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A Habitat-Based Point-Count Protocol for Terrestrial Birds, Emphasizing Washington and Oregon

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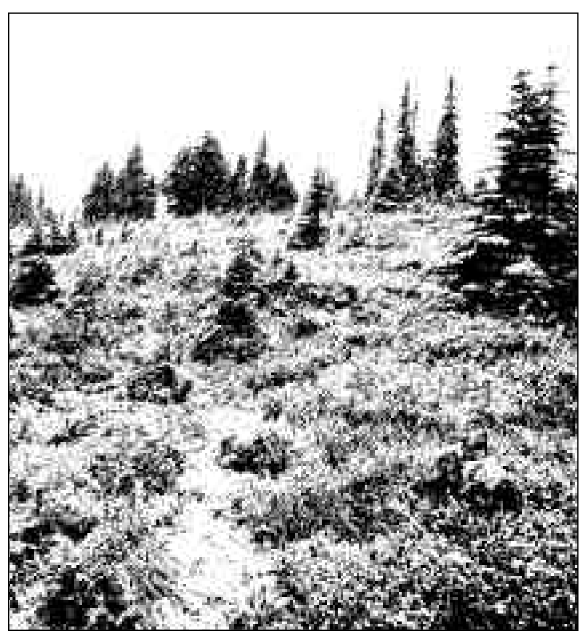

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Abstract

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We describe a protocol and provide a summary for point-count monitoring of land-birds that is designed for habitat-based objectives. Presentation is in four steps: preparation and planning, selecting monitoring sites, establishing monitoring stations, and conducting point counts. We describe the basis for doing habitat-based point counts, how they are organized, and how they differ from other approaches using point counts. We discuss links between local scale and larger scale monitoring and methods to evaluate sample size for monitoring. We develop a framework for identifying potential monitoring sites and provide an attribute database to characterize the potential sites, including rules to select sites. We describe buffer requirements for sites, rules for distances between points, ways to mark individual count stations, and alternative methods for riparian areas. We conclude with guidelines for counting birds and recording data.

Keywords: Bird sampling, avifauna, monitoring, point count, Pacific Northwest, bird protocol, avian field methods, population trends, bird detections.

Summary

Background

This paper gives the rationale and a protocol for habitat-based bird monitoring using point counts. This protocol was developed through collaboration between the Pacific Northwest Research Station and Washington-Oregon Partners in Flight to study population trends and bird-habitat relations in these states.

Point-count monitoring is a common way to monitor bird populations. It is characterized by tallying all birds observed at a fixed location during specific, repeated observation periods. It provides the relative abundance of all bird species and, over time, can detect trends in the abundance with a relatively small amount of work compared to other methods. Consistency with established monitoring protocols is essential for local-scale point-count monitoring, because small efforts are unlikely to have sufficient sample sizes to perform one of the key functions of monitoring: detecting changes in bird abundance. Such work can be meaningful when pooled with a larger body of compatible data.

Two general approaches have been used in broad-scale point-count monitoring. The widely used population-based method disperses point-count stations at random across a geographic area or along roadways, usually without specific consideration for habitat at each point. The results represent the geographic area, but without additional design considerations they do not distinctly represent any specific habitat type.

In contrast, the habitat-based approach stratifies points by habitat. The geographical extent of such monitoring can be large, as similar habitats can be separated by great distances. The results apply clearly, but also exclusively, to the habitats selected. For the purpose of associating bird species with habitat characteristics, the habitat-based approach likely will require a smaller sample size than dispersed counts—though each count may be more laborious if multiple stations are used at each site and stations are placed away from roads. The habitat-based protocol we describe here has four general steps.

Step One: Preparation and Planning

Before surveys are conducted, an investigator should consider the following aspects:

- What are the objectives of your monitoring program? Is point-count monitoring the right technique for your objectives?
- How does your plan fit into other monitoring efforts? You should not reinvent the wheel; rather, have your work contribute to and complement other terrestrial bird monitoring.
- Through consultation with a statistician, determine if the monitoring is capable of detecting the kind of changes you are looking for. If not, consider collaborating.
- What are your long-term resources for monitoring? We suggest three breeding seasons of observations for investigating bird-habitat relations, and five to ten or more seasons for investigating trends in abundance.
- What are your resources in money and personnel? These will determine your maximum possible sample size.
- What habitats are your subjects of study? Will it be necessary to separate or stratify your observations by ecotypes, physiographic provinces, or other factors?
- Are any likely sites undergoing rapid vegetation change (succession), obvious disturbance, or human management activities? If so, you will need a statistical design set up explicitly to detect the effects of those changes.

Step Two: Site Selection

Because habitat is an explicit subject of study in this protocol, the choice of study sites is crucial. You need to:

- Identify the types of habitats or range of conditions that correspond to your monitoring goals.
- Use photographs or other sources to identify a preliminary set of likely sites that correspond to those criteria.
- Remove from consideration those potential sites that are too smal—in most cases, $\leq$16 ha of relatively consistent habitat.
- Do field studies to determine detailed characteristics of the remaining sites; for example, vegetation type.
- Select the final list based on principles of good study design and ease of logistics.

Step Three: Establishing the Point-Count Stations

The protocol requires five or more point-count stations within each monitoring site ("location"). Place them:

- At least 125 m from the edge of the location boundary.
- At least 150 m apart from each other.
- In an arrangement that offers an efficient way of entering and exiting the area, of traveling between stations, and of changing the order in which stations are surveyed between visits.

After accounting for those considerations:

- Set the exact coordinates of the first station with random number methods, to minimize bias at this level of selection.
- Mark the station point with rebar or another permanent marker.
- Using the station point as the center, mark with flagging a 50-m radius in the four cardinal directions.

Step Four: Conducting the Point Counts

We recommend three visits to each location in each breeding season to make the most of varying detectability over time and among species. The visits should be spread across the breeding season, at least 7 to 10 days apart, and occur at about the same dates each year. Each visit to a location should consist of point-count observations at all stations at that location. Observations should begin around sunrise and be completed about 10:00 a.m., 5 hours after the "dawn chorus." Weather conditions should be calm and warm enough for birds to be active and for detection by sight and sound to be likely. Avoid counting on days with high wind, heavy rain, or other conditions of poor bird detectability. Field observers should be tested and highly qualified to detect birds by sight and sound. Even qualified observers differ from each other, so try to use observers who have consistent bird detection abilities.

At each station, the counts themselves are conducted in a 5-minute span. Tally every bird detected over 5 minutes and record it in one of four categories:

- Typical detection 0 to 50 m: birds up to top of vegetation/canopy, $\leq$50 m from the station center point.
- Typical detection >50 m: birds up to top of vegetation or canopy, >50 m from the station center point.
- Fly-over associated: birds above top of vegetation or canopy, but in your judgment are associated with the local habitat.
- Fly-over independent: birds above top of vegetation or canopy, and in your judgment are unassociated with the local habitat.

Record juveniles in a separate count of immature birds.

Record the data on the standard paper data form provided or similar electronic format. After returning to the office, you can enter it into a computer using Flight Attendant 4, a specialized data entry program, and analyze what you have entered through a database, spreadsheet, or statistical program.

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Introduction

Populations of some Neotropical migratory landbird species seem to be declining across North America (Finch and Stangel 1993, James and others 1996, Peterjohn and others 1995). Declines are noted for the Pacific Northwest in data from the North American Breeding Bird Survey (BBS) (Andelman and Stock 1994a, 1994b; Saab and Rich 1997; Sharp 1996); however, long-term population trends and status have not been investigated by habitat for most species. For resource managers to develop and implement effective bird conservation strategies (for example, Altman 1999) within their land management plans, they must have information on habitat-specific population trends, demographics, and habitat relations applicable to ecological conditions and management practices of the planning area (Ganey and Dargen 1998).

Many different field methods are used to monitor terrestrial birds; the choice depends on monitoring objectives, target species, and type and characteristics of ecological communities selected. Ralph and others (1993) review ways to develop monitoring priorities and collect data, and they discuss strengths and weaknesses of various methods. Comprehensive reviews and assessments of monitoring techniques for terrestrial birds are found in Bibby and others (1992), Butcher and others (1993), Manuwal and Carey (1991), and Ralph and Scott (1981). In this paper, we discuss only one monitoring technique: point counts. Overviews on point-count monitoring and recommended standards are found in Hamel and others (1996) and Ralph and others (1993, 1995a, 1995b).

The purpose of this paper is to provide biologists and resource planners with a protocol for monitoring birds in specific habitats by using point counts. Subject matter needed to implement habitat-based monitoring is not addressed sufficiently in descriptions of population-based monitoring, such as the North American BBS (Robbins and others 1986), systematic road counts for management units (Ralph and others 1993, 1995a), and the Finnish Bird Monitoring Programme (Koskimies and Vaisanen 1991). Population- and habitat-based monitoring can be used together to achieve a broad range of monitoring objectives at various spatial and biological scales.

We present the habitat-based protocol in four steps: preparing and planning to monitor, selecting monitoring sites, establishing monitoring stations, and conducting point counts. Two critical components of monitoring, data management and interpretation, are not included in our paper. For data entry, we suggest Flight Attendant 4, a program[1] developed to complement the habitat-based field instructions in this paper. Examples of habitat-based point count data management, analysis, and interpretations are found in Huff and Brown (1998) (also see footnote 1). Flight Attendant 4 and Huff and Brown (1998) can be accessed from the following Web sites: www.fs.fed.us/pnw/bird-populations and www.gorge.net/natres/pif.html.

[1] Brown, M.J.; Huff, M.H. 2000. Managing local bird point count data using FLIGHT ATTENDANT 4 and a PC database. Review draft manuscript. On file with: M. Huff.

The Protocol

Step One: Preparation and Planning

Setting objectives and direction—Development of specific objectives is the foundation to an effective monitoring program. A set of general objectives for monitoring landbirds in the Pacific Northwest was established through a series of meetings by Washington-Oregon Partners in Flight (WA-OR PIF):

- Establish a regional approach to prioritize habitats for monitoring
- Collect data with consistent field methods
- Identify species and populations that are increasing, decreasing, or stable
- Characterize vegetation and habitat attributes of monitoring locations
- Examine relations between habitat characteristics and species abundance patterns
- Identify how management activities influence the distribution and abundance of species (here, collaboration with research is essential)
- Develop habitat management guidelines to maintain, restore, and enhance bird populations

Through this collaboration, specific “major” habitat type priorities were established to focus monitoring to fill information gaps, and to provide baseline information for developing area-based conservation plans in Washington and Oregon. The major habitat-type priorities followed those of Andelman and Stock (1994a, 1994b),[2] who specify as areas of interest (unranked):

- Riparian zones
- Oak woodlands
- Late-successional and mature coniferous forests
- Shrub-steppe
- Steppe grasslands

In setting habitat-based objectives, WA-OR PIF assumed that where and how birds are surveyed needed to be habitat specific. They also wanted to provide opportunities for landowners with small acreages (above a minimum size) to contribute to larger scale monitoring without being obligated to monitor systematically over large landscapes within which they would have minor ownership or responsibility.

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[2] Saab and Rich (1997) identified the five highest priority habitats for conservation of Neotropical migratory species in the interior Columbia River basin, which includes eastern Washington and Oregon, Idaho, and parts of Montana, Wyoming, and Nevada. They are riparian, old-growth and mature coniferous forests, shrub-steppe, grasslands, and juniper woodlands. Their assessment is based on species declines, habitats with species highly vulnerable to alternative management activities, and vulnerability to habitat loss.

