPECIES = 'HAFL' THEN MIGRANT = ‘SD’;
IF SPECIES = 'LEFL' THEN MIGRANT = ‘SD’;
IF SPECIES = 'ALFL' THEN MIGRANT = ‘LD’;
IF SPECIES = 'HOLA' THEN MIGRANT = 'SD';
IF SPECIES = 'TRES' THEN MIGRANT = 'SD';
IF SPECIES = 'VGSW' THEN MIGRANT = ‘SD’;
IF SPECIES = 'BANS' THEN MIGRANT = ‘LD’;
IF SPECIES = 'CLSW' THEN MIGRANT = ‘LD’;
IF SPECIES = 'GRAJ' THEN MIGRANT = 'PR';
IF SPECIES = 'BBMA' THEN MIGRANT = 'PR';
IF SPECIES = 'CORA' THEN MIGRANT = 'PR';
IF SPECIES = 'BCCH' THEN MIGRANT = 'PR';
IF SPECIES = 'BOCH' THEN MIGRANT = 'PR';
IF SPECIES = 'BRCR' THEN MIGRANT = 'NA';
IF SPECIES = 'ARWA' THEN MIGRANT = 'PA';
IF SPECIES = 'RCKI' THEN MIGRANT = 'SD';
IF SPECIES = 'TOSO' THEN MIGRANT = 'SD';
IF SPECIES = 'SWTH' THEN MIGRANT = ‘LD’;
IF SPECIES = 'GCTH' THEN MIGRANT = ‘LD’;
IF SPECIES = 'HETH' THEN MIGRANT = 'SD';
IF SPECIES = 'VATH' THEN MIGRANT = 'NA';
IF SPECIES = 'AMRO' THEN MIGRANT = 'SD';
IF SPECIES = 'NOWH' THEN MIGRANT = 'PA';
IF SPECIES = 'NSHR' THEN MIGRANT = 'NA';
```

```
IF SPECIES = 'AMPI' THEN MIGRANT = 'SD';
IF SPECIES = 'AMDI' THEN MIGRANT = 'NA';
IF SPECIES = 'BOWA' THEN MIGRANT = 'NA';
IF SPECIES = 'OCWA' THEN MIGRANT = ‘SD’;
IF SPECIES = 'YRWA' THEN MIGRANT = 'SD';
IF SPECIES = 'MYWA' THEN MIGRANT = 'SD';
IF SPECIES = 'TOWA' THEN MIGRANT = ‘SD’;
IF SPECIES = 'BLPW' THEN MIGRANT = ‘LD’;
IF SPECIES = 'YWAR' THEN MIGRANT = ‘LD’;
IF SPECIES = 'WIWA' THEN MIGRANT = ‘SD’;
IF SPECIES = 'NOWA' THEN MIGRANT = ‘LD’;
IF SPECIES = 'SAVS' THEN MIGRANT = 'SD';
IF SPECIES = 'ATSP' THEN MIGRANT = 'NA';
IF SPECIES = 'DEJU' THEN MIGRANT = 'NA';
IF SPECIES = 'SCJU' THEN MIGRANT = 'NA';
IF SPECIES = 'WCSP' THEN MIGRANT = 'SD';
IF SPECIES = 'GWCS' THEN MIGRANT = 'SD';
IF SPECIES = 'GCSP' THEN MIGRANT = 'NA';
IF SPECIES = 'FOSP' THEN MIGRANT = 'NA';
IF SPECIES = 'LISP' THEN MIGRANT = ‘SD’;
IF SPECIES = 'LALO' THEN MIGRANT = 'NA';
IF SPECIES = 'SMLO' THEN MIGRANT = 'NA';
IF SPECIES = 'SNBU' THEN MIGRANT = 'NA';
IF SPECIES = 'RUBL' THEN MIGRANT = 'NA';
IF SPECIES = 'PISI' THEN MIGRANT = 'NA';
IF SPECIES = 'WWCR' THEN MIGRANT = 'IR';
IF SPECIES = 'PIGR' THEN MIGRANT = 'IR';
IF SPECIES = 'CORE' THEN MIGRANT = 'IR';
IF SPECIES = 'REDP' THEN MIGRANT = 'IR';
IF SPECIES = 'HORE' THEN MIGRANT = 'IR';
IF SPECIES = 'ROFI' THEN MIGRANT = 'PR';

IF MIGRANT = 'PR' THEN MIG = ‘RESIDENT  ’;
IF MIGRANT = 'IR' THEN MIG = ‘IRRUPTIVE ’;
IF MIGRANT = 'NA' THEN MIG = ‘NEARCTIC ’;
IF MIGRANT = ‘LD’ THEN MIG = ‘LD NEOTRP’;
IF MIGRANT = 'SD' THEN MIG = ‘SD NEOTRP’;
IF MIGRANT = 'PA' THEN MIG = ‘PALEARCT ’;
```

Appendix E. SAS subroutine to sort taxa into order of AOU phylogeny.