About point-count monitoring—Monitoring is a quantitative assessment, involving repeated measures at regular intervals at fixed locations to reveal change. Bird point-count monitoring, carried out in its most basic form, is a tally of all birds seen or heard for a given time at a given location. Point counts are used extensively for monitoring in the Pacific Northwest (for example, Hansen and others 1995, Ruggiero and others 1991) and elsewhere (for example, Ralph and others 1995b). They are used to develop relative indices of abundance and inferences about bird-habitat relations. The primary advantages of point counts are that the relative abundance of many species can be determined over broad areas at a moderately low cost and that species-habitat relations can be evaluated effectively compared to other methods. Point counts are not a census from which density can be estimated (unless distance estimation sampling techniques are used; see Burnham and others 1980), and they are not used to gauge the relative fitness of a population, as can be done with demographic information on birth, death, and dispersal rates. An integrated monitoring program that supplements point counts with demographic methods, such as nest searches and constant-effort mist netting (see Baillie 1990, Koskimies and Vaisanen 1991, Nur and Geupel 1993, Ralph and others 1993), is vital to effectively interpret trends from point counts (DeSante and George 1994).

There are two general approaches to bird point-count monitoring for determining relative population size and trends: a population approach with surveys done independent of specific habitats, and a habitat approach done in specific habitats. The population approach is most widely used (for example, Peterjohn and others 1995, Ralph and others 1995b), although both approaches are suitable for monitoring birds. Specific objectives developed at local and larger scales will direct when to use each approach, including the species that need to be monitored, ecological situation, efficiency, desired accuracy, type of collaboration, and capability of achieving monitoring objectives. Reliability of data depends on implementing consistent standards while using either approach.

Methods and standards for the population-based approach are described in Ralph and others (1993, 1995a). It is an intensive adaptation of the BBS (Robbins and others 1986), wherein various habitats are monitored on survey routes randomly selected from a systematic grid of an area (such as a subwatershed), and point-count stations are located sequentially along a road network from a random starting point. Point-count stations usually are spaced ≥250 m apart and are considered an independent sample. Counts usually are made only once a year, although more visits may be recommended depending on objectives (Dettmers and others 1999). The advantages of a population-based approach are that the counts are relatively easy to implement; population information is robust given the high number of independent samples; landscape scale population trends are easy to monitor; and data are relatively easy to compare with other large ongoing monitoring such as the BBS. The major disadvantage is that habitat relations are difficult to understand without habitat stratification.

Standards for a “delineated” habitat-based approach are described later in this paper, and new standards for road and off-road habitat-based transects are being developed by the Colorado Bird Observatory.[3] [4] In delineated habitats, multiple point-count stations (replicates) are established away from roads, each delineated location is an independent sample, and each location usually is visited several times each year. Advantages of the habitat-based approach include ease of linking population trends to habitat relations information; broad areas are sampled for determining trends over a physiographic province for specific habitat types; and direct application can be made to habitat-based conservation planning. Disadvantages include fewer independent samples to determine population trends (from using delineated habitats with multiple stations), higher expense, and poorer access than population-based counts along roads.

Bird point counts along roads are an integral part of a monitoring program and the basis for most of the population-based trend information on birds within North America. Road counts, however, continue to be controversial (Hutto and others 1995, Keller and Fuller 1995, Rotenberry and Knick 1995). Effects of roads on bird composition and abundance can be diminished considerably by establishing count stations along narrow, less-traveled roads and avoiding places where vegetation has been altered by the road environment (for example, avoiding vegetation thickets stimulated by openings from roads). Still, planning for road-based surveys must take into account that road networks engineered for travel through a landscape may not be representative of the entire landscape and, thus, inferences that can be drawn about species and habitats are limited (Thomas 1996). Habitat-specific surveys should supplement the road surveys as needed.

Emphasizing general population trend over habitat-specific information provides the user with more design options; for example, count stations can be established over a given land area by using a stratified, clustered, or systematic sampling scheme without regard to habitat (see Johnson 1999). Whereas, to understand habitat relations, and also be efficient, count stations need to be established in preselected habitats according to a set of criteria. These criteria should include count stations being placed in patches of vegetation that are relatively similar in structure and composition and large enough to minimize influences from outside the focal habitat.

Time commitment—Monitoring for population trends needs a much longer time commitment than with other objectives. To detect bird population trends requires 5 to 10 years or more of continuous annual sampling, depending on what is being monitored, sample size, and desired level of accuracy (Nur and others 1999). To determine relative abundance of birds, how abundance varies among different habitats, or habitat relations, sampling for 3 years or less often is sufficient.

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[3] Leukering, T. 1999. Point-transect protocol for monitoring Colorado’s birds. 14 p. Unpublished document. On file with: Colorado Bird Observatory, 13401 Piccadilly Road, Brighton, CO 80601.

[4] Leukering, T.; Carter, M. 2000. Monitoring Montana’s birds: a plan for count-based monitoring. 16 p. Unpublished document. On file with: Colorado Bird Observatory, 13401 Piccadilly Road, Brighton, CO 80601.

Regional collaboration—Regional models should be developed that identify where and how much to monitor based on objectives, known gaps of information, and statistical considerations. Providing a model for all government and nongovernment organizations to execute together is a desired future outcome of the WA-OR PIF collaboration. To date, most terrestrial bird monitoring in this region has been initiated opportunistically at a local scale as priorities have shifted and resources have become available: For an integrated regional model to work, long-term commitments of resources are needed from a broad base of organizations to monitor certain geographic locations and habitat types so that statistical considerations can be met. Until that happens, large-scale analyses (of population trends and habitat relations) likely will evolve from many local monitoring efforts working together, with the designers having the foresight to understand that their data could be threaded together for this purpose.

To facilitate collaboration, monitoring at the local scale needs to be organized along key physical and biological characteristics found within the region. In Washington and Oregon, the widely accepted delineations proposed by Franklin and Dyrness (1973) are followed. They delineate the two states into 15 physiographic provinces by climate and geology and then overlay four broad categories of vegetation: forests; woodland-grassland-shrubland mosaic (found in the interior valleys of Oregon); steppe and grassland; and alpine and subalpine parklands (timberline) (fig. 1). Each vegetation category is divided into vegetation zones: broad areas of a relatively uniform macroclimate dominated by similar plant species. The vegetation zones are classified into community types or associations; that is, a group of plant species that identify the later phases of succession and are indicators of a set of environmental conditions. The range of variability representative of natural disturbance events and climatic conditions should be included in the local monitoring program at the same time as criteria are established to exclude nonrepresentative vegetation situations.

Other considerations for data collaboration include:

- Monitoring vegetation types not being sampled in a physiographic province or increasing the sample size of a particular habitat type to improve the statistical power of the trend tests. Data from the most common habitats types will be more reliable than those from sparsely distributed types and will have the broadest potential for use in conservation planning.

- Integrating randomness into the site-selection process through random selection from a pool of possible locations (Pendleton 1995). Although policies, management planning directives, and funding considerations may dictate where monitoring is done, randomness often can be integrated into the process even with such obstacles.

- Avoiding sample locations that are undergoing rapid changes in vegetation composition and structure, unless monitoring of changes in bird populations associated with successional development is an objective. Without sufficient sites for controls and for sampling replication, and random selection of these sites, true effects can be difficult to determine (Johnson 1999).

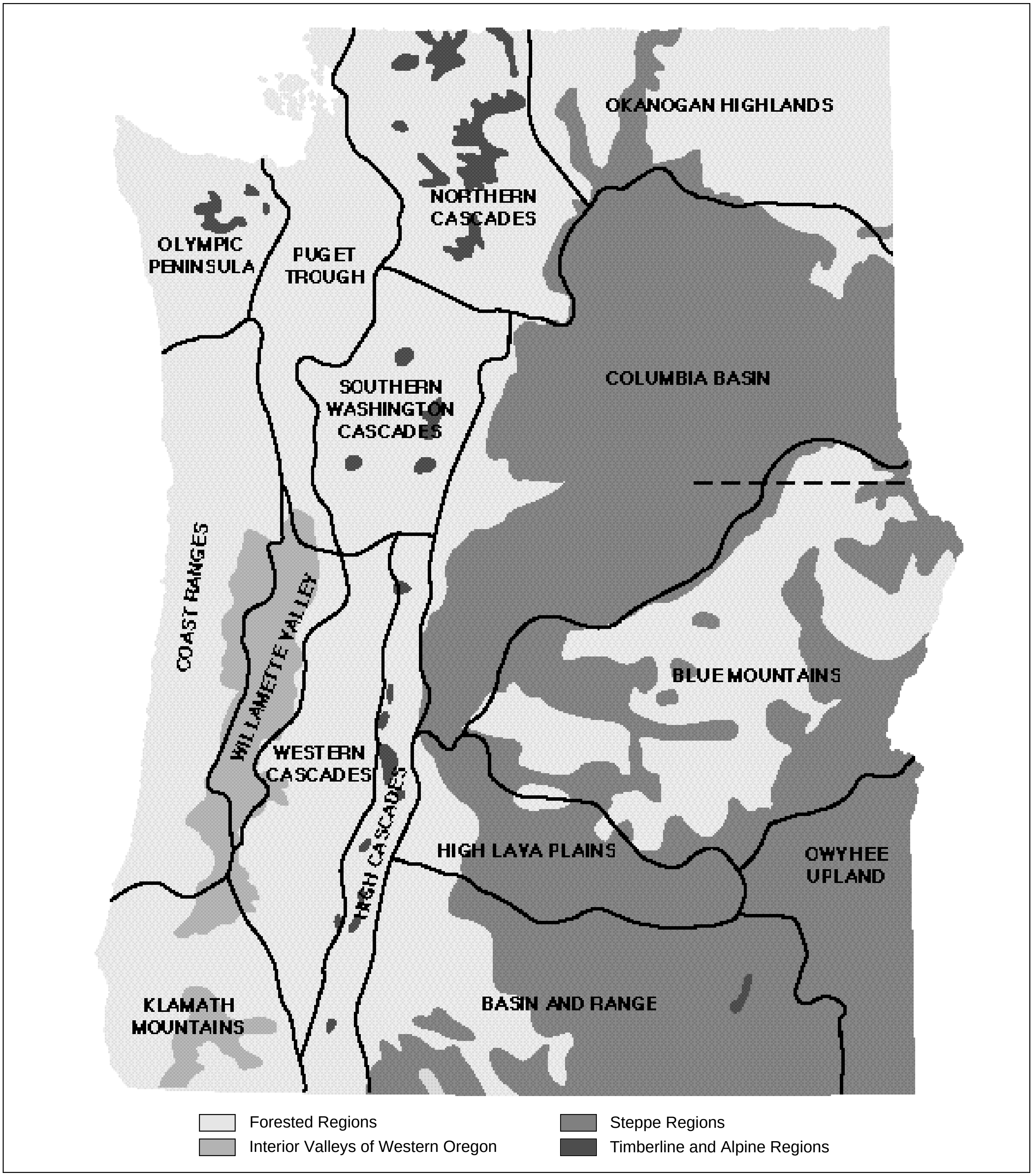

Figure 1—Fifteen physiographic provinces and distribution of four broad vegetation categories in Washington and Oregon (adapted from Franklin and Dyrness 1973).

- Stratifying the site-selection process by successional stage and confining monitoring to one general successional stage, unless several successional stages can be monitored satisfactorily (see Hanowski and Niemi 1995). Shifts in species composition with succession are well documented in the Pacific Northwest (for example, Huff and Raley 1991) and elsewhere (for example, Johnston and Odum 1956, Shugart and James 1973). Without appropriate stratification of sample sites for vegetation development, habitat-based information probably will be unreliable.

- Entering field data into an electronic format, verifying promptly, and summarizing each field season.

Sample size—Sample size is the number of independent locations[5] sampled to monitor population trends at each scale of analysis. The number of stations at a given location and how often each is visited constitute sampling replication. The decision on how many sites to sample focuses on three considerations: (1) the criteria used to sample birds at count stations (for example, duration of a count), (2) variation in species' detectability, and (3) statistical inference (see Nur and others 1999, Pendleton 1995). Count criteria affecting sample size include the number of visits to a count station during a count period, duration of individual counts, and number of count stations at a site (see papers in Ralph and Scott 1981, Ralph and others 1995b). These criteria have fixed values in our habitat-based protocol and are considered constants in determining sample size. A sample size should be large enough for satisfactory sampling of species having low relative abundance or that are difficult to detect; however, as average detection rate decreases (becomes rarer), the sample size to detect change increases, linearly and proportionally. At some point, the costs become more than any local monitoring project can afford, and tradeoffs are made between desired level of precision and resources available to accomplish the task. Approaches for testing sample size by collecting and interpreting abundance data from pilot or existing information are given in Hamel and others (1996) and Smith and others (1995).

The question of how many samples (for example, independent locations) should be taken is strongly guided by how much change needs to be detected, the desired power of the test to detect change, and what levels of error, type I[6] (alpha) and type II[7] (beta), are acceptable (for additional information, see Nur and others 1999). These decisions are interrelated but to some degree arbitrary. In ecology, confidence levels for type I and II errors are traditionally set at 5 to 10 percent and 10 to 20 percent, respectively, though looser or more stringent levels may be appropriate in some situations.

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[5] Alternative terms include sites, stands, patches, or polygons.

[6] Rejecting the null hypothesis, for example; no significant change in bird population trends, when it is actually true.

[7] Accepting the null hypothesis, for example; no significant change in bird population trends, when it is actually false.

Table 1—List of site characteristics used to develop a site attribute database

1. Site identification number
2. Province, township, range, and section
3. GPS coordinates or other spatial electronic registry
4. Site size or acreage
5. Site shape (for example, linear, elliptical, square, or amoeboid)
6. Elevation (range)
7. Slope (range)
8. Aspect (range)
9. Dominant landform (for example, valley, ridgetop, or midslope)
10. Dominant vegetation
11. Vegetation type
12. Successional stage
13. Forest canopy cover and layers
14. Tree sizes, dominants, and range
15. Adjacent site conditions (proportions in specific successional stage and dominant vegetation)
16. Acreage and influence of riparian vegetation, water channels, and wet areas
17. Level of past disturbances (for example, tree removal, blowdown, insect and diseases, grazing, or fire activity)
18. Allocation in land management plan (for example, reserve, general timberland, no management activities planned for 10 years)
19. Access (for example, road conditions, distance from road, logistical constraints such as time of snow melt, or trail)
20. Potential noise distractions (for example, nearby major rivers, highways)
21. Safety considerations
22. Stand resource examination (for example, site-specific vegetation inventory)

Table 2—List of topics for developing criteria for final site selection

1. Preference for larger size sites
2. Preference for least fragmented landscapes (this may require addition analyses to determine the amount of landscape fragmentation; analytical tools such as FRAGSTATS [McGarigal and Marks 1995] are available)
3. Preference or tolerance for certain type, extent, and severity of past disturbances
4. Preference for elevation or other physical features that may influence bird detection
5. Preference for homogeneity of site vegetation composition and structure
6. Preference for access issues such as distance from road, drive time to arrive at dawn
7. Preference for distance between sites, if two are sampled per day (for example, <15 minute drive time)
8. Preference for level of protection from future management activities
9. Preference for sufficient dispersion of sites over the local area to optimize broad spatial considerations of the vegetation type and range of environmental conditions

The level at which an investigator wants to detect change has a profound effect on determining the sample size. The general rule for detecting a smaller component of change, and thus increasing precision, is that the standard error will decrease in proportion to the square of the sample size (Nur and others 1999). To more precisely detect change going from a level of 50 to 25 percent, for example, would require about a fourfold increase in sample size. Acceptable significance levels for detecting change of species with low relative abundance have to be set high (for example, to detect a 50-percent change) to keep the sample size at a level reasonable to achieve. Sample sizes meeting minimum statistical standards and usable in detecting large population changes are likely to be achieved only through a network of monitoring sites where data are pooled within and across habitat types and provinces. Helpful discussions on balancing these constraints are given in Hamel and others (1996), Nur and others (1999), and at the Department of the Interior, U.S. Geologic Survey, Patuxent Wildlife Research Center Web site (http://www.pwrc.usgs.gov).

Step Two: Habitat-Based Site Selection Process

Our habitat-based site-selection process has three broad steps: (1) developing a framework for identifying potential monitoring sites, (2) developing an attribute database to characterize the potential sites, and (3) developing rules for using the database to refine the site-selection process. We refer to a site (see footnote 4) in this site-selection process as the sample unit. It is an area of relatively uniform vegetation composition and structure[8] (or physical features), which is distinct from surrounding conditions, where multiple point-count stations are established to monitor terrestrial birds. A site for habitat-based monitoring needs to be large enough to accommodate all the point-count stations and to buffer them from contrasting environments found along the edges.

To begin the site-selection process, identify a set or range of environmental conditions within a physiographic province(s), vegetation zone(s), or community vegetation type(s), based on monitoring priorities and objectives. The environmental conditions might include macroclimate (for example, rainfall), topographic or broad landform features, or parent material associated with a vegetation zone or community vegetation type. Use this set of environmental conditions to delineate broad land areas useful for monitoring. Next, locate sites of desired vegetation associations and successional stages with relatively homogenous vegetation ≥16 ha[9] by using aerial photographs, spatial analytical tools, or other resource information. Once sites are located, create a database of characteristics about each site. Example characteristics are shown in table 1. Most data can be collected remotely from maps, aerial photographs, or existing computer databases. Field-verify characteristics gathered remotely and develop a process to select “potential” sites best fitting monitoring objectives. Examples of selection criteria are shown in table 2. From this pool of potential sample sites, randomly select the final sites. Create a map with directions to locate each site and store it where others can easily access it.

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[8] *Relatively uniform vegetation composition and structure* refers to a set of conditions that are relatively uniform, whether heterogeneous or homogeneous in composition and structure.

[9] This is the minimum size for a site into which five count stations can be fit effectively, be spaced 150 m apart, be buffered 125 m from the edge, and meet the habitat-based establishment criteria for point counts. If the objectives call for smaller sites to be sampled, fit as many stations as feasible, 150 m apart and buffered 125 m from the edge of the site.

Table 3—Minimum and preferred distances for establishing point-count stations

Type	Minimum distance	Preferred distance
	---------------*Meters*---------------	
Stand edge (to center of point-count station)	125	200
Between point-count stations	150	200-250, terrain dependent
Roads, secondary	50	150
Sharp break in vegetation structure and composition	75	150
Water (small stream or wetland)	50	150

Monitoring done in riparian areas and other linear habitats presents special challenges for a point-count site-selection process. The concept of a patch of relatively similar conditions (vegetation structure and composition) is applied more loosely in riparian systems than to blocks of upland terrestrial vegetation. A site as defined for a riparian area is a stretch of similar patterns of landforms and vegetation that extends for at least 0.8 km along a waterway and into which five point-count stations can be fit and be at least 150 m apart. Physical and vegetation characteristics change rapidly along riparian systems. Special care is needed to identify the dominant features shaping a riparian system, including the interaction of topography, channel morphology, and deposition patterns. Different mixes of vegetation structures (for example, grass-herb, shrub, or tree dominated) and composition (for example, patches of hardwood or conifer dominance) occur over very short distances. Features that should be included in the site-selection process are width of riparian vegetation, channel width and shape, flooding patterns, upland vegetation composition and structure, potential interferences of bridges and traffic and water-related recreation, and noise from water that could interfere with detection of bird vocalizations.

Step Three: Establishing Point-Count Monitoring Stations

A point-count station is a permanent location within a site that is revisited according to protocol standards to tally birds by sight and sound for a fixed time. The station is established through standards to minimize bias and sampling error. Important considerations include criteria for locating a point-count station, layout of multiple stations at a site, and marking distances at each station.

Preliminary layout of point-count stations—The habitat-based criteria for establishing point-count stations are shown in tables 3 and 4, and an example of point-count stations placed at a site is shown in figure 2. There are many factors to consider for locating stations at each site before going into the field. First, use an

Table 4—Criteria for establishing point-count stations

Subject	Criteria
Number of census stations	Minimum of 5 stations per location
Starting point	Randomly located (see text for details)
Time between 2 visits on same day	<15-minute drive or walk between locations
Time between stations	<10-minute walk
Safety considerations	Avoid cliffs or other dangerous terrain
Station permanent markers	Use permanent stakes or trees for holding monitoring signs (use nontoxic nails in trees)
Flagging route	Mark route between stations and site entrance and exit with flagging every 20 to 50 m depending on visibility
Flagging stations	Each station is flagged at 50 m in 4 compass directions: 0 degrees (north), 90 degrees (east), 180 degrees (south), and 270 degrees (west)
GPS	Each station location should be registered by using GPS equipment

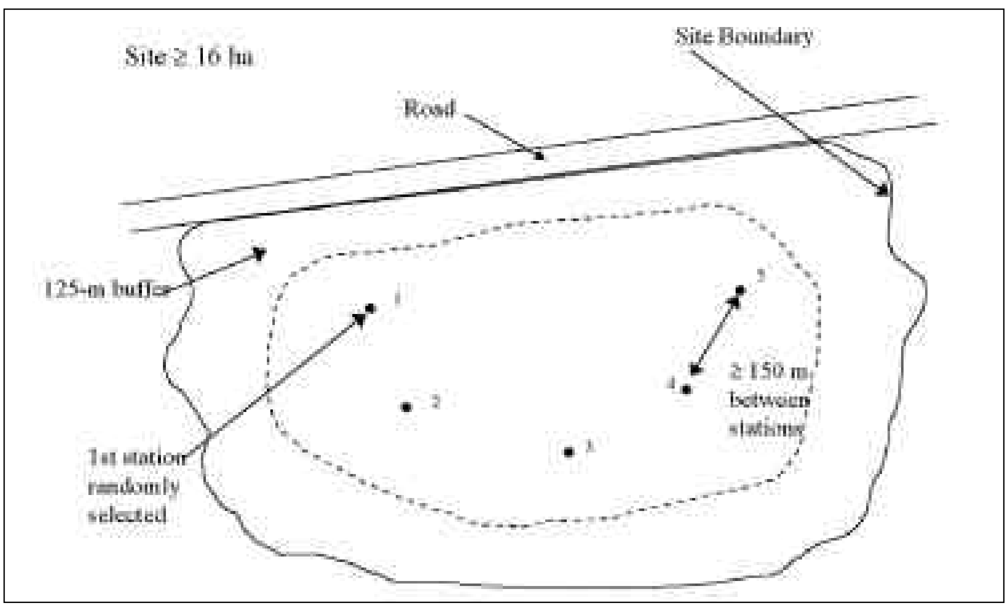

Figure 2—Example layout of point-count stations at a site.

aerial photograph (or electronic equivalent) to delineate a site boundary (major changes in vegetation structure and composition and other conditions) and a buffer zone 125 m inward from this boundary so that data will be truly representative of the habitat selected. Consider a buffer zone wider than 125 m if the site is large enough. The portion of the site inside the buffer is the area where point-count stations will be established (fig. 2). To locate the first station on an aerial photograph, begin by locating all the possibilities for accessing a site, and allow enough space to hypothetically fit in all the point-count stations with $\geq$150 m between them. Among these, select one randomly, if a choice exists. The first point-count station is located from the access position by using a random procedure adapted to keep the first station reasonably close to the access position. Select a random compass bearing and distance from the site boundary access position by using preestablished limits for the bearing and distance. For example, select a random distance between 150 and 300 m to keep the first station 150 to 300 m from the edge of the site; for direction, select a random azimuth between a minimum and maximum angle that is within the buffer and offers a reasonably efficient traverse route through the site. Establish the remaining stations sequentially by examining the aerial photograph for possible ways to accommodate the distance between count stations and to efficiently exit the site. Trace the potential route on the photo, mark the general locations for the point-count stations at one fixed distance spaced $\geq$150 m apart, and then measure the azimuths between stations. With azimuths and distances in hand, you now can begin establishing the point-count stations in the field.