```
IF SPECIES = 'RTLO' THEN CODE = 1;
IF SPECIES = 'ARLO' THEN CODE = 2;
IF SPECIES = 'COLO' THEN CODE = 3;
IF SPECIES = 'YBLO' THEN CODE = 4;
IF SPECIES = 'HOGR' THEN CODE = 5;
IF SPECIES = 'RNGR' THEN CODE = 6;
IF SPECIES = 'WHSW' THEN CODE = 7;
IF SPECIES = 'TRUS' THEN CODE = 8;
IF SPECIES = 'WFGO' THEN CODE = 9;
IF SPECIES = 'GWFG' THEN CODE = 9;
IF SPECIES = 'SNGO' THEN CODE = 10;
IF SPECIES = 'BRAN' THEN CODE = 11;
IF SPECIES = 'CAGO' THEN CODE = 12;
IF SPECIES = 'GWTE' THEN CODE = 13;
IF SPECIES = 'AGWT' THEN CODE = 13;
IF SPECIES = 'MALL' THEN CODE = 14;
IF SPECIES = 'NOPI' THEN CODE = 15;
IF SPECIES = 'BWTE' THEN CODE = 16;
IF SPECIES = 'NOSH' THEN CODE = 17;
IF SPECIES = 'EUWI' THEN CODE = 18;
IF SPECIES = 'AMWI' THEN CODE = 19;
IF SPECIES = 'CANV' THEN CODE = 20;
IF SPECIES = 'REDH' THEN CODE = 21;
IF SPECIES = 'RNDU' THEN CODE = 22;
IF SPECIES = 'GRSC' THEN CODE = 23;
IF SPECIES = 'LESC' THEN CODE = 24;
IF SPECIES = 'SCSP' THEN CODE = 24.5;
IF SPECIES = 'HADU' THEN CODE = 25;
IF SPECIES = 'OLDS' THEN CODE = 26;
IF SPECIES = 'BLSC' THEN CODE = 27;
IF SPECIES = 'SURF' THEN CODE = 28;
IF SPECIES = 'WWSC' THEN CODE = 29;
IF SPECIES = 'COGO' THEN CODE = 30;
IF SPECIES = 'BAGO' THEN CODE = 31;
IF SPECIES = 'BUFF' THEN CODE = 32;
IF SPECIES = 'COME' THEN CODE = 33;
IF SPECIES = 'RBME' THEN CODE = 34;
IF SPECIES = 'OSPR' THEN CODE = 35;
IF SPECIES = 'BAEA' THEN CODE = 36;
IF SPECIES = 'NOHA' THEN CODE = 37;
IF SPECIES = 'SSHA' THEN CODE = 38;
IF SPECIES = 'NOGO' THEN CODE = 39;
IF SPECIES = 'RTHA' THEN CODE = 40;
IF SPECIES = 'RLHA' THEN CODE = 41;
IF SPECIES = 'GOEA' THEN CODE = 42;
IF SPECIES = 'AMKE' THEN CODE = 43;
IF SPECIES = 'MERL' THEN CODE = 44;
```