Some field considerations—Minimum distance between stations is set at 150 m, corrected for slope. Use a fixed distance >150 m to lower the possibility of double-counting individual birds. Travel time between stations needs to be factored into the selection of a distance. Stations should be set up so that a surveyor in “reasonable” physical condition can safely walk between them in 10 minutes or less. In challenging terrain, the distance between stations likely will need to be set at the minimum of 150 m. Be careful of using trails with switchbacks because slope distance relative to trail distance can be deceptive.

Occasionally when laying out stations at fixed distances, the center point will land in a dangerous or awkward location, such as in the middle of a slash pile or in steep rock outcrops. Go around or avoid the situation by using a predetermined fixed distance of 50 m and maintain the compass bearing to avoid the hazard. It is not appropriate, however, to alter the location because there is a “better-looking” spot for a point-count center nearby; this would bias data collection.

The question may arise whether a station should be located within a distinct change in vegetation characteristics or if such areas should be avoided. The decision should be based on predetermined rules derived for the local scale. For example, placing a point-count station in the middle of an avalanche chute or riparian zone vegetation embedded within the site may not represent a sample of the continuous and relatively homogenous forest environment that was selected for monitoring. Such situations need to be evaluated carefully and action taken based only on the predetermined rules to avoid making potentially biased decisions in the field. If a fixed location for a point-count station is rejected, skip over the point-count location, establish the next station as planned, and add an additional station to the end of the

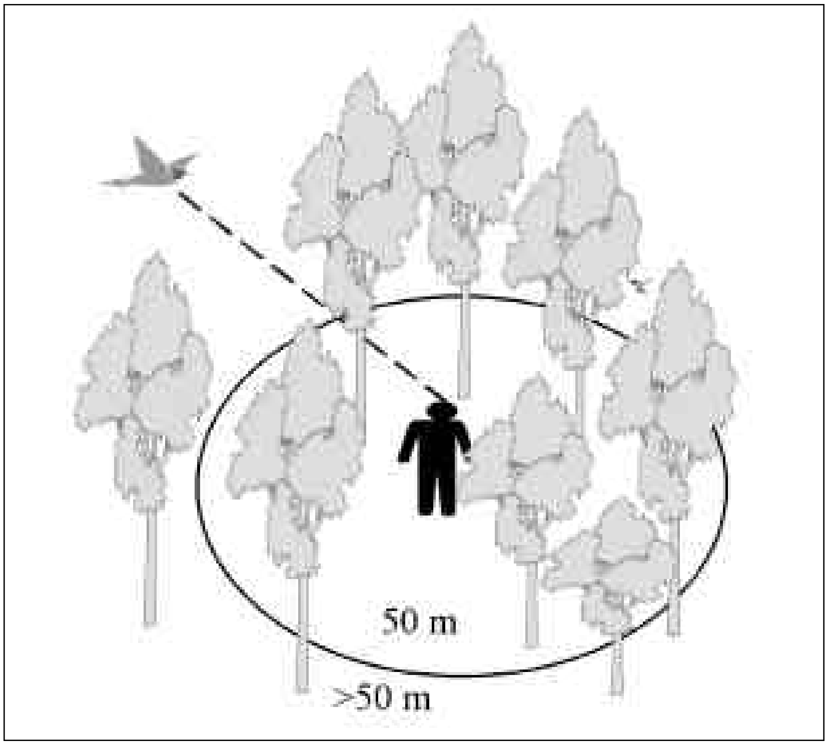

Figure 3—Example of point-count station with distance bands of 0 to 50 m and >50 m.

route at the fixed distance between stations. Distances to use with discrete breaks in vegetation are shown in table 3. The station establishment process should be documented:

- Record how the site was established with azimuths and distances.
- Create a detailed site map, marking access positions, survey route, and point-count stations drawn to scale.
- Attach an aerial photograph to this information in the files.
- Document how to find electronic information, such as digital maps.

Setting up an individual point-count station—Use a measuring tape to determine the distance (slope corrected) to each count station. Flag and permanently mark each station with rebar (steel reinforcing bar) or some other permanent marker. Take a Global Positioning System (GPS) reading from this point and store with other site information.

At each point-count station, birds are tallied for two bands of distance: 0 to 50 m and >50 m (fig. 3). Place flagging 50 m from the center point—corrected for slope—at north, east, south, and west compass bearings (fig. 4). In thick vegetation, where it is difficult to see the flagging at 50 m, hang the flagging at 25 and 50 m from point center to better gauge where 50 m lies and detection distances.

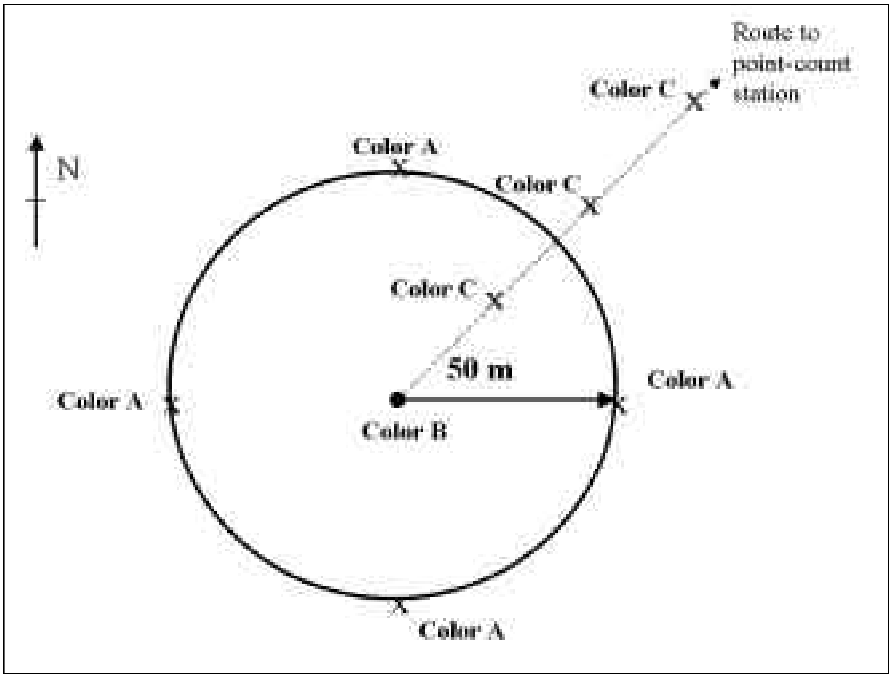

Figure 4—Placement of flagging at X symbols and center of an example point-count station.

Use bright colors to flag the station, such as orange, pink, and neon yellow, because some colors, (such as white and blue) are hard to see in the dim predawn light and blend in with the environment. Use different colors to indicate the center of the point-count station, 50-m circle boundaries, and the path between point-count stations at every 20 to 50 m or more depending on the thickness of the vegetation. Flag (or paint) the stations and routes such that surveyors unfamiliar with the site could easily find their way during a survey. Each year, before beginning point counts, all the routes and stations should be revisited to flag as needed, because much of the flagging will have deteriorated or been modified by animals.

Riparian areas—Establishing point-count stations in riparian areas poses several unique situations that are different from sampling birds in upland terrestrial environments. Because riparian areas are linear environments, they may be sampled more effectively with methods other than point counts (see Bibby and others 1992). In developing a regional approach, however, sampling consistently across different habitats, including riparian areas, was a higher priority to WA-OR PIF than applying different methods for each environment based on sampling effectiveness.

Habitat-based sampling in riparian areas, unlike terrestrial upland areas, has no delineated boundaries for sampling birds, because the width of riparian vegetation zones fluctuates widely and counting birds along variable boundary delineations is a very difficult task. Buffers are made for the access locations only (≥125 m). Distance, not direction, to the first count station is selected randomly within a set range or is selected at a preset distance because of the linearity of riparian areas. For larger streams and rivers, the stations are established on only one side of the channel; for smaller streams, that can be crossed or waded (consider peak flow in

Table 5—Visit and station point-count protocol

Event	Protocol
Number of visits	1 visit to 2 sites per day (minimum 5 stations per site) 3 visits to each site per breeding season
Visit timing	May 15 to June 30 (adjusted up to a week later for cool sites) Begin point count 15 minutes before sunrise Complete point count by 10:00 a.m., or earlier on warm days 1-minute settle down period before beginning count
Weather guidelines	Do not survey in rain, cold drizzle, sleet, snow, heavy ground fog or wind >32 km/h
Station count time	5-minute count divided into periods of 3 and 2 minutes
Detection	When and where a bird is first heard or seen during a point count in 2 categories: typical and fly-over Juvenile birds are recorded separately
Detection distance categories	0 to 50 m and >50 m

spring), station placement can bisect the middle of the riparian zone. Consider the possible condition of the riparian site during survey season when the water might be high and noisy. Point-count stations should be established so that the 50-m counting circle includes as much of the zone of riparian vegetation as possible. If water noise interferes with detecting birds, then the station should be set back from the water (wide riparian zone) or follow rules established for breaks in vegetation (narrow riparian zone).

Step Four: Conducting Point Counts With the Habitat-Based Regional Protocol

Background—To conduct point counts, standardized criteria are needed for the length of time for an individual count, distances that birds are counted from the center of the count station, assemblage of species to be counted, circumstances establishing suitable and unsuitable detections, appropriate weather conditions, and controlling observer effects. Counting standards from Ralph and others (1993) were used wherever possible in the habitat-based protocol. A point-count paper field-form is shown in appendix A, and a summary of the protocol standards for station counts is shown in table 5.

Survey criteria and data description—Each location should be surveyed several times each year; each survey is called a visit. To qualify as a valid visit, all the point-count stations at a site should be surveyed in one morning according to protocol standards. A minimum of three visits to each site is required per breeding season for each year. The habitat-based protocol was developed specifically for the breeding season. The methods can be modified for use in other seasons, although a collaborative approach has not been adopted for this purpose.

May						
Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	2 Visit all sites to re-hang	3 flagging, cut logs from	4 access roads, etc.	5 Schedule	6 4 +/- sites/day	7
8	9	10	11	12	13	14
15	16	17	18 sites I&J visit 1	19 sites A&B visit 1	20 sites M&N visit 1	21 sites K&L visit 1
22 sites O&P visit 1	23 sites E&F visit 1	24 sites G&H visit 1	25 sites C&D visit 1	26	27	28
29	30	31				

June						
Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
			1 sites P&O visit 2	2 sites D&C visit 2	3 sites B&A visit 2	4 sites H&G visit 2
5 sites J&I visit 2	6 sites L&K visit 2	7 sites N&M visit 2	8 sites F&E visit 2	9	10	11
12	13	14	15 sites A&B visit 3	16 sites K&L visit 3	17 sites E&F visit 3	18 sites C&D visit 3
19 sites I&J visit 3	20 sites M&N visit 3	21 sites O&P visit 3	22 sites G&H visit 3	23	24	25

Figure 5—Hypothetical sample visit schedule to 16 sites, without cancellations owing to inclement weather or other factors

Bird detection rates differ among species, during breeding season, and throughout a given day. At each site, the schedule for the three visits needs to be well distributed throughout the breeding season because of this variation. When to begin surveying depends on latitude, elevation, seasonal weather, and objectives. Surveys that emphasize breeding by Neotropical migratory birds should begin after the major influx of migrant species have moved through the area, and breeding birds have begun to advertise their territories by singing. In Washington and Oregon, most migrants generally have moved through by mid-May at warm, low-elevation and low-latitude sites such as those in southwestern Oregon, and surveys should begin no sooner than about May 15; for residents, a week or two earlier would be appropriate. At the cooler, high-elevation or high-latitude sites, such as those in the Okanogan Highlands in north-central Washington, surveys might begin about the last week of May, or even later at very high-elevation sites in cooler than average springs. All surveys should be completed by the end of June, except for the coolest sites, where surveys often extend through the first week of July. Surveys should be completed before most young of terrestrial landbirds have fledged their nest. Juvenile birds (fledglings) are counted separately in the point-count tallies; their presence is not reflective of the breeding population at a site, and it is likely that too many young birds (sampling too late in the breeding season) could hamper the observer's ability to do an accurate count of adult breeding birds.

The schedule for visiting sites is set by determining the best time to detect the maximum abundance of all species. This decision is based mainly on the expected time that species will need to begin establishing breeding territories and the breeding phenology for a site. It is important that visits for each site occur at about the same dates each year, but annual adjustments will be needed for breeding phenology to reduce detection variation that might result from substantially different sampling schedules among years. Slight adjustments are made, if needed, a few days later or earlier, depending on a cool or warm spring, respectively. There should be a minimum of 7 to 10 days between visits to the same site. Sites are selected so that two sites can be visited each morning. The order for the first visit on the first trip to the field should be chosen randomly (for example, by coin toss) to avoid bias; after that, alternate the order in subsequent visits. An example of a two-site-per-day visit schedule for 16 sites that are hypothetically located at a mid-elevation along the west side of the Cascade Range in Oregon is shown in figure 5. Whenever feasible, change the order of the station routes for each visit; for example, reverse the order to begin with station 1 on the first visit and station 5 on the second visit.

For a delineated habitat-based approach, we recommend 16 sites per field biologist for a 45-day breeding season sample, visiting two sites per day, three visits per site, and five stations per site. Although this allows 24 sample days, expect that many days will be unsuitable for sampling in the relatively wet climate of the Pacific Northwest. Note that the field season is short in mountainous terrain with deep snow packs, and thus fewer sites can be sampled by one person.

Weather conditions unsuitable for sampling include rain, cold drizzle, sleet, snow, heavy ground fog, or wind >32 km/h. Surveying during a drizzle is suitable if birds are active and can be detected without interference of moisture dripping from the foliage. If weather conditions become unsuitable during a survey, wait to see if conditions will change soon. However, if the stations are not completed before about

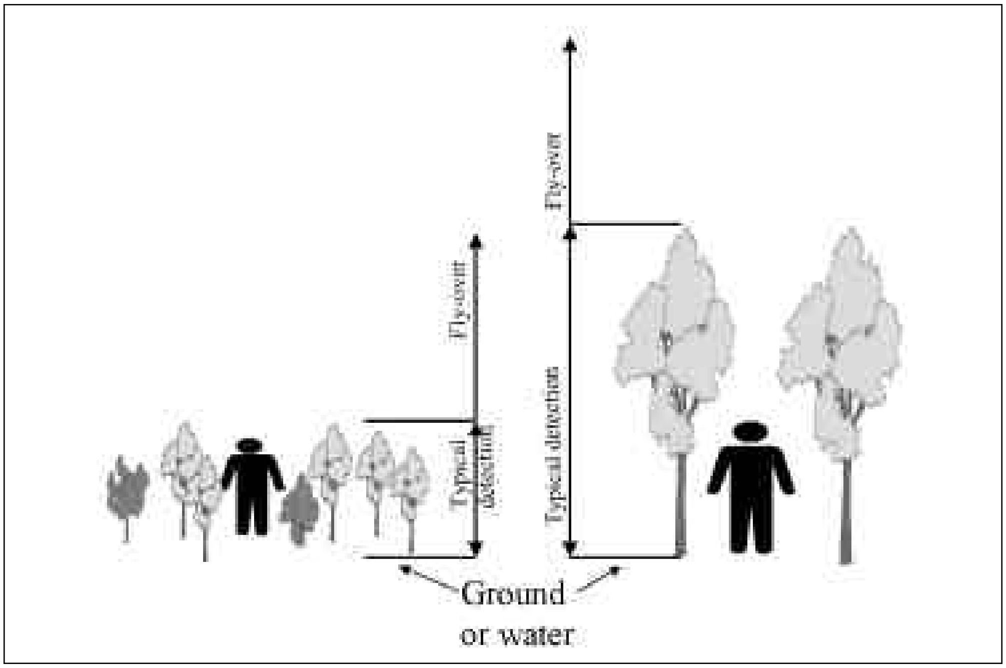

Figure 6—Division of vertical space for typical and fly-over detection.

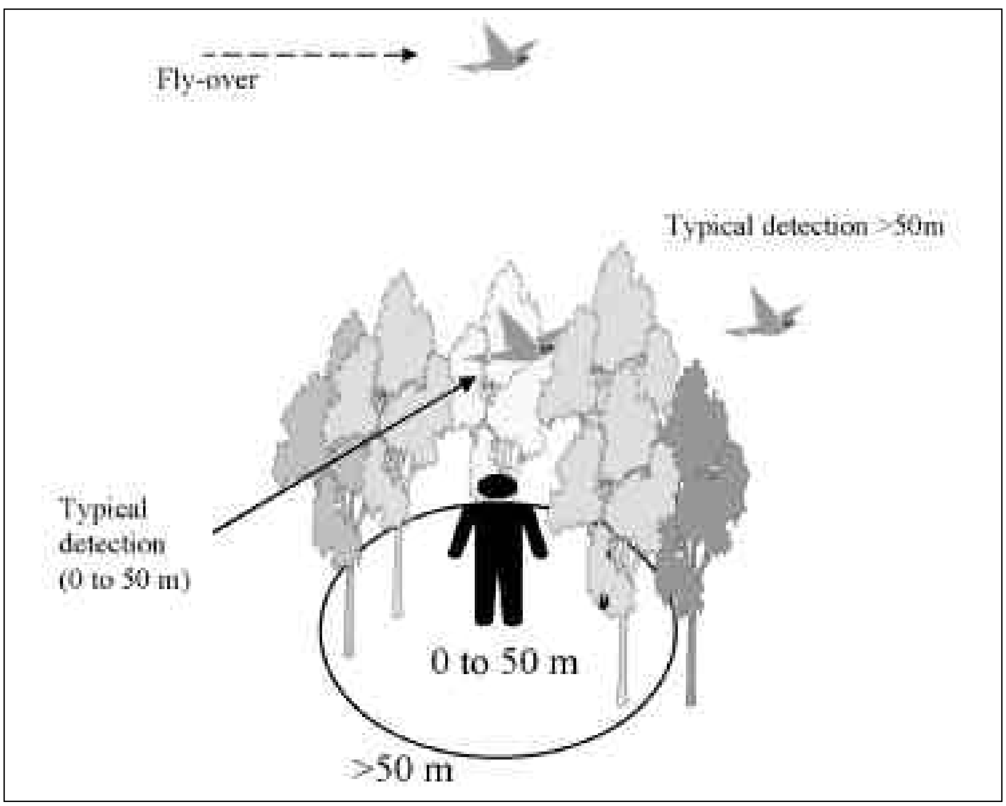

Figure 7—Example of locating typical and fly-over detections.

10:00 a.m.[10] or before bird activity declines, the survey is declared invalid. A visit (of multiple stations at one site) cannot be split between days (because they would not be independent samples). Thus, a new visit has to be scheduled to survey all the stations at sites where surveys were incomplete. If the temperature is cold at dawn, use bird activity as the criterion for starting the counts. Delay the counts until bird activity is judged satisfactory. If the center point becomes inaccessible owing to standing water, do the count while standing as close to the center as safely possible, and extrapolate the counts from the center of the point-count circle.

Defining detections—Individual tallies of birds during a visit are termed "detections." Point-count detections are fixed events in time and space, a snapshot of when and where birds are first heard or seen during a point count. Strictly adhering to this protocol standard helps minimize potential observer bias associated with detecting birds.

We group detections into three types: primary, juvenile birds, and supplemental. The primary group includes detection types used to detect (adult) birds when they are first heard or seen during a point count. Detections of juvenile birds are counted separately in their own tally group. The supplemental group covers specific detection changes of birds after they are first seen or heard, as well as detections of birds before and after a point count.

There are two types of primary detections: typical and fly-over. A typical detection is defined spatially and is habitat specific. Vertically, a typical detection is a bird seen or heard from the ground or water level up to the top of the surrounding vegetation (figs. 6 and 7), and this extends horizontally to the boundary area delineated for the site.

Typical detections have two distance bands, 0- to 50-m and >50 m, and two-time periods, 0 to 3 minutes and 3 to 5 minutes. The 0- to 50-m band is corrected to the angle of the slope, wherever necessary; envision a column of air over a point-count station that has a 50-m radius level with the center of the station (fig. 8). Thus, as slope angle increases, the greater the corrections needed for ground distances and the more difficult it is to perceive distances. To aid the observer, slope adjustments to ground distance need to be well marked at the stations. No correction is needed for the >50-m band, which extends just to the site boundary. Station counts can be longer than the minimum 5 minutes, but the 0- to 3- and 3- to 5-minute periods must be used during the first 5 minutes. Using a 0- to 3-minute period allows for potential comparisons with other studies or monitoring that uses only this time interval (for example, BBS). If longer periods are preferred, consider that counts must be completed before bird activity declines, usually by 10:00 a.m. (see footnote 10).

A fly-over detection is defined as a bird detected above the highest vegetation during a point-count survey; that is, the area (sky) above a typical detection and delimited horizontally by the site boundary (figs. 6 and 7). An exception to this is made for

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[10] Fixed times are used only as a rough gauge, because day lengths and duration of bird activity and relative frequency of morning vocalizations change daily.