```
IF SPECIES = 'PEFA' THEN CODE = 45;
IF SPECIES = 'GYRF' THEN CODE = 46;
IF SPECIES = 'SPGR' THEN CODE = 47;
IF SPECIES = 'WIPT' THEN CODE = 48;
IF SPECIES = 'ROPT' THEN CODE = 49;
IF SPECIES = 'WTPT' THEN CODE = 50;
IF SPECIES = 'RUGR' THEN CODE = 51;
IF SPECIES = 'SACR' THEN CODE = 52;
IF SPECIES = 'BBPL' THEN CODE = 53;
IF SPECIES = 'AGPL' THEN CODE = 54;
IF SPECIES = 'SEPL' THEN CODE = 55;
IF SPECIES = 'KILL' THEN CODE = 56;
IF SPECIES = 'GRYE' THEN CODE = 57;
IF SPECIES = 'LEYE' THEN CODE = 58;
IF SPECIES = 'SOSA' THEN CODE = 59;
IF SPECIES = 'WATA' THEN CODE = 60;
IF SPECIES = 'SPSA' THEN CODE = 61;
IF SPECIES = 'UPSA' THEN CODE = 62;
IF SPECIES = 'WHIM' THEN CODE = 63;
IF SPECIES = 'RUTU' THEN CODE = 64;
IF SPECIES = 'SURF' THEN CODE = 65;
IF SPECIES = 'SESA' THEN CODE = 66;
IF SPECIES = 'WESA' THEN CODE = 67;
IF SPECIES = 'LESA' THEN CODE = 68;
IF SPECIES = 'BASA' THEN CODE = 69;
IF SPECIES = 'PESA' THEN CODE = 70;
IF SPECIES = 'DUNL' THEN CODE = 71;
IF SPECIES = 'STSA' THEN CODE = 72;
IF SPECIES = 'SBDO' THEN CODE = 73;
IF SPECIES = 'SDDO' THEN CODE = 74;
IF SPECIES = 'COSN' THEN CODE = 75;
IF SPECIES = 'RNPH' THEN CODE = 76;
IF SPECIES = 'REPH' THEN CODE = 77;
IF SPECIES = 'LTJA' THEN CODE = 78;
IF SPECIES = 'BOGU' THEN CODE = 79;
IF SPECIES = 'MEGU' THEN CODE = 80;
IF SPECIES = 'RBGU' THEN CODE = 81;
IF SPECIES = 'HEGU' THEN CODE = 82;
IF SPECIES = 'GLGU' THEN CODE = 83;
IF SPECIES = 'ARTE' THEN CODE = 84;
IF SPECIES = 'GHOW' THEN CODE = 85;
IF SPECIES = 'SNOW' THEN CODE = 86;
IF SPECIES = 'NHOW' THEN CODE = 87;
IF SPECIES = 'GGOW' THEN CODE = 88;
IF SPECIES = 'SEOW' THEN CODE = 89;
IF SPECIES = 'BOOW' THEN CODE = 90;
IF SPECIES = 'BEKI' THEN CODE = 91;
IF SPECIES = 'DOWO' THEN CODE = 92;
IF SPECIES = 'HAWO' THEN CODE = 93;
```

```
IF SPECIES = 'TTWO' THEN CODE = 94;
IF SPECIES = 'BBWO' THEN CODE = 95;
IF SPECIES = 'NOFL' THEN CODE = 96;
IF SPECIES = 'YSFL' THEN CODE = 96;
IF SPECIES = 'OSFL' THEN CODE = 97;
IF SPECIES = 'WWPE' THEN CODE = 98;
IF SPECIES = 'ALFL' THEN CODE = 99;
IF SPECIES = 'LEFL' THEN CODE = 100;
IF SPECIES = 'HAFL' THEN CODE = 101;
IF SPECIES = 'SAPH' THEN CODE = 102;
IF SPECIES = 'HOLD' THEN CODE = 103;
IF SPECIES = 'TRES' THEN CODE = 104;
IF SPECIES = 'VGSW' THEN CODE = 105;
IF SPECIES = 'BANS' THEN CODE = 106;
IF SPECIES = 'CLSW' THEN CODE = 107;
IF SPECIES = 'GRJA' THEN CODE = 108;
IF SPECIES = 'GRAJ' THEN CODE = 108;
IF SPECIES = 'BBMA' THEN CODE = 109;
IF SPECIES = 'CORA' THEN CODE = 110;
IF SPECIES = 'BCCH' THEN CODE = 111;
IF SPECIES = 'BOCH' THEN CODE = 112;
IF SPECIES = 'BRCR' THEN CODE = 113;
IF SPECIES = 'AMDI' THEN CODE = 114;
IF SPECIES = 'ARWA' THEN CODE = 115;
IF SPECIES = 'RCKI' THEN CODE = 116;
IF SPECIES = 'NOWH' THEN CODE = 117;
IF SPECIES = 'TOSO' THEN CODE = 118;
IF SPECIES = 'GCTH' THEN CODE = 119;
IF SPECIES = 'SWTH' THEN CODE = 120;
IF SPECIES = 'HETH' THEN CODE = 121;
IF SPECIES = 'AMRO' THEN CODE = 122;
IF SPECIES = 'VATH' THEN CODE = 123;
IF SPECIES = 'AMPI' THEN CODE = 124;
IF SPECIES = 'BOWA' THEN CODE = 125;
IF SPECIES = 'NSHR' THEN CODE = 126;
IF SPECIES = 'OCWA' THEN CODE = 127;
IF SPECIES = 'YWAR' THEN CODE = 128;
IF SPECIES = 'YRWA' THEN CODE = 129;
IF SPECIES = 'MYWA' THEN CODE = 130;
IF SPECIES = 'TOWA' THEN CODE = 131;
IF SPECIES = 'BLPW' THEN CODE = 132;
IF SPECIES = 'NOWA' THEN CODE = 133;
IF SPECIES = 'WIWA' THEN CODE = 134;
IF SPECIES = 'ATSP' THEN CODE = 135;
IF SPECIES = 'SAVS' THEN CODE = 136;
IF SPECIES = 'FOSP' THEN CODE = 137;
IF SPECIES = 'LISP' THEN CODE = 138;
IF SPECIES = 'GCSP' THEN CODE = 139;
IF SPECIES = 'WCSP' THEN CODE = 140;
```