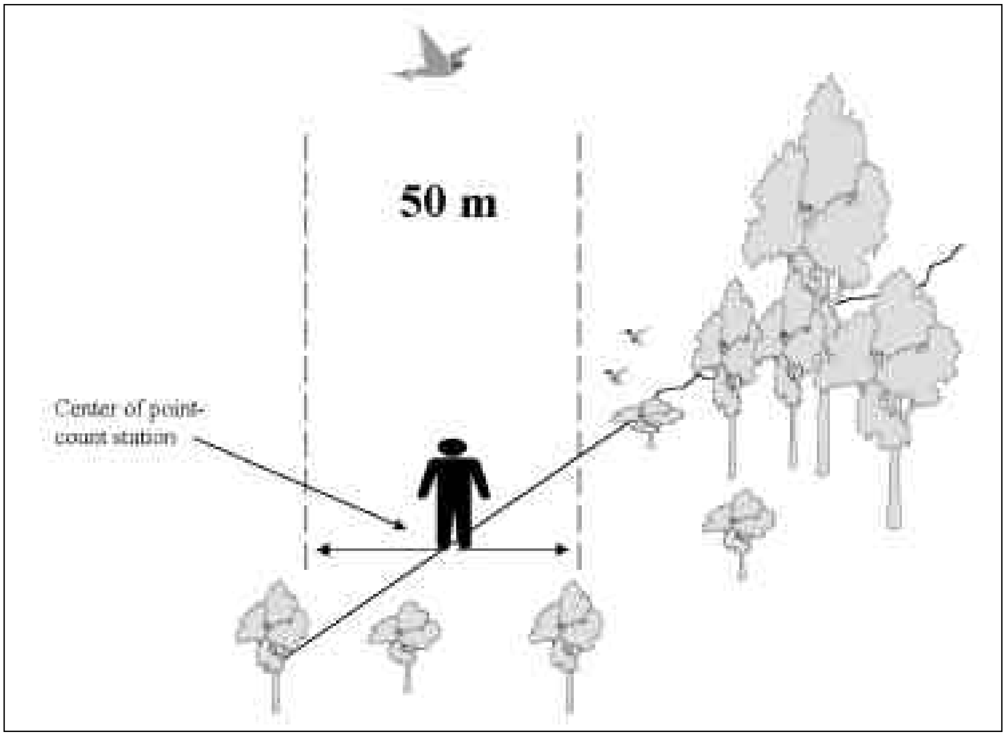

Figure 8—Envisioning the 50-m distance band on a slope at a point-count station.

birds detected during very short flights directed from plant to plant, above and close to the highest vegetation; for example, a bird is detected while in flight above some shrubs in a shrubland, flitting between shrubs. This type of observation is *not* tallied as a fly-over, but as a typical detection, even though the bird is detected above the highest vegetation.

There are two categories of fly-over detections: associated and independent. A fly-over-associated detection is that of a bird actively foraging, searching, or traveling in the local sense (for example, in a corridor) above the highest vegetation at a site. Examples are swifts foraging above the treetops or raptors actively looking, from above the vegetation, for food below. The fly-over activity of certain species is difficult to determine, such as that of vultures; these encounters require close scrutiny by the observer. The fly-over-independent category refers to birds not using the site below them, but usually flying away (for example, in a fixed flight pattern), thereby giving the perception that the detection is distant. An example is a raven flying high overhead toward a ridge several miles away. Knowledge of the life history and behavior of species can help to determine whether a fly-over is associated or independent. Fly-over detections have two periods, 0 to 3 and 3 to 5 minutes, the same as typical detections. There are no distance bands for fly-over detections.

During breeding season surveys, juvenile or subadult birds, usually identified by their plumage or behavioral characteristics, are counted separately from adult birds. A simple tally of individuals of species is done, regardless of detection type. Additional information about the detection of juvenile birds can be recorded in the field notes. Most of the juvenile birds tallied will be those fledged by resident or short-distance migratory species, which tend to breed earlier than long-distance migratory species.

After using and testing several different types of supplemental detections (see app. B), we used only one type, flush detection, for the habitat-based point-count protocol. Flush detection is used to tally birds neither seen nor heard during station counts. Flush detections are not used to determine relative abundance, but rather to establish presence of a species at a site. Birds encountered for this detection usually are disturbed, or flushed, by the observer as that person enters or leaves a point-count station and are not detected again during any of the station point counts. Flush detections are limited to birds detected only within the 0- to 50-m band from the center of the point-count station. The flush detection provides additional information on bird occurrence at the site that is not obtained from point counts. Species seen or heard at a site, but not detected as a typical detection, fly-over, or flush (for example, detected between stations), are recorded in the space provided for field notes.

Observer considerations—The observer doing point counts must be able to identify by sight and sound all birds occurring within the monitoring area. Recommendations for observer training and standards are presented in Ralph and others (1995b). Annual workshops on bird identification and monitoring protocol are held the first two weeks in May in Washington and Oregon; information on these workshops is available at two Web sites:
www.gorge.net/natres/pif.html and www.fs.fed.us/pnw/birds-populations.

Much has been written about potential biases that different observers have in detecting birds (for example, see Ralph and Scott 1981). Observers are the major source of variation in bird counts. The use of three or more observers rotated among sites and visits is recommended to help reduce this source of variation (Verner and Milne 1989). But no matter how desirable, rotating multiple observers among sites often is not feasible, and not accounting for observer bias during data collection could compromise the ability to detect trends when data sets are aggregated. Analytical methods are available that may reduce observer effects among years (for example, Link and Sauer 1998, Sauer and others 1994).

Guidelines for observers to follow during surveys include (1) using only one observer at a station during a count to minimize potential interference with detecting birds and to maintain consistency among counts, and (2) remaining as quiet as possible during a site visit, neither intentionally attracting nor scaring birds until all the station counts are completed.

Time considerations—Use time wisely when walking between stations and commuting between sites. Tracking down unknown bird detections between station counts is justifiable, yet there will be limited time available for this pursuit plus finishing the surveys before bird activity declines. We recommend a 1-minute settling down period before starting a station count. Use this time to organize data sheets, timing devices, writing instruments, and other equipment. Do a precount identification of birds at the station while getting organized. When sampling in steep terrain, an observer's breathing should be nearly normal before beginning a station count to minimize hearing impairment.

Recording data—An example of a field form for recording data using the regional protocol is shown in appendix A. The field form has two parts, a visit description at the top of the form (header), followed by a tally area for bird detections. The visit description has 10 data fields: date, observer name, state, physiographic province, identification of geographic area, site name, sequential visit number, weather, wind conditions, and field notes. The bird detection information section has 14 data fields: station number, station count start time, species, four separate tallies for typical detections divided into two distance bands and two periods, four separate tallies for fly-over detections divided into two types and two periods, a juvenile and fledgling count, a flush detection, and field notes. The first three data fields of the bird detection information are used to distinguish detections by time and location, the next nine data fields are used for tallying, and the last for any additional notes.

Each bird detected is tallied only once during a site visit when it is first heard or seen during a station point count. To prevent double counting of individual birds, mental records or sketch notes are made of the location and movements of each bird at a site. Large flocks of birds that change locations and flock size during a site visit are particularly troublesome for making accurate counts, especially in forests. Make the best possible initial estimate of flock size. If flock size increases, make the appropriate additional tallies for the station(s) where the additional birds are recognized. For example, if 12 individuals of a species are detected at station one and 15 individuals of the same species and flock are detected at station three, then the numbers12 and 3 are recorded for that species in stations one and three, respectively. Juvenile birds are tallied in the column provided and not in the primary and supplemental detection data fields. Unknown birds are recorded with the species code UNKN.

Recording of data on the field form needs to be done skillfully and legibly and needs to be checked. At the end of each station point count, make sure that a tally was made for each species recorded. At the end of each field day, establish a routine to read the field forms to ensure that numbers and letters are understandable and codes have been entered correctly while the memory of each site visit is fresh. Never erase a detection that has been recorded, unless the tally was clearly a mistake; crossing out of mistakes is preferred. Once a bird has been first detected, do not let additional bird movement change how it is recorded on the field form. If a bird, for example, moves from >50 m to within 50 m of the center of the point-count station during a count, the detection is tallied as >50 m. If desired, the movement to within 50 m can be recorded in the field notes.

Each data field has specific recording instructions and some have data codes; these are explained and presented below:

A. Visit description

1. DATE: Enter the survey date using the month/day/year format.
2. OBSERVER: Enter observer’s name, not initials.
3. STATE: Enter two-letter state abbreviation (OR or WA) for the site.

Table 6—Physiographic province codes for Washington and Oregon

Codes	Location	Codes	Location
OLPEN	Olympic Peninsula	NOCAS	Northern Washington Cascades
CORAN	Coast Ranges	HICAS	High Cascades
KLMOU	Klamath Mountains	OKHIG	Okanogan Highlands
WILVA	Willamette Valley	COBAS	Columbia Basin
PUTRO	Puget Trough	HLPLA	High Lava Plains
OWUPL	Owyhee Upland	BLMOU	Blue Mountains
WECAS	Western Cascades	BARAN	Basin and Range
SWCAS	Southern Washington Cascades		

4. PROVINCE: Select a province for the site from table 6 and enter the code.
5. AREA ID: Enter a user-defined eight-letter code to identify the broad geographic area that encompasses several sites, such as a watershed, basin, or mountain range. This code is not regionally standardized. Each year, the meaning of each area identification code should be described once in the field notes (to carry institutional knowledge across years).
6. SITE NAME: Enter a user-defined eight-letter code to identify the site. Errors arise when this name is used inconsistently. Check records for correct spelling before each field season. Each year, the meaning of each site name code should be described once in the field notes (to carry institutional knowledge across years).
7. VISIT NUMBER: Enter the sequence number of the current visit since the start of the sample season. This number generally will be 1, 2, or 3.
8. WEATHER: Select and enter one of five weather codes listed below. The choice is based on the average conditions for the entire visit. If conditions are variable, enter the average and record any additional weather information in the field notes on the data form. Rain, sleet, and snow are unsuitable conditions for monitoring and have no codes because the visit should be cancelled when these conditions prevail.
   a. DRIZ—drizzle
   b. OVC—overcast, >90 percent cloud cover
   c. BRK—broken, 50-90 percent cloud cover
   d. SCT—scattered, 10-50 percent cloud cover
   e. CLR—clear, <10 percent cloud cover

9. WIND: Select and enter one of two wind codes listed below. The choice is based on the average wind conditions for the entire visit. If conditions are variable, enter the average and record any additional wind information in the field notes on the data form. Wind >32 km/h is deemed unsuitable for monitoring; a visit should be cancelled when wind conditions negatively affect the observer's ability to detect birds.
   a. WINL—wind speed 0 to 8 km/h—low, calm
   b. WINM—wind speed >8 to 20 km/h—moderate
10. FIELD NOTES: All field notes are entered into the database and thus are an important form of permanent record keeping. Record natural history observations (for example, nests found or species carrying nest material), weather notes (for example, temperature), and noteworthy field encounters. Also, record permanent reference information for the site on the first data form of each site each year. Include township, range, and section or Universal Transverse Mercator coordinates, GPS coordinates for the first station, storage location of topographic maps, aerial photographs, and electronic files of the site. For riparian habitat monitoring or other situations where water noise is present, include a code in the field notes section to describe the level of water noise:
    0—no noise
    1—gentle bubbling brook noise, probably not missing any birds
    2—babbling creek noise, might be missing some of the higher pitched songs and calls or some distant birds
    3—rushing creek noise, probably detecting only those birds within 50 m and might be missing the high-pitched songs and calls of some species close to the center of the station
    4—roaring creek and river noise, probably detecting only the very loudest calls and songs within 50 m

B. Bird detection information

1. STATION NUMBER: Enter the permanent monitoring station number once per station. When doing surveys not in station number order (1, 2, 3…), be sure to record the real station number and not the sequence number of stations surveyed.
2. STATION COUNT START TIME: Enter the time the count starts at each station, once per station.
3. SPECIES CODE: Enter the species code for each different species detected at a station. The most recent species codes are listed at Web site www.pwrc.usgs.gov/bbl/manual. A species code is used only once per station.

For numbers 4 through 12 below, tally the number of individuals detected of each species at each station in the appropriate data column provided. An individual bird is tallied only once and is not recorded if detected at any subsequent stations.