```
IF SPECIES = 'GWCS' THEN CODE = 141;
IF SPECIES = 'DEJU' THEN CODE = 142;
IF SPECIES = 'SCJU' THEN CODE = 143;
IF SPECIES = 'LDLO' THEN CODE = 144;
IF SPECIES = 'SMLO' THEN CODE = 145;
IF SPECIES = 'SNBU' THEN CODE = 146;
IF SPECIES = 'RWBL' THEN CODE = 147;
IF SPECIES = 'RUBL' THEN CODE = 148;
IF SPECIES = 'ROFI' THEN CODE = 149;
IF SPECIES = 'PIGR' THEN CODE = 150;
IF SPECIES = 'WWCR' THEN CODE = 151;
IF SPECIES = 'REDP' THEN CODE = 152;
IF SPECIES = 'CORE' THEN CODE = 153;
IF SPECIES = 'HORE' THEN CODE = 154;
IF SPECIES = 'PISI' THEN CODE = 155;
```

Appendix F. SAS subroutine to calculate frequency of occurrence (the proportion of stations with detection) for point count data. Programmers, it is important to remember that one needs add each species to each point count station, even when they were absent, to correctly calculate frequency.

```
PROC SORT;
  BY ROUTE DATE SPECIES STOP;
PROC MEANS NOPRINT N;
  BY ROUTE DATE SPECIES STOP;
  VAR ALL;
OUTPUT OUT = OUT1 N = N1;

DATA OUT2;
 SET OUT1;

PROC SORT;
  BY ROUTE DATE SPECIES;

PROC MEANS NOPRINT SUM;
  BY ROUTE DATE SPECIES ;
  VAR N1;
OUTPUT OUT = OUT3  SUM = SUM;

DATA OUT4;
SET OUT3;

DIV = 50;

IF ROUTE = 4 THEN DIV = 36;

FO = SUM/DIV;
VARIANCE = FO*(1-FO)/DIV;
SE = SQRT(VARIANCE);

PROC SORT;
  BY ROUTE DATE DESCENDING FO;
PROC PRINT;
 VAR ROUTE DATE SPECIES SUM FO SE;
TITLE1 'FREQ. OF OCCURRENCE ANALYSIS';
TITLE2 'FO & SE FOR EACH DAY';
TITLE3 'SORTED IN DESCENDING SEQUENCE, I.E. MOST COMMON ON TOP';
TITLE4 ‘ON-ROUTE ROUTES’;
RUN;
```

Appendix G. SAS subroutine to calculate total counts (the total number of individuals detected at each statioin) for point count data.

```
PROC SORT;
  BY ROUTE DATE SPECIES STOP;
PROC MEANS NOPRINT SUM;
  BY ROUTE DATE SPECIES STOP;
  VAR ALL;
OUTPUT OUT = OUT1 SUM=SUM;

DATA OUT2;
 SET OUT1;


PROC SORT;
  BY ROUTE DATE DESCENDING SUM;
PROC PRINT;
 VAR ROUTE DATE SPECIES SUM;
TITLE1 ‘TOTAL COUNT ANALYSIS';
TITLE2 'SORTED IN DESCENDING SEQUENCE, I.E. MOST COMMON ON TOP';
RUN;
```