4. TYPICAL DETECTION 0-50 M AND 0-3 MINUTES
5. TYPICAL DETECTION 0-50 M AND 3-5 MINUTES
6. TYPICAL DETECTION >50 M AND 0-3 MINUTES
7. TYPICAL DETECTION >50 M AND 3-5 MINUTES
8. FLY-OVER ASSOCIATED 0-3 MINUTES
9. FLY-OVER ASSOCIATED 3-5 MINUTES
10. FLY-OVER INDEPENDENT 0-3 MINUTES
11. FLY-OVER INDEPENDENT 3-5 MINUTES
12. JUVENILE (NO DISTANCE AND TIME CATEGORIES)
13. FLUSH: Tally the number of individuals of each species detected within 50 m of each count station before or after each timed point count that were not detected during the counts. Note that species not detected during the counts but detected >50 m from a point-count station (between stations) are recorded in the field notes. If a species is recorded as a flush detection and then subsequently detected at another station point count during the visit (typical or fly-over detection), the flush detection should be removed by crossing out the entire data line on the field form.
14. FIELD NOTES: Write remarks about individual bird detections or clarifications about data collected.

Acknowledgments

We thank the 40+ biologists who participated in the initial discussions in 1994 to develop the habitat-based protocol, and those who field-tested it for several years. Important contributions to these discussions were made by David Dobkin, Rick Lundquist, Joseph Buchanan, and Chris Chappell. Valuable comments that improved this manuscript were provided by Rex Sallabanks, C.J. Ralph, David Manuwal, Grant Gunderson, Terrell Rich, and Kent Woodruff. Major funding for this paper was provided by the U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. We thank Erick Campbell, U.S. Department of the Interior, Bureau of Land Management, Oregon State Office, for the agency's financial commitment to annual bird monitoring workshops in Washington and Oregon, which provided the venue for developing and refining a habitat-based protocol; and, to Barbara Kott, U.S. Department of Agriculture, Forest Service, Mount Hood National Forest, for organizing 14 monitoring workshops over 7 years.

English Conversions

When you know:	Multiply by:	To find:
hectares (ha)	2.471	acres
meters (m)	3.281	feet
kilometers (km)	0.621	miles

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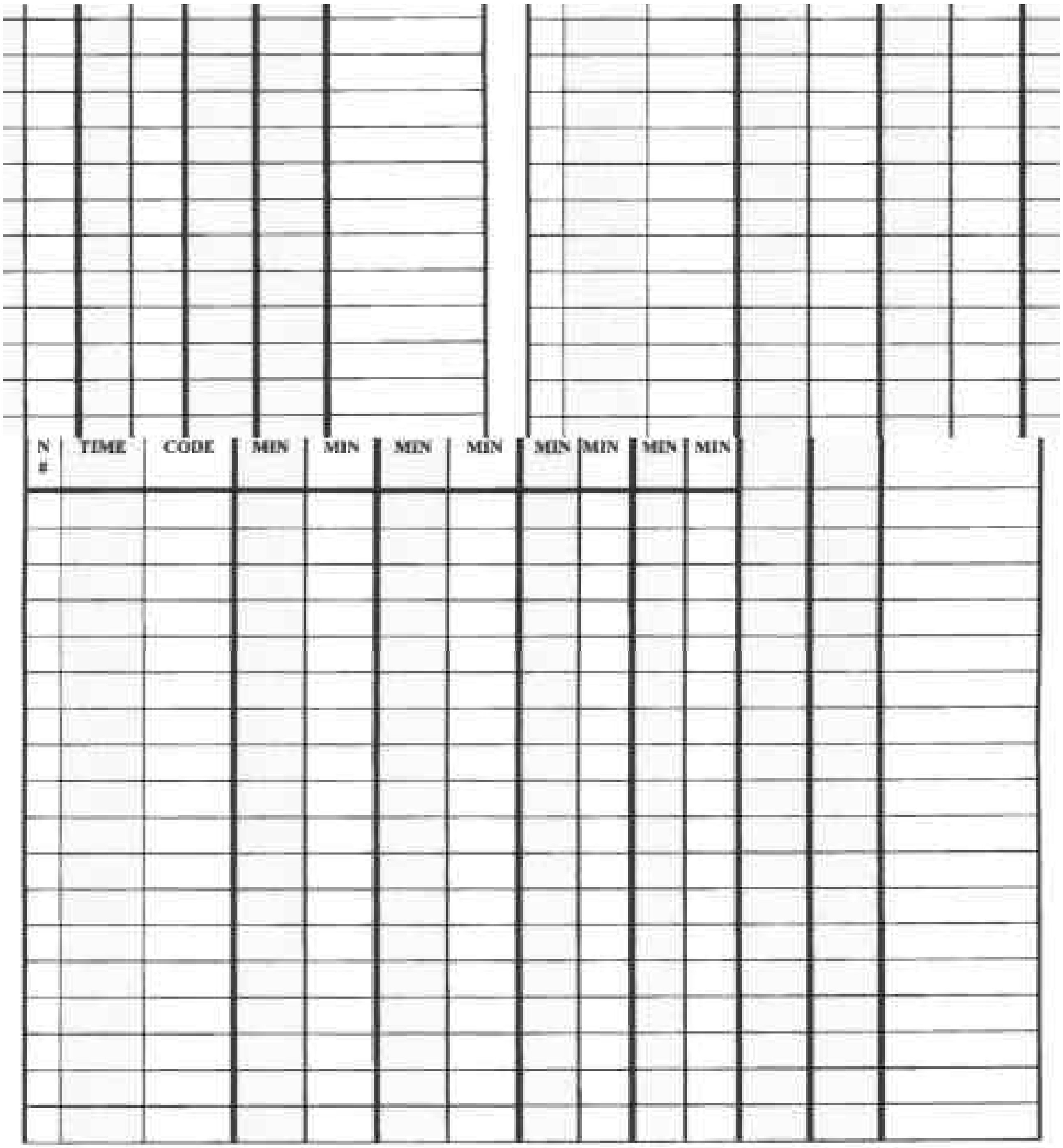
Appendix A—Point-Count Data Form[1]



N #	TIME	CODE	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN			

[1] Electronic copies of the form are available at the following Web sites: www.fs.fed.us/pnw/bird-populations and www.gorge.net/natres/pif.html.

Appendix B—Evaluation of Supplemental Detections

Background

The regional point-count protocol to monitor terrestrial birds was developed through a collaborative undertaking of WA-OR-PIF. From this collaboration, it was agreed that all birds surveyed during a point count would be recorded as typical and flyover detections, and those surveyed before and after a count as flush detections. In addition, it was agreed that the protocol should include ways to track birds that move closer to the center of the point-count station during a count, namely those that move from their initial detection of >50 m to 0 to 50 m. In theory, birds detected within 50 m of the center of a point-count station are likely to have a closer affinity to the habitat characteristics measured near the center of a point-count station than those detected farther away. It was reasoned that tracking birds moving closer to the center of a point-count station potentially could strengthen future analyses of habitat relations, especially because only about half of the (initial) bird detections at count stations are within 50 m of the center (see Huff and Brown 1998).

Three situations (supplemental detections) where birds moved to within 50 m were identified: (1) distance band adjustment: a bird is first detected as a typical detection >50 m during a 5-minute station count and during the same count the same bird is detected 0 to 50 m from the center of the point-count station; (2) previous station adjustment: a bird is first detected as a typical detection >50 m during a 5-minute station count and, while at the next station, the same bird is detected 0 to 50 m from the center of the point-count station during this 5-minute station count; and (3) fly-in adjustment: a bird is first detected as a fly-over during a 5-minute station count, and during the same count the same bird is detected 0 to 50 m from the center of the point-count station (matching a typical detection). Recording data for these three situations is a two-step process. First, a bird has to have been previously detected and recorded as a typical detection >50 m or as a fly-over. Then, after a bird is detected moving to within 50 m, it is tallied again in one of three additional data columns provided on the field form for tallying these supplemental data. Field observers were trained that for a supplemental detection to be complete, both steps have to be recorded on the field form and the (initial) typical and fly-over detections should not be changed or deleted if a supplemental detection is recorded.

Several questions needed to be addressed by including these supplemental detections: How often did the three types of supplemental detections occur relative to other types of detections? Did certain species tend to have higher numbers of supplemental detections? How accurately were these detections recorded, given that they add more complexity to the collection of data?

Approach

To evaluate the first two questions, we determined the percentage of secondary detections that occurred as part of the total number of >50-m and fly-over detections, as well as for each species with $\geq$20 records. Next, we assessed the number of recording errors for the supplemental detections by counting the number of supplemental detections that did not have the other required piece of information; that is, a record of a typical detection >50 m or fly-over (depending on which supplemental detection). The proportion of incorrect detections was calculated for each year (geographic areas combined). We did a test for differences in recording errors among the geographic areas (with years combined), assuming each geographic area has equal probability of recording supplemental detections incorrectly. We then looked for significant deviations from this assumption (no difference among geographic areas) using a chi-square test (Snedecor and Cochran 1967). Different surveyors were used in each geographic area. Four of the seven geographic areas retained the same observer among all the years sampled. Observers were trained each year before the field season on data recording methods. Differences among geographic areas, not individual observers were tested. For each geographic area, data were pooled among years (and thus observers too) to do the chi-square tests, because the proportion of supplemental detections in any given year for a geographic area was small.

We used a database of bird detections that was collected from 1994 to 1998 and covered seven different geographic areas located on 10 different National Forests in Washington and Oregon. These data consisted of 7,250 station counts, with >80,000 individual birds counted from >50,000 species records.

Findings

Over the five years of monitoring, 781 distance band adjustments, 527 previous station adjustments, and 68 fly-in adjustments were recorded (table 7). These three types of adjustments occurred as only 4.6 percent of total >50-m and fly-over detections. The amount of supplemental detections for individual species was generally low; most were below 10 percent of the total number of >50-m and fly-over detections (table 8). Species with the highest proportion of supplemental detections were spotted sandpiper[1] (17.0 percent), white-crowned sparrow (16.7), house wren (14.8), and western wood-pewee (14.1). These species tended to have a low number of >50-m and fly-over detections, ranging from 47 (spotted sandpiper) to 269 (western wood-pewee). The highest proportion of distance band adjustments was recorded for chestnut-backed chickadee (11.5 percent), but only 20 distance band adjustments were recorded for this species. The hermit and Townsend's warbler complex had 78 distance band adjustments, the highest total number recorded (6.7 percent of its >50-m and fly-over detections). The highest proportion of previous station adjustments was recorded for the spotted sandpiper (12.2 percent). Dusky flycatcher and hermit thrush each were recorded 31 times for previous station adjustments, the highest among the species sampled.

Of the 1,376 supplemental detections recorded over the five years, 11.9 percent were recorded incorrectly; that is, they were recorded without an initial detection of >50 m or fly-over. Distance band adjustment was recorded incorrectly 3 to 17 percent of the time among years, averaging about 8 percent over the period (table 7). Errors for recording the previous station adjustment were similar to the distance band adjustment (range 4 to 18 percent among years). The highest level occurred in 1998, when the average was 11 percent. The highest proportion of recording errors occurred with the fly-in adjustment (range 23 to 83 percent among years; average 63 percent). However, the fly-in adjustment occurred at very low levels: <5 percent of the total supplemental detections and <0.2 percent of the total bird records.

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[1] Scientific nomenclature given at Web site http://pica.wru.umt.edu//birdlist.html.

Generally, the number of recording errors of supplemental detections did not differ among geographic areas. Six of the seven geographic areas showed no discernible differences ($p>0.25$) and one area (southern Oregon Cascades) had notably fewer errors than expected ($p<0.02$). Despite measures taken before the 1998 field season to fix the high amount of secondary detections being recorded incorrectly, the errors for distance band and previous station adjustments more than doubled from 1997 to 1998 (table 7).

Implications

Supplemental detections represent a small portion (<3 percent) of all detections recorded. Because this number was so low for any given species, we suspect that analyses of species-habitat relations are not likely to benefit from this additional information. Supplemental detections were consistently recorded incorrectly throughout the geographic areas studied, which may have resulted from the complexity that supplemental detections added to the fieldwork. Recommendations to correct this problem apparently did not work. We suspect that the attention needed to record supplemental detections may interfere with the surveyor's ability to record typical and flyover detections—information that is more important to the overall monitoring objectives.

Problems associated with the three supplemental detections seemed to overshadow what potential benefits they may bring to the monitoring data. These concerns were taken under consideration with government and nongovernment participants in WA-OR PIF. It was concluded that distance band, previous station, and fly-in adjustments would be dropped from the regional protocol beginning with the 2000 field season, thus simplifying field procedures.

Table 7—Summary of recording errors for supplemental detections, by year, 1994-98

Records	1994	1995	1996	1997	1998	Total
Number of records:						
Total subset of relevant records: >50 m and fly-overs (no.)	5502	559	6687	6195	5757	29740
Total records (no.)	8856	9779	11315	10200	10612	50762
Distance band adjustment:						
Total records (no.)	111	135	187	196	152	781
Records used correctly (no.)	92	122	176	190	139	719
Records used incorrectly (no.)	19	13	11	6	13	62
Percentage used incorrectly	17	10	6	3	9	8
Percentage of correct uses among relevant records	1.7	2.2	2.6	3.1	2.4	2.4
Percentage of correct uses in total records	1.0	1.2	1.6	1.9	1.3	1.4
Previous station adjustment:						
Total records (no.)	94	103	149	88	93	527
Records used correctly (no.)	90	94	129	79	76	468
Records used incorrectly (no.)	4	9	20	9	17	59
Percentage used incorrectly	4	9	13	10	18	11
Percentage of correct uses among relevant records	1.6	1.7	1.9	1.3	1.3	1.6
Percentage of correct uses in total records	1.0	1.0	1.1	0.8	0.7	0.9
Fly-in adjustment:						
Total records (no.)	0	42	7	6	13	68
Records used correctly (no.)	0	7	5	3	10	25
Records used incorrectly (no.)	0	35	2	3	3	43
Percentage used incorrectly		83	29	50	23	63
Percentage of correct uses among relevant records	0.0	0.1	0.1	0.0	0.2	0.1
Percentage of correct uses in total records	0.0	0.1	0.0	0.0	0.1	0.0

Table 8—Contribution of supplemental detections (distance band, previous station, and fly-in adjustments) to relevant bird records (typical detection >50 m and flyover detection), 1994-98 (for species with >20 relevant records)

Species (migratory class[a])	Total records	Total subset of relevant records: >50 m and fly-overs	No. (correct) distance band records	No. (correct) prestation records	No. (correct) fly-in records	Relevant records using distance band adjustment	Relevant records using previous station adjustments	Relevant records using fly-in	Relevant records using any supplemental detection
	Number					*Percent*			
Mallard (S)	54	28	0	0	0	.0	.0	.0	.0
Northern goshawk (S)	30	22	0	0	0	.0	.0	.0	.0
Red-tailed hawk (S)	48	38	0	0	0	.0	.0	.0	.0
Blue grouse (R)	301	249	0	13	0	.0	5.2	.0	5.2
Ruffed grouse (R)	149	107	0	4	0	.0	3.7	.0	3.7
Mountain quail (R)	29	26	0	2	0	.0	7.7	.0	7.7
Spotted sandpiper (S)	110	47	2	6	0	4.3	12.8	.0	17.0
Band-tailed pigeon (L)	63	42	1	1	0	2.4	2.4	.0	4.8
Mourning dove (S)	34	30	0	1	0	.0	3.3	.0	3.3
Northern pygmy-owl(R)	41	33	0	1	0	.0	3.0	.0	3.0
Common nighthawk (L)	33	28	0	0	0	.0	.0	.0	.0
Vaux's swift (L)	161	145	0	1	2	.0	.7	1.4	2.1
Belted kingfisher (S)	37	29	1	1	0	3.4	3.4	.0	6.9
Red-naped sapsucker (S)	42	25	0	1	0	.0	4.0	.0	4.0
Red-breasted sapsucker (S)	179	59	2	4	2	3.4	6.8	3.4	13.6
Williamson's sapsucker (S)	198	114	1	2	0	.9	1.8	.0	2.6
Downy woodpecker (R)	58	29	1	1	0	3.4	3.4	.0	6.9
Hairy woodpecker (R)	647	335	7	14	1	2.1	4.2	.3	6.6
Northern flicker (S)	646	552	7	8	0	1.3	1.4	.0	2.7
Pileated woodpecker (R)	554	465	3	7	0	.6	1.5	.0	2.2

Table 8—Contribution of supplemental detections (distance band, previous station, and fly-in adjustments) to relevant bird records (typical detection >50 m and flyover detection), 1994-98 (for species with >20 relevant records) (continued)

Species (migratory class[a])	Total records	Total subset of relevant records: >50 m and fly-overs	No. (correct) distance band records	No. (correct) prestation records	No. (correct) fly-in records	Relevant records using distance band adjustment	Relevant records using previous station adjustments	Relevant records using fly-in	Relevant records using any supplemental detection
	Number					*Percent*			
Olive-sided flycatcher (L)	147	129	1	3	0	.8	2.3	.0	3.1
Western wood-pewee (L)	401	269	12	26	0	4.5	9.7	.0	14.1
Hammond’s flycatcher (L)	1407	676	16	3	0	2.4	.4	.0	2.8
Dusky flycatcher (L)	815	515	12	31	0	2.3	6.0	.0	8.3
Pacific-sloped flycatcher (L)	1931	621	36	6	0	5.8	1.0	.0	6.8
Cordillerian flycatcher (L)	363	153	8	8	0	5.2	5.2	.0	10.5
Tree swallow (S)	67	49	0	0	0	.0	.0	.0	.0
Gray jay(R)	395	216	5	1	1	2.3	.5	.5	3.2
Steller’s jay (R)	1172	878	20	6	0	2.3	.7	.0	3.0
Clark’s nutcracker (R)	172	158	1	1	1	.6	.6	.6	1.9
Common raven (R)	408	381	3	4	1	.8	1.0	.3	2.1
Mountain chickadee (R)	1758	993	41	9	0	4.1	.9	.0	5.0
Chestnut-backed chickadee (R)	1375	174	20	1	0	11.5	.6	.0	12.1
Red-breasted nuthatch(R)	3314	2133	73	12	0	3.4	.6	.0	4.0
White-breasted nuthatch (R)	328	189	4	3	0	2.1	1.6	.0	3.7
Brown creeper (S)	1472	291	14	0	0	4.8	.0	.0	4.8
Rock wren (S)	25	21	0	2	0	.0	9.5	.0	9.5
House wren (L)	242	142	6	15	0	4.2	10.6	.0	14.8
Winter wren (R)	2866	1574	39	16	0	2.5	1.0	.0	3.5
Golden-crowned kinglet (S)	2224	226	5	0	0	2.2	.0	.0	2.2

Table 8—Contribution of supplemental detections (distance band, previous station, and fly-in adjustments) to relevant bird records (typical detection >50 m and flyover detection), 1994-98 (for species with >20 relevant records) (continued)

Species (migratory class[a])	Total records	Total subset of relevant records: >50 m and fly-overs	No. (correct) distance band records	No. (correct) prestation records	No. (correct) fly-in records	Relevant records using distance band adjustment	Relevant records using previous station adjustments	Relevant records using fly-in	Relevant records using any supplemental detection
	-----Number				-----	-----Percent			-----
Ruby-crowned kinglet (S)	496	341	3	3	0	.9	.9	.0	1.8
Mountain bluebird (S)	42	30	1	1	0	3.3	3.3	.0	6.7
Townsend's solitaire (S)	539	426	5	5	1	1.2	1.2	.2	2.6
Swainson's thrush (L)	1624	1244	8	11	0	.6	.9	.0	1.5
Hermit thrush (S)	1905	1594	22	31	0	1.4	1.9	.0	3.3
American robin (S)	1824	1277	47	23	2	3.7	1.8	.2	5.6
Varied thrush (R)	1132	931	12	22	0	1.3	2.4	.0	3.7
European starling (R)	49	37	1	0	0	2.7	.0	.0	2.7
Cassin's vireo (L)	363	251	9	0	0	3.6	.0	.0	3.6
Hutton's vireo (R)	128	37	0	0	0	.0	.0	.0	.0
Warbling vireo (L)	704	423	15	26	0	3.5	6.1	.0	9.7
Orange-crowned warbler(L)	88	48	1	2	0	2.1	4.2	.0	6.3
Nashville warbler (L)	195	154	2	1	0	1.3	.6	.0	1.9
Yellow warbler (L)	78	40	2	0	0	5.0	.0	.0	5.0
Yellow-rumped warbler (S)	2306	1394	51	18	0	3.7	1.3	.0	4.9
Townsend's warbler (L)	1291	844	13	5	0	1.5	.6	.0	2.1
Hermit warbler (L)	397	133	6	0	0	4.5	.0	.0	4.5
Hermit and Townsend's warbler complex (L)	1811	1166	78	7	0	6.7	.6	.0	7.3
MacGillivray's warbler (L)	533	220	3	13	0	1.4	5.9	.0	7.3
Wilson's warbler (L)	307	140	2	2	0	1.4	1.4	.0	2.9

Table 8—Contribution of supplemental detections (distance band, previous station, and fly-in adjustments) to relevant bird records (typical detection >50 m and flyover detection), 1994-98 (for species with >20 relevant records) (continued)

Species (migratory class[a])	Total records	Total subset of relevant records: >50 m and fly-overs	No. (correct) distance band records	No. (correct) prestation records	No. (correct) fly-in records	Relevant records using distance band adjustment	Relevant records using previous station adjustments	Relevant records using fly-in	Relevant records using any supplemental detection
	Number					*Percent*			
Western tanager (L)	2131	1581	25	23	0	1.6	1.5	.0	3.0
Black-headed grosbeak (L)	305	198	5	3	0	2.5	1.5	.0	4.0
Green-tailed towhee (L)	70	47	0	5	0	.0	10.6	.0	10.6
Chipping sparrow (L)	816	527	6	10	0	1.1	1.9	.0	3.0
Fox sparrow (S)	30	26	0	0	0	.0	.0	.0	.0
Song sparrow (S)	153	74	2	3	0	2.7	4.1	.0	6.8
Lincoln's sparrow (L)	106	42	2	2	0	4.8	4.8	.0	9.5
White-crowned sparrow (S)	124	66	4	7	0	6.1	10.6	.0	16.7
Dark-eyed junco (S)	2389	1127	22	16	0	2.0	1.4	.0	3.4
Brewer's sparrow (S)	169	80	3	0	2	3.8	.0	2.5	6.3
Brown-headed cowbird (S)	477	275	7	4	1	2.5	1.5	.4	4.4
Cassin's finch (S)	553	311	5	4	0	1.6	1.3	.0	2.9
Red crossbill (R)	1012	874	3	0	6	.3	.0	.7	1.0
Pine siskin (S)	930	681	5	1	2	.7	.1	.3	1.2
Evening grosbeak (R)	384	356	1	0	1	.3	.0	.3	.6

[a] L=long-distance migratory species; R=resident species; S=short-distance migratory species.

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